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UIC

Yard Waste Programs

Existing Regulations, Collection, Composting, Compost Characteristics and Land Application

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Preface and Acknowledgments

This public service report is a result of the concern of the Illinois Governor, State Legislature, and the Public for the magnitude of the solid waste problem in Illinois. The concern led to the passage of the Illinois Solid Waste Management Act of 1986. One result of this Act was the creation of the University of Illinois Center for Solid Waste Management and Research. The Office of Technology Transfer (OTT) is part of this Center. One of OTT's means of transferring technology is the publication of public service reports which contain discussions of important topics in solid waste management.

Funding for this public service report was provided by the Illinois Department of Energy and Natural Resources (IDENR), Office of Solid Waste and Renewable Resources. The views expressed in this report do not necessarily reflect the policy of the IDENR. OTT would like to acknowledge the thoughtful review provided by Mr. Thomas R. Halbach, Assistant State Specialist, Water Quality and Waste Management, University of Minnesota Extension Service.

Copies of this report are available through the Office of Technology Transfer (M/C 922), School of Public Health, The University of Illinois at Chicago, Box 6998, Chicago, Illinois 60680, telephone 312-996-6927.

Summary

In order to extend the life of municipal solid waste (MSW) landfills and help minimize future costs associated with waste disposal in Illinois, the state legislature banned the landfill disposal of landscape wastes starting July 1, 1990. Landscape waste (yard waste) includes grass, shrubbery cuttings, leaves, tree limbs and other materials. Yard waste constitutes about 20% of the MSW stream by weight.

This report discusses experiences from some mandatory and pilot yard waste collection and composting programs, with the intent of better informing Illinois municipalities. The following yard waste programs provided information for this report: Barrington and Urbana, Illinois; Anoka, Carver, Dakota and Washington Counties, Minnesota; and Madison, Wisconsin.

An economical and effective method of yard waste management for the generator and municipality alike is to utilize the yard waste produced on-site. Grass can be mulched into lawns rather than collected. Grass, leaves and soft brush can be composted in bins or piles. Brush and prunings can be ground or shredded and used as ground cover. Homeowners may utilize the services of a local waste hauler or transport their yard waste to a compost or drop-off site themselves. While yard waste pick-up at curb side may typically cost $1 per bag, transporting yard waste to a compost site and debagging may cost 15¢ per bag.

A common concern regarding municipal yard waste compost is nutrient and contaminant content. Results of compost analysis programs in Minnesota, New York and Oregon indicate that metal and pesticide concentrations are either below detection limits or below allowable contaminant limits. Product specifications for compost have been developed by the Minnesota Department of Transportation.

An alternative to yard waste composting is the land spreading of leaves and grass (without composting) on crop land. Although the Illinois EPA does not require a permit for farm land application of yard waste, guidelines, are available. Application of leaves and grass to farm land adds organic matter to the soil at minimal cost and reduces wind erosion. A primary aspect of leaf application is the supplemental nitrogen required for degradation of leaves and plant growth. Leaves have been the primary yard waste applied because of the large amounts generated in the fall when open farm land is available for spreading.

While a number of areas are utilizing land spreading of yard waste to reduce landfill usage, few are researching the acceptable rates of land application. Projects in Wisconsin, Minnesota, and New York are discussed. The biggest problem arising so far has been finding a more time-efficient method of spreading leaves. Leaf application rates have

ranged from 10 to 50 tons per acre and nitrogen application rates have ranged from 50 to 300 pounds per acre. Overall, it was concluded from these projects that the effect of leaf application on corn yield may be dependent on the supplemental nitrogen applied. Additional research is necessary to determine the effect of leaf and nitrogen application rates on crop yield and soil. Leaf application did not increase metal contaminants in soil or plant tissue. The total costs of running a full scale land spreading program are less than that of running a full scale composting program (e.g., $17/ton versus $26/ton in Anoka County, Minnesota).

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1. Introduction

In order to extend the life of municipal solid waste (MSW) landfills and minimize future costs associated with waste disposal in Illinois, the state legislature enacted legislation banning the landfill disposal of landscape wastes starting July 1, 1990. Landscape waste (yard waste) is defined as "all accumulations of grass or shrubbery cuttings, leaves, tree limbs and other materials accumulated as the result of the care of lawns, shrubbery, vines and trees" [IEPA, 1990]. The specific provisions of the law (Section 22.22 of the 1990 Illinois Environmental Protection Act) are as follows:

a. No person may knowingly mix landscape waste that is intended for collection or for disposal at a landfill with any other municipal waste.

b. No person may knowingly put landscape waste into a container intended for collection or disposal at a landfill, unless such container is biodegradable.

c. No owner or operator of a sanitary landfill shall accept landscape waste for final disposal, except that landscape waste separated from municipal waste may be accepted by a sanitary landfill if (1) the landfill provides and maintains for that purpose separate landscape waste composting facilities and composts all landscape waste and (2) the composted waste is utilized, by the operators of the landfill or by any other person, as part of the final vegetative cover for the landfill or for such other uses as soil conditioning material.

1.1 Yard Waste Generation

Yard waste is one of the largest single components of the MSW stream in the United States, second in weight percent only to paper and paperboard products (Table 1-1). In the spring and fall seasons yard waste can comprise up to 45% of the total waste stream destined for a landfill [Michigan DNR, 1989]. The annual U.S. yard waste discards for 1986 were estimated at 28.3 million tons, with the amount forecast to rise to 32.0 million tons by 2000 [Franklin Associates, 1988]. There are large variations in yard waste generation from one community to the next due to lot size, turf mowing heights, forest density and disposal options. The average generation rates for yard waste from single family households are 1000 lbs/year for grass and green vegetative waste and 500 lbs/year for leaves and brush [Illinois ENR, 1989, and Michigan DNR, 1989]. Depending on the amount of compaction, the density of leaves is between 200 and 450 lbs/yd^3 and the density of grass is between 350 and 500 lbs/yd^3 [Yesney, 1988].

- Purchase a mulching lawn mower which will mulch grass acceptably at the normal rate of lawn care maintenance.
- Backyard compost as much as possible the grass and shrubbery trimmings, leaves and soft-bodied plant materials collected each year.
- Transport the yard waste to a local, usually municipally organized, drop-off site on an as-needed basis (typically no fee or a reduced fee is assessed for using drop-off sites).
- Transport the yard waste to a composting facility on an as-needed basis (typically no fee or a reduced fee is charged, as with a drop-off site).
- Utilize the curb side collection services of the local waste hauler or public works department (for a fee).
- Utilize the maintenance and collection services of a landscaping company (for a fee).

Table 1-2 Recommended Mowing Heights of Lawns [Allen and White, and Gass, 1990]

Grass Type	*Recommended Mowing Height (inches)*
Kentucky bluegrass: (Most Illinois Lawns)	
Common varieties (such as Aquilla, Monopoly, Nassau, Newport, Nugget, Park, Ram I, Rugby, Sydsport, Touchdown)	$1\frac{1}{2}$ - $2\frac{1}{2}$
Improved varieties (included in most sod; most varieties not listed above)	$\frac{3}{4}$ - 2
Fine fescue grasses	2 - $2\frac{1}{2}$
Tall fescue grasses	2 - $2\frac{1}{2}$
Perennial ryegrass	1 - 2
Bluegrass/fescue mixture	$1\frac{1}{2}$ - $2\frac{1}{2}$
Bluegrass/ryegrass mixture	1 - 2
Bentgrass	$\frac{1}{4}$ - $\frac{3}{4}$
Zoysiagrass	$\frac{1}{2}$ - 1

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Table 1-1 Components of the Municipal Waste Stream in 1986 [Franklin Associates, 1988]

Material	*Million Tons Discarded*	*Percent of Waste Stream*
Paper and paperboard	50.1	35.6
Yard wastes	28.3	20.1
Food wastes	12.6	8.9
Metals	12.6	8.9
Glass	11.8	8.4
Plastics	10.3	7.3
Wood	5.8	4.1
Rubber and leather	3.9	2.8
Textiles	2.8	2.0
Miscellaneous organics	2.6	1.8
Other	0.1	0.1
Total	140.8	100.0

1.2 Yard Waste Disposal Options

Since there is no requirement as to which governing bodies must coordinate the diversion of yard waste from landfills, the coordination is left to the municipal waste haulers, public departments, private enterprises, homeowners and individuals which interface with or dispose of yard waste in some way. Government agencies, Cooperative Extension Services and consultants in all parts of the country where yard waste bans are taking effect are placing primary emphasis on the "leave it on the lawn" or "backyard composting" approach to handling yard waste. Home management is the most cost effective way for homeowners and for municipalities to divert yard waste from area landfills. The following partial options for home management of yard waste exist:

- Cut grass frequently enough with the existing lawn mower to mulch the grass trimmings into the lawn. A rule of thumb to follow is mow often enough so that no more than 1/3 of the vertical grass height is removed with each mowing and that clippings are no more than 1" in length. For example, if the desired height is 2", cut the grass when it is no more than 3" high. Recommended mowing heights for a variety of grass types are provided in Table 1-2. It should be noted that leaving clippings from diseased lawns is not recommended.

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The latter four options, to a certain extent, will be utilized by individuals for disposing of excess leaves, tree limbs, shrubbery cuttings and grass even if home yard waste management (the first three options) is practiced. Public departments providing landscape management programs for parks, parkways, roadsides, golf courses, forest preserves, recreational areas, gardens and arbor programs may utilize similar additional options:

- Maximize the amount of grass trimmings left in place through adequate maintenance and mulching mowers, a practice which is frequently performed for turf in the above areas.
- Chip soft-bodied plant material (bush trimmings) and brush for use and easier decomposition.
- Chip tree limbs for use by the public and parks as a ground cover for pathways, gardens and unimproved road grades.
- Split healthy large tree limbs and trunks for use by the public as firewood, and landfill diseased wood.
- Compost leaves, grass, and chipped wood collected.
- Contract out for composting yard waste or land spreading of leaves and grass on farmland.

Because public and private municipal waste haulers are the groups which ultimately must comply with the yard waste landfill ban, they must collect yard waste separately from MSW or not collect it at all. Haulers must either arrange a management and operation program for, or pay for the disposal of, landscape waste collected. The effectiveness of a yard waste collection program can be measured through the amount of foreign matter (MSW) in the yard waste collected. The ultimate result of collection will be the composting or direct land application of leaves, grass and soft bodied plant material. Smaller particles of wood waste may also be composted, but overall must be managed separately from more readily degradable yard waste materials.

1.3 Illinois Information on Composting and Home Yard Waste Management

The Illinois Department of Energy and Natural Resources (ENR) has published a number of documents describing different composting techniques and practices, how to develop markets for compost, estimating the cost of a compost program and practicing home yard waste management. The reader is encouraged to refer to the following free

publications to inform and help municipalities, businesses and homeowners initiate composting in their area:

- Management Strategies for Landscape Waste: Collection, Composting, Marketing
  Revised September, 1989 ILENR/RR-89/09 70 pp.

- Landscape Waste Compost: Distribution and Marketing Strategies for Centralized Municipal Composting Operations
  Printed March, 1989 ILENR/RR-89/02 41 pp.

- Permit Requirements for Setting Up a Yard/Landscape Waste Composting Operation
  ILENR/RR-89/01 2 pp.

- Solid Waste Management Programs and Services
  ILENR/RR-89/05 2 pp.

- A Homeowner's Guide to Recycling Yard Wastes (available in bulk)
  Printed August, 1989 ILENR/RR-89/03 4 pp.

- Economics and Feasibility of Co-Composting Solid Waste in McHenry County
  Printed July, 1987 ILENR/RE-EA-87-12 265 pp.

Illinois ENR publications may be requested by phone at (800) 252-8955 (Illinois only), or by writing to Illinois ENR, Office of Solid Waste and Renewable Resources, 325 W. Adams Street, Springfield, Illinois, 62704.

The Illinois Environmental Protection Agency also makes available the following material to assist in identifying yard waste composting legislation and permitting required for a yard waste compost site:

- Instructions for Application for Permit to Develop and Operate a Composting Facility for Landscape Waste (LPC-PA12)
  Revised November, 1989 4 pp.

- Landscape Waste Composting: Legislation and Permit Requirements
  Printed November, 1989 5 pp.

- Application for Permit to Develop and Operate a Composting Facility for Landscape Waste (LPC-PA12)
  Revised November, 1989 4 pp.

The University of Illinois Cooperative Extension Service provides valuable information and guidelines regarding home lawn management through its network of county agents. It has published a 12 page newspaper on home yard waste management titled "Home, Yard & Garden Today," printed in March, 1990 (available in bulk from

county extension offices). The service also maintains a bibliography on yard waste, fertilizers, composting and turf management, available upon request.

1.4 Yard Waste Bans

Although there are many voluntary yard waste diversion programs across the country, there are few which are mandated by legislation (Table 1-3). Illinois is a leader in enacting a state wide yard waste ban (effective 7/1/90), preceded only by New Jersey (effective 4/88 for the fall leaf collection season only and effective 8/89 for year round separation), whose law bans the landfilling and incineration of leaves only, and the District of Columbia which requires residential separation of yard waste from MSW (effective 4/89). The 7-county area making up metropolitan Minneapolis-St. Paul, Minnesota also enacted a ban on the landfilling or incineration of any type of yard waste, effective 1/90, with the rest of the state to follow by 1/92. Other states which have enacted future yard waste bans include Iowa (effective 1/91), Wisconsin (effective 1/93) and Pennsylvania (effective 9/90).

In Illinois there were no counties which initiated mandatory yard waste separation prior to the effective date of the state law. Three municipalities *did* begin voluntary programs with relative success: the Village of Barrington (mid-1988), the City of Urbana/Champaign County (mid-1987) and Springfield (late 1988).

1.5 Yard Waste Compost Site Regulations

Composting yard waste has been recognized as a simple, cost-effective way to divert a large portion of the MSW stream from being landfilled. The Illinois EPA has established a formal permitting process to ensure yard waste compost operations meet minimum requirements. Sites which conduct landscape waste composting for landscape waste generated within the site (such as golf courses, parks, arboretums or gardens), and which also store and apply the same material on-site, are not required to obtain a compost facility permit from the state of Illinois. The minimum compost siting requirements for Illinois and for some similar states with existing yard waste programs are provided in Table 1-4. The requirements provided for Wisconsin and New Jersey are for composting operations which take in less than 20,000 yd^3 annually. As can be seen from the table, New Jersey has the most specific (although not the strictest in all cases) requirements for operating a [leaf] compost site.

Some states have set up more expedited permit processes for composting sites. Minnesota for example, has a "permit-by-rule" arrangement with compost sites, meaning if you follow the rules, you are permitted. The state permitting agency (Minnesota Pollution

Table 1-3 Yard Waste Restrictions Effective Prior to the Illinois Yard Waste Law

Area	*Date Effective*	*Restriction*	*Yard Waste Included*
Eau Claire County, Wisconsin [a]	4/88	Prohibits disposal in landfill for 7 weeks each spring & fall	grass, leaves, non-woody garden material
Dane County, Wisconsin [a]	1/89	Prohibits disposal in county landfills year round	grass, leaves, garden debris, brush, wood
Sauk County, Wisconsin [a]	1/89	Prohibits disposal in county landfill year round	grass, leaves, brush < 6" diameter
Outagamie County, Wisconsin [a, b]	4/89	Prohibits disposal in county landfill year round	grass, leaves, garden debris, prunings < 6" diameter
Portage County Wisconsin [a, c]	6/89	Prohibits disposal in county landfill year round	grass, leaves, brush, prunings < 6" diameter
New Jersey [d, e]	8/89	Prohibits disposal in landfills and incineration year round & requires source separation & collection system	leaves
District of Columbia [f, g]	10/89	Requires residential source separation of YW year round	grass, leaves, prunings hedge clippings
Minnesota [h]	1/90	Prohibits disposal in landfills & incineration year round for 7 county Minneapolis/ St. Paul area	grass, leaves, prunings, garden material
Illinois [i]	7/90	Prohibits disposal in landfills year round	grass, leaves, shrubbery, tree limbs

a. Wisconsin DNR, 1989
b. Rundquist, 1990
c. Stemple, 1990
d. Glenn, 1989
e. New Jersey Public Law 1987, Chapter 102
f. Misner, 1989
g. Bullock, 1990
h. Wirth, 1989
i. Illinois EPA, 1990

Table 1-4 Yard Waste Compost Site Permit Regulations

Illinois	Wisconsin [a]	New Jersey [a, b]	Minnesota
	Location Relative to Water Supply Well		
Must be 200' from a potable well	1000' from a supply well	None	None
	Location Relative to Flood Plain		
Outside a 10 yr. floodplain or floodproofed	Outside a floodplain	None	Outside a 100 yr. floodplain
	Separation Distances		
200' from a residence	1000' from lake, pond or flowage & no adverse impact on surface water, wetlands or critical habitats	150' from a residence to windrows	None
5' from a water table	300' from river or stream	50' from property line to windrows	
	1000' from highway or public park unless screened		
	10,000' from jet & 5,000' from piston engine airport		
	Runoff and Leachate		
Manage runoff & leachate	No detriment to groundwater	Manage runoff; prevent ponding	Manage runoff & leachate
	Dust, Odor and Noise		
Describe the operation for appropriate dust & odor control measures	Maintain hazardous air emissions below regs. and maintain combustible gases <25% of LEL [c] except by design	Operation shall not result in detectable odors off-site in areas of human use/ occupancy	Odors shall not exceed limits specified in parts 7005.0900 to 7005.1400
Describe noise control measures for shredding, chipping & similar eqpt.	None	Noise shall not exceed state limits at surrounding property lines	None

Table 1-4 Yard Waste Compost Site Permit Regulations (Continued)

Illinois	Wisconsin [a]	New Jersey [a, b]	Minnesota
		Operations	
Describe control of noncomp-postable waste	Describe destination of noncompostable waste	3500 yd^3/acre maximum application	Control non-compostable waste
Limit operating hours		Fence off access road; receive leaves only with operator present; limit operating hours	
Describe mgt. & termination procedures, record keeping	Describe oper-ational practices	Describe location & volumetric capacities of areas, drainage	
		Separation of site from adjacent property through visual vegetative buffer	
		Adequate water supply & fire fighting eqpt.	
		Use approved method for composting	
		Grade area prior to composting	
		Surface access to site as necessary	
		Attend compost course	
		Reporting	
Annually report tonnage received	None	Re-certify original filing & operations annually	Annual report

a. Permit requirements for sites accepting less than 20,000 yd^3 annually.
b. New Jersey permit rules for leaf composting only (New Jersey DEP, 1989b).
c. Lower Explosive Limit

Control Agency) must be notified by the operator of the site prior to commencement of activities. The notification must include the facility location and its design capacity, the name, address and phone number of the contact person, the type of waste received, and the intended distribution of the finished product [MPCA, 1989]. If the compost site does not operate in an environmentally sound manner, then the operator must go through a full site permitting process. Using the permit-by-rule method, some basic rules such as operating in an aerobic fashion, having runoff collection and filing an annual report are the only guidelines. New Jersey, a state where compost sites run as large as 150,000 yd^3 of leaves per year, has set up an expedited review process for compost sites which will take in less than 20,000 yd^3 annually. This type of site receives no technical review from the New Jersey Department of Environmental Protection. Normally, a site permit process takes about a year, with examination of fresh water runoff, water resources, encroachment and green acres encumberment (use of public recreation, conservation or open space areas for purposes other than their intended use).

1.6 Yard Waste Land Application Regulations

The State of Illinois does not require a permit for the application of landscape waste or composted landscape waste at agronomic rates [Illinois EPA, 1989]. The Illinois EPA does recommend the following actions be taken for proper and safe land application: 1) analyze the material to be land spread for nutrients such as nitrogen and phosphorus, 2) develop a proper application rate through consultation with an agronomist, and 3) do not exceed the nutrient requirements of the crop being grown and maintain records on total acreage covered, application rate and material analysis [Keller, 1990]. New Jersey allows facilities performing land application of leaves (termed leaf mulching) exemption from being permitted as a leaf composting facility provided the following requirements are met [New Jersey DEP, 1989a]:

- Leaves shall be delivered unbagged to land deemed actively devoted to agricultural or horticultural use, as defined in the Farmland Assessment Act of 1964, N.J.S.A. 54:4-23.5.
- Within seven days of delivery, the leaves shall be spread onto the field in a thin layer no higher than six inches.
- No later than the next tillage season, the layered leaves shall be incorporated into the soil.
- At no time shall leaves delivered to the leaf mulching operation be stockpiled on site for more than seven days.

- The land application operation is included in or consistent with the area's solid waste management plan.

1.7 Yard Waste Collection, Composting and Land Application Programs

While there are few mandatory full-scale yard waste programs (grass, leaves, brush and prunings), many communities are involved in composting voluntarily; an estimated 986 yard waste programs in the U.S. were identified at last count [Glenn, 1990]. This report discusses the approaches and methods being used in some communities and counties which have conducted yard waste diversion, with the intention of better informing Illinois municipalities. It is a summary of information collected by inspection trips, interviews, publications and letters from yard waste operations conducted in 1987 through 1989.

The following programs provided information for this report: Barrington and Urbana, Illinois; Anoka, Carver, Dakota and Washington Counties, Minnesota; Omaha, Nebraska; Monroe County, New York Cooperative Extension Service; Madison, Wisconsin; and the University of Wisconsin-Madison. Some of these areas have full-scale programs, while others conducted pilot projects. Important features of each are discussed. Information regarding compost quality and specifications, and the land application of leaves and grass to cropland is also provided. Additionally, some communities mentioned continue to participate in test programs which will provide valuable information in the future. This includes areas such as Urbana, Illinois (corn starch additive plastic bags) and Anoka County, Minnesota and Madison, Wisconsin (monitoring the effect of land application of leaves and grass on corn crops).

2.1 Bags and Containers

Plastic Bags

Composting Concepts, a hauler/composter in Washington County, Minnesota has determined that a pay-by-the-bag process, using a corn starch additive plastic bag, works best for them. The plastic bag is clear, which was reported to have a large impact on the presence of foreign matter in with the yard waste; when the bag was colored, measurable amounts of other waste were found. In 1989, the company entered into agreements with 9 cities in Washington and Ramsey County, Minnesota to conduct separate yard waste pick-up using the corn starch additive plastic bags. To inform homeowners of the program, a door-to-door "flyer" campaign was conducted, explaining:

- Where to purchase the bag
- Why the project was being done
- Weekly collection would be performed
- The collection service is not of concern to "home composters" and "let it lay" people

One free bag was included with the flyer. The cost of the bag partially included the price of the collection and composting, which was also subsidized by area solid waste grants. Because the bags were prepurchased, the hauler reported the following positive aspects: volume based rates worked out well, there was no cost borne upon home composters, there were no billing problems or delinquent accounts and there was no cost borne upon those homeowners who elected to utilize the county run drop-off sites. In general, there were no complaints lodged against this collection method.

Composting Concepts used two different collection methods, depending on the season: in the spring and fall, 25 yd^3 rear packers traversed every street due to the large amount of yard waste. A normal fall collection would bring 1200 bags for each packer, estimated at about five tons net. During lighter seasons such as the summer when there are smaller amounts of primarily grass, satellite vehicles (a pickup truck with a dump box on the back, which could hold 6 yd^3) would be used for collecting on each street. The hauler reported being able to get collection done quickly using the satellite vehicle collection method [Eisinger, 1990]. For the 1990 year, Composting Concept's volume based collection rate is 95¢/bag.

The City of Urbana, Illinois sells plastic bags with a corn starch additive (35 gallons each) in bundles of 6 for $2.99 (or 50¢ per bag) marketed under the name "U-Cycle", and 6' lengths of rope under the name "U-Ties", estimated to hold about 1/2 yd^3, at $2.49 each. The single costs of the bag and rope factors in the cost of collection and composting. The overall cost of yard waste collection and the compost program was 70¢ per bag in previous years. This amounted to a 20¢ per bag subsidy by the city. The "U-Bag" and "U-Ties" are the only bagged/tied materials accepted at the compost site; all other materials must be debagged. Due to the diverse range of sources from which the Urbana compost site accepts its yard waste, about 10%-20% of the yard waste at the site has been collected in this form.

Paper Bags

Because they can be broken easily by a windrow turning machine and degrade in about the same period of time as yard waste composts, a number of communities in Illinois are deciding on the use of paper bags as the preferred method to collect yard waste.

In Barrington, Illinois 10 paper bags are provided to each household free of charge each fall season and then sold at 2 hardware stores in town and at the public works department for 25¢ each, a price which is not subsidized and does not include the cost of the composting program. About 40,000 bags were purchased for the fall 1989 season. The village also provides a container to homeowners free of charge. In the previous year the public works department utilized corn starch additive plastic bags, but experienced problems in the composting process due to their degradation time and breakage. When the village switched over to paper bags the biggest complaint was the size reduction because the plastic bags were 60 gallons each and the paper bags 30 gallons.

Carver County, Minnesota has distributed paper bags in the spring as a promotional vehicle to call attention to their voluntary yard waste program prior to the ban and sold them in volume at city hall for 10¢/bag (with a 25¢/bag subsidy). As with Barrington the cost of the bag does not include the cost of the composting program. They have experienced complaints from residents not being able to close the bags and some stores have been reluctant to sell the bags due to their size on the shelf.

No Bags

Due to the presence of foreign matter in bagged materials, potential for anaerobic conditions prior to debagging, and the problem of plastic bags at compost sites, Anoka County, Minnesota banned the use of plastic bags for transport of yard waste in 1989. Yard waste has to be picked up in bulk or debagged at the curb side by the hauler.

Hennepin County, Minnesota also had banned use of plastic bags, but recently rescinded the ordinance before the beginning of the yard waste season due to public opposition. One of the haulers in Anoka County which services 5000 households, Lake Sanitation, conducts their own composting operation and debags at the curb side. They find it is the most beneficial way to operate for a small community service and can be sure there is no foreign matter going to their compost site [Ayde, 1990].

Containers

A pilot collection and composting program has been ongoing in Omaha, Nebraska since 1987, where the city public works department decided to utilize 90 gallon wheeled plastic containers for collection. Collection methods also considered were existing citizen owned trash cans, plastic bags and corn starch additive plastic bags. Mr. D. Slattery, with the public works department, reported the carts to be uniform, convenient to use, made for semi-automated collection and constructed using replaceable parts. The cost of their containers was $45-$50 per cart when purchased in quantity. Homeowners are charged $12 per season (May through November) for the cart and the collection service. The city estimated the average homeowner in the pilot area spent $30 per year on plastic bags for yard waste, and therefore the $12 charge was an incentive for use. Of the 560 participating households in the subdivision (with 850 households, or 66% participation) in 1989, 18% had more than 1 cart. Many participants in 1988 had reported that a single 90 gallon container wasn't large enough to accommodate the yard waste generated in the spring and fall peak times, so 33 gallon corn starch additive bags were provided as a supplement. Homeowners commenting on a participant survey of the program indicated the carts were convenient to use, saved time and preferred over bags [Slattery].

The Omaha yard waste collection contractor uses a semi-automated system to empty the carts into a side-loading packer truck. One difficulty with the cart in the past was due to its heaviness. A "catapult effect" occurred, whereby the cart frames were being damaged by the rapid unloading with the hydraulic dumper. This problem was corrected by adjusting the governor to slow the dumping cycle.

The local hauler for Barrington, Illinois was contracted out to perform separate curb side pickup of leaves and grass. The village uses two systems: a 90 gallon wheeled container for grass clippings and brush and 30 gallon kraft paper bags. The bags are meant to supplement hard containers in the fall for leaf collection purposes, but residents are allowed to use them all season. The Superintendent of Public Works for Barrington, Mr. M. Werksman, reports that many people never need to use the paper bags because the

containers are large enough. The containers cost about $55 each, and are paid for by the village.

2.2 *Citizen Drop-Off Sites*

Local drop-off sites are one alternative to curb side collection. They can be located throughout counties in the vicinity of yard waste generation areas or in forest preserves and can save homeowners the cost of curb side collection. In return for residents transporting their yard waste to the drop-off area, they are typically allowed to dump their grass, leaves and brush free of charge provided it is debagged and does not contain foreign matter. Of course there is no way to verify all citizens will comply with this unless an attendant is stationed (and even then it is difficult to reduce foreign matter to zero), but some drop-off sites report debagging and foreign matter has not been a large problem. A public works crew may typically maintain the site every week in the yard waste season by picking up filled bins of debagged yard waste. A drop-off site also serves as a convenient residential distribution point for compost and wood chips, both of which are always in high demand by homeowners.

Residents in Carver County, Minnesota use local drop-off sites free of charge for dumping of leaves, grass and brush, but are required to debag the yard waste brought in plastic bags. Paper bags are not required to be broken or debagged. A public works employee travels around to each of the drop-off sites every few weeks to maintain the area and chip brush which is left for public use. The chipper can handle wood up to 12" in diameter.

Madison, Wisconsin conducts and Anoka County, Minnesota is recommending a curb side pickup only in the spring and fall when the largest amount of material is generated. For the remainder of the year a central drop-off site is available to residents which choose to bag their yard waste.

2.3 *Madison, Wisconsin's First Year of Mandatory Leaf Collection*

Background

A ban on the disposal of yard waste at the Dane County, Wisconsin landfill took effect January 1, 1989. During the autumn of 1989 the City of Madison (population 171,000) first collected leaves under these new rules. A municipal hauling system is used which does not pick up yard waste on a regular basis throughout the year; residents must use one of three drop-off sites for disposing of yard waste, transport the yard waste to the county compost sites or perform home yard waste management. The City does provide

cleanup of leaves in the fall for about six weeks and general spring cleanup for a period of four weeks free of charge. In previous years, the city conducted a voluntary separate leaf collection program in which residents could put their leaves out on the streets and be picked up within two weeks. At the same time, the city encouraged residents to bag their leaves for weekly refuse pick-up because it was the most efficient method of collection.

Problem Description

The following is a summary of a study performed by the City of Madison due to numerous complaints it received during leaf pick-up under the new law and due to dissatisfaction with the service provided by the City.

In planning for the new mandatory leaf pick-up, the city underestimated the amount of leaves to be collected. During a 12 week period in the fall, the municipal waste collected decreased about 2,300 tons (due to separate leaf collection), while the leaf collection increased approximately 5,000 tons from the previous three year average. The result was a net increase of 2,700 tons for the same time period. Possible reasons for the reduction in MSW collected and the increase in leaves collected include:

- Unusual leaf growth in 1989 due to the 1988 drought.
- Residents cleaning their yards more thoroughly than in previous years due to good weather.
- Residents saving their leaves from weeks prior to fall collection.
- Materials dropped off at drop-off sites by non-city residents.
- Greater use of the city service by private yard care services due to the landfill ban.
- Inaccurate data estimates.

Overall, 7,533 tons of leaves were collected at the curb, 1,050 tons at the city's three drop-off sites and about 1,500 tons by street sweepers, for a total of 10,083 tons [City of Madison, 1990]. The 1989 program collected 4,325 more tons of leaves at the curb than the average collected at curb side in the previous three years (Figure 2-1). The collection by the Madison Streets Division lasted from October 16 to December 22, 1989 and took five weeks for the first round, three weeks for the second round, and ten days for the third round. All 600 miles of Madison's streets received the same number of collection passes.

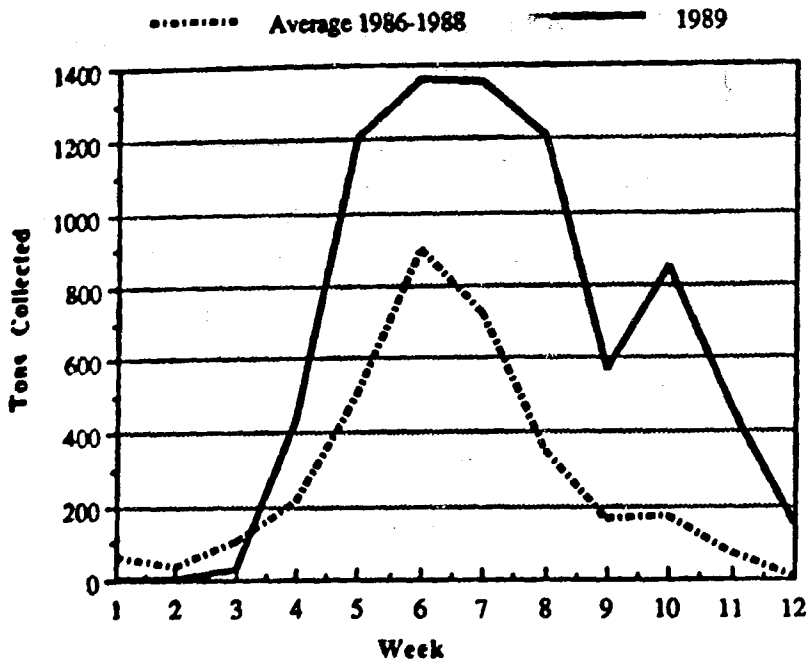

Figure 2-1 Fall Municipal Curb Side Leaf Collection for Madison, Wisconsin (free pickup from mid-October through mid-December) [City of Madison, 1990]

Residents were encouraged to place their leaves loosely at the curb; bagged leaves were also collected.

The 1989 week-by-week collection comparison with the previous three year average (Figure 2-1) shows the large effect of the leaf landfill ban. The 1989 collection may be one or two weeks offset from the previous years due to the time delay in collecting the large amount of leaves. Data regarding weekly MSW collection from the previous three years was used to help determine when the leaves were put out for refuse collection (Figure 2-2). For 1990, the city has projected that the peak curb side collection will occur between 10/29 and 11/17, a period of three weeks corresponding to weeks five, six, and seven on Figure 2-2.

Findings and Recommendations

To improve collection service, the following recommendations by the City of Madison's "Leaf Team" were made:

- Schedule collection to be no more than three weeks between rounds.
- Since many leaves are down in early October, fall leaf collection should begin a week early (October 8, 1990), allowing two rounds to be complete before Thanksgiving.

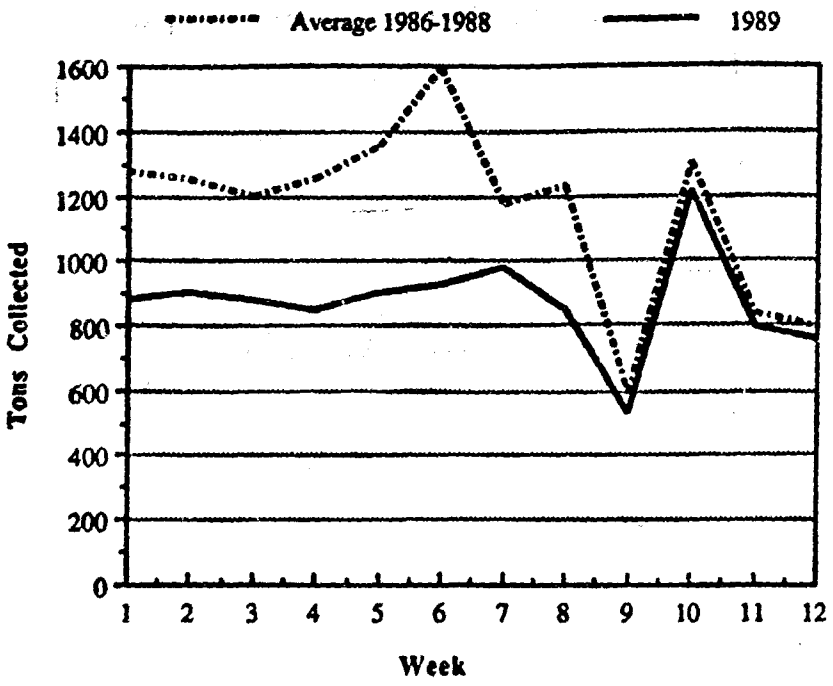

Figure 2-2 Comparison of MSW Collected for Madison, Wisconsin During Fall Leaf Collection [City of Madison, 1990]

- Allocate additional equipment and staff to meet the improved service level and expected volume growth.

Table 2-1 shows a review of the cost effectiveness and productivity of four different collection methods used by the City. The collection methods used and a summary of the effectiveness of each were as follows:

- A "pan crew" and "pan truck" served as the primary collection method (73% of all collections). The crew consisted of three workers using a rear load refuse packer with a large pan attached to the rear. The "pan truck" was supported by a leaf "pusher"- a jeep, tractor or small pickup with a sweep on the front which pushed leaves onto the pan of the packer. The pan crews had the lowest cost/ton collected and second highest tonnage collected per crew/hour.

- The "open crew" and "open truck" method was used to collect 15% of the leaves. Three to four open dump trucks at a time were filled with loose leaves by a front end loader, which were pushed into piles for the loader by a pusher. The open crew method uses 5 to 6 operators. The open crews had the highest cost/crew/hour, but had the second lowest cost/ton and the highest tons collected/crew/hour.

- "Bag crews" were used to collect 5% of the leaves. The bag crew is a one or two person crew assigned to a side or rear load packer without a pan. The crew would travel ahead of the pan crew or open crew and collect and debag leaves at the curb into a packer. The bag crews have the lowest cost/crew/hour, but have the second highest cost/ton and the second lowest tons/crew/hour.

- Vacuum trucks were the final collection method (7% of the total). Three persons were needed to run each vacuum truck. The vacuums have the highest cost/ton and the lowest tons/crew/hour. The City of Madison's vacuums are over 25 years old and are subject to numerous breakdowns. They are costly to operate and relatively slow.

Table 2-1 Effectiveness of 1989 Leaf Collection Methods for Madison, Wisconsin [City of Madison, 1990]

Component	Collection Method[a]			
	Pan Crews	*Bag Crews*	*Open Crews*	*Vacuum Truck*
Equipment Cost per Crew-Hour	$16.50	$9.88	$50.43	$5.58
Labor Cost per Crew-Hour	$45.84	$28.39	$86.35	$45.63
Total Cost per Crew-Hour	$62.34	$38.27	$136.78	$51.21
Tons Collected per Equipment-Hour	0.873	0.826	0.702	0.655
Tons Collected per Man-Hour	0.50	0.44	0.55	0.15
Tons Collected per Crew-Hour	1.75	0.83	3.87	0.66
Total Cost per Ton[b]	$34.99	$51.06	$38.22	$83.96

a A "pan crew" used 3 workers to fill a rear packer equipped with a pan using a sweep equipped vehicle; an "open crew" used 5-6 workers to fill a dump truck using front-end loaders; a "bag crew" used 1-2 workers to fill a packer after manual debagging of leaves; and a "vacuum truck" used 3 workers.

b Adjustments included in cost per ton (total cost per ton cannot be completely derived from information contained in the table). For example: pan crew cost per ton = ($62.34 Total Cost/Crew-Hour) / (1.75 Tons Collected/Crew-Hour) = $35.63/ton, compared to $34.99/ton reported.

Overall, the pan and open crews are the most costly per crew per hour, but they collect the most tonnage per crew per hour, resulting in the lowest cost per ton collected.

Some of the more specific recommendations made in the use of equipment was: reduction in equipment downtime to meet the higher service standards (10% maximum downtime on rear loaders), increased use of side loaders for curb side debagging to free up rear loaders for collection and utilization of open truck collection only when it is necessary. Work procedure recommendations included: all debagging should be done at the curb since off site debagging results in time consuming rework, debagging should be done by pan crews as they go along, an additional laborer should be added to pan crews for areas with a large amount of bags and support staff should exist at main disposal sites.

2.4 Fall and Spring Pilot Collection Costs in Carver County, Minnesota

One-day pilot collection programs were conducted in selected towns and neighborhoods in Carver County, Minnesota during fall 1986 and 1987 and during spring 1987. The fall collections included the pick-up of leaves, grass and other easily degradable yard waste while the spring collection included tree trimmings, brush, grass, leaves and other yard wastes.

Costs and collection rates from the fall 1986 collection program are shown in Table 2-2. Five cubic yard open-bed city trucks and city employees were used for collection. A cost of $33/ton was arrived at for the 1987 fall collection program.

The spring 1987 collection program was conducted on two days approximately four weeks apart in three Carver County, Minnesota towns: Chanhassen, Victoria, and Waconia. All residents in the test areas received a 2 ply kraft paper bag with a flyer attached prior to the first collection, and then reminder notices about two weeks before the second pick-up. A summary of the collection method, size and collection costs for Chanhassen is shown in Table 2-3. The same is shown for Victoria and Waconia in Table 2-4. Although the collection methods were different for Victoria and Waconia, the costs were reported together. The spring pick-up ended up costing between $7 and $10 per household, compared to a fall pick-up cost of $3 per household or less. For comparison purposes, the fall costs using the 5 yd^3 open bed trucks in Chanhassen came to $12/truckload while spring costs using the same method came to $66/truckload [Genereux and Genereux, 1989]

The unit task costs measured in the study came to 4 ¢/bag for debagging, 48 ¢/brush unit for separating brush, 21 ¢/brush unit for chipping brush on site and

a brush unit for chipping brush during collection, including the cost of time spent driving around and turning the machine on and off between brush piles. A brush unit is defined as the amount of brush that could be loosely packed into a 30 gallon garbage can.

Table 2-2 Fall Pilot Collection Costs for Chanhassen, Minnesota [Genereux and Genereux, 1989]

Description	
Number of bags collected	7097
Average weight per bag (lbs.)	14
Total tons collected	50
Number of participating households	663
Average number of bags / participant	10.7
Number of truckloads (Open Bed, 5 yd^3)	126
Cost of collection	$1400
Cost of debagging/bag	$0.04
Total Cost per bag	$0.24
Collection Cost per Ton	$34
Cost per participating household = ($ 0.24)(7097) / 663 =	$ 2.57/household

Table 2-3 Spring Pilot Collection Costs for Chanhassen, Minnesota [Genereux and Genereux, 1989]

Description		
Collection Method	Bags and brush collected in separate 5 yd^3 capacity open-bed trucks with city employees. Five workers, 5 trucks and 1 front end loader were used at a cost of $25/hour per truck and worker.	
Households in test area	345	
Participation day 1	83	
Participation day 2	64	
Collection cost day 1	$500	(5 trucks and workers @ $25/hour for 4 man-hours)
Collection cost day 2	$450	(5 trucks and workers @ $25/hour for 3.6 man-hours)
Number of bags collected	577	
Number of brush units collected [a]	164	
Total Costs:		
Collection		$ 950.00
Debagging	$0.04 (577 bags) =	$ 23.08
Brush Separating	$0.48 (164 units) =	$ 78.72
Brush Chipping	$0.21 (164 units) =	$ 34.44
Total		$ 1086.24
Cost per participating household =	$1086.24 / (83+64)=	$ 7.39/household

a. Brush volumes were established using a brush unit, i.e., the amount of brush that could be loosely packed into a 30 gallon garbage can.

Table 2-4 Spring Pilot Collection Costs for Victoria and Waconia, Minnesota [Genereux and Genereux, 1989]

Description		
Collection Method:		
Victoria	Bags and brush collected together in a 20 yd^3 rear packer truck.	
Waconia	Bags collected in a 20 yd^3 rear packer truck. Brush was chipped and collected using a brush chipper hooked to an open-bed 5 yd^3 truck.	
Households in test area	543	
Participation day 1	83	
Participation day 2	30	
Collection cost day 1	$ 642.70	(Truck and 2 workers @ $64.27/hr for 10 hrs.)
Collection cost day 2	$ 321.35	(Truck and 2 workers @ $64.27/hr for 5 hrs.)
Number of bags collected	568	
Number of brush units collected [a]	264	
Total Costs:		
Collection		$ 964.05
Debagging	$0.04 (543 bags) =	$ 22.72
Additional brush handling		$ 124.66
Total		$ 1111.43
Cost per participating household =	$1111.43 / (83+30) =	$ 9.84/household

[a] Brush volumes were established using a brush unit, i.e., the amount of brush that would be loosely packed into a 30 gallon garbage can.

This chapter summarizes information from interviews with people who have operated compost and brush management programs, with emphasis on methods used, participation and user costs. While a majority of the programs discussed are smaller, county run operations, many of the experiences are of value and can be scaled up. For the smaller operation, existing equipment such as a front end loader and brush chipper with only a few days of work per month involvement is all that is necessary to establish a compost operation. Regardless of the size of the compost site operation, the same planning steps and review of yard waste composting processes and literature are necessary to make it successful. Appendix A contains an outline of tasks for initiating a community yard waste composting program.

3.1 Barrington, Illinois

The Village of Barrington, Illinois started its voluntary yard waste collection and compost program in Spring, 1988. It has a population of about 10,000 with 3,500 households on three square miles of land. The public works department has estimated an 85% residential participation rate. Barrington started to monitor the amount of yard waste collected in June, 1988. Their collection season starts April 1 and ends November 30. The yard waste collected by month for the year ending June 1, 1989 is shown in Figure 3-1 (1,200 tons total for the year). Of the total collected, 75% was leaves and 25% grass.

A slightly different approach is used to set up the compost piles in Barrington. All yard waste is sent through a tub grinder before being windrowed. Yard waste is collected in kraft paper bags or 90 gallon toters, and therefore no debagging is necessary prior to shredding. An old rear drop manure spreader is then used to form windrows, which has reported to work very well. When turning is necessary (twice a week in April, May and the fall months, and once per week in the summer), a front-end loader is driven to the site on back roads by the public works department. Delivery rates in the spring amount to three garbage trucks (about 25 yd^3 each) per week.

The compost site is small, about two acres in size, and is leased from a local farmer. There has been little foreign matter included with the separate yard waste truckload collection thus far. Most of the foreign matter has been car tires in the packer loads which are easily removable, and large logs from tree maintenance. Although preshredding yard waste with the tub grinder has worked well in the composting process, it cost approximately $35,000 in 1989 to lease the machine.

Prior to starting the compost piles in the spring of the 1989 season, the village distributed the prior year's (1988) compost, with the exception of one windrow for incorporation with grass in the summer. Truckloads of finished compost and chipped brush are transported to the public works department garages in town and dumped in separate bins for residents to come and pickup for free. According to public works superintendent Mr. M. Werksman, distribution using this method was effective and appreciated by the residents. The village also performs delivery of truckloads of compost to residents. Both services are typically provided from April through November.

The village is ceasing its direct involvement in yard waste composting at the end of the 1990 season, due to contract expiration with the community's hauler. The proposal for the next hauling contract includes provisions for separate collection and handling of landscape waste on the part of the hauler.

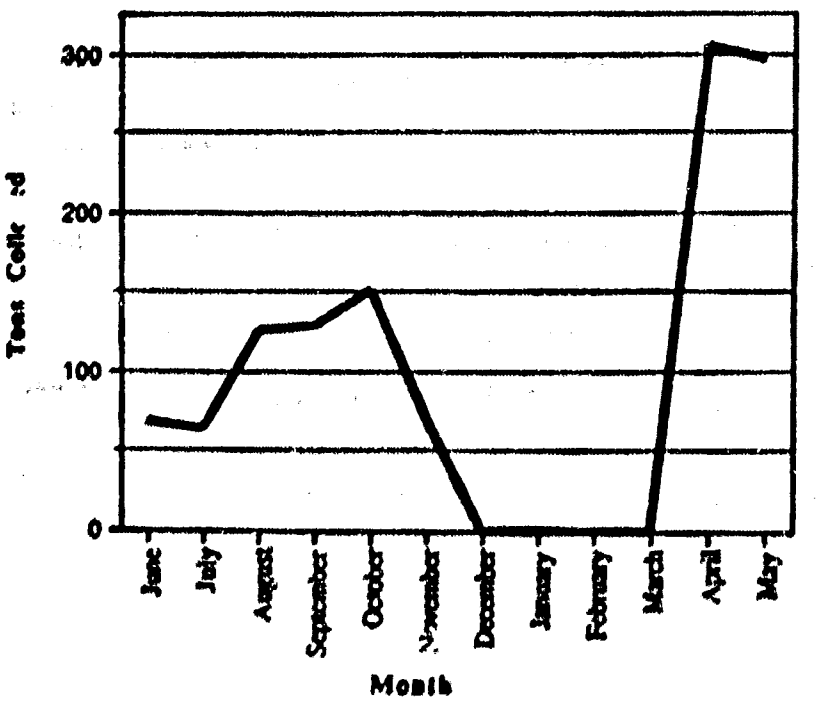

Figure 3-1 Yard Waste Collected in Barrington, Illinois Voluntary Program, June, 1988 through May, 1989 [Werksman, 1990]

3.2 Urbana, Illinois

The City of Urbana and Champaign County, Illinois initiated a yard waste diversion program in 1985, accepting leaves, grass, brush, prunings and tree trunks. There are about 15 haulers in the county (population 172,000), which has an open hauling system. The collection program affects approximately 30,000 households. Several municipal programs from Champaign and Urbana use the site for public area cleanup, large bulk wood disposal and tree maintenance.

The city also accepts bagged yard waste from the Urbana "U-Bag" corn starch additive plastic bag and the "U-Tie" brush tie curb side collection program. The only way bagged yard waste can be left bagged at the compost site is in the corn starch additive U-Bag form. In 1989, 10 - 20% of the yard waste taken in at the site was in the form of the corn starch bags and ties. The city also accepts unbagged yard waste from haulers, landscapers or individuals. The 1989 tip fee for debagged yard waste was $3.00/yd^3.

The compost site operation is divided into four parts: a) All brush less than 8" in diameter is ground in a tub grinder; b) Logs over 8" in diameter are split and sold as firewood; c) The grass-leaf composting operation, and d) Bulk wood storage (primarily tree trunks). In 1989, 27,000 yd^3 of yard waste (grass, leaves, brush, bulk wood) were accepted at the site. Of the total yard waste accepted at the site each year, it is estimated that 50% is leaves and grass and 50% is brush and bulk wood. Bulk wood comprises 40% of the brush taken in, or 20% of the total. The site currently stockpiles about 5,000 tons of finished compost.

The 22 acre site is situated on top of a closed landfill, with seven acres for composting, three acres for brush collection and grinding, seven acres for bulk wood storage, one to two acres for split firewood storage and road access and the remainder buffer zone. The program utilizes a windrow machine attached to an agricultural tractor for turning windrows about once per week in the spring and summer and monthly the rest of the season. Mr. R. Fletcher, Urbana Solid Waste Manager, uses roughly a 50/50 mixture of grass and leaves with some brush, with turn-around from incoming yard waste to finished compost taking seven to eight months. Incoming debagged grass in the spring and summer is dropped off by packer trucks on top of existing windrows consisting mostly of leaves from the previous fall. Their windrow machine is then used for incorporating the leaves and grass.

The yard waste collected in corn starch bags under the Urbana program is currently formed into its own windrow. The bags are allowed to decompose for a season prior to turning. As a method of reducing bag and waste particle sizes, Mr. Fletcher has experimented with grinding bags of yard waste prior to windrowing. Three months of

bagged yard waste were sent through a tub grinder in two days which reduced the bags to about the size of a 3 by 5 inch card or less. The operation was reported to work well with the exception of cleaning. The cleaning problem arose in the confined space area around the hammermill of the tub grinder, where the action of the hammermill created a mud consistency material, which then took a week to clean. The grinding also increased wear on the hammers and wore down the outside retaining ring which had to be replaced. Mr. Fletcher believes that if more brush were ground up with the grass and leaves the mud build-up and wearing would not occur.

The Urbana compost site is being used for research on the degradability of plastic bags by the Illinois Department of Energy and Natural Resources, the University of Illinois at Urbana-Champaign and a producer of corn starch additive plastic films, Archer Daniels Midland Co. The groups are studying biodegradable and photodegradable additives in plastic bags, as well as blends of these additives. Different turning methods are also being looked at by leaving piles static, turning with a front-end loader and turning with the windrow machine. Results on the work being done will begin to be available in late 1990. Major equipment on-site includes the windrow turner, two agricultural tractors, a tub grinder, log splitter and shelter.

The yard waste program operates as an enterprise fund whereby the gross operating expenses (about $180,000 for 1989) are supported by tip fee revenues (about $81,000 for 1989), revenue generated from the resale of compost, wood chips and fire wood ($15,000 for 1989) and the remainder of funding coming from government agencies. The eventual goal is to become a self-supporting entity. The county currently sells firewood for $35/rick and $70/full cord which is a discount to the current market rate in the area. Bulk wood, which is too large to be split, is available to the public for free of charge at the site. The compost is primarily sold in bulk for $2.50/yd^3. Since the compost has not been screened, the market for it has not been good. Fletcher hopes to purchase a screen for obtaining a higher quality product in the near future.

3.3 Anoka County, Minnesota

Anoka County, Minnesota, one of the metropolitan Minneapolis/St. Paul counties, established a compost program which requires a larger amount of effort on the part of the homeowners and site users than other communities. An open hauling system is used in the county for MSW pickup and neither the county nor communities perform municipal curb side collection of yard waste (an open hauling system allows any generator, including homeowners, of municipal waste to obtain the hauling company of their choice). Additionally, in late 1988 the county banned the use of bags at both compost sites. The

county has a population of 237,000 in 80,000 households and 21 communities with an estimated yard waste generation of 15,000 tons for 1990. A primary 20 acre fenced compost site (15 acres useable) at a county owned park has been operating since 1985. Another secondary site is 4 acres in size.

Mr. B. Fields, Anoka County Administrative Assistant, reports that Anoka County employs the "low-tech" approach in its composting operations, utilizing a water truck and front end loader for turning. The main site is unpaved and fairly level with a slope of less than 4%. The county reports a good buffer due to the surrounding vegetation and park land. Rainwater and runoff is not collected and is allowed to drain into the soil, which is sandy. The compost piles are turned on an as needed basis, approximately every few weeks during active seasons. When the grass comes in, it is mixed with leaves from the previous season. Windrows are formed based on loader capacity, typically 12' wide by 6' high. Using the present method, turn-around time is one and one-half to two years. To obtain a one year turn-around, the county anticipates purchasing a windrow turner which attaches to a front end loader. In previous years when bagged yard waste was accepted, the county experienced large amounts of foreign matter in the bags. As a consequence, bags are now banned from the compost site. Since the finished product is not screened or shredded, its uses may be more limited. Approximately 4,000 yd^3 were in storage at the site from previous years at the beginning of the 1989 season.

Prior to the banning of bags at the compost sites, the county experimented with Department of Corrections crews to perform debagging operations and clean up of foreign material. The program did not work as optimally as expected. At best working conditions were difficult: stench from grass clippings decomposing in the bag, lack of drinking water and dirty work conditions. There was also a lack of motivation on the part of the crews to debag efficiently, as there was no incentive program offered.

Up until the 1990 law, haulers were allowed to use the compost site for free provided the yard waste was debagged. Yard waste had to be either debagged at the curb or at a transfer station. The charge for haulers to use the county site is presently \$3.55/yd^3, debagged prior to arrival on site. Residents and municipalities which have local unmonitored drop-off sites are allowed to bring yard waste in without charge but are required to debag it themselves and take the bags with them. An independent landfill operator in the county which is operating a compost site adjacent to its landfill is accepting yard waste in 1990 at \$26.40/ton bagged, or \$9.90/ton debagged.

In 1989 the county composted 23,000 yd^3 grass and leaves at its 2 sites and reported problems keeping up with the volume. The expenses for the main site in 1989

totaled $87,000, of which approximately $28,000 was for seasonal labor, $39,000 was for one-time purchase of a water truck and installation of 3 groundwater monitoring wells and the remainder being operation expenses [Anoka County, 1989].

3.4 Carver County, Minnesota

Carver County, also one of the seven Minneapolis/St. Paul counties, is mostly rural, with some built-up suburban developments. There are 16 haulers in the county which utilizes an open hauling system.

The county (population 45,000) has been operating its primary two acre compost site on the edge of the University of Minnesota Arboretum since about 1983 (Figure 3-2). It maintains three free drop-off sites, each about a half-acre in size, for local residents. Four communities totaling 30,000 people are serviced by the current county run composting and drop-off operations. The county provides transport of yard waste to the arboretum site when the drop-off sites are full. Residents are not allowed to access the main compost site. In addition to the arboretum site, haulers performing curb side pick-up may use a private tree waste service for composting yard waste.

The county compost site is used for spring and fall cleanup seasons (for which a free residential curb side pickup is provided) and for whatever is collected at the drop-off sites throughout the year. As with other yard waste operations in the area, the primary emphasis has been on composting leaves and brush. In the past, only grass which had been discarded at the drop-off sites was composted, estimated at 5% to 10% of the total volume, with no resulting odor problems. In 1989 the county experimented with 300 yd^3 of grass at a 50-50 mixture with leaves; at the time of receipt the grass had already gone anaerobic in the bags and odor complaints from a nearby subdivision (closest house being [illegible] away) were experienced during debagging and three months later when turned. The county has decided not to accept large loads of grass, such as those which may be brought in by a landscaper or a hauler during summer periods. It does not anticipate experiencing odor problems from the grass collected solely at the drop-off sites.

Mr. M. Lein, Environmental Services Director for Carver County, has emphasized that a minimal involvement approach is applied at the Carver County site, with a front end loader brought on site three to four times per year for turning. Compost piles as large as the loader can make are formed (about 12' high and 18-20' at the base), and the piles are broken down three to six months later at a time which is convenient to the public works [illegible]. Two to three years are necessary to generate a well decomposed material using this [illegible]. A screener is rented for one week each spring (for about $2000) and brought to [illegible] provide a better finished product. In the past, the screenings have been turned

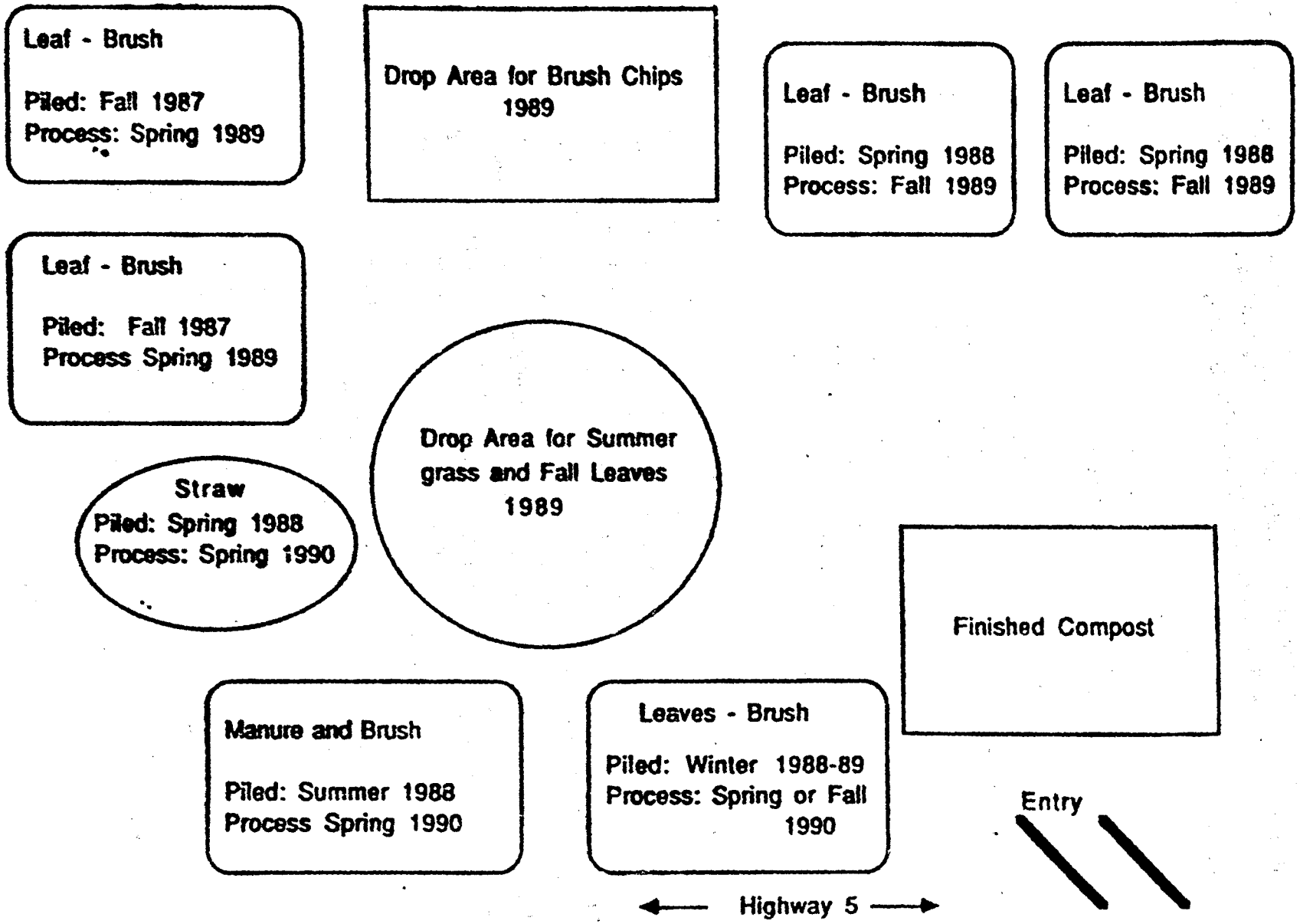

Figure 3-2 Carver County, Minnesota Two Acre Compost Site

back into the compost piles as a bulking agent for about three years in a row and used as landfill cover after separation the next year. Seasonal workers, often college students, are hired to debag yard waste brought to the site in bags by haulers. This work has usually been done over the Christmas break period, after all the bags for fall have been collected and short-term help is available. The workers can debag at a rate of 150 bags/hour and are paid about $6/hour which results in a cost of about 4¢/bag.

A simple method was developed by Mr. Lein for monitoring pile temperatures: A temperature element with wire leads was taped to the end of a conduit and the conduit inserted into the piles at desired locations, leaving the wire leads to the temperature element accessible. This allowed monitoring of core temperature from the outside of the pile by means of the accompanying temperature meter. Total cost was estimated at $150.

The county has also used a low-tech method to minimize and eliminate weed seeds. They have noted that weed seeds have accumulated on about the outer 6" of the compost piles. To remedy this, the front end loader operator shaves off about the first 6" of the pile and sets it aside to start the next year's pile. The remaining material is then screened for use.

The county has been charging a typical sale price of $12/yd^3 for the compost, delivered. In 1989, 500 yd^3 of screened product were sold to golf courses, landscapers and developers. The arboretum uses a large amount of unfinished compost each year. Mr. Lein estimated that 8,000 yd^3 (1000 tons at 8 yd^3/ton, received uncompacted) of yard waste were composted at their primary site in 1989, and another 2000 yd^3 at smaller sites. To improve operations for 1990, the county purchased a brush chipper for chipping brush at drop-off sites and at the arboretum site.

The county operation costs for the compost site in 1989 was roughly $3,000 for the [illegible] works department (half was for the front end loader and half was for labor), $2,000 for screener rental and $2,000 for additional rental of a front end loader. Although there is no current charge for use of the compost site, the county may establish price rates in the [illegible]. The privately operated tree waste service in the county has set the following prices for haulers:

	Bagged	Debagged
Leaves, Grass	$8.10/yd^3	$4.25/yd^3
Prunings <1" diameter	-	$4.25/yd^3
Prunings >1" diameter	-	$8.00/yd^3
Tree Stumps	-	$12.00/yd^3

The leaves and grass can be compacted and the prunings can be chipped. Costs associated with fall and spring collection days performed in 1986 and 1987 was studied by the county and is shown in Chapter 2.

3.5 Dakota County, Minnesota

Dakota County, Minnesota initiated its county composting program on a voluntary basis in November 1988 and preceded the Minneapolis metro area yard waste law by banning the landfill disposal of yard waste within Dakota County after August 1, 1989. There are about 24 haulers in the county and half of them utilized the county compost site in 1989. Dakota County has a population of 290,000, with 92,000 households.

It was estimated that the county's one nine acre compost site received 25% of the yard waste generated in the county in 1989. For 1990, additional sites were scheduled to be added to the county program and the expected usage rate was projected to increase to 33%. The county composting process uses large piles for decomposition rather than windrows (discussed below). Dakota County received 97,705 yd^3 of grass, leaves, garden waste, weeds and prunings up to 4" in diameter at the compost site in 1989. Sod strippings, Christmas trees and yard waste in bags was also accepted at the site. Of the nearly 98,000 yd^3, 54,508 yd^3 (55.8%) were shrubbery and prunings and 43,196 yd^3 (44.2%) were grass, leaves and garden waste. County personnel accepted the yard waste loose or in bags (for a higher fee) from public and commercial users (Table 3-1).

Table 3-1 Commercial and Public Use of the Dakota County, Minnesota Compost Site in 1989 (Dakota County, 1990)

	Grass, Leaves Garden Waste (yd^3)	*Prunings (yd^3)*	*Total (yd^3)*
Public Users	21,327	51,502	72,829
Commercial Users	21,869	3,006	24,875
Total	43,196	54,508	97,704
Loose [a]	24,867	54,489	79,356
Bagged	18,349	0	18,349
Total	43,216	54,489	97,705

a. All materials delivered by the public were considered loose since they were debagged upon delivery.

The number of deliveries and volumes delivered by month are shown in Table 3-2 and in Figure 3-3 and Figure 3-4. It can be seen that there is an overwhelming use of the county site by the public, both in number of deliveries and total yardage, even though a considerable amount of extra effort is required on the part of public users to transport the waste to the site. The large increase in site usage after the August 1 effective date can also be seen, even though haulers could have taken their yard waste out of county to a landfill. It should be noted that no yard waste from outside Dakota County is accepted at the site and that the totals in Tables 3-1 and 3-2 are slightly different, probably due to logging differences. Of the commercial volumes shown in Table 3-2, 25% was loose and 75% was bagged with almost all of the latter being compacted [Dakota County, 1990, and Pecar, 1990]. By weight, a total of 12,478.2 tons were accepted at the site, with 2,910.3 tons (23.3%) being prunings and 9,569.1 (76.7%) tons being other types of yard waste. Distribution of yard waste between grass and leaves was not available.

Table 3-2 Monthly Yard Waste Use of the Dakota County, Minnesota Compost Site by Commercial Businesses and the Public in 1989 [Dakota County, 1990]

Month	Volume		Weight	
	Commercial (yd^3)	*Public (yd^3)*	*Commercial (tons)*	*Public (tons)*
April	2,815	3,741	632	150
May	3,077	7,695	1,397	605
June	2,159	9,962	778	707
July	1,591	10,307	573	701
August	4,506	11,738	1,639	772
September	3,747	12,165	1,513	855
October	5,064	13,657	935	718
November	1,835	3,550	321	182
December	72	4	1	1
Total	24,866	72,819	7789	4691

• Site closed in first three months of 1989.

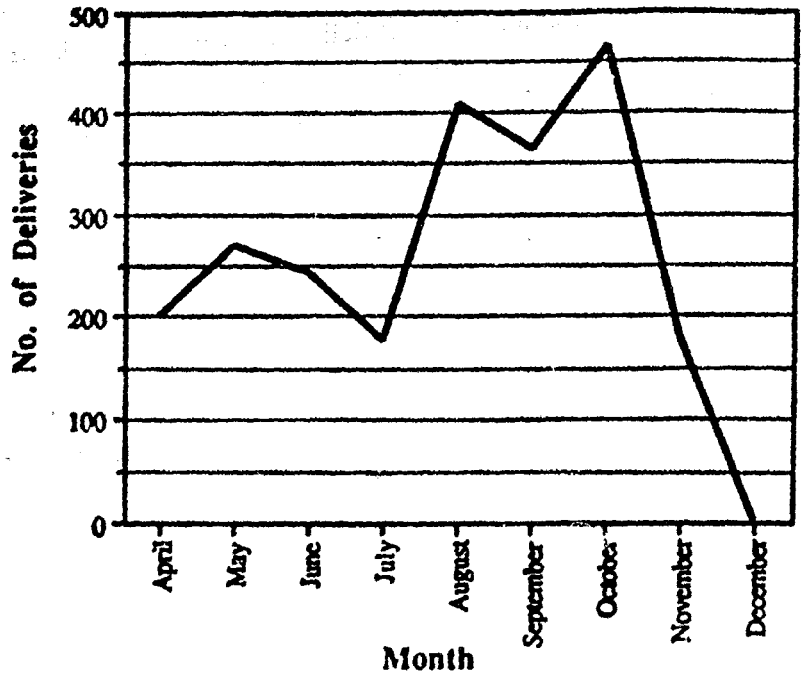

Figure 3-3 Site Usage of the Dakota County, Minnesota Compost Site by Commercial Businesses in 1989 (site closed January - March) [Dakota County, 1990]

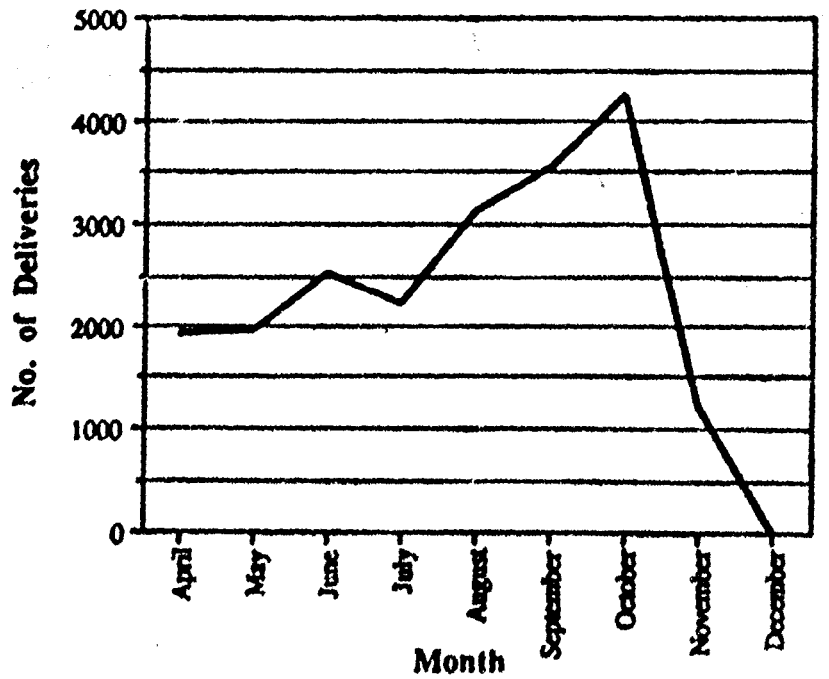

Figure 3-4 Site Usage of the Dakota County, Minnesota Compost Site by the Public in 1989 (site closed January - March) [Dakota County, 1990]

In 1989, the compost site accepted yard waste between April 1 and November 15 during the hours of 9:00 am - 8:00 pm on Monday, 9:00 am - 6:00 pm Tuesday through Friday and 10:00 am - 4:00 pm on Saturday, with the following rate structure: public drop off of debagged yard waste was free and bagged yard waste was $2.50/yd^3; all other users (commercial businesses) were charged $1.75/yd^3 for debagged yard waste and $2.75/yd^3 for bagged yard waste. The facility was open by appointment between November 16 and December 31. The 1990 rate structure is as follows:

	Bagged	Debagged	Prunings
Commercial User	$5.50/yd^3	$3.75/yd^3	$3.00/yd^3
Individual User	$0.50/bag	$1.00/yd^3	$2.00/yd^3

Yard waste debagged by the individual user on a per bag basis is 15¢/bag. County Solid Waste Planner Mr. W. Wilson, has estimated the total cost of compost site operation, not including delivery to the site, at $22 - $25/ton for 1989. It should be noted that although the compost site operator charges more for debagging yard waste, they would prefer to not deal with it altogether. The Dakota County compost operation ran largely year round in 1989, due in part to the mildness of the winter. It was estimated that the site was down for a maximum of 20 days over the 1989-1990 winter season [Wilson, 1990].

Overall, the site is operated in compost *pile* operations, rather than windrows, and can best be described in 4 phases. In phase 1, material is debagged and cleaned, and brush is chipped. The brush and yard waste are then mixed together with compost from the previous year and broken down and compressed using the bottom side of a front end loader bucket and the weight of the loader itself. The purpose of the compression and breakdown of yard waste is to generate smaller size particles (for higher surface area exposure for decomposition) and to densify the material (to provide for more economic handling of material). Using this method, the site operator estimates the volume initially taken up by [illegible] five loader buckets of yard waste can be transported by one bucket, a practice which [illegible] of those followed at other sites. The material is then put into piles about 30' [illegible] using one of two front end loaders on the site, watered with a water truck (depending [illegible] dryness of the pile) and, under optimal conditions, allowed to decompose for 5 to 6 [illegible] phase 2, termed consolidation). The pile is formed to be wetter on the outside than [illegible] the inside. A pile may typically be watered with 7,000 gallons one or more times in its [illegible] process (depending on wetness). The subcontractor to the county which [illegible] the compost facility, Mr. R. Pecar, estimates when phase 2 decomposition is done [illegible] examination of pile shrinkage (when crevices start to form on the outside and [illegible] it is time to transfer the pile to phase 3). Pecar has used forced aeration

with a 4" perforated tube running through the pile base, but has reported not needing it much. The piles drying out are more of concern. In phase 3, the partially decomposed yard waste piles are broken down and non-uniform piles (too wet, too dry, too much grass, too much leaves) mixed together to achieve a better balanced mixture. The material is then fed into a conveyor belt feeder and subsequent conveyor belt, and then transferred to a second belt, which creates a new pile from the previous piles about 40' high (see Figure 3-5 and Figure 3-6). Pecar feels pile breakdowns with the loader and conveyor belt transfers provide adequate aeration. The compost is then allowed to finish the decomposition process, screened for distribution and placed in a third pile for storage/distribution (phase 4). The typical turn around through the different phases is about 4 months; the county was targeting to have the 1989 batch done in time for spring 1990 marketing.

A unique feature of the composting operation is the debagging and hand-picking when the yard waste is brought in. Although not logged, it was estimated that 700,000 bags were delivered in 1989. The bags are spread out in rows with a front-end loader, leaving alleys between rows, and personnel manually open each bag, throwing any brush off to one side and bags to the other side. Another person follows behind, picking up bag empties and a front end loader transports the brush to a stockpile area. Approximately 655 yd^3 of process rejects and residuals (empty bags, incidental household waste) were disposed of in a local landfill from the operation. This represents 0.67% of the total volume accepted [Dakota County, 1990].

Wood chip incorporation into the compost piles as a bulking agent is another difference from other compost sites. From the 54,500 yd^3 of prunings delivered to the site in 1989, approximately 4,000 yd^3 of wood chips were made (2,000 yd^3 of the chips were stockpiled for future public disbursement and in the 1990 composting operation, 1,700 yd^3 were used in the 1989 compost piles and 300 yd^3 were distributed to the public).

As may be expected with large volume and time intensive operations, Pecar has experienced timing problems getting all the ingredients together to obtain the proper mixture. To remedy this, wood chips and leaves/compost were stockpiled from the 1989 year to initiate more timely compost piles in the future.

The site which was used for composting in 1989 was temporary and located on normal farmland. The site was not paved and had a gravel access road and entrance gate. It did not have runoff or rainwater collection capabilities.

In 1989 there was one complaint due to odor, which was reported to occur on a day

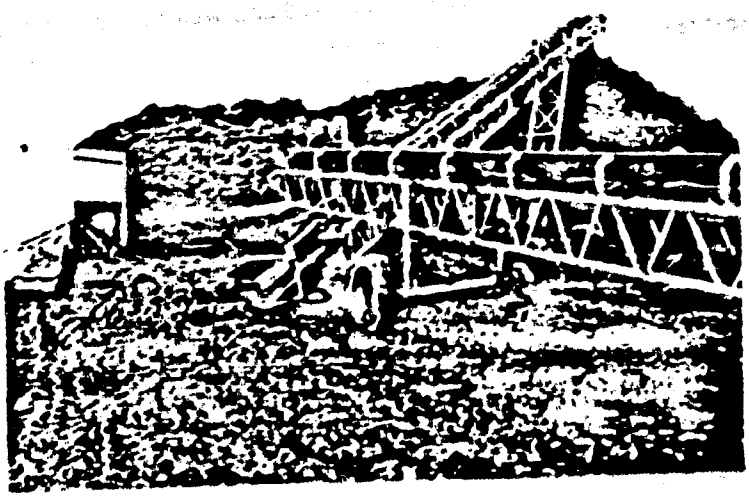

Figure 3-5 Compost Transfer to Phase 3 of Decomposition After Hand-Picking at Dakota County, Minnesota Compost Site

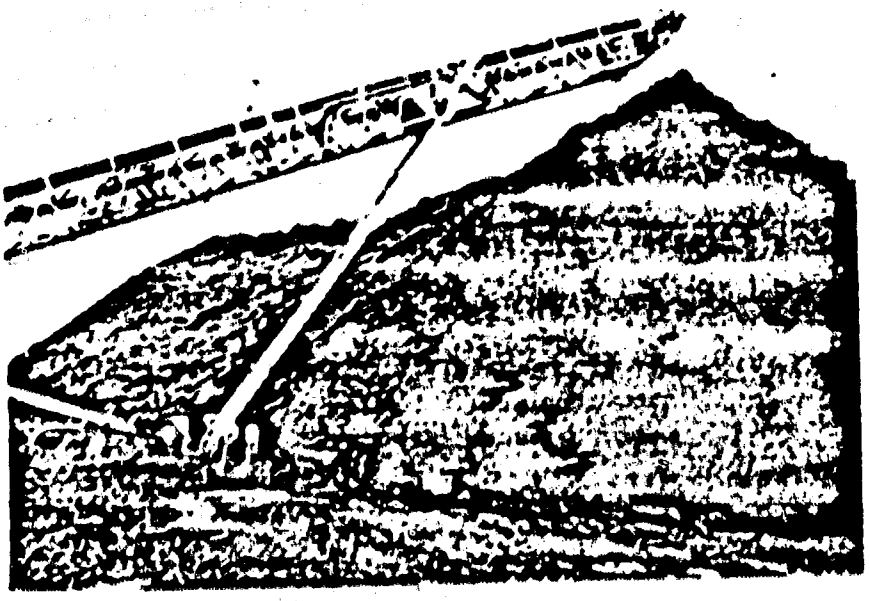

Figure 3-6 Phase 3 Compost Piles Being Set-up at Dakota County, Minnesota Compost Site

when large amounts (truckloads) of grass was received and weather conditions were not normal. The closest residences (a subdivision and trailer park) are about 1/2 mile away. The county attributes its relative success in keeping odor down to efficient debagging upon arrival and incorporation into piles.

Pecar draws on about 12-15 people to work for him. About seven personnel were necessary on a constant basis in the summer and fall when material came in. He estimates 10 personnel per 20 yd^3 packer per day are necessary to debag if the packer truck comes in with compacted bags of yard waste. During slower months after the brush is chipped and the yard waste debagged, about 2 workers are necessary, one to run the front-end loader for transferring piles onto the conveyor belt feeder and another for the second phase of hand-picking, which takes place at the transfer point between the belt feeder and the belt (Figure 3-7 and Figure 3-8). Two front end loaders are necessary most of the time, one to break down piles and another to transport materials around the site. Other equipment and resources necessary are the water truck, conveyor belts, belt feeders and aeration blower (mentioned previously), a chipper and trommel (which is currently rented), a power source or generator, a water source and shelter of some sort.

In 1989 the county gave away 1/2 yd^3 to individuals as an introductory offer and then sold additional amounts for \$10/yd^3 or \$1.50 per garbage can. As 1988 was the initial year, 400 yd^3 were produced; 190 yd^3 were sold, 190 yd^3 were distributed free and the remaining 20 yd^3 were stockpiled at the site. The county is developing large scale users for the 1989 compost, and is anticipating that the public (20,000 deliveries in 1989) will take home compost when they drop off yard waste in 1990.

For 1990 Dakota County established another four acre compost site and a two acre public drop-off site. The county is prepared to subsidize the cost of the 1990 yard waste composting program and the new compost site/drop-off site development an additional 15% above the composting tip fee revenues generated.

3.6 Washington County, Minnesota

Composting Concepts, a yard waste compost company in Washington County operated by a hauler, conducted a voluntary yard waste collection and composting operation for 9 municipalities in Washington and Ramsey County, Minnesota, in part to gear up for the Minnesota yard waste law and in part for studying under a grant program. Results of the collection program are discussed in Chapter 2. The company owns a 20 acre

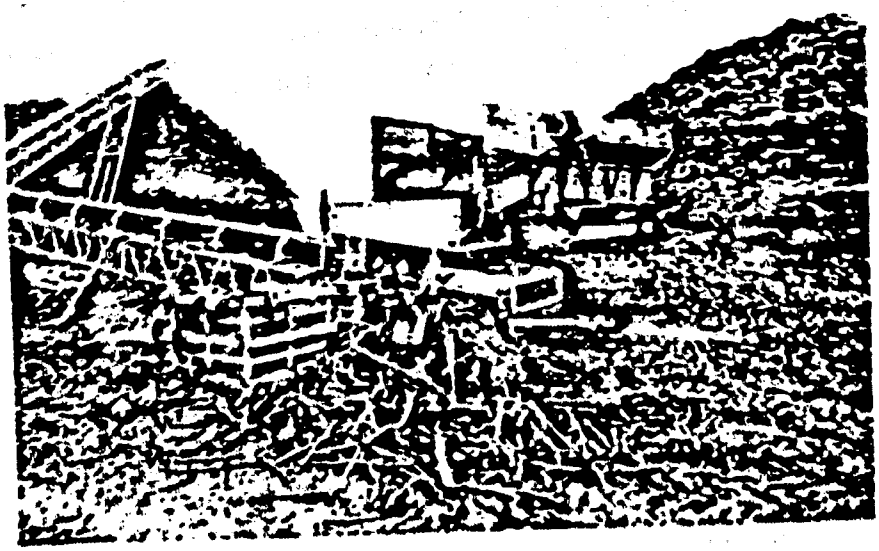

Figure 3-7 Hand-Picking Station at Compost Site in Dakota County, Minnesota

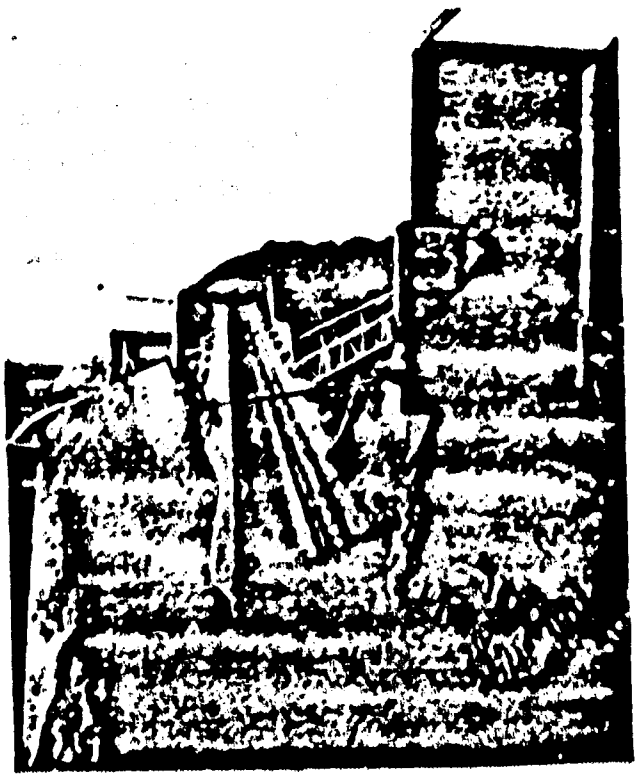

Figure 3-8 Manure Spreader Transferring Compost to Conveyor at Hand-Picking Station

site, of which 3 acres are currently used for composting. In 1989 about 2000 tons of leaves and grass were composted; no brush was accepted at the site. The operation is conducted adjacent to a landfill and a nursery. The county, with a population of 145,000 and 45,000 households, also maintains 5 citizen drop-off/debagging sites which are currently free to the public but which may be charged in the future.

A feature which Composting Concepts considered important with weekly collection service were all weather roads and foul weather pads at the site for access and storage of equipment/vehicles. This company used construction rubble for building of its roads.

A windrow turning machine which attaches to a front end loader is used for composting. The machine has the capability to break the 1.5 mil thickness corn starch bags the company uses which reduces manual debagging. When grass collection is high, the windrows are turned 1-2 times per day; at other times the turning is every few days. The company adds no water to the piles, except that which is received by rain. After partial pile degradation, 3-4 windrows are formed into 1 windrow (a process referred to as the Rutgers method) to finish off decomposition. The finished product is reported to be obtained within 90 - 120 days.

Since the plastic does not decompose as quickly as the grass, Composting Concepts purchased a trommel with 1" diameter screens to remove plastic particles and residuals. It was reported to work out well. About 50% of the plastic is removed in 1 pass through the trommel. The low end of the trommel discharges the "overs" into the back end of a garbage truck, which then transports residuals to the area refuse-derived fuel plant for combustion. The company also obtained a conveyor belt for collection and movement of the screened compost ("unders") from under the trommel, so the operation does not have to be stopped to bring a front end loader in to clear the area.

The composted product was given away free in 1989 to a local landscape business and the nursery next to their compost site. The company is considering delivering it for a fee in the future. Estimated future yearly capacity is 70,000 tons if all 20 acres are utilized.

4. Yard Waste Compost Characteristics and Specifications

One common concern in municipal composting is the quality of the product, in terms of beneficial use and presence of foreign material. The ultimate goal is to produce a good growing medium for plants. Parameters such as porosity, water retention, particle size, pH, nutrient content and specific conductance (soluble salts) are factors used in evaluating compost product. The presence of foreign materials such as viable weed seeds, pesticide residues and heavy metals are also important to measure.

Although there is a large amount of published data regarding the analysis of municipal waste compost, there is little information on the analysis of strictly yard waste compost. This chapter provides a review of compost analysis conducted by the Portland, Oregon Metropolitan Service District, the University of Minnesota and Cornell University. It also provides contaminant limits for compost from Iowa, New York and Minnesota, and discusses Minnesota specifications for procurement of finished compost.

4.1 Physical Properties

The texture and structure of a soil is important for plant productivity, and the particle size distribution of compost makes it a good soil conditioner [Gurkewitz, 1989a]. Also important is the water holding capacity of the soil, which is dependent on the clay, organic matter and humus content. The addition of compost will increase the water holding capacity of a soil mainly through the addition of organic material. Table 4-1 shows a good size distribution for yard waste compost used as a potting mix in Portland, Oregon. Table 4.2 shows the range in water holding capacity for various soils and yard waste compost.

Examples of particle size being used to market finished compost come from the Portland area where two companies make available different particle size grinds and compositions commercially. McFarlane's Bark, Inc. of Clackamas, Oregon produces a fine, medium and coarse compost (less than 5/8", less than 1" and 1" to 4", respectively), which are composed of 10% sawdust and 90% yard debris. Grimm's Fuel Co. of Tualatin, Oregon produces a "Garden Fine Debris Mulch" (less than 5/8" and 100% yard debris), a blended soil (less than 5/8" and composed of 50% loam and 50% yard debris), a fine hemlock mulch (less than 5/8" and composed of 50% hemlock bark dust and 50% yard debris) and a medium hemlock mulch, less than $2^1/_2$" in size [Gurkewitz, 1989a].

The density of the Portland yard waste compost from their quarterly testing program has averaged 682 lb/yd^3, which is a little less than half that of a clay soil loam and

one-quarter the density of sandy soil loam. The addition of compost to soil will decrease its density and help increase porosity, which will reduce soil compaction.

Table 4-1 Particle Size Distribution of Yard Waste Compost [a] [Gurkewitz, 1989a]

Particle Size - Percent Passing Through (inches)					
1/3	1/4	1/5	1/10	1/25	1/50
95%	85%	78%	60%	34%	20%

a. From Portland Metro quarterly test program.

Table 4-2 Water Holding Capacities of Soils [Gurkewitz, 1989a]

Material	Percent Dry Weight
Quartz sand	28
Clay loam soil	44
Half quartz sand/half peat moss	89
Yard waste compost	110
Half clay soil/half peat moss	114
Reed peat	289
Moss peat	1057

4.2 Chemical Characteristics

The chemical characteristics of a soil or compost supplement the physical properties in assessing the compost value as a soil additive. The Portland yard waste test program provides the results of their quarterly testing to landscape and nursery industries and home gardeners as a method to encourage the use of composted material. The nutrient analysis of the Portland testing is shown in Table 4-3. The Portland program changed laboratories and analysis methods, which shows up in the data results. Similar nutrient results of a survey of 11 compost sites in Minnesota is shown in Table 4-4 and of a leaf compost site in Westchester County, New York are shown in Table 4-5. One time analysis of the Carver County, Minnesota compost site is shown in Table 4-6. The range of results is similar, even though they were conducted in different areas of the country. For comparison, concentrations of elements considered phytotoxically excessive levels is shown in Table 4-7.

While a low pH (acid pH) will tie up phosphorus and deter the breakdown of humus in the soil, a high pH (alkaline pH, above 7.5) will deter humus production in the soil and will make metals less soluble [Gurkewitz, 1989a]. The University of Minnesota extension service has identified that the pH of most yard waste composts tested by them is slightly alkaline, between 7.0 and 8.0, and should prove beneficial to plants growing on acid soils. Because of the alkaline pH, the extension service reports compost is not well

Table 4-3 Analysis of Portland, Oregon Yard Waste Compost from April, 1986 through January, 1990 [Gurkewitz, 1989a, and Vernon, 1990] [a]

Element	Partial Acid Extraction [b] April, 1986 - March, 1988		Water Extraction [c] June, 1988 - January, 1990	
	Mean (ppm)	Range (ppm)	Mean (ppm)	Range (ppm)
Ammonia Nitrogen	13	3 - 52	10 [d]	<1 - 35
Arsenic [e]	5			
Boron	0.5	0.11 - 0.81	0.4 [d]	<0.1 - 1
Cadmium [e]	0.80			
Calcium	3,437	2,504 - 4,726	68	36 - 155
Chromium [e]	23			
Copper	3	2 - 6	0.07	0.04 - 0.1
Iron	270	144 - 412	3	2 - 5
Lead [e]	72			
Magnesium	779	615 - 920	35	16 - 113
Manganese	203	66 - 300	2	0.8 - 4
Mercury [e]	0.06			
Nickel [e]	22			
Nitrate Nitrogen	5	2 - 8	1 [d]	<1 - 2
Phosphorus	132	93 - 171	3	1 - 6
Potassium	2,827	2,062 - 3,756	184	41 - 370
Zinc	32	16 - 42	0.3	0.12 - 0.63
pH	6.5	5.8 - 7.2	6.5	5.3 - 7.1

a Dry basis.
b Average of 7 samples from 2 different processors (n=14). Sampling conducted April, June and October, 1986, February, June and September, 1987, and March, 1988. Partial acid extraction used for most elements.
c Average of 4 samples from 2 different processors (n=8). Sampling conducted June, 1988, July and October, 1989 and January, 1990. Water extraction used.
d Average contains measurements less than the detectable limit.
e Results of a one-time test [Gurkewitz, 1989b].

Table 4-4 Analysis of Minneapolis, Minnesota Metropolitan Area Yard Waste Compost [Rosen et al., 1989] a, b

Element	Mean (mg/kg)	Range (mg/kg)
Aluminum	2,700	600 - 3,100
Boron	41	7 - 141
Cadmium	0.4	<0.1 - 1.4
Calcium	30,200	7,000 - 80,400
Carbon	193,000	44,000 - 414,000
Chromium	6.3	1.2 - 52.5
Copper	11	3 - 143
Iron	2,500	600 - 3,100
Lead	49	1 -380
Manganese	420	223 - 1,261
Magnesium	5,400	900 - 13,400
Nickel	7.3	1.7 - 33.3
Phosphorus	1,900	500 - 5,000
Potassium	3,900	400 - 27,100
Sodium	154	36 - 921
Total Nitrogen	12,600	3,300 - 42,000
Zinc	88	39 - 585
pH	7.6	4.5 - 8.3

a. Partial acid extraction used for most elements. Dry basis.
b. Mean values of 11 compost sites over 2 years shown.

Table 4-5 Analysis of Westchester County, New York Leaf Compost [Richard and Chadsey, 1990] [a,b]

Element	*Mean (mg/kg)*	*Standard Deviation (mg/kg)*
Aluminum	33,800	3,400
Boron	15.00	1.03
Cadmium	ND [c]	-
Calcium	18,400	1,100
Chromium	10.46	1.13
Cobalt	4.24	0.68
Copper	19.14	4.29
Iron	26,700	35,500
Lead	31.70	9.57
Manganese	373.76	25.38
Magnesium	5,900	300
Nickel	10.08	0.91
Phosphorus	400	100
Potassium	11,100	1,000
Sodium	15,100	1,400
Sulfur	2,300	300
Titanium	900	500
Total Nitrogen	6,200	1,900
Zinc	81.60	9.86
pH	8.16	0.21
Organic Matter (%)	22.44	6.87
Water Content (%)	54.60	6.90

a Partial acid extraction used for most elements.
b Five samples tested.
c Not detectable (ND).

Table 4-6 Analysis of Carver County, Minnesota Yard Waste Compost [Genereux and Genereux, 1989] [a]

Element	*Concentration (mg/kg)*
Aluminum	2,000
Barium	15
Boron	41
Cadmium	0.4
Calcium	50,000
Chromium	4
Copper	7
Iron	3,300
Lead	35
Magnesium	11,000
Manganese	500
Nitrogen	750
Phosphorus	200
Potash	270
Zinc	50
pH	7.6
Conductivity (mmhos/cm)	2.8

a. Results of a one-time test.

Table 4-7 Phytotoxic Concentrations of Trace Elements in Surface Soils [Kabata-Pendias and Pendias, 1984] [a]

Element	*n*	*Mean (mg/kg)*	*Range (mg/kg)*
Antimony	2	13	5 - 10
Arsenic	5	28	15 - 50
Beryllium	3	10	10
Boron	4	64	25 - 100
Bromine	2	15	10 - 20
Cadmium	4	5	3 - 8
Chromium	4	94	75 - 100
Cobalt	6	43	25 - 50
Copper	6	98	60 - 125
Fluorine	3	567	200 - 1,000
Lead	5	180	100 - 400
Manganese	2	2,250	1,500 - 3,000
Mercury	4	3	0.3 - 5
Molybdenum	5	6	2 - 10
Nickel	5	100	100
Selenium	4	9	5 - 10
Silver	1	2	2
Thallium	1	1	1
Tin	2	50	50
Vanadium	3	70	50 - 100
Zinc	6	270	70 - 400

a Dry basis.

suited to acid loving plants such as azaleas and blueberries [Rosen et al., 1989]. The Portland quarterly yard waste testing program has reported a range in their compost pH from 5.8 to 7.2. They have recommended that when added as a mix component or incorporated as a soil amendment, compost will have little or no effect on soil pH. The average pH of leaf compost from Westchester County, New York was 8.2 and would not be recommended for use on acid loving plants without the addition of sulfur or other acidifying agents [Richard and Chadsey, 1990]. It would, however, be suitable for application to lawns, most trees and general gardening uses.

A high concentration of soluble salts in contact with the roots of germinating seeds can cause injury by forcing the plant to lose water and dry out [Gurkewitz, 1989a]. The Minnesota Department of Transportation (MnDOT) has proposed a maximum specific conductance (soluble salt content) of 15 mmho/cm in the revisions to its compost specifications. For comparison purposes, the Portland program has identified organic amendments as having a specific conductance of 3 mmho/cm, potting media ranging from 0.7 to 3.5 mmhos/cm, and peat moss ranging from 0 to 224 mmhos/cm. The specific conductance of the Carver County, Minnesota compost site was 2.8 mmhos/cm and the concentrations measured in the Portland quarterly testing program ranged from 0.17 to 1.9 mmhos/cm.

4.3 Compost Contaminants

The presence of residual pesticides and herbicides, metals and weed seeds are generally non-desirable components in yard waste compost. Testing for these materials is important to ensure acceptance and use.

The metals measured in some Oregon, Minnesota and New York composts are shown in Tables 4-3 through 4-6. As would be expected, they are of relatively low levels. Although intended for municipal waste or manure compost, the Minnesota Pollution Control Agency, New York Department of Environmental Conservation and Iowa Department of Natural Resources have established limits for compost contaminants which must be verified prior to use (Table 4-8). These levels as well as those provided in Table 4-7 may serve as a benchmark in evaluating significant metal levels in composted yard waste.

Table 4-8 Allowable Contaminant Concentration for Compost [MPCA, 1989, Iowa DNR, 1990, and New York DEC, 1989] [a]

Contaminant	Concentration (mg/kg)		
	Minnesota	Iowa [b]	New York
Cadmium	10	4	10
Chromium	1,000	-	1,000
Copper	500	100	1,000
Lead	500	400	250
Mercury	5	-	10
Nickel	100	100	200
PCB	1	-	1
Zinc	1,000	200	2,500

a. Intended for municipal waste compost.
b. Proposed standards.

EPA registered yard herbicides and insecticides can be expected to degrade at least as fast in a compost pile as when applied to the soil [Rosen et al., 1989]. Table 4-9 shows the persistence of some common home lawn care herbicides in soils. Results of testing Portland compost for pesticides during 1988 and 1989 show mostly nondetectable measurements (Table 4-10). The chlordane most likely is a residual from termite treatment around houses (chlordane is now banned from general use) and the pentachlorophenol is from treatment of outdoor wood such as fenceposts [Tracey, 1990]. Initial Portland studies have shown the presence of such compounds is not toxic to seed germination or plant growth as evidenced by seed germination tests and demonstration plots using locally produced yard waste compost [Gurkewitz, 1989a].

Table 4-9 Persistence of Herbicides in Soil [Rosen et al., 1989]

Common Name	Trade Name	Persistence in Soil (months)
Benefin	Balan, Balfin	4 - 8
DCPA	Dacthal	4 - 8
Bensulide	Betasan, Prefar	6 - 12
Glyphosate	Roundup, Kleenup	<1
2,4-D	(Many forms)	1 - 2
MCPP	(Many forms)	1 - 3
Dicamba	Banvel	3 - 12

Table 4-10 Pesticide Analysis of Portland, Oregon Yard Waste Compost [Vernon, 1990] [a]

Pesticide Classification	*Residue*	*Number of Samples*	*Samples Above Detection Limit*	*Mean (mg/kg)*	*Range (mg/kg)*
Chlorophenoxy herbicides	2,4-D	16	0	ND [b]	-
	2,4-DB	16	0	ND	-
	2,4,5-T	16	0	ND	-
	Silvex	16	0	ND	-
	MCPA	16	0	ND	-
	MCPP	16	0	ND	-
	Dichloroprop	14	0	ND	-
	Dicamba	16	0	ND	-
	Pentachlorphenol	14	9	0.229	0.001 - 0.53
Chlorinated Hydrocarbons	Chlordane	19	17	0.187	0.063 - 0.370
	DDE	14	3	0.011	0.005 - 0.019
	DDT	8	0	ND	-
	opDDT	14	2	0.005	0.004 - 0.006
	ppDDT	14	4	0.016	0.002 - 0.035
	Aldrin	16	1	0.007	0.007
	Endrin	16	0	ND	-
	Lindane	16	0	ND	-
Organo-phosphates	Malaithion	14	0	ND	-
	Parathion	14	0	ND	-
	Diazinon	14	0	ND	-
	Dursban	15	1	0.039	0.039
Miscellaneous	Dieldrin	13	1	0.019	0.019
	Trifluralin	10	0 [c]	-	-
	Dalapon	4	0	ND	-
	Dinoseb	5	1	0.129	0.129
	Casoron	8	0 [c]	-	-
	PCBs	8	0	ND	-

a. Number of samples is combined total for 2 suppliers of compost, which were sampled in June 1988, October 1988, April 1989, July 1989 and October 1989. The number of samples taken each time is not uniform (mostly 2 per period/supplier in 1988 and 1 per period/supplier in 1989). The minimum detection limit is 0.001 ppm for herbicides/pesticides and 0.01 ppm for PCBs. Dry basis.
b. Not detectable (ND).
c. Residue detected but not measurable.

Minimal pesticide presence in compost has also been measured in the Westchester County, New York study where four of 200 pesticides tested were detectable: captan (0.005 ppm), chlordane (0.09 ppm), lindane (0.18 ppm) and 2,4-D (0.003 ppm) [Richard and Chadsey, 1990]. All samples were analyzed using U.S. FDA test methods and were below their tolerance level for food.

The destruction of weed seeds and plant pathogens is dependent on the heat of decomposition of the composting operation. Compost must be exposed to high temperatures in the interior of the pile long enough to render most weed seeds unviable (a temperature of 150°F to 160°F). Since all yard waste compost in a pile may not achieve such temperatures, the introduction of large amounts of weeds into compost piles should be avoided [Rosen et al.]. A review of yard waste compost for the Portland, Oregon region yielded no weed seeds in germination testing [Golueke, Diaz and Gurkewitz, 1989].

4.4 Specifications for Use of Yard Waste Compost

Illinois has not yet established specifications for use of yard waste compost in landscape work. The MnDOT has developed specifications for the use of compost material used as a soil amendment for landscape planting or turf establishment purposes. The specifications were originally adopted by MnDOT in 1987; revisions as a result of their experience were proposed in 1990. MnDOT specifications cover composted yard waste and composted animal and poultry manure. The material is to be a humus rich type similar to a shredded peat. The department has proposed/used the material to modify or amend soil for landscape plantings, to establish turf on rights of way, as a top dressing over the tops of lot areas (e.g., rights of way and rest areas) and as a top soil developer where top soil is eroded away or removed and sub-soil is left [Holm, 1990a].

The agency wants to apply compost to promote the growth of plantings and as a long term nutrient source. A few of the departments observations thus far is that it has tremendous water holding capacity and improves the soil structure on rights of way that has compacted soil [Holm, 1990a].

Due to the leniency of the initial specifications adopted in 1987, MnDOT experienced poor plant growth with the compost they received. Primarily non-decomposed material was delivered to sites with subsequent anaerobic decomposition and overheating after being roto-tilled into the ground. Currently, the intended use of yard waste compost is as a landscape planting medium.

The specifications with the proposed revisions are excerpted as follows [MnDOT, 1987, and Holm, 1990b]:

- The decomposition process shall be complete as evidenced by the total breakdown of the raw ingredients and lack of odor and heat generation.
- The compost shall bear no pathogenic bacteria or weed seed and shall be free of plastic debris, stones, sand, glass and other extraneous matter.
- Compost shall be registered for sale with the Mn. Department of Agriculture and shall be produced on sites either permitted or have a permit pending with the MPCA.
- Compost shall meet the MPCA allowable levels of contaminant requirements (Table 4-8).
- Compost shall be air-dried at time of delivery.
- The department reserves the right to conduct bioassay testing of any material. When subjected to bioassay testing at a mix ratio of 1 volume compost to 2 volumes soil, it shall not be toxic or detrimentally affect the growth indicator plants.
- Compost shall be tested and approved by the [Department] Engineer prior to delivery to the project.
- Prior to the [Department] Engineer sampling the product, the Contractor shall furnish a certification from the supplier that the material has been produced by accepted aerobic composting techniques employing turning or aeration, pathogen reduction and curing.
- Prospective sources of compost shall be indicated to the [Department] Engineer at least one month prior to delivery to the project to allow adequate time for testing and approving the material.
- The current standard testing procedure of the University of Minnesota Soils Testing Laboratory shall be used for determining extractable phosphorus, exchangeable potassium and carbon content with total nitrogen determined by the Kjeldahl method. Testing for moisture content will be in accordance with ASTM D2016, Oven Drying Method.
- Compost shall meet the following requirements:

	Minimum	Maximum
Carbon to Nitrogen Ratio	12	25
Ammonium Nitrogen as a % of total N	-	10
Moisture Content (%)	20	40
Soluble Salts (mmhos / cm)	-	15
pH	5.5	7.0

The ammonium nitrogen content requirement is intended to ensure partially decomposed material will not be delivered to a site. MnDOT currently estimates they can utilize 10,000 yd^3/yr as a landscape planting medium, 2500 yd^3/yr in turf establishment, 650,000 yd^3/yr as a topsoil developer and 1000 yd^3/yr in top dressing. For the 1989 year it was estimated that at least 4000 yd^3 were used, about 10% yard waste compost and 90% manure compost, at a cost of \$20 - \$25 /yd^3,which includes delivery and placement [Holm, 1990a]. By May of 1990 MnDOT had applied 4000 yd^3 of yard waste compost. In order to increase use and acceptability, they have identified four requirements: maintain quality, make it locally available, be cost competitive and be environmentally acceptable.

5. *Land Application of Yard Waste*

Direct land spreading of leaves and grass (without composting) is receiving increasing attention in areas with available farmland as a method to divert yard waste from landfills. The most common practice has been to apply leaves onto farmland in the fall, mainly because cropland is available in the fall for application when the bulk of leaf collection occurs. The leaves are typically spread on cropland with a manure spreader and then incorporated into the soil with a plow and disc. Areas where farm land application of yard waste has been utilized include the Minneapolis-St. Paul area, New Jersey, New York and Wisconsin.

In 1989, the New Jersey Department of Agriculture (NJDOA) established a "leaf mulching hotline," where farmers with available cropland or set-aside land willing to accept leaves could connect with towns and municipalities wanting to dispose of leaves. The NJDOA viewed exchange service as a method for farmers to generate additional revenue and incorporate organic matter into their cropland. The fee associated with the exchange was individually agreed upon by each farmer and town. A price of $5/yd^3 was what most farmers seemed to be getting, although some farmers with close ties to a municipality accepted leaves for free (Bruch, 1990). The distance and cost associated with trucking the leaves was the most important factor in the process of negotiating a land spreading agreement between a town and farm. According to NJDOA count, 42 towns and 62 farmers were matched up in 1989, the first year of the program. Regardless of the arrangements, regulations for land spreading of leaves in New Jersey (or leaf mulching operations, as discussed in Chapter 1) were required to be met.

The following benefits have been reported from land spreading (Smith, 1990, and OLEO, 1990):

- Organic matter is added to soil at minimal cost.
- Reduced wind erosion has been observed to occur on sites where land spreading is performed versus where there is none.
- The expense of land application is less than that of composting. The cost of incorporation and a possible transf. . site involve less time and money than a compost site. In Anoka County, Minnesota, the cost of a full scale land application program has been estimated at $17/ton while that of a compost program has been estimated at $26/ton.
- There is no composted product to have to market.
- Water erosion may be slowed.

The following problems have been reported from land spreading [Nally, 1989, and Peterson, 1990]:

- Grass and leaves must be free of brush, glass, metal, plastic and other debris.
- Raw leaves and grass are difficult to handle.
- Spreading is time consuming.
- Grass clippings will become odorous if stockpiled prior to spreading.

There is little information regarding the land application of leaves, grass and soft bodied non-woody material, and any accompanying effects on plant growth or pollutant transfer. The study of application of yard waste to crop land is necessary in order to determine the effect on crop yield, fertilization requirements, soil analysis and plant analysis. Pilot projects regarding application of leaves to cropland have been conducted in Madison, Wisconsin, Pittsford, New York and Anoka County, Minnesota. This chapter discusses these projects and experiences in land application of yard waste.

Two projects which were initiated in the fall of 1989, for which results are not available, are being carried out at Illinois State University in Normal, Illinois (ISU) and the Fon Hays Experiment Station of Kansas State University at Hays, Kansas (KSU). ISU is examining application of leaves in the fall and spring on different test plots (25 tons/acre each) and also application of yard waste compost in the spring after crop emergence. Corn and soybeans will be used to evaluate the effect on growth, weed control, moisture control and costs. The KSU project is spreading grass clippings at rates of 5 tons/acre (t/a), 15 t/a and 45 t/a and growing drill feed, a hay crop used extensively in the winter for animal feed in Kansas. Application of shredded newspaper at the same rates is also being studied in the KSU project.

5.1 Application Methods and Rates

A primary aspect of leaf application is the supplemental nitrogen required for degradation of leaves. Fall leaves have a high carbon to nitrogen ratio (C:N, ranging from 40:1 to 80:1) and the rate of degradation can be limited by this. If the C:N ratio exceeds 30, breakdown usually will proceed slowly and nitrogen available for plant growth will be limited [Peterson et al., 1989]. As degradation progresses, nitrogen becomes available for plant growth or further degradation.

University of Wisconsin-Madison (UWM) Pilot Project

UWM, in cooperation with the city of Middleton, Wisconsin, collected 20 to 40 tons of leaves in the fall of 1986, 1987 and 1988. Leaves were spread at a two acre UWM test site at the West Madison Agricultural Research Station. The leaf application and control (no leaf application) field sizes for the UWM study are shown in Table 5-1. Replicates were planted in 1986 and 1987, and control fields were planted in 1986 and 1988. The years shown are for fall application; growth results are therefore from 1987, 1988 and 1989. Twenty and 40 t/a, 30 t/a, and 25 and 50 t/a were spread in the fall of 1986, 1987 and 1988, respectively. Granular ammonium nitrate (33% N) was the nitrogen form used in the UWM project. The UWM project planted ear corn on all test plots to monitor crop yield.

Dr. A. Peterson, the coordinator of the UWM project, experimented with various ways of incorporating and applying leaves. The older-style rear discharge manure spreader (with beaters), although labor intensive, has worked best so far. Leaves dumped in piles and moved with front-end loaders and side discharge manure spreaders did not work as well. Experiences with incorporating leaves in the UWM project are as follows: a) discing was not satisfactory for incorporation and a rototiller (a Howard rotovator) was necessary to mix the leaves into the soil, b) using a rototiller was difficult on heavier (40 t/a) leaf treatments, and c) incorporating leaves onto a bare field was easier than on hay or sod land [Peterson et al., 1989].

Table 5-1 Field Sizes in UWM Leaf Application Project [Peterson et al., 1989]

Year Leaves Spread	*Test Field Size*	*Control Field Size*	*Notes*
1986	2 @ 100' x 100'	2 @ 100' x 100'	Leaf fields and control fields divided into 2 - 50' x 100' lots each, with duplicates of each.
1987	2 @ 90' x 100'	none	Leaf field divided into 4 - 90' x 25' lots, with duplicates of each.
1988	50' x 100'	50' x 100'	Leaf field and control field divided into 2 - 50' x 50' lots each, no duplicates.

Cornell Cooperative Extension Service (CCES) Pilot Project

The CCES of Monroe County, New York, in cooperation with the town of Pittsford, New York collected leaves in the fall of 1987 and spread them in spring 1988 on 6 acres of corn crop land. Six different treatment combinations of 1/2 acre each, with one replicate of each, were used for the project (for a total of 1 acre per treatment combination). The extension service spread 0", 1 1/2" and 3" of leaves. This corresponded to a spread rate of 0 t/a, 6.4 t/a, and 12.8 t/a on a dry basis, respectively, and a wet basis of 0 t/a, 20 t/a and 40 t/a, respectively. Nitrogen rates of 60 lbs N/acre, 120 lbs N/acre and 140 lbs N/acre were applied (using a 33% liquid nitrogen form). The project coordinator, Mr. T Nally, of the CCES, used two different type manure spreaders to conduct the spreading and recorded the time required for different spread rates (Table 5-2). The times recorded include loading the spreader, trips to and from the plot and spreading. A total of 125 man-hours were involved in the operations of hauling, loading, spreading and incorporating for the project [Nally, 1989]. Spreading of leaves with a manure spreader was reported to be the most inefficient and time consuming task of the entire project.

Table 5-2 Spreading Times Recorded in CCES Leaf Application Project [Nally, 1989]

Manure Spreader Capacity [a] *(lbs)*	*Leaf Spread Rate (dry tons/acre)*	*Number of Loads Required*	*Total Time Required (hours/acre)* [b]
550	6.4	22	4.5
550	12.8	42	9.0
850	6.4	16	2.5
850	12.8	30	4.5

a. The 850 lb spreader operates at a higher rate of speed than the 550 lb spreader.
b. For a 1 acre test spread.

Complete incorporation using a mold board plow at the maximum application rate of 3" (12.8 t/a, dry) was reported in the CCES project, but when leaves were mistakenly applied at a 5"-6" depth they were found to "ball up" in the plow and not get incorporated. It should be noted that at project onset, the investigators determined the 140 lbs N/acre

application rate would not be enough to overcome the possible crop yield reduction caused by leaf nitrogen immobilization (180 lbs N/acre was necessary). However, local environmental officials would not permit nitrogen application exceeding 140 lb/acre without a variance. A variance was determined to be too costly for the project size (since then the New York Department of Environmental Conservation has granted an exemption for farmers applying leaves on crop land).

On-Land Environmental Opportunities (OLEO) Pilot Project

In 1989, the not-for-profit OLEO group in Anoka County land spread 1400 tons (approximately 5600 yd^3, assuming 4 yd^3/ton compacted) of yard waste comprised mostly of leaves. The application was performed on 5 farms: one farm used leaves for animal bedding and spread after use, one farm spread manure and then leaves, one spread leaves on irrigated land, one spread partially decomposed leaves and one directly spread leaves on cropland. The method of yard waste application at each of the OLEO farms is shown in Table 5-3. Most of the leaves were received at the Minnesota farms in the spring of 1989. Ideally, the spreading would have taken place in the fall of 1988, however this was not possible because the proper permits were not obtained in time. The OLEO project's application of leaves using a manure spreader was reported to have even and uniform distribution. If the material was slightly moist (such as being picked up after a rainstorm), it spread better and was less likely to be wind-blown.

In all cases the OLEO farmers reported problems handling the leaves due to compression and debagging, and having to clean foreign matter from the yard waste prior to application. Examples of material found include glass, wire, automotive parts, tires, cement, car batteries and plastic and glass bottles. The farms which took bagged yard waste reported the excess time and cost associated with debagging was a problem. Debagging and cleaning of the yard waste by the farmers was not a task they wanted to repeat in the future. The following solutions were offered to remedy future operations [OLEO 1990, OLEO 1989b]:

- Additional public education and awareness to keep foreign matter out of yard waste.
- Additional public education for delivery of leaves unbagged.
- Enforce the separation of foreign matter at the curb.
- Provide a central dispatch area to provide necessary cleaning and delivery to farm.

The application rates used in the OLEO project are shown in Table 5-4. Additional application combinations of nitrogen and leaves were conducted in their project, but the data were not available at time of publication. The application rates at farm site E are not reported due to its large difference in leaf application rates from the other farm sites. At leaf application rates of around 20 t/a, the OLEO project reported no problem with incorporation. At rates higher than this, tillage operations had to be repeated an additional one or two times with a disc to get good incorporation of material [Buchite, 1990a]. Three farmers used mold board plows, one used a disc and field cultivator and one used a chisel plow in the initial incorporation pass. Four farms used an additional disc to cut the leaves into the soil surface. One farm which used one pass with a chisel plow received poor growth results due to layering of leaves. The OLEO group planted shelled corn on three farms, corn silage on one farm and ear corn at one farm.

Table 5-3 Field Sizes and Application Methods Used in OLEO Project [OLEO, 1989a]

Farm Site	*Field Size (acres)*		*Yard Waste Application*	*Application Method*
	Leaf	*Control*		
A	2.5	4.5	Spread on corn crop acres	1 axle manure spreader, tandem disc incorporation and 5 bottom 18" plow (10" setting) w/packer
B	7.0	3.0	Spread on corn crop acres with manure spread prior	1 axle manure spreader, 5 bottom 16" plow (10" setting) and disc
C	10.0 a	0.0	Leaves used as animal bedding and spread on corn silage acres	1 axle manure spreader, 4 bottom 18" plow (10" setting) and disc harrow
D	13.0	7.0	Spread on irrigated corn crop acres	2 axle manure spreader, leaves were cleaned, chopped, spread, side raked, disc and chisel plow (10" setting)
E	5.7	2.8	Decomposed leaves spread on corn crop acres	1 axle manure spreader, disc, cultivate

a Four acres direct spread, 6 acres bed and spread.

Table 5-4 Application Rates in OLEO Leaf Application Pilot Project [OLEO, 1989b, and Buchite, 1990b]

Farm Site	*Leaves (tons/acre)*	*Nitrogen (pounds/acre)*	*Nitrogen Form*
A	0	0	Ammonium
	0	68	Nitrate
	15	0	
	15	68	
B	0	0	
	0	170	Anhydrous
	15	170	Ammonia
	30	170	
C	15-30	0	
	15-30	34	Ammonium
	15-30	136	Nitrate
D	0	51	
	0	85	Ammonium
	10	0	Nitrate
	10	51	
	10	85	
	20	0	
	20	51	
	20	85	

5.2 Pilot Project Test Results of Land Application

University of Wisconsin-Madison (UWM) Pilot Project

The analyses of the leaves applied in the fall of 1986, 1987 and 1988 are shown in Table 5-5. The variation in chemical analysis of leaves is within the expected ranges [Peterson et al., 1989].

The 1987, 1988 and 1989 corn yields for the plots spread with leaves and the control plots are shown in Table 5-6. The fertilizer plot (no leaves, 200 lbs N/acre and 50 lbs P/acre) represents the normal rate of application for corn in the area. The reduced yield in 1988 from the 1986 spreading was due to drought. The study noted that the location of the 1987 plots provided more moisture and an excellent yield in 1988 despite the drought. Corn plant population remained constant regardless of treatment method and averaged about 25,000 plants/acre.

Table 5-5 Analysis of Leaves in UWM Leaf Application Pilot Project [a] [Peterson et al., 1989]

Year	Sample	N	P	K	Ca	Mg	S	Zn	B	Mn	Fe	Cu	Al	Na
		(%)						(ppm)						
1986	Maple	0.72	0.35	0.51	2.44	0.42	0.18	34	34	397	389	<2.59	298	<63
1986	Maple	0.86	0.24	0.71	2.54	0.43	0.20	28	39	348	294	<2.54	132	<62
1986	Oak	0.78	0.10	0.37	1.23	0.33	0.10	22	29	598	503	<2.45	381	<60
1986	Oak	0.84	0.09	0.35	1.33	0.36	0.10	32	35	692	370	<2.46	269	<60
1987	Leaves [b]	1.10	0.24	0.68	2.15	0.46	0.15	47	30	312	357	6.41	241	<65
1988	Leaves	1.02	0.15	0.70	2.27	0.51	0.16	33	33	306	-	5	-	-
1988	Leaves	1.02	0.24	0.88	2.53	0.48	0.17	21	35	140	462	5	336	<64

a. Samples corrected to 25% moisture.
b. Type of leaves unspecified.

Table 5-6 Corn Yields from UWM Leaf Application Pilot Project [a] [Peterson et al., 1989]

Year Leaves Spread	Treatment		Corn Yield (bushels/acre)		
	Leaf Rate (tons/acre)	Nitrogen Rate [b] (pounds/acre)	1987	1988	1989
1986	0	0	133	67	115
	0	200 [c]	143	73	126
	20	0	136	78	116
	20	300	153	74	114
	40	0	130	63	117
	40	300	148	63	117
1987	30	0	-	124	128
	30	75	-	126	124
	30	150	-	129	115
	30	300	-	133	116
1988	0	0	-	-	121
	0	200 [c]	-	-	109
	25	0	-	-	112
	25	300	-	-	103
	50	0	-	-	107
	50	300	-	-	115

a. Average of 2 samples for each treatment (corrected to 15% moisture content).
b. Nitrogen rate constant for each season (supplied as topdressing when the corn was approximately 4" high).
c. Fifty pounds per acre phosphorus (P_2O_5) also spread.

Findings reported by the UWM project are as follows:

- Metal concentrations in ear leaf and grain samples show no differences among treatment methods (Tables 5-7 and 5-8, respectively).
- Leaf application had no major effect on soil pH, nitrogen, potassium, calcium, magnesium and sulfur (Table 5-9). Leaf applications increased soil phosphorus when compared to the control plots of no leaves and no nitrogen (Table 5-9). Organic matter either increased or remained approximately constant.
- How to apply and incorporate the leaves in a more time-efficient manner was the most difficult part of the study. The leaves would be easier to incorporate into the soil if they were shredded when collected. The transfer of leaves to a manure spreader for spreading takes considerable time and equipment.

Overall, the UWM project shows that although there are variations in crop yield with respect to leaf and nitrogen treatment methods and rates, leaf application had little effect on the growth of corn (plant population, corn yield, soil characteristics and tissue and grain metal content). Further work is required to determine appropriate nitrogen and leaf treatment rates and more effective methods of application and incorporation into soil.

Table 5-7 Metal Concentrations in Corn Ear Leaf Samples from UWM Leaf Application Pilot Project [a] [Peterson et al., 1989]

Year Leaves Spread	Treatment: Leaf Rate (tons/acre)	Treatment: Nitrogen Rate (pounds/acre)	Cd	Cr	Cu	Ni	Pb	Zn
			(ppm)					
1986	0	0	<0.1	<0.1	11	0.4	<1.0	33
	0	200 [b]	<0.1	<0.1	12	0.3 [c]	<1.0	28
	20	0	<0.1	<0.1	11	0.3 [c]	<1.0	30
	20	300	<0.1	<0.1	12	0.4 [c]	<1.0	31
	40	0	<0.1	<0.1	10	< 0.3	1.4 [c]	27
	40	300	<0.1	<0.1	12	0.3 [c]	1.0 [c]	41
1987	30	0	<0.1	<0.1	11	0.3 [c]	<1.0	33
	30	75	<0.1	<0.1	11	0.4 [c]	1.2	32
	30	150	<0.1	<0.1	11	0.3 [c]	<1.0	32
	30	300	<0.1	<0.1	12	0.4	<1.0	35
1988	0	0	<0.1	<0.1	12	0.5	<1.0	33
	0	200 [b]	<0.1	<0.1	11	<0.3	<1.0	27
	25	0	<0.1	<0.1	11	0.4	<1.0	34
	25	300	<0.1	<0.1	12	<0.3	<1.0	28
	50	0	<0.1	<0.1	11	<0.3	<1.0	28
	50	300	<0.1	<0.1	12	0.3	<1.0	32

a. Average of 2 samples for each treatment.
b. Fifty pounds per acre phosphorus (P_2O_5) also spread.
c. Average contains "less than" values.

Table 5-8 Metal Concentrations in Corn Grain Samples from UWM Leaf Application Pilot Project [a] [Peterson et al., 1989]

Year Leaves Spread	Treatment: Leaf Rate (tons/acre)	Treatment: Nitrogen Rate (pounds/acre)	Cd	Cr	Cu	Ni	Pb	Zn
			(ppm)					
1986	0	0	<0.1	<0.1	1.3	<0.3	<1.0	16
	0	200 [b]	<0.1	<0.1	1.4	<0.3	<1.0	22
	20	0	<0.1	<0.1	1.4	<0.3	<1.0	22
	20	300	<0.1	<0.1	1.4	<0.3	<1.0	18
	40	0	<0.1	<0.1	1.3	<0.3	<1.0	25
	40	300	<0.1	<0.1	1.4	<0.3	<1.0	17
1987	30	0	<0.1	<0.1	1.4	<0.3	1.9	26
	30	75	<0.1	<0.1	1.4	<0.3	1.6	18
	30	150	<0.1	<0.1	1.5	<0.3	1.4	16
	30	300	<0.1	<0.1	1.4	<0.3	1.4	23
1988	0	0	<0.1	<0.1	1.4	<0.3	1.6	26
	0	200 [b]	<0.1	<0.1	1.4	<0.3	1.4	17
	25	0	<0.1	<0.1	1.4	<0.3	1.9	16
	25	300	<0.1	<0.1	1.5	<0.3	1.7	24
	50	0	<0.1	<0.1	1.4	<0.3	1.6	15
	50	300	<0.1	<0.1	1.4	<0.3	1.5	15

a. Average of 2 samples for each treatment.
b. Fifty pounds per acre phosphorus (P_2O_5) also spread.

Table 5-9 Soil Analysis from Plots in UWM Leaf Application Pilot Project, taken November, 1989 [a] [Peterson et al., 1989]

Year Leaves Applied	Treatment: Leaf Rate (tons/acre)	Treatment: Nitrogen Rate (pounds/acre)	pH	OM [b] (tons/acre)	NH4-N (ppm)	NO3-N (ppm)	TKN [c] (%)	P (pounds/acre)	K (pounds/acre)	Ca (pounds/acre)	Mg (pounds/acre)	S (pounds/acre)
1986	0	0	6.7	24	7.3	7	0.15	18	180	3350	1495	6
	0	200 [d]	6.7	30	10.0	20	0.16	40	195	3350	1370	9
	20	0	6.9	29	10.7	12	0.16	30	190	3275	1365	9
	20	300	6.6	30	10.0	40	0.19	31	190	3300	1310	8
	40	0	7.0	34	10.0	20	0.19	50	225	3500	1290	12
	40	300	6.7	35	12.0	65	0.19	50	230	3700	1370	9
1987	30	0	6.9	38	7.7	33	0.20	46	185	3400	1115	12
	30	75	6.9	37	7.5	45	0.22	46	175	3525	1130	11
	30	150	6.8	36	8.0	35	0.20	41	180	3375	1110	9
	30	300	6.4	38	8.5	78	0.22	49	200	3250	1070	10
1988	0	0	6.7	26	5	10	0.15	13	160	3100	1270	9
	0	200 [d]	6.9	30	6	18	0.16	33	170	3150	1250	11
	25	0	7.0	28	11	10	0.16	20	180	3200	1350	11
	25	300	6.8	29	7	11	0.16	20	170	2950	1050	11
	50	0	6.8	29	9	13	0.16	27	165	3050	1100	12
	50	300	6.9	31	10	37	0.18	39	205	3150	1200	14

a. Samples taken from 0" - 10" depth.
b. Organic matter (OM).
c. Total Kjeldahl nitrogen (TKN).
d. Fifty pounds per acre phosphorus (P_2O_5) also spread.

Cornell Cooperative Extension Service (CCES) Pilot Project

Crop yields and silage generation for the spring of 1988 leaf spreading in Pittsford, New York are shown in Table 5-10. The 0 t/a leaf rate and 120 lbs N/acre rate represents standard nitrogen rates for corn in the area. Although crop yield decreases as leaf rate increases, yield increases as the nitrogen rate increases, which can be seen at the 0 t/a or 12.8 t/a application level. The CCES project analysis of metals in the soil before planting and at harvesting, in the leaves before application and in the corn plant leaves before harvesting did not show significant levels [Nally, 1989].

It was noted that the stockpiling of leaves near the field to be spread can be critical to the success of such a project. Stockpiling reduced the transport time during collection and/or application and increased project efficiency. This allowed workers to transport leaves when other work was not pressing.

Table 5-10 Corn Yields and Silage Generation in 1988 CCES Leaf Application Pilot Project[a] [Nally, 1989]

Leaf Application Rate (tons/acre)	60 lbs N/acre		120 lbs N/acre		140 lbs N/acre	
	Bushels Grain	Tons Silage	Bushels Grain	Tons Silage	Bushels Grain	Tons Silage
0	126	19.7	132	20	-	-
6.4	118	18.2	-	-	-	-
12.8	105	17.4	109	17.3	112	17.4

a. Average of 10 samples per treatment combination.

On-Land Environmental Opportunities (OLEO) Pilot Project

Overall, the corn was reported to grow well. The effect of nitrogen application rate on crop yield can be observed in the yields from farm site D, which was the most uniform in application, had minimal slope changes and utilized irrigation (Table 5-11). At a nitrogen rate of 51 lbs/acre and a leaf rate of 20 t/a, crop yield is reduced, while yield was not affected by leaf application at 85 lbs N/acre. A summary of the average corn plant tissue nutrient and metal contents from differing OLEO project applications is shown in Table 5-12. The samples were taken from ear bent corn leaf after silking at the end of

August, 1989 and are summarized according to their relative application rates. Sodium concentration appeared to decrease on plots with leaves applied. It should be noted the number of samples from each combination and farm are not uniform and that the data shown are for one season.

A significant result in the OLEO project was the reduction in soil loss due to wind erosion. Minnesota has sandy soil and yard waste had the ability to allow the plant to hold sand particles together more and to form a rougher surface which limits the amount of sand blowing.

Table 5-11 Corn Yields from OLEO Farm Site D [Buchite, 1990b]

Leaf Application Rate (tons/acre)	*Nitrogen Application Rate (pounds/acre)*	*Corn Yield (bushels/acre)*
0	51	152
0	85	149
10	51	142
10	68	150
10	85	156
20	51	114
20	68	120
20	85	146

5.3 Guidelines for Land Application of Yard Waste

As seen in Chapter 1, few regulations exist for the land application of yard waste. Anoka County, Minnesota has set up a licensing arrangement for farmers which intend to perform land application. This agreement, as well as a draft two party agreement between an OLEO member and a supplier of yard waste, are provided in Appendix B. Primary features of the county agreement include:

- Incorporation of material in a timely manner (within 45 days). Material received between 6/1 and 10/31 may be stored for use in the fall up until 11/15. Yard waste (defined to mean leaves and grass) received between 11/15 and 4/1 may be stored for use in the spring and will be incorporated by 6/1.
- Yard waste for bed and spread management will be applied at a rate sufficient to guarantee its use within 6 months of waste delivery. Winter and spring used bed and spread yard waste will be spread by 5/15 and incorporated by 6/1.

Table 5-12 Analysis of Corn Ear Leaf Tissue in OLEO Pilot Project [a] [Swanson, 1990]

Treatment	n	N (%)	P	K	Ca	Mg	Al	Fe
					(ppm)			
No Leaves, No Nitrogen	3	2.97	2873	27585	5749	2992	30.93	104
No Leaves, Nitrogen [b]	5	2.95	2833	25952	6817	2700	29.07	162
Leaves [c], No Nitrogen	6	2.74	2902	22181	7101	3704	31.38	124
Leaves [c], Int. Nitrogen [d]	8	2.74	2791	23277	6264	3020	26.80	115
Leaves [c], High Nitrogen [e]	6	2.65	2749	19168	7048	3531	29.05	140

Treatment	n	Na	Mn	Zn	Cu	B	Cr	S
					(ppm)			(%)
No Leaves, No Nitrogen	3	20.14 [f]	64.6	33.21	8.21	5.99	0.35	0.221
No Leaves, Nitrogen [b]	5	21.42 [g]	91.4	32.38	6.47	6.98	0.38 [h]	0.212
Leaves [c], No Nitrogen	6	12.32	74.4	32.98	5.72	7.22	0.31	0.212
Leaves [c], Int. Nitrogen [c]	8	14.61	92.0	31.82	5.73	7.23	0.42 [i]	0.203
Leaves [c], High Nitrogen [e]	6	12.17	77.6	31.75	4.43	6.85	0.33 [j]	0.206

a. Eighteen of 32 sample analyses detected cadmium (average 0.44 ppm), 2 of 32 sample analyses detected lead (average 2.9 ppm) and 3 of 32 sample analyses detected nickel (average 1.1 ppm).
b. The average application rate was 93 lbs N/acre, with a range from 51-170 lb/acre.
c. Average application rate 8.5 tons/acre, with a range from 4.5-30 tons/acre.
d. Intermediate nitrogen application rates were 34 lbs N/acre, 51 lbs N/acre 68 lbs N/acre.
e. High nitrogen application rates were 85 lbs N/acre, 136 lbs N/acre and 170 lbs N/acre.
f. n=2 (1 non-detectable (ND) sample).
g. n=4 (1 ND sample).
h. n=3 (2 ND samples).
i. n=7 (1 ND sample).
j. n=5 (1 ND sample).

- No field applied yard waste shall remain unincorporated over the summer or winter.
- Yard waste deliveries shall be prearranged and only from commercial or municipal haulers approved by the county.
- Application rates shall not exceed 20 t/a.
- Soil tests shall be conducted before and 6 months after application.
- An annual report shall be submitted which addresses quantity of waste received and field applied, application rates, soil analyses, problems and sources.

Additional recommendations have been made to supplement the agreement [Smith, 1990 and Buchite, 1990a]:

- Yard waste should go to the farm debagged; farmers do not want plastic bags or pieces of degradable bags cluttering up their farmland, unless it is desired by the farmer to use dry fall leaves over a period of time for animal bedding prior to spreading.
- The hauler should pay the farmer as part of the rate for picking up yard waste.
- Educate the public to understand that their yard waste may end up on food production land.
- Monitor for chemical and metal contaminants.

For 1990, Anoka county has projected the use of a transfer trailer to haul yard waste from smaller cities out to the farms as a means of reducing the number of trips.

5.4 Costs Comparison Between Land Applying and Composting Yard Waste

Anoka County performed a cost comparison between the OLEO project and its own yard waste composting program for the 1989 year (Table 5-13). Overall, the cost of the OLEO project for the first year ($8.01/yd^3) was higher than the compost site operation cost ($4.54/yd^3). This higher cost was primarily due to first year costs associated with legal consultation and testing ($4.37/yd^3) which were not amortized. Additionally, the compost site "Consultation & Testing" cost included a one time fee of $16,418.60 for the drilling of test wells. Adjusting for these factors results in a land spreading cost of $14.56/ton ($32.03/ton - $17.47/ton) and a compost site cost of $16.36/ton ($12.53/ton + ($51,418.60 - $16,418.60) / 9,125 tons). The total land spreading cost in Table 5-13 is different from the full scale program cost of $17/ton mentioned previously due to first year expenses and due to not including the cost of a transfer site and truck. The total compost site cost in Table 5-13 is lower than the full scale program cost of $26/ton due to lack of

expenses associated with the use of a windrow machine, shredder/grinder and a trommel screen. The OLEO project estimated a drop-off fee of $10/ton for unbagged clean (no foreign matter) yard waste at a designated field road entrance.

As an initial illustration of the farmer's costs associated with land application of leaves, suppose a farmer land applies 20 tons/acre of clean leaves from a nearby town for the above mentioned fee of $10/ton, resulting in a gross income of $200/acre. From the corn yield results provided above, crop yield may be reduced the first year even if supplemental nitrogen is applied. Assuming the yield is reduced by 20 bushels/acre at a corn price of $2.50/bushel results in a $50/acre loss from what may be normally expected. Assuming an extra 50 lbs N/acre is necessary to supplement leaf application at a nitrogen price of 25¢/lb also results in an added expense of $12.50/acre. A labor cost to the farmer of $15/hour at a spread time of 4.5 hours (from the smaller manure spreader in Table 5-2 for 20 tons/acre wet) and an incorporation time of 1.5 hours requires $90/acre. The net income then would be $200 - $50 - $12.50 - $90 = $47.50/acre, not including cost of equipment and other incidentals.

Table 5-13 Anoka County, Minnesota Yard Waste Cost Comparison [Smith, 1990]

	First Year Expenses ($)			
Operation	*Administration* [a]	*Operation*	*Consultation & Testing*	*Total*
Land Spread				
Total Cost	4,396.46	16,931.00 [b]	25,580.39	46,907.85
Per Cubic Yard Basis [c]	0.75	2.89	4.37	8.01
Per Ton Basis [d]	3.00	11.56	17.47	32.03
Compost Site				
Total Cost	- [e]	114,373.84	51,418.60	165,795.44
Per Cubic Yard Basis [f]	-	3.13	1.41	4.54
Per Ton Basis [d]	-	12.53	5.63	18.16

a. The expenditures do not include county administration staff time spent on either program.
b. Includes some expenses which were donated to OLEO, Inc. and $6,625 highway department cost for transfer of yard waste.
c. Based on 5,380 yd^3 of leaves spread in spring of 1989 and 476 yd^3 spread in fall of 1989.
d. Yard waste converted from volume to mass using a 4 yd^3/ton basis.
e. Compost site administration expenses included in operation cost.
f. Based on 13,504 yd^3 of yardwaste from 1988 and 22,997 yd^3 from 1989.

Appendix A

Starting a Community Composting Project

STARTING A COMMUNITY COMPOSTING PROJECT [McCown, 1988]

Starting a successful composting program requires proper planning. The various tasks associated with each project phase are listed in the following outline.

I. Feasibility Study and Conceptual Design

1. Identify quantities and composition of wastes for municipal composting
2. Identify and investigate end uses of the final product
3. Evaluate existing collection system, identify required modifications
4. Identify and evaluate potential sites
5. Evaluate potential environmental impacts
6. Identify institutional requirements and permit requirements
7. Assess public support
   - home composting and recycling grass clippings
   - participation in municipal collection
   - as users of final product
8. Perform conceptual design
   - site requirements
   - structural requirements
   - general design and site layout
   - equipment requirements
   - operating procedures
   - personnel requirements
9. Perform preliminary economic analysis
   - capital costs
   - operating and maintenance costs
   - potential revenues
   - avoided costs
10. Identify financing options
11. Formulate conclusions and recommendations
    - select site
    - determine owner/operator
    - determine financing methods and obtain funds

II. Design and Engineering

1. Initiate necessary permits and approval procedures

2. Establish collection system requirements and procedures

3. Prepare detailed design of facility
   - surface and drainage
   - receiving area layout
   - windrow area layout
   - storage/curing area
   - utility hook-ups, if needed
   - building/structures
   - access roads
   - fencing
   - irrigation system, if needed

7. Prepare equipment specifications

8. Establish uses for end product and obtain commitments

9. Establish personnel requirements

10. Prepare operating plan

11. Develop public education program
    - home composting and recycling lawn clippings
    - participation in municipal collection system
    - as users of final product

12. Perform detailed economic analysis

III. Construction and Operation

1. Procure equipment

2. Implement public education program

3. Make site improvements

4. Hire personnel

5. Begin operations

6. Maintain records

7. Evaluate the project regularly

8. Refine operational procedures

Appendix B

Land Application of Yard Waste

Example Memorandum of Agreement Between Anoka County, Minnesota and Individual Farmers (pp. 75)

Draft Agreement for Acceptance of Yard Waste Between On-Land Environmental Opportunities (OLEO) Group and Second Parties (Haulers, Cities - pp. 79)

MEMORANDUM OF AGREEMENT

Agricultural Application of Yard Waste

WHEREAS the Anoka County Solid Waste Ordinance requires that all solid waste disposal facilities be licensed; and

WHEREAS yard wastes are defined as a solid waste in the County's Solid Waste Ordinance; and

WHEREAS I have applied for a license for the agricultural application of yard waste; and

WHEREAS the reuse and/or recovery of resources from the solid waste stream is consistent with the County's policy of land disposal abatement; and

WHEREAS the agricultural use of yard wastes for soil amendment purposes has value as a soil conservation technique;

NOW THEREFORE BE IT RESOLVED:

I. Purpose of Agreement

The purpose of this agreement is to provide additional information and clarification of my application for a license for the agricultural application of yard wastes and to establish conditions of licensure.

II. License Application Amendment and Conditions

Upon execution of this agreement, I agree that the following items are incorporated as part of the subject license application and as conditions of licensure:

1. I will limit the yard wastes to be utilized to grass clippings and leaves obtained from commercial haulers and/or governmental waste abatement programs collecting source separated wastes. I will submit the name of the hauler or waste abatement program to the Environmental Services Department, hereinafter the "Department," at least three County working days prior to delivery to my farm. Other sources will not be used unless approved by the Department. Yard waste deliveries will be by prearrangement and only from the sources approved by the Department.

2. I will, in all cases, spread and incorporate the yard wastes on agricultural production lands to enhance fertility and reduce erosion losses. Application rates will not exceed 20 tons per acre (@ 15% moisture) (approximately 57 cubic yards per acre) or a depth which would adversely affect the quality of incorporation, whichever is a lesser quantity. I will manage the yard waste received by one or more of the following practices upon written notice to, and approval by, the Department.

a. Direct field spreading.

b. Livestock bedding followed by field spreading.

c. Silo composting followed by field spreading.

3. I will maintain soil pH at a satisfactory level for agricultural production. Soil test data will be submitted to the Department for soil tests before and six months after yard waste application.

4. Laboratory services will be obtained from University of Minnesota Soil Testing Laboratory.

5. I will use storage, composting, and/or application areas as identified on the attached exhibit(s). These properties are owned by me. I will use a field application site which is suitable for the production of food, fiber, or fuel. The application site will be placed in such production and will not be irrigated at a rate which exceeds one inch every five days. This shall not preclude allowing the application site to lay fallow if it is provided with a suitable protective vegetative cover.

6. I will debag yard wastes before use (field application, bedding, composting).

7. I will separate from the yard wastes before field application any wastes other than yard wastes which may be mixed with the yard waste received and it will, together with the yard waste bags, be stored and disposed of in a nuisance free manner in compliance with the County's Solid Waste Ordinance.

8. I will provide and maintain easy access to designated hauler unloading sites.

9. I will comply with the following application site conditions: a) no storage within 300 feet or spreading within 50 feet of an occupied dwelling (other than that of the applicant's) unless specifically approved by the Department; b) no storage within 100 feet or spreading within 25 feet of a ditch, stream, or lake; c) surface drainage will be diverted around any storage area and runoff to the ditch, stream, or lake will be prevented; d) spreading will not be done at times that runoff is likely to occur before incorporation.

10. I will comply with the following schedule for yard waste management:

a. Yard waste for direct field spreading will be spread within 30, and incorporated within 45, days of receipt. Yard waste received between June 1 and October 1 may be stored for use in the fall and will be spread by October 31 and incorporated by November 15.

Yard waste received between November 15 and April 1 may be stored for use in the spring and will be spread by May 15 and incorporated by June 1.

b. Yard waste for ensiling will be placed in the silo within one week of yard waste receipt. Ensiled yard waste will be field spread in the spring by May 15 and incorporated by June 1 or field spread in the fall by November 1 and incorporated by November 15. All ensiled yard waste will be field spread and incorporated within 12 months of waste delivery.

c. Yard waste for bed and spread management will be applied at a rate sufficient to guarantee its use within six months of waste delivery. Winter and spring used bed and spread yard waste will be spread by May 15 and incorporated by June 1. Summer and fall used bed and spread yard waste will be spread be November 1 and incorporated by November 15.

d. I will allow no field applied yard waste to remain unincorporated over the summer or winter.

11. I will incorporate the yard waste by plowing or discing to a depth sufficient to prevent blowing of the yard wastes.

12. I will confine the yard waste storage area in such a manner as to retain the integrity of the yard waste storage pile and control wind blown loss.

13. I will accomplish field application by use of my manure loading and spreading equipment or other equipment acceptable to the Department.

14. I will keep records sufficient to prepare the project evaluation report set forth in item 15.

15. I will submit an annual report to the Department by January 31, for the preceding year, which addresses at least the following: quantity of waste received; quantity of waste directly field applied, composted, and/or bed and spread; application rate; decomposition rate; soils analysis (before, during and after); management evaluation; problems encountered, sources of yard wastes, and such other information the County may need to monitor and evaluate this waste management practice.

16. I will not spread yard waste, regardless of type, condition, or mixture with other materials on any area with 10% or greater slopes or seasonal water table within three feet of ground surface.

17. I will use good cropping practices with the 1989 crop.

18. I will maintain the facility free of litter, vermin, or other nuisances.

19. All applicable provisions of the County's Solid Waste Ordinance (Ordinance Nos. 73-1, 82-1, 83-2, 84-2, 85-5, 86-1, 88-1, 88-4, 88-5, and as may be amended hereafter) will apply to this project, which I will comply with, except as may be waived by the County.

20. I will submit to the Department for approval before implementation any aspect of the operation not set forth in this memorandum. No changes in the project will occur until submitted to the Department and approved.

21. I agree that failure to comply with any condition of licensure will constitute grounds for summary suspension and/or revocation of the license.

22. I will hold the County harmless for any claims, losses, or damages resulting from this operation.

23. I will terminate all yard waste facility operations and will apply and incorporate all yard waste received within 14 calendar days of cessation of licensure. The final condition will be subject to the approval by the Department.

24. The County may amend, modify, suspend, revoke, or not renew this license for non-compliance with County Ordinances or conditions of licensure, or if there is, or threat of, any adverse environmental impacts from this type of management practice.

III. Waivers

Upon execution of this agreement I request the following waivers be granted:

1. It is requested that the plan review/application fee and license fee be waived.

2. It is requested that the County waive those ordinance requirements not essential for this project.

DRAFT

AGREEMENT

THIS AGREEMENT is entered into this ___ day of _____, by and between OLEO, Inc. and _____ (hereinafter referred to as "party of the second part").

WHEREAS, the State of Minnesota has forbidden the disposal of yard waste in landfills; and

WHEREAS, the State of Minnesota has adopted a policy of encouraging land spreading yard waste; and

WHEREAS, various cities in the state have assumed the obligation of collection and disposal of yard waste; and

WHEREAS, certain cities in carrying out their responsibility for yard waste disposal have contracted with OLEO, Inc. to accomplish the orderly and environmentally sound disposal of yard waste; and

WHEREAS, the parties hereto wish to enter into this agreement to assure the orderly and environmentally sound disposal of yard waste.

NOW, THEREFORE, the parties hereto agree as follows:

1. OLEO, Inc. shall provide the party of the second part with sites for disposal of their yard waste.

2. OLEO, Inc. agrees, when the party of the second part has caused the yard waste to be deposited at a place designated by OLEO, Inc., to assume the full possession and obligation for disposal of the yard waste that has been deposited and OLEO, Inc. assured the party of the second part that said yard waste would be spread and incorporated into the soil in an orderly and environmentally sound manner.

3. The party of the second part shall pay OLEO, Inc. $__ per ton for every ton deposited as hereinabove described, said payment to be due and payable to OLEO, Inc. within ____ days after said deposit has been accomplished.

4. It is presumed by the parties that said price is predicated upon the yard waste being free of non biodegradable material. If non biodegradable material is present, then the party of the second part agrees to reimburse OLEO, Inc. for all costs incurred in removing said non biodegradable material at the rate of $18.00 per hour. Said payment is due and payable to OLEO, Inc. ____days after said work is accomplished and the party of the second part notified of the cost incurred in removing biodegradable material consistent with the hereinabove described conditions.

5. The parties hereto agree to submit any disputes arising from this agreement to arbitration conducted by and in accordance with the rules of the American Arbitration Association.

IN WITNESS WHEREOF, the parties hereto have executed this contract this _____ day of _____, 1989.

OLEO, Inc.

By _____

PARTY OF THE SECOND PART:

By _____

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