RESOURCE RECOVERY

ALTERNATIVES FOR RURAL

NEW ENGLAND

Prepared for:

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide Federal, State and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

EPA Region I Project Manager: Conrad O. Desrosiers

ACKNOWLEDGEMENTS

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INTRODUCTION

In October 1978, a workshop was held in Concord, New Hampshire to present alternative approaches to resource recovery in rural areas of New England. That workshop was prepared by CSI Resource Systems Group, under the auspices of EPA's Technical Assistance Program. The reaction of workshop attendees, who were mainly representatives of Northern New England communities, indicated that there was strong interest in refining the data presented and incorporating it into a "how-to" type document. That reaction provided the impetus for this report.

The original workshop material was largely based on data from specific case studies of projects in several rural New England communities. This report has incorporated that data into a more generalized form so that the experiences can have wider applicability. The case studies themselves have been summarized and included as an Appendix to this report. The purpose of this report is to serve as a planning and decision-making tool for local officials, town managers and public works directors. The report persents an overview of the important issues involved in deciding whether resource recovery is a viable option for a rural community (defined here as less than 30,000 population) and discusses in some detail the mechanics of the applicable alternative approaches. The report also includes Appendices containing information regarding existing recycling efforts in New England, a glossary of solid waste/resource recovery terms, and a comprehensive bibliography.

A summary of the major sections of the report are presented below.

SUMMARY

The report is divided into four sections: Planning; Resource Recovery Alternatives; Implementation; and Alternative Approaches.

The Planning section discussed the information that the community needs to develop in order to make a sound decision regarding resource recovery, or any other solid waste management alternative. It is very important to accurately ascertain the community's current and future needs, including the costs of existing systems and the quantity and nature of the waste stream. Equally important in evaluating resource recovery is determining the existence of potential markets for recovered energy or materials and analyzing the community's ability to procure and implement a complex, capital intensive facility.

If the preliminary indications are positive then an analysis of available resource recovery approaches should be performed. The Resource Recovery Alternatives section of the report presents discussions of some of the more proven recovery alternatives that are applicable to rural (small-scale) situations. The major approaches involve either materials recovery through source separation or mechanical processing, or energy recovery in the form of a refuse-derived fuel or steam from refuse combustion. Detailed costs are not provided since the case-by-case needs of different communities cannot be assessed. Rough costs are provided in some cases to point out the relative differences between approaches or alternatives.

The next section briefly examines the steps that must be taken in order to implement the preferred resource recovery system. The key issues are finalization of the markets and financing commitments, and then selecting a procurement approach that will efficiently satisfy local needs.

The final section of the report looks at some solid waste management options that should be considered as alternatives to resource recovery. These include means of extending landfill life through shredding or baling, and alternative high technology options such as conventional (non-energy recovery) incineration or the codisposal of refuse and sewage sludge.

CONCLUSIONS

Communities need to be aware that there are no "cookbook" solutions to solid waste problems - each situation has a unique set of conditions which usually require unique solutions. However, this report does point out several general conclusions that have widespread applicability for rural situations:

- There is a basic set of data that should be developed by any community that is re-evaluating its solid waste management system, regardless of whether resource recovery is the specific goal or not. At a minimum, this data should include the costs of existing systems and quantities of waste generated.

- The single most critical element in determining the feasibility of resource recovery is the existence of firm markets. Without revenues from the sale of recovered products (energy or materials), most resource recovery systems are too expensive to compete with the more conventional alternatives. Identification of markets is an essential early step.

- One of the most serious obstacles to resource recovery in rural areas is the small quantities of waste that are typically involved. Most resource recovery approaches experience significant economies of scale and are more attractive economically and technically at higher volumes. For this reason, rural communities considering resource recovery should thoroughly explore the possibility of regional cooperation in order to consolidate and thereby increase the waste quantities involved.

- Because of the relatively small scale involved, resource recovery options with realistic chances for success are limited in rural areas. Source separation is one approach which has demonstrated potential. Another is energy recovery through modular incineration. Although they have not been proven to be infeasible, most of the other approaches should be considered speculative at this time.

- Finally, resource recovery implementation is a long, difficult process. It is by no means the universal panacea for any community experiencing solid waste disposal problems. For rural areas especially, which by definition often have large tracts of undeveloped land nearby, potentially low cost alternative options based on land disposal should be very thoroughly explored.

- Due to the hydrogeologic conditions found in the rural areas of New England, and the cost of constructing and operating a sanitary landfill which meets the federal criteria for land disposal (or more stringent standards developed by the states), the true cost of sanitary landfilling as an alternative is quite high.

PLANNING

Prior to selection and operation of any resource recovery system, attention must be given to local conditions and needs, including the solid waste situation, markets, and institutional factors. This initial planning will help to insure that the system selected will be best suited to the interested community. A flow chart for this phase is presented in Fig. 1.

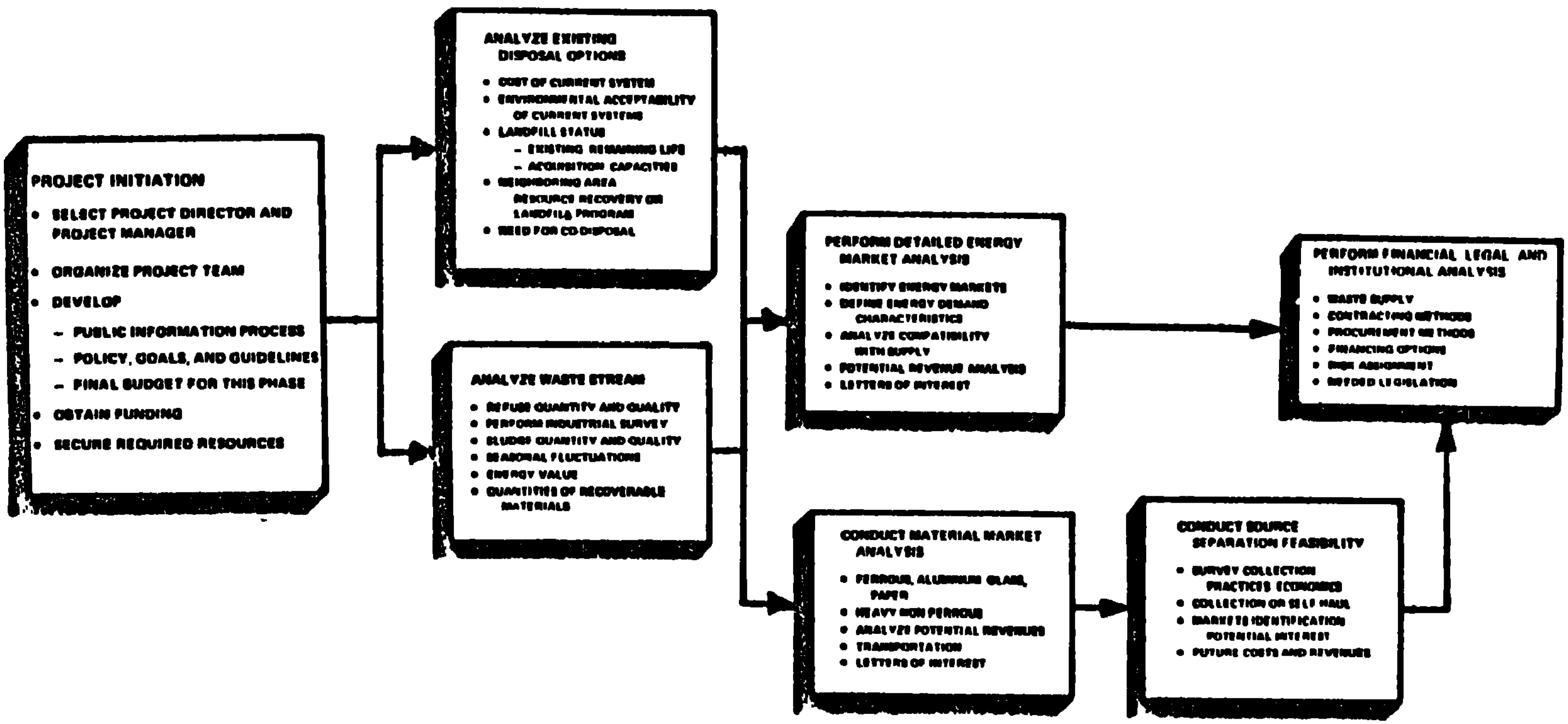
As a first step in the planning process, a manager, who has overall responsibility for the project, must be designated. An advisory group comprised of various community interests also needs to be appointed. Inclusion of divergent interests assures these viewpoints will be presented to the project manager in the initial phases of a project rather than at a later point where serious conflicts could delay or end the project. It is important to include a balanced mixture of skills within the membership of such a committee. For example, a preponderance of technical people on the group might bias system selection (e.g., central processing rather than source separation) or overlook legal and economic issues important to the project's success.

As a complement to the advisory group, a public participation program should be developed to inform citizens of the issues under consideration. A viable program will enable the manager to disregard options which are unacceptable to the community. Without such information an unacceptable recovery option might be selected, thus causing serious conflict. In some areas of New England, the town meeting might serve as the necessary public forum. Additional meetings could be needed if the project is progressing rapidly.

DETERMINING LOCAL NEEDS

Generation rates, composition, and collection and disposal practices and costs are important factors to consider in an evaluation of the local solid waste situation. These factors are a major determinant of the type and size of system, if any, which is appropriate for a community.

Figure 1: THE INITIAL PLANNING PHASE FOR
RESOURCE RECOVERY/SOURCE SEPARATION PROJECTS



Adapted From: Resource Recovery Management Model
U.S. EPA, October 1979

To determine the scale of a recovery system, approximate average tonnages, as well as seasonal fluctuations, must be developed. Seasonal variation is important because, if significant, cost effective recovery under high and low solid waste generation rates will be difficult. Equipment and personnel needed to process waste under the high operation rate conditions will be under utilized in the low situation. Of course, this condition will exist to some extent with any waste management system. Decision-makers in rural New England communities, where tourism is a major business, should give special attention to seasonal variation in waste quantities. In addition to current generation rates, information should be developed on future waste quantities. This information will enable a recovery system to meet projected growth in the waste stream.

Composition data, both average and seasonal, is another important factor. Knowledge of composition, in addition to generation rate, will indicate the quantity of material which could be recovered. Another important aspect is the effect future changes might have on a recovery system. Institution of beverage container deposits would remove substantial quantities of ferrous, aluminum, and glass from the waste stream. Deposits have been proposed for every state in New England and currently exist in Vermont, Maine and Connecticut.

Current and projected solid waste disposal costs provide a basis upon which to evaluate the cost effectiveness of recovery. Disposal practices should be examined to determine if alternatives to current operations and recovery might be the preferable choice. Data on collection practices, equipment, and costs will be important if a community elects to recover materials via source separation. Costs, however, should be projected for operating a facility which satisfactorily meet state regulations and federal criteria.

PRELIMINARY MARKET ANALYSIS

Advance commitment for the purchase of recovered products is the most important step in resource recovery planning. Commitments provide municipal managers with financial assurances, and the specifications accompanying the commitments determine the type of recovery system to be selected. A recovery plant must be designed and operated to produce products which meet the specifications of the market commitments. Otherwise the economic success of the plant will be unlikely.

A market survey should be designed to achieve two objectives: (1) locate potential buyers and (2) determine the conditions - price and quality - under which they will purchase recovered products. This is the first step towards selection of a recovery system. Only those systems which produce marketable products need to be given serious consideration. Three factors which determine marketability are:

- economic transportation,
- ability to meet purchase specifications, and
- satisfactory price estimate.

An important first step in taking a survey is determining the area to be searched. Obviously, the survey area should be limited to areas where the recovered materials can be shipped economically. Recovery costs, shipping rates, and market value will determine cost effective transportation distances. However, these figures will only be estimates at this point, so potentially attractive markets in the marginal area should be included in the survey.

Transportation distance, in terms of the market survey, is really a concern for secondary materials. Some of these materials (e.g., aluminium) can be cost effectively shipped for several hundred miles. Recovered energy (e.g., steam), conversely, can be transported only about a mile, so that a recovery system would have to be located near the buyer.

For secondary materials, perhaps the best market is scrap processors. Information on these organizations can be obtained easily by using the yellow pages of telephone directories within the survey area. Scrap processors are listed under headings such as wastepaper and scrap metals. Another approach is to contact user industries directly. These industries typically demand higher quality products than scrap dealers, who upgrade the materials they receive. While materials can be upgraded as part of the recovery process, the added revenue from such activities must be weighed against increased costs. Information on both scrap dealers and user industries also can be obtained from other recovery projects in New England, and State and Federal solid waste offices. This information is listed in Appendix A.

Consumers of recovered energy on a small scale will very likely be located only in the community where the solid waste is generated. The market survey, therefore, should concentrate on the energy needs of local industrial and institutional users.

Specifications: Potential buyers identified in the previous step should be contacted to determine their quality requirements and potential price. The quality of recovered products must meet potential buyers' specifications or be able to be upgraded to their requirements Buyers will tend to be reluctant to purchase small quantities of recovered products if upgrading is necessary. Energy users are particularly reluctant to consider energy sources which fail to complement their existing system.

Prior to contacting prospective energy buyers, relatively detailed information on the quality and quantity of energy estimated to be available should be calculated. Prospective energy buyers are likely to be unfamiliar with recovered energy and how it can fit into their energy system.

Letter of Intent: A Letter of Intent (LOI) is an agreement between the seller and buyer of recovered products which states that the buyer intends to purchase specific products if they are offered. It is the culmination of the market survey and the financial underpinning of the recovery system.

Length of commitment, quality and quantity of material, delivery schedule, termination conditions and price are the fundamental conditions to be included in an LOI. Depending on the products recovered the relative importance of the conditions and terms will vary. Commitment length, for example, is very important if energy in the form of steam is recovered. If a buyer sought to discontinue purchase of steam, another buyer within serviceable distance of the recovery plant might be unavailable. For this reason, length of commitment for energy buyers usually is well defined prior to construction of an energy recovery facility.

INSTITUTIONAL CONSIDERATIONS

Study of institutional factors should be considered as important to the success of a resource recovery project as the identification of markets and selection of a recovery system. These factors include the organizational, legal, and financial aspects of the project, which influence a community's ability to plan, procure, finance, and operate a system.

. Organizational

Rural areas, especially in New England, typically do not have extensive public administrative structures already in existence. This means that organizing for a potentially complex project such as resource recovery can in itself present a formidable obstacle.

As noted in the Planning section, it is important to establish a project manager as early as possible. This can be done informally in the preliminary stages. The main point is to have someone, in either the public or private sector, who can provide the driving force for the investigation of feasibility.

A potentially more significant problem is created by the need for rural communities to joint together in order to increase the quantities of waste involved. This consolidation is dictated by the significant economies of scale associated with resource recovery. The multi-jurisdictional approach also necessitates some form of regional organization so that costs and risks can be fairly allocated. Possible organizational approaches that have worked previously in New England include use of Regional Planning Commissions to take the lead in early planning stages, or developing solid waste authorities such as the Union Municipal District in Rutland County, Vermont. The important organizational issues that need to be defined involve methods of financing, allocating costs, risks, responsibilities, and establishing sufficient powers so that operations of the eventual administering body will not be hampered.

Legal

In order to ensure that the administering body is adequately empowered, a thorough legal review of relevant State and local statutes should be performed. This review should focus on identifying and developing means of removing any legal barriers that would affect a public administering body's ability to incur long-term indebtedness or enter into long-term contracts; raise money by levying charges; gain revenues through sale of products; or procure services through negotiated bid procedures.

An equally important legal issue stems from the communities' need to secure control of the waste stream. Control of the waste stream is essential to the development of a resource recovery system since a reliable, relatively unvarying inflow of waste is an economic and technical prerequisite. In most rural areas, waste collection is performed by individual households or private entrepreneurs. Local government typically has little involvement and experience has shown that, under such conditions, it may be difficult to direct the waste to a particular disposal site.

Alternative public strategies for gaining control of the waste stream include: licensing or franchising of private haulers, including a specific final disposal site as a contractual condition; providing a tipping fee at the resource recovery facility that is cheaper than available alternatives; or implementing a local law which specifies that refuse is public property. The legality of this latter approach is currently being tested in the courts. However, it appears that any legal questions surrounding this strategy are removed if the State specifically delegates waste control powers to the local administering body. The important point here is that, for resource recovery to succeed, the communities involved must somehow develop a mechanism for guaranteeing a steady supply of waste to the project.

Financial

The amount of money required to plan and build a resource recovery system is naturally dependent upon the size and technological complexity of the proposed project. For the purposes of this brief discussion, costs will be grouped in three categories: planning, capital and operating.

The costs involved with planning and preparing the feasibility study are very often underestimated in resource recovery projects. Since the success of the final system is a direct function of the thoroughness of planning that went into it, economizing on the front end can prove to be very inefficient. There are currently several Federal programs that can provide assistance in the planning stage. EPA can make available technical assistance through the Regional Panels contractors or through the peer-matching program, and there is a possibility that the President's Urban Grant Program (which provides planning money only) may be continued in the future. Regional EPA representatives can provide more information about these programs.

Capital costs vary according to the resource recovery approach selected. Low technology systems such as source separation or composting often can be financed out of general funds or through issuance of general obligation bonds. More complex systems, such as modular incinerators, typically require higher levels of capital and may necessitate alternative financing plans such as selling State or municipal revenue bonds, or industrial development bonds. This is especially true if the private sector (either the system contractor or market) is involved in the ownership and/or operation of the system. For complex or costly systems, debt service can be a significant portion of the community's annual systems costs and it is therefore advisable to secure the services of an experienced financial consultant to ensure that the lowest interest rates are obtained.

Operating costs are typically defrayed through tipping fees charged at the disposal facility and revenues from sale of recovered products (energy and/or materials). If tipping fees must be held to a specified ceiling (e.g., for waste control purposes), any remaining costs may have to be subsidized through general tax funds or special charges directly to households within the jurisdictions composing the administering body.

RESOURCE RECOVERY ALTERNATIVES

A variety of approaches for the recovery of materials and/or energy from municipal solid waste have been designed and operated over the last ten years. From an economic perspective, many of these systems were designed to operate most efficiently on a large scale (250 TPD and over). How these materials and energy recovery processes operate and the cost of the systems, as well as their applicability to rural New England, are reviewed in this section.

MATERIALS RECOVERY

Materials can be recovered from municipal solid waste using any of three different approaches: (1) source separation, (2) mechanical recovery, and (3) composting. The suitability of these approaches to rural solid waste management needs, particularly in New England, is examined in this section.

Source Separation

Separate collection and recycling ("drop-off") centers are the two basic types of source separation programs. They are relatively simple to develop and can have a low cost to construct.

Separate Collection

With separate collection from residences, householders place separated recyclable materials usually at curbside for collection. These programs generally are conducted, or at least endorsed, by local governments.

Participant rates tend to be higher when programs are designed for simplicity and convenience. An important factor in this area is minimizing the storage requirements placed on householders. Consequently, frequency of collection is an important factor in planning a separate collection program. Householder inconvenience also is minimized initially by beginning programs with the separation of a single material. As participants adjust to separating recyclables, other materials can be added to the program without requiring a dramatic shift in their personal habits. To hold storage requirements to a minimum under a multi-material program, several materials (e.g., cans and bottles) can be stored together. These materials can be segregated later by an intermediate processer, see review under mechanical recovery.

Collection programs in most communities concentrate on newspaper only. Regular collection vehicles either used separately from general refuse collection or fitted with racks for paper storage are the basic equipment needs for a newspaper collection program. In a few cases, trailers attached to the regular collection truck are used.

In New England, 78 municipal separate collection programs were reported in operation during 1978-1979 (see Appendix A). Fifty-nine of these programs were in towns with less than 50,000 population. However, only five of the separate collection programs are in the three northern New England states. This scarcity of programs reflects the lack of local refuse collection, rather than an absence of markets. Multi-material collection programs were operating in 37 (47 percent) of the communities with separate collection.

Cost to operate a separate collection program tends to vary over a wide range. No recent cost data programs in New England were available. A recent study for EPA found the net cost of a multi-material separate collection program to be $8.16 per ton of solid waste generated. This figure is based on a participation rate of 30 percent and includes the cost of separate collection plus the disposal cost for the nonrecyclables.

<u>Recycling Centers</u>: Recycling, or drop-off, centers are the second approach to source separation. As with separate collection programs, participants must separate their recyclables from their other discards. However, unlike separate collection programs, participants must deliver the separated materials to the recycling center.

Participation rates are usually low because of the additional effort, energy, and time required of householders. Some centers pay for the materials which are delivered. Those centers which pay have higher participation rates than those which do not pay. Even so, recycling centers tend to have a minimum impact on the quantity of local solid waste for disposal.

Contrary to the normal pattern, recycling centers in several northern New England towns have managed to significantly reduce the amount of waste for landfill. Refuse in these communities commonly must be taken to a dump by residents for disposal, since household collection service is uncommon. Consequently, participation is easier under this condition because the only requirement is separation and storage of the refuse in the home. Very high compliance (e.g., 95 percent) with these programs has been reported in towns with mandatory ordinances.[2]

Private, non-profit organizations usually staffed by volunteers are one category of recycling centers. Other types of centers include commercial enterprises and those operated by local government. Most of the recycling centers operating in rural New England are government operated. A fourth category is centers which are financed and/or operated by beverage container companies. Aluminum, which is the material in solid waste with the highest value, is generally the focus of these centers.

As of 1978-1979, 143 recycling centers were operating in New England (see Appendix A). Most of these centers were multi-material programs. These centers do not include those operated by industries such as aluminum can recycling centers.

Cost data on the operation of recycling centers in New England is limited. Some costs are presented in the case studies (Appendix B). Costs vary considerably depending on the approach taken. Low-cost centers normally have unsupervised bins for the materials being collected. Participants must place their recyclables in the proper bins. Additional costs are incurred with more elaborate systems. Centers with attendants, however, do generate higher quality, and thus more valuable, materials.

Mechanical Recovery

Mechanized processing of mixed materials into recyclable categories is implied by this approach. In rural areas, two forms of mechanical recovery are potentially viable: (1) intermediate processing and (2) small-scale systems.

Intermediate Processing: Intermediate processors serve as a middle step between source separation programs and materials manufacturers. In this role, they provide important marketing and upgrading services for both groups. Emergence of intermediate processors can be traced to growth in the supply of post-consumer recyclables from source separation programs. They fulfill a need to assure quality control and provide a reliable supply to manufacturers.

Two approaches have evolved towards intermediate processing. One approach has been towards low volume processing, which emphasizes color-sorting of glass plus separation of metals. This method has enabled communities to institute mixed material (e.g., cans and bottles) separate collection programs. Storage requirements are minimized under such a program, thus encouraging participation. Curbside collection also is simplified, as fewer materials categories must be picked-up and stored during collection. Low volume processors have been able to produce a consistently high quality product from a mixed feedstock. Cullet and aluminum are separated by hand picking, while ferrous are magnetically recovered, see Figure 1. Hand sorting of glass is possible because the majority of bottles remain unbroken after collection and initial processing. Many of the bottles which have broken are in large, recoverable pieces, so that only a small amount of the incoming glass is discarded. Also included in the discards are ceramics and plastics, as well as other non-recyclables. Low volume processors in New England are shown in Appendix A.

High throughput is the second approach to intermediate processing. To achieve high volume processing, however, relatively uncontaminated sources of materials are sought. Industrial, commercial, and clean community sources are typical supply sources. Recycling centers are the usual clean community sources to high volume processors. A flow diagram for high volume processors is shown in Figure 2. Appendix A lists the high volume processors in New England.

Figure 2

Low Volume Intermediate Glass Processor

Flow Diagram

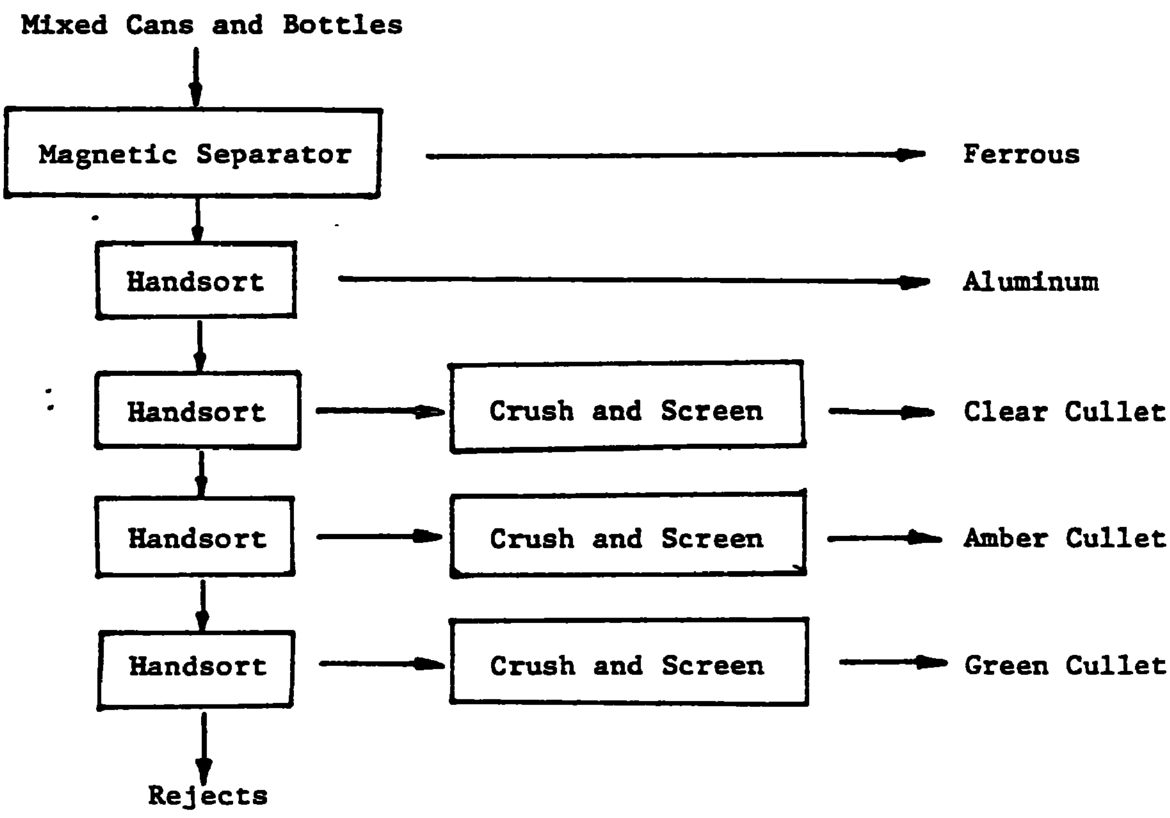
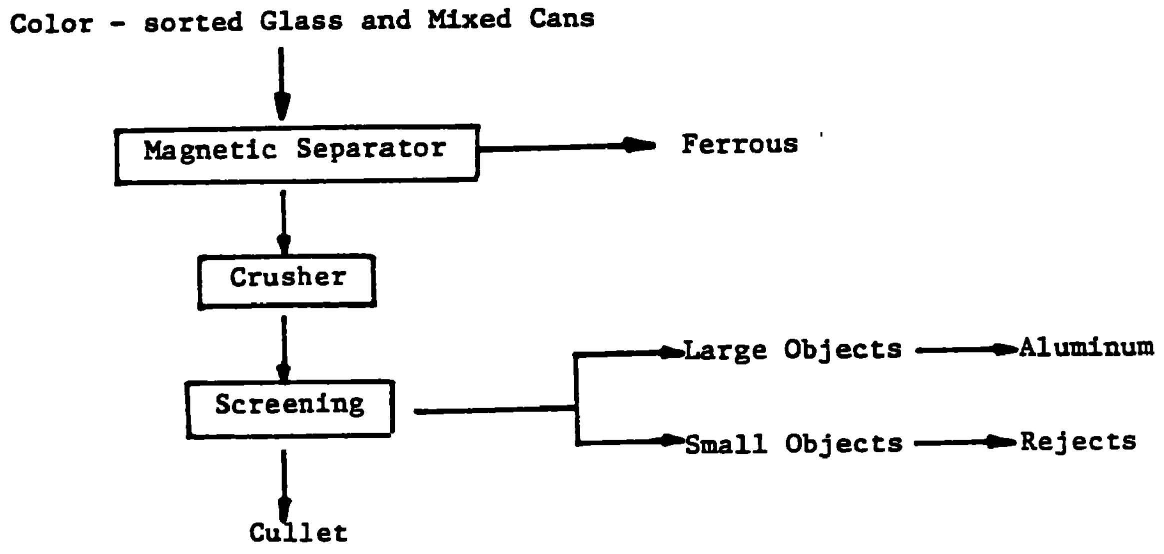


Figure 3

High Volume Intermediate Glass Processor
Flow Diagram



Small-Scale Systems: Various methods for the mechanical recovery of paper, metals and/or glass from mixed municipal solid waste have been designed. The economic viability of these systems depend on their ability to process significant quantities (over 500 tons per day) of solid waste.

Rural communitities because of their size (under 30,000 population as defined in this report) generate relatively small quantities of solid waste (less than 100 tons per day). Consequently, the options for the economic mechanical recovery of materials are very limited. In fact, only one option - magnetic separation - could be potentially economically viable and then only under very specific circumstances.

To magnetically separate ferrous from MSW, the refuse must first be shredded. General MSW is transformed by shredding into waste having relatively even consistency and uniformity of size. These factors are important in the recovery of ferrous. Shredding, however, is an expensive operation both in terms of capital of operational costs. These costs have been justified in some communities because shredding increases refuse density, thus reducing the landfill volume requirements. In areas where landfill costs are high, these savings may be sufficient to offset the cost of shredding. See section on shredding in chapter on alternative solid waste management approaches. Communities which have installed a shredding facility usually find the addition of magnetic separation equipment to be economically justifiable. Revenue from the sale of recovered ferrous metals should cover the cost of magnetic separation. As with any recovery operation, markets must be available for the recovered metal.

Two shredder/magnetic separation units have been installed in New England. Both units have a rated capacity of 30 tons per hour, or 240 tons per 8-hour day. The units are located in Ansonia, Connecticut and Lewiston, Maine.

Composting

Composting is the biological decomposition of organic solid waste under controlled conditions. Use of organic wastes that are simple in structure are more desirable in the composting process because a greater variety of biological species will attack the waste, resulting in a more rapid rate of decomposition. Food waste is a good example of a simple organic waste. This renders typical municipal solid waste unsuitable for composting. The poor quality of municipal solid waste as measured by the carbon-nitrogen (C-N) ration can be improved by the addition of sewage sludge, or other simple organic wastes that are high in nitrogen. Adding these materials creates a favorable C-N ratio, thereby allowing more rapid and efficient rates of decomposition of the waste.

Compost projects typically are classified by oxygen use. Aerobic composting takes place in the presence of oxygen and is the type commonly associated with the term composting. Anaerobic composting, which occurs in the absence of oxygen, generally is referred to as methane digestion.

Aerobic Composting: The end-product of the aerobic composting process is a humus-like material used almost exclusively as a soil conditioner. The two technologies utilized in aerobic composting are: (1) the windrow system, and (2) the mechanical method.

There are no windrow projects currently in operation in the United States using municipal solid waste as a feedstock. This type of composting has been attempted several times, but has proven economically infeasible.

Mechanical systems, the more popular alternative, is designed for frequent turning and aeration by air suction. A mechanical system is in operation in Altoona, Pennsylvania, and one is under construction in Key West, Florida.

The economic outlook for aerobic composting is poor. The most significant problem is the lack of markets for compost. Compost is classified as a soil conditioner rather than a fertilizer because its NPK (nitrogen, phospherous, potassium) content is too low to legally term it as a fertilizer. Because nitrogen, phosphorous and potassium are present in compost in such small amounts, the value of application of compost to the land is generally viewed as negligible as compared to the cost of application itself.

The net system cost of mechanical digester aerobic compost plant with ferrous recovery is about $28 per ton.[3] The annual capital and operating costs per ton are $18 and $10 respectively. Although markets for composting are poor, there are potential markets for compost as a topsoil substitute. Even so, composting does not appear to be a viable recovery option in New England.

Anaerobic Composting (Methane Digestion): Methane and carbon dioxide, along with a small quantity of hydrogen sulfide, are the gaseous products of the composting method. Methane is the primary constituent of natural gas. To improve the value of methane gas, the other gases must be separated.

Methane digestion of sewage sludge has been practical for many years in various parts of the world. However, anaerobic composting of MSW has never been done on a commercial scale. A 100 TPD demonstration plant using both MSW and sludge currently is in operation in Pompano Beach, Florida. The plant is operated by Waste Management, Incorporated and was funded by a grant from the U.S. Department of Energy.

Until methane digestion of MSW has been proven successful, this option cannot be considered viable. Successful demonstration in Florida, however, still does not indicate the suitability of anaerobic composting in New England. To maintain digestion the mixture must be kept at a warm temperature. In colder climates this means that the digester unit must be heated. Depending on the location in New England, considerably more energy could be required to maintain composting operations than would be produced.

ENERGY RECOVERY

Modular incineration, refuse-derived fuel (RDF), and waterwall incineration are three approaches to recovering the potential energy in solid waste. The acceptability of these approaches to rural solid waste management needs in New England is examined in this section.

Modular Incineration

Steam, hot water, and hot air are those forms in which energy can be recovered from waste with modular incinerators. This recovery option is designed for simplicity of operation. The first step is the unloading of refuse, which then is moved into the charging hoppers using small tractors. Normally, the only processing done is the removal of bulky items. A heat exchanger or boiler is used to capture the energy from the hot gases produced during combustion. Newer, larger units have the capability to automatically and continuously remove the residue from the combustion process. Thus, 24-hour operation is possible. However, older designs and some current units require a cool-down period each day. Ashes then can be removed either mechanically or manually before the unit is re-ignited.

Air pollution is a concern with any combustion process. Entrainment of particles is minimized in modular incinerators through use of the starved air concept. Afterburners in the secondary chamber provide additional control in the reduction of particulate emissions. Gaseous emissions (e.g., nitrous oxides, and metalized salts) also are controlled because of the low bed temperature in the combustion chamber. Even so, the data are incomplete on the ability of these incinerators to consistently meet air quality standards. Tests are being conducted to determine the stack emissions from these units. Stricter regulations at the federal level may necessitate additional controls in the future, even if modular incinerators are able to meet current local standards.

Individual heat recovery modular incinerators are available with capacities ranging from 1 to 50 TPD. Units are often installed in groups of two, three, or four (or more) to provide adequate capacity and backup. Units above 3 TPD may be designed for 24-hour operation.

The incinerator unit typically is located close to the user of the energy. The shorter the distance between the two, the lower the transmission loss and the higher the economic benefit for the incinerator operator. Steam may be transmitted in excess of 1.5 miles; it is generally not economical to do so. Probable uses for the recovered energy are industrial processes, and a connection with an existing steam loop, augmenting the steam generated in a central boiler. These situations may be present in hospitals, prisons, airports, office buildings, and garden apartment complexes.

Depending on local regulations, the operation of these units may not require the presence of a full-time stationary engineer but successful operation of an incinerator does require the presence of trained personnel.

In general, a net cost of \$11.68 per ton of input refuse at 100 TPD has been estimated for modular incineration.[4] Value of the recovered energy will vary depending on the value of comparable energy. Using the example above, the energy was valued at \$8 per input ton.

A modular incinerator with energy recovery capability currently is operating in Groveton, New Hampshire (pop. 1,597). Reported capacity of this unit is 30 TPD. In addition to MSW, non-hazardous industrial wastes also are incinerated. Another unit is under construction at present in Auburn, Maine (pop. 24,000). Expected start-up date is the fall of 1980. A regionalized solid waste plan will provide the incinerator with sufficient refuse to make full use of the 150 TPD rated capacity. Two other towns - Rutland, Vermont and Claremont, New Hampshire - also are seriously considering modular incineration with heat recovery. Several towns in New England have installed modular incinerators but without energy recovery capabilities. These units are used to simply reduce this volume of solid waste prior to landfill.

Refuse-Derived Fuel (RDF)

Refuse-derived fuel is an energy source produced from the combustible fraction of solid waste. Three basic types of RDF can be produced: fluff, dust, and densified. Shredding, separation of the combustible and noncombustible fractions of waste by air classification and secondary shredding of the combustibles are the basic steps in RDF production. Specific production methods for these types varies, as do the burn characteristics and markets.

Market acceptance of RDF currently appears uncertain. Users of RDF must modify storage, handling and combustion practices to burn the material in existing boilers. Similarly, uncertainty of future supply and quality control makes boiler owners wary of commitments to this type of fuel.

An estimate of the net cost per input ton at a 100 TPD facility was $13.15.[5] Revenues from this plant were placed at $6.00 per ton FOB the recovery facility. The high cost of combustion and market uncertainty make RDF production a nonviable recovery option in rural areas.

Two facilities are producing RDF in New England - Bridgeport, Connecticut and East Bridgewater, Massachusetts. Both operations are large in scale: 1,800 and 550 TPD respectively.

Waterwall Incinerators

This approach to energy recovery is somewhat similar in principle to modular incineration. In both cases, unprocessed refuse is fed into a unit for burning. The resulting hot combustion gases are used to generate steam. Actual conditions under which incineration takes place are different, however. Waterwall units burn solid waste with the addition of excess air, while modular incinerators usually operate under starved air conditions. Use of excess air during combustion causes the refuse to burn faster and hotter. More refuse can therefore be incinerated, and steam temperature and pressure also are higher. Entrainment of particulates, however, also is greater in waterwall incinerator combustion gases. Control of the particulates necessitates the addition of pollution control equipment (i.e., precipitators) to the incinerator.

Waterwall incineration traditionally is considered to be economic only with large quantities of refuse (over 500 TPD). A facility for processing 80 TPD, however, began operation at the Norfolk Navy Shipyard in Portsmouth, Virginia in late 1977. Economic data from this facility still are preliminary. Using this data, the operating cost and revenue from steam sale the first year were $17 and $13 per ton for a net cost of $4 per ton of solid waste.[6] Capital costs were $4.2 million. Until reliable economic data are available, waterwall incineration in rural communities should be considered inappropriate.

Two waterwall incinerators are operating in New England. These incinerators are in Braintree, Massachusetts (250 TPD) and Saugus, Massachusetts (1,200 TPD).

IMPLEMENTATION

Implementation of a resource recovery system can begin once the plannng stages for recovery have been completed. Planning stages include analysis of market feasibility and recovery processes and economics.

Formalization of markets is the first step in the implementation phase. Firm contracts for recovered products based in the Letter of Intent should be signed. Energy recovery systems are especially dependent on these contracts. These systems typically will be dedicated to supplying energy to one buyer. Without firm assurances that the user will purchase energy for an extended period, there is no reason to believe there will be a market for the energy. Since generated energy in the form of steam or hot water can be transported only limited distances (e.g., usually less than 1.5 miles) alternative buyers generally would be restricted. Consequently, a contract with a buyer is negotiated for the life of the recovery facility.

For secondary materials, contracts are important but for different reasons from energy recovery. A contract with a materials buyer provides assurance of a base price, which would be important in the event of a slump in demand for recovered materials. Unlike energy recovery contracts, materials contracts are negotiated for much shorter periods of time. So that if a contract is not continued after the expiration period, other buyers can usually be found. Secondary materials can be transported economically over relatively long distances.

In conjunction with formalizing the market contracts, procurement of the capital equipment necessary to operate the desired recovery process also can begin. Formal advertising procedures should be followed in the procurement of equipment and facilities. Overall, the procurement process should be relatively easy since the types of recovery systems applicable to rural communities generally are not high capital cost items. Furthermore, existing source separation equipment might meet the needs of the project. So no additional equipment would need to be purchased. Capital needs should be determined in the planning phase so that purchase can proceed with minimum disruption.

As the implementation process proceeds, attention needs to be given to other factors which are essential to smooth completion of this phase. These factors include final agreement on any regional cooperative arrangements, public education, and enactment of any necessary ordinances. Depending on the approach selected, these factors will be more or less important. If a separate collection system is to be implemented, for example, more emphasis must be put on public education than if a modular incinerator is to be installed.

With completion of the purchase and installation of any capital equipment, the system can then enter the shakedown phase. Problems with the system are worked out at this time so that when full operation begins the process is ready. By the time shakedown begins the marketing and other implementation factors should be completed. Public education is the only exception. Particularly with separate collection, public education should be viewed as an ongoing activity. The level of activity will decline once the project begins, but education on a continual basis is necessary to maintain participation.

ALTERNATIVE SOLID WASTE MANAGEMENT APPROACHES

A scarcity of land suitable for sanitary landfill might cause a community to initiate a program to reduce the volume of solid waste requiring land disposal. Resource recovery is one option a town might select. However, resource recovery might not be feasible because of lack of markets or prohibitive costs. If recovery is not feasible, other alternatives (baling, shredding, incineration) exist which will reduce the volume of refuse for disposal. Unlike recovery, these volume reduction methods do not conserve natural resources.

BALING

High density compression of solid wastes is accomplished through the use of a series of hydraulic rams which subject the wastes to weighing approximately 2,500 lbs. with dimensions of 3' x 4' x 3', are automatically tied and ejected onto appropriate transportation equipment for transfer to the land disposal site. In this manner compacted waste densities of approximately 1,800 lbs. per cu. yd. are achieved; approximately 80 percent greater than the compaction density of 1,000 lbs. per cu. yd. achieved in an efficiently operated conventional landfill.

The higher compacted density obviously extends the useful capacity of the receiving landfill by a corresponding amount. Economic benefits include transportation cost savings as well as lower landfilling costs due to the reduced quantities of cover material required. Landfill operations are also facilitated with baled wastes, due to the reduction in blowing litter, dust, vectors, fires, and traffic.

The primary disadvantages of baling are the high capital costs involved and the fact that baling precludes any form of resource recovery once the bale is formed.

Based upon experience across the country to date, in order to achieve economics of scale baling as a waste volume reduction technique appears feasible (total cost per ton less than or equal to $10) only for areas with populations in excess of 50,000 with solid waste tonnage exceeding 100 tons per day.

SHREDDING

Shredding is another method to size-reduce municipal solid waste prior to land disposal. The density of shredded refuse is 25 to 60 percent greater than with conventional land disposal depending on whether daily cover is applied. Depending on hydrogeological conditions daily cover may be unnecessary. In addition, to reduce landfill volume requirements, shredded wastes have been demonstrated to not attract vectors, not support combustion, have less objectionable odors, and reduce littering problems associated with normal sanitary landfills.

Several disadvantages have been identified with shredders. Two problem areas are the material handling aspect of feeding the mill and component wear. Significant improvements supposedly have been made during the past few years toward improving these problems. Perhaps a more serious problem, though a less constant one, is the threat of explosion. Most shredder explosions are very minor causing little or no damage. However, some explosions can cause major equipment damage and harm to employees. An explosion at the City of Lewiston shredder during the first year of operation caused about $25,000 worth of damage.

As mentioned earlier, shredders are currently operating in two New England cities with less than 50,000 population: Lewiston, Maine and Ansonia, Connecticut. These units are rated at 30 tons per hour, or 240 tons per eight-hour day. Although regional solid waste plans are in effect in both communities, only 175 TPD and 250 TPD are being processed in Lewiston and Ansonia, respectively.

Costs of the Lewiston operation (shredder only) were estimated to be $6.50 per ton in 1978, while the Ansonia shredder operation cost, in a recent EPA report[7], was estimated to be $6.75 per ton for a 100 TPD operation.

INCINERATION

Small modular units are the type of incinerator which would be applicable to rural communities. As indicated in the previous chapter, modular incineration has received much attention lately because of the capability to connect waste heat to useful energy. From an economic and natural resource conservation perspective, the preferable option includes incineration. However, lack of markets may preclude heat recovery. Modular incineration might still be beneficial to a community from the perspective of refuse volume reduction. Reductions of 80 to 90 percent of the total volume of municipal solid waste, and 98 to 99 percent by weight of the combustible portion are possible through incineration. Incinerator residue, which consists of non-combusted materials, requires disposal. Compaction of this residue results in further volume reduction so that solid waste processed in an incinerator and then compacted in a landfill may occupy only four to ten percent of its original volume.

Several towns in rural New England have installed modular incinerators without energy recovery, including Nottingham, Plymouth and Meredith, New Hampshire and Windham, Maine. No data was available on the cost to operate these units. An approximate cost estimate for incineration is $16 per ton at a daily rate of 100 tons.

CODISPOSAL

Codisposal is an integrated solution to the disposal of two or more waste streams, typically solid waste and sewage sludge. Although codisposal usually involves some form of energy recovery, in this report it is being considered separately as an alternative approach because of its limited applicability in rural areas. This is because most codisposal technologies are economically and technically feasible only when the quantity of sludge involved is large enough to create problems with conventional disposal approaches such as landfilling or landspreading. This is rarely the case in rural situations. However, for communities with significant amounts of sludge, either from a centralized waste water treatment plant or an industrial generator, codisposal may be viable and merits thorough investigation.

Most codisposal technologies are based on utilizing solid waste as a fuel for the incineration or drying of sewage sludges. Waste heat from this process can be recovered for sale to energy markets. Another approach is to employ processed solid waste (RDF) as a bulking agent for the composting of sludge to produce a potentially marketable soil conditioner. The feasibility of either of these approaches is very dependent upon the specifics of the local situation, but public officials should be aware that codisposal is a technically and economically viable approach under the right conditions.

FOOTNOTES

1. Peterson, C., E. Bouring, G. Mitchell and B. West. Small-scale and Low Technology Resource Recovery Study. U.S. Environmental Protection Agency, Cincinnati, Ohio. 1979, p. 71.

2. Tichenor, R.L. and E.F. Jansen, Jr. "Recycling As An Approach to Solid Waste Management," New Hampshire. University of New Hampshire, Durham. July 1978, p. 1-2.

3. Peterson, C., et al. Small-scale and Low Technology. p. 206.

4. Ibid. p. 60.

5. Ibid. p. 56

6. Collins, J.P. and T.C. Wisehart. "U.S. Navy Reports on Its Newest Mass-Fired Refuse-to-Energy Facility." Solid Waste Management. 22(6):62. 1979.

7. Peterson, C., et al., Op. Cit.. p. 219.

APPENDIX A

RECYCLING IN NEW ENGLAND

FEDERAL AND STATE CONTACTS

U.S. EPA

Mr. Steven Levy
U.S. Environmental Protection Agency
Office of Solid Waste
State Programs and Resource Recovery Division
Resource Recovery Branch (WH-563)
401 M Street, S.W.
Washington, D.C. 20460
(202) 755-9140

U.S. EPA, Region 1

Mr. Conrad Desrosiers
U.S. Environmental Protection Agency
Waste Management Branch, Solid Waste Program
Air and Hazardous Materials Division
John F. Kennedy Building, Room 1903
Boston, MA 02203
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U.S. Department of Energy

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U.S. Department of Energy
Community Technology Systems Branch
Conservation and Solar Energy (1H-031)
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Washington, D.C. 20585
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Connecticut

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Solid Waste Management Unit
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06115
FTS 8-641-3672
CML (203) 566-3672

Stephen Hitchcock, Director
Industrial & Hazardous Materials Management Unit
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06115
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CML (203) 566-5148

John J. Housman, Chief
Hazardous Materials Management
Industrial & Hazardous Materials Mgmt.
Department of Environmental Protection
State Office Building
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Hartford, Connecticut 06115
FTS 8-641-5712
CML (203) 566-5712

Russel L. Brenneman, President
Connecticut Resources Recovery Authority
179 Allyn Street, Suite 603
Professional Building
Hartford, Connecticut 06103
CML (203) 549-6390

Maine

Ron Howes, Chief
Division of Solid Waste Management Control
Bureau of Land Quality
Department of Environmental Protection
State House - Station 17
Augusta, Maine 04333
CML (207) 289-2111

Massachusetts

William Caughan, Director
Bureau of Solid Waste Disposal
Department of Environmental Management
Room 1905
Leverett Saltonstall Building
100 Cambridge Street
Boston, Massachusetts 02202
CML (617) 727-4293

Solid Waste Regulatory

Vartkes K. Karaian, Chief
Solid Waste Branch
Division of Air and Hazardous Materials
Department of Environmental Quality Engineering
600 Washington Street, Room 320
Boston, Massachusetts 02111
CML (617) 727-2658

Hazardous Waste Regulatory

Glenn Gilmore, Chief
Hazardous Waste Section
Division of Water Pollution Control
Department of Environmental Quality Engineering
110 Tremont Street
Boston, Massachusetts 02108
CML (617) 727-3855

New Hampshire

Thomas L. Sweeney, Chief
Bureau of Solid Waste
Department of Health and Welfare
State Laboratory Building
Hazen Drive
Concord, New Hampshire 03301
CML (603) 271-4610

Rhode Island

John S. Quinn, Jr., Chief
Solid Waste Management Program
Department of Environmental Management
205 Health Building
Davis Street
Providence, Rhode Island 02908
CML (401) 277-2808

Lou David, Jr. Executive Director
Rhode Island Solid Waste Corp.
39 Pike Street
Providence, Rhode Island 02903
CML (401) 831-4440

Vermont

Richard A. Valentinetti, Chief
Air and Solid Waste Programs
Agency of Environmental Conservation
State Office Building
Montpelier, Vermont 05602
FTS 8-832-3395
CML (802) 828-3395

SEPARATE COLLECTION - NEW ENGLAND [1, 2]

Connecticut

Berlin
Bloomfield
Cornwall
Durham-Middlefield
East Hartford
East Lyme
Enfield
Goshen
Greenwich
Groton
Hartford
Manchester
Meriden
New Hartford
New London
Newington
North Haven
Norwalk
Oxford
Rocky Hill
Seymour
Shulton
South Windsor
Stamford
Tewkesberry
Waterbury
Waterford
West Hartford
Westbrook
Wethersfield
Winchester

Maine

Brunswick

Massachusetts

Agawan
Andover
Amherst
Arlington
Bedford
Beverly
Braintree
Brookline
Cambridge
Chelmsford
Chelsea
Dartmouth
Fitchburg
Greenfield
Hamilton
Haverhill
Lexington
Littleton
Ludlow
Marblehead
Newton
North Andover
Peabody
Petersham

1 Cohen, D. M. A National Survey of Separate Collection Programs. U.S. Environmental Protection Agency, Washington, D.C., July 1979, pp. B-1.

2 A New England Recycling Directory. U.S. Environmental Protection Agency, Office of Public Awareness, Washington, D.C., April 1979, pp. 5-27.

Massachusetts
(continued)

Pittsfield
Princeton
Reading
Salem
Somerville
South Hadley
Springfield
Stoughton
Topsfield
Waltham
Weymouth
Williamstown

New Hampshire

Hampton
New Market

Rhode Island

Barrington
Lincoln
Tiverton

Vermont

Northfield
Shraftsbury

RECYCLING CENTERS -
NEW ENGLAND [1]

Connecticut

Avon
Berlin
Bridgewater
Bristol
Cheshire
Chester
Cornwall
Danbury
East Granby
East Hartford
Farmington
Glastonbury
Goshen
Granby
Greenwich
Griswald, Jewelt City
Groton
Guilford
Hartford
Hebron
Madison
Marlborough
Meriden
Middlebury
Milford
Morris
New Fairfield
New London
New Milford
North Haven
Norwalk
Old Lyme
Orange
Oxford
Redding
Ridgefield
Salisbury
Seymour
Simsbury
Southbury
Southington
Stamford
Suffield
Thomaston
Torrington
Union
Vernon
Wallingford
Waterford
Watertown
West Hartford
Westbrook
Weston
Westport
Wethersfield
Windsor
Wilton

Maine

Brunswick
Farmington
Lincoln County
Orono

Massachusetts

Acton
Amesbury
Amherst
Arlington
Barnstable
Belmont

[1] A New England Recycling Directory. U.S. Environmental Protection Agency, Office of Public Awareness, Boston, April 1979, pp. 5-27.

Massachusetts
(continued)

Boxborough
Brewster
Brookline
Carlisle
Charlestown
Cheshire
Cohasset
Concord
Dartmouth
Dedham
Dennis
Duxbury
Eastham
Falmouth
Fitchburg
Foxborough
Granby
Greenfield
Hampden
Hanover
Hingham
Ipswick
Lexington
Lincoln
Ludlow
Manchester
Marblehead
Mattapoisett
Maynard
Natick
Needham
North Adams
North Andover
Northhampton
Orleans
Paxton
Pembroke
Raynham
Reading
Rockport
Scituate
Sharon
Sheffield
Somerville
Springfield
Watertown
Wellesley
Wellfleet
West Boylston
Westboro
Westford
Westwood
Weymouth
Williamston
Woburn
Worchester
Worthington
Yarmouth

New Hampshire

Amtrim
Durham
Hanover
Lebanon
Meredith
Plymouth
Swanzey
Windham

Rhode Island

Barrington
Glochester
Little Compton
Pawtucket
South Kingstown
Woonsocket

Vermont

Bennington
Burlington
Shraftsbury
Woodstock

INTERMEDIATE PROCESSORS NEW ENGLAND[1]

Processor	Location	Approx. Monthly Tonnage
Barrett Trucking	Burlington, Vermont	800
Maine Beverage Containers	Portland, Maine	1,500
Maine Recycling Corp.	Topsham, Maine	1,500
Recycling Enterprises, Inc.	Oxford, Massachusetts	3,000
Resource Recovery Systems, Inc.	Branford, Connecticut	300
Tiverton Recycling	Tiverton, Rhode Island	1,000
Waste Central	White River Junction, Vermont	100

[1]Weiss, D.B. "Intermediate Glass Processing," NCRR Bulletin The Journal of Resource Recovery, 9(3):56. 1979.

MARKETS FOR RECYCLED MATERIAL IN NEW ENGLAND[1]

Following is a listing of the names and addresses (and where available, the phone numbers) of markets for recycled paper, glass, and metal that EPA is currently aware of for New England. As stated earlier, this list is not complete and other sources should be referenced if necessary.

Before your recycling program begins accepting materials, be sure to check with your buyer to ensure that the materials you collect meet the buyers specifications. For example metal rings may have to be removed from bottles or glass may have to be separated by color

1 A New England Recycling Directory, Office of Public Awareness, U.S. Environmental Protection Agency, Boston, Massachusetts, April, 1979, p. 29-42.

LEGEND

MATERIAL TYPES

Paper

N .... Newsprint
C .... Corrugated
L .... Office Ledger
M .... Mixed Paper
O .... Other

Glass

C .... Clear
G .... Green
A .... Amber

Metals

F .... Ferrous
N-F ...... Non-Ferrous
B .... Bulky Metals
M .... Mixed Metals
S .... Scrap Metals

CONTRIBUTORS

I ...... Individuals
O ...... Organizations
C ...... Contractors

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
CONNECTICUT						
Tri-City Recycling 655 Christian Lane Berlin, 06037 (203) 223-3601	Paper	N C L M O	I O C	YES	YES	YES
Atlas Scrap & Recycling Co. P. O. Box 624 Bloomfield, 06002 (203) 242-6251	Paper Glass Metals	N C L M O F N-F B M S	I O C I O C I O C	YES NO YES	YES YES YES	YES
Southern CT Resource Recovery Center, Inc. 50 Maple Street Branford, 06405 (203) 481-2325	Glass Metals	 F N-F	O C O C	YES YES	YES YES	YES
Glass Containers Corp. Route 101 Dayville, 06241 (203) 774-9636	Glass		I O C	NO	NO	YES
Camerota Scrap Recycling 245 Shaker Road Enfield, 06082 (203) 763-0436	Metals	F N-F B S	I O C	YES	YES	

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
Columbia Poly Pack Co. 15 Ashton Street Hartford, 06106 (203) 522-4943 or 1-800-842-1456	Paper	N	I O C	YES	YES	YES
Automated Material Handling 260 Tolland Turnpike Manchester, 06040 (203) 643-9636	Paper Metals	N C L M B M	 C	YES YES	YES YES	YES
M. Wilder & Son, Inc. 569 North Colony Street Meriden, 06450 (203) 235-4225	Paper Metals	N C L M O F N-F S	I O C I O C	YES YES	NO NO	YES
E. H. Wentworth 221 Faith Road Newington, 06111 (203) 667-0644	Metals	F B M S	I O C	YES	YES	
Vulcan Scrap Metal Co. 60 Taff Avenue Stamford, 06905 (203) 357-1720	Metals	F N-F S	I O C	YES	YES	
Data Security Corp. 9 Willow Stream Drive Vernon, 06066 (203) 875-2341	Paper	N L	I O C	YES	NO	YES
S & T Industries, Inc. 21 Willow Stream Drive Vernon, 06066 (203) 875-2384	Metals	F B M	I O C	YES	YES	
B. Swirsky & Co., Inc. 260 Railroad Hill Street Waterbury, 06708	Paper Glass	N C L M O	I O C I O C	YES YES	YES YES	YES YES
Marcus Paper Company, Inc. 93 Wood Street West Haven, 06516 (203) 934-6351	Paper	N C L M O	I O C	YES	YES	YES

LEGEND . . .

MATERIAL TYPES

Paper

N . . . . Newsprint
C . . . . Corrugated
L . . . . Office Ledger
M . . . . . . Mixed Paper
O . . . . Other

Glass

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A . . . . Amber

Metals

F . . . . Ferrous
N-F . . . . . . Non-Ferrous
B . . . . Bulky Metals
M . . . . Mixed Metals
S . . . . Scrap Metals

CONTRIBUTORS

I . . . . . . Individuals
O . . . . . . Organizations
C . . . . . . Contractors

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
MAINE						
Isadore T. Miller Co. Old Hotel Road Auburn, 04210 (207) 783-8371	Metals	F N-F M S	I O C	YES	YES	NO
Tom Sawyer, Inc. RFD 2 Bangor, 04401 (207) 862-4200	Paper	N C L M	I O C	YES	YES	NO
Aroostock Paper Recycling Co. 8 Second Avenue Fort Kent, 04743 (207) 834-3846	Paper Metals	C M	I O C I O C	YES YES	NO NO	YES
William Goodman & Sons, Inc. 81-87 Marginal Way Portland, 04104 (207) 773-4709 or 773-4700	Paper	N C L M	I O C	YES	NO	YES
Barry N. Springer, Inc. 36 Greene Street Sabattus, 04280 (207) 375-4279 or 783-6672	Paper	N	I O C	YES	YES	

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
Waldron Scrap Iron & Metal Box 917, Rt. 1 Scarboro, 04074 (207) 883-9921	Metals	F N-F B M S	I O C		YES	
Rich Insulation Co. Rt. 302 So. Windham, 04082 (207) 892-2191	Paper	N	I O C		NO	NO
Keyes Fibre Company College Avenue Waterville, 04901 (207) 873-3351	Paper	N	I O C		NO	NO

LEGEND . . .

MATERIAL TYPES

Paper

N . . . . Newsprint
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L . . . . Office Ledger
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S . . . . Scrap Metals

CONTRIBUTORS

I . . . . . . Individuals
O . . . . . . Organizations
C . . . . . . Contractors

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
MASSACHUSETTS						
Kemble Waste Co., Inc. 27 Kemble Street Roxbury, 02119 (617) 445-5758	Paper	N C L	I O C	NO	NO	
Town of Brookline 333 Washington Street (617) 232-9000	Glass Paper Metals	C G A N M F N-F B	I O I O C I O	NO NO NO	YES NO YES	NO NO
Bay State Paper Recycling Corp. 98 Taylor Street Dorchester, 02122 (617) 445-3900	Paper	N C L M O	I O C	NO	NO	NO
Shaffer Paper Fibres, Inc. 98 Taylor Street Dorchester, 02122 (617) 825-9040	Paper	N C L M O	I O C	YES	YES	YES
Suffolk Services, Inc. 98 Taylor Street Dorchester, 02122 (617) 825-9045	Paper Glass Metals	N C L M O C G A 3 G/A F N-F B M S	I O C O C I O C	NO NO NO	YES YES YES	YES YES
Bird & Son, Inc. Washington Street E. Walpole, 02032 (617) 668-2500	Paper	N C M	C		NO	NO

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
Resource Recovery Corp. – Browning Ferris Industries 115 Washington Street Holliston, 01746 (617) 429-6150	Paper	C	I O C	YES	YES	YES
Sonoco Products Company P. O. Box 631 Holyoke, 01040 (413) 536-4546	Paper	N C L M	I O C	YES	NO	YES
Essex Waste Paper Co., Inc. 207 Marston Street Lawrence, 01841 (617) 682-5226	Paper Metals	N C L M F N-F B M S	I O C I O C		YES YES	
B. Greenblatt & Co., Inc. 231 Tanner Street Lowell, 01851 (617) 453-5111	Paper	N C L M O	I O C	NO	NO	NO
Owens-Illinois, Inc. 241 Francis Avenue Mansfield, 02048 (617) 339-9321	Glass	C G A	I O C	NO	NO	
Foster Forbes Glass Co. National Street Milford, 01757 (617) 478-2500	Glass	C	I O C		NO	YES
A. W. Martin, Inc. 1200 Shawmut Avenue New Bedford, 02746 (617) 993-4359	Metals Paper	F N-F B M S N C L M O	I O C I O C	YES YES	YES YES	
Reynolds Aluminum Recycling Co. 50 Rear Tower Road Newton Upper Falls, 02164 (617) 965-1350	Metals	N-F	I O C	YES	NO	NO

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
No. Adams Junk Co. 327 Ashland Street No. Adams, 01247 (617) 663-3185	Paper	N	I	NO		NO
P. Allen & Son, Inc. P. O. Box 27 Easthampton Road Northampton, 01060 (413) 584-3040	Paper	N C L M O	I O C	YES	YES	
Recycling Enterprises, Inc. Old Webster Road P. O. Box 269 Oxford, 01540 (617) 987-2700	Glass Metals	C G A 3 G/A F N-F	I O C I O C	YES YES	YES YES	YES
North Shore Recycled Fibres Corp. 53 Jefferson Avenue Salem, 01970 (617) 289-9400	Paper	N C L M O	I O C	YES	YES	YES
Martel Plant Dismantling & Recycling, Inc. 29 Elmwood Avenue Saugus, 01906 (617) 233-2908	Metals	B	I O C	YES	NO	
Acme Metals & Recycling, Inc. Rear 64 Napier Street P. O. Box 514 Springfield, 01101 (413) 737-3112	Paper Metals	N C L O F N-F B M S	I O C I O C	YES YES	YES YES	YES
Harry Goodman, Inc. 203 Tremont Street Springfield, 01104 (413) 785-5331	Paper Metals	N C L M O F N-F B M S	I O C I O C	YES	YES	YES

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
Springfield Goodwill Industries 285 Dorset Street Springfield, 01101 (413) 788-6981	Glass	C G A	I O C		NO	NO
Mid-City Scrap Iron and Salvage 548 State Road Westport, 02790 (617) 675-7831	Paper Metals	N C L M O F N-F B M S	I O C I O C	YES YES	YES YES	YES YES
Babco Metals Corp. 2 Kansas Street Worcester, 01610 (617) 756-3001	Glass Metals	 F N-F	I O C	NO NO	YES YES	

LEGEND . . .

MATERIAL TYPES

Paper

N . . . . Newsprint
C . . . . Corrugated
L . . . . Office Ledger
M . . . . Mixed Paper
O . . . . Other

Glass

C . . . . Clear
G . . . . Green
A . . . . Amber

Metals

F . . . . Ferrous
N-F . . . . . . Non-Ferrous
B . . . . Bulky Metals
M . . . . Mixed Metals
S . . . . Scrap Metals

CONTRIBUTORS

I . . . . Individuals
O . . . . Organizations
C . . . . Contractors

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
NEW HAMPSHIRE						
CPM Inc. East Ryegate VT Division Claremont, 03743 (603) 542-2592	Paper	O	C	YES	NO	NO
Valley Recycling Inc. Corner Maple and Plains Road Claremont, 03743 (603) 542-9392	Paper	C L O	I O C	YES	YES	YES
George Wool, Inc. Kingston Road Exeter, 03833 (603) 772-5857	Paper Glass Metals	N C L M C G A N-F	I O C O I O C	YES NO YES	YES YES YES	YES
J. Schwartz Motor Transportation, Inc. 185 Woodland Avenue P. O. Box 4333 Manchester, 03108 (603) 627-4191	Paper	N C L M O	I O C	YES	NO	NO
Spaulding Fibre Co., Inc. Spaulding Avenue No. Rochester, 03867 (603) 332-0940	Paper	N C	C O	YES	. . .	NO

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
Harding Metals, Inc. Rte. 4 Northwood, 03261 (603) 942-5573	Metals	F N-F B M S	I O C	YES	YES	NO
L. Weinstein & Sons, Inc. 10 Wallace Street Rochester, 03867 (603) 332-3704	Paper	N C	I O	NO	NO	

LEGEND

MATERIAL TYPES

Paper

N .... Newsprint
C .... Corrugated
L .... Office Ledger
M .... Mixed Paper
O .... Other

Glass

C .... Clear
G .... Green
A .... Amber

Metals

F .... Ferrous
N-F ...... Non-Ferrous
B .... Bulky Metals
M .... Mixed Metals
S .... Scrap Metals

CONTRIBUTORS

I ...... Individuals
O ...... Organizations
C ...... Contractors

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
RHODE ISLAND						
National Bottle Mfg. Co. Route 117 Coventry, 02816 (401) 397-3371	Glass	C G	I O C	YES	NO	NO
American Waste Paper 8 Webb Street Cranston, 02920 (401) 781-2666	Paper	N C L M O	I O C	YES	YES	YES
Metals Recycling, Inc. P. O. Box 7226 Johnston, 02919 (401) 831-7799	Metals	N-F M S	I C	YES	YES	
Eastern Scrap Co. 655 Roosevelt Avenue Pawtucket, 02860 (401) 724-2200	Metals	F N-F B M S				
United Paper Stock Company 33 India Street Pawtucket, 02860 (401) 724-5700	Paper	N C L M O	I O C	YES	YES	YES

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
A. Bazar & Son, Inc. 32 Thurbers Avenue Providence, 02905 (401) 781-5750	Paper	N C L	I O C	YES	NO	NO
Cove Metal Co. P. O. Box 29 Providence, 02901 (401) 724-3500	Metals	N-F M	I O C	YES	YES	
Ralph Shuster, Inc. P. O. Box 2762 Providence, 02907 (401) 781-2435	Metals	F N-F B M S	I O C	YES	YES	
Valley Paper Stock Co., Inc. 118 Valley Street Providence, 02909 (401) 438-1810	Paper	C L M	I	NO	YES	
Tiverton Recycling Co. 20 Cornell Road Tiverton, 02878 (401) 624-4454	Glass	C G A	I O C	YES	NO	YES

LEGEND

MATERIAL TYPES

Paper		Glass		Metals		CONTRIBUTORS	
N	Newsprint	C	Clear	F	Ferrous	I	Individuals
C	Corrugated	G	Green	N-F	Non-Ferrous	O	Organizations
L	Office Ledger	A	Amber	B	Bulky Metals	C	Contractors
M	Mixed Paper			M	Mixed Metals		
O	Other			S	Scrap Metals		

COMPANY NAME AND ADDRESS	MATERIALS ACCEPTED	MATERIAL TYPES (see legend)	ACCEPTS MATERIAL FROM (see legend)	PICK-UP AVAILABLE	CONTAINERS PROVIDED	CONTRACT AVAILABLE
VERMONT						
Burlington Paper Stock Co. 111 Archibald Street Burlington, 05402 (802) 862-9641	Paper Metals	N C L F N-F M S	I O C I O C	NO	NO NO	YES
Burlington Waste & Metal Co. North Winooski Avenue Burlington, 05402 (802) 862-5333	Paper Metals	O F N-F				
Gates Salvage Yard, Inc. Rt. 14 Hardwick, 05843 (802) 472-5794 or 472-5058	Metals	F N-F B M S	I O C	YES	YES	
Donahue Salvage Co. 32 Allen Street Rutland, 05701 (802) 773-7630	Metals	F N-F	I			
Rutland Waste & Metal Co. 246 West Street Rutland, 05701 (802) 773-2877	Paper Metals	N F N-F M	C I O C	YES YES	NO NO	NO

APPENDIX B

A SUMMARY OF THREE NEW ENGLAND SOURCE SEPARATION PROJECTS

CASE STUDIES

In order to reduce the volume of solid waste disposed through landfilling, rural communities in New Hampshire have implemented projects which rely on recovery of materials through recycling. Some recovery projects have utilized incineration in order to increase volume reduction. Three rural New Hampshire resource recovery projects were selected for case studies of the implementation process. Summary information on these projects in Meredith, Plymouth, and Swanzey, New Hampshire is presented in this appendix.

Each of these projects was undertaken in response to passage in 1972 (by the New Hampshire Legislature) of an act requiring closure of all open burning dumps by July 1974. (A July 1974 amendment to this legislation extended the deadline for closing to July 1, 1976 and provided a mechanism for administratively determined extensions beyond that date.)

Figure 1 illustrates the diversity among the three projects. Meredith and Plymouth successfully imposed mandatory recycling whereas Swanzey relies upon voluntary participation in its recycling program. Although Meredith and Plymouth both have mandatory recycling, the scope of materials required to be recycled is far greater in Plymouth. The Swanzey project has minimal volume reduction and relies primarily upon landfilling as a means of disposal. Only one project (Meredith) was forced to deal with a large influx of summer residents. All three projects have about the same year-round population, and, although Meredith has a significantly higher tax base (total assessed valuation) than Plymouth or Swanzey, all three possess a substantial tax base. Two projects (Meredith and Swanzey) involve interlocal agreements for disposal, but with different sets of circumstances and sponsorship.

Care should be taken in evaluating the capital costs and the net disposal fees shown in Figure 1. For example, in Swanzey the capital costs are only for the construction of a small recycling building because the transfer station is leased from and operated by a private contractor. In the case of Meredith and Plymouth, the capital costs are for different years and the size of the Plymouth facility is larger because: a) it was designed to house all materials processing and handling inside, whereas the Meredith facility was not; b) the building was designed to permit handling of larger volumes of solid waste and recovered materials than generated within the town; and c) the Meredith facility is undersized with respect to the tonnage of solid waste which must be processed from Memorial Day to Labor Day. The net disposal costs differ not only because of differences in revenues received from recycling due to differences in tonnage and composition of materials recycled, but in the case of Plymouth, capital costs are being amortized over a relatively short period of 10 years compared to the 20 year amortization period in Meredith.

While not shown in Figure 1, there are substantial differences among the projects in the amount of time involved from the beginning of planning to the start of facility operations. The reasons for these differences are varied, but can be explained in part by the fact that those undertaking these projects were among the pioneers in the implementation of rural resource recovery. From the start of planning to the start of facility operation, the following time periods were required:

- Meredith - 46 months
- Plymouth - 34 months
- Swanzey - 28 months

A brief discussion of each of these projects follows. More detailed information in relation to these case studies is available through the Region I Office of EPA.

FIGURE 1

	MEREDITH	PLYMOUTH	SWANZEY
POPULATION	3,775 (1977) Permanent	5,330 (1976)	4,800 (1976)
TAX BASE (1977) (Total Assessed Valuation)	$62,224,450	$33,348,657	$38,442,441
STATUS (Winter 1978)	Facility in Operation 1 Year	Facility in Operation 2 Years	Facility in Operation 2.75 Yrs.
SYSTEM	• Two Kelley Incinerators: 2.5 Tons/Hour Capacity. • Mandatory Separation of Glass by Color. • Recycling: Glass, Cans, Newspapers, Cardboard, Metal Containers, White Goods & Tires. • Paper & Cardboard Baler: 800 lb. Bales. • Incinerator Ash Landfill. • Stumps, Brush Disposal at Old Dump.	• One Combustion Engineering Incinerator: 1.6 Ton/Hour Capacity. • Mandatory Separation and Recycling of: Glass by Color, Cans, Metal Containers, Newspapers, Cardboard, White Goods, Scrap Metal. • Paper & Cardboard Baler: 1,700 lb. Bales. • Cans & Glass Crusher. • Tires Stockpiled. • Incinerator Ash Landfill. • Stumps, Brush, Construction Disposal Site.	• One Compactor-Transfer Station. • Voluntary Separation. • Recycling: Glass by Color, Cans, Newspapers, and Cardboard. • Paper and Cardboard Baler: 800 lb. Bales. • All Solid Waste not Recycled is Landfilled.
ANNUAL TONNAGE PROCESSED (1977)	3,082 TPY	2,008 TPY	2,550 TPY
ECONOMICS AND FINANCING	$232,343 Capital Cost (1976) FmHA 20 Yr. Loan: $200,000 Federal Rev. Sharing: $25,143 Town Revenues: $7,200 Net Disposal Cost: $18.49/Ton (1977) $ 0.96/Tax Rate	$345,663 Capital Cost (1975) FmHA 10 Yr. Loan: $300,463 RC&D Grant: $45,200 Net Disposal Cost: $42.63/Ton (1977) $ 2.57/Tax Rate	$32,000 Capital Cost (1976) General Revenue Financed Net Disposal Cost: $12.96/Ton (1977) $ 0.86/Tax Rate : $31.41/Ton for Waste Handled by Transfer/Recycling Center Only.
KEY CONTRACTS	• Center Harbor (Waste Disposal). • Recycling Enterprises (Glass and Cans). • Hogue-Sprague (Cardboard).	• Recycling Enterprises (Glass and Cans).	• City of Keene (Landfill Disposal). • Recycling Enterprises (Glass and Cans). • Springfield Paper Stock (Newspaper and Cardboard).

THE INCINERATOR AND RECYCLING PROJECT OF MEREDITH, N.H.

Meredith, located on the northwestern shore of Lake Winnipesaukee, is situated in one of the major water resort areas of New Hampshire. As a result its population sharply increases in the summer from an estimated 3,775 permanent residents (July 1977) to an estimated 15,000 persons. The increase in population places an inordinate demand upon the town's services, particularly in the case of solid waste disposal where tonnage increases from a winter average of 25 to 30 tons per week to around 80 tons per week during the summer season. The characteristics of the solid waste alter as well, because summer residents tend to consume more foods and beverages packaged in glass and can containers. Meredith, therefore, has an unusual problem: How can capacities for solid waste disposal be both reliably estimated and increased in the summer at the least cost when landfilling is no longer a viable option? Its implementation of an incinerator/recycling project is of interest because it:

- Demonstrates how a viable alternative to an open dump can be created in a situation where sanitary landfilling is not geologically and environmentally possible;
- Demonstrates the ingredients of effective planning and implementation for a small town and the importance of local leadership in that process;
- Indicates the importance of mandatory source separation;
- Illustrates the cost to a small town undertaking a project on its own;
- Illustrates some of the problems of determining facility size and materials handling requirements;
- Illustrates some of the problems of determining facility size and materials handling requirements.
- Points to the importance of competent personnel for operating the facility; and
- Offers significant operating and capital cost information and experience to other communities.

Planning Phase

The planning phase began with creation of a Solid Waste Disposal Committee at a March 1973 Town Meeting. During its first year the Committee focused on finding a sanitary landfill site because of recommendations made by the Lakes Region Planning Commission.

As a result, it made field investigations of 25 potential sites located in Meredith and/or Center Harbor. Much of this activity of the Committee was undertaken jointly with representatives of Center Harbor. The conclusion of the Committee was that no suitable sites existed in either town because of bedrock or high water table conditions.

In early September 1974 Meredith sponsored a meeting to learn more about recycling and what other towns were doing to solve their solid waste disposal problem. During the fall, town officials spent considerable time investigating incinerators. One selectman developed a layout and built a small-scale model of an incinerator building for Meredith. Because available data concerning solid waste generation and the volume of recyclables was inadequate, it was difficult to determine the appopriate size and layout of the building. Therefore, the preliminary design and projected costs for a proposed incinerator plant had to be based upon very rough estimates.

Despite the lack of a critically needed data base, sufficient progress had been made on the incinerator and recycling concept that the Selectmen were willing to hold a public meeting on the subject in mid December 1974. One week before the scheduled public meeting the Selectmen launched a multi-media publicity campaign which ran for the entire week. The theme of the campaign is best illustrated by one of the local radio spot announcements — "It's about garbage but it's not garbage. Your money is involved." The results of that public meeting confirmed the belief of the Meredith Selectmen that conventional incineration combined with some form of mandatory recycling, especially of glass, was the best route. With assistance from the Town Engineer, the design of the building was improved and more realistic cost estimates were developed.

In April 1975 the Selectmen reported to the State Air Pollution Control Commission the results of the Town Meeting and advised that a tentative site had been selected and that incinerators made by three companies were being considered for possible purchase.

System Procurement Phase

By the beginning of 1975 the Selectmen had chosen equipment, developed firm cost estimates, and determined that the best financing route was through the Farmers Home Administration. In late February the Selectmen, responding to a communique from the Governor's office, advised that they could not meet the legislatively set deadline of July 1, 1976 for the closing of its burning dump because they would not by then have an alternative disposal method. They also pointed out that while some work had been accomplished on arrangements for the bond issue and preparation of site plans and construction specifications there was still a long implementation process involved, since they had to obtain State approval of their plan.

In June 1976 Town officials notified FmHA of its intent to apply for a loan for $200,000 and to meet all required conditions. In the latter part of that month they also complied with requirements of the State Clearinghouse which is responsible for coordinating all requests for Federal funds. In September 1976 the Town issued $200,000 in bond anticipation notes to pay for construction and equipment. Site work and construction proceeded rapidly as did delivery and installation of the two Kelley-Hoskinson incinerators. As a result, the facility was ready for the start of operations on January 4, 1977.

The Town was fortunate in being able to hire as plant manager an employee of the Kelley-Hoskinson dealer for New Hampshire. As a result, Meredith's plant manager was completely familiar with the operations of the incinerators.

On March 22, 1977 the Selectmen of Meredith and Center Harbor (year-round resident population of 640 persons) entered into an agreement permitting Center Harbor to dispose of solid waste at the Incinerator/Recycling Facility. In December 1976 Meredith executed a one year contract (effective January 3, 1977) with Hooley and Rice Tire Co. in

Derry, New Hampshire for the monthly removal of retreadable automobile tire carcasses. In late May or early June the Town executed a contract with Recycling Enterprises, Inc. for the sale of glass and cans. Finally, in early November 1977 the Town executed a memorandum of understanding with a Charles Elliot of Meredith for maintenance and clean up of the heavy metal disposal and for removal, no less than twice weekly, of accumulated materials.

Due to the inability of the incinerators to adequately process the high tonnage of solid waste generated by the influx of summer residents and tourists, the Town decided to remove cardboard, bale it, and sell it. The Town, therefore, installed a Maren Vertical baler in late summer. While no contract appears to exist, the Town sells, on a regular basis, baled cardboard to Hogue-Sprague located in West Hopkinton, New Hampshire.

Operating Phase

In early February 1977 the Selectmen held a public hearing on award, by the Selectmen, of the $200,000 bond issue to FmHA at par value and accrued interest. The bonds were issued February 10, 1977, the same date as the public hearing. Immediately following the public hearing, the Selectmen passed a resolution awarding the sale of the bonds to FmHA.

With the start of incinerator opertions in January, the Selectmen wisely decided not to implement the mandatory glass separation ordinance approved by the 1975 Town Meeting. Rather, they relied upon a voluntary program until they could establish how successful it would be and the extent of the impact on incinerator opertions. (Early in their investigations of incineration, manufacturer representatives had made the Selectmen keenly aware of operating problems caused by glass in small, noncontinuously operated incinerators.) Town officials estimated that prior to Memorial Day, about 40 percent of the residents participated in the voluntary recycling program. Despite this high participation, glass did create substantial operating problems due to slagging. With the influx of summer residents on Memorial Day, the Selectmen realized that they had to institute mandatory separation and depositing of glass. Prior to actual implementation on July 5, 1977 the Selectmen provided citizens information on the need for glass removal. Town officials attribute the extremely positive response to imposition of the mandatory requirement to the education/information program and to the fact that many summer residents came from towns in Massachusetts where recycling programs existed.

During the summer of 1977, the Town used the CETA program to employ teenagers to direct traffic at the recycling area and to assist persons in depositing glass and cans into the appropriate compartment. Even with traffic direction and disposal assistance the recycling area became a major traffic bottleneck resulting in long queues on the major road to the facility.

The volume of glass and cans deposited in the 30 cubic yard container was so great during the summer months that substantial over flows occurred between pick-ups by Recycling Enterprises. The unsitely over flows created a considerable maintenance problem and caused some Townspeople to question the adequacy of the operation.

The Town has developed a new layout for the glass and can recycling area which would greatly improve the traffic flow. However, this layout has not been implemented since it would involve an estimated expenditure of $13,000. This summer the plant manager intends to assign one person responsibility for the deposit of glass and cans in appropriate compartments. Recycling Enterprises, if it picks up containers of badly contaminated glass, deducts what it would have paid the Town for acceptable tonnage from payments due the Town.

The decision by the plant manager to designate one employee responsible for the glass recycling area during the summer months represents an attempt to reduce the level of glass contamination to an acceptable level. Most households have difficulty in understanding the economic importance of keeping pieces of ceramics, plastics, and other nonglass items out of the separated glass and for keeping colored glass separated from clear glass. Therefore, by inspecting each load of glass before it is deposited in the appropriate compartment, the plant manager hopes to improve the quality of recyclable glass, hence, revenues to the Town.

One unexpected and serious operating problem has occurred which other waterfront communities should take into account when considering an incinerator project. Because Meredith is located on Lake Winnipesaukee, there is a large power boating population during the summer months. While there are special disposal tanks provided at the various marinas for pumping out boat toilets, there is a $3 charge for the use of such facilities. As a result, a pattern has developed over the years whereby boat operators have placed fecal matter in plastic bags, placed those bags in larger plastic bags containing refuse, and deposited this mixture of refuse and fecal matter in publically provided trash barrels located at the Town pier for the convenience of summer residents living on nearby islands. The plant manager has notified the Selectmen that if this situation is not corrected by this coming summer, he will not permit the incinerator building to be operated.

In 1977 during the period from Memorial Day to Labor Day, both incinerators were operated 7 days per week. Each incinerator was operated an average or 19.2 hours per day. Because the approximately 5 hours was allowed for cooling down which was insufficient, the incinerators were cleaned out while ash was still smoldering.

The volume of refuse was so great during the summer of 1977 (80 tons per week) that on many days the skid steer could not be used to load the incinerators. As a result, the operators had to hand shovel the waste into the automatic loading bin. The plant manager reported that on some days refuse was piled up to the eaves of the building. This condition resulted due to adequate information on the summer resident population and the per capita solid waste generation rate. This lack of information led the Town to undersize the building by an estimated 20-30 feet in length. Correction of this situation would be costly because located outside at one end of the building is the fuel storage tank and at the other the septic system. Furthermore, extension of the building length would result in the incinerator loading areas being located so that materials handling owuld be considerably less efficient. The Town, therfore, has decided to live with the summer overload problem.

In summary, the Incinerator/Recycling Facility handled the following tonnages in 1977:

	TONS	PERCENT DISTRIBUTION
Incinerator	2,762.5	89.6
Recyclables	319.4	10.4
Cardboard	73.9	2.4
Glass	228.0	7.4
Cans	17.5	0.6
TOTAL TONNAGE	3,081.9	100.0

Although tonnage data on white goods, other heavy metals, and tires is unavailable, an estimate based upon the pricing formula for heavy metals and certain assumptions about the average price per ton suggests that about 310 tons were sold during 1977.

Financing and Economics

The total capital cost of the Meredith facility is $225,143. The Town Engineer prepared the final design of the incinerator building and prepared the construction bid specifications. The value of this in-house service is estimated to be $7,200 which has been added to actual capital outlays. Thus, the estimated total capital cost of the facility (including equipment) is $232,343. In addition, the Town has appropriated $6,200 from general revenues for restoration of the old dump.

Project costs were financed through a 20 year low interest loan of $200,000 from the Farmers Home Administration (FmHA). The FmHA loan is secured by a 20 year general obligation bond issued by the Town in March 1977. The terms of the bond provide that the annual principle payment is $10,000 and that interest is at 5 percent on the unpaid balance. The balance of the project cost was paid for from Revenue Sharing funds ($25,142.94) and in-house services (estimated at $7,200). The imputed debt service for 1977 was estimated to amount to $23,234.30 (as opposed to actual debt service on the $200,000 bond issue of $20,000). The imputed debt service accounts for the value of funds used from Revenue Sharing and general appropriations and, thus, provides a more accurate assessment of real project costs.

Operating costs were estimated to amount to $43,313 in 1977 which differs from the reported Town expenditure of $37,745. The reason for this difference is due to adjustments made to account for omissions from the operating accounts for the cost of fringe benefits paid to employees and exclusion of the cost of CETA employees which were charged to another budget account. Inclusion of these two items was necessary in order to establish the true operating cost of the facility. In this connection it should be noted that in the Town's 1978 budget these two items have been included as part of the cost of operation for the facility. It also should be noted that under the terms of the Disposal Agreement with Center Harbor the omitted and excluded costs could be accounted for by Meredith in establishing the disposal charge to be paid by Center Harbor.

The combined 1977 imputed debt service and adjusted operating cost of $66,547 was reduced by net revenues of $9,561. Gross revenues were generated through recycling ($4,576) and the Center Harbor disposal service charge ($5,409), but reduced by recycling costs of $423. Thus, annual net costs in 1977 amounted to $56,986, or $18.49 per ton processed at the facility. In terms of the impact on the tax rate, solid waste disposal amounted to $0.92 per $1,000 of total assessed valuation and accounted for 3 percent of the total tax rate.

TOWN OF MEREDITH, N.H.

INCINERATOR/RECYCLING FACILITY

I. CAPITAL COST

A.	LAND	Not Applicable
B.	SITE DEVELOPMENT	$ 40,134.00
C.	BUILDING	$ 50,678.33
	Block Building	82.10
	Building	30,857.00
	Plumbing	1,172.22
	Electric	3,050.83
	Platforms and Ladder	6,068.88
	Fuel Tank	5,488.15
	Septic System	450.00
	Water Main Extension	1,807.51
	Shower Room	1,701.64
D.	EQUIPMENT	$132,621.28
	2 Incinerators & Stack Extensions	115,429.45
	Rake	184.88
	Baler	7,042.79
	Steam Cleaner	2,106.26
	Skid-Steer Loader	7,529.75
	Recycling Bins	328.15
E.	ENGINEERING, LEGAL & ADMINISTRATION [1]	$ 500.75
F.	MISCELLANEOUS	$ 1,208.58
	Signs	980.00
	Bulletin Board	154.82
	Other	73.76
	TOTAL CAPITAL COST	$225,142.94

II. CAPITAL COST FINANCING

A.	BOND ISSUE (20 yrs. @ 5% on unpaid balance)	$200,000.00
B.	REVENUE SHARING FUNDS	$ 25,142.94
C.	IN-HOUSE ENGINEERING SERVICES [2]	$ 7,200.00
D.	ACTUAL DEBT SERVICE [3]	$ 20,000.00
E.	IMPUTED DEBT SERVICE (incl. In-House Cost & Rev. Shar.) [4]	$ 23,234.30

TOWN OF MEREDITH, N.H.

INCINERATOR/RECYCLING FACILITY

III.	OPERATING COSTS (1977)	
	A. LABOR	$ 25,021.07
	Manager[5]	12,432.11
	Operators[6]	12,588.96
	B. UTILITIES	2,495.71
	Electricity	2,090.66
	Telephone	405.05
	Water	Not Available
	C. FUEL	$ 7,556.22
	No. 2 Oil for Incinerators	6,168.50
	Propane for Skid Steer	
	Gasoline	1,387.72
	D. MAINTENANCE	$ 1,511.87
	Equipment	1,511.87
	E. PARTS AND SUPPLIES	$ 5,307.53
	Stock Parts	3,274.65
	Sm. Tools & Equip.	713.91
	Operating Supplies	286.67
	Uniforms	423.05
	Build. Maint. & Supplies (Primarily Pest Control Chemicals)	609.25
	F. INSURANCE	$ 717.12
	G. OTHER	$ 703.46
	Dump Maintenance	703.46
	TOTAL OPERATING COST	$ 43,312.98
IV.	ANNUAL DEBT SERVICE (Imputed)	$ 23,234.30
V.	TOTAL ANNUAL COST (Operating & Debt Serv.)	$ 66,547.28

TOWN OF MEREDITH

INCINERATOR/RECYCLING FACILITY

VI. REVENUES

A. REVENUES	$ 4,575.65
Cardboard	1,867.60
Heavy Metals	620.74
Can	87.68
Glass	1,804.43
Tires	190.20
Batteries	5.00
B, OTHER	$ 5,409.03
Center Harbor Service Fee	5,409.03
TOTAL REVENUES	$ 9,984.68
Less: Recycling Transportation Costs	423.08
TOTAL NET REVENUES	$ 9,561.60

VII. NET ANNUAL COST (Total annual cost less net revenue)	$ 56,985.68
A. PER TON OF SOLID WASTE (3,081.9 TPY)[7]	18.49
B. PER CAPITA (4,425 persons incl. C.H.)	12.88
C. AMOUNT ON TAX RATE PER $1000 TAV	.92

TOWN OF MEREDITH, N.H.

INCINERATOR/RECYCLING FACILITY

NOTES:

1. The total of $500.75 excludes the cost of engineering services. Engineering design and preparation of construction bid specifications was performed by the Town Engineer. Engineering costs whether performed by a Town engineer or consultant represents a real project cost which should be included in determining project economics. See Note 2 for the imputed value of in-house engineering services.
2. The imputed cost of engineering services performed by the Town Engineer was estimated at 8 percent of the combined capital cost for the building and site development. Eight percent represents a typical engineering consultant fee.
3. Actual debt service is for 1977, and is comprised of $10,000 for principal repayment and $10,000 for interest. Interest payments will decline in succeeding years per terms of the bond which requires that interest will be applied to the unpaid balance of the bond issue. Thus, for example, in 1978 interest will amount to $9,500.
4. In order to determine the full debt service that should apply to the Incinerator/Recycling facility and imputed debt service was estimated based upon inclusion of Revenue Sharing funds used for construction of the facility and inclusion of the imputed cost of the Town Engineer's services. The total capital cost used to compute the imputed debt service was $232,342.94. Imputed principal and interest were each estimated to be $11,617.15. Inclusion of the Revenue Sharing funds and the estimated Town Engineer's costs appears to be consistent with the formula used to establish the charge to Center Harbor for disposal at the Incinerator/Recycling facility.
5. The 1977 cost of the facility manager was inflated to account for the omission by the Town of fringe benefits in its accounts for the facility. Also added to the cost of the facility manager was a pro rata share of overtime expenses reported by the Town.

6. Operator labor costs were inflated to account for the omission of fringe benefits in the Town accounts for the facility as well as pro rata share of reported overtime expenses. In addition, an estimated cost of summer help was added to the operator labor cost. In the summer of 1977 the Town employed teenagers to direct traffic at the recycling area of the facility and to assist in the disposal of color sorted glass into the appropriate compartments of the roll-on- roll-off container provided for glass and cans. The summer employee payroll was charged to a different account as funds came through the Summer Youth Corps program of the U. S. Department of Labor. The estimate for summer teenage employment was estimated on the basis of 1978 budget requests for facility operation which included summer employment. The amount estimated for summer employment in 1977 amounted to $3,788.70.
7. The total tonnage of solid waste includes 2,762.5 TPY of trash which was incinerated and 319.4 TPY of recyclables. The net cost for incineration amounted to $20.48 per ton of refuse.

(Note: The cost associated with the closing of the old dump is excluded from the economic analysis of the facility. In 1977 the Town appropriated $4,200 for this work, but it was unexpended and carried over to the 1978 budget.)

THE RECYCLING PROJECT OF SWANZEY, NEW HAMPSHIRE

Located in the southwest corner of the State of New Hampshire, just south of Keene, Swanzey is a small community with an estimated 1976 population of 4,800. It serves as a bedroom community of Keene and its finances are beset with traditional problems of this type of a community, particularly large numbers of children in school and rising costs of services. It is dependent upon the traditional town meeting and elected Selectmen. The recycling project in Swanzey leads to the following insights:

- Mandatory recycling is important if a project is to be successful.
- When a community depends upon another community's facilities, its solid waste solutions are subject to the conditions set by the other community.
- Small communities may require technical and planning assistance when developing solutions to their solid waste problems.

Planning Phase

Planning began with a search for a landfill site in the community. Because all investigated sites had environmental and/or neighborhood problems, Swanzey opted to take advantage of Keene's decision to open its landfill operation to adjacent communities. The interesting aspect of this project is Swanzey's relationship with Keene.

System Procurement Phase

Swanzey has contracted to send its solid waste to Keene, except for that portion recycled, and wood, brush, whitegoods and tires. It pays Keene $4.26 per ton, delivered to Keene; Community Sanitation, Inc. hauls waste from the recycling/transfer center to the Keene site at a cost of $762 per month. In addition, there are private commercial haulers in the town who also haul solid waste directly to the Keene facility. Swanzey pays Keene $4.26 for each ton these haulers deposit as well. Private hauler pick up and transportation costs are paid by the individuals. For recycled goods, contracts have been let with Recycling Enterprises for glass and Springfield Paper Stock for paper and cardboard.

The town in its 1974 town meeting appropriated a total of $70,000 for the recycling center. Of this amount, $32,000 was expended and the center opened in July 1975. Swanzey has financed the process throughout, without federal assistance.

All of the technical planning work was performed by the selectmen and the road agent. The building was contractor-built without the services of an architect.

Operating Phase

The recycling center opened on July 1, 1975. The dump was closed at that time except for open burning of wood. It has slowly been cleaned and leveled by the Department of Public Works.

The facility is located immediately adjacent to the highway department and is supervised by the road agent for the town. In 1977, approximately 2,500 tons of waste were generated in Swanzey, about 2,400 of which were deposited at the Keene landfill. Only 704 tons of this waste were processed through the recycling/transfer center and transported to Keene by Community Sanitation, Inc. In this same year approximately 73.4 tons of paper and corrugated board and 38.8 tons of glass were recycled and sold for a revenue of $2,215.53.

The recycling facility is utilized for the baling and storage of paper and the storage of cans. Residents color separate glass in marked bins by the entrance, drop off cardboard, paper and cans in separate bins, then deposit the remaining solid waste in a compactor/container supplied by Community Sanitation. White goods, tires and brush are deposited approximately 200 yards behind the building. No adequate arrangements for selling white goods, tires and cans has been made.

The one employer, who works thirty hours per week, maintains the facility, bales and stores paper, and runs the compactor for Community Sanitation. The operation is relatively simple; the major problem has been inadequate resident participation in the separation of recyclable materials. Many citizens send unseparated waste with private collectors to the Keene landfill.

This situation suggests mandatory recycling would be advisable in Swanzey. Because it is not required, residents can elect to go outside the system to meet their solid waste needs. This and the need to further develop alternatives for solid waste disposal are the greatest problems facing Swanzey. The current dependence on Keene represents a partial and unsatisfactory solution for Swanzey. If Keene decides, for example, to extend the life of its landfill by reserving the site exclusively for its own waste, Swanzey would have no recourse. Furthermore, Keene's landfill will be saturated in approximately six years. These problems are compounded by the fact that Swanzey appears to lack both the resources and the planning capacity to fully develop solutions for its solid waste disposal problems, while the need to develop solutions has been mandated by the state.

Currently, two options are being discussed, both involving regional solutions using waste to produce energy. Developing adequate solutions will not be easy for a community the size of Swanzey, and it is possible decision-makers would benefit from state or federal assistance in assessing and developing options.

Financing

The metal building, including foundation, electrical systems, and town water cost the town $24,200. Additional capital costs involved a $5,000 baler and a second-hand forklift worth $2,800. Capital costs were financed directly from the Town's annual budget. Out of the $70,000 originally voted for this purpose, only $32,000 was expended.

Table 1 illustrates total costs for all solid waste disposal in Swanzey and also shows the costs attributable to the recycling center. Table 2 indicates the income received from the recycling center for 1977 (1976 figures are not available): $10 per ton was paid for glass; $30 for newspaper; $10 for mixed paper; and $20 for corrugated board.

TABLE ONE: COSTS OF SOLID
WASTE DISPOSAL, SWANZEY, NEW HAMPSHIRE
1976 and 1977

	1977		1976	
	Total	Recycling Center Only	Total	Recycling Center Only
Salaries	$ 4,873.58	$ 4,873.58	$ 5,015.56	$ 5,015.56
Group Insurance	--	--	995.28	995.28
Withholding	269.90	269.90	327.70	327.70
FICA	252.90	252.90	709.50	709.50
Fuel	1,373.23	1,373.23	1,284.39	1,284.39
Telephone	195.88	195.88	175.46	175.46
Electricity	481.03	481.03	542.51	542.51
Pest Control	37.00	37.00	50.00	50.00
Repair Parts	339.76	339.76	--	--
Signs	287.89	287.89		
Refuse Removal	9,144.00	9,144.00	9,906.00	9,906.00
Rental of Keene Landfill	10,379.00	2,999.04*	10,672.36	2,299.04*
Insurance	--	--	1,472.00	1,472.00
Total	$28,204.17	$20,824.41	$31,459.28	$23,786.06

* For portion of solid waste generated by recycling center only.

TABLE TWO

INCOME FROM SWANZEY RECYCLING CENTER FOR 1977

February 28	Springfield Paper Stock	$ 259.61
May 5	Springfield Paper Stock	260.81
June 1	Recycling Enterprises	253.90
July 5	Springfield Paper Stock	317.50
July 13	Recycling Enterprises	134.70
July 22	Springfield Paper Stock	389.35
September 7	Norman Buffum	60.00
September 28	Springfield Paper Stock	292.46
November 30	Recycling Enterprises	247.20
	Total	$2,215.53

TOWN OF SWANZEY, N.H.

RECYCLING/TRANSFER FACILITY

1. CAPITAL COST	
A. LAND	Not Applicable
B. SITE PREPARATION & BUILDING	$24,200.00
C. EQUIPMENT	7,800.00
Paper Baler	5,000.00
Skid Steer Loader (used)	2,800.00
D. ENGINEERING, LEGAL & ADMINISTRATION	Not Applicable
TOTAL CAPITAL COST	$32,000.00
IMPUTED ANNUAL DEBT SERVICE[1]	4,072.92
Financed for 10 years @ 5 percent interest	
11. OPERATING COSTS (1977)	
A. LABOR	$ 7,658.42
Manager (imputed)[2]	1,500.00*
Labor[3]	6,158.42*
B. UTILITIES	676.91*
Electricity	481.03
Telephone	195.88
Water & Sewer	Not Available
C. FUEL	$ 1,373.23*
Fuel for Skid Steer	1,373.23
D. MAINTENANCE	$ 37.00*
Pest Control	37.00
E. PARTS AND SUPPLIES	$ 1,197.65*
Repair Parts	339.76
Strapping for Baler & Signs	287.89
Rental Equipment (Compactor)	570.00
F. INSURANCE[4]	$ 736.00*

TOWN OF SWANZEY, N.H.

RECYCLING/TRANSFER FACILITY

	G. OTHER	$19,523.00	
	Refuse Removal	9,144.00*	
	Rental of Keene Landfill	10,379.00	
	TOTAL OPERATING COST	$31,202.21	($23,783.26)[5]
III.	ANNUAL DEBT SERVICE (Imputed)	$ 4,072.92*	
IV.	TOTAL ANNUAL COST (Operating and Debt Service)	$35,275.13	($27,856.18)[5]
V.	RECYCLING REVENUES		
	A. PAPER	$ 1,519.73	
	News	1,111.40	
	Mixed	248.65	
	Corrugated	159.68	
	B. GLASS AND CANS	635.80	
	C. MISCELLANEOUS	60.00	
	TOTAL REVENUES	$ 2,215.53	
VI.	NET ANNUAL COST (Total annual cost less revenues)	$33,059.60	($25,640.65)[5]
	A. PER TON OF SOLID WASTE (2550.2 TPY)	$ 12.96	
	B. PER CAPITA (4,800 persons)	6.89	
	C. AMOUNT OF TAX RATE PER $1,000 TAV	.86	
	D. RECYCLING/TRANSFER FACILITY ONLY (816.2 TPY)	31.41	

TOWN OF SWANZEY, N.H.

RECYCLING/TRANSFER FACILITY

NOTES:

1. The Town financed all capital expenditures out of general appropriations. In order to provide comparison with all the other facilities in New Hampshire, an imputed debt service was assigned to the facility. Because other facilities in New Hampshire have been financed over a ten year period, the imputed debt service was calculated on the assumption of a ten year financing at an interest rate of 5 percent. It also should be noted that use of an imputed debt service gives a more realistic picture of the annual cost of solid waste disposal.
2. The Town does not assign the supervisory time of the Highway Agent to the Recycling/Transfer Facility, but rather includes the cost of the Highway Agent to the Highway Department budget. In order to estimate the true annual cost of disposal, an allocation of an estimated $1500 for management was made to the annual operative cost of the Facility. This estimate assumed that only 10 percent of the Highway Agent's time was involved in supervision of the Facility because of the location of the Highway Department office and the Facility.
3. In 1977, the Town did not show any expenditure for group insurance for the employee at the Recycling/Transfer Facility. However, it did report an expenditure in 1976 for this item. Therefore, an estimate was made for 1977 based on the proportion group insurance was to total salaries and fringe benefit expenditures in 1976.
4. In 1977, the Town did not show any expenditure for insurance. However, in 1976, the Town spent $1,472 for insurance. It was assumed that half that amount represented premium payment for 1977.
5. Values in parentheses apply to Recycling/Transfer Facility. The components of cost identified by an asterisk (*) represent those which are applicable to the Facility per se. To derive the total cost and net annual cost for the Facility, the total payment to Keene for disposal

at the landfill was apportioned on the basis of the proportion of total solid waste tonnage landfilled accounted for by the tonnage hauled from the transfer operations at the Facility.

(Note: The cost for final grading and closing of the open dump is not included in the above cost figures. It was impossible to break-out the cost for dump closing from the Highway Department budget.)

THE INCINERATOR AND RECYCLING PROJECT OF PLYMOUTH, NEW HAMPSHIRE

Plymouth is located about 30 miles north of Concord, the state capital of New Hampshire, and about 126 miles north of Boston. The town is situated in the lakes region of the state, but unlike many of its neighboring towns does not contain a lake affording recreational opportunities and attractions. As a result Plymouth is not subject to a large influx of summer tourists and residents. In 1976, the estimated population of the town was 5,330 persons. Of this total, about 2,300 persons were students at Plymouth State College. Town officials estimate that summer residents offset the loss of students during that season, thus providing a stable year round population level. In addition to being a college town, Plymouth has a substantial business center which serves a trading area containing a population of approximately 20,000 persons.

The Plymouth incinerator/recycling project is of interest because it:

- Demonstrates how a viable alternative to an open dump can be created in a situation where sanitary landfilling is not geologically and environmentally possible;
- Demonstrates how an effective implementation process can be carried out by small towns;
- Illustrates the cost which must be borne by a small town when it must "go it alone" because of the lack of willingness by neighboring towns to cooperate in a regional solution to solid waste disposal;
- Contributes to the realization that with careful planning mandatory recycling can work and make a positive contribution to solving the overall solid waste disposal problem faced by small towns;
- Has significant operating experience and data from which other small towns contemplating a similar project can learn and benefit; and
- Illustrates some of the problems in materials handling which can arise when a project is not designed from a systems point of view.

Planning Phase

In response to the legislation requiring its open dump to close, Plymouth created the Regional Refuse Disposal Committee at its 1973 Town Meeting. (All committee meetings were open to the public and media was invited. At least one Selectman was present at each meeting.) During the first year of the Regional Refuse Disposal Committee a thorough study was made to locate sanitary landfill sites within the Town as well as to establish a regional landfill solution with the neighboring towns of Compton, Rumney, Holderness and Ashland. Using soils maps, four potential sites were selected, all of which were later rejected. The effort to seek a regional solution also failed, because none of the neighboring towns wanted to host a regional sanitary landfill and none was currently under pressure to close their burning dumps. Because these communities were likely to cease operation of their burning dump within a few years, Plymouth officials remained resolute in their belief that a regional approach would ultimately materialize. This belief affected decisions on incinerator selection and facility design.

Very early the Committee tentatively concluded that incineration was probably the best solution to the town's disposal problem. To learn more about incineration the Committee invited a number of manufacturers to provide equipment information, and the Committee and Selectmen visited incinerator installations and spoke with individuals associated with the projects. Both the Committee members and Selectmen became convinced as a result of their visit to the installation in Wellfleet, Massachusetts that incineration was highly feasible in Plymouth.

In April 1974 Selectmen requested from the Air Pollution Control Commission a one year extension in the date for closing the burning dump. The Commission notified the Town in late June that it was granting a variance only until January 1, 1975 contingent upon submission of a favorable report of progress being made within the first three month period of the six month extension. Also in April representatives from the Solid Waste Management office of the Department of Public Health and Welfare visited the dump site and advised the Selectmen that in their opinion part of the Town dump could be safely used for the disposal of incinerator residue.

During their many deliberations on incineration the Committee and Selectmen came to appreciate the role recycling could play not only as part of the overall management of solid waste disposal (because of its contribution to reducing the volume of material to be ultimately land-filled) but through improvement in incineration operation, especially if glass were removed. However, Committee members and Selectmen were highly doubtful that recycling would be acceptable to residents, especially if it were mandatory. Despite this uncertainty with respect to recycling, the Committee and Selectmen proceeded to develop a facility concept involving substantial processing of recyclable materials-baling of cardboard and newspapers, separation of tin and aluminum cans, separation of glass, crushing of glass and cans, and substantial indoor storage areas for each of these various materials. Central to their approach was the need to make it as easy as possible for residents to deposit each type of separated material, in order to encourage participation in a recycling program. Thus, they developed a concept of a one stop area adjacent to the incinerator operation at which residents could simply and quickly deposit their recyclables.

In addition to carefully developing a recycling concept, town officials also explored the possibility of producing steam for sale to a local user. Because of severe space limitations faced by local industry, the only potential user apeared to be Plymouth State College. The timing seemed propitious since the college had an old boiler which it needed to replace; however, for a few reasons, the college rejected the concept and as a result it was clear that an incinerator/recycling facility would have to be located at the existing dump site.

By mid summer the Committee and Selectmen had narrowed their choice of incinerator equipment down to that supplied by one vendor. As a result, the Selectmen held a public meeting on August 12, 1974 at which Combustion Engineering Company was invited to give a presentation on the incineration of refuse. This meeting was held about 6 weeks prior to the Town Meeting rescheduled for September 24, 1974. The reason for selection of Combustion Engineering was:

- Their installation at Wellfleet was working well, whereas at other incinerator installations visited the equipment had not been operating properly or had broken down.

- The bombay door feature for ash removal and ram loading whereas the Kelley equipment they had seen required manual loading and manual removal of ash. (Note: It is understood that sometime in 1976 Combustion Engineering withdrew from the manufacture and sale of small municipal incinerators.)

- The company guaranteed the equipment would meet air pollution control standards and if after state testing the state did not issue the Town a certificate for operation the company would remove the equipment at its cost and the Town would not have to pay for the purchase.

The October 3, 1974 Emergency Town Meeting voted (in secret ballot) an overwhelming 87 percent in favor of the article to finance for $25,000 an incinerator and recycling facility. Town officials believe that in addition to information on the success in wellfleet the following factors accounted for the high support given to the project:

- Documentation that sanitary landfill sites did not exist within the Town, and there was no likelihood of a regional landfill solution.

- The facility would be located at the existing dump-site.

- Recycling had advantages in that it would produce some income as an off set against operating cost; would contribute to reducing the volume of material to be landfilled, thus extending the useful life of the area to be set aside at the dump for ash disposal; and the removal of glass through recycling would improve the operating efficiency of the incinerator.

- A negative vote by the Town Meeting would permit the State to come in and build the plant and bill the Town over a period of 20 years. (It was argued that this would be more costly than if the Town issued its own bonds for the facility.)

At the Emergency Town Meeting, the Committee discussed the fact that consideration had been given to establishment of a fee system to pay for the operating cost of the facility. This payment method had been investigated primarily as a means of collecting from Plymouth State College its fair share for the use of the incinerator/recycling facility. In the end, however, it was decided to rely on taxation as the method of payment even though the college could not be taxed. The reason for this decision was that it was felt that a fee system could prove to be most complicated. Although the Town does not collect from the college for its use of the facility, it did work out a very satisfactory arrangement. The college agreed to assign one of its employees to work at the facility on a full time basis, and to cover salary and fringe benefits for this person.

System Procurement Phase

In late October 1974 the Selectmen (following interviews with representatives from several firms) retained the services of a local area consulting engineer to undertake preparation of the design of the facility, to select equipment and materials, to prepare plans and specification for building construction and site development, to assist the Selectmen in obtaining and evaluating bids and awarding contracts, and to provide construction supervision. Also in late October the Selectmen entered into an agreement to purchase a Model 2000 Combustall incinerator from The Air Preheater Company (a subsidiary of Combustion Engineering, Inc.) for a price of $95,000. The Selectmen also in October notified the Air Pollution Control Commission of the Town Meeting to vote on the bond issue and the purchase agreement for the incinerator, and requested an extension of its variance with respect to the January 1, 1975 date to cease open burning at the dump. (Extension to July 1, 1975 was granted by the Air Pollution Control Commission in mid-January 1975.)

In late March 1975 the consulting engineer filed a permit application for the incinerator with the Air Pollution Control Agency, and a few days later filed Site Operations Plans for the Incinerator/ Recycling Facility along with soil data with the state Department of Health and Welfare.

In mid April the Department approved the use of the existing dump as the site for the Incinerator/Recycling Facility subject to the conditions on the following page.

- No open-burning (of stumps and brush) was to occur except as authorized by the Air Pollution Control Agency.
- The existing dump must be properly closed.
- The site could only be operated in accordance with the Site Operation Plan.
- Only incinerator ash could be landfilled at the site.

All construction work was to be completed within 180 days, or by December 1,1975. It was particularly important that site work, foundations, and the building shell (at least for refuse disposal) be completed in July, since the Town was anticipating delivery of its incinerator that month.

During the early summer the Town advertised for the purchase of a paper baler, truck scales, travelling can and glass smasher (crusher/mutilator), and a skid steer with a lifting capacity of 1700 pounds. Orders for this equipment were placed in late August.

As construction progressed it became clear that actual costs would exceed the original $250,000 approved by the Emergency Town Meeting. Revised estimates prepared in early August 1975 indicated that local project costs were likely to amount to slightly under $301,000. This increase in costs resulted from construction change orders and the need for additional site work, such as the Town's share of the dump face resurfacing and paving of the access to the facility. With respect to the cost for restoring and refacing the old dump, the Selectmen decided that $4,000 would be spent out of the capital account, and the remaining $5,200 cost would be taken out of general revenues. The reason for this decision was that restoration work would be spread over a 2 to 3 year period following the start of operation of the Incinerator/Recycling Facility. Because the Town had not been required to pay the full purchase price of the incinerator until certification by the State, the Selectmen decided to wait until the next regularly scheduled Town meeting to obtain approval for the additional expenditures. During the fall, the Selectmen also determined that they could secure another FmHA low interest loan for the additional $50,000.

Prior to completion of construction, the Selectmen became convinced that mandatory recycling would be necessary in order to be successful. However, they decided that it would be best to start recycling on a voluntary basis in order to get townspeople accustomed to a change in behavior.

Operating Phase

The incinerator/recycling facility began operating on February 1, 1976. The facility provides for combined incineration and recycling processing operations under one roof. The facility is equipped with one incinerator capable of processing up to 12.5 tons per day (TPD) of municipal refuse at a continuous charging rate of 8 hours per day. The capacity of the incinerator is in excess of the daily tonnage of solid waste generated by the Town. Because of excess capacity, the incinerator is operated only 4-5 days per week. Ash from the incinerator is removed once every three days. The incinerator is physically located outside the building on an elevated concrete platform. The incinerator has an automatic ram loading device and is equipped with bombay doors which permit ash to drop directly into an ash bin located directly beneath the incinerator. Refuse is dumped on an enclosed tipping floor comprising about half the total floor area of the building. Refuse is moved by a skid steer loader from the tipping floor via a ramp to the automatic ram loading hopper of the incinerator.

All vehicles bringing refuse for incineration are weighed on 30 ton capacity truck scales before entering the tipping floor area. The dumped refuse is inspected by the facility staff to determine that it is relatively free of materials mandated to be separated from refuse by households and commercial, institutional and industrial enterprises. Based upon scale recordings an estimated 1500 tons per year are processed through the incinerator.

When the facility opened, the Selectmen established a voluntary recycling program which was well received by Townspeople. Taking advantage of the positive response, Selectmen held several public hearings on the subject of a mandatory program. At these hearings the

Selectmen pointed out the effect of glass and cans on the operations of the incinerator--slagging, increased auxiliary fuel consumption due to non-combustible material in the refuse to be incinerated, the need to daily remove incinerator ash, the advantage of reducing the volume of incinerator ash and landfill requirements through removal of recyclables, and the increase in revenues from the sale of recycled materials which could help offset annual operating costs. Wisely, the Selectmen also used these public hearings to obtain reactions from residents as well as their suggestions for implementing a mandatory program. As a result of this public education and information process the Selectmen were empowered by the Town Meeting to institute a mandatory recycling program. A copy of the ordinance is presented following this discussion.

In May, 1976, the Town entered into a two year agreement with Recycling Enterprises, Inc. of North Oxford, Massachusetts for the purchase of glass and cans. Although a formal agreement does not appear to exist for the sale of newspaper and corrugated cardboad, the Town sells these recovered materials on a regular basis to Haverhill Boxboard in Massachusetts. It has also made some sales to a boxboard company in Canada. Contracts for the sale of white goods and other large scrap metal items do not exist. These materials are stored outside and perodically sold to a scrap metal dealer. Other bulky items, such as used furniture, are stored and sold to town residents through a continuously run "yard sale." Discarded automobile tires currently are stored at the facility site. However, the Town is optimistic that the recent opening of a tire processing operation which will produce tire based fuel pellets as a supplemental fuel for the New Hampshire Public Service Company will provide a market outlet.

Recyclable materials processing involves baling of newspapers and corrugated into 1,700 pound bales, and the use of an automatic can and glass crusher to increase the density of materials for transport to Recycling Enterprises, Inc. A special entrance and tipping area is provided for trucks delivering paper products. Inside storage is provided for approximately 40 bales. A special entrance is provided for access by truck (and the 30 cu. yd. roll-on-roll off container) to pick up the bales. Some 42-54 tote bins are used to store crushed glass and cans. These bins are periodically dumped into a 30 cu. yd. roll-on-roll off container supplied by Recycling Enterprises.

One attractive feature of Plymouth's recycling operation is the one-stop area for deliveries of glass, cans, newspapers, corrugated cardboard and mixed paper products delivered by automobile. Vehicles stop on one side of the building and the vehicle operator then deposits, through a series of specially marked windows, each of the recyclable materials. Facility staff carefully inspect the glass for contaminants, such as ceramics, plastics and bottletops, and to make certain that brown and green glass containers are not mixed in with the clear glass, all contaminants are removed by hand. Glass and cans are manually shoveled separately into an automatically controlled, travelling crusher/mutilator. Crushed materials are deposited into tote bins which once filled are pushed to a special storage area. Once this area is filled other tote bins are stored outside on one side of a 35 foot long loading dock.

Annually, the tonnage of recovered materials processed through the facility in 1977 was:

Newspaper & Corrugated	Tons
Glass and Cans	183.26
	324.64

In addition, an estimated 15-20 tons of white goods and scrap metal and approximately 50 tons of tires were stored at the facility as of April 1978. The Town also operates a so called "yard sale" where residents can buy old furniture, radios, TV's, picture frames, etc. left by other residents.

In summary, annual tonnage processed through the facility (exclusive of white goods, heavy metals, tires and yard sale items) in 1977 was:

	Tons	Percent Distribution
Refuse	1500.0	74.7
Recyclables	507.9	25.3
Total	2007.9	100.0

Despite the advantage and success of the recycling operations, the Plymouth facility has experienced some problems. The ramp from the refuse disposal portion of the building to the incinerator loading bin ices up in the winter complicating skid steer operations. The skid steer purchased by the Town did not have sufficient capacity to lift the 1700 pound bales of paper, therefore, it was necessary to rent a skid steer for much of the time during the first year. The can/glass crusher also presented problems - delivery was delayed, and then frequent jamming occured. Because of the layout of the facility's recycling portion, it was difficult to get the 30 cubic yard container provided by Recycling Enterprises into and out of the building. Town officials admit this is an example of the price they have had to pay due to lack of experience in materials handling.

Financing and Project Economics

The total cost of the Plymouth project was $351,463. Of this total, $300,463 represents the cost of building construction, equipment purchase and installation, engineering, legal and administrative costs and a small outlay for closing the dump and its reclamation. The balance of $51,000 represents the remaining cost for restoration of the dump.

Project costs are financed through a 10 year low interest loan from the Farmers Home Administration (FHA) for $300,463. Because the maximum size of any one FHA loan is $250,000, it was necessary for the Town to file two loan applications at different time periods. As a result, each loan bears a different rate of interest. The combined annual debt service (principal and interest) on the two loans amounts to $45,000. Loan repayment funds are raised through local property taxes. The $51,000 cost for resurfacing the old dump face, trench work and planting is split between the Town ($5800) and the North Country Resource Conservation and Development Project, Inc., (NCRCDP) ($45,200). The Town has treated its share as an operating cost of the incinerator/recycling facility. Funds for the NCRCDP portion of the dump reclamation work were supplied through the Soil Conservation Service, U.S. Department of Agriculture.

Operating costs are included as part of the Town's budget. Annual operating costs (including the salary of one man currently paid for by Plymouth State College) amounted to $42,006 in 1976 and $50,737 in 1977. The 1977 increase in operating costs over those for 1976 is largely accounted for by the fact that the Town found it necessary to trade in its front end loader (used to feed MSW into incinerator??) (to lift recycled paper) for a new one with a greater lift capacity.

The combined debt service and operating cost of $95,737 was reduced by revenues of $11,962 generated through recycling and (to a minor extent) through fines charged for non-compliance with the mandatory recycling requirement. Thus, annual net costs in 1977 amounted to $85,150, or $16.06 per capita. Based on annual tons of solid waste processed at the facility, annual net costs in 1977 amounted to $42.63 per ton. The 1977 annual net cost per ton in Plymouth (while high) is expected by Town officials to decline modestly because there will be no inclusion of a one-time cost for a new front end loader and the currently high insurance premiums on the facility should decline substantially when a Town water main is extended to the facility in 1978 for fire protection purposes.

TOWN CF PLYMOUTH, N.H.

INCINERATOR/RECYCLING FACILITY

I. CAPITAL COST (1975)

A.	LAND	Not Applicable
B.	SITE DEVELOPMENT	$ 47,304
	General Conditions	7,455
	Excavation & Site Work	20,536
	Fencing	3,050
	Seeding & Mulching	2,700
	Reface Slopes of Dump & Close[1]	4,000
	Pave Access Road	9,563
C.	BUILDING	109,713
	Foundation & Masonry	45,253
	Building Structure	39,405
	Mechanical	8,736
	Electrical	16,319
D.	EQUIPMENT	$129,139
	Incineration Equipment	95,000
	Truck Scale	10,500
	Skid-steer Loader	9,000
	Crusher	5,579
	Paper Baler	6,560
	Container, tools, etc.	2,500
E.	ENGINEERING, LEGAL & ADMINISTRATION	$ 12,740
F.	CONTRACTOR'S BOND	$ 1,567
	TOTAL COST FINANCED	$300,463

II. CAPITAL COST FINANCING

A.	BOND ISSUE	
	10 years @ 4.3% interest	$250,000
	10 years @ 5.0% interest	50,000
B.	ACTUAL DEBT SERVICE	
	Principal	$ 30,000
	Interest	15,000
	TOTAL DEBT SERVICE	$ 45,000

TOWN OF PLYMOUTH

INCINERATOR/RECYCLING FACILITY

III. OPERATING COSTS (1977)

A. LABOR	$ 25,835.00
Manager	10,935.00
Laborers[2]	14,900.00
B. UTILITIES	$ 2,488.00
Electricity	1,871.00
Telephone	545.00
Water & Sewer	72.00
C. FUEL	$ 6,027.00
Gas for Skid Steer	1,171.00
Gas for Incinerator	47.00
Fuel for Incinerator	4,809.00
D. MAINTENANCE	$ 3,879.13
Case Uni Loader	328.84
Incinerator	1,665.20
Can Crusher	757.82
Baler	-
Building and Grounds	783.27
Scales	35.00
Mowing	28.00
Work by Highway Dept.	118.00
Construction & Sitework	163.00
E. PARTS AND SUPPLIES	$ 1,695.00
Tires	26.00
Ties for Baler	166.00
Tools	116.00
Parts (crusher incinerator)	1,226.00
Rental of Front End Loader	161.00
F. INSURANCE[3]	$ 3,771.00
G OTHER	$ 7,490.00
Miscellaneous	643.00
Net Purchase of Case Uni[4] Loader	6,800.00
Travel	47.00
TOTAL OPERATING COST	$ 51,185.13

TOWN OF PLYMOUTH, N.H.

INCINERATOR/RECYCLING FACILITY

IV.	ANNUAL DEBT SERVICE	$ 45,000.00
V.	TOTAL ANNUAL COST (Operating & Debt Service)	$ 96,185.13
VI.	REVENUES (1977)	
	A. RECYCLING	$ 10,096.00
	Paper	6,665.00
	Cans & Glass[5]	2,525.00
	Scrap Metal	552.00
	Yard Sale	354.00
	B. OTHER	$ 1,866.00
	Separation Fees (Fines)	1,530.00
	Scale	66.00
	Permits	30.00
	Insurance Refunds	240.00
	TOTAL REVENUES	$ 11,962.00
VII.	TRANSPORTATION COST OF RECYCLABLES	
	Paper	$ 1,375.00
	TOTAL	1,375.00
VIII.	NET ANNUAL COST (Total annual costs less revenues plus transportation costs)	$ 85,598.13
	A. Per Ton of Solid Waste[6] (incl. recyclables)	$ 42.63
	B. Per Capita (5,330 Persons incl. College)	$ 16.06
	C. Amount on Tax Rate per $1000 TAV	$ 2.57

TOWN OF PLYMOUTH, N.H.

INCINERATOR/RECYCLING FACILITY

NOTES:

1. Only $4,000 of the total cost to the Town of $9,200 was included in the bond issue. The balance of $5,200 will be paid out of general revenues, and thus treated as an operating cost, since work on resurfacing the face of the dump planting and landscaping is being done over several years. The total cost of dump resurfacing is $55,100 of which $45,200 is being paid for by a grant from the North Country Resource Conservation and Development Project, Inc.

2. Includes the cost of $8400 per year for the laborer supplied by Plymouth State College at no cost to the Town.

3. The cost of insurance on the facility is expected to decline substantially during 1978 as a result of a water main being extended to the facility and a hydrant being located at the facility.

4. The Town decided to purchase in May 1977 a new front end loader because the one originally purchased was unable to lift the bales of paper weighing 1700 lbs. to sufficient height for stacking. Following a competitive solicitation, the Town purchased a Case 18455 Uni Loader for $13,290 with a trade-in allowance of $6,490 for its 1976 Melroe Bobcat Skid Loader, or a net price of $6,800.

5. Revenues for cans and glass are net of transportation and processing costs borne by the buyer of these materials. Transportation costs are understood to include round trip mileage between North Oxford, Mass. and Plymouth, N.H. as well as transportation costs for delivery of glass to Dayville, Conn. and tin cans to Elizabeth, N.J.

TOWN OF PLYMOUTH, N.H.

INCINERATOR/RECYCLING FACILITY

6. Tons of solid waste processed through the incinerator and recycling facility amounted to 2007.9 tons in 1977. The high cost per ton is due to several factors: a) amortization of the debt service over 10 years rather than 20 years; b) the cost for replacing the skid steer; c) the high insurance premium due to lack of a hydrant at the facility. If the $300,000 bond issue had been amortized over 20 years, annual debt service would have been $17,413 less than that required for the 10-year amortization period. This would have reduced annual cost by $8.67 per ton of solid waste processed through the facility. If the skid steer had not had to be purchased, but the high maintenance and parts cost experienced in 1976 been expended in 1977, the cost per ton would have been reduced by $2.59. Despite these factors, Plymouth does pay an unusally high cost for disposal as a result of having to go it alone.

TOWN OF PLYMOUTH
INCINERATOR-RECYCLING FACILITY

ORDINANCE

1. HOURS

The Incinerator-Recycling facility will be open for use by Plymouth residents and non-resident property owners during the following days and hours under the following conditions:

A. Admission to the facility will be by permit or stickers issued by the Selectmen.

B. The facility will be open:

9:00 - 5:00 Monday, Tuesday, Thursday, Friday
9:00 - 12:00 Saturday
9:00 - 2:00 Sunday

2. SEPARATION

All material shall be separated into the following categories:

A. GLASS

(1) COLORED GLASS SHALL MEAN ANY BROWN OR GREEN EMPTY GLASS CONTAINERS

(2) CLEAR GLASS SHALL MEAN ANY EMPTY TRANSPARENT GLASS CONTAINERS OR GLASS PRODUCTS THAT ARE NOT COLORED

B. METAL

(1) All metal containers under 5 gallon size

(2) White goods such as refrigerators, etc.

(3) Scrap metal such as pipe, car parts, cast iron, etc.

(4) Other metal such as wire, metal strapping, metal containers containing grease or other inflammables shall go to the incinerator.

C. NEWSPAPERS — SHALL BE CLEAN AND DRY. PAPER BAGS AND MAGAZINES SHALL BE KEPT SEPARATE FROM NEWSPAPERS.

D. CARDBOARD — SHALL MEAN ALL CORRUGATED CARDBOARD WHICH IS CLEAN AND DRY

E. TREE LIMBS, BRUSH, WOOD BUILDING MATERIAL, LAWN AND GARDEN WASTE SHALL BE PLACED AT LOCATION DIRECTED BY MANAGER. TRUCK LOADS OF CLEAN BRUSH AND LIMBS SHOULD BE DELIVERED TO SEWAGE TREATMENT PLANT.

F. GARBAGE — SHALL MEAN ANY OTHER HOUSEHOLD WASTE WHICH IS NOT LISTED ABOVE.

G. CLEAN, NON-FLAMMABLE BUILDING MATERIALS SUCH AS PLASTER BOARD, BRICKS, CONCRETE BLOCKS, SHALL BE SEPARATED AND DUMPED IN LANDFILL AS DIRECTED BY MANAGER.

There shall be a one penny a pound fine for trash which is not separated into above categories. These fines shall be assessed at the facility and paid to the Town of Plymouth.

3. SUPERVISION

A. The Incinerator-Recycling Manager shall have the right to refuse the use of the Plymouth Incinerator-Recycling facility to any citizen who is misusing said facility.

B. There shall be a minimum fee of five dollars ($5.00) for any monthly bills not paid.

4. BURNING

All outside burning at the facility shall be at the direction and supervision of the District Fire Warden.

Tires and tubes will be accepted if separated from other materials. There will be no burning of tires and inner-tubes: it is illegal.

5. SHOOTING

Shooting is prohibited at the facility.

6. NON-RESIDENT RUBBISH COLLECTORS

Non-resident rubbish collectors will be permitted to use the Plymouth facilities for materials, etc., collected within the limits of Plymouth township only.

7. COMMERCIAL HAULERS

All persons engaged in the commercial hauling of rubbish materials, etc. will be charged a fee of $10.00 per year and shall furnish a $1,000.00 bond or a deposit of $500.00 cash.

All commercial containers shall be kept water tight and dry.

A charge will be made for all commercial dumping of materials, such as brush (no tree stumps accepted), clean building materials, etc., as follows:

Truck loads of up to seven yards - $5.00 per load

Truck loads of more than seven yards - $10.00 per load

Repeated pick-up loads will be based on an accumulative basis. A record of the charges will be given to the driver of the truck dumping such materials at the time of dumping. Weekly payment of Dump Use Fee to the Selectmen of the Town of Plymouth will be required.

8. The gate will be locked at all times when the dump is not open to the public. Anyone apprehended inside the dumping area when it is supposed to be locked will be charged with violation of the above ordinances and be subject to a maximum fine of $50.00.

9. Any previous ordinances shall be considered void upon the passage of this ordinance.

10. Effective date of this ordinance will be the 1st day of August 1978.

Date: ____________________

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PLYMOUTH BOARD OF SELECTMEN

APPENDIX C

GLOSSARY

Reprinted with permission from the November 1978 Resource Recovery Briefs.

GLOSSARY

of Solid Waste Management and Resource Recovery

Like any emerging technology, resource recovery and modern solid waste management have developed a jargon all their own — often leaving the layman puzzled by a maze of incomprehensible terminology. "What's pyrolysis? What's the difference between a dump and a sanitary landfill?"

In this new edition of the Glossary, the National Center for Resource Recovery, Inc., provides brief definitions for some of the more commonly used — but frequently misunderstood — terms. The definitions were prepared for lay readers, and should not be considered technically complete. Emphasis was placed on interpreting word meanings in the context of resource recovery and solid waste management, so that an interested reader without a technical background will find the terms to be helpful, understandable and relevant.

Aerobic Digestion: The utilization of organic waste as a substrate for the growth of bacteria which function in the presence of oxygen to reduce the volume of the waste. The products of this decomposition are carbon dioxide, water and a remainder consisting of inorganic compounds and any undigested organic material.

Air Classifier: A unit process in which mixed material is injected into a forced air stream and separated according to the size, bulk, density and aerodynamic drag of the pieces.

Aluminum: A light, strong, silver-colored metal, and the most abundant metallic element in the earth's crust. It is derived chiefly from the mineral bauxite.

Aluminum Magnet: See *Eddy Current Separator*

Anaerobic Digestion: The utilization of organic waste as a substrate for the growth of bacteria which function in the absence of oxygen to reduce the volume of waste. The bacteria consume the carbon in the waste as their energy source and convert it to gaseous products. Properly controlled, anaerobic digestion will produce a mixture of methane and carbon dioxide, with a sludge remainder consisting of inorganic compounds and any undigested organic material.

"Back-End" System: Jargon for any of several processes for recovering resources from the *organic* portion of the waste stream. (Front-end processes separate and recover the *inorganic* portion from the incoming refuse.) Back-end system operations include refuse-derived fuel recovery, conversion to oil or gas, fiber reclaim, composting, conversion to animal feed, etc.

Ballistic Separator: A mechanical separation system in which the mixed material is ejected with a horizontal velocity, and segregated by the respective ballistic path or arc of each piece according to its mass and drag.

Beneficiation: The concentration, enhancement or upgrading of waste materials in a resource recovery processing system so that they may be more readily used as secondary materials. (See *Secondary Materials*.)

Biodegradable Material: Waste material which is capable of being broken down by bacteria into basic elements. Most organic wastes, such as food remains and paper, are biodegradable.

Biochemical Oxygen Demand (BOD): A measure of the amount of oxygen used by microorganisms to break down organic waste materials in water.

Collection Center: A place or facility designed to accept waste materials from individuals. This is usually for such specific items as glass bottles or cans. The term may also be used to mean a central receiving point for waste material collected by a government or private agency.

Color Sorting of Glass: A technique for sorting by color glass reclaimed from solid waste. Two experimental methods have been developed: (1) Optical sorting which compares light reflected from each piece with light reflected from a background standard. Successive passes, with different light source filters and standards, could be color selective. (2) Magnetic sorting which utilizes high-intensity magnetic forces on small glass pieces to sort the clear glass from the colored glass (which contains iron compounds).

Combustibles: Various materials in the waste stream which are burnable, such as paper, plastic, lawn clippings, leaves and other light, organic materials.

Commercial Waste: Waste material which originates in wholesale, retail or service establishments, such as office buildings, stores, markets, theaters, hotels and warehouses.

Composting: The natural conversion of most organic materials to humus by microorganism activity. Commercial methods speed up the action of aerobic microorganisms by mechanical mixing and temperature control, aeration and acidity. Composting is not effective on plastic and rubber.

Consumer Waste: Materials which have been discarded by the buyer, or consumer, as opposed to "in-plant waste," or waste created in the manufacturing process.

Cover Material: Sand and dirt used to cover compacted waste in a sanitary landfill.

Cullet: Scrap glass, usually broken up into small, uniform pieces.

Cyclone Separator: A mechanical separator which uses a swirling air flow to sort small particles according to their size and density.

Deinking: A process in which most of the ink, filler and other extraneous material is removed from printed waste paper or broke. This produces pulp which can be used along with varying percentages of virgin paper in the manufacture of new paper, including high quality printing, writing and office papers as well as tissue and toweling

Densified Refuse-Derived Fuel (d-RDF): A refuse-derived fuel which has been compressed or compacted through such processes as pelletizing, briquetting or extruding, causing improvements in certain handling or burning characteristics. (See *Refuse-Derived Fuel*.)

Dewatering: The removal of water by filtration, centrifugation, pressing, coagulation or other methods. Dewatering makes sewage sludge suitable for disposal by burning or landfilling. The term is also applied to removal of water from pulp.

Dump: An open land site where waste materials are burned, left to decompose, rust or simply remain. Because of the problems which they create, such as air and water pollution, unsanitary conditions, and general unsightliness, dumps have been declared illegal (with varying moratorium dates) in all states.

Eddy Current Separator: A type of equipment used to separate aluminum and other non-magnetic metals through the use of electrodynamic induction of a magnetic field; *i.e.*, an alternating current is passed through a piece of metal in a specified manner causing the metal temporarily to become magnetic and making it possible to deflect it and separate it. Also referred to as "aluminum magnet" and electrodynamic separator.

Effluent: Solid, liquid or gas wastes which enter the environment as a by-product of chemical or biological processes, usually from man-oriented processes.

Electrodynamic Separator: See *Eddy Current Separator*.

Electrostatic Precipitator: A system for removing unwanted colloidal particles from a solution by passing the particles through an electrostatic field and then collecting the charged particles on collecting plate or pipe. Sometimes used in incinerators, furnaces and treatment plants to collect or separate dust particles.

Elutriation: The separation of finer, lighter particles from coarser, heavier particles in a mixture by means of a usually slow upward stream of fluid so that the lighter particles are carried upward.

Energy Recovery: A form of resource recovery in which the organic fraction of waste is converted to some form of usable energy. Recovery may be achieved through the combustion of processed or raw refuse to produce steam (*e.g.*, as a supplemental fuel in electric utility power plant boilers or as the primary fuel in incinerators), through the pyrolysis of refuse to produce oil or gas, and through the anaerobic digestion of organic wastes to produce methane gas.

Ferrous: Metals which are predominantly composed of iron. Most common ferrous metals are magnetic. In the waste materials stream, these usually include steel or "tin" cans, automobiles, old refrigerators, stoves, etc.

Fluid Bed Incinerator: An incinerator in which the waste is maintained in suspension in air by an upward controlled flow of the air. The bed of solids acts like a fluid when the upward air flow has sufficient velocity to float some of the solids. One such incinerator confines combustion within a bed of waste and sand supported on a perforated plane. Air is blown upward through the plate which churns the waste and sand into a turbulent mass. Volatile gases are collected above the bed.

Fly Ash: Small solid particles of ash and soot generated when burning coal, oil or waste materials. With proper equipment, fly ash is collected to prevent it from entering the atmosphere. Fly ash can be used in building materials, such as bricks, or disposed of in a landfill.

Fossil Fuels: Fuels, such as coal, oil and natural gas, which are the remains of ancient plant and animal life.

"Front-End" System: Jargon referring to processing of municipal solid waste for recovery of materials (*e.g.*, metals, glass and paper). A front-end system also prepares the organic portion in a form readily usable in energy recovery, or back-end systems.

Froth Flotation: A process frequently used in the minerals industry whereby one type of finely divided solid may be separated from another by immersing them in a tank of water with an appropriate chemical surface active agent and introducing air bubbles at the bottom of the tank. The agent imparts to one material or the other a greater affinity for air than water, causing it to rise with the bubbles to the surface where it can be collected. This method is used to recover small particles of material such as sand-sized pieces of glass by separating them from rock and stone.

Furnace: An enclosed refractory or water wall structure equipped with grates. The furnace is the area in an incinerator where the preheating, drying, igniting and most of the burning of refuse takes place.

Glasphalt®: A highway paving material in which recovered ground glass replaces some of the gravel normally used in asphalt.

Glass: Vitreous material from the fusion of sand and soda ash, with adjuvant ingredients, common glass is impermeable, transparent, sanitary and odorless. Clear bottle glass is made basically by melting almost pure silica sand in furnaces at 2700°F. with burnt lime or limestone and soda ash. Crushed glass (cullet) has traditionally been added to make the mixture of raw materials more workable. Colored glass is usually obtained by adding small amounts of selected metals, salts or oxides such as iron salts or chromia.

Gravity Separation: The collection of substances immersed in a liquid by taking advantage of differences in density.

Hammermill: A type of crusher used to break up waste materials into smaller pieces or particles, which operates by using rotating and flailing heavy hammers.

Hazardous Waste: Waste materials which by their nature are dangerous to handle or dispose of. These materials include old explosives, radioactive materials, some chemical and some biological wastes, usually produced in industrial operations or in institutions. Not meant to imply that other wastes are non-hazardous.

Heavy Media Separator: A unit process used to separate materials of differing densities by "float/sink" in a colloidal suspension of a finely ground dense mineral. This suspension, or media, usually consists of a water-suspension of magnetite, ferrosilicon or galena.

Home Scrap: Scrap that is utilized within the plant where it originates. (See *In-Plant Waste*.)

Hydrolysis: A type of chemical reaction in which water acts upon another substance to form one or more entirely new substances. Hydrolysis is usually catalyzed by the presence of an acid or alkali. An example is the breakdown of cellulose to carbohydrates, or, further, to glucose. The products of the hydrolysis of cellulose may be fermented to produce ethanol.

Hydrapulper®: A large mechanical device used primarily in the paper industry to pulp waste paper or wood chips and separate foreign matter. The effect of pulping is to suspend finely divided cellulose fibers (and other matter) in water. This process has been incorporated in certain resource recovery systems.

Incinerator: A plant designed to reduce waste volume by combustion. Incinerators consist of refuse handling and storage facilities, furnaces, subsidence chambers, residue handling and removal facilities, chimneys and other air pollution control equipment.

Industrial Waste: Those waste materials generally discarded from industrial operations or derived from manufacturing processes.

Inorganic Refuse: Waste material made from substances composed of matter other than plant, animal, or certain chemical compounds of carbon. Examples are metals and glass. (See *Organic Refuse*.)

In-Plant Waste: Waste generated in manufacturing processes. Such might be recovered through internal recycling or through a salvage dealer (See *Home Scrap, Prompt Industrial Scrap*.)

Institutional Waste: Waste materials originating in schools, hospitals, research institutions and public buildings. The materials include packaging materials, certain hazardous wastes, food wastes, disposable products, etc.

Jigging: A process used to segregate presized solid materials of different densities and operated by periodic pulsation of a liquid, usually water, through a bed of the mixture of solids, which tends to float the lighter solids.

Leachate: A liquid containing decomposed waste, bacteria and other noxious and potentially harmful materials which drains from landfills and must be collected and treated so as not to contaminate water supplies.

Litter: Solid waste discarded outside the established collection-disposal system. (Solid waste properly placed in containers is often referred to as trash and garbage, uncontainerized, it is referred to as litter.) Litter accounts for about two percent of municipal solid waste.

Magnetic Separator: Equipment usually consisting of a belt, drum or pulley with a permanent or electro-magnet and used to attract and remove magnetic materials from other materials. (See *Separation*.)

Manual Separation: The separation of waste materials by hand. Sometimes called hand-picking, manual separation is done in the home or office by keeping newspapers separate from garbage, or in a recovery plant by picking out certain materials. (See *Separation*.)

Materials Recovery: The initial phase — front-end — of a resource recovery system where recyclable and reusable materials are extracted from waste for sale. (See *"Front-End" System*.)

Methane: An odorless, colorless, flammable gas which can be formed by the anaerobic decomposition of organic waste matter or by chemical synthesis. It is the principal constituent of natural gas.

Microorganisms: Generally, any living thing microscopic in size including bacteria, yeasts, simple fungi, some algae, slime molds and protozoans. They are involved in the stabilization of waste materials (composting) and in sewage treatment processes.

Mixed Paper: Waste paper of various kinds and quality, usually collected from stores, offices and schools.

Modular Combustion Unit: A small, self-contained incinerator designed to handle small quantities of solid waste. Several "modules" may be combined in a plant, as needed, depending on the quantity of waste to be processed. (See *Incineration*.)

Municipal Solid Wastes: The combined residential and commercial waste materials generated in a given municipal area. The collection and disposal of these wastes are usually the responsibility of local government.

Newsprint: The kind or type of paper generally used for printing newspapers.

Nonferrous: Metals which contain no iron. In waste materials these are usually aluminum, copper wire, brass, bronze, etc.

Obsolete Scrap: Scrap derived from products which have completed their useful economic life.

Organic Refuse: Waste material made from substances composed of chemical compounds of carbon and generally manufactured in the life processes of plants and animals. These materials include paper, wood, food wastes, plastic, and yard wastes.

Packaging Materials: Any of a variety of papers, cardboards, metals, wood, paperboard and plastics used in the manufacture of containers for food, household and industrial products.

Paper: In a general sense, the name for all kinds of matted or felted sheets of fiber formed on a fine screen from a water suspension. More specifically, paper is one of two broad subdivisions (the other being paperboard) of the general term paper. Paper, usually lighter in basis weight, thinner and more flexible than paperboard, is used largely for printing, writing, wrapping and sanitary purposes.

Paperboard: Relatively heavier in basis weight, thicker and more rigid than paper. There are three broad classes of paperboard: (1) container board, (2) boxboard, and (3) special types such as automobile board, building board, tube board, etc.

Paperstock: A general term used to designate waste papers which have been sorted or segregated at the source into various recognized grades. It is a principal ingredient in the manufacture of certain types of paperboard.

Particulates: Suspended small colloidal size particles of ash, charred paper, dust, soot, or other partially incinerated matter carried in the products of combustion.

Plastics: Man-made materials, large molecules called "polymers," containing primarily carbon and hydrogen with lesser amounts of oxygen or nitrogen. Frequently compounded with various organic and inorganic compounds as stabilizers, colorants, fillers and other adjuvant ingredients. Plastics are normally solid in their finished state, but at some stage in their manufacture, under adequate heat and pressure, they will flow sufficiently to be molded into desired shape. Thermoplastics, such as polyethylene, polyvinyl chloride (PVC), polystyrene and polypropylene, become soft when exposed to heat and pressure and harden when cooled. Thermosetting plastics, such as phenolics and some polyesters, are set to permanent shapes when heat and pressure are applied to them during forming, and reheating will not soften these materials.

Primary Materials: Virgin or new materials used for manufacturing basic products. Examples include wood pulp, iron ore, silica sand and bauxite.

Prompt Industrial Scrap: Waste which is generated during a manufacturing operation. (See *In-Plant Waste*.)

Putrescible: Subject to decomposition or decay. Usually used in reference to food wastes and other organic wastes.

Pyrolysis: The process of chemically decomposing an organic substance by heating it in an oxygen-deficient atmosphere. High temperatures and closed chambers are used. The major products from pyrolysis of solid waste are water, carbon monoxide and hydrogen. Some processes produce an oil-like liquid of undetermined chemical composition. The gas may contain hydrocarbons and frequently there is process residue of a carbon char. All processes leave a residue of inorganic material. The gaseous products cannot be mixed with natural gas in principal distribution systems unless there is additional chemical processing. Applied to solid waste, pyrolysis has the features of effecting major volume reduction while producing storable fuels.

Recycling: A resource recovery method involving the collection and treatment of a waste product for use as raw material in the manufacture of the same or a similar product, *e.g.*, ground glass used in the manufacture of new glass. (See *Transformation*.)

Refractory Material: Incinerator lining material which resists the abrasion, spalling, and slagging effects due to heat and refuse material movement which are present in incineration.

Refuse-Derived Fuel (RDF): A solid fuel obtained from municipal solid waste as a result of a mechanical process, or sequence of operations, which improves the physical, mechanical or combustion characteristics compared to the original unsegregated feed product or unprocessed solid waste. (See *Densified Refuse-Derived Fuel*.)

Residential Waste: Waste materials generated in houses and apartments. The materials include paper, cardboard, beverage and food cans, plastics, food wastes, glass containers, old clothes, garden wastes, etc.

Residue: The materials remaining after completion of a chemical or physical process, such as burning, evaporation, distillation or filtration. (See *Sludge*.)

Resource Conservation: The reduction of the amounts of solid waste that is generated, reduction of overall resources consumed, and utilization of recovered resources.

Resource Conservation and Recovery Act of 1976: This law amends the Solid Waste Disposal Act of 1965 and expands on the Resource Recovery Act of 1970 to provide a program to regulate hazardous waste; to eliminate open dumping; to promote solid waste management programs through financial and technical assistance; to further solid waste management options in rural communities through government grants;

and to conduct research, development and demonstration programs for the betterment of solid waste management, resource conservation and recovery practices.

Resource Recovery: A term describing the extraction and utilization of materials and values from the waste stream. Materials recovered, for example, would include metals and glass which can be used as "raw materials" in the manufacture of new products. Recovery of values including energy recovery by utilizing components of waste as a fuel or feedstock for chemical or biological conversion to some form of fuel or steam. (See *Recycling*, *Transformation*.)

Rising Current Separator: A unit process utilizing a form of elutriation which separates by a counter-current flow of water (or other fluid).

Rubber: An elastic substance obtained by coagulating the latex of various tropical plants and prepared as sheets and dried. It can then be modified by chemical treatment to increase its useful properties (toughness and resistance to wear) and used in tires, electrical insulation, etc.

Rubble: Waste materials made up mainly of fragments or pieces of rock or masonry, sometimes containing lumber or other construction materials.

Sanitary Landfill: A method of disposing of refuse on land without creating nuisances or hazards to public health or safety. Careful preparation of the fill area and control of water drainage are required to assure proper landfilling. To confine the refuse to the smallest practical area and reduce it to the smallest practical volume, heavy tractor-like equipment is used to spread, compact, and usually cover the waste daily with at least six inches of compacted dirt. After the area has been completely filled and covered with a final two- to three-foot layer of dirt, and has been allowed to settle an appropriate period of time, the reclaimed land may be turned into a recreational area such as a park or golf course. Under certain highly controlled conditions the land may be used as a plot on which some types of buildings can be constructed.

Scrap: Waste material which is usually segregated and suitable for recovery or reclamation, often after mechanical processing.

Screening: A sieve-like device used to separate pulverized waste material into various sizes. Two or more stages of separation may be used, each stage having a different hole size in order to separate material by size. (See *Separation*.)

Scrubber: A device for removing unwanted dust particles from an air stream by spraying the air stream with a liquid (usually water) or forcing the air through a series of baths. (See *Electrostatic Precipitator*.)

Secondary Materials: All types of materials handled by dealers and brokers that have fulfilled their useful function and usually cannot be used further in their present form or at their present location, and materials that occur as waste from the manufacturing or conversion of products.

Separation: To divide waste into groups of similar materials, such as paper products, glass, food wastes and metals. Also, used to describe the further sorting of materials into more specific categories, such as clear glass and dark glass. Separation may be done manually or with specialized equipment.

Settling Chamber: A mechanical collector which removes coarse particulate matter when the force of gravity pulls the dust to the bottom of the chamber. The air is introduced into the chamber at a very low velocity to allow the particulate to fall out more effectively.

Shredder: A mechanical device used to break up waste materials into smaller pieces by tearing and impact action.

Sludge: Waste materials in the form of a concentrated suspension of waste solids in water. One type of sludge is produced from the treatment of sewage.

Solid Waste: Discarded solid materials. Includes agricultural waste (*e.g.*, animal manure, crop residues), mining waste (*e.g.*, mine tailings), industrial waste (*e.g.*, manufacturing residues) and municipal waste. (See *Industrial Waste*, *Municipal Solid Waste*, *Residential Waste*, *Waste Materials*.)

Solid Waste Management: Conduct and regulation of the entire process of generation, storage, collection, transportation, processing, recovery and disposal of refuse.

Source Separation: The segregation and collection of individual recyclable components before they become mixed into the solid waste stream (*e.g.*, bottles, cans, newspapers, corrugated containers or office papers).

Spiral Classifier: A mechanical device for performing two types of wet separation of fine solids. (1) large solids are separated from small solids of approximately the same density, (2) higher density solids are separated from lower density solids of the same approximate size. The large or denser solids are delivered up the spiral, somewhat drained.

Steel: Commercial iron that contains carbon in any amount up to about 1.7 percent as an essential alloying constituent. It is distinguished from cast iron by its malleability and lower carbon content.

Tin-Free Steel (TFS) Cans: Cans made from low-carbon steel with a very thin anti-corrosion coating of chromium oxide rather than tin.

Transfer Station: A place or facility where waste materials are taken from smaller collection vehicles (*e.g.*, compactor trucks) and placed in larger transportation units (*e.g.*, over-the-road tractor trailers or barges) for movement to disposal areas, usually landfills. In some transfer operations, compaction or separation may be done at the station.

Transformation: A resource recovery method involving the collection and treatment (other than by biological or chemical means) of a waste product for use as raw material in the manufacture of a different product, *e.g.*, ground glass used to make brick. (See *Recycling*.)

Trash: Waste materials which usually do not include garbage but may include other organic materials, such as plant trimmings.

Trommel: A perforated, rotating horizontal cylinder which may be used in resource recovery facilities to break open trash bags, remove glass in large enough pieces for easy recovery and remove small abrasive items such as stones and dirt. Trommels have been used to remove steel cans from incinerator residue.

Urban Waste: A general term used to categorize the entire waste stream from an urban area. It is sometimes used in contrast to "rural waste."

Vibrating Screen: A mechanical device which sorts material according to size. The vibration serves to prevent clogging of the screen and to accomplish outfeed. Mechanical screens are used wet or dry, in single or multiple decks.

Virgin Materials: Any basic material for industrial processes which has not previously been used, *e.g.*, trees, iron ore, silica sand, crude oil, bauxite. (See *Secondary Materials*, *Primary Materials*.)

Volume Reduction: The processing of waste materials so as to decrease the amount of space the materials occupy. Reduction is presently accomplished by three major processes: (1) *mechanical*, which uses compaction techniques (sanitary landfill, etc.) and shredding; (2) *thermal*, which is achieved by heat (incineration and pyrolysis) and can reduce volume by 80-90 percent; and (3) *biological*, in which the organic waste fraction is degraded by bacterial action (composting, etc.). (See *Biodegradable*, *Composting*, *Incinerator*, *Pyrolysis*, *Sanitary Landfill*, *Hammermill*, *Shredder*.)

Voluntary Separation: The separation of glass bottles, food and beverage cans or newspaper by hand by individuals or groups of individuals, at home or in local collection centers.

Waste Materials (Solids): A wide variety of solid materials that may even include liquids in containers, which are discarded or rejected as being spent, useless, worthless, or in excess. Does not usually include waste solids found in sewage systems, water resources or those emitted from smoke stacks.

Waste Pulper: A pulping system designed specifically for waste material processing.

Waste Stream: A general term used to denote the waste material output of an area, location or facility.

Water-Wall Furnace: Furnace constructed with walls of welded steel tubes through which water is circulated to absorb the heat of combustion. These furnaces can be used as incinerators. The steam or hot water thus generated may be put to a useful purpose, or simply used to carry the heat away to the outside environment.

Yard Wastes: Grass clippings, pruning, and other discarded material from yards and gardens.

APPENDIX D

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BIBLIOGRAPHY

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