AN INDUSTRIAL ECOLOGY APPROACH TO ON-SITE WASTE MANAGEMENT PLANNING AT THE FORKS MARKET

By

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A Practicum
Submitted to the Faculty of Graduate Studies
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ABSTRACT

What can be done with 500 tonnes of organic waste generated annually at The Forks Market? Waste management is an integral part of any development. Organic waste is a product at The Forks that is currently discarded. This material can and should be reused on-site. New technologies and methods must be incorporated into future planning and development at The Forks and the principles of industrial ecology fully incorporated.

This study has two objectives. The first is to identify alternative composting technologies that could be used for organic waste management at The Forks as an integral part of a Market garden project, as put forward in The Forks North Portage Partnership's *Business Plan* (October 1996). The second is to present an organic waste management plan and implementation strategy suitable for incorporation into current waste management systems at The Forks.

Results of this study identify that seventy percent of the waste stream is compostable. In 1995/96, disposal of this materials in city owned land fill sites cost the Partnership in excess of $50,000 in collection and disposal fees. Study results also indicate that an in-vessel composting system best fit needs at The Forks. Finally, the results suggest that comprehensive source separation programs are key to the success of on-site composting.

It is recommended that the Partnership take the following actions:

- i. adopt a source separation program and appoint a coordinator to monitor and maintain it;
- ii introduce an in-vessel composting system and purchase the fully enclosed flow-through equipment required;
- iii incorporate the concepts of industrial ecology and ecological design into the *Planning and Development Guidelines*;
- iv set aside sufficient funds for capital costs and further research to build upon the available base of knowledge and track operational costs;
- v capitalize on current economic, environmental and educational incentives.

ACKNOWLEDGMENTS

I would like to thank the Committee: Dr. Mary-Ellen Tyler. Elizabeth Sweatman and David Stones. for the guidance they have provided throughout this practicum. I also extend thanks to all those individuals and groups who shared their knowledge and expertise with me. It would not have been possible to complete this practicum without access to that body of information.

I must acknowledge the staff of The Forks North Portage Partnership. I am indebted to them for their patience and understanding as I journeyed through this learning experience. I especially thank Marilyn Williams for her support. patience . breakfasts and editing skills: and Dorothy Ridd for her unflagging encouragement and medical advice: and my parents and extended family for a lifetime of guidance and support.

To everyone. I apologize for taking so long.

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INTRODUCTION

1.0 Background and Context

The Forks is a 56 acre site in the heart of downtown Winnipeg, located at the junction of the Red and Assiniboine Rivers. The site is bounded by the Assiniboine River and Red Rivers on the south, the Red River on the east, and the CN High Line (main line) and some City owned properties on the west and north.

The Forks Renewal Corporation was established in 1987 by the Municipal, Provincial and Federal governments to own and redevelop the land at the junction of the Red and Assiniboine Rivers and the adjacent East Yards on their behalf. Through public consultation the Board of The Forks Renewal Corporation concluded that the site should be redeveloped as a special and distinct public gathering place that adds to the quality of life in the region. The terms of this renewal and the unique tripartite agreement were put forward in the *Phase I Concept and Financial Plan,* The current waste management system at The Forks resembles what Hardin Tibbs refers to as the "industrial system", which he states is

> "...less a system than a collection of linear flows - drawing materials and fossil energy from nature, processing them for economic value, and dumping the residue back into nature."

Material, such as fresh produce, brought to The Forks is processed and sold. Anything left over is discarded as waste and sent to landfill. Tibbs points out that in the natural environment there is no such thing as waste. Rather, it is a cyclic system "endlessly circulating and transforming materials, and managing to run almost entirely on ambient solar energy."[1]

1.1 Purpose and Objectives

According to a waste audit conducted in Fall 1995, approximately 800 tonnes of waste material is generated at The Forks each year, most by the shops and services located within The Forks Market. Current waste management practices include modest efforts to recycle cardboard, aluminum and glass. These comprise 30% to 45% of the total waste stream.

The majority of discarded material is sent to municipal landfills at a cost of $50,000. However, approximately 60% of this waste, or 500 tonnes, is organic in composition and therefore, appropriate for composting.

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1 Tibbs, H., "Industrial Ecology: An Environmental Agenda For Industry", in Whole Earth Review, Winter 1992.

Chapter 2 discusses in greater detail the character of the waste stream of The Forks Market.

The purpose of this practicum is twofold:

- identify appropriate environmental technologies for composting the 500 tonnes of organic material currently being sent to landfill: and
- develop implementation strategies for composting alternatives to divert organic material generated at The Forks from going to landfill and instead. reusing it on site.

The end result of the purpose of this practicum will result in the following products:

- identified alternative composting technologies that can be used for organic waste management at The Forks. tying in with the Market Garden concept. identified in the *Business Plan* as one of the projects to lead to self sufficiency: and
- a plan and implementation strategy to introduced one or a combination of organic waste disposal alternatives into the current waste management system at The Forks.

Further. it will demonstrate that alternative composting technologies and implementation strategies will create a more closed system of consumption and waste generation, reusing the organic component of the waste stream on site. This should achieve the following four key results at The Forks:

- assist in the reclamation of highly disturbed and unproductive soil into land suitable for use as Market Garden;
- reuse the organic portion of the waste stream, thereby reducing the amount of nutrients artificially introduced thus creating a valuable asset out of this material rather than an expense;
- create the vestiges of a cyclical ecological system that can be used as a redevelopment model; and
- reduce costs currently associated with waste disposal.

1.2 Rationale and Project Scope

What can be done with the 500 tonnes of organic waste generated The Forks Market each year? A waste audit of The Forks, conducted by the author and four graduate students of the department of City Planning at the University of Manitoba between October 1995 and March 1996, concluded that the waste stream of The Forks Market was composed of approximately 60% organic material, 30% cardboard, 5% aluminum and glass, and 5% other materials.

It was also determined that focusing on the organic component of the solid waste stream offered an opportunity to reduce waste management costs. Through identification of alternatives and implementation of strategies to demonstrate urban organic waste management that better utilizes this organic resource, a more self-sufficient organic waste management system can be implemented, turning organic refuse from an expense into a cost neutral resource and possibly a revenue generator.

As outlined in the *Business Plan* "The Forks North Portage Partnership is committed to strengthening private and public alliances in the implementation of innovative programs and projects that will benefit the entire downtown." The vision of the Partnership is to establish both The Forks and The North Portage Neighbourhood as unique and financially sustainable meeting places through pursuing the following key themes for development:

- maintaining a balance and blending of mixed uses
- continuing a commitment to design excellence in renewal efforts
- preserving the historical significance of site resources
- preserving and promoting an awareness of the natural environment, and
- making connections within the downtown, both physically and through partnerships.

The Forks offers an opportunity to publicly demonstrate ways in which sustainable principles can be economically incorporated into the planning and design of the built environment. One of the Partnership's areas of interest and activity proposed for future development is to undertake a demonstration environmental project with a proponent to develop/manage a Market Garden using the site's natural resources and organic products to grow vegetables for sale at The Forks Market.[2] The Market Garden concept is based on the idea of using sustainable design principles and eco-technologies for composting and reusing organic waste produced on site to recondition the soil for production of commercial produce.

The goal of this practicum is to design a program to compost organics generated at The Forks. diverting this valuable organic material from landfill and reusing it on site a Market Garden. This should reduce the cost of handling this organic material. saving the Partnership money now spent on solid waste disposal. and firmly establish the Partnership's commitment to an environmental project.

1.3 Methodology

The research methods used during this study included a literature review. structured interviews and personal communications. and an assessment of options.

1.3.1 Literature Review

A literature review is necessary to provide background information on:

- alternative urban waste management strategies currently being used in North America;

2 The Forks North Portage Partnership. 1996. *Business Plan.*

- the nature of compost demonstration projects across the country:
- composting gardens: and
- the latest improvements being made in this field.

This study attempts to use Canadian based examples and sources of information to reflect the Canadian climate and industry features.

1.3.2 Personal Interviews

Discussion with people across the country who work within the field provide excellent sources of information regarding composting in our climate. Equally important are interviews with the Partnership's employee's and tenants who will be most affected by the implementation of a composting program. Their comments and concerns regarding such an initiative should be considered prior to implementation.

The Forks Market has thirteen fast food kiosks and 3 full service restaurants. Review of information related to establishing composting projects with restaurants is essential for developing on site composting at The Forks. The Canadian Restaurant and Food Services Association was contacted for this information.

In addition, these key informants were contacted for their expertise:

- Randy Grooms, Operations Manager and Larry Werner, Composting Technician, both with Corcan Agribusiness, were contacted for their experience in operating composting facilities in Alberta and Ontario.

- Lydia Giles of Vermicomposting Products & Etc. was contacted for her experience with worms and the composting process.
- Ram Kamath, Operations Manager with the Brock Psychiatric Hospital, was contacted because the hospital uses the vermicomposting process to manage their waste.
- Edward Boyd of Wright Environmental was contacted for his knowledge of in-vessel composting systems, as well as his experience in implementing an in-vessel system at the Ontario Science Centre.

1.3.3 Assessment of Composting Options

The information and expertise obtained from the above has ensured a better understanding of urban organic waste management strategies. This also revealed composting alternatives available to The Forks North Portage Partnership and highlighted problems frequently experienced by demonstration projects. This allowed for the proper identification of technical, economic, environmental, educational, regulatory and administrative criteria to be used in the assessment of program options.

Assessment of options is based on four criteria adapted from Tchobanoglous et al[3]: technical, economic, environmental and educational.

- Technical criteria examines if the system can be used year round, how odours and pests are managed, the assurance of pathogen kill, the

3 Tchobanoglous, G., Thiesen, H., and Vigil, S., 1993. *Integrated Solid Waste Management*. McGraw-Hill Inc.

requirement for leachate management, effects of dust, noise and litter, and the range of materials a system can handle.

- Economic criteria scrutinizes capital and operating costs, and the processing time associated with each composting method.
- Environmental criteria probes end product quality, energy and resources required for manufacturing, and the energy and resources required for the continual operation of the system.
- Educational criteria explores the quality of the learning experience and the accessibility of the composting option in relation to areas of settlement.

Assessment of the composting options available to The Forks is discussed in chapter three.

1.4 The Study Subject - The Forks

The current built form of The Forks results from the *Phase I Concept and Financial Plan* set forth by The Forks Renewal Corporation in 1987. Today, plans for Phase II development are underway, guided by The Forks North Portage Partnership. This continuing renewal will move the site forward into the next century.

In 1987 The Forks Renewal Corporation was established by an unique agreement among the three levels of government representing Canada, Manitoba and Winnipeg. The Corporation's mandate, set out in the *Phase I Concept and Financial Plan*, was to own and redevelop The Forks as a "meeting place": a special and distinct, all-season gathering and recreation place, and a special addition to the quality of life in the region."[4]

Between 1987 and 1994, renewal supported through public and private partnerships transformed a significant portion of the former rail yard into a popular, public mixed use development (Figure 1). These renewal efforts encouraged broad public discovery of this historic location in Winnipeg's downtown and provided new public attractions and amenities:

- The Forks Market, two former stable buildings, now with more than 60 retail, fresh and specialty food shops, restaurants and businesses;
- The Market Plaza, a paved, open gathering place adjacent to the river, popular for casual performance and public use as well as special events. The Plaza features several restaurant patios, a canopy and fountains in the summer and an (outdoor) artificial ice, skating rink in the winter and shoulder seasons;
- The Forks Historic Port, a grass terraced amphitheatre on the river with free docking;
- The Assiniboine Riverwalk, a riverside pathway available in all seasons but during spring flooding. In winter this is augmented by

4 The Forks Renewal Corporation. 1993. *The Forks Heritage Interpretive Plan* FRC. p. 1.

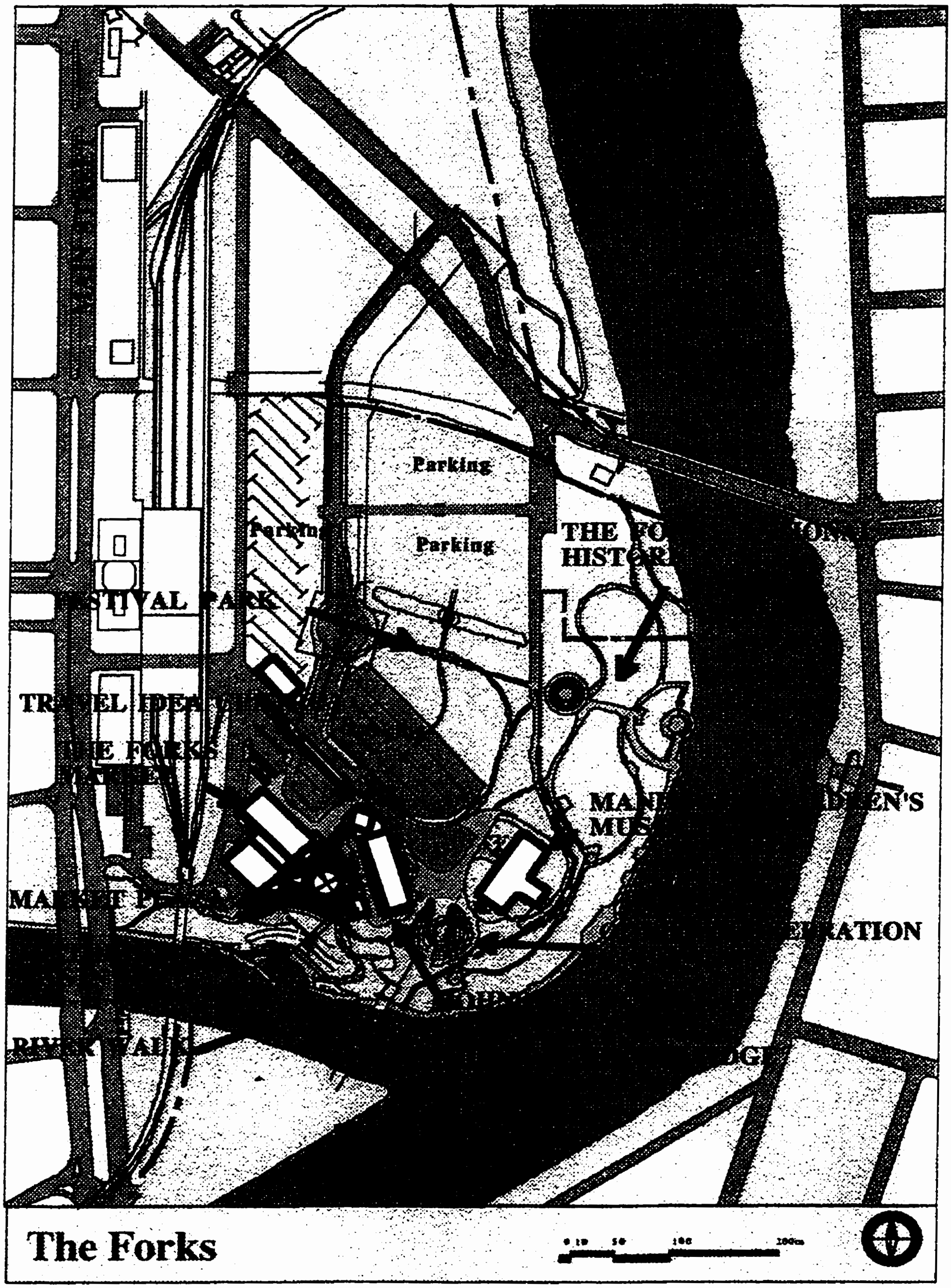

FIGURE 1. Present Development at The Forks

the RiverTrail, skating and walking trails on the river surface. The Riverwalk is part of a system maintained by the City of Winnipeg, Parks Canada and the Partnership;

- Johnston Terminal, a reclaimed four storey warehouse now housing retail shops, cafes and offices;
- The Pavilion on The Market Plaza, the first new structure on the site, with public washrooms and skate changing amenities;
- Manitoba Children's Museum, one of only a handful of experiential learning institutions in North America, housed in a refurbished rail repair facility now designated as a heritage structure;
- The Forks National Historic Site, ten acres along the Red River operated by Parks Canada as a nationally designated historic site;
- Manitoba Travel Idea Centre, a visitor information centre showcasing attractions throughout the province;
- Festival Park, a large, grassed, open area suitable for large scale events and festivals.

In 1994 The Forks Renewal Corporation was merged with its sister organization, North Portage Development Corporation. The newly formed company, The Forks North Portage Partnership, continued the ownership and management responsibilities for both The Forks and the North Portage Neighbourhood (Figure 2) on behalf of its shareholders:

Figure 2. Mandate Areas

Canada, Manitoba and Winnipeg. The Partnership continues to be governed by a ten member Board of Directors with three members are appointed by each level of government and a unanimously selected Chair.

The mission of The Forks North Portage Partnership is to encourage activities for people in the downtown through public/private partnerships and revitalization strategies; and to work to ensure financial self-sufficiency. Under that mandate, renewal at The Forks has continued through the addition of the following amenities:

- The Historic Rail Bridge, a railway lift bridge joining the South Point to the 'mainland', now refurbished for pedestrian traffic;
- Oodena - Celebration Circle, a grass lined bowl for smaller performances and gatherings with astronomical interpretation and architectural sighting devices for naked eye astronomy;

In addition, work has begun on the renovation of the former steam plant building. This will provide a new home for Manitoba Television Network (MTN) Winnipeg studios and offices, anticipated to open in fall, 1998. A capital fund raising campaign has been launched by the Manitoba Theatre for Young People (MTYP) for the construction of new live theatre performance studios. Construction is scheduled to begin in the summer of 1998.

Today, The Forks is a "meeting place" once more. A place where the heritage of the ancient and recent past is combined with the cultural diversity of the present., A place for celebration, for commerce, for visiting, for lingering just as it has been for so many centuries.

The business of the Partnership is to provide as many reasons as possible for visitors to live, work and play in the downtown. The Forks North Portage Partnership is committed to strengthening private and public alliances in the implementation of programs and projects that will benefit the entire downtown.

At The Forks, new development is critical to achieving self-sufficiency. The Partnership has established the following general planning principles to guide future development:

- highlight heritage,
- promote innovation and excellence,
- assure ease of access,
- create a rich pedestrian environment, and
- ensure diversity of uses.

Proposals have been received by The Forks North Portage Partnership to build a Marina Complex and housing units at the north end of the site, near the Provencher Bridge. The marina complex will be complete with docks, gas, sewage pump out, and other amenities.

Two housing proposals have also been received: one, as noted above, to build housing units in conjunction with the Marina/Brew Pub complex; another for an Eco

Village Complex on the strip of land north of the Provencher Bridge. Discussions are also underway to develop a "Butterfly House" on a parcel of land adjacent to the Manitoba Children's Museum.

Over 120 festivals and special events are held at The Forks each year. Activities range from small community fundraising efforts to major festivals such as the Winnipeg International Children's Festival and the Dragon Boat Races. Weekend events regularly draw 10,000 to 30,000 participants while major events such as Winnipeg's Canada Day celebrations, can attract 150,000 to 200,000 people to The Forks.

The popularity of the site as the location for seminal events in the community has prompted its choice for nightly celebrations throughout the Pan American Games, July 24 to August 8, 1999.

A $1.5 million upgrade is planned for Festival Park to prepare the site for these nightly celebrations. The upgraded site will be designed to accommodate the 50,000 people anticipated to attend each night and will have a permanent performance stage at the north end of the site.

The Forks, in its redevelopment process, has become a very dependant entity, much as the larger urban form. David Morris, in *Green Cities*, notes that "...a city of a hundred thousand people imports two hundred tons of food a day, a thousand tons of fuel a day, and sixty-two thousand tons of water a day." Morris states that the same city "dumps a hundred thousand tons of garbage a year and forty thousand tons of human waste a year."[5] The Forks also imports tons of food, fuel and water each day in order to function, and conversely creates approximately 800 tonnes of garbage each year.

The development of The Forks parallels the design of cities. Morris asserts that we have built our cities and systems on the underlying principle of cheap energy and the assumption of cheap disposal costs. With cheap energy and cheap disposal costs "...the designers of cities could ignore the efficiencies of those systems and their waste products."[6]

Morris argues that we have created systems that are fragmented, we have created an economy in which production, use and disposal are separated. He notes that the average food molecule travels a thousand miles to do its piece of work, and we leave about 50 percent of the plant matter that we grow on the fields. Long distance specialization and distribution of food is done in the name of economic efficiency. However, the farther food is transported the more waste is generated in terms of fuel, packaging, transportation, and spoilage.

Urbanization, usually thought of as a demographic or economic phenomenon, also has ecological consequences. William Rees notes that "...cities significantly alter natural biogeochemical cycles of vital nutrients and other chemical resources."[7] He goes on to

5 Morris, David. "The Ecological City as a Self-Reliant City", in *Green Cities: Ecologically Sound Approaches to Urban Space*. Gordon, D., ed., 1990. Montreal: Black Rose Books Ltd. p. 22.

6 Ibid. p. 21

7 Rees, William. 1997. Why Urban Agriculture? Notes from the IDRC Development forum on Cities Feeding People. Http://www.cityfarmer.org/rees.html#rees.

say that "...removing people and livestock far from the land that supports them prevents the economic recycling of phosphorous, nitrogen, other nutrients and organic matter back onto farm and forest lands."[8]

How does this relate to The Forks? First, the produce sold in The Market probably travels thousands of miles to get here. As noted the transportation and packaging creates waste in and of itself. Second, produce that is not sold gets discarded into the landfill. This act does not allow for the economic recycling of the phosphorous, nitrogen and other nutrients found in the produce into the soil at The Forks. In the market, produce is sold to the consumer at competitive prices. As consumers and society in general, we concern ourselves with the price of a product. David Morris claims we need to examine cost rather than price.

The Forks Market is profligate in its energy use, divorced from the natural cycle of an ecosystem. The local economy has embraced separation and long distribution systems as a means of production. The import/export paradigm permeates thinking and planning. Not included in the price of selling produce in The Forks Market is the cost associated with discarding off site unsold produce. The energy used to produce and import produce (i.e nutrients) is lost when it is discarded into landfill.

Development at The Forks parallels development of the greater urban form. As with the greater urban form, The Forks requires inputs of both renewable and non

8 Ibid.

renewable energy and resources to function while concurrently generating waste. Redevelopment has been along the traditional lines which sees a corporate technological approach to transform the desolated landscape into its present form. rather than an ecological approach. The corporate technological approach is based on the consumption of energy to function while generating waste that is not reused. The ecosystem approach would be capable of regenerating itself and becoming ecologically self-sufficient.

Human habitat is composed of the natural environment as well as cultural. social and political systems that function hand in hand within the naturally occurring environment. The planning and development of The Forks is aimed at restoring a "human habitat" that combines daily functions of the human experience: commercial. recreational. and social functions. within a naturally occurring system however disturbed it maybe by human industrial intervention. Redevelopment to date has focused on creating environmental qualities that are desired by people and the emotional and mental health derived from the recreational and aesthetic values of their environment: but has not focused on creating a healthy overall ecosystem.

Besides the small portion of Tall Grass Prairie that has been re-introduced. the daily function of the site is highly dependant on the import of energy and raw materials and the export of waste off site to the city landfill. The turfed portion of The Forks is a good example of the ecological deficiencies of the present development pattern.

The landscape design of Festival Park emphasizes leisure and aesthetic values, highly desirable qualities in the human habitat, but the design has ignored ecological functions such as nutrient recycling. While the grassed areas create a pleasant park like atmosphere, they require intensive maintenance: regular mowing, aerating, fertilizing and watering.

1.5 The Proposed Market Garden Project

In the *Phase II Development Plan*, the Partnership identifies a Market Garden project as one recommended development to help achieve financial self-sufficiency. The project is intended to embrace the ecological aspects of development. By growing products to be sold on site and reusing wastes generated as soil conditioners a loop of production, use and disposal is created.

The solid waste audit conducted in the fall of 1995 established that 800 tonnes of material is sent to the landfill each year from The Forks Market. Of this, it was determined that between 60% to 70% of the material (between 480 and 560 tonnes) was organic, generated mainly from the three restaurants, fast food kiosks and fresh food vendors located in The Market. This is roughly 3800 cubic metres of reusable material that is being discarded at a cost of approximately $50,000 each year[9]. Sixty per cent of the

9 The 1995/96 Financial Statements show expenditures of $19,000 for pick-up and hauling fees and $30,000 for tipping fees.

total cost associated with the removal of this material represents fees charged by the City for disposal in the City landfill.

The Market Garden concept emerged from discussions between the Partnership, the University of Manitoba Faculty of Architecture and environmental education representatives of Winnipeg School Division Number One. The concept is based on sustainable design principles and environmental technologies for composting to reuse the 500 tonnes of organic waste being generated yearly at The Forks. This material could be used to recondition the soil in the area identified for the location of the Market Garden (Figure 3), one of several projects recommended as a means of achieving financial self-sufficiency.

This practicum does not view waste management at The Forks as a problem: rather, this practicum is based on opportunity. Aside from the economics, there is no real problem with putting waste into the compactor and hauling it away to the landfill. The waste audit and the ensuing discussions about a Market Garden identified an opportunity for The Forks North Portage Partnership to develop a waste management strategy that will utilize the organic component of the waste stream on site rather than discard this material, at a significant cost, in the City owned landfill. Organic waste is a product - it could be considered a commodity - of The Forks that is currently thrown away. Proper management of organic matter must play an important role if significant gains are to be

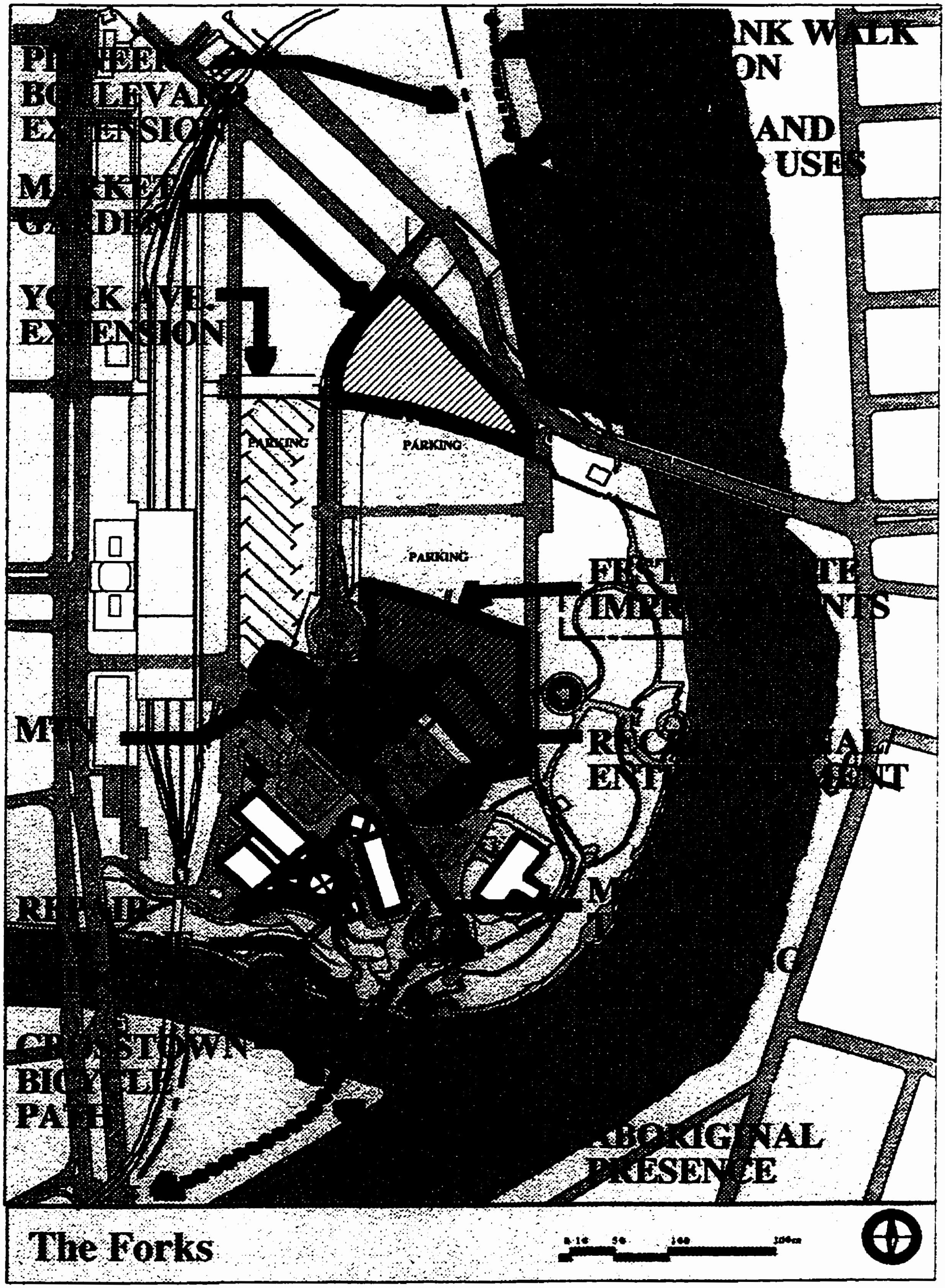

FIGURE 3. Recommended Development at The Forks.

made in dealing with waste, "Composting is seen to be one of the keys in making beneficial use of this valuable organic fraction."[10] Composting of this material will allow for nutrient recycling to occur on site.

Locating food production at The Forks could make it possible to close the nutrient cycles associated with human food production and consumption. The organic waste can be composted into soil conditioner and fertilizer and returned to the land where it is grown. This could result in ecological and economic savings. It would reduce the amount of organic matter that is currently being wasted in the city owned landfill. Using this material as organic fertilizer would also reduce the amount of artificial fertilizer currently introduced on-site each year. Further, organic fertilizer could reduce the potential for land and water contamination and help maintain and stabilize the soil at The Forks. Finally, nutrient recycling through composting and creating a Market Garden may lower food prices for the consumer.

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10 Canadian Council of Ministers of the Environment. 1995. *Guidelines For Compost Quality - Final Draft*. Canadian Cataloguing Publication Data.

Chapter Two

INDUSTRIAL ECOLOGY

Composting and Waste Management Planning at The Forks

2.0 Introduction

This chapter highlights the concept of industrial ecology: how it can be used as a model for development at The Forks and how it can be applied to the solid waste stream of The Forks Market. Important benefits The Forks could gain by composting the food waste generated on site are discussed.

The chapter begins with an outline of the model of industrial ecology and how it can be applied to The Forks. Next, a description of the solid waste management strategies in place at The Forks is given. Consideration is given to the need for coordinated leadership from The Forks North Portage Partnership to ensure successful implementation of composting the organic waste. The importance of a source separation program is stressed for the successful implementation of any composting initiative. On-site mid scale composting operations are discussed with attention given to economic and environmental concerns. The chapter concludes with a summary of findings.

2.1 Habitat Restoration - Learning From Nature

As noted, The Forks requires inputs of both renewable and non renewable energy and resources to function while concurrently generating waste. Redevelopment, to date, has been along the traditional lines which sees a corporate technological approach to transform the desolated landscape into its present form, rather than an ecological approach. The corporate technological approach is based on the consumption of energy to function while generating waste that is not reused. The ecosystem approach would be capable of regenerating itself and becoming ecologically self-sufficient.

Dr. Mary-Ellen Tyler states that the present "...urban form of modern North American cities is a structural response to the engineered infrastructure of roads, bridges, water and sewer lines, energy pipelines and transmission corridors." Further, Tyler states that "...future urban form must begin to incorporate an ecological infrastructure that provides a biological life support foundation."[11] The challenge for planners and developers of the built urban form is how to incorporate this ecological infrastructure into the existing built form.

The built human environment is an artificial system that is constructed within a pre-existing natural ecosystem. It is a system that is interrelated and must function within the larger "natural system". An ecological system is based on relationships among living things and between them and the physical and chemical elements with which they

11 Tyler, Mary-Ellen. 1994. "Ecological Plumbing in the Twenty-First Century" in Plan Canada, July 1994.

interact. In her book *Biomimicry*, Janine Benyus notes that nature is to be used as a measure, because "after 3.8 billion years of evolution, nature has learned: What works. What is appropriate. What lasts."[12] John Todd reiterates this point that nature has proven to be adaptive and successful in the long run. He asks, "would it not be prudent to design human enterprises on blueprints from nature."[13]

Development at The Forks is challenged to reconcile the pressures for self-sufficiency with the maintenance of widespread public appeal. As noted in chapter one, the Partnership is committed to achieving financial self-sufficiency by embracing ecological aspects of development. The corporation was established to be the catalyst to restore this site from an abandoned rail yard to a public meeting place once again. The Corporation is charged with restoring a "human habitat" at the site.

Habitat restoration not only involves the natural environment "but cultural, social and political systems" as well.[14] Redevelopment to date has not focused on developing a sustainable ecological system. Rather, focus has been on treating the built environment as a machine placed in a natural ecosystem. The position put forward in this practicum is that if there is commitment to becoming self-sufficient, future planning and development

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12 Benyus, Janine. 1997. Biomimicry: Innovation Inspired by Nature. New York: William Morrow and Company, Inc.

13 Todd, John. Architecture and Biology: A Necessary Synthesis.

14 Tyler, Mary-Ellen. 1994. "Ecological Plumbing in The Twenty-First Century". in Plan Canada. July 1994.

must embrace the concept of introducing an ecological system that provides a biological life support foundation for future development. The question remains: How?

2.1.1 A Model for Planning and Development at The Forks

A new environmental agenda is emerging in industry that seeks to close loops of production and create an industrial "ecosystem" by making maximum use of recycled materials in new production, optimizing use of materials and embedded energy, minimizing waste generation and reevaluating wastes as raw material for other processes. This industrial ecology, according to Hardin Tibbs, "...involves designing industrial infrastructure as if they were a series of interlocking manmade ecosystems interfacing with the natural global ecosystem".[15]

Tibbs lists six characteristics of the natural global ecosystem that could easily be emulated by industry. In summary, they are:

- in the natural system there is no waste, in the sense of something that cannot be absorbed constructively within the system;
- life giving nutrients for one species are derived from the death and decay of another;
- materials and energy are continually circulated and transformed, running almost entirely on ambient solar energy;
- natural system is dynamic and information driven;

15 Tibbs, Hardin. "Industrial Ecology: An Environmental Agenda for Industry", in Whole Earth Review, Winter, 1992.

- cooperation and competition of species are interlinked: and
- concentrated toxins are synthesized and used as needed only by the individuals of a species. they are not stored or transported in bulk at the system level.

Industrial ecology is an integrated management and technical concept with the aim of applying the understanding of the natural system to the design of manmade systems. Tibbs states that over time tools and techniques will be developed to lead to conceptual and practical advances in the following six areas:

- the creation of industrial ecosystems. This involves closing the loop on waste generation and reconceptualizing wastes as products:
- balancing industrial input and output to natural ecosystem capacity. to avoid industrial stress on the environment;
- dematerialization of industrial output. This is simply working towards a decline in materials and energy intensity in industrial production:
- improving the metabolic pathways of industrial processes and materials use;
- systematic patterns of energy use which promotes the development of an energy supply system that functions as part of the industrial ecosystem and is free of the negative impacts associated with current patterns of uses;

- policy alignment with long-term perspective of industrial system evolution. Simply this is coming to terms with reflecting the true costs of environmental degradation in market value of products.

Tibbs states that "...an analysis based on industrial ecology will prove to be the most effective way both of discriminating between policy options and of achieving an integrated policy platform for the environment."[16]

Future development will not see the introduction of one type of industrial ecosystem but rather a spectrum of ecosystems that range from single material recycling to advanced integrated natural ecosystems. Human modification of ecosystems is as old as the practice of agriculture. The challenge is to integrate urban development into the equation and consciously design a world that is aesthetically pleasing, biologically stable, and economically productive.

To profit from ecological management, Pratt and Shireman[17] suggest a business need only do three things over and over again:

- identify examples of materials use, energy use, pollution and waste (any form of throughput);
- brainstorm, test, and implement ways to reduce or eliminate it; and

16 Ibid. p.18

17 Pratt, Wendy & Shireman, William. *Industrial Ecology: The Only Three Things Business Needs to Do to Save Money*. Global Futures Network. http//www.globalff.org/Feature_Articles/

- count the money. Count how much was saved. then count how much is still being spent to create waste and pollution and start the cycle over.

Organic material is imported to The Forks. processed for economic value and the residue is disposed off-site. The Forks Market waste study (1995) identified that about 500 tonnes of organic material is sent to landfill each year from The Market. By applying the principles of industrial ecology. it is possible to reduce. re-use and close these waste flows on-site..

2.2 Current Solid Waste Management Strategies

Until five years ago. almost all of The Forks Market's collected solid waste was taken to landfill for final disposal. Most of the waste generated is still treated in this manner. To collect the waste material generated. The Forks Market employs four full time and three part time staff who concentrate the wastes at the building's compactor room in a forty cubic yard container for pick-up. After collection. the solid wastes are picked-up and transported by Laidlaw Wastes Systems Limited to the landfill site which is owned and operated by the City of Winnipeg. Laidlaw hauls the waste from the site seven days per week.

Currently. corrugated cardboard. glass and aluminum cans are separated from the rest of the waste stream for recycling. The cardboard is broken down and placed in a six cubic yard container which is picked-up by Laidlaw twice per week. Glass and aluminum is collected in the food court area and picked-up by a private recycler who transports it to a recycling facility. Both these methods are cost neutral in that profits from the sale of the material is equally shared by the contractors and the Partnership. The contractors deduct their hauling fees from the Partnership's portion of the sale.

As noted earlier, it costs $50,000 per year in hauling and tipping fees to dispose of the waste material generated. Waste reduction initiatives such as recycling and composting can reduce disposal costs by avoiding tipping fees. However, it must be noted that waste collection will still be required and the costs associated with this aspect may not be reduced.

According to the waste characterization study conducted in the fall of 1995 by the author with the aid of graduate students in the University of Manitoba's Faculty of Architecture, the amount of solid waste being sent to landfill from The Forks Market has steadily increased since 1989 (Appendix A provides results of the waste audit). The increase is most likely from the increased number of businesses in The Market as well as the continuing growth in popularity of The Forks. The study concluded that approximately 70% of the waste generated in The Market is compostable. To significantly reduce the amount of waste being sent to landfill, alternatives for the organic fraction must be identified.

2.3 Administering a Composting Project

The Forks has been a meeting place for thousands of years. Aboriginal peoples from across the plains came to this spot to hunt. to fish. to trade and to celebrate. As noted earlier. the area became the foundation for the City of Winnipeg and the settlement of the Canadian West. The area near the junction of the Red and Assiniboine Rivers became. at first. a steamboat then a major rail terminus.

Extensive archaeological investigation of the site has revealed that The Forks is rich in archaeological and historical resources. However. the rail activity at the site prior to current renewal left it highly disturbed with little usable wildlife habitat and virtually no native vegetation.

The Forks North Portage Partnership has a strong commitment to the preservation and promotion of the natural environment. Preserving the historical significance of site resources as well as preserving and promoting awareness of the natural environment have been identified by the Partnership as key elements in the future development of the site. The Partnership is faced with achieving and maintaining self-sufficiency. It is believed that environmental initiatives will yield economic benefits for the Partnership. The *Business Plan* establishes protecting the environment as a priority for the Partnership.

The importance of administrative leadership in the implementation of environmental measures has been highlighted by a number of organizations. The Canadian Standards Association suggests that as environmental concern grows.

> "...organizations need to determine how they can a) provide economic benefit to the organization and society while minimizing the adverse environmental impact of their activities; b) take into account stakeholders' expectations regarding the environment; c) anticipate and comply with applicable laws and regulations regarding the environment; and d) Continually improve their techniques to minimize the adverse impact of their activities on the environment".[18]

According to Anne Kothawala of the Canadian Restaurant and Food Services Association, it is important to have administrative leadership to establish responsibilities, practices, procedures, processes and resources for implementing environmental initiatives. Also she states that it is crucial to involve interested staff and generate enthusiasm for the project.[19]

2.4 Source Separation Program

"At source" separation refers to the sorting of a facilities waste stream by identified categories (i.e glass, plastics, aluminum, organics et cetera) at the place of origin. For example, a restaurant participating in a composting project could collect organic wastes in separate containers from the rest of the waste in the kitchen, or at the source of the restaurants' pre-consumer waste.

The Quick Service Restaurant Council (QSRC) in partnership with Correctional Services of Canada (Corcan) designed a program to compost organics from over thirty

18 Canadian Standards Association. 1994. *Environmental Management Systems*. CSA. Toronto. Canada. p. xi.

19 Personal communication February, 1997.

restaurants in the Kingston, Ontario area. QSRC identified that organic waste represents over 70% of the restaurant waste stream. In order to meet their goal of 50% waste reduction, QSRC needed to target the organic component of the waste stream.[20]

According to Randy Grooms, Operations Manager of the Corcan Compost Centre in Kingston Ontario, the quality of finished compost is dependant on the feedstock used to produce the finished product. Foreign matter in compost is material that is not biodegradable and as such detracts from good quality compost. Grooms states that "...most feedstocks and products contain foreign matter." However, this inert material can be kept to a minimum through "...a well administered and aggressive source separation program."[21]

The QSRC program targeted the collection of organics in two locations. First, in the kitchen, compostable material was separated from non-compostable material into brown bins that were placed as close to where the material was generated as possible. When the bins were full the material was transported to a centralized location for pick-up. The second area targeted was in restaurants with personnel to clear tables. Bins were placed in the tray cleaning area and staff were instructed to separate the organic fraction of the waste material.

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20 Personal communication, Anne Kothawala, Canadian Restaurant and Food services Association, February, 1997.

21 Personal communication, Randy Grooms, Operations Manager, Corcan Compost Centre. March, 1997.

When training people for this source separation program, a technique that Kothawala refers to as the three E's was followed: Educate, Encourage, Empower. Kothawala emphasized the importance of education. She noted that staff must be informed of all aspects of the program, what they are doing, what materials are to be separate, where material is going and the benefits of waste diversion.

The second E, encourage, comes from the regular monitoring and reminder to staff that they are or are not doing the right thing. Finally, by teaching staff the benefits of the program and the proper way to separate materials you are empowering them to operate the program themselves. Kothawala asserts that "...contamination is the single biggest issue when separating material for composting." A good rule of thumb, Kothawala states, is "when in doubt, throw it out."[22]

For good quality finished compost, a well administered source separation program is needed. Once this program is established, the next step is to identify the appropriate composting technology to use to process the separated material.

2.5 On Site - 'Mid-Scale' - Composting

On site composting, as the name implies, means composting the organic material generated at a particular facility at that facility's site, thus avoiding transportation costs. As defined by the CCC, mid-scale composting is generally composting less than 1 tonne

22 Personal communication, Anne Kothawala, Canadian Restaurant and Food services Association, February, 1997.

per day of organic materials. In Canada, there is no requirement for the commercial, industrial or institutional sector to source separate organics from their waste stream, therefore any mid-scale composting occurring in Canada is voluntary and based purely on interest in this technology. On site composting could potentially be applied to waste management strategies of schools, hospitals, restaurants, office buildings, apartment buildings, shopping malls, convention centres, et cetera.

In Manitoba, there is essentially no governing legislation pertaining to on-site composting operations; basically, the lead from Ontario is taken. In Ontario, on site composting is not considered to be a waste disposal site under the Environmental Protection Act, Part V. Therefore they do not require a provincial Certificate of Approval. However, it is advisable to contact the office of Manitoba Environment for environmental assessment and licensing processes under the Manitoba Environment Act before proceeding with an on-site facility.

Mid-scale on-site composting involves adapting one of the following composting techniques: windrows; a form of in-vessel composting; or large-scale vermicomposting. A detailed discussion of the different composting technologies will be discussed in the next chapter.

2.5.1 Economics

For implementation of any on-site composting initiative, viability will depend on its cost-benefit relationship as compared to other waste management strategies. The wide variety of composting techniques available makes economic comparisons quite difficult. Gupta and Shepherd state that benefits and costs of composting programs have not been examined well in comparison to other components of MSW management strategies.[23]

Anticipated costs associated with composting facilities may include all or a combination of the following elements: land acquisition, building and road construction, site preparation and the acquisition of processing equipment. The different elements are dependant on the composting technology chosen for the biological conversion strategy. There are further costs associated with implementing an on-site composting operation pertaining to the feedstock for the operation. Feedstock for the composting operation must, at some point, be separated from the rest of the waste stream. As noted above, separation can take place either 'at source' or from processing of commingled wastes. Greater costs are incurred when the desired material is commingled in the waste stream and must be separated out at some point after collection.

To offset associated costs of composting, money can be saved/made in a number of ways. Landfill tipping fees are avoided; the finished product can be sold; and the finished product can be used on site as a soil conditioner and fertilizer, reducing the need for petroleum based fertilizers. Martin and Gershuny state that "the higher the local cost of landfills or incineration, the more attractive composting becomes".[24] Greater savings

23 Gupta, B. & Shepherd, P. 1992. _Data Summary of Municipal Solid Waste Management Alternatives: Volume I: Text Report_. National Renewable Energy Laboratory, U.S. Department of Energy.

24 Martin, D. & Gershuny, G., 1992. _The Rodale Book of Composting_. Rodale Press: Pennsylvania. p. 252.

will be seen in jurisdictions with comparatively higher tipping fees if composting can be accomplished on site. Further savings can become available through avoided collection and transportation costs.

2.5.2 Environmental Concerns

Both positive and negative environmental implications of composting technologies should be considered when implementing an on site composting operation. Environmental implications will differ depending on the composting technology used. Generally, environmental consideration must be given towards direct surface drainage, proximity to the nearest individual dwelling, and level of ground water table in relation to the surface.

2.6 Conclusion

This chapter began with a description of the concept of industrial ecology and how it can be used as a model for development at The Forks. Industrial ecology was noted to state that in nature nothing is wasted. If planning and development is to learn from nature, then consideration has to be given to incorporating a biological infrastructure to the built urban form. It was noted that ecosystem design can be directed at a single material upwards to creating a complex natural system.

Organic material was noted to be a great "waste" generated by The Forks Market. This highlighted the question of how can this material be more efficiently used. Principles of industrial ecology can be related to this material and the solid waste management strategy used at The Forks Market to introduce on-site mid-scale composting technology.

This chapter gave consideration to the importance of administrative leadership in the implementation of an on site mid-scale composting program. The chapter discussed the importance of source separation in any composting program. The discussion of mid-scale composting concluded with a summary of economic and environmental concerns.

The solid waste management strategy at The Forks is limited to separation of corrugated cardboard, glass, and aluminum with the rest of the waste being concentrated in the compactor for pick-up and disposal by an outside contractor. To introduce composting as a solid waste management technique at The Forks will require the Partnership to expand the existing source separation program to include the separation of compostable material from the rest of the waste stream.

Economics of the composting program to be implemented at The Forks will depend on the technique used to biologically convert the material into a nutrient rich soil conditioner. To offset the associated costs of composting, it was noted that money will be saved on tipping fees at the landfill. Money can be made by selling the finished product. Also, the finished product can be used on site thus offsetting the costs and need for petroleum based fertilizer. Finally, further savings can become available through avoided collection and transportation costs.

An appropriate composting technique to be used at The Forks must mitigate direct surface drainage from the composting material, and the proximity to the nearest dwellings and negative impact on visitors to the site.

Chapter Three

COMPOSTING PRACTICES AND TECHNIQUES

3.0 Principles of Composting

Composting is low-temperature partial oxidation of the degradable proteins, fats, simple sugars and carbohydrates contained in plant cells and animal tissues. The Composting Council of Canada (CCC) defines composting as:

> "...a natural process whereby micro-organisms transform organic waste materials into a soil-like product", it "...includes a thermophilic phase..." and "...is a managed process of bio-oxidation of a solid heterogeneous organic substrate."[25]

Cullen and Johnson identify the importance of human manipulation as part of the definition of composting. They suggest that it is this human factor which separates composting from the naturally occurring decomposition process which breaks down organic material without human intervention.[26]

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25 Composting Council of Canada. 1995. *Composting Technologies and Practices: A Guide For Decision Makers*. p. 6. & *Guidelines for Compost Quality: 1996*. Composting Council of Canada.

26 Cullen, M. & Johnson, L.. 1992. *The Real Dirt*. Penguin Books. Toronto Canada. p. 152.

3.0.1 Microbial Action

Definitions of composting usually identify the significance of biological processes in the decomposition process. Decomposing organisms are all the micro-organisms and larger organisms involved in breaking down organic material. These organisms will grow spontaneously in any natural, organic waste given preferable moisture and aerobic conditions. After the initial colonization period, micro-organisms will invade the compost heap.[27] Bacteria are the primary decomposing microorganism. Arriving with the organic material, they start the process of decomposition by breaking down the organic material for their own food. The CCC states that these colonizing organisms consume oxygen and produce CO2 and it is this metabolic activity that produces heat causing the temperature to rise to over 45 degrees C; this is the mesophyllic stage.[28] The bacteria will multiply while the conditions are right for them and die off as they create conditions more favourable for others. The next stage of the composting process is the thermophilic phase.

The thermophilic phase will last as long as it takes to metabolize the assimilated contents of the biomass. This phase kills pathogens and weed seeds found in the biomass. The thermophilic phase defines composting, according to the Bureau de Normalization du Quebec:

27 Composting Council of Canada. 1995. Composting Technologies and Practices: A Guide For Decision Makers. Composting Council of Canada.

28 Ibid. p. 6.

> "compost is stabilized organic matter derived from composting which is a managed process of biooxidation of a solid heterogeneous organic substrate including a thermophilic phase in which the temperature is greater than or equal to 45 degrees C."[29]

After the organics have been metabolized, the temperature of the composting heap will drop until it reaches ambient temperature again.

Microscopic decomposers all consume waste directly and are generally referred to as first level decomposers or the chemical decomposers.[30] Second level decomposers or the macroscopic fauna such as feather-winged beatles, centipedes, ants and earthworms are collectively referred to as the physical decomposers.

Successful aerobic composting requires four critical conditions: temperature, oxygen, moisture and carbon/nitrogen ratio of feedstock.

As noted above, the greatest microbial action occurs when the temperature of the pile is between 30-55 degrees Celsius. Temperatures above 60 degrees Celsius reduce the biological activity; and some form of aeration, be it forced air or turning of the pile, is used to remove excess heat.[31] Further, aeration is needed to provide the microorganisms oxygen. If the oxygen levels within the composting pile fall below 10% by volume of the atmosphere within the biomass then anaerobic digestion takes over. While anaerobic

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29 Bureau de Normalization du Quebec, Draft Standard: *Organic Soil Conditioners - compost, Working Document*. p. 4.

30 Reference to these two terms can be found in Greater Vancouver Regional District, 1997. *Creating Our Future: Steps to a More Livable Region*. GVRD, and Composting Council of Canada, 1995. *Composting Technologies and Practices: A Guide For Decision Makers*. Composting Council of Canada.

31 Cullen, M. & Johnson, L., 1992. *The Real Dirt*. Penguin Books. Toronto Canada.

digestion also produces compost, this system can lead to objectionable odours. Moisture content of the biomass should be between 40 and 50% for ideal composting conditions.

The organic material is the principal nutrients for the micro-organisms. This material contains carbon (C) and nitrogen (N); ideally the ratio of the pile should be 25:1 of carbon to nitrogen. High C:N ratios retard the composting process, whereas low ratios tend to produce excessive nitrogen losses in the form of ammonia.[32] Composting depends on the proper mixture of wastes to achieve a favourable C:N ratio.

3.0.2 The Carbon Cycle

Carbon is an essential component of all living things. It exists mostly as carbon dioxide in the atmosphere and oceans, and in fossil fuels. There is a natural cycle to carbon. The major steps of the carbon cycle are:

- carbon dioxide in the atmosphere is absorbed into plants and converted into sugar by the process of photosynthesis;
- animals eat plants, breaking down the sugars and releasing carbon into the atmosphere, oceans and soil;
- other organisms break down dead plant and animal matter, returning carbon to the non-living environment;
- carbon is also exchanged between the oceans and the atmosphere.

32 Ibid.

Composting helps complete the carbon cycle by returning the carbon to the non-living environment by decomposing plant and animal matter.

3.0.3 What Makes Good Compost?

Compost is the product of a sequentially staged biological process that converts heterogenous solid organic matter into a homogenous fine particle, humus-like material. As noted above, the first stage of compost is the destruction or decomposition of organic matter causing the release of heat, phytotoxin, carbon dioxide, water and minerals. The second stage, in which the material stabilizes, is a process of humification and mineralization. After completion of the second stage, compost is said to be mature.

Compost maturity is not the same thing as compost quality. According to Brodie, Gouin and Carr, compost has reached maturity when the energy and nutrient containing materials have been combined into a stable organic mass. They differentiate quality by stating that it does reflect maturity, but that it also reflects the chemical makeup of the compost substrate. To exemplify this, material such as industrial sludge composted to maturity may contain a high level of contaminates thus regarding it as mature but with poor quality.[33]

The degree of compost maturity affects the usefulness of the compost as a soil additive or potting media. Brodie et al state that "Immature composts can interfere with plant growth through nitrogen immobilization and ammonia toxicity or by causing

33 Brodie, H., Gouin, F. & Carr, L., 1994. "What Makes Good Compost", in *Biocycle*. Vol. 35 No. 7. July, 1994. p. 66-68.

oxygen deficiency in soils or potting media."[34] If the compost is immature and too wet, it can decompose anaerobically which may result in the accumulation of methane, alcohol and acetic acid; also it may contain high enough concentrations of soluble carbon to support the growth of pathogens. Proper aeration of the compost pile is needed to prevent the build-up of methane, alcohol and acetic acid and to combat the development of undesirable odour.

Mature composted material results in a dark brown humic material in which the initial feedstock are no longer recognizable and further degradation is not noticeable. Curing compost to maturity requires time; the length of which is dependent on the efficiency of the initial composting technique and the complexity of the initial waste material.

The expected use of compost will define the degree of maturity required. Brodie et al give the following comparisons of compost maturity based on varying end uses:

- compost used for plant potting media must be more stable or mature than compost destined for mixing with soil;
- compost applied to agricultural and horticultural crops should be more stable than compost for land reclamation;

34 Ibid. p. 66.

- compost moved, stored and utilized in bulk need not be as mature as compost retailed in bags.[35]

Brodie et al identified a number of methods for measuring maturity of compost but state:

> "...methods to define the relative maturity of composts can be based on a combination of laboratory studies which may include plant growth and phytotoxicity bioassays, seed germination studies, viable weed seed content, odour development, dry respirometry, ammonium nitrogen content and organic carbon to nitrogen ration determinations."[36]

If more exacting criteria are not required, maturity of compost can be identified in the field. The first field method Brodie et al suggest is that compost can be considered stable when the temperature within a static pile remains near ambient for several days while the compost moisture is near 50 percent and the oxygen concentrations within the pile are greater than five percent. A second test they suggest is to place a wetted compost sample in a sealed plastic bag and store it for a week at 20 to 30 degrees Celsius. When the sample is opened, a mature compost will "emit a mild earthy odour", while immature compost will "become anaerobic and produce a septic odour." The third test they suggest involves a gallon sized insulated and sealed container filled with compost at 40 to 50 % moisture concentration and stored at room temperature. With this method, if a

35 Ibid. p. 67.

36 Ibid. p. 68.

thermometer placed in the centre of the pile remains at room temperature, then the compost is said to be mature.[37]

Compost quality is also measured by chemical and physical analysis. The quality necessary for the end product of compost is dictated by its end use. Colour, texture, structure, porosity and inorganic particle size are important aesthetic and physical factors that are determined by the end use of the compost. Heavy metal, organic chemical and pathogen concentrations in compost must be within limits established by the governing body having jurisdiction over compost quality. Compost quality standards will be discussed in greater detail in Chapter Four.

The recipe for the production of a mature quality compost requires the adoption of end product specifications. To achieve end product consistency requires the maintenance of a consistent process utilizing consistent feedstock. This could prove to be difficult at The Forks where the organic material generated can change from day to day, and season to season.

3.1 Composting Technologies

This section discusses composting techniques most commonly used in centralized composting facilities dealing with large amounts of organic waste. When dealing with large amounts of organic waste there is an engineering challenge to keep the microbial

37 Ibid. p. 68

processes active and efficient over time. To do this, aeration, moisture content and excess heat must be managed. Seven options or techniques are presented that respond to the challenge of managing aeration, moisture content and heat. The methods are: windrows, passively aerated static piles, actively aerated static piles, in-vessel composting - channels, in-vessel composting - containers, in-vessel composting - tunnels, and anaerobic conversion system. The following is intended to only be an overview of these various techniques.

3.1.1 Windrows

The technique of composting organics in elongated piles or windrows, involves spreading the waste in long triangular or trapezoid piles, about two metres high and four metres across. Length of the windrows is dependent on the size of the operation and the volume of material being composted. The windrow method require periodic turning of the pile to provide aeration.

Windrow composting can deal with a variety of organic waste at almost any operating scale. As detailed by the Composting Council of Canada, windrow composting has been successfully operated in the 5 to 100 tonnes per day range (1,000 tonnes per year); large mechanized windrow operations can process up to 100,000 tonnes per year.[38]

38 Composting Council of Canada, 1995. *Composting Technologies and Practices: a guide for decision makers.* Composting Council of Canada.

The windrow method is the most basic low-tech and low-cost approach to composting that limits the use of capital equipment.[39] Facilities using low tech approaches generally need to incorporate a higher level of process management when composting. The material brought to the composting site generally needs to be pre-processed to provide a uniform particle size and a larger surface area of the material. By increasing the amount of surface area available accelerates the composting process.

The size of the windrow is dependent on "balancing the need for oxygen with the need for an optimum temperature". The ideal windrow size will conserve enough heat to provide an optimum environment for microbial activity, but not so large as to cause overheating, compaction and an anaerobic environment. No single windrow size reconciles the conflict between the need for oxygen and the temperature requirements.

According to the Saskatchewan Waste Reduction Council, the desired conditions can be approached by starting with moderately sized windrows (three to four metres high by four to five metres wide), then combining two windrows after microbial activity occurs. Due to the cold climate in Saskatchewan, windrows can be somewhat larger (three to four metres high by seven to eight metres wide) as to composting windrows in more temperate climates.[40] The use of these larger piles is referred to as the "Prairie method" and it is utilized by Correctional Services of Canada (CORCAN) at their

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39 Croteau, G. & Alpert, J., 1994. "Low Tech Approaches to Composting Supermarket Organics" in *Biocycle*, Vol. 35 No. 5, p. 74 - 80.

40 Saskatchewan Waste Reduction Council, 1995. *Municipal Yard Waste Composting*.

Bowden Alberta composting operation. According to Larry Werner, the composting technician at the Bowden facility, by utilizing the "Prairie Method" of windrows, they are able to compost year round and produce mature compost in six to eight months.[41]

3.1.2 Passively Aerated Static Piles

Passively aerated static piles are windrows that do not require turning. Instead they use strategically placed perforated pipes open to the air to draw oxygen laden outside air into the pile at a rate dependent on demand of the micro-fauna inside the windrow.

Static piles are generally the same in dimensions as windrows, but they are not turned. This method is used generally when the organic waste being composted has strong odours of its own (i.e. Manure or fish waste). If turning were required, these odours would be dispersed. Allowing oxygen rich air to pass into the pile naturally through perforated pipes keeps the pile enclosed and obviates the need to turn the pile.

3.1.3 Actively Aerated Static Piles

Actively aerated static piles are the same as the passively aerated static piles in that they do not require turning. As opposed to the two aforementioned techniques, aeration is provided through a network of perforated pipes at the bottom of the pile with some form of fan forcing air into the pile.

It has been observed that actively aerated static piles "...can be quite limited in size and contained in simple open-ended structures, with air being drawn off through the

41 Personal communication with Larry Werner, Composting Technician, Corcan Agribusiness, Bowden Alberta. March 1997.

composting mass into piping or under-floor ducts connected to a central biofilter.[42] Biofilters are used to minimize odours.

The three above techniques are all similar in that the composting process takes place in the open, relatively simple equipment can be used to construct the composting pile, and capital costs are therefore relatively low.

These techniques also have a relatively large land requirement which is dependent on the quantities of organics being processed. The following composting techniques presented see the composting process taking place in a much more confined space that relies on intensive aerobic conversion.

3.1.4 In-Vessel Composting - Channels

In-vessel composting in channels relies on intensive aerobic conversion of the material in open channels or bays, located in a closed building, where the material is turned (mixed) by a machine and moves progressively through the structure by the pressure of the incoming new material.

In a typical open-channel system, the material is contained between two parallel vertical walls, with the material being entered at one end and the finished compost being discharged at the other end. It requires some type of turning machine to agitate the

42 Composting Council of Canada. 1995. *Composting Technologies and Practices: a guide for decision makers.* Composting Council of Canada. p. 16.

material and push it towards the opposite end of the channel. This system typically is used for processing 100 tonnes or more of organic material per day.[43]

In-vessel composting in channels has the following advantages:

- a shorter process time than other composting methods, reducing the size of equipment and space requirements;
- process control with use of a biofilter;
- a consistent high quality end product;
- good odour control; and
- low visual impact.[44]

However, this process requires higher construction and operation costs than windrows.

3.1.5 In-Vessel Composting - Containers

In-vessel composting in containers refers to intensive aerobic conversion of the organic material in closed containers where air is forced into a single batch of organic material. This method uses insulated containers (as found in the literature review, the containers tend to be metal or concrete) that are connected to air supply and discharge.

This method tends to improve the capture of any odours associated with composting allowing for closer proximity to residential areas; and the air used in the

43 Ibid.

44 Alberta Environmental Protection Association. 1995. *Sustainable Composting Options in the Province of Alberta*. Alberta Environmental Protection. Action on Waste. p. 58.

composting process can be reused with this technique reducing the total amount of air emissions.

3.1.6 In-Vessel Composting - Tunnels

In-vessel composting in tunnels refers to intensive aerobic conversion of organic material in a "tunnel" where air is forced through a single batch of organic material. While very similar to the container technique, this process uses concrete compartments that is closed with an insulated door. Each tunnel or compartment has ventilation equipment which recirculates the air and a means to heat or cool the recirculating air.

The previous three in-vessel composting techniques described are differentiated by the turning mechanisms and control technologies that are required to run the operations. All the above technologies described require the presence of oxygen in the biological conversion process. The final technique described used to convert organic material into mature compost occurs in the absence of oxygen.

3.1.7 Anaerobic Conversion Systems

Anaerobic conversion of organic material refers to the breaking down of organic materials in the absence of oxygen. Anaerobic conversion takes place in a landfill since the layers of wastes (which have an organic component) are compacted and covered, thus excluding air. Although the same process takes place naturally within a landfill, anaerobic conversion "...is normally used to describe the anaerobic process when artificially accelerated in closed vessels."[45] The process produces a gaseous mixture of carbon dioxide and methane that can be used as fuel.

The process involves putting pre-processed material into an anaerobic digester, ensuring there is an average solid to liquid ratio of 15 to 25%. The waste remains in the digester at temperatures of 35 - 37 degrees Celsius for a period of 10 to 20 days and the gases given off during this decomposition period are drawn off. After the initial digestion period, the material is usually removed and processed further aerobically, then screened to remove oversized and/or unwanted contaminants such as plastic and glass.[46]

3.1.8 Vermicomposting

Vermicomposting is the use of worms to convert organic material into a nutrient rich humus which is a good soil conditioner. A demonstration project was installed at the Brockville Psychiatric Hospital, in Brockville Ontario. The site uses approximately 800,000 worms (273 kg) housed in two units that are 1.8 metres wide by 13.4 metres long. They process approximately 150 to 200 pounds of organic material per day. According to Ram Kamath, Director of Facility Operations at Brockville Psychiatric Hospital, the vermicomposting technique has not met the hospital's needs as an alternative waste management strategy. Since its inception, there have been two main

45 Prism. 1995. *Anaerobic Digestion*. World Resource Foundation.

46 The above discussion is intended to be an overview of anaerobic systems in general. The initial degradation period will vary depending on the different anaerobic system used. For further information pertaining to anaerobic technologies refer to *Composting Technologies and Practices*, p. 57 - 60 and Prism. 1995. *Anaerobic Digestion*. World Resource Foundation.

problems. First, they have not seen any financial returns and second, they have problems harvesting the converted material to utilize it on site.[47]

3.2 Comparison of Composting Techniques

ITEM	Windrow-Turned	Windrow-Aerated	In-vessel	Anaerobic	Vermi-Compost
Capital Costs	Low	Low in small system	High	High	Medium
Operating Cots	Low	Medium	Low	Medium	Low
Land Requirement	High	High	Low. Can increase if windrow drying needed	Medium. Additional windrow curing needed	Low
Air Control	Limited	Complete	Complete	Complete	Low
Operational Control	Turning Frequency, amendment addition	Airflow rate	Airflow rate, agitation, amendment	Gases drawn off	Feedstock addition
Sensitivity to Cold	Sensitive, but demonstrated in cold	Demonstrated in cold and wet climates	Demonstrated in cold and wet climate	Demonstrated in cold and wet climate	Demonstrated in cold and wet climate
Odour Control	Dependent on feedstock. High potential	Dependent on feedstock. High potential	Potentially good	Potentially good	Good
Potential Problems	Cold. Run-off	Control of airflow. Cold. Run-off	System may be mechanically complex	System may be mechanically complex	Harvesting material may be problematic

The preceding chart is adapted from Tchobanoglous et al (1993), from discussions with Larry Werner and Randy Grooms of Corcan, Ram Kamath of the Brock Psychiatric

47 Personal communication with Ram Kamath, Brock Psychiatric Hospital, March, 1997.

Hospital, Lydia Giles of Vermicomposting Products, and Ed Boyd of Wright Environmental.

Composting options should be assessed in four critical areas: technical, economic, environmental, and educational.

There are seven technical criteria. First, the year round operability of a system must be considered. To be viable at The Forks, the system must be operable year round. Second, odours must be managed. The management and prevention of odours is critical to the operation of a composting system at The Forks. Third, pests must be controlled. The presence of rodents, flies and other pests must be managed to the greatest potential possible. Fourth, pathogens must be destroyed. Systems must be able to destroy pathogens so that they are not introduced into the soil at The Forks. Fifth, leachate must be minimized. Systems must properly manage any excessive amounts of moisture. Sixth, dust, noise and litter must be kept to a minimum. These need to be kept to a minimum especially since The Forks is situated in the centre of Winnipeg, surrounded by public buildings and adjacent to residential development. Finally, the system must be judged on the ability to process a range of material. The Forks waste stream contains animal waste as well as organic. A system must be capable of handling both.

The Forks North Portage Partnership does not have unlimited resources with which to implement a composting program. Preference needs to be given to those composting techniques that minimize costs through avoidance of tipping fees, fertilizer and soil amendment costs. and generate revenue through the sale of finished compost. Composting options have been assessed on capital costs: land. equipment. and site preparation. They have been assessed on operational costs: labour. maintenance. inputs such as water and electricity. and amendments. Economic criteria must also take into account processing time. Since composting is to be used as a waste management technique at The Forks. shorter processing times are preferable.

Environmental criteria consists of product quality. minimizing amounts of energy and resources required to manufacture. transport and implement a technology. and the minimization of energy requirements relating to operation of a system. Product quality will be discussed further in chapter four. Generally preference should be given to systems that produce finished compost which is free of contaminants.

A composting system at The Forks must allow for experiential learning opportunities. The impetus for a composting system is its ability to tie into the Market Garden concept. The Market Garden is to be a joint initiative between the University of Manitoba. Winnipeg School Division Number One. and The Forks North Portage Partnership. Students at all levels must be able to participate in the composting process.

3.3 Summary

This chapter described in some detail the basic principles of composting. Emphasis was given to the definition and principles of composting. available composting techniques and it touched on definitions and regulatory compliance of mid-scale, on site composting operations. It ended with a comparison of the various composting techniques available for implementation at The Forks. Given the benefits of composting, the next chapter examines the requirements for the establishment and operation of a composting facility.

Chapter Four

ROLE & ESTABLISHMENT OF COMPOSTING FACILITIES

4.0 Introduction

The purpose of this chapter is to provide an overview of the role composting plays in solid waste management. The chapter begins with a broad discussion of the necessity of municipal solid waste management, then gives a brief description of the principles of municipal solid waste management (MSW) and different strategies used for handling MSW. The role of composting as a strategy for handling municipal solid waste is discussed, followed by a description of the major benefits composting can provide. Jurisdiction of establishing a composting facility is discussed as well as guidelines for compost quality. The chapter ends with a summary of findings.

4.1 Wasted Again

Municipal Solid Waste (MSW) originates at four sources: residences, industries, commercial establishments, (i.e. Shopping centres, restaurants, offices) and institutions.

Municipalities are responsible for managing the solid waste generated within their jurisdiction. The primary purpose of municipal solid waste management is to handle waste safely, economically and in a way that protects human health and the environment.[48] Each community has its own criteria for selecting appropriate technologies in choosing a single waste handling technology or an integrated combination of technologies to form a waste management strategy. Within the framework of the municipal waste management strategy, the industrial, commercial and institutional (IC&I) sector tends to provide their own waste management strategies while residential waste is the responsibility of the municipality itself. In terms of volume the two streams (residential and IC&I) comprise 40% and 60% respectively of the total municipal waste stream.[49]

Waste is an inevitable by-product of the natural world. The Forks is like any other component of a large urban system: it consumes energy/resources and discards waste at a cost. However, ecology demonstrates that natural processes are cyclical, not linear, as is the current model in use at The Forks model. A natural system is capable of regenerating itself, through photosynthesis and decomposition, and becoming ecologically

48 Gupta, B. & Shepherd, P. 1992. *Data Summary of Municipal Solid Waste Management Alternatives: Volume 1: Report text.* National Renewable Energy Laboratory, U.S. Department of Energy.

49 Composting Council of Canada. 1995. *Composting technologies and Practices: A Guide for Decision Makers.* The Composting Council of Canada. p. 7.

self-sufficient.[50] As suggested by the World Commission on Environment and Development, it is no longer acceptable for society to consume and dispose of natural resources in such a manner that the availability of those resources is not assured for later generations.[51]

4.2 Municipal Solid Waste Management Strategies

Municipal solid waste management can be broken down into basic features that have general relationships to each other. In its most basic form, municipal solid waste management strategies extend from the waste's origin (the point at which the waste is set out for collection), through transportation and processing operations, to its final destination (whether it be recycling, combustion, landfilling et cetera). Tchobanoglous et al. identify six elements of solid waste management: waste generation; waste handling and separation, storage and processing at source; collection; separation, processing and transformation of solid waste; transfer and transport; and disposal.[52]

Waste generation, or waste origin, is the disposal of materials no longer deemed to have any value as identified by the person discarding the material. Solid waste's origin is the point at which the waste is placed by the generator (whether it is a household,

50 Tyler, Mary-Ellen. 1994. "Ecological Plumbing in the Twenty-First Century", in *Plan Canada: Special Edition*. July 1994, p. 169.

51 Brundtland, Gro Harlem. 1987. *Our Common Future*. World Commission On Environment and Development. Oxford University Press.

52 Tchobanoglous, G., Thiesen, H., and Vigil, S., 1993. *Integrated Solid Waste Management*. McGraw-Hill Inc. USA. p. 12.

commercial establishment or institution) for collection either by the municipality or a private solid waste disposal company such as Browning Ferrous Industries or Canadian Waste Ltd. (formerly Laidlaw Waste Systems Ltd). The second element, waste handling and separation, storage and processing, is the placement of the material in temporary containers (i.e. at the curb or back lane for households or in the centralized compactor at The Forks) and the movement of these containers.

4.3 Strategies For Handling Municipal Solid Waste

Municipalities across Canada and the United States employ a number of different strategies for handling the MSW stream. The following sub-section will briefly describe four main MSW management strategies, as identified by Gupta and Shepherd[53] that are currently employed by municipalities throughout North America. They are: sanitary landfill; mass burning; materials collection, separation and recycling; and composting.

4.3.1 Sanitary Landfills

Sanitary landfills, the most common waste management technology used in the United States and Canada, are used to store MSW in a way that protects human health and the environment. Landfills incorporate a liner system, a leachate collection system, a leachate treatment system, a cap system, a gas recovery system, as well as landscaping, security, groundwater monitoring, and a groundwater plan. As well, landfills require

53 Gupta, B. & Shepherd, P. 1992. *Data Summary of Municipal Solid Waste Management Alternatives: Volume I: Text Report*. National Renewable Energy Laboratory, U.S. Department of Energy.

approximately 30 years of post-closure monitoring, care and planning for eventual community use.[54]

The traditional landfilling operations consist of a daily cycle of filling, compacting the fill with heavy equipment and covering the fill with earthen materials. Sanitary landfills accounted for about 73% of all MSW in the United States in 1988.[55] These landfills require energy for construction, compaction, spreading daily landfill cover, collecting and treating leachate and similar activities.

4.3.2 Mass Burning

Mass burning is the process of feeding MSW directly into a furnace. As a MSW management strategy it ranks second to landfilling, accounting for disposal of 17% of all MSW.[56]

4.3.3 Materials Collection, Separation and Recycling

This section describes the processes to collect and separate recyclable material from waste and to recycle the separated materials into useful products. The reusable materials that are most commonly recycled are paper, glass, aluminum and ferrous metals, plastics and cardboard. According to the National Solid Waste Management Association (NSWMA) the recycling process can be broken down into five steps:

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54 Ibid.

55 EPA. 1990. *Characterization of Municipal Solid Waste in the United States*. United States Environmental Protection Agency.

56 Kiser, J.L., 1991. *National Solid Wastes Management Association*. Journal of Air Waste Management Vol. 41 No. 9, September 1991, p. 1161.

- separating material from the waste stream either at source or a central materials recovery facility;
- transporting and processing the separated materials for use as replacements for virgin materials;
- managing the wastes from separation and recycling;
- returning the materials to beneficial use or to commerce;
- selling the recycled product to consumers.[57]

4.3.4 Composting

Composting is "...low temperature partial oxidation of the easily degradable proteins, fats, simple sugars and carbohydrates contained in plant cells and animal tissues"; and when used as a MSW management strategy can reduce the volume composted by 50% and "consumes about 50% of the organic mass (on a dry weight basis), which is released mainly as CO2 and water".[58]

Composting technologies differ mainly in the manner in which oxygen is transferred into the composting material, either passively, actively or in an anaerobic environment. In all composting systems the following variables should be optimized:

- feedstock and particle size;
- bacteria, fungi and protozoa, which cause the reaction;

57 NSWMA. 1991. *Recycling in the States: 1990*. Review. National Solid Waste Management Association, Washington, D.C., 1991.

58 Gupta, B. & Shepherd, P. 1992. *Data Summary of Municipal Solid Waste Management Alternatives: Volume I: Text Report*. National Renewable Energy Laboratory, U.S. Department of Energy.

- additional nutrients (nitrogen, phosphorus, potassium and trace metals);
- pH, which should range between 4.5 and 8.5 during the composting cycle;
- aeration, except in anaerobic systems;
- moisture content, which should be greater than 12% but not saturated; and
- process residence time.[59]

As a waste management strategy, the Composting Council of Canada estimates that "centralized composting now diverts 11% of the volume of the organic fraction of Canada's waste stream."[60] Given that the waste stream at The Forks is about 70% organic, there is a great opportunity for The Forks North Portage Partnership to reduce the amount of material being sent to landfill each year by composting organic matter.

4.4 Roles and Benefits of Composting

All forms of composting fall within the third R - recycle - in the hierarchy of the 3 R's (reduce, reuse and recycle) waste management system. Composting is the recycling of the organic portion of the solid waste stream. As outlined by the Composting Council of Canada, "the hierarchy of composting starts with the individual household using backyard composting to recycle organics, and moves through 'mid-scale composting' to large

59 Ibid.

60 Composting Council of Canada. 1995. *National Survey Of Composting Operations In Canada: Second edition* Composting Council of Canada.

centralized composting systems"[61] such as the Edmonton Regional Co-Composter being planned to handle all of the City of Edmonton's organic component of the waste stream.[62]

The driving force behind all forms of composting in Canada is the agreement between the federal and provincial Ministers of the Environment to reduce Canada's waste stream by 50% by the year 2000. On average, the waste stream at The Forks is composed of 70% organic material, currently all landfilled. This material can be diverted and converted into an environmentally friendly product known as compost.

The objectives of composting are to:

- convert biodegradable organic waste into a biologically stable product while reducing the original volume of waste;
- retain the nutrient content of the organic waste fraction (nitrogen, phosphorus, potassium and minerals);
- produce a product that can be used to support plant growth and improve soil structure; and
- destroy pathogens or unwanted micro-organisms, insect eggs and weed seeds.[63]

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61 Composting Council of Canada. 1995. _Composting Technologies and Practices: A Guide For Decision Makers_. Composting Council of Canada. p. 5

62 Personal communication with Mark Brostrom, Office of the Environment, P.W., The City of Edmonton Public Works, October 1996.

63 Ibid. p. 5.

Composting of the organic fraction of the waste stream can provide a number of benefits. First, according to Martin & Gershuny, the addition of compost can provide extra organic material necessary to improve the structure of both clay and sandy soils to create a more ideal soil for plant growth; as well, improved soil structure can also provide protection against drought and erosion, improve aeration and the release of nutrients along with chemical buffering and neutralization of toxins.[64] Second, it requires relatively little energy to produce a valuable end-product and the process generates heat that can be harvested and used to supplement climate control in adjacent buildings. Third, composting can potentially divert the organic fraction of the waste stream for processing and reuse, extending the life of landfills as well as remove the possibility of creating odorous compounds that can escape or enter surface and groundwater systems.

To summarize, composting and compost is useful on several counts:

- it improves soil structure, texture, aeration and water retention;
- clay soils are lightened when mixed with compost and sandy soils retain water better; and
- mixing compost with soil aids erosion control, soil fertility, proper pH balance and healthy root development.

A national survey of composting operations in Canada shows that the number of composting facilities across the country has risen by 17% from 137 facilities (in 1993) to

64 Martin, D., and Gershuny, G., 1992. *The Rodale Book of Composting*. Rodale Press, Pennsylvania. p. 13-25.

162 facilities (in 1995). The survey estimates the organic fraction of Canada's waste stream to be about 6.2 million tonnes per year and concludes that centralized composting is diverting 11% of the volume of Canada's waste stream from landfill sites.[65] This suggests that composting is slowly becoming an accepted form of waste management in Canada. However, not all provinces are equally far advanced with respect to publishing or promulgating guide-lines or regulations with respect to the production and use of compost. The CCC state that, from east to west, the provinces that are the most advanced with respect to regulating the production and use of compost are Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia.[66] In terms of numbers of composting operations, Ontario ranks first with 56 (43 public, 13 private), Quebec is second with 30 and Manitoba ranks sixth with 8 (all public). Appendix B contains results of the survey.

Composting in Canada has made advances as a waste management strategy and also as a form of recycling that produces an environmentally responsible and desirable product. As is evident over and over again in the literature, if we are to meet the accepted goal of 50% waste reduction by the year 2000, the increased use of compost is essential.

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65 Composting Council of Canada. 1995. *National Survey of Composting Operations in Canada: Second Edition*. Composting Council of Canada. May, 1995.

66 Ibid. p. II

4.5 Government Jurisdiction

Composting facilities can fall under the jurisdiction of all three levels of government. In the planning and implementation of a composting facility it is important to secure the necessary permits as far in advance of program implementation as possible.

4.5.1 Federal Jurisdiction

Jurisdiction at the federal level stems from the administration, by Agriculture and Agri-Food Canada, of the Fertilizer Act, which regulates fertilizers and soil supplements sold in Canada. Therefore, compost is regulated by Agriculture and Agri-Foods Canada when it is sold as a soil amendment or as a product with plant nutrient claims. Composting operations which use the composted material on-site or give it away avoid the conditions of this piece of federal legislation.

4.5.2 Provincial Jurisdiction

The provinces and territories regulate the disposal and use of wastes, such as composting feedstock, and therefore, the production and use of compost. Manitoba has no composting guidelines in place, unlike Ontario and British Columbia.

4.5.3 Municipal Jurisdiction

Except for the 'Leaf-It-With US' program, the City of Winnipeg has no centralized or mid-scale composting operations. At the municipal level offensive bins are dealt with on a case by case basis.

4.6 Compost Quality Standards

Recognizing the significant growth of composting as a waste management strategy, the Canadian Council of Ministers of the Environment (CCME) Solid Waste Management Task Group established a national committee to develop guidelines for compost products. The guidelines have been established to protect public health, the environment, and ensure that compost products are able to be used beneficially. The CCME guidelines will also "help secure compost as a beneficial soil amendment, increase the demand for organic materials, and encourage source separation."[67]

As noted above, different sets of standards for several aspects of compost exists among the federal and provincial regulators. In 1993 an agreement was reached between stakeholders in an attempt to develop compost standards that provide a significant level of national standards while being flexible enough to allow for different regional interests and issues. Appendix C outlines the guidelines for compost quality as adopted by the Canadian Council of Ministers of the Environment.

4.7 Summary

This chapter has presented an overview of the most common municipal solid waste management strategies in place today, describing the life cycle of the waste stream from generation through separation and storage, to collection, transfer and transport and

67 Canadian Council of Ministers of the Environment. 1996. *Guidelines For Compost Quality*. Canadian Cataloguing in Publication Data.

finally disposal. Further this chapter has discussed the role and benefits of composting within the context of the U.S. EPA 3'R hierarchy of waste management strategies - reduce, reuse and recycle - identifying that it falls within the recycling category. Some potential benefits of composting were also identified, namely that: it converts organic waste into a stable product while reducing the original volume of waste; it retains the nutrient content of the organic waste fraction; and it produces a product that can be used to support plant growth and improve soil structure. These are benefits commensurate to the concept of an environmental project at The Forks as identified by The Forks North Portage Partnership in the ***Business Plan***. It fits with the development of a Market Garden at The Forks. The area identified for a garden is in need of reconditioning of the soil. It also reduces the volume of waste that will be sent to landfill, in turn reducing the cost associated with waste disposal.

Chapter Five

IMPLEMENTING COMPOSTING AT THE FORKS

5.0 Introduction

This chapter synthesizes the knowledge gained from the previous chapters and outlines a program for implementing composting as an alternative waste management strategy at The Forks. It begins with a description of the waste management planning process used. A comparison and assessment of the options identified is outlined and a strategy for implementing the plan over a defined planning period is given.

5.1 Planning Process

The purpose of the waste management plan is to set out how The Forks North Portage Partnership will manage waste material over the course of the prescribed planning period. The planning process followed for this study consists of four tasks. This four task process reflects a typical decision-making model where a problem is identified, alternative solutions are considered, and each evaluated for the purpose of selecting a preferred course of action. The four tasks are: identify the problem or opportunity;

determine the waste management system and diversion alternatives: assess options: and implement the plan. The first four chapters have dealt directly with tasks one, two and three and prepared the framework for task four.

The initial step task in this process was to identify the waste management problem or opportunity. Information accumulated established the foundation upon which the entire planning process was based. As outlined in the rationale and project scope, waste management at The Forks did not present a problem so much as an opportunity. The opportunity, identified in Chapter One, suggests reuse of the organic portion of the on-site waste stream versus discarding it in the City owned landfill, thus encouraging nutrient recycling. Composting and reuse of organic material will aid in creation of a nascent ecological system and recondition degraded soil conditions.

Task two identified an efficient waste management system. Research for this project focussed on mid-scale composting at The Forks. The Partnership has proposed a Market Garden as one project that could assist in achieving self-sufficiency. Composting the organic portion of the waste stream is compatible with a Market Garden, allowing for recycling of nutrients. The composted material can be used as soil conditioner.

The third task assessed available composting technologies. Chapter Three outlined the various technologies available and described the pros and cons of each. Methods range from simple piling (windrows) to more complex closed systems (in-vessel) and vermicomposting.

Chapter Four described the role and benefits of composting within the hierarchy of municipal solid waste management strategies. Further, the chapter outlined jurisdictions governing the establishment of composting facilities. Insight into compost quality standards to be adopted for the use and sale of composted material.

The remainder of this chapter focuses on the fourth task: implementation. This includes education, compliance, enforcement, design and location, and obstacles. The implementation of a successful composting project at The Forks is dependent upon several key factors: technology to be used, location, separation of feedstock supplying the system, and the number of staff required to maintain the operation.

5.2 Education

A strong commitment is required if implementation of a composting program is to be successful. The Forks North Portage Partnership must establish responsibilities, practices, procedures and resources.

Composting can only take place if the raw materials are present. As noted, approximately 500 tonnes of compostable material per year is generated annually at The Forks. The challenge lies in separating this material from the overall waste stream. A source separated waste stream requires less in-plant processing, lowering the overall cost of any composting technique used.

Individual businesses at the Forks feed the waste stream daily. Program implementation will require each business to separate waste into compostable and non-compostable material.

Recommendation: The Forks North Portage Partnership adopt and adapt the source separation program established by the Quick Service Restaurant Council of Canada (QSRC).

QSRC developed a source separation program that allows participating restaurants to divert food and paper waste from going to landfill. The QSRC program bought specialized equipment, produced informational materials, and provided extensive training in each restaurant. Equipment used consisted of bins and clear plastic bags. These ensures quality control, allowing materials to be identified thus assist in the reduction of contaminants. Appendix D further outlines QSRC's program.

It can be assumed that every business operating at The Forks produces some compostable material. Each business will require a bin suitable for separating compostable and non-compostable materials. Bins should be lined with plastic bags to ease collection and transportation of organic material. Suitable bags are economical and readily available. Success of this program is totally dependant upon the well trained and dedicated participants.

Recommendation: The Forks North Portage Partnership appoint a coordinator who will be responsible for the monitoring and maintenance of the source separation program.

A source separation program will be a new concept at The Forks. Training of tenants and staff will be fundamental to the program's success. The program will require a coordinator, who should be responsible for training of tenants and staff, and general management of the program. This includes communicating the importance of source separation and the benefits of composting on site. The coordinator should also oversee the regular monitoring of the bins to control contamination of the feedstock.

QSRC's experience identified the importance of educating staff on all aspects of the program: what the plan is; what material to separate, where the material is going, and; what the benefits of the program are.

Currently, waste material is collected and concentrated in the compactor area at the rear of The Forks Market for pick-up and delivery to the landfill. In the new system, compostable material can also be collected during regular maintenance rounds and concentrated in a similar common area, in preparation for biological conversion.

5.3 Composting Technology

Any composting technology chosen requires feedstock to ensure continued operation. Section 5.2 outlined a program to extract and centrally locate the necessary feedstock from the current waste stream. The source separation program should mimic the source separation program established by the QSRC in Ontario.

The literature review revealed that many commercial establishments sort waste for composting. however. the material is removed and processed at a centralized facility off-site. This option is not available to The Forks. as a large scale centralized composting facility is not available in Manitoba. A centralized composting facility was established in Winnipeg in 1991. however. this facility uses the windrow method of composting and only accepts leaves as the feedstock. severely limiting contributors.

Four compost technology assessment criteria were identified in Chapter Three. Technical criteria stated that a composting system must be operable year round. Research confirmed that each of the methods identified had been demonstrated year round in an area with similar climatic conditions as Winnipeg.

The chosen composting system must control odours to mitigate adverse affects on adjacent development. The greatest potential for odour pollution comes with using one of the open windrow methods. The best odour control is provided by in-vessel. anaerobic. or vermicomposting systems.

Leachate must also be considered. In-vessel systems provide the best leachate control as they are directly connected to the sanitary sewer. Windrow methods can be problematic with run-off and ground water contamination. as well as problems with dust. noise. odour and litter. The open windrow method presents the greatest potential for problems with dust noise and litter.

Given the public popularity of The Forks and its downtown location, the particular composting system chosen for the site must not add undue burden to site maintenance.

Research showed that in-vessel systems are able to process the widest range of material. The windrow method is limited to organic matter, vermicomposting can handle small quantities of animal products, and in-vessel systems are able to accommodate relatively large amounts of animal products and all organic matter. Chapter Three highlighted the necessity of a composting system at The Forks to handle a wide range of feedstock material.

Based on knowledge gained from the planning process, presented in the first four chapters, the position of this practicum is that the Partnership should consider an in-vessel composting system. As noted, windrow methods have a much larger land requirement and greater potential for litter, groundwater contamination and odour pollution than in-vessel systems. It is the author's opinion that vermicomposting would not be satisfactory due to the scale of the program. Research concluded that an in-vessel system best meets the technical, economic, environmental and educational criteria.

Recommendation: The Forks North Portage Partnership introduce an in-vessel system as the composting technology for use on site as a waste management technique.

In-vessel systems have several positive features. Biofilters control odours, mitigating the negative affects of odour and dust. Pests are also kept to a minimum because material is enclosed not open to invasion. Leachate can be managed by connecting the system directly to a sanitary sewer. The feedstock material is not exposed to the elements, thus controlling excess litter. In-vessel systems are able to accommodate the broadest range of feedstock materials. In addition, the land area requirements are about half that required by windrow methods and the processing time is considerably less than other methods. However, implementation of in-vessel systems is considerably more expensive than other methods due to the capital cost of equipment.

Public acceptance is critical to the success of a composting program at busy attraction, such as The Forks. An in-vessel system located close to The Forks Market would be highly visible and could have considerable educational potential. Business owners and employees must understand the benefits of composting and fully participate in the program. These individuals may be opposed to a program if it is perceived to add cost, create inconvenience or change work routines. Proximity to The Market would allow ease of access and an opportunity to observe the success of the composting process.

Environmental virtues alone will not ensure the acceptance of an in-vessel or any other composting system. Sound ecological design principles aside, the program must be cost effective and reduce the expense of managing waste.

5.4 Design and Location

The in-vessel system has to be capable of processing, on average, one tonne of organic waste per day. Currently, a staff of seven (4 full time and 3 part time employees) currently collect and concentrate the waste generated in The Market. The new system must be integrated within the current waste management system and not incur additional labour costs. Each business is responsible for transporting the waste it generates to the garbage chute (a 40 cubic yard compactor). It is the author's position that the in-vessel composting system should replace this compactor bin. In order to do this the system has to utilize a continuous flow through process. This will allow for the required daily feeding of material into the system. Research found that a fully enclosed flow through in-vessel system that would meet the needs of the Partnership is currently operating at the Ontario Science Centre (OSC).

Recommendation: The Forks North Portage Partnership acquire a fully enclosed flow through in-vessel composting system similar to the OSC's but adapted to process 1 to 2 tonnes per day of feedstock.

Appendix E provides greater information on the Wright Environmental Management in-vessel composting system. Edward Boyd, a principle at Wright Environmental, suggests that a similar system to the one used by OSC could be implemented at The Forks for a capital cost of $250,000. Current yearly expenditures for collection and removal of waste at The Forks is about $50,000. The projections of the waste audit data (Appendix A) suggest 70% of the waste stream can be diverted from landfill, composted, and reused on site as a soil conditioner. Assuming a comparable savings on yearly tipping and hauling fees, about $35,000, an in-vessel system could pay for itself within a six year period.

Boyd suggests the footprint of the composter required for 1 to 2 tonnes of material per day would be about twelve feet by 35 feet. This is not significantly larger than the current 40 cubic yard compactor bin. Figure 4 illustrates the footprint of the in-vessel system in relation to the current bin.

The composting process reduces the volume of material by 50%. One tonne of material would be approximately 10 cubic yards of material with a uniform particle size. Uniform particle size is achieved through shredding and mixing of the material as it enters the system. With a 14 to 20 day processing retention span, the end product comes out as a soil-like, nutrient rich humus. The end product can be collected and transported to the location identified for the Market Garden for further curing (Figure 3, p. 22) two vehicles capable of transporting the material from the proposed in-vessel location to The Market Garden site are currently is use.

Utilizing a flow through in-vessel system as the primary waste management strategy at The Forks will accomplish four objectives:

- reduction of material transported to landfill;
- reduction of costs associated with the current waste stream management system;

- reuse of the organic fraction of the waste stream:
- recycling of nutrients, creating a cyclical ecological system capable of regenerating itself year after year.

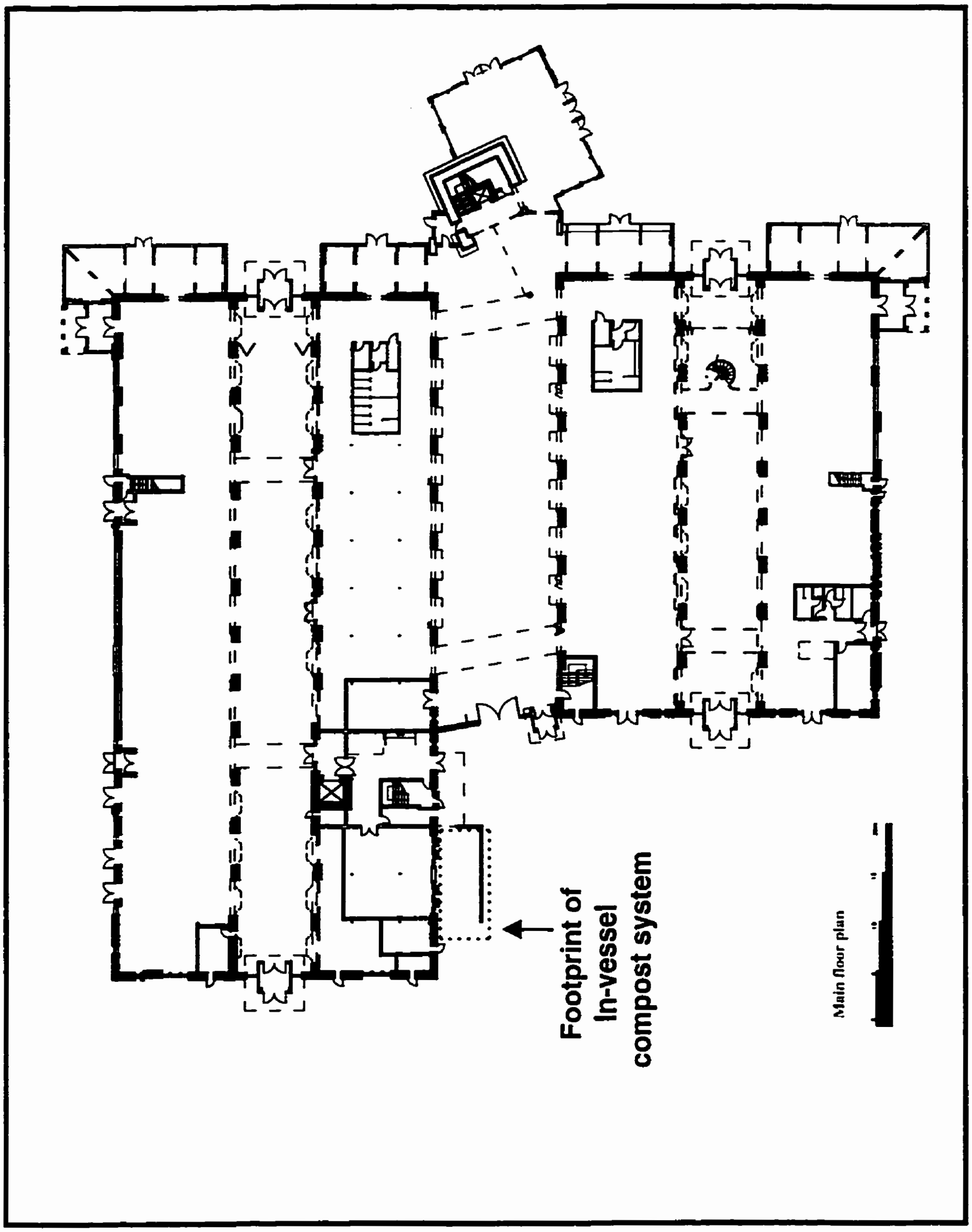

Figure 4 . Proposed Location of Recommended Composting System at The Forks Market

5.5 Summary

This chapter described the details of an implementation strategy for on site mid-scale composting at The Forks. The planning process was emphasized in the recommended composting program. This suggested that implementation of an in-vessel composting system best fit the needs (technical, economic, environmental and educational criteria) of the site. The benefits of composting highlighted throughout this practicum, lead the authour to conclude that an in-vessel composting system should replace the current cycle of disposing compostable material in the landfill. This would lay the foundation of a closed ecological system at The Forks.

Chapter Six

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter reviews the study objectives, presents the authour's conclusions and closes with a list and explanation of recommendations.

6.1 Summary

This practicum was undertaken to investigate an opportunity that was presented to The Forks North Portage Partnership during preparation of the *Business Plan*. It began with a waste characterization study of The Forks. This study found that around 70% of the waste stream generated by The Forks Market was organic in nature. Future development on the site will surely increase waste byproducts and the need to address effective management of these materials.

A Market Garden has been recommended within Phase II developments. This project is intended to embrace the Partnership's commitment to implement and environmental project. The Market Garden concept is based upon sustainable design principles and environmental technologies. As a result, the 500 tonnes of organic waste generated annually at The Forks will be reused on the site to recondition the soil for the growing of produce to be sold commercially. The intent is to mimic the natural ecosystem by replacing the current through-put system with a cyclical one.

The purpose of this practicum was to identify appropriate composting technologies commensurate with present development at The Forks, and develop implementation strategies to introduce an in-vessel system as part of the waste management strategy employed by the Partnership. Four objectives were established: reuse the organic portion of the waste stream to recondition soil for a Market Garden; reduce the amount of artificial nutrients entering system; implement a cyclical ecological system as a model for continuing development of the site; and save money on waste disposal.

The Partnership is charged with the continuing task of restoring the site to a meeting place - a "human habitat" - from an abandoned rail yard. This includes cultural, political and social systems that function within and as part of the natural environment. The argument presented suggests that if the Partnership is to restore this habitat it should mimic the "natural system" which has been able to sustain itself for 3.8 billion years. Principles of industrial ecology were presented as a model to guide future development at The Forks.

Industrial ecology involves developing interconnected manmade ecosystems that fully integrate with natural global ecosystem. Industrial ecology states that: there is no such thing as waste: life giving nutrients for one species are derived from the decomposition of another: materials and energy are endlessly circulated and transformed: natural systems are dynamic. and: cooperation and competition go hand in hand in a natural system. The intent of composting organic material on site is to demonstrate that principles of industrial ecology can and should be applied to planning and future development at The Forks.

An on site. mid-scale composting operation in conjunction with a Market Garden would emulate a natural system. Instead of being a throughput system where production. use and disposal are separated. a cyclical system mimicking a natural system could be created. closing the loop of waste management. Chapter Two discussed how combining composting and locating food production at The Forks makes it possible to close nutrient cycles associated with human food production and consumption.

The Forks is entering the second phase of development. The Partnership is intent upon the "Meeting Place" theme and is incorporating "Making Connections" as a planning and development goal. "Making Connections" is also implicit in the industrial ecology model. While. the Partnership has established principles of industrial ecology in the *Planning and Development Guidelines*. the concept is not explicitly recognized. something that must occur if the principles of industrial ecology are to be used as a model for future development. Composting in conjunction with the Market Garden could be an important catalyst in the demonstration of sustainable ecological urban design.

6.2 Conclusions

A primary objective of this practicum was to identify alternative composting technologies that could be used for organic waste management at The Forks. The Market Garden concept that was identified by the Partnership as one of the projects for Phase II Development that could assist in achieving financial self-sufficiency. Composting represents an important economic, educational and environmental opportunity for The Forks.

The Partnership is committed to the implementation of innovative programs and projects that benefit Winnipeg's downtown and now has the opportunity to continue its strong leadership in the downtown revitalization. There is public expectation for excellence at The Forks. By implementing the outlined composting project, the Partnership can demonstrate the ecological principle of nutrient recycling and begin to establish a biological infrastructure for The Forks.

Another objective was to present a plan and implementation strategy for the introduction of organic waste disposal alternatives into the current waste management strategy. The composition of the waste stream at The Forks changes from day to day and from season to season. A system is required that can accept a wide variety of feedstock material. In Chapter Three. eight different composting options were identified. These ranged from windrow methods. to mechanical enclosed systems and vermicomposting.

6.3 Recommendations

Chapter Five presented four recommendations:

i. Adopt and adapt the source separation program established by the Quick Service Restaurant Council of Canada:

ii. Appoint a coordinator to be responsible for the monitoring and maintenance of the source separation program:

iii. Introduce an in-vessel system as the composting technology:

iv. Acquire a fully enclosed flow through in-vessel composting system similar to the OSC's. and adapted to process 1 to 2 tonnes per day of feedstock.

In addition. the Partnership should:

v. Explicitly recognize the concept of industrial ecology and ecological design in the *Planning and Development Guidelines*. thus establishing the framework for creating a biological infrastructure for future development:

vi. Determine an implementation time line for this project. There is sufficient economic. environmental and educational incentive to implement this program:

vii. Approve sufficient funds for capital costs and further research for completion of the above recommendations.

6.4 Opportunities for Further Study

This practicum outlined a process for implementing composting on site as a demonstration of ecological design principles. How composting technology functionally connects to other processes by creating a nutrient cycle that mimics naturally occurring decomposition cycles was fully discussed. Continuing study should be undertaken to explore how all functions, projects and development at The Forks are, or can be, interconnected. For example, a new hydroponic operation, Growing Prospects Incorporated, to be located in the CN Garage adjacent to The Forks, will generate heat energy that could easily be captured and re-used in some other capacity.

Further study will be required regarding quantities of compost needed for soil reclamation in the area identified for the Market Garden. Soil studies and other chemical analysis will also be needed on a continuing basis as the Market Garden is established.

Other opportunities should also be explored. For example, it may be possible to harvest the heat generated by the decomposition process. It is not known at this time if leachate can be purified and reused on site rather than evacuated through the sewer system. Other opportunities may also present.

The Forks is an integral thread in the tapestry of the downtown community. It is connected to the biophysical environment to which it must positively contribute. The opportunity now exists for The Forks North Portage Partnership to incorporate principles of ecological design in present and future development and create an ecological infrastructure at The Forks. The Market Garden and composting projects present good opportunities for the practical application of ecological design principles. The key is to implement these projects now, and continue to implement and perfect the principles of industrial ecology in the continued design and development of The Forks.

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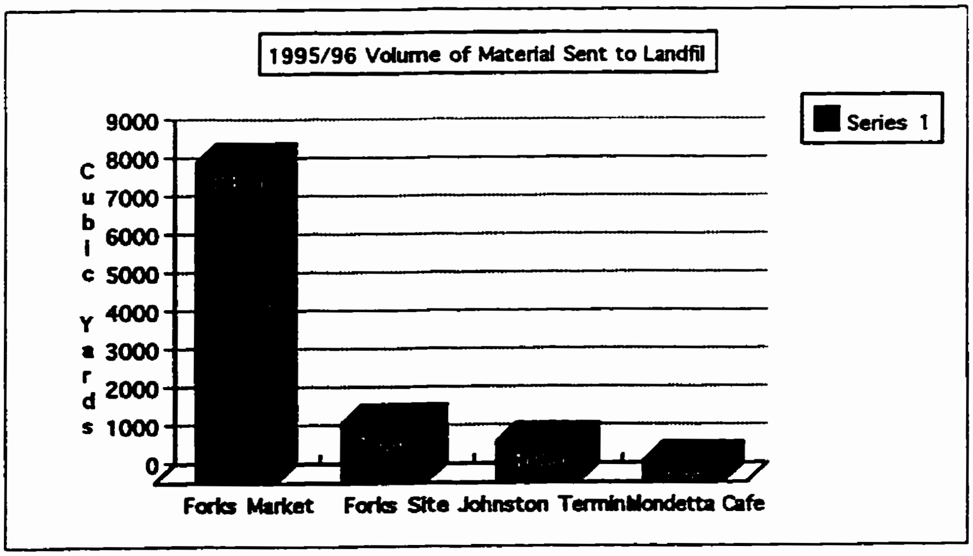
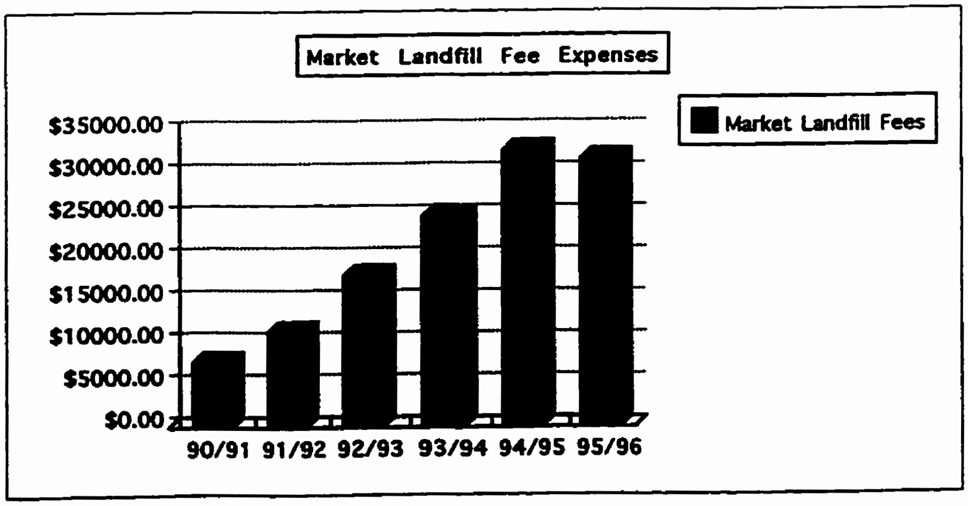
APPENDIX A

The Forks Waste Audit Data, Fall 1995

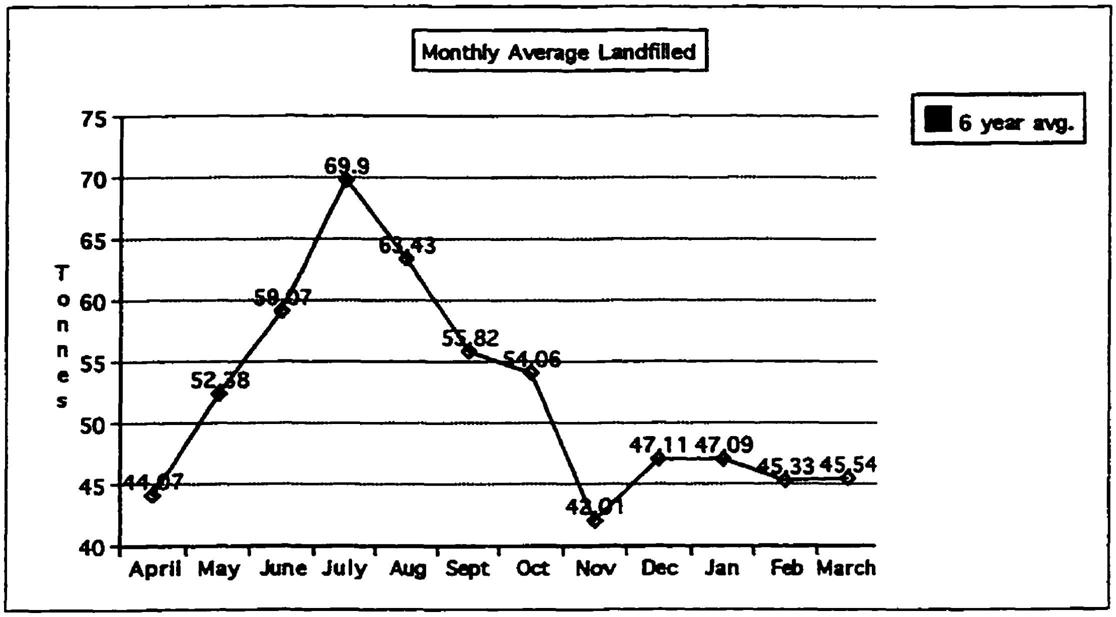
1995/96 Volume of Material Landfilled	
Location	Cubic Yards
Forks Market	8400
Forks Site	1536
Johnston Term	1080
Mondetta Cafe	576
Total	11592

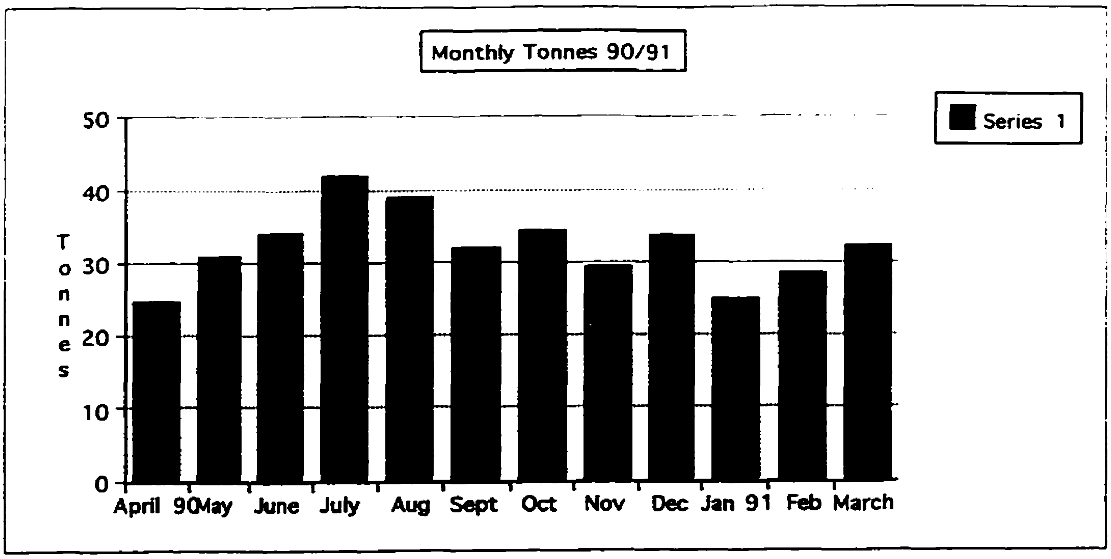


Market	Landf Market Landfill Fees
90/91	$7732.40
91/92	$11232.50
92/93	$17989.80
93/94	$24960.60
94/95	$32864.80
95/96	$31777.20



Monthly Averag	6 year avg.
April	44.07
May	52.38
June	59.07
July	69.9
Aug	63.43
Sept	55.82
Oct	54.06
Nov	42.01
Dec	47.11
Jan	47.09
Feb	45.33
March	45.54

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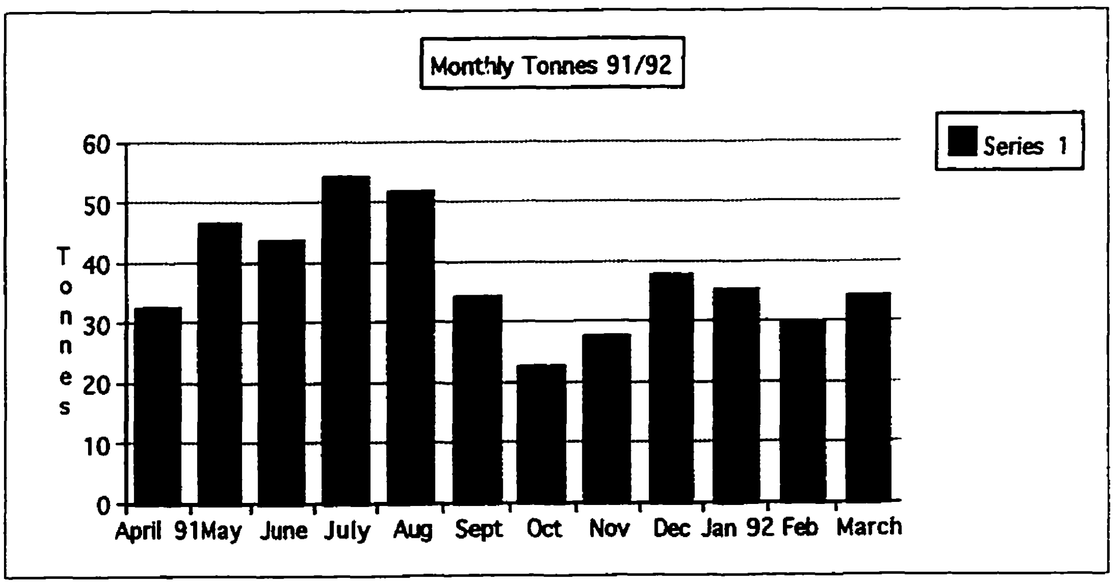
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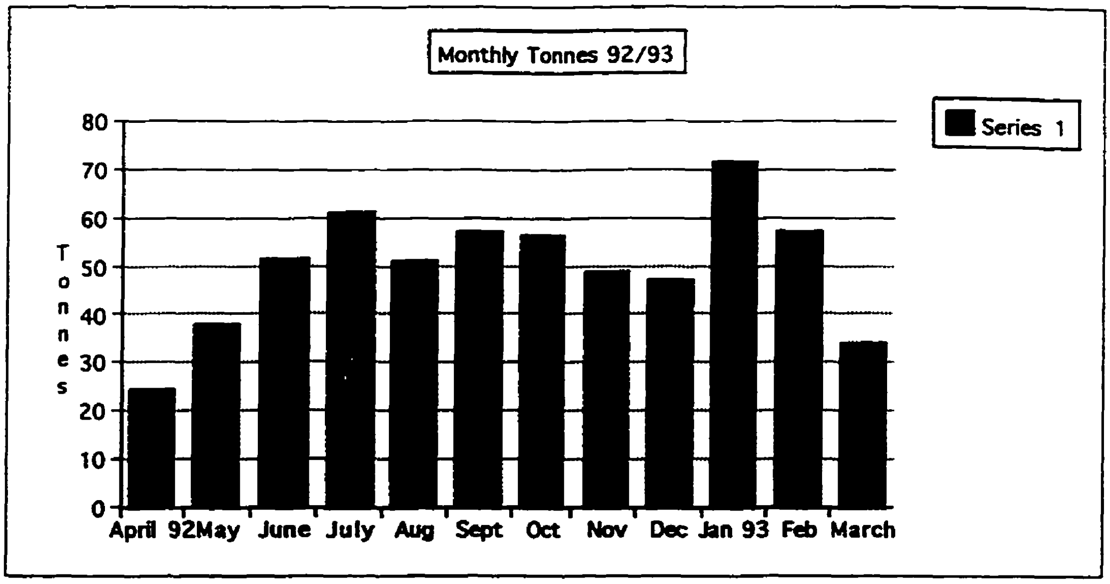

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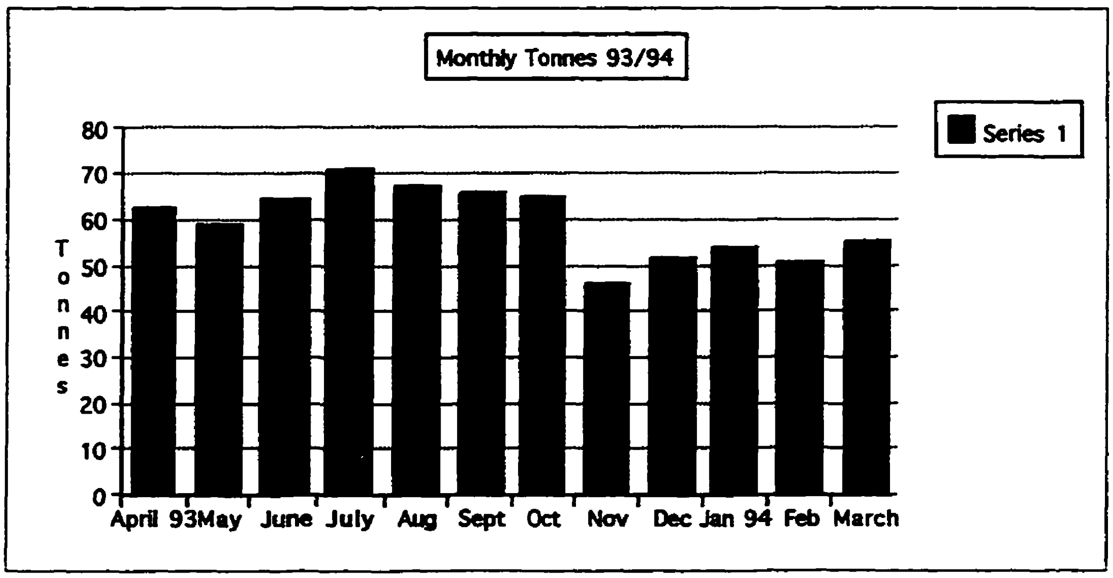

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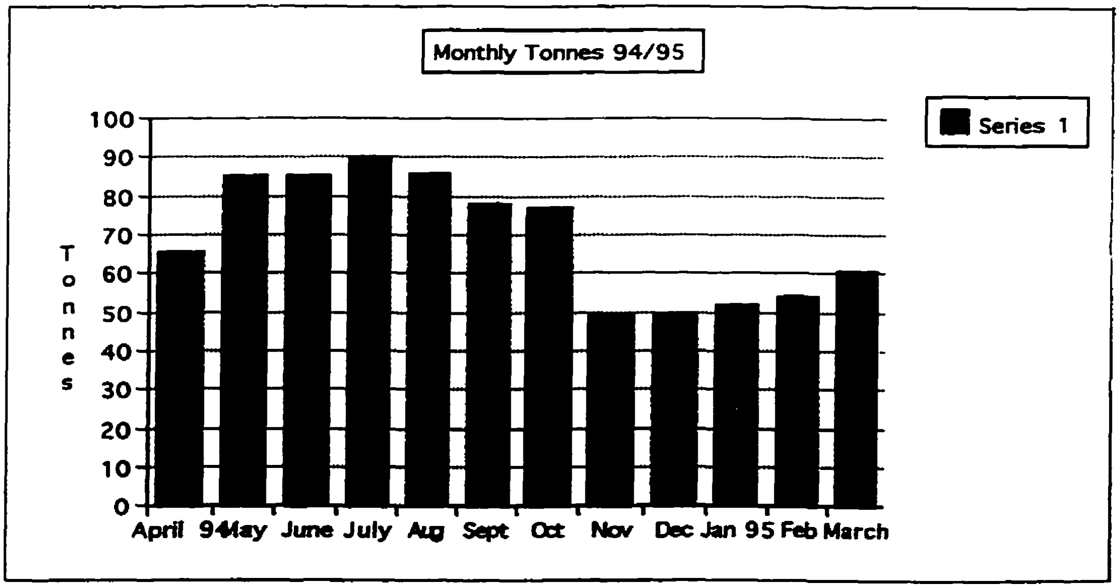
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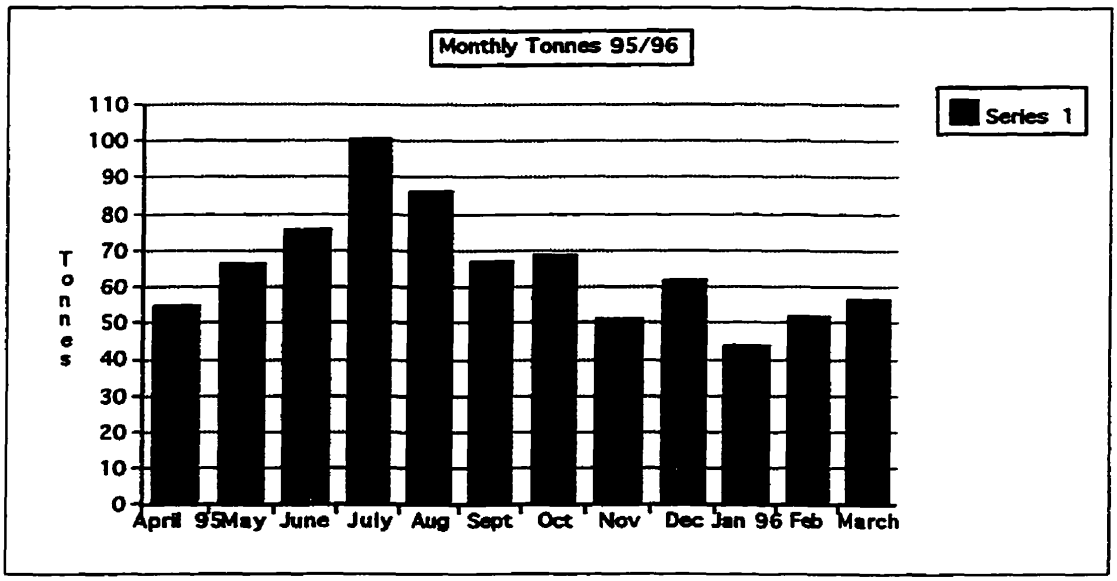
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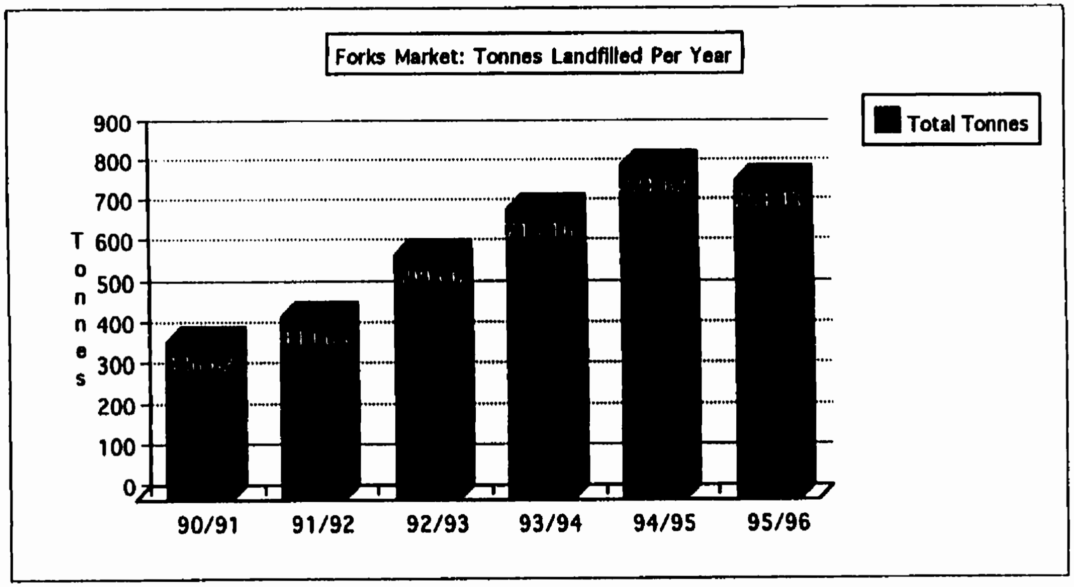
March

	Total Tonnes
90/91	386.62
91/92	449.65
92/93	599.66
93/94	713.16
94/95	821.62
95/96	784.43



APPENDIX B

National Survey of Composting Operations in Canada

NATIONAL SURVEY OF COMPOSTING OPERATIONS IN CANADA

Second Edition

Environment Canada Environnement Canada

The Composting Council of Cana[illegible]
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This paper contains a minimum of 50% recycled fibres, including 10% post-consumer fibres.

NATIONAL SURVEY OF COMPOSTING OPERATIONS IN CANADA

Second Edition

May 1995

Environment Canada **The Composting Council of Canada**

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INTRODUCTION

The first national survey of composting facilities in Canada was conducted from November 1992 through March 1993. Done by Michael Gibson and Dr. Lambert Otten of the School of Engineering of the University of Guelph, the survey results were published jointly by Environment Canada and The Composting Council of Canada.

This survey is an update of the 1993 effort on the basis of telephone interviews during the summer of 1994 and the first three months of 1995. In addition to information on composting sites in each province or territory, the survey includes summaries of the regulatory regime applicable in the various provincial and territorial jurisdictions in Canada with respect to the siting of composting facilities and the use of compost.

The survey is a collective effort between The Composting Council of Canada, Environment Canada and all provincial or territorial Ministries and Departments of the Environment. The latter supplied descriptions of the regulatory regime in their respective jurisdictions, as well as copies of Acts, Regulations and Guidelines with respect to the production and use of compost. Their cooperation in preparing this document is gratefully acknowledged, as is the financial support received for carrying out this work from Environment Canada and the Ontario Ministry of Environment and Energy, including the Ontario Environmental Youth Corps.

SURVEY RESULTS

Table 1 shows the results of the 1993 and 1995 national surveys of composting facilities in Canada.

- The 1995 survey identifies a total of 162 facilities, 112 municipal and 50 private. This reflects a growth rate of approximately 17% or an increase of 25 facilities versus 1993 (an increase of 11 municipal and 14 private facilities).
- The Province of Ontario and Québec continue to have the largest number of facilities, accounting for 86 facilities or 53% of total.
- The most significant growth in the number of composting facilities has been in Alberta (an increase of +7 sites to 19 facilities) and New Brunswick (an increase of +7 sites to 14 facilities). This increase is attributable to greater emphasis on composting's role in the province's integrated waste management plan as well as potentially improved survey coverage.
- The increase in private facilities (an increase of +26 sites to 50 facilities) is due in part to improved survey coverage, particularly in the Province of Québec, and in part, to real increase.

Table 1
Summary of Private and Municipal facilities in Canada for 1993 and 1995

	1993			1995		
Province	Public	Private	Total	Public	Private	Total
Newfoundland	2	3	5	2	5	7
Prince Edward Island	1	1	2	1	1	2
Nova Scotia	7	1	8	5	1	6
New Brunswick	2	5	7	5	9	14
Quebec	22	3	25	16	14	30
Ontario	35	18	53	43	13	56
Manitoba	8	-	8	8	-	8
Saskatchewan	1	1	2	5	1	6
Alberta	11	1	12	15	4	19
British Columbia	11	2	11	10	2	12
Yukon	1	1	2	2	-	2
Total	101	36	137	112	50	162

What these figures do not reveal, however, is the significant increase in quantities of organic waste processed at these facilities. The 1993 survey calculated that the total annual amount of organic waste processed was 275,000 tonnes. This has increased to approximately 697,000 tonnes annually, an increase of 154%.

If we estimate that the total organic fraction of Canada's waste stream is approximately 6.2 million tonnes per year, we must conclude that centralized composting now diverts 11% of the volume versus 4.4% in 1993.

The most common processing technology continues to be windrows; with naturally or actively aerated static piles as the second most common technology. In-vessel systems exist at 9 sites, excluding on-site composting.

Table 2 shows the relative share of the public (municipal) composting facilities as compared to the private operations in addition to the total and absolute averages of processed waste for those facilities reporting quantity. The "adjusted average" is calculated by deleting the largest operations from both types (ie. in the case of the municipal facilities, Metro Toronto was excluded and Les Composts du Québec, in Québec, and Consolidated Envirowaste in Abbotsford, B.C. were excluded from the private facilities). After these adjustments, it appears that the private facilities have, on average, approximately 2,545 tonnes more throughput annually than municipal facilities.

Table 2

Annual Tonnages of Processed Waste as Reported by Public and Private facilities for 1994

		Total tonnage in 1994 tonnes	%	Average tonnage per plant	Index to Total	Adjusted tonnage per plant	Index to Total
Municipal	112	293,014	42	2,616	61	2,009	72
Private	50	403,570	58	8,071	188	4,554	164
Total	162	696,584	100	4,300		2,777	

THE REGULATORY ENVIRONMENT

In addition to reporting the number of centralized composting facilities in Canada, this survey also considered the regulatory regime across the country as it applies to compost production and use.

As can be seen from the following sections, not all provinces are equally far advanced with respect to publishing or promulgating guidelines or regulations with respect to the production and use of compost. Going from east to west, the provinces that are the most advanced with respect to regulating the production and use of compost are Nova Scotia, New Brunswick, Québec, Ontario, and British Columbia. Each provincial section on the following pages is prefaced with a summary of the applicable regulatory regime, as well as addresses of the responsible authorities in that province or territory. For specific enquiries, the reader is advised to consult the original regulatory documents and to contact the appropriate provincial or territorial authority.

At the time of this survey, two national sets of discussions are proceeding with respect to national compost quality standards. The first set of discussions is taking place under the aegis of the Canadian Council of Ministers of the Environment (CCME), whereas the second set of discussions, with emphasis on industry participation, is being led by the Bureau de normalisation du Québec (BNQ), acting on behalf of the Standards Council of Canada.

The Standards Council of Canada (SCC) coordinates voluntary industry standardization activities in Canada, and represents Canada in the International Organization for Standardization (ISO). Five standards-writing organizations are accredited by the SCC; one is the BNQ. Within the SCC, the BNQ is recognized as having primary responsibility for fertilizations, organic fertilizers and soil supplements. As such, the BNQ is the only standards-writing organization of the SCC accredited to develop industry standards for compost.

The two sets of standards are, in part, based on the concept of no-net-degradation, and in part, on the concept of best achievable results. The no-net-degradation approach requires that the application of compost with certain concentrations of heavy metals not change the normal background levels of those compounds in the environment. The best-achievable-results approach takes that to be the standard. The development of the two sets of standards now being discussed in Canada has been guided by the no-net-degradation approach, but has taken into account the provincial standard of British Columbia which is based on "what is achievable through well-managed source-separation programs." The two approaches produce rather stringent, but harmonized results as can be seen in Table 3.

Table 3

CONCENTRATION OF TRACE ELEMENT UNITS FOR CANADIAN NATIONAL COMPOST AS PROPOSED BY CCME AND BNQ in mg/kg dry weight

Heavy Metal (or Trace Element)	CCME/BNQ Proposal Category A, AA	CCME Proposal Category B	BNQ Proposal Category B
Arsenic	13	75	75
Cadmium	3	20	20
Cobalt	34	150	150
Chromium	210	*	1060
Copper	100	*	757
Mercury	0.8	5	5
Molybdenum	5	20	20
Nickel	62	180	180
Lead	150	500	500
Selenium	2	14	14
Zinc	500	1850	1850

* Limits for Chromium and Copper are still being considered for Class B under the CCME standard.

As can be seen from Table 3, both proposed standards recognize two "tiers" of quality: Class A (and AA) and B. Class A (and AA) compost would have no restrictions as to its use, whereas the use of Class B compost could be governed by Provincial regulation and would typically be restricted to applications related to forest lands and roadsides, the rehabilitation of mine sites, and other landscaping purposes. The designation, Class AA under the BNQ proposal, refers to Class A compost that is free of foreign material.

In terms of international comparison, the proposed CCME/BNQ standard falls in a family of environmentally-stringent standards that have been set for the Netherlands, Austria, Germany, Denmark, Switzerland, and those proposed for Italy. The family includes the Canadian provincial standards for British Columbia, Ontario, and Nova Scotia.

MARKETS

Composting in Canada has made significant advances over the past two years, not only as a waste management strategy, but also as a form of recycling that produces an environmentally-responsible and desirable product. The development of quality standards is of great importance in this regard and will allow ever-increasing use of compost for horticultural, agricultural and landscaping purposes. Moreover, if Canada is to meet its target of 50% waste reduction by the year 2000, the increased use of composting is essential.

This is the first survey in which the respondents were asked about the markets for their product. The answers show the increased importance of agricultural and horticultural applications of compost, particularly in Atlantic Canada, Quebec and Western Canada. With increased understanding of the horticultural and agricultural advantages of compost will come increased demand for compost as an environmentally-responsible product for a host of applications as a soil amendment and growing medium.

APPENDIX C

Guidelines for Compost Quality

CCME

Canadian Council of Ministers of the Environment
Le Conseil canadien des ministres de l'environnement

Guidelines for Compost Quality

CCME 106 E
March 1996

Guidelines for Compost Quality

prepared by the

Composting Subcommittee
Solid Waste Management Task Group
Canadian Council of Ministers of the Environment

CCME 106 E
March 1996

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Readers' Comments

The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international, and global concern. The 13 member governments work as partners in developing nationally consistent environmental standards, practices, and legislation.

Readers who wish to comment on this report should address their comments to:

Waste Treatment Division
Hazardous Waste Branch
Environmental Protection Service
Environment Canada
Ottawa, Ontario
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Ce rapport est aussi disponible en français sous le titre:
Critères de qualité du compost.

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CCME Documents
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Abstract

Recognizing the likelihood of significant growth within the composting industry and the potential health and environmental concerns associated with compost, the CCME Solid Waste Management Task Group established a national committee to develop quality guidelines for compost that is sold or given away. The CCME, Agriculture and Agri-Food Canada, and the Bureau de normalisation du Québec agreed to coordinate efforts in an attempt to develop compost standards that provide a significant level of consistency, while being flexible enough to accomodate different (e.g., regional) interests, and issues.

These compost guidelines are based on the following four criteria for product safety and quality: foreign matter, maturity, pathogens, and trace elements. These guidelines attempt to integrate the concept that exposure is an integral part of risk by establishing two grades (unrestricted and restricted grade) of material. These guidelines will help protect public health and the environment, and help composting to develop as an important waste/resource management solution.

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Glossary

Aerated static pile composting is a heap of compostable materials so formed as to promote the aerobic decomposition of the organic matter. Ventilation is either provided by passive or forced aeration, rather than through frequent agitation.

Compost is a solid mature product resulting from composting. Composting, which includes a thermophilic phase, is a managed process of bio-oxidation of a solid heterogeneous organic substrate.

Contaminant is an element, compound, substance, organism, or form of energy which through its presence or concentration causes an adverse effect on the natural environment or impairs human use of the environment.

Foreign matter is any matter resulting from human intervention and made up of organic or inorganic components such as metal, glass, synthetic polymers (e.g., plastic and rubber) that may be present in the compost. Foreign matter does not include mineral soils, woody material, and rocks.

In-vessel composting is a diverse group of composting methods in which composting materials are contained in a reactor or vessel; the purpose is to maintain optimal conditions for composting.

Municipal Solid Waste (MSW), for the purpose of this guideline, means solid non-hazardous refuse that originates from residential, industrial, commercial, institutional, demolition, land clearing, or construction sources.

Pathogens are organisms, including some bacteria, viruses, fungi, and parasites, that are capable of producing an infection or disease in a susceptible human, animal, or plant host.

Sludge is a semi-solid substance consisting of settled sewage solids combined with varying amounts of water and dissolved materials generated from municipal or industrial wastewater treatment plants.

Source separation refers to the separation of wastes into specific types of material at the point of generation.

Thermophilic phase is a biological phase in the composting process characterized by the predominance of active micro-organisms which thrive at a temperature range of 45 to 75°C.

Windrows are elongated piles of triangular or trapezoidal cross-section that are turned in order to aerate and blend the material.

Acknowledgements

The Solid Waste Management Task Group of the Canadian Council of Ministers of the Environmer (CCME) would like to express their appreciation to the Composting Subcommittee for producing tl "Guidelines for Compost Quality". The following members of the subcommittee are acknowledgec for their assistance in developing these guidelines.

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Introduction

In 1992, Canadians disposed of about 21 million tonnes (Environment Canada, 1995) of municipal solid waste each year, and organic waste makes up a significant fraction of this amount (about 50%). If waste reduction targets set by the Canadian Council of Ministers of the Environment (CCME) are to be achieved (50% reduction by the year 2000, relative to a 1988 base year), the composting of organic waste material is essential.

In addition to the amount of waste going to landfill, composting also returns nutrients and organic matter to the soil, making it a valuable amendment for landscaping, horticulture, and agriculture. It is not suprising, then, that industry and municipalities have implemented large-scale composting operations.

Recognizing the likelihood of significant growth of composting operations and the potential health and environmental concerns associated with the use of compost, the CCME Solid Waste Management Task Group established a national committee to develop guidelines for compost products. By setting standards for the quality of compost material, the guidelines would help protect public health and the environment, as well as ensure that compost products are beneficially used. The composting industry would also benefit since the guidelines would help secure compost as a beneficial soil amendment, increase the demand for organic materials, and encourage source separation. In short, the guidelines would help organic materials to be regarded as a resource rather than a waste.

1.1 Background

Several standard-setting organizations across Canada are mandated to regulate compost and or write standards concerning compost. These include the federal government, provincial and territorial governments, and the *Bureau de normalisation du Québec (BNQ)*, acting on behalf of the Standards Council of Canada (SCC)*. Within the federal government, Agriculture and Agri-Food Canada (AAFC) administers the *Fertilizers Act* that regulates fertilizers and soil supplements sold in Canada. Agriculture and Agri-Food Canada, therefore, regulates compost when it is sold either as a soil amendment or as a product with plant nutrient claims. The provinces and territories regulate the disposal and beneficial use of wastes, and therefore, the production and use of compost. In its role, acting on behalf of the SCC, the BNQ establishes industry standards for adoption by the SCC and endorses products that meet their standards.

When the CCME began developing national compost guidelines, different sets of standards for several aspects of compost existed among the federal and provincial regulators. These included standards for trace element concentrations and product labelling under the federal *Fertilizers Act* (AAFC), the *B.C. Waste Management Act: Production and Use of Compost Regulation*, and the "Interim Guidelines for the Production and Use of

* The SCC coordinates voluntary industry standardization activities in Canada and represents Canada in the International Organization for Standardization (ISO). Five standard-writing organizations are accredited by the SCC, one of which is the BNQ. Within the SCC, the BNQ is primarily responsible for standardizing fertilization, organic fertilizers, and soil supplements. As such, the BNQ is the only standard-writing organization of the SCC accredited to write industry standards for compost.

Aerobic Compost in Ontario". Federal and provincial regulators, as well as the BNQ/ SCC, were in the process of developing additional standards for compost safety and quality. In January 1993, stakeholders met in Ottawa to discuss and evaluate the existing and future compost standards, and the general regulatory situation pertaining to compost. As a result, the parties agreed to coordinate efforts in an attempt to develop compost standards that provide a significant level of national consistency, while being flexible enough to accommodate different interests (e.g., regional) and issues.

It was recognized that, due to the different mandates and objectives of the CCME, AAFC, and BNQ, three separate documents must be produced. These would consist of CCME Guidelines (for use by provinces and territories adopting new regulations for compost); a Trade Memorandum describing compost standards adopted under AAFC's *Fertilizers Act*; and BNQ or SCC voluntary industry standards.

A sound and consistent approach is more likely to decrease frustration and increase the level of credibility of all public agencies and standard-setting organizations involved in this exercise.

1.2 Objectives

The objectives of these guidelines are to:

- protect public health and the environment across the country;
- encourage source separation of MSW to produce a high quality compost product;
- produce compost standards that are fairly consistent across the country, while accommodating different interests and issues;
- ensure consumer confidence through consistent nationwide product quality standards; and
- ensure that composting develops as an important waste/resource management solution and an environmentally sound industry that diverts valuable organic materials from landfills and incineration.

1.3 Scope and Applicability

These guidelines apply to compost produced from municipal solid waste (MSW) or other feedstock as determined by regulatory agencies. They apply to compost that is sold or given away. These guidelines do not apply to on-site composting such as residential backyard composting or on-farm composting of materials generated on-site with use of finished compost on-site. Specific definitions and regulatory information on on-site composting can be obtained from the provincial/territorial contacts listed in the Appendix.

These guidelines do not apply to compost-based products, e.g., potting soil mixes, although, the provinces may wish to apply or modify the guidelines for these products.

Due to the diversity of regulatory approaches that exists in Canada, these guidelines apply to the quality of compost rather than the composting process. Provinces will develop individual siting and operating guidelines to accommodate jurisdictional needs.

In response to special concerns, a province or territory may decrease or increase the number of parameters to be analyzed and the frequency of analysis based on monitoring data, changes in the waste stream or processing techniques, effectiveness of source separation programs, or the potential presence of toxic substances.

Section 2

Product Safety and Exposure

For sale or use products must be safe. However, by the same token "safety" (or "risk") is a function of exposure. When assessing the safety of a product, exposure must also be considered; if there is no exposure there can be no "risk". Ultimately, exposure is a function of the quantity, the intended use, and the users of a product. The question then becomes whether a product is "safe enough" for "use as intended". It should be recognized that a product may be safe for one type of use and user, but not for another use in which, the product may be further exposed to the public, water, environment, or plants in the food chain. These guidelines attempt to integrate the concept that exposure is an integral part of risk by establishing different grades of material (unrestricted and restricted grade) on the basis of safety and quality.

Compost Product Guidelines

These compost guidelines are based on the following four criteria for product safety and quality: foreign matter, maturity, pathogens, and trace elements.

The standards for compost quality are summarized in this section. For additional information on the limits recommended, please refer to the "Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria]".

3.1 Categories

Two compost categories have been developed for trace element concentrations. These categories (A and B) are based on the end use of the compost material.

Category A- Compost that can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other businesses.

Category A criteria for trace elements are achievable using a source separated MSW feedstock. The trace element criteria meet or are more stringent than the current CCME interim soil quality criteria for contaminated sites.

Category B- This is compost that has a restricted use. Compost may require some control when deemed necessary by a province or territory.

Please note that for a compost to meet the unrestricted use category, it must meet the unrestricted (Category A) requirements for all trace elements. If the compost fails one criterion of the guideline for unrestricted use but meets the criteria for restricted (Category B) use, then it is classified as a Category B product. Products that do not meet the criteria for either Category A or B must be used or disposed of appropriately.

3.2 Trace Elements

Trace elements, i.e., mercury, cadmium, lead, may be present in the raw materials from which compost products are produced. Although some trace elements, e.g., copper, molybdenum, zinc, are plant micro-nutrients, compost applied to land without monitoring trace element concentrations could cause adverse effects on human health or the environment.

The concentrations of trace elements in the finished compost (Categories A and B) and the cumulative additions to soil (Category B) shall not exceed those levels provided in Table 1 as calculated on a dry weight basis.

3.3 Foreign Matter in Compost

Foreign matter in compost, also referred to as inerts, nonbiodegradables, and contraries, is material that is not biodegradable and as such detracts from good quality compost. As most compost feedstocks and products contain foreign matter, the following quality criteria are important.

Compost should be virtually free of foreign matter that may cause nuisance, damage, or injury to humans, plants, or animals during or resulting from intended use. It should contain no sharp foreign matter measuring more than 3 mm in any dimension and no foreign matter greater than 25 mm in any dimension.

Table 1 Concentrations of Trace Elements in Compost and Cumulative Trace Element Additions to Soil

	CATEGORY A	CATEGORY B	
Trace Elements***	Maximum Concentration within Product (mg/kg dry weight)	Maximum Concentration within Product* (mg/kg dry weight)	Maximum Cumulative Additions to Soil* (kg/ha)
Arsenic (As)	13	75	15
Cadmium (Cd)	3	20	4
Cobalt (Co)	34	150	30
Chromium (Cr)	210	**	**
Copper (Cu)	100	**	**
Mercury (Hg)	0.8	5	1
Molybdenum (Mo)	5	20	4
Nickel (Ni)	62	180	36
Lead (Pb)	150	500	100
Selenium (Se)	2	14	2.8
Zinc (Zn)	500	1850	370

* These concentrations are the existing standards under Agriculture and Agri-Food Canada's *Fertilizers Act* (Trade Memorandum, T-4-93, January 2, 1991).

** Limits for copper and chromium are not established in the *Fertilizers Act*. Calculated in the same manner as limits for the other nine elements, the limits for chromium and copper would be: chromium = 210 kg/ha and copper = 150 kg/ha for the maximum acceptable cumulative trace element additions to soil, and chromium = 1060 mg/kg and copper = 757 mg/kg for maximum acceptable trace element concentrations within the compost product. Details of these calculations are in the "Support Document for the Bureau de normalisation du Québec Standard and the Canadian Council of Ministers of the Environment and Agriculture and Agri-Food Canada Guidelines".

Agriculture and Agri-Food Canada will begin a consultation process for adopting limits for chromium and copper. The CCME will re-evaluate these parameters when this process is complete. The CCME Compost Subcommittee recognizes that the effect on liquid waste management of setting specific limits for copper has yet to be determined.

*** Concentrations of other elements, such as boron, manganese, aluminum, and iron, may eventually be regulated in certain provinces to accommodate regional and national concerns.

3.4 *Maturity of Compost*

Characteristics of mature compost include biostabilization and humus formation. Guidelines for compost maturity are necessary as immature product has the potential to cause adverse effects on plants when applied in large amounts.

At present, no single test of compost maturity is reliable and sufficient by itself, therefore, the use of more than one test is recommended. The compost shall conform to one of the following:

1. Two of the following three test requirements shall be met:

    a) Testing for the ratio of carbon and nitrogen, which must be: $C/N \leq 25$

    b) Oxygen uptake, which shall be: < 150 mg O_2 /kg organic matter (volatile solids) per hour

    c) The germination of cress (*Lepidium sativum*) seeds and radish (*Raphanus sativus*) seeds in compost shall be greater than a value corresponding to at least 90% of the germination rate of the control sample, and plant growth rate of the compost-soil mix shall not be less than 50% in comparison to plant growth of the control sample.

OR

2. The compost must be cured for a minimum of 21 days and the compost will not reheat upon standing to greater than 20° C above ambient temperature.

OR

3. The compost must be cured for a minimum of 21 days and the reduction of organic matter must be > 60% by weight.

OR

4. If no other determination of maturity is made, then the compost must be cured for a six-month period. The state of the curing pile must be conducive to aerobic biological activity. The curing stage begins when the pathogen reduction process is complete and the compost no longer reheats to thermophilic temperatures.

3.5 *Pathogens in Compost*

As pathogenic organisms may be present in the compost feedstock, the compost itself may also contain pathogenic organisms and, as a result, may pose health risks. To adequately reduce these health risks, the compost shall conform to the criteria outlined in either a) or b) depending on the feedstock source.

a). When a compost does not contain feedstock high in human pathogens, the following criteria shall be met:

1. The compost shall undergo the following treatment or other process recognized as equivalent by the relevant province or territory.

    Using the **in-vessel composting method**, the material shall be maintained at operating conditions of 55° C or greater for three days.

    Using the **windrow composting method**, the material shall attain a temperature of 55° C or greater for at least 15 days during the composting period. Also, during the high temperature period, the windrow shall be turned at least five times.

Using the **aerated static pile composting method,** the material will be maintained at operating conditions of 55° C or greater for three days. The preferable practice is to cover the pile with an insulating layer of material, such as cured compost or wood chips, to ensure that all areas of the feed material are exposed to the required temperature.

OR

2. Organisms shall meet the following:

fecal coliforms <1000 most probable number (MPN)/g of total solids calculated on a dry weight basis,

AND

Salmonella sp. <3 MPN/4g total solids calculated on a dry weight basis

Note: fecal coliforms are good indicators of pathogenic bacteria

b). When compost contains feedstock high in human pathogens, the following criteria shall be met:

1. Undergo a treatment (described in a) or other process recognized as equivalent by the relevant province or territory.

AND

2. Organisms shall meet the following:

fecal coliforms <1000 MPN/g of total solids calculated on a dry weight basis,

OR

Salmonella sp. <3 MPN/4g total solids calculated on a dry weight basis

3.6 Organic Contaminants in Compost

Organic chemicals enter waste streams from a variety of industrial and domestic sources. While many degrade or volatilize during wast collection, treatment (includes composting) a storage, some of these organic chemicals persist. However, the risk of contamination b organic compounds is negligible in the majori of composts, e.g., leaf and yard waste compos As well, the lack of information about the presence of organic contaminants in other typ of compost prevents the inclusion of any requirements in a national guideline. The provinces/territories and federal government can establish specific requirements for organic contaminants based on feedstock source, e.g., some industrial sludges. For specific example in each province, contact the organizations listed in the Appendix.

More information is required about organic contaminants in Canadian compost, and existing data must be compiled, reviewed, and evaluated, with particular focus on dioxins, furans, and pesticides.

Section 4

Sampling and Analytical Methods for Testing Compost Quality

The following documents can be used as a basis for sampling and analytical test methods.

CAN/BNQ 0413-200-M95 - Amendement organiques - Composts (Organic Soil Conditioners - Compost)

CAN/BNQ 0413-210-M95 - Amendements organiques - Détermination de la teneur en corps étrangers - Méthode granulométrique (Organic Soil Conditioners -Determination of Foreign Matter Content - Sieving Method)

CAN/BNQ 0413-210-M95 - Amendements organiques - Détermination du taux d'assimilation d'oxygène - Méthode respirométrique (Organic Soil Conditioners - Determination of Oxygen Uptake - Respirometric Method)

These are available at the Bureau de normalisation du Québec, 70 Dalhousie Street, Suite 220, Quebec, Quebec, G1K 4B2,
☎ (418) 644-5114 or 1-800-386-5114,
📠 (418) 646-3315

References

AC (Agriculture Canada), "Metal Concentrations in Processed Sewage and By-products", Trade memorandum T-4-93, Ottawa, Ontario, p. 3 (January 2, 1991).

BC (British Columbia), "Waste Management Act: Production and Use of Compost Regulation", British Columbia Regulation 334/93, p. 15 (November 19, 1993).

CCME (Canadian Council of Ministers of the Environment), "Interim Canadian Environmental Quality Criteria for Contaminated Sites", Report CCME EPC-CS34 (September, 1991).

OMEE (Ontario Ministry of Environment and Energy), "Interim Guidelines for the Production and Use of Aerobic Compost in Ontario", Toronto, Ontario (November 1991).

"Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria]", Final Version (March 1996).

Appendix

Provincial, Territorial, and Federal Contacts

Province/Territory/Federal	Organization	Telephone/Fax
Alberta	The Action on Waste Division Alberta Environmental Protection 1401, Standard Life Centre 10405 Jasper Avenue Edmonton, Alberta T5J 3N4	☎ (403) 422-8466 Fax (403) 427-1594
British Columbia	Municipal Waste Reduction Branch Ministry of the Environment, Lands and Parks 777 Broughton Street Victoria, British Columbia V8V 1X5	☎ (604) 387-6663 Fax (604) 356-9974
Federal Government	Fertilizer Section, Plant Products Division Agriculture and Agri-Food Canada 59 Camelot Drive, 3rd Floor, East Ottawa, Ontario K1A 0Y9	☎ (613) 952-8000 Fax (613) 992-5219
Manitoba	Pollution Prevention Division Department of Environment 139 Tuxedo Avenue, Building 2 Winnipeg, Manitoba R3N 0H6	☎ (204) 945-8443 Fax (204) 945-1211
New Brunswick	Solid Waste and Recycling Section New Brunswick Department of the Environment 364 Argyle Street, 1st Floor, Box 6000 Fredericton, New Brunswick E3B 5H1	☎ (506) 457-4848 Fax (506) 457-7805
Newfoundland	Environmental Management Division, Department of Environment Confederation Building West Block P.O. Box 8700 St. John's, Newfoundland A1B 4J6	☎ (709) 729-2556 Fax (709) 729-1930
Northwest Territories	Environmental Protection Division Department of Renewable Resources Government of Northwest Territories 600, 5102-50 Avenue Yellowknife, NWT X1A 3S8	☎ (403) 873-7654 Fax (403) 873-0221

Nova Scotia	Resource Management & Pollution Control Division Department of the Environment 5151 Terminal Road, 5th Floor P.O. Box 2107 Halifax, Nova Scotia B3J 3B7	☎ (902) 424-2387 Fax (902) 424-0503
Ontario	Program Implementation Section Waste Reduction Office Ontario Ministry of the Environment and Energy 40 St. Clair Avenue West, 7th Floor Toronto, Ontario M4V 1M2	☎ (416) 325-4440 Fax (416) 325-4437
Prince Edward Island	Waste Management Section Environmental Protection Division PEI Environmental Resources 11 Kent Street, 4th Floor, Box 2000 Charlottetown, Prince Edward Island C1A 7N8	☎ (902) 368-5029 Fax (902) 368-5830
Québec	Ministère de l'Environnement et de la Faune Service de l'assainissement agricole et des activités de compostage 2360, chemin Ste-Foy, 2e étage Sainte-Foy (Québec) G1V 4H2	☎ (418) 644-6588 Fax (418) 528-1035
Saskatchewan	Municipal Unit Standards and Approvals Section Municipal Branch Saskatchewan Environment and Resource Management 3211 Albert Street Regina, Saskatchewan S4S 5W6	☎ (306) 787-6200 Fax (306) 787-5623
Yukon	Environmental Protection and Assessment Branch Department of Renewable Resources Government of Yukon 10 Burns Street, Box 2703 Whitehorse, Yukon Y1A 2C6	☎ (403) 667-5683 Fax (403) 667-4727

APPENDIX D

Quick Service Restaurant Council Source Separation Program

QSRC

Quick Service Restaurant Council

The Quick Service Restaurant Council (QSRC), a sector council of the Canadian Restaurant and Foodservices Association (CRFA) is delighted to join CORCAN in welcoming you to the official opening.

QSRC has worked with CORCAN to design a program to compost organics from over 80 restaurants in the Kingston area. A first of its kind in North America, this source separation program has allowed quick service restaurants to divert food and paper waste from landfill. Organic waste represents over 70% of the restaurant waste stream.

CORCAN and the City of Kingston should be proud of their lead role in establishing the infrastructure to compost commercial food waste.

The CORCAN composting facility has developed new community partnerships between local restaurants, local waste haulers, Laidlaw and A&B Disposal and municipal government.

Please join us to celebrate this outstanding initiative which demonstrates that stakeholders in the community are thinking locally and acting globally.

Pride in their community is the reason that competitors in food production have become partners in waste reduction.

[redacted]

Quick Service Restaurant Council
316 Bloor Street West, Toronto, Ontario, M5S 1W5

Restaurant Industry Invests in Composting

Background:

The Quick Service Restaurant Council, or QSRC, was formed in 1991 by quick service restaurant companies and suppliers to the industry with the mandate to meet or exceed waste reduction goals established by federal and provincial governments. The QSRC is a sector council of the Canadian Restaurant and Foodservices Association (CRFA).

Extensive research undertaken by QSRC in 1992 revealed that 66% of waste from quick service restaurants is organic (paper and food). Armed with this information QSRC has invested considerable resources to investigate the feasibility of composting. One of its recent initiatives is the Kingston source separation pilot project:

* Launched in November 1994, this QSRC initiative was a 4-month pilot composting project in the City of Kingston.

* In conjunction with Correctional Service Canada (CORCAN) and the local waste haulers, QSRC developed a source separation program for 24 quick service restaurants in Kingston.

* QSRC developed the program, bought specialized equipment, produced important information materials and provided extensive training in each restaurant.

Results:

* At the conclusion of the four month pilot composting project, the 24 restaurants in Kingston diverted almost a third (30%) of their waste from the local landfill site. Organic waste is now being sent to a centralized composting facility operated by CORCAN.

* In addition to significantly diverting their waste from landfill, these composting pioneers have also reported an average savings of 25% on their waste hauling fees.

Future Direction:

* Due to the success of the pilot composting project, the program has been extended.

* There are important questions that still must be addressed before this project can be expanded including cost assessments in each jurisdiction and identifying other appropriate centralized composting facilities.

* Any restaurant wishing to find out more about this program should contact Anne Kothawala at CRFA (416) 923-8416 or 1-800-387-5649.

CRFA is the largest hospitality association in Canada representing 11,700 corporate members controlling more than 35,000 outlets. CRFA members include restaurants, quick service establishments, hotels, caterers, institutions, educators and foodservice suppliers.

Canada's $27 billion foodservice industry employs more than 667,000 Canadians.

QSRC

QUICK SERVICE RESTAURANT COUNCIL

Partners in Waste Reduction

PLEASE SEPARATE THE FOLLOWING ITEMS

ALL FOOD WASTE	ALL PAPER PRODUCTS
• Cooked Food	• Paper Towels & Napkins
• Raw Food	• Paper Packaging (Bags, Cups, Plates, Milk Cartons)
• Coffee Grounds & Filters	• Egg Trays
• Produce Trimmings	• Tray Liners
• Egg Shells	• Newspapers/ Office Paper
• Bones	• Boxboard
• Dairy Products	• Grease Filters

Do not include metal, glass or plastic.

REDUCE...REUSE...RECYCLE!

How the Program Works

In the Kitchen

- Staff in your kitchen will separate compostable materials from non-compostable materials in the kitchen area.
- Compostable materials are to be separated into the special brown bins - each bin must have a clear plastic liner bag.
- Important - clear plastic bags <u>must</u> be used - they are required for quality control so that we can identify materials at the composting site.
- Place the brown bins close to where the organic material is generated such as the preparation area, grill area or dishwasher - move them around if necessary.
- Full bags of compostable materials are to be taken to the special container in your corral or parking lot - this container will be emptied by your waste hauler and taken to Corcan.
- At Corcan, the material will be debagged and put through the composting process.
- The end product of this process will then be used to help fertilize soils in the Kingston area

In the Dining Area

Note: This applies only if your restaurant does not have waste receptacles for customers and uses people to clear tables!

- If your restaurant uses staff people to clear tables and dispose of garbage - then these people can also separate material for composting.
- Place the special brown container with clear liner bag at the tray cleaning area - employees will separate compostable from non-compostable material.
- In the future we will expand the program to include customer separation programs in specific restaurants - but for now it is only for employees.

Hints for Success

All waste diversion programs are based upon common sense. Nobody wakes up in the morning and says, "Wow, what a beautiful day, I think I'll go out and pollute". People want to do the right thing.

When training people for 3 R's programs (reduce, reuse and recycle) we like to follow the 3 E's - Educate, Encourage and Empower.

> Educate - inform staff of all aspects of the program, what they are doing, what materials to separate, where material is going and the benefits of waste diversion.
>
> Encourage - regular monitoring and reminders will encourage staff that they are doing the right thing - check the bins, if you come across some contamination, pull it out, if you know who put it in there, educate and encourage them to do better.
>
> Empower - By teaching employees the benefits of the program and the proper way to separate materials you are empowering them to operate the program themselves - then everybody is trying to divert as much material as possible with zero contamination.

Please remember these key points

1) **CONTAMINATION** - 3 E's - contamination is the single biggest issue when separating material for composting - make sure everyone is properly trained and empowered and is separating the proper compostable materials.

2) **Skimming** - it is good habit to occasionally look into the brown composting bins to make sure there are no contaminants - if you see some pull them out, if you know who put them there, educate and encourage them.

3) Do not let the bags get too full before emptying - compostable materials are heavy.

4) **When in doubt, throw it out!** If you are not sure about something ask a manager or throw it in the garbage.

5) **CONTAMINATION** - contaminants such as plastics or glass can cause problems at the composting facility - too much contamination will result in an extra charge - your staff must separate the materials properly.

QSRC - KINGSTON COMPOSTING PROJECT

✔ Acceptable Materials	✖ Unacceptable Materials
✔<u>Food Waste</u> fruits vegetables dairy products meat (including bones and fat) coffee grounds and filters egg shells bread and bakery products small amounts of grease grease filters ✔<u>Paper Products</u> food contaminated paper paper towels/paper napkins newspaper/magazines take-out bags and trays tray liners wax cups and plates box board (e.g. cereal box) ✔<u>Other Materials</u> office paper grass clippings/leaves plants wrapping paper ✔Special Materials small amounts of corrugated cardboard and wax coated cardboard can be composted if they are bundled separately (not in bags)	✖<u>Any type of plastic</u> polyethylene film rigid plastic containers coffee pouches polystyrene foam plastic cutlery/straws plastic condiment packages ✖<u>Other Materials</u> glass metal cans or foil tetra pack drink boxes laminated packaging diapers feminine hygiene products cloth/textiles painted or treated wood

APPENDIX E

On-site mid-scale composting

WRIGHT ENVIRONMENTAL MANAGEMENT INC.

RECEIVED

JAN 13 1998

THE FORKS NORTH
PORTAGE PARTNERSHIP

January 9, 1997

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Suite 200
Richmond Hill
Ontario, Canada
L4C 9S6
Tel: 905 881-3950
Fax: 905 881-2334

Mr. Andrew Wallace
Development Coordinator
The Forks North
Portage Partnership
201 - One Forks Market Road
Winnipeg, Manitoba R3C 4L9

Dear Mr. Wallace,

I enjoyed speaking with you and further to our discussion I have enclosed our corporate brochure and promotional video for your interest. The video was done at The Ontario Science Center Facility and is very descriptive of the composting process.

Wright Environmental Management have designed and developed an in-vessel composting technology which will compost all of the organics in a safe and cost effective manner. The unit requires no permanent structure or housing facility and by locating it in a central area, you could eliminate or substantially reduce costly tipping and transportation fees. The output from our process is a rich soil-like compost, *The Right Stuff*™, which can be returned to the land or taken to market. The unit once sited simply requires attachment to power and water hookup. The vessels are designed to accept hundreds of pounds to hundreds of tons of waste in a continuous load.

In addition to being able to compost the entire food and sludge waste streams, including red meats, bones, fish, poultry, greens, and all the dairy products, other waste amendments such as shredded waxed cardboard, soiled cardboard, shredded paper towels, grass, yard waste and wood chips can be added to provide carbon and increase porosity. *

Andrew, our technology is environmentally friendly, safe and efficient to operate and above all cost effective. Consultants from throughout North America and Europe, who have been mandated to examine current composting technologies, have stated that they have not been able to find anything like it. Since our introduction at the Ontario Science Center we have sold 42 systems in North America with one sited in Belfast Ireland. This is truly leading edge <u>**CANADIAN COMPOSTING TECHNOLOGY!**</u>

If you would like any additional information or if you would like to inspect any of our facilities, I would be happy to make the necessary arrangements.

It would be a pleasure to hear from you.

Yours truly,
WRIGHT ENVIRONMENTAL MANAGEMENT INC.

E.S. Boyd.

Edward S. Boyd
Manager: Sales & Marketing
Telephone: 1-905-881 3950 / FAX: 1-905-881 2334

* Cost estimates shown reflect our small range of composters
.Quotes for larger capacities available upon request:
Leasing options available upon request:

* Key design features which make the WEMI In-Vessel Composting system particularly safe, efficient and above all Cost Effective:

) Proven technology
) Cost Effective
) Completely enclosed, hence full odor control
) Continuous loading(Ours is not a static box. It can be loaded everyday.)
) Automatic Unloading
) Automatic mixing and addition of water in-vessel
) Containment of all exhaust air in-vessel for health & safety and containmnet of global warming gases
) Rapid thermophyllic composting allowing a limited retention time
) Zero Leachate discharge, no ground water contamination
) Sophisticated containment and treatment of all composting exhaust air
) Stainless Steel interior.Ensures minimal maintenance and long term life expectancy (20 to 30 years)
) Able to compost all of the organics, including biosolids
) Able to accommodate significant fluctuations in daily feedstock
) Ease of operation of vessel, through automatic material and tray floor advancement
) Modular construction, therefore ease of expansion for additional capacities. Very small footprint required.
) Maintenance of oxygen levels above 15%. Ours is an aerobic composting process
) Flexibility in control via manual adjustments in water addition rates and supply air humidity and temperature levels
) Thorough in-vessel addition of moisture - to maintain optimum levels

WRIGHT
ENVIRONMENTAL
MANAGEMENT INC.
"The Right Start"

WRIGHT'S FULLY ENCLOSED FLOW-THROUGH IN-VESSEL COMPOSTER

SYSTEM DESCRIPTION

The fully enclosed flow-through vessel can transform any type of organic waste including meats, fish, dairy products, fruits and vegetables, cooked food and paper wastes into a soil-like material in a 14-28 day retention span. Temperatures, oxygen, moisture and odours are controlled by an automated system within the vessel for optimal microbial activity.

With a minimum of moving parts and the use of corrosion resistant stainless steel the system can be maintained on low energy, labour and maintenance costs.

The following describes the unit located at the Ontario Science Centre which presently handles food waste from seven provincial government facilities. However depending on the needs of the waste generators, the unit can be designed as an on-site or central composting facility in urban and rural areas ranging from 100 lb/day up to 100s of tons/day.

- source-separated food waste is collected in 64 gal. roll-out carts and is delivered to the Science Centre composting operation 3 days per week.
- food waste and amendment is loaded into a drag chain mixer in appropriate proportions by a hydraulic lift.
- an appropriate ratio of food waste to amendment was determined as 2:1 by weight or a volume ratio of 1:1.
- a variety of amendments can been used such as wood chips, regular and waxed corrugated cardboard, blue prints, paper sludge, etc. Rubber tire crumb which is used for porosity combined with shredded paper was tested as a possible amendment for the Ministry of Environment & Energy.
- the drag chain mixer has 2 opposed, two speed augers which break up the food waste into a more suitable size for decomposition. When the mixing is complete a discharge gate is manually opened and the infeed material is discharged by 2 augers to a conveyor system. The conveyor moves the food waste to the top of the vessel where a hydraulic loading door is opened to accept the new load of food.

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- the mixer is equipped with a balance beam scale for accurate food waste and amendment weighing. This allows the operator to judge the characteristics of the batch and record food waste and amendment weights
- the Wright Environmental composting vessel is a fully enclosed tunnel with a corrosion resistant stainless steel interior; air supply plenums and duct work and insulated wall panels.
- the unit located at the Ontario Science Centre is 43'L x 7'W x 10'H
- equipped with 3 forced air supply fans, recirculating air ducting, 2 sets of spinners, hydraulic ram and exhaust ducting to the biofilter
- the vessel consists of 3 zones:

Loading Zone

- loading and off-loading happen concurrently thus creating a void at the loading end for a new perforated steel tray to be inserted.
- the newly mixed waste falls through the loading door where it piles up on the tray to a height of 6 to 8 feet.

Zone 1

- the material travels through Zone 1 for 6 days with temperatures of 55°C or greater for a minimum of 3 days.
- to ensure that temperatures do not get so high as to be detrimental to microbial activity - temperatures are monitored in each zone by an automated graphic/ alarm system and printing module. The controller interprets the signals from 6 3ft. long probes which relay the temperature from within the composting material. Each probe has a high and low alarm temperature setpoint which is linked to the appropriate supply fan for each zone. When a temperature probe measures a temperature higher than the high alarm setpoint (one degree window is maintained) the designated supply air fan is activated and air cools the mass temperature down. When the temperature is below setpoint the supply air fan is disengaged.

Zone 2

- as the mass moves from Zone 1 to Zone 2 the material is cross-mixed through a set of spinners. At this time, a fine spray of water is added to maintain proper moisture levels.
- for optimal microbial activity, moisture levels for infeed must be maintained between 55% and 65% moisture. As some moisture is lost during the decomposition stage during Zone 1, the spray of water added at the mixers will bring the moisture levels back up to 55%. Moisture levels in Zone 2 are maintained at 50-55% and then in Zone 3 this drops to approximately 45%.
- the material travels through Zone 2 for 15 days with temperatures maintained at 51.6°C (125°F) for optimal biodegradation

Zone 3 (applicable in Models larger than WEMI 2000)

- as the material moves from Zone 2 to Zone 3 the material is cross mixed again by a set of spinners.
- the material travels through Zone 3 for 7 days with temperatures maintained at 51.6°C (125°F).
- at the end of the 28 day process, a set of augers moves the mass to a chute which off-loads to a conveyor belt to a shaker screen which screens the material to 1/8 and 1/4" sizes.
- after 28 days the material will be significantly stabilized so that curing time is reduced.
- finished compost from the Ontario Science Centre is used by Metro Parks on lawns and gardens.

Oxygen

- oxygen is controlled by the automated air supply control system which operates the supply fans.
- oxygen in the vessel has been maintained consistently at 17%. Heat and moisture in the vessel is redistributed from the top to the bottom of the composting mass. The exhaust fan runs at half speed continuously with at times 2 or more fans on at high speed depending on what is taking place in the mass.

Biofilter

- is an external biofilter which is 19'x19'x3'H
- sits on a gravel bed and is a mixture of crushed limestone, gravel, mushroom compost and wood chips.
- the exhaust air from the compost vessel is pumped through a series of pipes under the filter. The biofilter mass eliminates odours as it exhausts to the open air.

Odour Tests

- in February 1994 a private environmental consulting firm was retained to perform odour testing on the biofilter at the Ontario Science Centre.
- tests were conducted on two consecutive days and no measurable odour was detected in both the actual and worst case scenario examples.
- exhaust from the biofilter was captured in a tube and the odour tests were conducted using a panel of human noses.
- although the unit at the Ontario Science Centre is enclosed for the convenience of visitors, these vessels can be located outside requiring only the mixing/loading area to be enclosed if this is a requirement of the user.

Unique Characteristics

This invessel composter is able to handle high concentrations of meat, fish, dairy products and cooked foods in addition to the regular leafy products. Due to the design and automation of the system, a high-rate composting process occurs.

Technical Data

The Wright in-vessel composter can be designed for on-site and central composting facilities requiring very little land space. Each unit is designed to meet the client's requirements. Standard requirements for the vessel would be electrical and water hook-up and discharge line to a sanitary sewer. However, the client has the option to choose a leachate recirculating system contained within the unit. Units ranging from 175 lbs/day up to 2,000 lbs/day would have water requirements of 1.5 gal/day up to 6.0 gal/day and electrical requirement of 16.75 kw/day up to 38.20 kw/day.

Financing

Pilot projects and full-scale facilities can be obtained on a purchase, lease-to-own, lease or cost-sharing arrangements.

Experiences to Date

Since the opening of the OSC, additional units of varying sizes 300 lbs - 100 tons/day for on-site and central composting facilities have been implemented or are in negotiation stages with the following: Provincial, Federal and Municipal Governments across Canada; US Air Force Bases; Canadian Forces; Private sector companies for central facilities across Canada and the US; and Europe.

Literature References

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Market

Compost, depending on the application of the end user, can be used as a mulch or soil conditioner. Material cured and managed for an additional 2-4 weeks is then a replacement for peat moss and potting soil.

WRIGHT ENVIRONMENTAL MANAGEMENT INC.

"The Right Stuff"

In-vessel Composter Canadian Price List

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	60	[illegible]	[illegible]	[illegible]
[illegible]	200	100	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	170	[illegible]	[illegible]	[illegible]
[illegible]	500	250	[illegible]	[illegible]	[illegible]
[illegible]	700	300	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	500	[illegible]	[illegible]	[illegible]
[illegible]	1350	650	[illegible]	[illegible]	[illegible]

Leasing and financing available upon request.

* Pricing excludes any applicable taxes, duties, shipping, installation, site preparation, onsite supervision, and training. Prices are based on 600 volt power - cost may vary if voltage is changed. ** based on 7 day generation period, 28 day retention time, 67% food waste and 33% bulking agent by weight.

Pricing and specifications subject to change without notice
Prices are listed in Canadian Dollars, March 14, 1997

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Optional Pricing

) MIXER	$ 15,000.
) INFEED CONVEYOR / S.S.	$ 10,500.
) OUTFEED CONVEYOR	$ 6,000.
) BUCKET LIFTER	$ 12,000.
) SHAKER SCREEN	$ 15,000.
) 64 GALLON SCHAEFER BINS (OSC MODEL)	$ 100.
) ROUGH NECK CONTAINERS 36 L (Dimensions: 24" X 16" X 8 3/4"H)	$ 20.
) POWER WASHER	$ 600.
) LEACHATE RECYCLING	$ 3,500.
) SHREDDER	$ TBA

All Prices in Canadian Dollars
Pricing Subject to Change without Notice:
Applicable Taxes Extra.

May 23/97

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Ontario, Canada
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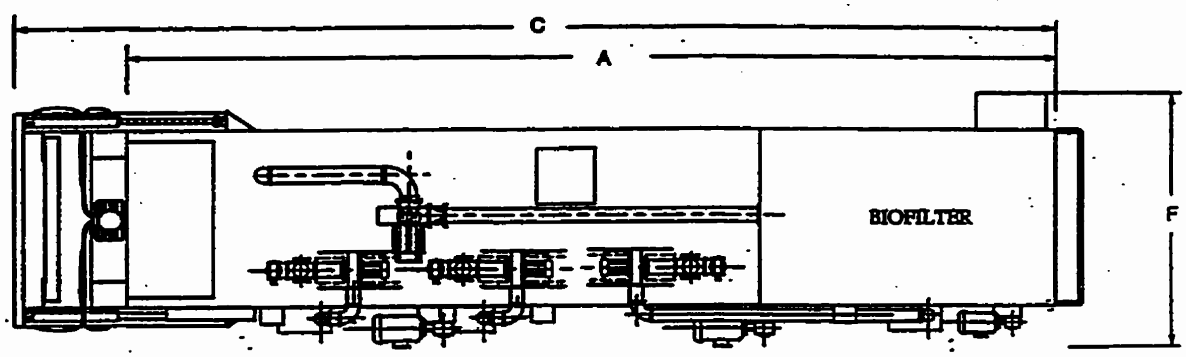
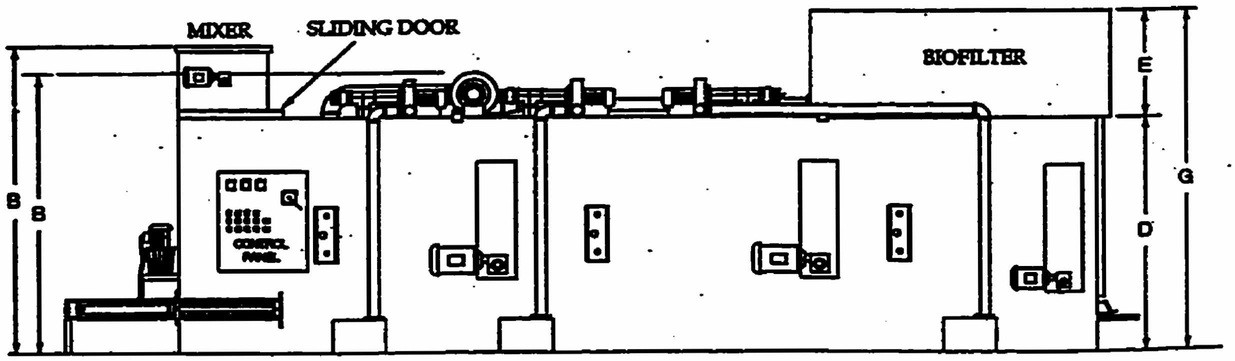
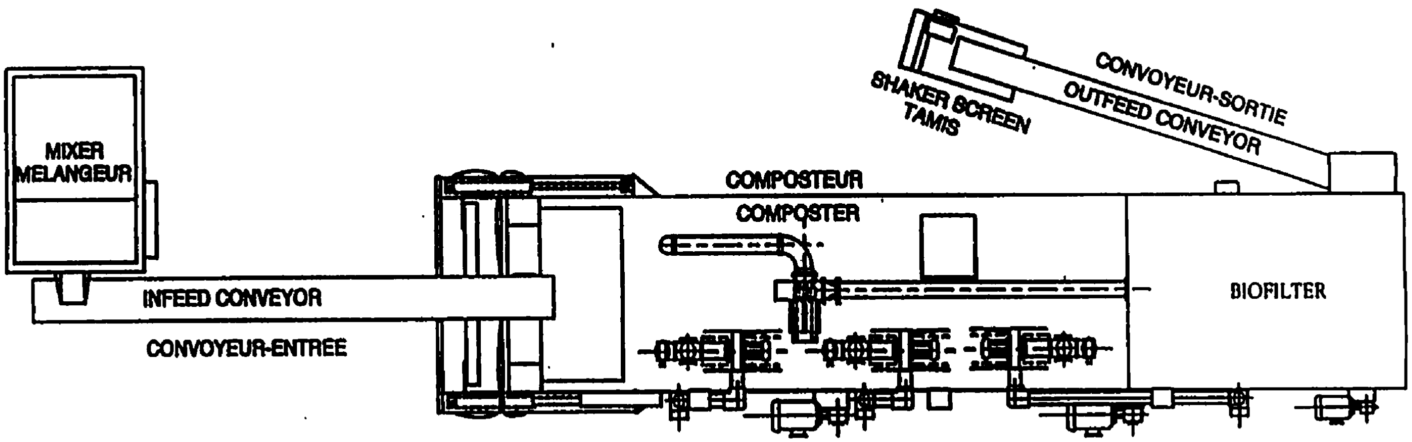
MODEL #	"A"	"B"	"C"	"D"	"E"	"F"	"G"
WEMI 2,000 MIXER	30' - 8"	12' - 2"	36' - 8"	9' - 8"	3' - 9"	10' - 3"	13' - 5"
WEMI 2,000	30' - 8"	11' - 3"	36' - 8"	9' - 8"	3' - 9"	10' - 3"	13' - 5"



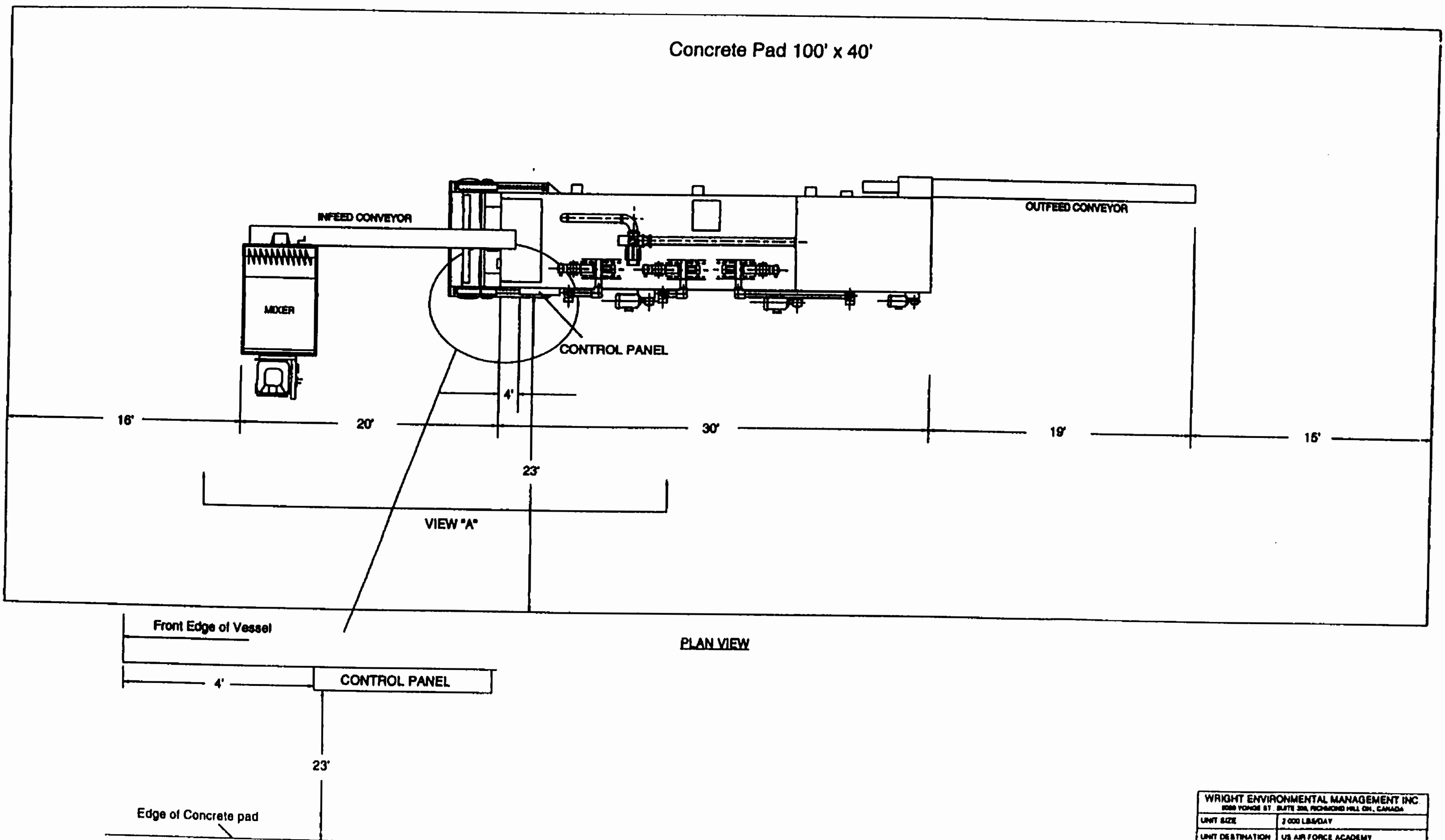
PLAN VIEW



ELEVATION VIEW



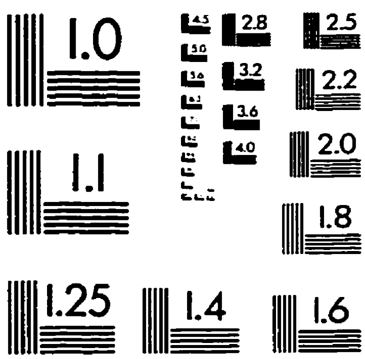
WRIGHT ENVIRONMENTAL MANAGEMENT INC. 9050 YONGE ST., SUITE 300, RICHMOND HILL ON, CANADA		
UNIT SIZE:	2,000 LBS/DAY	
UNIT DESTINATION:		
DATE: SEPT. 30, '97	REVISION: 2A	DRAWING # 2002



PLAN VIEW

WRIGHT ENVIRONMENTAL MANAGEMENT INC		
UNIT SIZE	2 000 LBS/DAY	
UNIT DESTINATION	US AIR FORCE ACADEMY	
DATE SEPT 30 '97	REVISION 1A	DRAWING # 2004

IMAGE EVALUATION TEST TARGET (QA-3)



150mm

6"

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