HANDBOOK ON WASTE MANAGEMENT FOR RURAL COMMUNITIES

For: Ontario Federation of Agriculture

DRAFT Version

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Executive Summary

The objective of this project has been to create a report that will be helpful to members of the Ontario Federation of Agriculture and to other rural organizations who want to help in the waste management processes affecting rural Ontario.

This report has been prepared with the knowledge that technical information on waste and its treatment is always incomplete and uncertain. Therefore it is impossible to have a complete technical analysis of a waste problem and its solutions. The conclusion from this fact is that the social factors and the human elements must be given equal weight with the technical information.

In order for the human element to be given its proper weight in the final decision-making, the people in the community must be involved in the process from almost the beginning. People judge what is the problem and what information is relevant to looking for alternative solutions and in weighing which one is preferred to the other possible solutions.

One solution to the waste problem is to reduce the amount of waste generated in the first instance: this is the first of the 4 R's. Since some waste will inevitably be created, the people can then try to reuse, recycle or recover some of the useful portions of the waste stream. Even with maximum success in the 4 R's there will still be waste to get rid of, and if we cannot export it to someone else we must bury it or burn it.

The report summarizes in detail the potential for recycling, and the factors that affect the techniques and impacts of landfills and of incinerators including recovering energy from waste (EFW) incinerators.

The report points out that every possible human activity creates some form of solid waste. The current proportions appear to be that roughly one-half comes from households and one half from all forms of business and government activity. About one-third each is (a) paper and cardboard, (b) food and garden debris, and (c) the final third is everything else including metal, glass, plastic, wood, etc.

The quantity of waste generated grew rapidly in the last several decades with increasing affluence, and our problem has exploded only recently as environmental standards were raised a great deal. There is no evidence that there is going to be a continued rapid rise in waste quantities, and economic factors will act against such a trend.

Throughout the report as each of the alternative methods of waste management is discussed there is provided much information on the locational factors and the impacts of each method, especially landfills and incinerators of various designs. A conclusion is that there are no rigid formulae in 'the literature and that each case is unique to a significant degree. The kinds of waste vary from place to place and can be expected to vary substantially from one time to another.

The Ontario legislation governing public and private waste projects provide opportunity for the public to become involved but do not require more than token participation. The advantages of public participation are outlined, primarily serving to avoid mistakes, increase the quality of the final decisions and increase the community's confidence in the outcome.

It would be possible from this report to arrive at a recommendation that the Ontario Federation of Agriculture study how it might work with other rural organizations to increase the capacity of these community groups to take constructive roles in the waste management processes that are affecting them. This report could be of value to the Federation in providing the background that members of the community need in order to work together in solid waste management.

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1. INTRODUCTION

Waste management issues are increasingly becoming focal points of community concern and involvement. files of the concerns include environmental damage like groundwater contamination from landfills or uncontrolled dumping, nuisance factors such as traffic, noise and birds, as well as lengthy and controversial searches for new disposal facilities, which frequently threaten to consume valuable farmland and reduce estate values. Besides having to deal with wastes generated locally, many rural communities are under pressure fruit urban centres to accept city wastes.

The Ontario Federation of Agriculture (OFA) has identified the need for rural people to be able to understand and knowledgeably assess waste management options (including landfill, incineration, and the **"4 R's"- reduction, reuse, recycling and recovery**), and to be able to respond effectively to proposals that will have a direct effect on themselves or their community. Every rural community should be able to participate in waste management discussions in a confident and constructive way, knowing how they might be affected and what can be done to arrive at an acceptable set of solutions.

This handbook is intended to support OFA participation in waste management decision-making by providing representatives with an overview of municipal solid waste management. Information on the makeup of the solid waste stream (which includes all solid wastes with the exception of toxicological, corrosive, pathological or radioactive wastes), the disposal options and criteria for evaluating the appropriateness of their selection (like locational needs, costs, and environmental and social impacts), policies and regulations relating to waste management, and opportunities for public involvement are provided.

The following report is intended to provide an introduction to waste management alternatives, and not a detailed analysis of each. It is hoped that it will guide readers in search of more information pertaining to their specific concerns, and as such has provided recommended readings at the end of each section.

1.1. THE WASTE STREAM

The "municipal solid waste stream" is made up of discarded paper; glass; metals; plastics; lumber and other wood wastes; yard wastes including leaves, lawn clippings, prunings, etc.; food scraps; and other solid wastes that are generated in the household, on farms, in businesses, institutions, industries, and the service sector. Toxic wastes, otherwise known as "special wastes" are not included.

Waste Stream Composition

Population change, level of affluence and buying patterns, technological changes, product development and changing social patterns all influence the types and quantities of waste generated. For example, during the 1980's, the widespread use of computers has resulted in a greater proportion of fine paper in the waste stream, while the increased participation of women in the labour force and use of microwaves has resulted in an accelerated demand for prepared foods, most commonly with paper or plastic packaging (Franklin, 1986).

The most recent large scale waste stream composition study in Canada was completed in 1979 by Bird and Hale consultants. The national average percent composition for "as generated wastes" for communities with a population greater than 100,000 is provided in Table 1. These wastes represent the "normal wet weight of material in its natural state, as manufactured, produced, grown, etc."

A more recent study completed for the U.S. Environmental Protection Agency by Franklin Associates is also provided in Table 1. The estimates in this study were based on published data on products and materials consumed that enter the municipal waste stream, essentially comparable to Bird and Bale's "as generated" wastes. Estimates of food and yard wastes were derived from sampling data Obtained from a wide range of sources.

TABLE 1: Composition Of The Municipal Solid Waste Stream

Component Percentage Of Municipal Solid Waste Stream	Canada, 1976-77	U.S., 1984
Paper	36 %	37 %
Glass	7	10
Metals	7	10
Plastics	5	7
Wood (lumber, scraps)	4	4
Yard Wastes and Food Scraps	34	26
Misc. (eg. leather, rubber, textiles, rubble, ceramic, etc.)	7	6

Sources: Bird and Hale, 1979; Franklin, 1986.

The variability in components of the waste stream can be significant depending on whether it has rural or urban origins, and the type of commercial and industrial activity occurring at its source. On average, roughly one third of the waste stream is comprised of paper, one third food and yard wastes, with the remaining one third being composed of glass, metals, plastics, wood and miscellaneous wastes.

Table 1 shows a significant difference in the amount of food and yard wastes documented in both studies. This may be due to differences in sampling locations and techniques. The proportion of the waste stream consumed by yard wastes varies dramatically on a seasonal basis. The Bird and Hale study shows it fluctuating from the winter low of one percent of the waste stream, to the spring high of 12%.

The Franklin study calculated the proportions of the U.S. waste stream that comprised organic and inorganic materials in 1984, and forecasted their proportions to the year 2,000 (Table 2). Over time, organics like food and paper wastes, will decompose, leach and produce gas when landfilled. Plastics, although made of organic chemicals, will not rot in a landfill. The entire organic portion will provide the fuel for combustion if incinerated. The inorganic portion becomes the residue, or unburnable portion, when incinerated.

TABLE 2: Organic And Inorganic Portions Of The Waste Stream

YEAR	% ORGANIC	% INORGANIC
1984	78.9	21.1
1990	79.8	20.2
1995	80.7	19.3
2000	81.3	18.7

Source: Franklin, 1986.

Since 1970, the organic portion of the waste stream has increased steadily. This can be attributed to the expanded use of paper and plastics in the municipal solid waste stream. Containers and other for of packaging make up about one third of total discards by weight. However, by volume, they make up one half of the total solid waste stream (Lampi, 1988). Franklin observed that in recent years, the overall weight of packaging has decreased, as aluminum and plastics replace glass and ferrous metals. Ontario is following the American lead in its reduced use of refillable bottles in favour of metal beer and pop cans. The use of laminated paper, foil, and plastics is also increasing, complicating the recycling potential of more and more packaging.

Thus, while paper and plastics increase their share of the solid waste stream, glass, ferrous metals, yard and food wastes, wood and other miscellaneous wastes are increasing more slowly, or even declining (Franklin, 1986).

Municipal solid waste stream composition can vary greatly depending on the proportions of residential and business-related wastes (Table 3). Generally, the larger the municipality, the greater the non-residential (i.e. "other") component of the waste stream. For example, Metro Toronto's waste stream is split into approximately one third residential, and two thirds non-residential (Wallace, 1988). Halton Region reports a 45:55 split between residential and non-residential (Shamess, 1988), London 43:57 (Patten, 1988), while Peel Region has approximately a 40:60 split between residential and non-residential (Condlin, 198S). In small towns and rural areas, the split is frequently 50:50, with sone areas experiencing a larger residential than non-residential component Middleton & Associates Limited, 1974; Wallace, 1988).

While farm families generate the typical domestic wastes, they also produce many of the wastes that a small industry would. Many farms generate large volumes of relatively inert solid wastes like replaced fencing materials, building scraps, and scrap metal. While the scrap metal can be reclaimed, the other materials mentioned can be used as clean fill, and need not consume expensive sanitary landfill space. However, these wastes should be kept separate from other refuse, including household garbage, which is usually best handled in a controlled landfill or incinerator. Ministry of Agriculture guidelines should be followed for manure management, especially as it relates to the prevention of surface water contamination. Other farm wastes, including potentially hazardous materials such as oils, grease and chemicals, are discussed in the following section.

TABLE 3: Sources Of Municipal Solid Waste

RESIDENTIAL
- Homes, apartments
OTHER
- Agriculture (farms, food processing)
- Commerce (retail and service sectors)
- Construction/Demolition
- Industry (factories)
- Institutions (schools, hospitals)
- Municipal services (street cleaning, landscaping, sewage treatment solids)

Per Capita Waste Generation

Studies indicate that the per capita generation of residential garbage is close to half a tonne per year, or over one kilogram per day (Bird and Hale, 1979; Condlin, 1988; Franklin, 1984).

These estimates fail to account for the non-residential wastes which constitute at least half of the total municipal waste stream in most communities. The Region of Peel calculated that in addition to residential wastes generated, each employee generates approximately 1.29 tonnes of solid waste per year on the job, for a total per capita average of about 1.40 tonnes per year (Condlin, 1988). Similarly, for Hastings County, annual per capita generation of residential plus non-residential wastes, excluding hazardous wastes, was calculated to be approximately 1.15 tonnes (The Proctor and Redfern Group, 1987).

Franklin predicts that per capita refuse generation will increase 6% between 1984 and 2000. This represents a slowing down of the upward trend experienced in the past.

Hazardous Wastes In The Municipal Waste Stream

A U.S. study of hazardous wastes states that each person produces 20 to 40 litres of household hazardous wastes per year (The ERM Group, 1985). Although it is illegal to dispose of hazardous wastes in municipal landfill sites or incinerators, some toxic substances do become mixed in with other domestic wastes, and find their way to these sites. Amongst the potentially hazardous items found in the domestic waste stream are those which are flammable, toxic, corrosive, reactive or explosive. They include:

antifreeze	floor wax	paints
batteries	herbicides	pesticides
degreasers	metal polish	septic tank cleaners
drain cleaners	motor oil	solvents
dry cleaning wastes	oven cleaners	wood preservatives

Sources: Ellis, 1986; MOE, 1986.

There are approximately 40 household hazardous waste programs in Ontario, servicing Some 60 to 70 communities. Halton Region, Metro, Peel Region and Waterloo operate depots on an on-going basis to accept hazardous wastes. Many other municipalities hold annual household hazardous waste days with depots set up to accept toxic wastes. These arc usually combined with educational efforts to increase awareness of the problem, and suggestions on less harmful products which can be used in place of hazardous ones. MOE funding is available to municipalities wishing to operate such programs.

Toronto has integrated battery collection into their depots for recyclables. All of the city's depots have bright red boxes attached to them for the deposit of batteries. Batteries are of particular concern since many contain mercury which forms a gas when burned which standard pollution control equipment in incinerators cannot remove.

Improper disposition of agricultural containers holding insecticide, herbicide, fungicide, bactericide, rodenticide and other compounds is a potential source of environmental contamination. Discarded containers often contain very toxic residues which are slow to disintegrate and can leach into surface or ground water systems.

Ideally, farm chemicals should be available in refillable containers, or should be returnable to the dealer. Failing this, a formal collection system could be set up to have these containers collected and properly disposed of. Without the availability of these options, the Ministries of the Environment and Agriculture recommend that so-called empty containers be filled with water three times, with the diluted solution being sprayed and used for the same purpose the product was intended. Not only does this system ensure that the substance being used is not wasted, but the container is restored to being non-hazardous, and can be buried without the concern of substantial ground water contamination. Paper bags which contained pesticide or herbicide powders should be burned away from people and livestock.

For surplus supplies of materials no longer registered, the Environmental Protection Service of Agriculture Canada should be contacted. Farms within close proximity to a household hazardous waste depot should take advantage of them for solvents, grease, batteries and like materials used in farm practices. Waste oil can be brought to most service stations, where it is collected for recovery.

Following reports of improperly disposed of agricultural containers in rivers and floodplains, Alberta's Environment Department established a series of depots around the province for the voluntary deposition of agricultural containers. These depots are recovering at least 50% and probably about 70% of the containers used on farms (Byrtus, 1988). They found that not only were empty containers appearing at the depots, but full or partly-full containers of compounds no longer used (such as DDT), were being received as well. After these containers are collected, residues are emptied from them. Metal containers are crushed to go to steel mills. Plastic ones are shredded and being stored while research is done on the removal of absorbed chemicals, and the safe use of them as feedstock in plastic manufacturing where there is a demand. A process for removing the residues and identification of a market for the plastic is currently being investigated.

1.2. RECOMMENDED READINGS

Bird and Hale, A Review and Analysis of Data Pertaining to the Per Capita Generation of Municipal Solid Waste and Municipal Refuse Statistics for Canadian Communities over 100,000 (1976-77).

- standard Canadian source for composition data.

Frank and Ripley (for OMAF), "Management of Pesticides on the Farm"

- AMEX #607

Franklin, Characterization of Municipal Solid Waste in the U.S., 1960-2000

- standard U.S. source for composition data.

MOE, "Household Hazardous Wastes Collection Program".

- designed for groups wishing to set up collection program.

2. WASTE MANAGEMENT ALTERNATIVES

There are three broadly defined methods for managing municipal wastes: landfill, incineration, and the 4 R's. In this handbook, open dumping will be discussed along with landfilling; energy from waste in the section dealing with incineration, despite the fact the it also falls under the "4^{th} R" - Recovery; and the 4 R's will include reduction, reuse, recycling and recovery. Composting will be covered under "recovery".

It is important to note that this report does not advocate one waste management alternative to the exclusion of others. There is no one solution or set of solutions for dealing with municipal solid *wastes* across the board; the "best" solution will vary from one community to another. The types and quantities of wastes generated, local soil and ground water characteristics, the urgency of finding a solution, and financing are amongst the factors to be considered when selecting an alternative.

Landfill is the only option which is able to accommodate virtually all solid waste. "Special wastes" such as medical wastes that contain pathogens, or disease-producing organisms, and other hazardous wastes are the exceptions. Incineration or energy from waste, and recycling are more selective of the types of wastes they can handle (Table 4). It rust be recognized that about 20% (by weight) of all solid waste generated will have to be landfilled, since this portion cannot be incinerated or recycled (Wallgren, 1987). Thus, an integrated approach which carbines one or more waste management techniques makes good sense, ensuring that the techniques selected are compatible, complementary, and sited carefully.

Studies indicate that between about 60 to 80% of the average solid waste stream can be incinerated to achieve appreciable reduced weight and volume. This is highly dependent upon the system utilized and the types of wastes burned. The Victoria Hospital, for example, has the potential to handle about 40% of London's total solid waste. It is capable of handling almost the entire residential waste portion.

Approximately 30% of the weight of burned material remains as residue following incineration, which needs to be landfilled. This translates to a 28% diversion from the landfill by weight by the London incinerator system.

TABLE 4: Waste Management Options And Refuse Handling Capability

Technique	Wastes Suited To Technique	Wastes Unsuited To Technique
LANDFILL (MUNICIPAL) -	solid wastes	hazardous wastes, including pathogens airline wastes
INCINERATION / EFW	combustibles: paper food/yard wastes wood plastics pathogens airline wastes	non combustibles: glass metals rubble ceramics batteries excessively wet materials
RECYCLING	paper: fine newsprint cardboard glass metal wood homogeneous plastics food and yard wastes	paper: glossy contaminated plastics (mixed) laminates and heterogeneous wastes

Class 1 recycling programs (i.e. those with weekly curbside pick-ups and special recycling boxes) in Ontario can capture 15% of residential wastes, or approximately 8% of the total solid waste stream. As well, further diversion can be achieved by capturing commercial and industrial recyclables, most notably corrugated cardboard, which in Peel and Metro makes up about 15% of the total solid waste stream. Municipal composting of food and yard wastes has the potential to divert up to 30% of the waste stream. The success of 4 R's programs are to some extent dependent upon markets for reclaimed products. For instance if a mixed plastic market opens up, the total percentage which the 4 R's can handle could increase. Options which hold future promise include the "wet-dry" recycling-recovery system (see section 5.1) which has the potential to handle about 70% of municipal refuse.

Some reuse, recycling, and recovery of wastes has been done in Canada by municipalities and industries for decades. Their performance has been highly variable as prices and markets for recyclables fluctuated and technology changed industrial practices. While markets have been stable for the past several years and are expected to continue to strengthen in the future, there remains much room to further develop techniques to reduce, reuse, recycle and recover, to increase the demand for "used" materials, and to expand markets. In the future, we are likely to see more of the social and environmental costs of resource use being reflected in manufacturing and wastes disposal techniques. More government policies may develop to encourage and subsidize waste reduction and the other 3 R's.

2.1. <u>RECOMMENDED READINGS</u>

VHB Ltd. (for MOE), being prepared fall 1985, Generic Waste Management Alternatives Study.

- information and framework for evaluating waste management alternatives.

3. LANDFILL

3.1. DESCRIPTION

Landfilling, an improved form of dumping, is the traditional method of disposing of wastes. There are 3,000 municipal and private waste sites in Ontario, 1,339 which are active, and 1,990 which are closed (MOE, 1986). In the past, dumping was regarded as a free or inexpensive solution to garbage problems. In some areas, the lack of discrimination in site selection and absence of mitigation against environmental impacts has resulted in numerous cases of ground and surface water contamination and other nuisances and offenses.

Landfilling is the deposit of layers of refuse on or in the ground, compacted or loose, and covering the wastes with a clean material (usually soil) at regular intervals. Ontario Regulation 309 prohibits hazardous and liquid industrial wastes from being placed in municipal landfill sites, except for a few sites which are licensed to accept limited amounts of slightly toxic material.

Locational Considerations

Among the factors to consider when siting a landfill, are soil type and water table depth. Unfractured clay soils are the best for slowing down the migration of contaminants to the groundwater. In zany cases, the best potential landfill site locations from a hydrogeological (i.e. the movement of groundwater) perspective will be on prime agriculture land - a conflict which should be addressed by site selection teams. Clearly, floodplains (i.e. "hazard lands") are inappropriate since they often have organic soils, shallow water tables, are difficult to control in terms of water entering and leaving the site, and increase the risk of water pollution. Environmentally Sensitive Areas and Heritage or Archaeological sites should also be avoided.

The site selection process for landfills should also examine potential traffic congestion problems, noise and other nuisances, aesthetic impact, and other regular concerns of nearby residents. Controls against disease carriers such as birds, insects and rats should be established. Adequate road networks, thorough monitoring, buffer zones, berms, and landscaping are important preventative measures.

If transfer sites (i.e. facility where solid waste is temporarily stored prior to bulk transporting to a waste disposal site) are required, the same locational considerations should apply as for the actual landfill site.

Landfill Liners

Landfill design typically varies from one site to another depending on the amount and types of wastes to be disposed of and the environmental conditions of a particular site. Figure 1 illustrates a large scale, engineered landfill. Leachate production is the primary concern in site and design selection. Leachate is the water (i.e. rain and snow) which filters through a landfill, and liquid from rotting garbage, containing dissolved, suspended and/or microbial contaminants from the solid wastes (Wilson, 1987). If not controlled, leachate can find its way into aquifers used for drinking water and irrigation in the rural areas they are situated near.

Sites with thick clay deposits which act to reduce leachate discharge and have a low water table, may simply require ditching and grading for control of surface run-off. Sites with more permeable soils and a high water table may require an "engineered landfill" with clay trucked in for use as a liner. Synthetic (plastic) membrane liners can supplement clay for preventing against leachate migration.

A plastic liner by itself is not considered reliable enough for the long-term protection required. Ministry of Environment (MOE) policy supports this, stating that because there is currently no system for establishing how well leachate is being neutralized or degraded underground, they will not approve proposals relying solely on synthetic liners for perpetual confinement of leachate (MOE Policy 14-15, 1988).

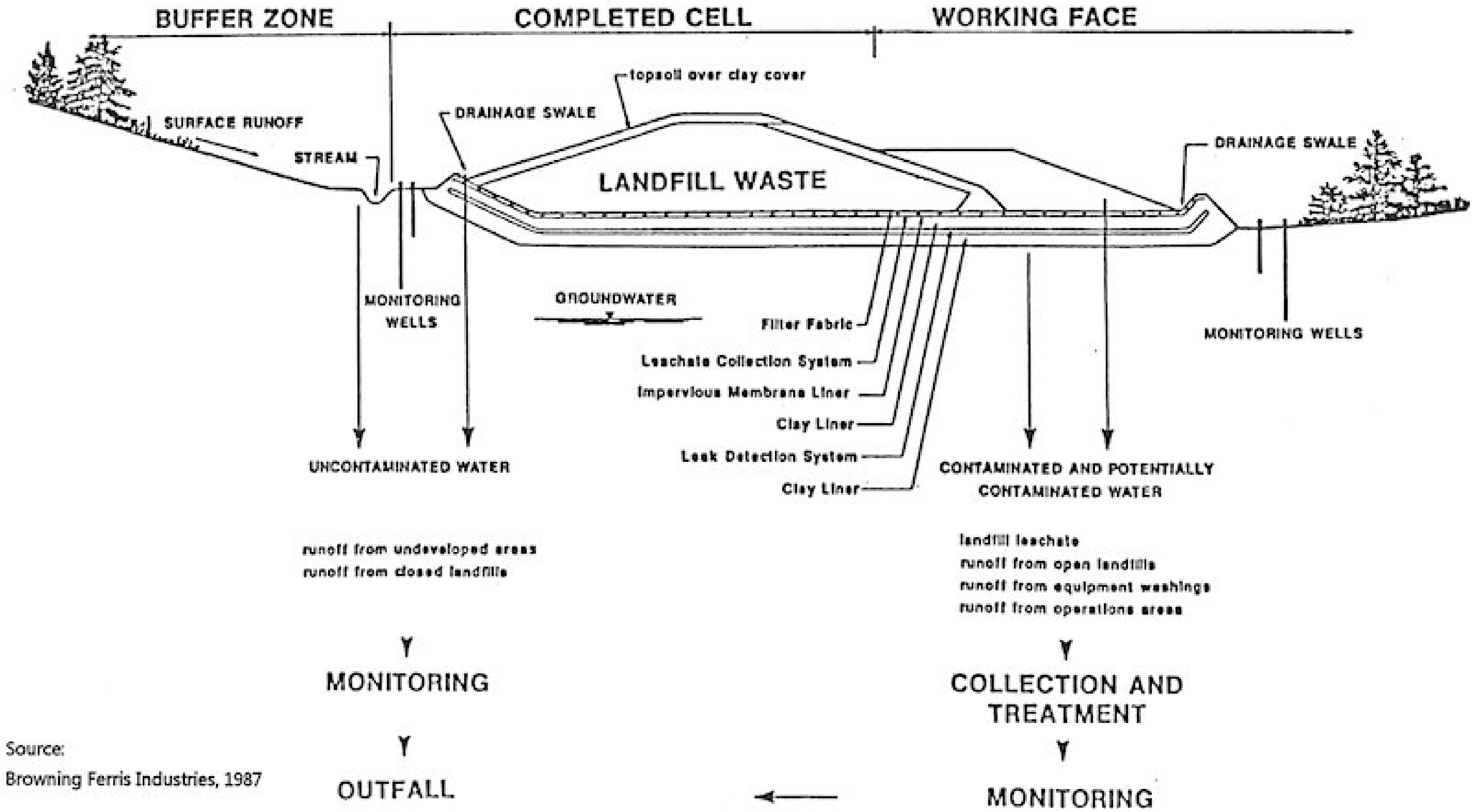


Figure 1: An Engineered Landfill Site.

Large safety margins should therefore be incorporated into all leachate production calculations and landfill designs.

Despite the use of liners, molecular diffusion - the process whereby dissolved chemical compounds move from areas of high concentration to areas of lower concentration - will occur over time, causing contaminants to migrate through clay liners and caps (Cherry, MacQuarrie, and Ruland; 1987). No regulations in Canada recognize the occurrence of diffusion. Although the U.S. Environmental Protection Act does not specifically refer to the existence of diffusion, it is mandatory in the U.S. (as well as in West Germany and Italy) to install artificial liners to contain leachate (Cherry, MacQuarrie, and Ruland, 1987; Harrington and Maris, 1986).

Landfill Caps Or Covers

After a landfill cell has been filled to capacity, clay or synthetic membrane covers are used to reduce the amount of rainfall which can filter into the landfill, pick up contaminants in the refuse and become leachate. However, the amount of time it takes a landfill to stabilize and settle is lengthened by capping, which by slowing leachate production, essentially increases the contaminating lifespan of a landfill. Clay covers should be at least four feet thick, and vegetated to stabilize soil moisture in the cap and reduce erosion. Synthetic membranes nay be problematic in that they inhibit the upward venting of gases, methane in particular, resulting in increased underground build-up or migration of these gases MOE Policy 14-15, 1988).

Settlement results from consolidation and decomposition of the wastes in landfills such that the depth of the landfill is eventually reduced 25 to 50% (Stearns, 1987). Settlement may take only 10 years in a landfill containing primarily loosely packed vegetative wastes. However, more commonly, 30 to 50 years or longer is required for the settlement of drier, more densely packed landfills (Stearns, 1987). The time required to collect and treat leachate is correspondingly long, or longer than settlement; some claim it may be necessary for centuries (Cherry, MacQuarrie, and Ruland; 1987).

Leachate Collection Systems

Leachate collection systems consist of subsurface collection tile networks and drains around the periphery of the landfill. Once collected from artificial drains, leachate is usually released into a trunk line leading to a municipal sewage treatment plant. Another option which is commonly used in the United Kingdom is the recirculation of leachates through the landfill. This speeds up landfill stabilization (and accelerates leachate production) since it usually contains bacteria which assists in decomposition as it filters through refuse. However, with this system, the leachate will eventually accumulate to a level exceeding the storage capacity of the landfill (MOE Policy 14-15, 1988). Alternatives, which are frequently adopted in sewage treatment facilities are biological and physical-chemical treatments.

Biological treatment can be used to stabilize degradable organics and is most effective on "young" leachate. Physical-chemical treatment is more effective at removing metals and breaking down the less degradable organics found in "older" leachate. Land application (spraying) and recirculation of leachate to the landfill are options for dealing with leachate following treatment. Thus, a co-ordinated, multi-staged approach to leachate treatment will help to ensure the decontamination of leachate (McBride, Gordon, and Groenevelt, 1988).

Methane Gas Control

Landfill sites also require methane gas control systems, since methane is explosive at low concentration, can migrate over large distances, and has heath risks associated with it (The Proctor and Redfern Group, 1987). Gas is tapped with vertical wells in and around the landfill, and is either burned at the top of the well, utilized in boilers or engine-generator sets, or cleaned for off-site use. At present, landfill gas is being recovered at the Kitchener landfill, and is planned for Metro's Brock West landfill in 1989 (Bolton, 1988).

Monitors

Monitors rust be placed at and around the landfill to observe leachate migration, in order to warn of potential groundwater pollution problems. They help to measure the performance of the landfill, and provide warning of failure early enough to all contingency measures to be taken (MOE Policy 14-15, 1988).

3.2. COST OF LANDFILIING

It is important to consider the "full cost" of waste management systems, regardless of who pays those costs, in order to make realistic cost comparisons of the different systems. Tatham, a councillor for Oxford County provides further rationale for full costing: "Much of the waste and excess that has characterized our "consumer" culture has resulted from not taking the total costs of our actions into account" (1987).

Among the costs which are often overlooked or hidden in other municipal operations are the costs associated with the approval process. These include payment for engineering studies and impact analyses, public participation activities, and hearings. Other expenses which are often omitted are off-site administration costs and costs for road construction or upgrading. Perpetual care costs, which include monitoring and remedial measures, should be acknowledged in cost accounting. In addition, there should be compensation to landowners whose property values will be affected by a new landfill, or the municipality in which a landfill site is to be located. A number of other harmful effects of a landfill may need to be compensated, or money spent on efforts to mitigate side-effects such as works to buffer noise and dust, traffic nuisance, bird damage, water contamination, etc.

Because there is such a wide variety in landfill capacities, locations relative to waste generators, abatement technologies used, land values, etc., not to mention accounting considerations, it would be misleading to provide a single number as an estimated cost to landfill a tonne of wastes. However, Table 5 provides a list of expenses to be tallied in order to identify the full cost of landfill collection and disposal, which is clearly not a simple task, despite its value. In 1979, a U.S. study calculated that refuse collection costs were nine times greater than disposal costs (Institute for Local Self Reliance, 1987). However, in this calculation, capital costs, as listed in Table 5, were incompletely factored in, and landfill standards were lower than today. It is doubtful that collection costs would be lower than disposal costs in large landfills if full costs are calculated for landfill according to current standards.

It has been customary for municipalities to refer to the tipping fee charged (i.e. fee paid at the landfill or incinerator to dump refuse) when assessing the cost involved in landfilling. Some dump sites, particularly small, rural sites, do not charge a tipping fee. Those municipal dumps which do have tipping fees often set them arbitrarily, or without full consideration of all costs associated with waste disposal, including environmental protection.

In response to more stringent MOE policies; to avoid being the recipients of wastes from outside of the municipality where tipping fees may be higher; and to encourage the adoption of the 4 R's, many municipalities have recently increased their tipping fees. A survey completed by the Metro Works Department (1988) exemplifies a change in attitude towards the real cost of landfilling (Table 6). It is only very recently that most authorities began to do cost accounting on waste facilities. They have been surprised both by the high level of costs and by the willingness of most waste generators to pay for environmentally safe waste disposal. There is a long period ahead of us to develop and implement full costing and payment.

Funding Programs For Landfills

Municipalities ray be eligible to receive financial assistance for establishing or expanding landfill sites, transfer stations, and processing facilities under the MOE's Financial Assistance Program (FAP). Assistance is provided for site design and consulting services, hydrogeologic studies, hearing/approvals costs, public consultation, capital costs, and retrofitting or expanding existing facilities.

TABLE 5: Cost Considerations For Landfill

REVENUES/GRANTS	EXPENSES			
	STUDIES & APPROVALS	CAPITAL COSTS	OPERATING COSTS	POST-CLOSURE COSTS (PERPETUAL CARE)
- Tipping fees - Methane sales - Waste Management Improvement Program (MOE)* * costs of a municipality which are subsidized by a provincial grant are still costs to society; the burden is shifted to a different pocket	- Waste Management Master Plan Process - Environmental Assessment	- Financing - Land, including buffer zone - Planning & Engineering - Roads - Buildings - Equipment • hauling trucks • forklifts • scales • monitors • liners • leachate collection system • sewers - Transfer station - Fencing - Gates - Compensation to landowners / municipality	- Labour, including administration - Refuse collection - Weighing - Dumping, compacting, covering landfill - Leachate collection, treatment & disposal - Site monitoring - Security - Grounds maintenance • litter control • pest control - Utilities - Environmental Impairment Insurance - Public information - Debt servicing	- Environmental monitoring - Leachate collection, treatment & disposal - Landscaping - Gas collection, venting - Environmental Impairment Insurance - Remedial measures eg. purge wells

TABLE 6: Tipping Fees In Several Municipalities In Ontario

LOCATION	1987 TIP FEE/TONNE	1988 TIP* FEE/TONNE	% INCREASE
Region of Halton	$36.50	$53.50	47%
Metro Toronto, Durham, York	$18.07	$50.00	177%
Region of Peel**	$34.50	$49.50	43%
Waterloo	$17.05	$30.80	81%
Wellington County	$14.60	$28.00	92%
Essex-Windsor	$15.60	$27.00	73%

* either proposed or already approved.
** fee for commercial waste
Adapted from "SWEAP News", Jan. 22, 1988, No. 5.

The MOE's Waste Management Improvement Program was set up to relieve municipalities, particularly those with a law tax base, from the financial burden of meeting their operating standards for existing solid waste disposal sites. Assistance is provided for the completion of technical studies, upgrading sites, provision of remedial measures, and site closure. Grants for both programs are calculated on the basis of population.

3.3. RECOMMENDED READINGS

Cherry, MacQuarrie and Ruland, "Hydrogeologic Aspects of Landfill Impacts on Ground Water and Some Regulatory Implications" (PCAO conference).

- overview of environmental concerns.

MOE, Policy Manual, "Engineered Facilities at Landfills that Receive Municipal and Non-Hazardous Wastes".

- describes MOE policy.

Waste Age (magazine)

- regular articles on landfill

4. INCINERATION

4.1. DESCRIPTION

Burning, either in the open air or in incinerators, has long been a method of removing wastes. Simple incinerators were commonly used for burning domestic wastes and in industries until concern over the impact on air quality was reflected in more stringent MOE controls, forcing many closures.

Energy from Waste facilities, or incinerators modified to generate energy from the heat produced in the incineration process, have recently revived interest in incineration. Examples of EFW plants in Ontario include the Victoria Hospital Energy From Waste (EFW) plant for London's residential solid wastes, the 3M plant in London for in-plant and external solid wastes, Oakville's Ford Plant where corrugated cardboard is burned to produce electricity, and the General Motors plant in Oshawa for waste wood and cardboard. Many more proposals have recently been tabled, including ones in Peel Region, Waterloo, and Halton Region.

Concern over the environmental impacts of landfilling, escalating costs, and the difficulty in locating suitable new sites which are acceptable to nearby residents of landfill sites, has motivated the support for alternatives. Technical advancements in incineration and the potential to recover energy fruit burning wastes has revived municipal and private interest in it as the modern alternative to landfilling.

As with landfills, incinerators typically vary from one location to another. Quantity and type of waste, and energy consumer specifications (if an EFW facility), are amongst the factors considered when selecting an incinerator design. Figure 2 provides a generalized schematic of an incinerator.

Locational Considerations

In locating a site for an incinerator, wind direction must be taken under

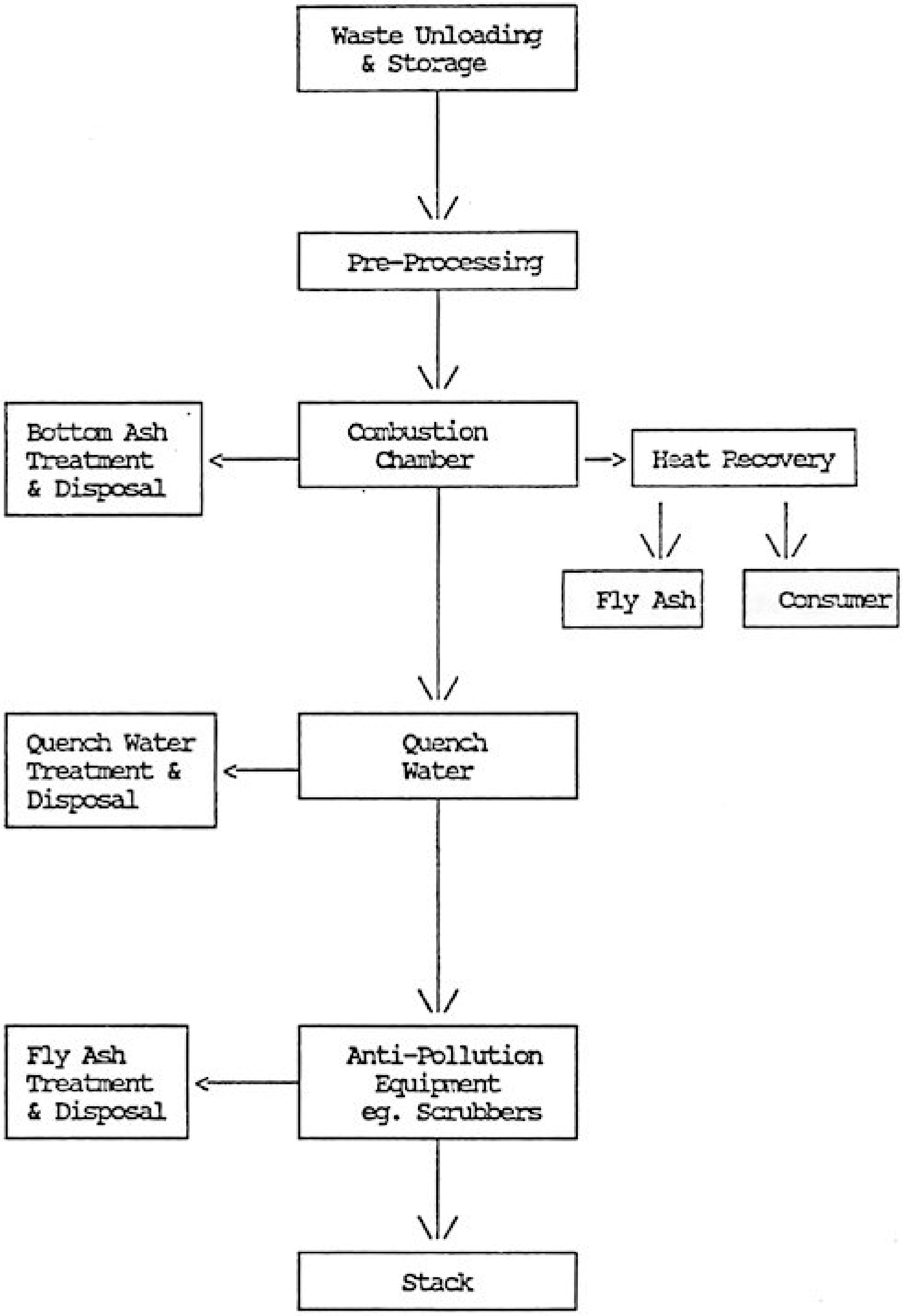


FIGURE 2: Generalized Schematic Of The Incineration Process.

consideration. Despite the use of pollution control equipment, the downwind population must be protected from any risks associated with emissions. Residential areas, farmlands or water resources should not be directly downwind of an incinerator unless equipped with state-of-the-art pollution control devices. Given the choice, industrial locations with substantial buffer strips and dust controls are usually more appropriate.

Increases in traffic volume should also be assessed. Where possible, access roads which are relatively unpopulated and sparsely travelled are most favourable. If transfer stations are required, all of the considerations should equally apply.

Because the incineration process creates residuals in the form of pre-separated non-combustibles and ash which must be buried, location of the incinerator relative to an appropriate landfill is another important factor to consider. Also, in the case of EFW's, close proximity to the energy consumer is an advantage, and sometimes a necessity.

Pre-Processing

In order to improve combustion, avoid operational difficulties, reduce ash and moisture content, and improve the energy value of refuse, wastes to be incinerated should be pre-processed (The Proctor & Redfern Group, 1987). This involves the removal of non-combustibles either at the source (i.e. by the waste generator), or through manual, mechanical or gravity separation at the incinerator site.

The Incineration Process And Energy Production

Once the municipal solid waste has been pre-processed, it is fed into the incinerator's primary combustion chamber. Here the waste is agitated and moved by grates, rams, or other equipment while being injected with air. In an EFW plant, the heat energy produced is transferred to water in a boiler, where steam is produced and sold or used to generate electricity, according to the needs of the energy customer. In incineration without energy recovery, this heat is vented.

There are four main types of combustion systems which can be used in an incinerator: mass burn, modular or two-stage incineration, semi-suspension burning (i.e. refuse-derived fuel system), and fluidized bed combustion.

Mass Burn Incineration - Combustion occurs within a single chamber, ideally after oversized and non-combustibles are removed. These are usually custom designed, large capacity systems for 200 to 3,000 tonnes of waste per day. They can have either refractory-lined or waterwall incinerators. Refractory-lined furnaces have a temperature-resistant coating to keep heat from escaping outside the unit. However, they require large volumes of excess combustion air which increases the pressure on emission control systems. Waterwall furnaces have walls lined with tubes filled with water. The water cools the walls and acts as a heat recovery medium. These require less excess air for combustion and tend to recover heat more efficiently than refractory-lined incinerators (The Proctor & Redfern Group, 1987).

Modular or Two-Stage Incineration - These are pre-fabricated systems with refractory-lined walls. Combustion occurs in two separate chambers. In the first chamber, wastes are dried, gasified, and have their carbon burned out. Rotary kilns are commonly used in the primary chamber to tumble wastes through the system. The remaining wastes then enter the second chamber where final combustion takes place. Modular incinerators are designed to handle 50 to 100 tonnes of waste per day.

Semi-Suspension Burning (Refuse-Derived Fuel Systems) - Refuse becomes shredded and processed, with the combustible fraction available for burning, either in a shredded form known as fluff, or compressed into cubes to make refuse-derived fuel (RDF). RDF can be used as an on or off-site fuel source when used in combination with other types of fuel. This system is generally considered only for plants handling more than 300 tonnes of refuse per day.

Fluidized Bed Incineration - Instead of being burned on grates as in the other incinerator types, fluidized bed systems use constantly circulating, pressurized, heated sand beds to underlie the wastes. This system has not yet been used successfully for generalized refuse (Cross, O'Leary, and Walsh, 1987).

Incinerator Ash

Even if pre-processing of wastes is undertaken, other non-combustibles and non-gaseous by-products remain in the form of ash after incineration. Bottom ash is the material which remains behind in the combustion chamber. Electrostatic precipitators, Venturi scrubbers, dry scrubbers, wet scrubbers and/or baghouse fabric filters are used to remove remaining particulates and gas prior to the emissions being discharged up the stack. The residual collected by pollution control devises prior to the final emissions being released up the stack is called fly ash.

Although the amount of ash remaining following incineration is dependent upon the types of wastes entering an incinerator and the pollution control equipment used, on average, 10% of the volume, and 30 to 35% of the total weight of refuse incinerated is left to be disposed of by some other means. This ash is highly soluble and contains heavy metals such as lead, cadmium, manganese, chromium, arsenic, copper, and zinc of varying concentrations. While bottom ash can contain concentrations acceptable for disposal in municipal landfill sites, an incinerator with a highly effective pollution control system will likely produce fly ash which would be classified as hazardous waste according to MOE standards. Mixing of bottom and fly ash specifically to reduce the concentration of toxic materials, allowing it to qualify as non-hazardous is done at some EFW plants. However, the metals in ash may be highly leachable, particularly if the ash has a high pH level due to the use of scrubbers which inject lime into flue gases.

The U.S. Environmental Defense Fund recently conducted tests on the toxicity of fly, bottom and combined ashes from 26 garbage incinerators. Virtually all fly ash failed the leach test, indicating that it was hazardous waste, one-third of the bottom ash failed, and about half of the combined ash failed (RCO, 1988). If the ash is classified as hazardous, it must go to a special hazardous waste landfill.

Ash can be processed prior to disposal to decrease its toxicity. Metals can be extracted, as is done in Quebec City's incinerator. Ash can also be stabilized in cement or a similar material to reduce leaching. “Monofilling” - the use of a landfill specifically designed for incinerator ash - is an alternate to disposal in standard municipal or hazardous waste sites.

The MOE has recently established a task force to review the classification of incinerator ash and disposal requirements (RCO, 1988).

Chlorinated Organics

The highest profile issue with incineration has been the emission of chlorinated organics, namely dioxins and furans. Some of these by-products of combustion have been found to be carcinogenic. It is commonly believed that sufficiently high burning temperatures, adequate residence time, as well as scrubbers and other pollution control devises can largely destroy or capture dioxins and furans. However, reports indicate that dioxins are bound to the particulates in bottom and fly ash (Cook, 1987; Kidd, 1984).

Air Emission Control

In order to prevent threats to human health and the environment due to air emissions, the MOE has specified in Policy 01-01 that a consistently hot fire must be maintained (at or above 1000 degrees Celsius), a minimum residency time of one second be upheld, 6% oxygen supply provided, and a high degree of turbulence created. Various air pollution control devices (as summarized in Table 7) should also be used (usually in combination) to prevent the release of contaminants up the stack:

Scrubbers - are used to remove particulates, water soluble gases, and/or acid gases from the flue, as well as controlling odor. The Venturi-type scrubber (V.SCRUB) has been found to be more effective at small particulate removal than dry scrubbers

(D.SCRUB). When dry scrubbers are used in combination with baghouse filters, they are very effective at capturing fine particulates.

Baghouse filters (B.HOUSE) - are used for the removal of very small particles. Dry or wet lime can be injected above the filter to control the acidity of the emissions.

Electrostatic precipitators (E.PREC.) - are used to remove small particulates and mist. They do not collect gases.

TABLE 7: Air Pollution Control Devices.

Device	Particulate Removal (μ) *			Acid Gases	Metals	Max. Temp.(C)
	0.1-1.0	1.0-10	<10			
V. SCRUB.	G	E	E	YES	F- G	537
D. SCRUB.	F	G	G	YES	F - G	499
B. HOUSE.	F	G	E	NO	F- G	260
E. PREC.	E	E	G	NO	F	399

* μ = microns (10^{-6}) - millionth of a metre
E= Excellent, G= Good, F = Fair

Source:Cross, O'Leary, and Walsh; 1987.

Waste Water

The water used to cool the ash as it exits the incinerator (quench water), and the water used for plant maintenance, can contain dissolved metallic compounds. The designation of waste quench water as a "special" waste is currently being considered. Few, if any, facilities in Ontario are approved to receive these wastes if regulations require it to be treated as a special waste.

4.2. COST OF INCINERATION

While EFW's may not yet compete financially with landfilling, they may in the near future if landfill costs continue to increase, and if suitable energy customers are available (The Proctor & Redfern Group, 1987). It appears the financial cost is no longer the only "bottom line" in waste management decision-making. Facility location and proven health or environmental advantages may now be higher priorities.

The revenues and expenses related to incineration are listed on Table 8. One frequently over-looked expense is the cost of landfilling the ash residue which remains following incineration, the pre-separation of non-combustibles like appliances, and wastes collected while the incinerator is shut down. At the London EFW plant, down-time amounts to three to four days every two to two and a half months for routine maintenance (Gibson, 1988). Ash not meeting non-hazardous standards will need to be sent to a hazardous waste site. Current tipping fees at such a site are approximately $150 per tonne (RCO, 1988). Therefore, in calculating the full cost of EFW, cost should be based not on the tipping fee charged, but rather among other items, should be calculated to include the full cost of landfilling residuals, and the perpetual care of landfills (Table 6).

The tipping fee charged at incinerators is usually comparable to that charged at the local landfill (if one exists). However, a higher fee may not deter haulers if transportation costs are reduced.

The cost-effectiveness of EFW's is partially dependent upon the cost of alternative sources of fuel and the revenues from the sale of energy. The energy market for an EFW plant be should be long-term (i.e. a minimum of 20 years) to ensure the viability of the operation. The facility must then be committed to generating the amount of energy promised to its consumers, regardless of changes in the waste stream. It can be tempting to build over-capacity incinerators which have the capability to handle anticipated future increases in garbage generation. This may not only result in higher capital costs, but in less efficient combustion, and a disincentive to reduce

TABLE 8: Cost Considerations For Incineration

REVENUES/GRANTS	EXPENSES			
	STUDIES & APPROVALS	CAPITAL COSTS	OPERATING COSTS	POST-CLOSURE COSTS (PERPETUAL CARE)
- Tipping fees - Energy sales (if EFW) - Diversion credits - Sales of recovered materials from pre-processing eg. metals - Waste Management Improvement Program (MOE) - Capital Assistance Program (Min. of Energy)	- Waste Management Master Plan Process - Environmental Assessment - Environmental Protection Act	- Financing - Land - Planning & Engineering - Roads - Buildings -Equipment • hauling trucks • forklifts • scales • waste storage & handling • pre-processing system • combustion system • energy converter • monitors • anti-pollution equipment - Transfer station - Fencing - Gates - Compensation to landowners / municipality	- Labour, including administration - Refuse collection - Weighing - Utilities - Environmental Impairment Insurance - Auxiliary fuel - Waste water treatment & disposal - Ash treatment - Landfill: • of non-combustibles which are non-recyclable • of fly & bottom ash • of refuse collected during routine plant down-times - Security - Grounds maintenance - Debt servicing	- see landfill costs (pg.19) for residuals

waste generation. Retrofitting of incinerators to adapt to changes in the waste steam, or altered specifications of the energy consumer can be prohibitively expensive.

One recent advance in support of EFW's is the policy for Ontario Hydro to purchase electricity from outside generators, such as EFW plants. A set price for the power has been established at one of the higher levels.

Private incineration operations may result in cost savings for municipalities equal to the costs of the alternative methods of disposing of wastes - usually landfill. *As* such, incinerator operators may receive a "diversion credit" from the municipality in recognition of these savings from the municipality.

Funding Program For Incineration Operations

Capital Assistance Program grants are available to municipalities and grants and loans to private sector proponents from the Ministry of Energy. These can be used to assist with the costs of constructing EFW's for nonhazardous wastes.

4.3. RECOMMENDED READINGS

The Proctor and Redfern Group (for MOEnergy), Energy From Municipal Solid Waste: A Status Report on EFW Planning and Technology in Ontario.

- very readable reference on EFW. Deals with technology, costs, regulations, and provides case histories.

Biocycle

- 8 issues in 1987 provide an excellent overview of the technical, legal, pollution aspects of EFW. Material was designed as correspondence course material.

5. THE 4 R'S

The catchy phrase "4 R's" has caught hold among us. It has the sound of goodness that we associate with the 3 R's from school. Like the value of reading, writing and 'rithmetic, there are complex benefits (and some cost) for us all from the reduction, reuse, recycling, and recovery of waste.

Waste reduction, although one of the 4 R's, stands aside from the others in one sense. With reduction of one tonne of waste, there is nothing to treat, sort, burn or bury; that tonne was not created in the first place. In another sense, reduction does fit with the rest of the R's; in all four, the objective is to keep another tonne out of the landfill. To the extent that any of the 4 R's succeeds in keeping that tonne out of the waste disposal site, it represents a substantial saving of money, environmental effects, and nuisance. To the extent of net social savings it is worth subsidizing and assisting any one of the 4 R's.

5.1. DESCRIPTION

Concerns over water quality and air emissions, rising costs, and the difficulties in locating landfills and incinerators, has led to a renewed interest in the 4 R's. The 4 R's are:

Reduction - is the decreased generation of waste. On an industrial level, a variety of approaches can reduce waste such as fewer errors in production, increased use of durable products and adoption of recyclable or reduced packaging for products produced can result in reduction. On the household level, reduction is accomplished through decreased purchase of disposable or heavily packaged products.

Reuse - is the use of an item again in its original form, for the same or a different purpose. Refillable beer and soft drink bottles are examples of this. Reuse of corrugated cardboard for shipping is another example. Surplus good sales in institutions, garage sales and donations of reusable items to a charity are common techniques for stimulating reuse.

Recycling - is the source separation of waste material to be used as a replacement for all or part of a virgin material in a manufacturing process. While many industries naturally integrate recycling into their manufacturing process, several materials can be sorted and collected for recycling on a post-consumer basis. At the present time, there are technology, markets, and programs to recycle newsprint, fine paper, cardboard, glass bottles, metal cans, and two-litre plastic pop bottles. Composting is also considered recycling if source separation is involved. Large quantities of miscellaneous wastes such as plate glass, demolition wastes, wood, and homogeneous plastics, usually from industrial or commercial sources, may also have local markets to encourage recycling.

Recovery - is the extraction of material or energy from mixed waste to meet market demand. EFW is an example of recovery. The pre-processing of mixed waste prior to incineration is another form of "recovery".

(definitions from MOE's "The Municipal Recycling Support Program")

Clearly waste reduction is a different approach than the other 3 R's which are used once the waste has been created. The following pages emphasize recycling because it is not much different from reuse and recovery of waste. Experience indicates that people who actively recycle waste learn how they can reduce the amount they generate. They become more aware.

Locational Considerations

Most recycling operations today are labour intensive and function without pollution-creating equipment. A large warehouse space is usually required for sorting and processing materials. It is important when siting a recycling plant to locate it in a centralized place to reduce transportation costs. Industrial areas are the preferred sites to minimize potential land use conflicts.

Large scale aerobic composting sites will usually be located in rural areas for aerobic or outdoor decomposition. Here, buffers will be required, as will odour and pest controls. Depending on the wastes being composted, for some large scale operations (eg. for pulp and paper sludge treatment), hydrogeologic conditions should be similar to those for landfills to avoid leachate migration. Anaerobic composting sites which usually involve tanks require less land area, and are suited to industrial locations.

"Carrot" And "Stick' Approaches

The first step in the 4 R process is to engage in promotion and public education to encourage residents and businesses to get involved. "Carrots" to motivate involvement can range fruit feedback to recyclers on the number of trees saved through paper recycling efforts, to lottery tickets for those individuals participating (as is done in Plymouth, Maine). Other means. of encouraging waste reduction include suggesting or arranging markets for commercial-industrial sources by Recycling or Waste Reduction Co-ordinators. This can often result in significant financial benefits to waste product generators.

"Stick" type motivators include legal controls such as bans on the disposal of certain it in the landfill or incinerator, mandatory recycling by-laws, and packaging regulations. The Region of Halton has banned corrugated cardboard from its landfill, and the Region of Peel is soon to do the same. This forces generators to search for alternative disposal locations, or more favorably, markets for recycling the material.

Mandatory recycling requires all residents to separate recyclables from their garbage, with penalties including leaving unsorted garbage left uncollected at the curb, or fines. Fort Erie, Midland, Neustadt, and South West Oxford County all have mandatory recycling. In 1987, New Jersey enacted state-wide mandatory recycling. Under this bill, municipalities are required to pass ordinances requiring local residents, businesses and institutions to source separate materials specified in their county plan (Maynes, 1988).

At the present time, there are few limitations on the amount or type of packaging produced in Ontario. However, in Austria, for example, the production, sale or import of any packaging that is not reusable or recyclable is banned. In Massachusetts, a bill was introduced which would result in a three cent surcharge on most packaging. This is also being considered in New York State (Metro Toronto Works Depts., 1988).

Sorting Techniques

There are two basic sorting techniques for separating materials out from the rest of the waste stream: co-mingling (i.e. "recovery") and source separation (i.e. "recycling"). With co-mingling, mixed garbage is collected and brought to a processing facility where the recyclable fraction is removed, either mechanically or manually.

Source separation, or the separation of the recyclable fraction of the waste stream by the waste generator is a favoured approach in Ontario for several reasons: it fosters environmental consciousness in participants; it reduces the contamination which occurs in co-mingled wastes, thereby improving marketability; and it cuts down on sorting requirements and costs at the recycling facility. However, because a certain degree of contamination can also be expected in source separated materials, manual sorting at the recycling plant is still usually required.

There are currently approximately 90 townships, villages, towns, and cities in Ontario with source separation programs. In 1987, 47,790 tonnes of recyclables were sold to various markets in Ontario (Hanson, 1967).

Collection Techniques

Source separated materials can be brought to a depot, or collected at the curb. Depots or drop-off centres are often used in rural areas which do not have the population density to support a curbside program. Some apartment recycling programs essentially use the depot system, wherein bins are placed in a convenient location, often in or near the parking lot, for dwellers to dispose of their recyclables. Centralized depots can also be used as back-up systems to curbside programs, or for use by apartment dwellers or commercial operations which do not have curbside pickup.

Because of their convenience, curbside programs are able to capture more recyclables than depot programs. Frequency of pick-up varies from one community to another, but most cities in southern Ontario with programs have weekly collections. This frequency has been found to greatly increase the number of participants and total amount recovered for recycling.

While the majority of recycling programs are located in southern Ontario where markets are close, programs in Huntsville, Gravenhurst, and Bruce County are slated to start up as well. Several rural communities have curbside programs as well. In South West Oxford, a township of 8,270 people, the garbage truck pulls a trailer to hold recyclables. Neustadt, with a population of 514 residents, has Ontario's smallest curbside program (Taylor, 1988).

About half of all recycling programs in Ontario are multi-material programs, with newspaper, glass bottles, metal cans, and usually 2 litre plastic soft drink containers being collected. By the end of 1988, 44 of the communities in Ontario with multi-material programs, or 1.2 million households, will have been provided with "blue boxes" (OMMRI, 1988). The blue boxes are distinctive plastic containers in which to place recyclables. This adds convenience and recognition to the recycling process, and thus increases participation rates and recovery amounts.

"Beyond Curbside"

Several municipalities in Ontario (eg. Durham, Guelph, Metro, and Ottawa) are becoming involved in "beyond curbside" activities, often stimulated by Waste Reduction Co-ordinators. These activities include composting, both in the residential and business-related sectors, fine paper recycling in offices, recycling of demolition wastes, cardboard recycling, and waste materials exchanges, along with high profile educational campaigns.

Durham Region and Metro Toronto have set their objective at reducing the total solid waste weight by 25% , Ottawa 34%, and Peel Region 23 to 24% through the use of such techniques. A few successful American examples include Wilson, New Hampshire (population 8,500) which has a 44% diversion rate, Prairie du Sac Wisconsin (population 2,300) with 30-50% diversion, and Portland Oregon (population 450,000) with 24% diversion of the total solid waste. These three cities all have mandatory recycling, and have programs set up for glass, metal, cardboard, office paper, leaves, mixed paper, motor oil, appliances, and auto batteries (Peters, Grogan; 1988).

Wet-dry System

One source separation system which has proven successful in West Germany and Austria is the wet-dry system. This system involves the separation of residential wastes by the householder into dry wastes including packaging and paper, and wet wastes which include food and yard wastes. Colour coded bins or bags may be used for this. A third container may be used for miscellaneous wastes such as diapers. Needless to say, this system would require relatively extensive sorting of the dry wastes in a processing facility, and composting of the wet wastes. On the other hand, recovery rates can be very high. Neunkirchen, Austria (population 100,000) achieves a 65% reduction using this system (Metro Toronto Works Dept., 1988). Metro Toronto plans to begin a wet-dry pilot project at the beginning of October, 1988 (Wallace, 1988).

A variation of this approach has already been tried in Metro. A demonstration project involving 72 households in North York's Hogg's Hollow neighbourhood used a three-bin system for their recyclables. One bin was used for food and some yard wastes, one for paper, and one for other recyclables. The participants were able to divide their wastes in such a way that 70% were recyclable (Perks, 1988).

Composting

Because food and yard wastes comprise about one third of the municipal 38 solid waste stream, it is very advantageous from the point of view of waste reduction to consider various composting techniques. Composting is the biological decomposition of waste into a humus-like material which can be used as a soil conditioner.

Composting is in its infancy and efficient techniques for large-scale compost making must be developed and learned to bring costs down. There are some problems with centralized composting. Despite the fact that composting can convert the "nasty and smelly" into nice soil, all is not pure. Rotting will not remove the fragments of glass, metal and plastic which get into garbage, nor the occasional toxic chemical such as the paper towel soaked in oven-cleaner. Markets for this material are not yet well established. Although it might be used to increase the organic content of clay or eroded farmland, the trucking costs might be formidable, set against the benefits.

Backyard composting is a feasible approach for the self-motivated. In Kitchener and Peel Region, hundreds of homes have been provided with home composting bins free of charge, on an experimental basis. Cambridge, Guelph, the Region of Halton, and Metro are amongst the municipalities currently collecting leaves in the fall from residential roadsides for composting. Christmas trees are also collected for this use in some municipalities.

In the spring of 1989, the City of Guelph will undertake a curbside program for stables in a portion of the city. The project is expected to be city-wide by 1990. Each household will be given a plastic bin for their food and yard wastes. Commercial and industrial compostibles will also be collected. The composting program is expected to result in 20 to 30% diversion from the residential sector, and 15 to 20% in the industrial/commercial sector. This percentage diversion will be in addition to the 15% or so that is achieved in Guelph's multi material curbside program (Hoornweg, 1988).

The village of Ryley, Alberta (population 500) is cutting its landfill use by 30%

with its curbside composting program. Participants in the program are welcome to use the compost, once matured, in their own yards.

Large-scale composting is occurring for paper sludge twin mills in Ontario and Quebec by Niagara Falls' Grow Rich Waste Recycling Systems.

One technique for large scale handling of biodegradable wastes is anaerobic composting. Biogas (methane) is produced for off-site use, as is compost. Because this method uses fermentation towers, it utilizes less land area then aerobic composting and minimizes odors and other nuisances. This system *has* been proven successful in France and Belgium.

5.2 COSTS OF RECYCLING

The revenues generated from the sale of recyclables do not usually cover the cost of administering recycling programs, and collecting, processing and transporting recyclables. Nevertheless, the recycling is generally recognized as being less expensive than landfill or EFW when full costs are calculated (Frish, 1988; Perks, 1988). Capital costs of the other two technologies are thought to be at least four to five times that for recycling operations. However, operating and maintenance costs are more than twice as much for recycling operations, primarily due to the labour intensiveness of recycling (Quigley, 1988). Table 9 provides *a* breakdown of the expenses and revenues to consider when calculating the full cost of operating recycling programs.

There is tremendous variability in the net cost per tonne for collection, processing and administering recycling programs. Net cost estimates range from $40 to $60 per tonne for the types of expenses and revenues/benefits listed in Table 9 (Alhberg, 1988). While this figure may seem high, it does not reflect the social value of recycling from the perspective of:

- savings in the mining or harvesting of raw materials used to manufacture

TABLE 9: Cost Considerations For Recycling

REVENUES/GRANTS	EXPENSES			
	STUDIES & APPROVALS	CAPITAL COSTS	OPERATING COSTS	POST-CLOSURE COSTS (PERPETUAL CARE)
- Sales from recovered materials - Diversion credits and/or fee for service - 4 R's Program (MOE) - start-up funding from Ont. Multi- Material Recycling Inc.	- None required, but 4 R's are part of the Waste Management Master Plan Process	- Financing - Land - Buildings - Equipment • hauling trucks • scales • waste storage areas/containers • waste handling eg. conveyors, forklifts • compactors, balers	- Labour, including, administration - Collection costs - Transportation to markets - Utilities - Public education - Debt servicing - Weighing	- Not applicable

goods made from recyclable materials, including the conservation of renewable and non-renewable resources.

- energy savings from using recycled materials instead of virgin materials in production (see Table 10).
- deferred capital expenditures for new landfills, or reduced size of incinerators.
- reduced pollution.
- employment opportunities, particularly for unskilled and handicapped persons.

(Proctor & Redfern, 1987)

TABLE 10: Energy Savings From Recycling.

MATERIAL	% Energy Saved By Processing Recycled Materials Over Raw Materials
Paper	70 %
Glass	50 %
Plastic (from crude oil)	90 %
Aluminum	95 %

Source: Yost, U. *et al.*, 1986.

As with EFW facilities, some recycling operations receive a diversion credit. More and more though, this is reserved as an incentive for scrap metal dealers to take accept large household appliances and other complex goods which are not accepted at the landfill or incinerator. Many multi-material recycling program operators are now receiving a "fee for service" instead, in recognition that recycling is considered a public service, just as landfilling is a public service (Hanson, 1988). This fee is generally equal to net costs, which includes a reasonable profit margin.

Funding Programs For Recycling

The MOE's 4 R's Program has several components. The Municipal Recycling Support Program provides municipalities with funding for feasibility studies of source separation programs, operating costs, capital costs, household bins (blue boxes), advertisement and promotion, demonstration projects, and education programs. A program has also been established to assist municipalities in setting up facilities for recovering materials from nixed solid waste, or for processing these wastes into useful products such as fuel or compost. The Municipal Reduction/Reuse Program provides funding to municipalities and the private sector for implementing projects aimed at altering consumer waste-generation behaviour. It covers projects related to composting, packaging, and new product approaches. Industries can also qualify for funding to manage their wastes and explore waste reduction techniques.

Ontario Multi-Material Recycling Incorporated, a corporation of soft-drink manufacturers, their packaging suppliers and industry associations also provides support for municipal recycling programs. It will fund one third or the costs of program launches, including all capital costs of class 1 recycling programs. It will also provide technical expertise, coordinate promotional activities, and train recycling program coordinators and operators in Ontario.

5.3. RECOMMENDED READINGS

Biocycle (magazine)
- regular articles on recycling (U.S.).

Metro Toronto Public Works, SWEAP News.
- broader context than Metro

Recycling Council of Ontario, Ontario Recycling Update.
- provides information on the latest happenings in the recycling field.

Victor Burrell Research and Consulting, The 4 R's in Ontario: An Examination of Selected Options.
- looks at costs associated with recycling, landfill, and EFW, and presents strategic options for the future.

6. OPPORTUNITIES FOR PUBLIC INVOLVEMENT IN THE PLANNING AND REGULATORY PROCESS

6.1 PUBLIC INVOLVEMENT IN THE WASTE MANAGEMENT PROCESS

There are-three main questions that a local community needs to consider when facing a waste management problem or proposal:

(a) why should we get involved

(b) what do we need in order to get involved

(c) when can we get involved in the process.

It must be recognized that the legal process for waste management in Ontario creates opportunities for public involvement but only token amounts of participation are actually required by law.

It must also be recognized that increasingly the authorities responsible to prepare and carry out waste management plans are convinced of the benefits that can be obtained from positive and receptive public involvement. The proponents of waste management facilities see both a public relations benefit in open public participation, and a saving in the time and conflict of obtaining final approval for plans. Furthermore there is some belief that a better plan with better effects on the local community can be obtained with public involvement than with the old approach of "top-down" decision-making. Public involvement requires the community to take the initiative to contribute to the waste management planning process. Community leaders must recognize what opportunities do exist and how participation can be effective and efficient.

In the past, the legacy of sub-standard dumps and incinerators built up an immense body of justified fear of waste proposals and suspicion of the officials given authority to make decisions. An effective public participation programme must face up to those fears and suspicions and use techniques that build assurance and trust.

Effective public involvement and participation should have the following kinds of objectives and benefits:

(a) to build knowledge
(b) to build agreement on as many facts, principles and remedies as possible
(c) to build mutual trust where it is merited
(d) to focus on the matter at hand rather than imagined sins and flaws of character
(e) to reduce the costs and length of time required to reach a mutually acceptable decision
(f) to help the engineers, planners and politicians integrate the points of view of the various residents and interests in the community into their decision-making.

In the absence of a well-conceived and well-managed public involvement and information programme, the process will sink back to the inefficient adversarial legalistic engineer-dominated battles of former years, in which human valued and environmental concerns tended to suffer badly. The strategy of the public was then usually the NIMBY Syndrome -- not in my backyard!

There are three major requirements for a good participation programme - community leadership, resources, and the spirit of cooperation. Leaders are required in the community who can gather together the major interest groups in the area so that they become an organization, even if fairly informal. The group then requires resources of both funds and people-resources. Depending on the size of the area a paid staff may be needed. The funds can came from donations and fund-raising, and should be supplemented by grants from the government and/or contracts for the work they do as part of the process. Volunteer input and donations are essential, but intervenor-funding is new on the way to being a part of government policy in environmental protection. Cooperation of the proponent is necessary in order to avoid the NIMBY response, and to speed the exchange in information that lubricates the process.

6.2 ORGANIZING LOCAL INVOLVEMENT

A variety of people and inputs can be involved and valuable in each stage of waste management planning. The stages start with efforts to identify the waste generation problem and follow a series of steps to the final disposal and safe care of waste handling facilities.

Members of the community are most valuable in a pro-active role rather than coming in much later in a reactive way which will usually result in a negative and we-they mood. Metro Toronto Works Department has a specially-trained, full-time Public Participation Facilitator on staff to help organize effective public participation opportunities, and act as an intermediary between staff and citizens.

Over the past two years, Metro Toronto Solid Waste Environmental Assessment Plan (SWEAP) has had an extensive public participation program with several components. The enormity of the Metro Toronto problem has required specialized working groups, but in a smaller community some of these might be combined. Their work illustrates the kinds of tasks that must be performed. They have: a) advisory caucuses, b) task forces, and c) committees.

A caucus is an advisory group of representatives that share some common interest but also have differences. Their function is to define their common views and advice the program. The SWEAP caucuses include:

- government,
- waste handlers/private sector,
- politicians,
- waste managers/ industry, and
- environmental organizations

The task forces are study groups that prepare reports that go to the senior levels of the process. They include the following: site selection criteria, legislative changes for recycling, waste reduction, incineration, public education and evaluating the mix of options. Each task force provides expertise on a specific part of the plan.

The peak of the hierarchy is the Metropolitan Toronto Works Committee which is responsible for the decisions just below the full Metro Council. The Metro Works Committee is advised on waste issues by the SWEAP Steering Committee which is composed of officials from the municipal works and legal departments, Ministry of Environment, as well as local political representatives. Its monthly meetings are open to the public. The Multi-Stakeholders Committee integrates recommendations from various public groups and proposes a single consolidated recommendation to the Steering Committee through its representatives.

While this whole structure could be organized more simply, the functions are essential, with the goal of giving public participants direct access, through SWEAP, to the politicians on the Works Committee which advises Council.

6.3. THE PLANNING AND REGULATORY PROCESS

In Ontario, solid waste management is primarily controlled by four legislative acts: The Planning Act, The Municipal Act, The Environmental Assessment Act, and The Environmental Protection Act.

The Planning Act grants municipalities the power to regulate where municipal waste management systems can be located. The Municipal Act grants municipalities the power to establish by-laws on particular aspects of waste management such as mandatory waste separation at source.

The Environmental Assessment Act (EAA) is intended to "provide for the protection, conservation, and wise management of the environment in Ontario" (Ministry of the Environment, 1987). Under the Act, good environmental planning and public comment on projects which may affect them is encouraged. Under the EAA, the aims of the planning process are: to consider positive and negative environmental effects of a project, to provide sufficient information and justification to decide among alternatives to a project, and to allow the Minister of the Environment, or the Environmental Assessment Board, to decide whether or not a project should be approved and how it should be carried out.

The EAA defines "environment" in the most inclusive way. Environment includes the technical, economic, financial, social, cultural and ecological impacts of an undertaking. The EAA applies to almost all provincial and municipal projects but rarely applies to private companies. All projects of Ontario Ministries and agencies, and major municipal projects (eg. landfill sites and incinerators), including public utility commission and conservation authority projects, except when the Minister of Environment exempts the project, are subject to the EAA. Federal government projects are exempt, as are most private projects at this time. However, the Minister's exemptions can be overruled by Cabinet.

If a project is subject to the EAA, an environmental assessment document must be submitted to the Minister of the Environment for review, acceptance and approval. Figure 3 outlines public participation in the Environmental Assessment process. The document must describe the proponent's planning process in evaluating alternatives and their potential impacts.

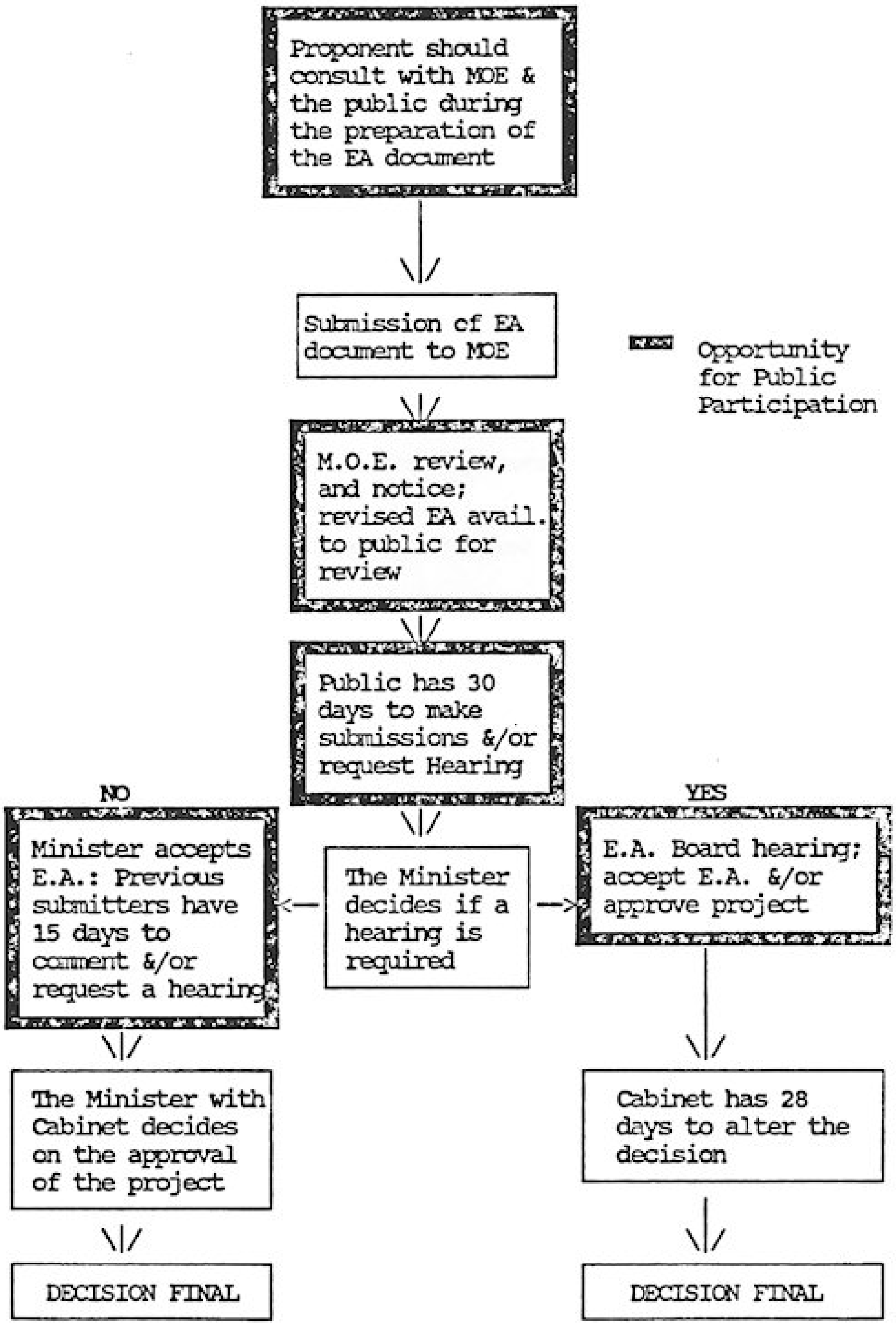
The Environmental Protection Act (EPA) deals primarily with the technical aspects of a proposed project and the protection of the environment from contamination. Its application is primarily limited to private projects. The EPA defines the term "environment" within a narrower context then the EAA, referring specifically to air, land and water.

The EPA grants the Province the power to require waste management projects to get specific approvals from the Ministry of the Environment before the project can become operative. Approval of all waste management systems (by public and private) and sites in Ontario fall under Part V of the EPA. Municipally awned and operated solid waste management facilities such as landfills and energy from waste plants, also require approval under the EAA.

Regulation 308 of the EPA (dealing with air pollution) currently provides controls on emissions to the atmosphere in terms of the maximum concentrations of stack gases where they come down to ground level (point of impingement), and the overall quality of the air in the community. Under this earlier regulation, emissions to the environment were limited on the basis of point of impingement effects after dispersion. Under a proposed revision to Regulation 308, the use of dispersion to deal with air pollution will be replaced by controlling an emission in the stack at its source before it escapes into the atmosphere. Also, air "standards" for communities in close proximity to industries will be established, requiring all facilities to meet those standards in order to receive a certificate of approval.

Section 12 of Regulation 308, dealing with incinerators, is being updated with changes to the existing design and operating criteria for incinerators of all types. The updated criteria will provide required temperatures, residence tines, monitoring requirements and operating practices for new and modified incinerators seeking approval in the Province. Continuous total hydrocarbon or carbon monoxide monitors will be required.

Regulation 309 of the EPA delineates standards for the maintenance and operation of sites accepting municipal waste in the Province. This regulation is being revised to make standards more specific. Based on the revised regulation, municipal waste disposal sites will be categorized into different classes based on two criteria; the amount of waste being brought into a site, and the proximity to and nature of surrounding land uses. The new approach will apply to new municipal waste disposal sites, with a phasing program for existing sites.



Source: Ontario Ministry of the Environment, 1987.

FIGURE 3: Public Participation In The Environmental Assessment Process.

Waste Management Master Plans

The Waste Management Master Plan covers a planning period of at least twenty years into the future, and is a process used by municipalities to develop long-term plans for managing solid wastes (Jackson, J. and Wright, C., 1987). Household, commercial, and non-hazardous industrial wastes are addressed.

This process is not required by provincial legislation, but is encouraged by the Ministry of the Environment through the provision of fifty percent of the study costs. The Ministry of the Environment also strongly suggests that municipalities take their master plan through the Environmental Assessment process (Figure 3). Specific waste management projects (such as landfills and incinerators) will be required to go through the Environmental Assessment process.

The approval process for a waste management master plan is as follows and is summarized in Figure 4:

Stage 1: Data Collection - involves the gathering of background data on the municipal waste stream, current waste management systems, estimates of expected future wastes, and the status of current waste management facilities and their future potential.

Stage 2a: Development of Master Plan Options - includes the description and a preliminary assessment of all feasible waste management alternatives.

Stage 2b: Ranking Options - involves the evaluation and ranking of options, concluding with the selection of preferred waste management methods and sites.

Stage 3: Master Plan formulation - involves the development of the actual Waste Management Master Plan document. This document will contain a detailed description of the municipality's long term planning for waste management.

Municipal Council Approval is required to create a policy statement out of the waste management master plan which the municipality must follow. The policy can be revised at any time by a vote of the council.

The next step, Provincial Approval, involves sending the Waste Management Master Plan to the various government agencies for formal review and approval. Most undertakings involving waste management will require approval under the EAA. Specific components of the plan will also need approval under the EPA.

Public Involvement In The Waste Management Master Plan

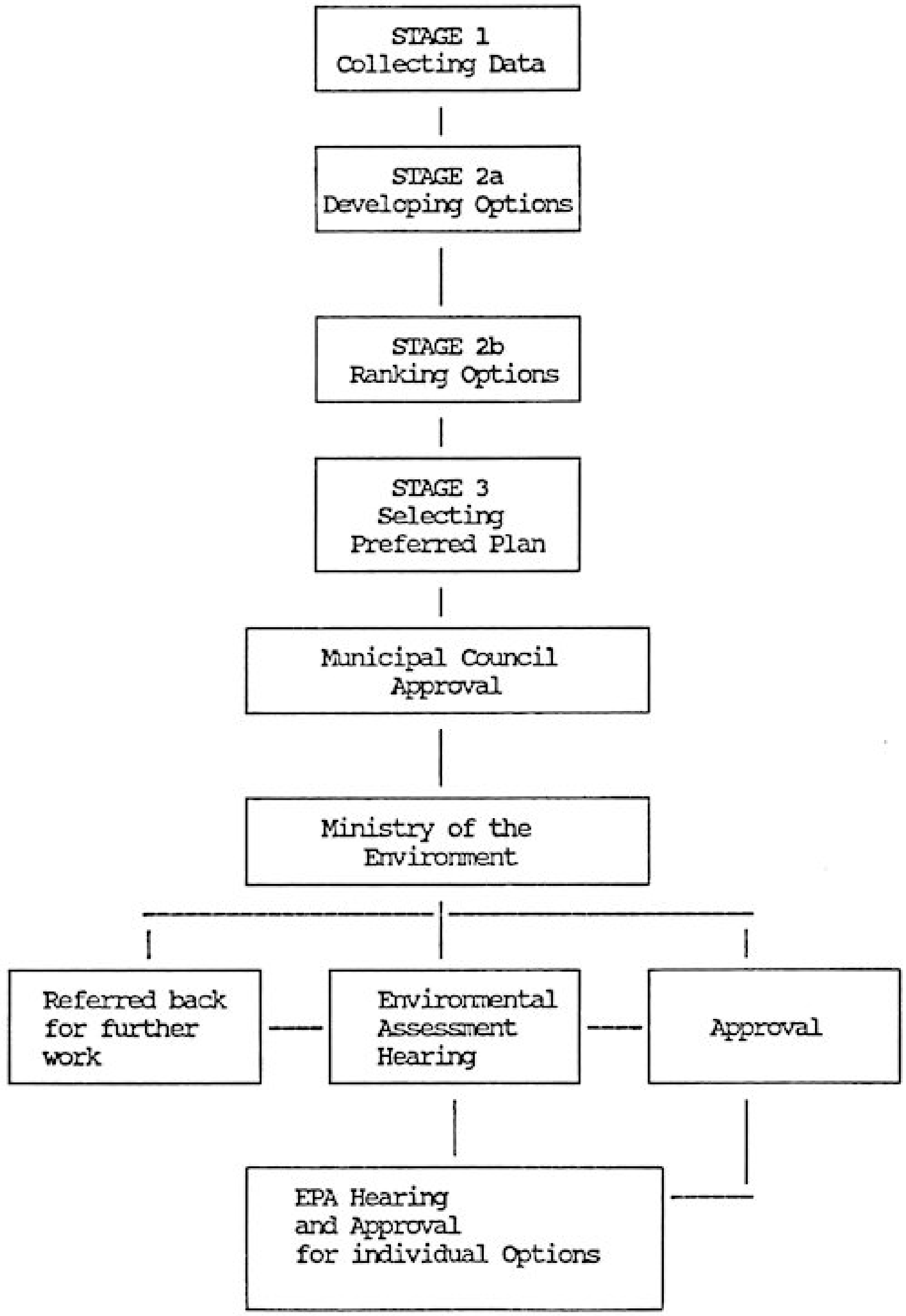
Under the Waste Management Master Plan Program, the Ministry of the Environment states that mechanisms should be set up for public participation. The public is to be involved from the outset so that they can be informed and allowed to express their concerns and comment on options. Municipalities have used public information meetings, public meetings, and public liaison committees as mechanisms to involve the public.

Public information meetings, held throughout the planning process, involve the dissemination of information to the public by the municipality's consultants and provide a chance for the public to have any questions answered.

Public meetings allow the public to make formal deputations to the steering committee or a committee of council. Presentations by specific groups are encouraged here.

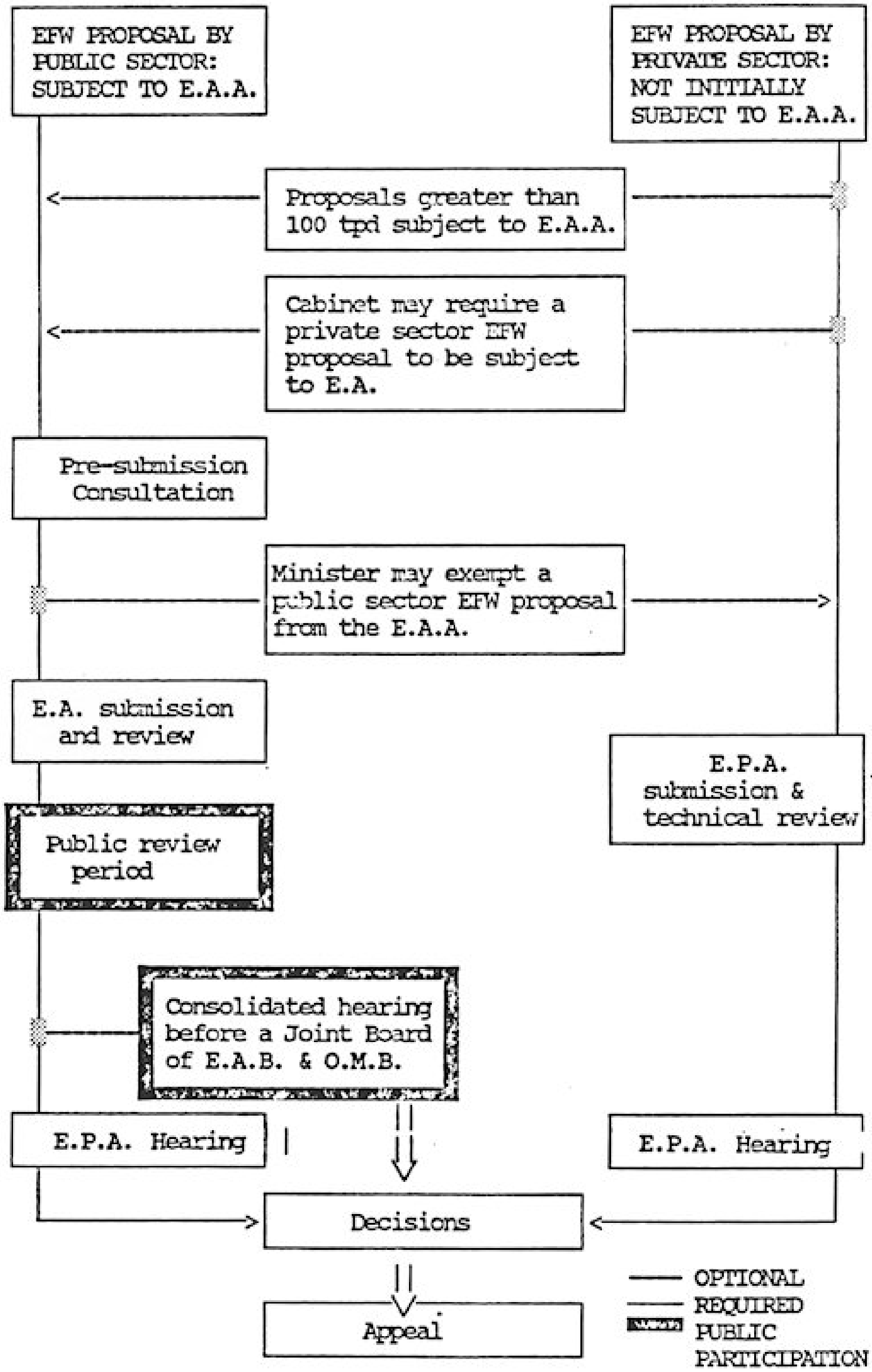
Public liaison committees can be set up to oversee the public participation programmes and to relay information to and from the public. The municipality usually appoints community members to a liaison committee.

Public hearings are also provided under both the EAA and the EPA (Figures 3 and 5). The Provincial Government provides intervenor funding for citizen's groups appearing at public hearings. Figures 3 and 5 point to the process which specifically provide for public participation are highlighted. The points at which public participation is required are highlighted.



Source: Jackson, J. and Wright, C. 1987.

FIGURE 4: Waste Management Master Plan Approval Process.



Source: The Proctor and Redfern Group. 1987.

FIGURE 5: Summary Of Hearings And Approvals: Process For EFW Proposals.

Because of the difficulties in siting landfills and incinerators, and economies of scale of waste management systems, it is advisable for adjacent or nearby communities to become partners in solving their waste management problems. Working together on the waste management master planning process, the design and operation of facilities, and even joint financial risk-sharing can be advantageous for all parties involved.

6.3. RECOMMENDED READINGS

Jackson and Wright, Waste Management Master Plans: What You Should Know.

- covers topic of Waste Management Master Plans and has a good section on the planning process.

M.O.E., Stopping Air Pollution At Its Source, CAP Clean Air Program.

- discussion paper on proposed revisions to E.P.A. Regulation 308

M.O.E., A Citizen's Guide to Environmental Assessment.

- brief description of Environmental Assessments

The Proctor and Redfern Group, Energy From Municipal Solid Waste: A Status Report on EFW Planning and Technology in Ontario.

- good section on the Regulatory Environment.

7. EVALUATING ALTERNATIVES IN WASTE MANAGEMENT

The alternative waste management practices and techniques identified in a waste management master plan and/or an environmental assessment document will normally be evaluated using a set of evaluation criteria to identify the potential effects of each alternative upon each component of the environment. The underlying intent of this evaluation is to avoid hazardous effects associated with waste management - for this and future generations.

The evaluation criteria employed must include all possible impacts that each alternative might have on public health and safety, the natural environment, the social environment, the cultural environment, economics, and technical considerations. Environmental interactions are multidimensional and almost every action will have repercussions throughout sectors of the environment.

The evaluation methodology employed must all for a comparison of alternatively measuring the ability of each alternative to meet the goals of the waste management plan. Given the complexity of waste management systems, especially when all three types of waste management are being examined in combination (landfill, incineration and the 4 R's), the measurement and comparison of alternatives is very involved.

7.1. EVALUATION CRITERIA

The criteria which must be used in evaluating a project are set out in the Environmental Assessment Act in general terms, and include technical, economic, financial, social, cultural and ecological impacts.

Beyond the legislated requirements, evaluation criteria should reflect the goals of the community. For example, if preservation of prime agricultural land has been identified to be one of the goals, then this must be reflected in the criteria used to select the best alternative or combination of alternatives for waste management.

The main elements often included in evaluation criteria are listed below:

- Public Health and Safety
- Natural Environment
- Social Environment
- Cultural Environment
- Economics
- Technical Considerations

Each of these main elements should be further sub-divided and the effects and possible mitigation measures for each examined for all alternatives considered in a waste management project.

Public health and safety includes examining the impact of each alternative on the risks of acute or chronic injury or illness via: contamination of land, air and water; increased traffic in and around specific project locations; or fire and explosions. The effects of each criterion should be examined to determine what impact each will have on public health and safety and what mitigation measures can be implemented to avoid or lessen the impact.

While there is often only a superficial difference between public health and natural environment concerns, since toxics released to the environment may ultimately impact health, the natural environment category includes mineral resources, agricultural resources, forest resources, and terrestrial biology (vegetation and wildlife). The significance loss of the resource (mineral, wildlife and vegetation) or loss of production (agriculture and forestry) should be identified and possible mitigation measures outlined. The impact on the sustainability of future resource use should also be examined.

The effects on the social environment, such as neighbourhood character, community control of projects, recreational facilities placed in waste site buffer zones, and the convenience of alternatives to the public, are necessary elements to consider. A landfill alternative may have a significant impact depending on its location within a community.

Our cultural environment includes archeological, historical, architectural, aesthetic, and other heritage resources. Threats to these sites from waste management practices should be considered and a value placed on these resources by the community.

Economics includes the net costs to the community both direct and indirect. Direct costs such as capital, operating and maintenance costs, as well as indirect costs such as compensation and leachate controls, are weighed against community benefits such as employment created.

Technical concerns involve examining the risk of failure and the degree of flexibility in waste management systems. Risk is a function of the reliability of components of a waste management system and the complexity of the components. The flexibility of the system should be examined to identify how effectively each alternative can be adapted to changes in waste quantities, qualities or changes in the environment or technology available.

When examining the criteria being used in an evaluation:

- ensure that all criteria are included that address the key arc of concern to the community,
- be sure that for each criterion there is sufficient information to identify all major potential environmental effects both locally and regionally, and
- recognize the interactions of criteria.

7.2. EVALUATION METHODOLOGIES

In order to select the most appropriate set of components for a waste management system, it is necessary to consider many detailed evaluation criteria. To arrive at a judgement of each alternative's desirability, it is necessary to assemble all the detailed parts into an understandable whole. The selection of an evaluation methodology which can consider all of the impacts of each alternative is a critical part of any waste management plan.

The most limited form of evaluation is the simplest form of cost-benefit analysis which considers only the direct dollar costs and benefits (revenues) of the project operation, to find the project or company with the most favourable net cash benefit. An extension of the method includes the indirect economic (dollar) costs and benefits that are generated elsewhere as a result of the project. The fullest form of cost-benefit analysis considers also the "non-economic" costs and benefits that are created anywhere by the project. It includes a description of all effects imposed on anyone in the community such as the loss of habitat for wildlife or the anxiety and pain inflicted by air pollution. The full accounting of all private and social costs and benefits including non-monetary effects is called social cost-benefit analysis or socio-economic impact analysis.

Decisions on wide-reaching projects such as waste management projects Should be made after a fairly complete socio-economic impact analysis or assessment.

If a project is evaluated on more than dollar amounts, community input is necessary to discover what the people really care about and how much they care about them as important criteria. The evaluation team rust study with the people the ways in which the project will have effects. Some effects will be considered to be acceptable, i.e., not significant to any interest group, while other effects will be considered to be less acceptable or even entirely unacceptable. The factors or criteria can be ranked from most important to least important, and there are procedures that can attach weights to each factor (as an example, an area may feel that preventing pollution of the groundwater is twice as important as avoiding class 1-3 farmland).

The full socio-economic impact analysis is virtually identical to the planner's methods called planning balance sheet and the goals achievement matrix. In all these methods the objective is to set out in tables, for each alternative version of the project, how each of the impacts of the project affects a goal or a value held by some part of the community and who is affected by that impact. Some methods convert the descriptions into an overall numeric index of the net merits of each alternative.

Evaluation methods can be used wisely with sensitivity for people and the environment, or they can be used badly, even corruptly, to undeservedly slant the findings toward one proposal or another. One of the greatest values of active and early public involvement in the process is to improve the quality of information used in the evaluation stage, and to broaden the group that analyses the information.

7.3. RECOMMENDED READINGS

SWEAP Task Force, "Site Criteria: Issues to be Addressed by SWEAP.

- presentation of prioritized criteria for site selection for each waste management option.

Armour, "Facility Siting: A No-Win Situation" in Canadian Environmental Mediation Newsletter.

- excellent discussion of importance of public participation in criteria selection.

8. LIST OF CONTACTS

Canadian Environmental Law Association (Toronto)	(416) 977-2410
- legal assistance to individuals and groups affected by environmental problems.	
Concerned Alma Citizens (Township of Peel)	(519) 837-2600
- very active citizens' group in Wellington County	
Environmental Lawyers	
David Estrin (Toronto)	(416) 927-8226
Stephen Garrod & Associates (Guelph)	(519) 837-0500
Willms & Shier (Toronto)	(519) 823-0711
John Jackson (Kitchener)	(519) 744-7503
- consultant specializing in advising citizen's groups	
Ministry of Agriculture	
- see Ag. representatives from local office regarding farm waste treatment, or	
John Vanderdonk, or other environmental scientist in Pesticide Section (Toronto)	(416) 323-5099
Ministry of Energy (Toronto)	
Patricia Bolton, Alternative Energy Development Section	(416) 965-5303
Ministry of the Environment (Toronto)	
Environmental Assessment Branch	
Mr. Roger Clarke, Waste Management Division	(416) 323-4319
Waste Management Branch	
Mr. Joe Petoia, Waste Disposal Unit (waste management master plans, funding progs.)	(416) 323-5210
Mr. Neal Ahlberg, Waste Reduction Unit	(416) 323-9671
Ontario Waste Management Corporation (Toronto)	(416) 923-2918
- hazardous or "special" wastes	
Hal Miettinen, Communications Officer	
Recycling Council of Ontario (Toronto)	1-800-263-2849
- information on recycling opportunities, markets, etc.	
Waste Reduction/Recycling Coordinators (see Public Works Dept. of municipality)	
Victoria Hospital Energy From Waste Facility (London)	(519) 432-5241
John Finney, Public Relations	

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