MATERIALS RECOVERY FACILITY OPTIMIZATION STUDY

(WDO OPT-R2-04 & OPT-R3-03)

COMPLETED FOR:

WASTE DIVERSION ORGANIZATION

COMPLETED BY:

EARTH TECH CANADA INC.
MACVIRO CONSULTANTS INC.
GARTNER LEE LIMITED

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NOTE TO READERS

Ontario continues to increase the amount of residential recyclables diverted from waste disposal facilities. Estimates for 2001 have confirmed the amount has increased again. A fundamental component of Ontario's waste diversion system is the processing of residential recyclable materials through material recovery facilities (MRFs). More than 60 MRFs process in excess of 650,000 tonnes of residentially generated recyclables. The majority of processing capability was developed between 1986 and 1991, corresponding with the rapid growth of curbside collection programs over that same period. The Ministry of the Environment (MOE), municipal governments, the Ontario Multi Material Recycling Inc (the forerunner of CSR: Corporations Supporting Recycling) and many private firms were key organizations in the establishment of the original MRF infrastructure.

From 1991 to 2001 there were numerous investigations at individual MRFs for the purpose of improving processing performance, reducing cost and/or expanding service areas. Missing from these examinations was a province-wide examination or a holistic approach at analyzing the established infrastructure.

During the preparation and analysis of potential residential recycling targets by the Ontario Waste Diversion Organization (WDO), many key questions and concerns were raised about the impact of increased diversion on both the collection and processing infrastructure across Ontario. For many this was not new dialogue. Questions and concerns were raised in various discussions between MOE, CSR and a number of municipalities during 1998 and 1999.

Interestingly, there has been a growing body of knowledge and Ontario examples of advanced collection systems for recyclable materials. Access to information and the ability to examine new collection systems has contributed to the evolution in curbside collection of recyclables. This has now been extended to advancements in organics and garbage collection in some locations.

The understanding and analysis of processing systems has taken a different route with less information being available in the public domain. This is not a surprise. Operational assessments at MRFs have been undertaken in the last ten years. However, these data, when available, are often very specific to an individual MRF. Transferability of data and findings at MRFs are often more difficult than those obtained by examining collection systems.

A prime objective of the WDO is to increase the cost efficiency and effectiveness of processing recyclables from residential sources. The need for a MRF Optimization Study was widely endorsed by the Recycling Optimization Task Group as a necessary project to assist in fulfilling this objective.

Purpose of This Study

The study was undertaken to address two primary questions. First, is new MRF capacity required to process the projected tonnage of residential recyclable materials that will be collected in the future? Second, how can the performance of the MRF processing network be optimized?

WDO fully funded this study. Two workshops were held to obtain key input from a variety of stakeholders. Several special sessions were held to critique vital portions of the study. The study has answered the two questions from above and, in fact, many more. Just as importantly, it has raised new questions.

Understanding the Context of this Study

This study is about a macro-analysis of the current MRF infrastructure in Ontario and extrapolation of this knowledge into possible arrangements in the future. Emphasis on the word macro is important. The detail and analyses undertaken in this study form the basis of findings and conclusions that assist with any future policy or strategic direction that may occur at the local government level, the provincial government level and/or within various industry participating in the recycling system. The study reflects data, knowledge and insight for the period 2000 to 2001.

To ensure that the reader understands what this study is about, it is worth highlighting what the study is not about. For example, no single MRF arrangement has been recommended as the answer for the future. Readers cannot pickup this study and determine the cost of a current or future MRF to serve their municipality or a region.

This study will serve as an underpinning for future MRF discussions by municipal staff. It will provide insight to waste management service providers on opportunities that may not have been as apparent as they thought. It will provide interesting discussion for elected officials that may not traditionally look beyond their own political boundaries for waste diversion initiatives.

The Resources Behind the Study

This study was directed by a Steering Committee with diverse backgrounds and from different places of work. These folks were instrumental in staying on track during the study and overcoming the many challenges, debates, disagreements - all signs of a great Steering Committee.

Equally strong, talented and dedicated were our consulting firms and technical resources.

Direct involvement and feedback from the private sector recycling industry, municipal staff, representatives from the material and packaging industry was essential to increasing the insight, value and credibility of this study. . thank you.

This study is worth reading. More importantly it should be read in the context of what can I do within and beyond my borders. The time is right to step out of the box. The Steering Committee, the consultants and the WDO have provided you with a much needed spring board.

MRF Optimization Steering Committee Error! Bookmark not defined.	**Consulting Firms and Technical Resources**
Chuck Beach (S.C. Johnson) Brad Brooks (Miller Waste Systems) Sue Campbell (Region of Durham) Rob Cook (Ontario Waste Management Association) Herb Lambacher (HGC Management) Bob Graham (EnvirosRIS, Technical Consultant to the Steering Committee) Geoff Love (WDO Technical Representative) Mary Little (County of Northumberland) Geoff Rathbone (WDO Technical Representative, moved to City of Toronto) Ben Shepherd (City of Toronto, moved to the Region of Peel) Jay Stanford (City of London) Jake Westerhof (Canada Fibres)	Michael Pratt, Dan Lantz (Earth Tech Canada) Robert Lippett (Gartner Lee Limited) Dave Merriman, Brian Oke (MacViro) Association of Municipal Recycling Coordinators (AMRC) Municipal Waste Integration Network (MWIN) Ontario Waste Management Association (OWMA)

Respectfully submitted on behalf of the MRF Optimization Steering Committee,

Jay Stanford, Chair, MRF Optimization Steering Committee
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EXECUTIVE SUMMARY

Introduction

This report documents the process and results of the study of material recycling facilities (MRFs) infrastructure in Ontario. The study was initiated under the auspices of the Ontario Waste Diversion Organisation (WDO). The study's terms of reference were established by a Steering Committee comprised of representatives of Ontario Municipalities, private sector solid waste management service providers, consumer goods and packaging manufacturers/distributors and recyclable materials end markets.

The Steering Committee provided periodic direction on methodology, data analysis and interpretation of findings to the consulting team in its conduct of the study. In addition, the Steering Committee sourced MRF location and capacity data and organized and conducted the study's stakeholder consultation events. The Steering Committee and the consulting team were assisted in these efforts through the participation of the Association of Municipal Recycling Co-ordinators (AMRC) and the Municipal Waste Integration Network (MWIN).

Study Purpose

The study was undertaken to address the following two questions:

- Is new MRF capacity required to process the projected tonnage of residential recyclable materials that will be collected in the future?
- How can the performance of the MRF processing network be optimized?

Study Methodology

The study involved the following four categories of tasks:

- Data collection and analysis of the actual through-put and permitted processing capacity of the existing network of MRFs, and comparison with an estimation of the future demand for processing capacity, in order to derive findings on the first study question,
- Estimation of the capital and operating costs for MRFs and transfer stations of various capacities and for materials' transportation via direct and transfer haul, in order to derive unit cost curves, (i.e. dollars per tonne per MRF size, dollars per tonne per transfer station size, dollars per tonne per transportation mode (direct haul, transfer haul and urban vs. rural haul route contexts)),
- Comparative evaluation of the economic costs (utilizing the unit cost curves) and environmental impact (measured in terms of truck kilometres travelled) of systems involving different numbers of MRF facilities and varying use of transfer stations and transfer haul vs. direct haul, in order to derive findings on the second study question,
- Periodic consultation with stakeholders on the study's methodology and findings to derive study conclusions and recommendations.

Study Findings With Respect To The Aggregate Capacity Of Ontario's System Of MRFs To Meet Future Demands

The study found that the combined actual throughput capacity and estimated unutilized permitted capacity of the existing MRFs (i.e. 655.000 + >650,000 = >1,300,000 tonnes per year) was substantially greater than the estimated future demand for capacity (i.e. 1,000,000 tonnes for year 2010).

This study finding was supported by the following factors:

- The estimation of existing processing may be understated, as permitted capacity data was only available for one-third of the MRFs. It is highly probable that unutilized permitted capacity exists in the other two-thirds of the MRFs,
- The estimation of future processing capacity needs may be overstated, as the figure is premised upon the overall waste diversion target for the province being met, under assumptions that high end recycling program participation and material capture rates would be fully achieved,
- Anecdotal information provided by stakeholders indicated that the majority of MRFs operate on one, or at best, two shifts per day. Thus, as demand for capacity increases, MRFs could add second and/or third shifts to existing operations, avoiding the need for new facilities or major equipment purchases.

Study Findings With Respect To Opportunities To Optimize MRF Network Performance

The study found that economic cost savings, in the range of 20%, could be realized by moving from Ontario's current network of MRFs, which is characterized by many smaller capacity facilities, to a network comprised of significantly fewer facilities, having larger capacities and employing transfer stations /transfer haul vs. direct haul. This later network is termed a system of Municipal Recycling Regions (MRRs). The study also found that this cost saving would come at the expense of an increase in total truck kilometres travelled, with attendant potential impact to the environment.

With respect to these findings, the study recognized the following limitations:

- The analysis which was employed to identify the optimal (i.e. least total cost) network of MRFs involved modeling systems using substantially generic, rather than empiric, unit costs, and those costs did not incorporate consideration of revenue streams ,
- The analysis could not account for the multiplicity of specific circumstances that would determine which municipalities could (and would) in fact associate together to use larger more centralized MRFs,
- The analysis could not account for the significant capital value, resident in many of the existing MRFs, that would be lost if those MRFs were to be closed in an effort to consolidate capacity.

On the basis of these limitations and in recognition of the fact that 'performance' must ultimately be considered in terms of environmental impact as well as dollar cost savings, the study recommended the following:

- That, movement to realize MRF network optimization opportunities should be via a process of incremental, rather than wholesale, change. Progress should stem from decisions taken in the course of periodical evaluation of the status of a municipality's, and its neighbours', recycling program costs, including lifecycle cost analysis of the MRFs serving those municipalities.
- That, the transportation implications be carefully considered in respect of any optimization opportunity being contemplated. Where possible, the impact of truck haul routes and vehicle numbers in terms of traffic safety and congestion, roadway wear and maintenance, and fuel consumption and tailpipe emissions should be quantified. These impacts could be substantial in nature, potentially nullifying any benefits to be derived from consolidating MRFs to gain economies of scale. For example, certain of the MRR systems which were modeled would increase truck kilometres traveled by a factor of 200% over the kilometres traveled under the current MRF system in the Province. This increase in tailpipe emissions could have an impact on health care costs far in excess of the 15 - 20% saving estimated to accrue from the consolidation of MRF operations.

Conclusions

As a result of stakeholder consultation, a number of barriers and solution to overcoming those barriers, related to the study's findings were identified. Principal among these suggestions was; the need to establish a MRF data assembly and MRR options' analysis program, together with some form of financial incentive to encourage the adoption of optimization opportunities which are identified as serving a suitable balance of economic, social and environmental objectives.

Other recommendations included suggested techniques for structuring recycling program service provision contracts to reduce capital financing costs and to facilitate the co-ordinated integration of the programs of municipalities whom may be contemplating merging into an MRR framework.

Still other suggestions pertained to the need for investigation of subject matters that were outside the purview of this study, such as the relationships between MRF network optimization opportunities and collection program elements and end market (and associated revenue) circumstances.

The study has resulted in a number of information resources and technical aids being developed which address certain of the recommendations cited above. These resources could be used in the future by stakeholders in decision making on MRFs and potential MRR configurations. The resources include; an assembly of existing data pertaining to the actual throughput and permitted capacities of the current MRF infrastructure network, and relatively detailed capital and operating cost breakdowns and unit cost curves for MRFs and transfer stations of varying capacities. It is envisioned that these resources could be used in 'benchmarking' contexts to compare the performance implications of possible changes being contemplated for a MRF facility or a MRF network. The analyses could in turn be incorporated into financial incentives programs, such as may be established pursuant to the proposed Waste Diversion Ontario legislative initiative (Bill 90). A third resource, outcome from the study, is a geographic information systems (GIS) MRR model, which combines data related to material generation-sheds in the Province, together with an analytical ability to calculate the total tonnes of materials that would be associated with any combination of those material-sheds. Although not developed to the level of sophistication as envisioned in the recommendation stakeholders have made, nevertheless, the MRR GIS model is a good base upon which could be built more comprehensive analytical functions including those related to materials' transportation impact analysis.

Finally, it is concluded that this study has constituted a process which, on the basis of the balance of input received from stakeholders, is viewed has having successfully identified answers to the questions of whether the materials processing capacity potential of the existing MRF network in Ontario is sufficient for projected needs, and how the performance of that network could be optimized.

1. INTRODUCTION

1.1. Statement of Study Purpose

This study was undertaken to address the following two questions:

- Is new MRF capacity required to process the projected additional tonnage of residential recyclable materials that will be collected in the future, and

- What opportunities exist to improve the performance of the network of MRF processing capacity in the Province; what barriers exist to realising those opportunities; what solutions could be employed to overcoming those barriers?

The term “performance” was defined at the outset of the study as economic (ie annualised capital and operating dollar) costs. Stakeholder consultation input received during the course of the study resulted in the term being broadened to incorporate consideration of the potential for the materials' transportation component of Ontario's MRF network to adversely effect the environment. The potential impacts on the environment of fuel consumption, tailpipe emissions, traffic accidents, traffic congestion and road operations and maintenance were assumed to be manifest by the total kilometres of truck travel required to transport recyclable materials from the material generation-sheds to the MRFs.

In addressing the above two questions, the study's terms of reference embodied the objective of identifying means of improving the performance of the Province's network of MRFs, within the challenging context of a projected increase in the amount of materials requiring transportation and processing capacity. If opportunities for improvement were found to exist, their realization could free up finite resources, such as dollar funds, which would otherwise be consumed by existing recycling program costs. This in turn could make possible investments in expanding recycling and other waste diversion program activities to beyond the limits that would otherwise have been reached.

1.2. Background

Ontario has made consistent progress in increasing the quantity of materials diverted from waste disposal through municipal waste recycling programs. From these programs' initiation, circa 1986 to 2000, the quantity of residential waste sourced recyclable materials processed through the network of MRFs has increased to a rate of approximately 650,000 tonnes per year.

The majority of this processing capacity was developed over the period 1986 to 1995, corresponding to the rapid growth of curbside collection programs. In that era, it was the policy, and latterly the regulatory, requirement that all waste was to be handled on a municipality-by-municipality basis. Substantial financial grants were available from the Province to assist municipalities in establishing MRF infrastructure. The packaging and consumer goods industry sector, involved in waste management from the standpoint of product extended stewardship, provided funding assistance to municipalities for the operating costs of MRFs. Also in that period, private industry involved in direct waste management services provision generally focused its efforts on serving the IC&I (non residential) waste stream or on operating MRFs that had been established by municipalities.

Thus, as a general result of municipalities addressing their regulatory obligations and responding to the financial incentives of the day, coupled with the role the private sector waste industry adopted, Ontario’s residential waste MRF capacity came into being and evolved to meet individual municipality by municipality needs. Decisions as to a proposed MRF's design capacity and site location were made from the standpoint of the single municipality who had originated the proposal, usually as a result of successfully sourcing funds under grant frameworks. It was not common practice to decide capacity and siting questions from a consideration of the needs of surrounding municipalities or the potential for surplus processing capacity to exist in MRFs in those municipalities. Exceptions to this pattern occurred in certain cases where a number of municipalities had historically come into association typically cooperating in regard to shared waste disposal facility (landfill) use. In addition, a few private sector waste service providers evolved their businesses from serving an initial single municipal client to an aggregation of municipal clients.

More recently, there have been significant changes in the waste management regulations and related environmental policy, economic forces and municipal jurisdictional elements. These changes are briefly described below as they are shaping the evolution of Ontario's MRF infrastructure network.

In 1995-96 the Province ceased capital grant funding for MRFs. While the Province has continued to provide general policy direction through enunciating an overall Provincial diversion target, the prescriptive regulatory structure of the past, which reflected the philosophical view that all of a municipality's waste management needs must be satisfied locally, has been removed. As with virtually all other economic activities, waste management reflects the movement towards increasing centralization or consolidation of processing functions in order to achieve economies of scale, with the associated movement of goods being transported over greater distances. Over the same recent period, municipalities have increasingly successfully cooperated in delivering municipal infrastructure programs through associations sharing facilities. Examples of this include coordinated inter-municipal sewage, water and transit programs.

The role that the private sector plays in defining and delivering recycling program MRF capacity has increased. Private sector waste management service providers see a business opportunity in accruing economy of scale cost savings by linking their tradition focus of IC&I materials processing, with expanded roles in processing residential recyclables. Through the Waste Diversion Ontario initiative, (Bill 90), the packaging and consumer goods industry sector has proposed to take on a significant role in funding aspects of residential materials processing capacity. It is envisioned that this funding will be structured to promote movement towards greater cost efficiency in recycling program delivery.

1.3. Study Administrative Structure & Resources Context

Recycling programs are delivered as a result of the combined efforts of municipalities and the private sector. If practical opportunities to improve the performance of programs are to be identified, implemented and sustained, all relevant stakeholders must be involved in the process which identifies those opportunities. As a result, a multi stakeholder Steering Committee was established to finalize the study's initial terms of reference and give periodic direction to the ongoing course of the study.

The Steering Committee’s composition and members' stakeholder affiliations are presented below:

Members	**Affiliation**	**Stakeholder Group**
Chuck Beach	S.C. Johnson	Waste Diversion Organization
Brad Brooks	Miller Waste Systems	Private Sector Service Providers
Sue Campbell	Durham Region	Municipalities
Rob Cook	Ontario Waste Management Association	Private Sector Service Providers
Herb Lambacher	H.G.C. Management	Private Sector Processing Equipment Manufacturers

Mary Little	Northumberland Recycling	Municipalities
Geoff Rathbone (Co-chair) (1)	Corporations Supporting Recycling (CSR)	Waste Diversion Organization
Ben Shepherd	City of Toronto	Municipalities
Jay Stanford (Co-chair)	City of London	Municipalities
Jake Westerhof	Canadian Fibres	Material End Markets
Bob Graham	EnvirosRIS	Technical Advisor to Steering Committee

(1)- In early June, 2001, Geoff Rathbone became Director of Solid Waste Management with the City of Toronto. Geoff Love, with CSR assumed the Co-chair position.

In the Fall 2000, the Steering Committee engaged Earth Tech Canada Inc., MacViro Consultants Inc. and Gartner Lee Limited, to undertake this study. The three firms had agreed to work as a team on the study in consideration of the study's requirement and the firms' relative expertise. The Steering Committee authorized the consultants' proposal to engage the Association of Municipal Recycling Coordinators (AMRC) and the Municipal Waste Integration Network (MWIN) to coordinate the canvass of their memberships in the information data call phase, to facilitate dialogue and reporting during the stakeholder consultation events and to act as a further means of communication between individual members of the associations and the Steering Committee and consulting team.

The study was initially defined by 12 discreet task items, as described in the terms of request for proposals for consulting services and the consulting teams' response to that request. The study's budget, defining the extent of resources available and committed to executing the study tasks, involved approximately 1,100 senior consulting team participant hours. The study was to be undertaken over the period of October 1999 to February 2001.

During the course of the study, relatively minor adjustments were made to the definition of the study tasks. Specifically, the original intent to describe the recycling program experiences of jurisdictions outside of Ontario was deleted in favour of reallocating study resources to developing a more detailed GIS model of Ontario MRF infrastructure and data information. The time frame for the study was extended to the summer of 2001 as a result of initial unavoidable delays in data collection and a desire to provide additional stakeholder consultation events and consultation comment periods.

The single significant addition that was made to the original study scope of work involved the establishment of the MRF facilities' capital and operating costs information. Pursuant to the original scope of work, the information was sourced from a data call. The information was converted to unit cost curves pertaining to MRFs of varying capacities. The curves were then used to derive the MRF facilities' component of the total system costs of the nine various networks of MRFs that were modelled. When this work was completed, the significance of the MRF capital and operating costs in defining the total MRFs' system costs became evident. As a result stakeholders requested the opportunity to participate in a more detailed process for defining costs. This request was accommodated through consultation meetings and exchange of new information documentation, over the late spring and summer. Consensus agreement was reached on revised and more detailed MRF costs. New unit cost curves were derived and the 9 networks of MRF systems were re-evaluated. The outcome of this additional work reinforced the conclusions that had been originally drawn.

2. STUDY METHODOLOGY

2.1. Outline of Study Methodology

To address whether the current network of MRF infrastructure in the Province would have sufficient capacity to process the future projected tonnage of recyclable materials, data on the permitted capacity (Certificate of Approval upper limits on through-put operations) and actual tonnage through-put operations was sought. A series of data calls were employed to source MRF location and capacity information. The data received was analyzed to estimate the total capacity of the existing network. This total capacity was compared with the projected future demand for processing capacity. The projected demand figure was sourced from the Ontario Waste Diversion Organization's recommendations pertaining to the role that recycling programs would play in the context of Ontario achieving certain recommended overall diversion targets.

To address whether the existing network of MRF facilities could be optimized, a comparative analysis of MRF network systems was undertaken. The performance of a system, which was generally representative of the existing MRF network in Ontario, was defined from the data used in the earlier analysis of processing capacity capability. This system was compared to the performance of a series of alternative systems. These alternatives were systems which could evolve, on the basis of certain assumptions, (termed 'decision guidelines' and described in Section 2.2, below), from the existing MRF network. The decision guidelines pertained to the geographic location of material generation-sheds, the associated scale of operation of MRF facilities and the splits between use of direct haul versus transfer stations and transfer haul and were employed to define the elements of the alternative MRF network systems which would in turn define the systems' performance. As was discussed previously, performance was defined by economic cost and environmental impact.

The method used to quantify the economic performance of the systems involved a “full cost” approach. Under this approach, combined annualized capital and operating costs were developed for various capacities of MRFs and transfer stations. This information was then used to define unit cost curves ($/tonne versus facility capacity in tonnes/yr); one for MRFs and one for transfer stations. Similarly, unit haul costs were developed for both direct haul and transfer haul.

For each system modeled, the quantity of material “feeding” the individual facilities, the round trip haul distance to the facilities from the material generation areas and the round trip haul distance from transfer stations to MRFs, were all used to calculate a total measure of haul, expressed in “tonne-km”. The total cost for each system was calculated by summing the facility capital and operating costs with the haul costs. Capital and operating costs were determined for each facility by multiplying the facility capacities by the appropriate unit capital and operating costs (taken from the cost curves discussed earlier). Similarly, haul costs were determined by multiplying the “tonne-km” of haul for each facility by the unit haul costs ($/tonne-km). The total truck-kilometers of haul under each system was also calculated and tabulated.

As mentioned above, by graphing the estimated annualized capital and operating costs for MRFs and transfer stations of varying scales of operation, unit cost curves were created. These curves were then employed to identify the costs for MRFs of any of the sizes as were found to comprise each of the networks of MRFs that were modelled. Pursuant to the original study scope of work, the information required to construct the curves was derived from a data call to MRF equipment and process system manufacturers. A limited response to the call was received. As a result, the limited empirical data was coupled with information output from a generic design exercise. The capital and operating elements (building equipment labour, financing, etc.) of four MRFs which would be representative of the following scales of operation: 15,000, 30,000, 50,000 and 100,000 tonnes per year were identified and costed using conceptual engineering design assumptions. Conceptual engineering design typically has a costing accuracy of ±50%. A similar approach was used to estimate unit costs for four 'typical' transfer stations.

Subsequent to completing the MRF network modelling and total systems' cost analysis tasks, the importance that the cost information underlying the cost curves had in defining the overall MRF network costs became evident to stakeholders. Stakeholders requested that the cost curve input data be reviewed and developed to a greater level of detail, both in terms of breaking out individual equipment and process operations and in supporting the costs estimated for those elements. Support was determined to be constituted by stakeholders reaching consensus agreement to the new cost figures that were adduced. New cost curves were developed and the costs of the MRF networks were recalculated. The outcome of this aspect of the study's methodology was twofold. The apparent opportunity to save costs through the economies of scale that was afforded by consolidating smaller MRFs into larger facilities became more evident. The fact of stakeholders reaching consensus agreement to the underlying cost estimates for the cost curves could be interpreted as support for use of the cost curves in the future as one possible input to 'benchmarking' a MRF facility or MRF system's performance.

As a final comment on this aspect of the study, the reader's attention is drawn to the fact that, despite the significant focus that was given the matter of MRF capital and operating costs, the figures that were finally adopted must be treated as estimates. There remains a reasonable degree of uncertainty as to the accuracy of the figures if they are used in the context of any one specific MRF facility. However, although this uncertainty may be sizeable in the context of an individual facility, when the figures are used to estimate costs for a number of MRFs of varying capacities and those estimates are then aggregated into a system wide cost, the overall uncertainty associated with that system cost is greatly reduced.

During the early stages of exercising the methodology described above, it was recognized that there were unique circumstances in Northern Ontario, which is characterized by small quantities of materials and long transportation distances. In recognition of this uniqueness, MRF network systems were identified and comparatively evaluated separately for Southern Ontario and for Northern Ontario.

In concluding this discussion of the methodology employed, the reader’s attention is drawn to the fact that the methodology was structured to test whether performance improvements could be made to the current network of MRF facilities, ie the existing MRFs taken as an overall system. The methodology permitted a comparative evaluation of how the performance of the existing MRF network system would vary if systemic (not facility specific) changes were to be made. The methodology was not structured to identify specific existing facilities that should be “changed” i.e.; expanded, decommissioned relocated or transformed from MRF operations to transfer stations operations. As a result of this over-arching principle, all information reported in this document pertaining to MRF and transfer station locations has been identified anonymously.

2.2. Summary of Key Assumptions in the Methodology

In evaluating the current MRF network systems capacity to process projected future recyclable materials tonnages, the following key assumptions were adopted:

- Of the MRF facilities which reported permitted capacity, those facilities were assumed to be capable of operating in the future up to at least in the range of 75% of their permit limit, (on the basis that permitted tonnage figures generally accurately represent the practical circumstances which define a facility's ultimate capacity, e.g., site size and site servicing capacity and land use context including transportation/traffic site access).

- For those MRF facilities which are owned by the private sector and are processing municipal residential recyclables, it was assumed that the private sector would continue to offer processing capacity to municipalities in at least the same ratio of processing residential materials -to -IC&I materials as currently exists.

These assumptions, taken as a whole and in the context of the findings of this study, were not viewed as being potentially problematic. The supply of MRF capacity was calculated on the conservatively low side in that only the permitted capacity of the MRFs, which reported C. of A. data, was integrated with the actual current rate of processing operations to yield a future potential capacity. Capacity beyond existing current operations was not assumed for facilities that did not report C. of A. data. Secondly, the processing demand projection may also be viewed as being conservative as it was originally calculated employing high-end assumptions for program participation and capture.

With respect to defining and evaluating the performance of the alternative MRF networks systems, the following assumptions and decision-making guidelines were adopted:

- **quantity of material -** Each system was modeled to process the same total quantity of residential materials i.e. projected 2010 tonnages (1999 actual tonnes, adjusted for population growth and increased recycling program participation and material capture rates, net of increased 'at source' diversion rates).
- **sources of material -** In defining material-sheds, no Municipality (upper tier) was split up. The entire municipality was located within a single MRR and all of its material was subsequently transported to and processed at the attendant MRF facility.
- **material-sheds -** Where there currently existed a reasonably large group of municipalities acting in association to share collection/processing facilities (an existing MRR) the geographic definition and facilities' locational elements of that association were adopted. Municipal recycling regions were defined such that the quantity of materials required to be processed by the MRF serving that region would not exceed approximately one hundred thousand tonnes per year. One hundred thousand tonnes was assumed to be the upper limit at which meaningful economies of scale could no longer be achieved. (i.e. facility would already be operating three shifts and its processing equipments' design limits would be reached, such that additional capacity could only be achieved by duplicating processing lines.)
- **MRFs -** The location of the MRF facilities serving each of the MRRs were assumed to be at the location of existing MRFs. This decision guideline was adopted in recognition that a movement to more a optimized system (if one was to exist) would likely involve scaling up existing facilities rather than decommissioning existing facilities and relocating to “green fields” sites. (This approach would realize the value of capital invested in the existing facilities and other 'assets' such as established land-use and traffic contexts, etc). Further, in defining the existing MRFs that would be the most rationale location for serving a MRR, the largest population centres were selected. This decision guideline was adopted to avoid defining a system that would involve hauling significant quantities of waste within the MRR away from the highest population centre, with the attendant increase in transportation economic costs and environmental impacts that would occur.

A significant number of assumptions and decision guidelines were required to be adopted in order to estimate the unit costs of the MRF and transfer stations which formed the cost curves and to calculate transportation costs and environmental impact (truck-kilometres). These assumptions and guidelines are presented in the Appendices of this report. They pertained to site sizes, servicing requirements, building sizes and materials construction, process layouts, materials flows, equipment characteristics and labour functions. For the transportation analysis, they pertain to material densities, fleet characteristics and round trip travel times.

All dollar figures cited throughout this report are for the year 2000.

3. ANALYSIS OF STUDY INFORMATION BASE

3.1. Analysis of MRF Network Capacity Capabilities

In order to identify the current throughput capacity and to forecast capacity in relation to projected future demand, endeavours were made to collect data on each of the MRFs that were estimated to comprise the MRF infrastructure in the province. The Association of Municipal Recycling Coordinators (AMRC), the Municipal Waste Integration Network (MWIN) and the Ontario Waste Management Association (OWMA) were requested to canvass their memberships for capacity information. A survey asking the following information was distributed to each MRF owner/operator:

- current throughput, by material;
- current hours of operation;
- licensed throughput, i.e., as per the Certificate of Approval (C. of A.) for the site;
- licensed hours of operations, i.e., either through the C. of A., or by municipal by-law;
- current equipment in use and ages;
- whether or not the facility could accept fully commingled materials;
- public or private ownership/operation; and
- contract information.

1999 was selected as the reference year for the above information. At this point in the study, it was felt that data on operations in year 1999 would have been collected, reported and audited; whereas year 2000 operations' data might not yet be 'firmly' established.

A varied response to the data call was received. Approximately 80% of the MRFs canvassed reported their current throughput data. Approximately 35% reported their licensed capacity. A database from the annual reports received by Corporations Supporting Recycling (CSR) was used where possible to infill data gaps.

The consulting team considered the information, which had been assembled and concluded that it constituted an acceptable basis upon which to reasonably estimate the capacity of the current MRF network to process the quantity of materials that was projected to be collected in the period to year 2010.

Table 1 presents a summary of the results of the data collection exercise. The data indicated that the MRFs processed approximately 655,000 tonnes of residential material and an additional 120,000 tonnes of industrial, commercial and institutional (IC&I) material for a total actual throughput of 775,000 tonnes. This averages to about 12,000 tonnes per year per facility (10,000 tonnes residential and 2,000 tonnes IC&I combined).

Based on those MRFs that reported C. of A. data, there was an estimated 1,425,000 tonnes of permitted capacity available in the existing network of MRFs. This suggested that there was (as of 1999 throughput) approximately 650,000 (1,425,169 - 776,034) tonnes of unutilized permitted capacity available in the Province.

On the assumption that permitted capacity was a reasonably true representation of capacity which could actually be realized, and further, conservatively assuming that none of the capacity that was being utilized for processing IC&I materials would be given over to processing residential materials, the current actual residential materials processing capacity plus the unutilized permitted capacity was initially identified as being approximately 1,300,000 tonnes per year.

Table 1
Comparison of Throughput: Actual vs. C. of A. for 1999

	Actual Throughput (tonnes) 1999			C of A Throughput	
Line	Residential	IC&I	Total	Per Day	Per Year
1	6,703	0	6,703	n/a	n/a
2	908	0	908	n/a	n/a
3	9,000	3,000	12,000	n/a	n/a
4	2,437	0	2,437	n/a	n/a (1)
5	5,261	0	5,261	n/a	n/a
6	10,919	1,782	12,701	n/a	n/a
7	10,062	1,447	11,509	70	21,840
8	34,000	4,000	38,000	300	109,500
9	2,501	0	2,501	n/a	n/a
10	635	0	635	n/a	n/a (1)
11	8,020	0	8,020	n/a	n/a
12	1,118	0	1,118	n/a	n/a
13	4,915	25,601	30,516	140	36,400
14	3,280	0	3,280	n/a	n/a
15	4,905	0	4,905	n/a	n/a
16	11,000	2,000	13,000	66	16,500
17	762	0	762	n/a	588
18	2,910	667	3,577	n/a	n/a
19	1,895	600	2,495	90	23,400
20	22,852	86	22,938	299	77,740
21	803	1,000	1,803	n/a	n/a
22	8,502	4,620	13,122	375	117,000
23	983	0	983	n/a	n/a
24	599	0	599	n/a	n/a
25	8,896	470	9,366	96	35,040
26	18,508	3,085	21,593	n/a	n/a
27	659	0	659	n/a	n/a
28	10,170	18,600	28,770	224	69,888
29	29,211	686	29,897	600	219,000
30	24,899	0	24,899	185	67,340
31	2,788	1,356	4,144	216	67,500
32	136	0	136	n/a	n/a
33	1,800	200	2,000	n/a	n/a
34	2,455	4,175	6,630	199	62,088
35	132	0	132	n/a	n/a
36	26,000	6,487	32,487	n/a	n/a
37	3,100	750	3,850	n/a	n/a
38	8,782	0	8,782	50	13,000
39	2,032	0	2,032	n/a	n/a
40	10,771	0	10,771	190	59,470
41	34,384	0	34,384	360	93,600
42	22,617	0	22,617	n/a	n/a
43	51,082	0	51,082	n/a	n/a
44	11,000	3,000	14,000	n/a	n/a
45	1,852	0	1,852	n/a	n/a
46	2,268	0	2,268	n/a	n/a
47	1,847	25,117	26,964	175	63,875
48	2,405	300	2,705	n/a	n/a
49	9,770	0	9,770	n/a	n/a
50	5,623	368	5,991	24	6,240
51	136,343	0	136,343	n/a	n/a
52	26,632	0	26,632	n/a	n/a
53	1,647	0	1,647	n/a	n/a
54	486	320	806	192	47,920
55	1,345	15	1,360	n/a	n/a
56	163	0	163	n/a	n/a
57	455	0	455	n/a	n/a
58	18,849	0	18,849	500	130,000
59	383	0	383	n/a	n/a
60	341	0	341	n/a	n/a
61	2,288	0	2,288	n/a	3,000
62	69	0	69	n/a	n/a
63	1,719	0	1,719	n/a	n/a
64	6,400	10,000	16,400	270	84,240
65	6,030	1,750	7,780	n/a	n/a
66	3,155	90	3,245	n/a	n/a
TOTALS	**654,462**	**121,572**	**776,034**	**4,621**	**1,425,169**
Averages	**9,916**	**1,842**	**11,758**	**70**	**21,593**

Notes: The datasets reported facilities #4 and #10 as operating facilities, however, it was determined the facilities had closed. The dataset reported capacity for 'facility #51' as a single number, however, it was determined the capacity figure was the aggregate of 4 separate MRFs. Therefore, the information that was available to this study indicated that there were 67 MRFs in operation in 1999, processing, in whole or in part, residential materials.

This initial determination was reviewed from the context of the rigorousness of the database that had been employed and in consideration of the consulting team's empirical knowledge of MRF capacities. It was recognized that the permitted capacity figure of 1,425,169 was derived from only approximately one third of the MRF network. However, it was felt that there was a high probability that there would be unutilized permitted capacity in the approximately two-thirds of the MRFs for which permit data was not available (ie not reported). The phenomenon of there being a surplus in permitted capacity, when considering the actual though-puts of all of the MRFs, and only accounting for the permitted capacity of one-third of those MRFs, was not thought to be anomalous. The consulting team was of the view that it was the generally accepted knowledge of the industry that most of the MRFs in Ontario did not operate two or more shifts per day. It is the general practice that C of A permits define maximum capacities under assumptions that facilities could ultimately be operated to the limits of their process and installed equipment designs. Process and equipment is normally designed to function over more than one shift per day.

It was also recognized that practicalities, which are inevitably in play at any facility, potentially limit facilities' actual ultimate capacity to being somewhat below 'design' or permit capacity. Equipment aging over time, recent land-use developments surrounding an existing facility's site putting pressure on truck transportation access, spatial limitations within a finite building envelope are a few examples. However, the majority of these limitations are not absolute. Equipment can be rebuilt, modified or replaced. Land-use impacts can be mitigated with property fencing and landscaping and traffic improvements can be made. Buildings can normally be expanded.

Taking the above considerations as a whole, the consulting team felt that there was a high probability that significant surplus permitted capacity existed in the current MRF network and that the surplus would not be unreasonably constrained from being converted to actual through-put capacity.

3.2 Analysis of MRF Systems' Performance

As described in Section 2 - Methodology, the question of how the MRF network in Ontario could be optimized was addressed by progressively identifying and comparing the performance of a variety of MRF network systems. A system representing the generic elements of the existing MRF network ('base') was first defined. Alternative systems were then defined by varying the generic aspects of the base, i.e., modifying the number of MRFs (by making the attendant changes to the locations of the material generation-sheds feeding those MRFs) and/or modifying the splits between direct haul and transfer haul of materials to those MRFs.

The performance of each of the systems was then identified in terms of their economic costs (ie total capital and operating costs, exclusive of revenues, required to establish and operate the network of MRFs transfer stations and transportation fleet) and environmental impact (assumed to be manifest by the total truck kilometres traveled, exclusive of curbside collection within the neighbourhoods of the material generation-sheds). The performances of the systems were compared to identify the system (or systems), which trended towards a balance of least economic cost and environmental impact. The elements of that system (or systems) which gave rise to the superior performance were then identified as being the means by which the existing MRF network could be optimized on a systemic (not facility specific) basis.

Southern Ontario

Six systems were identified and their performance calculated ('modeled') for southern Ontario. Each system was modeled to process the same total quantity of material, i.e., 1,000,000 tonnes, (estimated capacity needed for year 2010).

The first system modeled was constructed to represent the generic characteristics of the existing MRF network, i.e. a system with many smaller capacity MRFs and a few larger capacity facilities. Originally the base system was identified as consisting of 57 MRFs., hence the 'base' system was termed the '57 MRF System'. While the base system was modeled using the capacities of all of the existing MRF facilities that were reported to be in operation at the time (1999), it is important to note that the economic performance of the system was calculated using the unit cost curves. The curves portrayed generic facilities' costs. As a result, readers should not interpret the calculated cost of the '57 MRF System' as being the actual cost of the existing MRF network in Ontario.

It had been determined at the early stage of the study that actual cost information on existing facilities could not be comprehensively collected and analyzed, from the standpoint of the difficulties of managing data that might be proprietary in nature and that could not be provided under a common reporting regime (i.e., 'apples - oranges' syndrome). It was recognized that the existing MRF network's actual costs were defined by a wide variety of financing arrangements, payment terms, etc., unique to the development history of each of the existing MRFs. It could not be assumed that these circumstances could (or necessarily would) be replicated in the future as major capital investments were made in the system. Therefore, it was decided to employ a 'full cost' approach using common assumptions for all facilities (for example, capital amortized over 10 years for equipment and 20 years for buildings). The cost of the '57 MRF System' can be viewed as an estimate of the full replacement cost of the current MRF system, given that, over the long term, the existing system will have to be replaced.

The efficacy of this approach was tested by comparing the calculated cost for the '57 MRFs System' with information available on the overall cost of the existing MRF network. Making certain necessary adjustments, e.g., adding revenue to the calculated cost, it was felt that the calculated cost of the '57 MRF System' constituted a reasonably accurate representation of the existing network's cost portrayed under a 'full cost' approach.

It was concluded that the '57 MRFs System' was an appropriate proxy for the existing MRF network for purposes of identifying systemic variations on the existing network and evaluating the performance of those systems to determine how the existing network might be optimized. From this conclusion, the following five systems were modeled having progressively fewer, larger capacity MRFs, with greater centralization and inherently more haul:

33 MRF System (with 16 transfer stations);
21 MRF System (with 2 transfer stations);
21 MRF System (with 28 transfer stations); a variation on the 21 MRF System above;
14 MRF System (with 4 transfer stations); and
9 MRF System (with 4 transfer stations).

The number of facilities in the 33 MRF System (with 16 transfer stations) was chosen to demonstrate the cost of a system that, conceivably, could most readily evolve from the current system of 57 MRFs. That is, it represented a system involving relatively insignificant increases in individual facility capacities and where the majority of existing facilities would be retained.

The 21 MRF System (with 2 transfer stations) was modeled to identify how a more significant reduction in facilities might affect system performance. The 21 MRF System (with 28 transfer stations) was modeled to identify how changing a system to reduce environmental impact (total vehicle travel kilometres required to transport materials) might effect overall system costs. (Ie reducing total vehicle kilometres by substituting transfer haul for direct haul at the expense of the additional capital and operating costs for the needed transfer stations.)

The 14 MRF System was modeled to identify the performance of a system with even fewer MRFs. It is noted that the 14 MRF System was defined as being the system with the minimum number of facilities that could practically operate. (The minimum number of MRFs was prescribed by the decision guideline which had been adopted which limited the size of any MRF (and therefore the size of the total contributing material-sheds) to approximately 100,000 tonnes. This figure had been identified during the development of the MRF unit cost curve as being the approximate point at which meaningful economies of scale would no longer be achieved.)

The 9 MRF System was modeled to identify what effect evolving to a 'radically' centralized system (ie serving 1,000,000 tonnes material generated throughout southern Ontario with only extremely large facilities) might have on system performance. It was acknowledged that with the majority of the facilities being equal to or greater than the decision guideline capacity limit of 100,000 tonnes, implementation of this system was not viewed as being practical, given current MRF equipment design and operating capacity experience.

Northern Ontario

The year 2010 quantity of material to be managed in northern Ontario was estimated at approximately 44,000 tonnes, (i.e., approximately 4.5% of the total material projected for the Province).

Three different systems were modeled for northern Ontario, as follows:

12 MRF System;
5 MRF System; and
3 MRF System (with 2 transfer stations).

The 12 MRF System represented the existing MRF network in the north. (As noted above, the system costs derived from modeling the 12 MRF System should not be interpreted to depict the actual cost of the current system.) The other two systems were modeled to ascertain how a progressive consolidation of facilities might effect system performance.

4. FINDINGS OF THE STUDY ANALYSIS

4.1. Findings Related to Development of Unit Costs

Figure 4.1.1 presents a graph of the unit costs (annualized capital and operating), which were calculated for the generic MRFs of various capacities. (Full annualized costs are derived by adding the operating and annualized capital costs.)

The graph indicated that there were definite economies of scale associated with building and operating a MRF. For example, building and operating a 15,000 tonne per year MRF would cost approximately $150 per tonne. In comparison, a 100,000 tonne per year MRF would cost approximately $70 per tonne. This finding directed the study team to model systems involving fewer, larger MRFs.

Figure 4.1.1

MRF - Annualized Capital & Operating Costs Curves

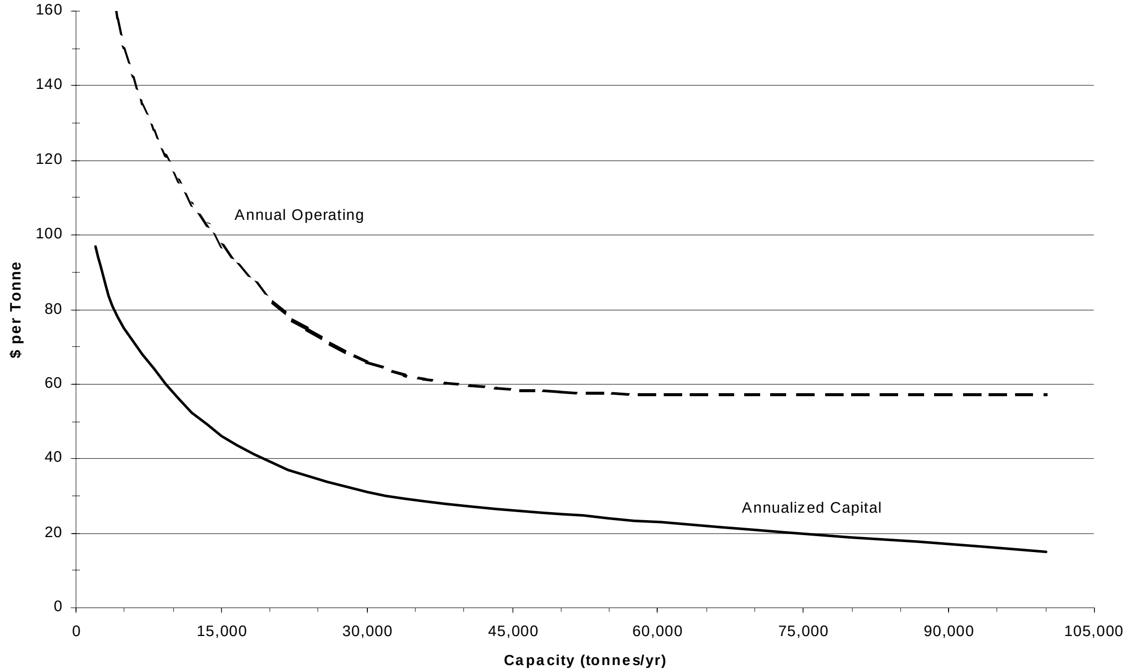
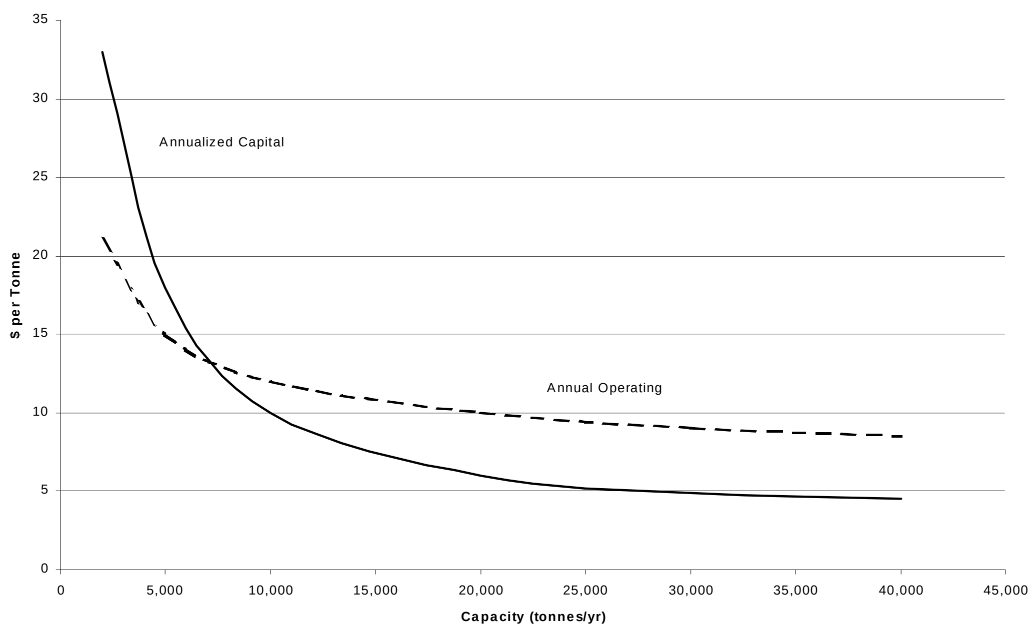


Figure 4.1.2 presents a graph of the unit costs, which were calculated for the generic transfer stations of various capacities. Similar to the findings of the MRF costing, significant economies of scale were found in utilizing larger facilities.

Figure 4.1.2Transfer Station - Annualized Capital & Operating Costs Curves



4.2. Findings Related to Systems Modeling

The economic cost and environmental impact performance of the nine systems modeled were compared. Table 4.2 presents a summary of the systems' performances. This information was graphed (Figure 4.2) and the curves were interpreted to define the trends discussed below.

Table 4.2 Summary of MRF System Costs and Transportation Requirements:

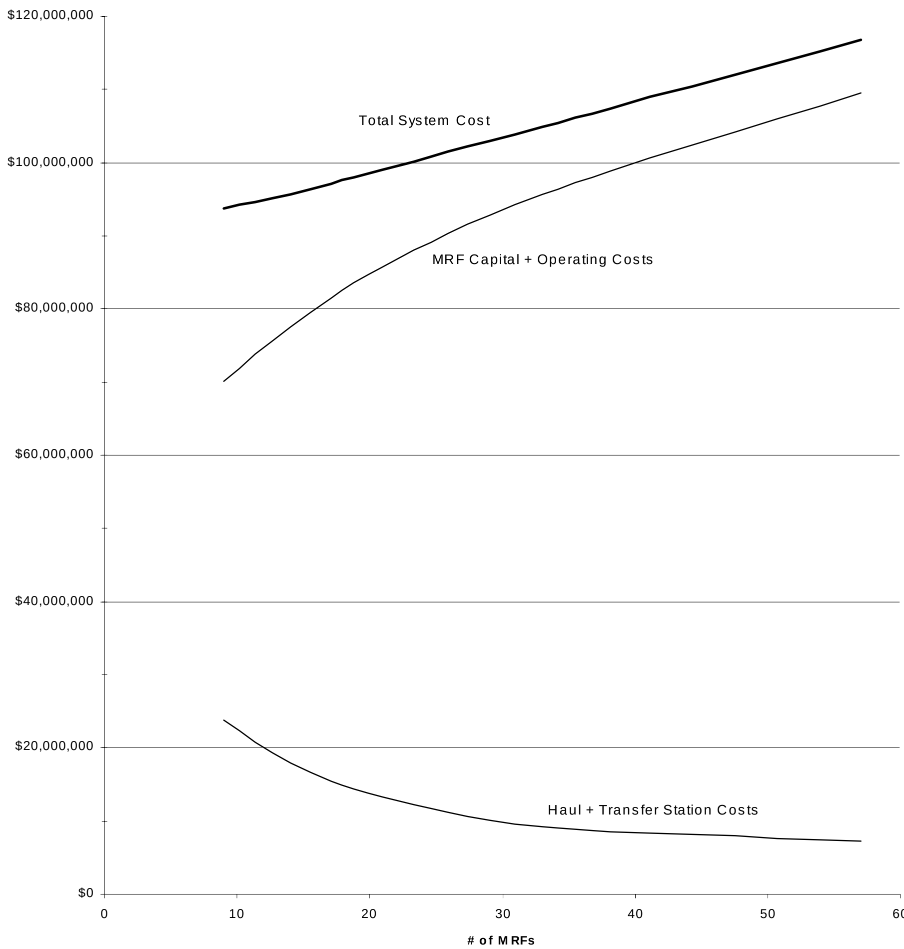
Southern Ontario (total quantity processed: 1,000,000 t/y)

System	(Excludes Revenues)		Capital	Operating	Haul	Direct	Transfer	**Total**
	($)	($/tonne)	($/tonne)	($/tonne)	($/tonne)	(truck-km/yr)	(truck-km/yr)	(truck-km/yr)
57 MRF System	$116,800,000	117	34	76	7	7,200,000	0	7,200,000
33 MRF System (with 16 Xfer Stns)	$105,700,000	106	30	68	8	6,900,000	500,000	7,400,000
21 MRF System (with 2 Xfer Stns)	$99,000,000	99	25	61	14	13,200,000	400,000	13,600,000
14 MRF System (with 4 Xfer Stns)	$95,800,000	96	20	59	17	16,200,000	1,200,000	17,400,000
9 MRF System (with 4 Xfer Stns)	$93,800,000	94	14	58	23	20,100,000	1,800,000	21,900,000
21 MRF System (with 28 Xfer Stns) (Transportation Impacts Minimized)	$99,000,000	99	27	63	10	6,900,000	2,200,000	9,100,000

Northern Ontario (total quantity processed: 44,000 t/y)

	Full Cost		**Cost Breakdown**			**Total Km of Haul**		
	(Excludes Revenues)		Capital	Operating	Haul	Direct	Transfer	**Total**
System	($)	($/tonne)	($/tonne)	($/tonne)	($/tonne)	(truck-km/yr)	(truck-km/yr)	(truck-km/yr)
12 MRF System	$10,818,000	246	74	150	22	962,000	0	962,000
5 MRF System	$9,352,000	213	55	110	47	2,057,000	0	2,057,000
3 MRF System (with 2 xfer stns)	$8,741,000	199	45	89	65	2,057,000	502,000	2,559,000

Figure 4.2



Costs trended downward as the number of MFRs within a system was decreased. For example, the '14 MRF System' (i.e. the system with the fewest possible facilities that could serve southern Ontario under the maximum 100,000 tonnes per day per facility decision rule) was estimated to cost $21,000,000 less than the existing MRF network (i.e. the '57 MRF System'). This trend was attributed to the economies of scale associated with use of larger facilities (centralization) and the relatively lesser contribution transportation costs play in defining total system costs in the context of southern Ontario’s population density.

While an opportunity to save costs (i.e. in the range of 20% of current costs, as in the example cited above) may exist with centralization, total truck kilometers will increase significantly (i.e. 150% increase in the example cited). The example of the two '21 MRF Systems' illustrates that use of transfer stations/transfer haul, in place of direct haul, can reduce the potential increase in transportation kilometres that would otherwise be associated with centralization. This reduction can be achieved without incurring increased total system costs. It is important to note that , as with the system cost analysis, the transportation analysis identifies only generic total kilometres. The actual circumstances of the routes that would be traveled will dictate the nature and magnitude of the transportation component of any MRF network's 'performance'. The impact of increasing (or decreasing) truck travel in terms of: traffic safety, congestion (as effects economic productivity), road wear and maintenance requirements, fossil fuel consumption, and tailpipe emissions of priority pollutants (such as greenhouse gases smog precursors, acid gases and heavy metals and trace organic contaminants) can only be quantified and integrated with consideration of economic performance on an actual case by case basis.

5. STAKEHOLDER CONSULTATION - OBSERVATIONS ON STUDY FINDINGS AND MEANS TO ACHIEVE SYSTEM OPTIMIZATION

It was evident at the outset that knowledge of the subject matter of this study lay with a broad range of stakeholders in both the public and private sectors. Therefore, the composition of the Study Steering Committee was struck to represent this broad knowledge base. The Steering Committee provided direction to the consulting team at the commencement and conclusion of each of the major tasks of the study. This direction generally pertained to methodology and interim findings. Notwithstanding the composition of the Steering Committee and 'hands-on' role it assumed, it was recognized that broad stakeholder consultation should inform the progress and outcome the study. If systems' modeling were to indicate a theoretical potential to improve the performance of the existing MRF network, the means whereby such potential optimization could be realized could only be defined in a practical sense by canvassing the views of as many stakeholders as possible, in addition to the advice of the Steering Committee.

The following five stakeholder forums were employed to broadly communicate the study's progress and in particular, to solicit input on how optimization opportunities and barriers could be addressed:

1. Workshop #1, November 30, 2000, held at Waste Expo, Toronto International, Centre, consisting of a presentation on study methodology and results to date of data collection followed by an open discussion forum on optimization ideas.

2. Study Interim Report, April 20, 2001, held at the WDO wrap-up meeting, Skydome, involving a presentation on study methodology and results of systems' modeling to date, followed by a poster presentation discussion between study consultants and interested participants.

3. Workshop #2, May 23, 2001, held at Holiday Inn, Burlington, involving presentation of study methodology and results of completed systems' modeling followed by breakout and plenary group discussion of optimization opportunities.

4. MWIN Conference, June 14,2001,held at the Nottawasaga Inn, involving presentation of the Study Draft Report, June 14, 2001, focussing on the draft conclusions drawn in relation to stakeholders' advice received over the course of the study and a discussion of realizing optimization opportunities.

5. Detailed MRF Cost Group, meetings and review of documentation, conducted over June and July, 2001, involving representatives of the Steering Committee, the Ontario Waste Management Association, public sector MRF operators and the consultants. Outcome from Workshop #2, stakeholders requested that the information used to define the MRF unit cost curves be reviewed and developed to a greater level of detail. The 'Cost Group' was struck and reached consensus agreement on revised capital and operating cost elements. The output of the Group was used to define revised cost curves which were then used to reevaluate the nine MRF systems, the outcome of which is presented in this Draft Final Report.

Appendix 5 of this Report presents documentation of the process and results of the two stakeholder consultation workshops.

Taken as a whole, the input received through the five stakeholder consultation events was interpreted as providing the following comments on the study's methodology and findings and advice re system optimization opportunities.

Stakeholders were generally of the view that the study's methodology and resources (nature and extent of detail of data analyzed, stakeholders' input canvassed and received, etc) were appropriate given the contexts of the study's purpose and the intended use to be made of the study's findings. Stakeholders strongly felt specific optimization opportunities (i.e. specific municipalities which could/should constitute an 'optimized' material-shed or MRR, or the fate of any specific MRF, transfer station facility or material transportation haul practice) should not be discerned from this study alone. While the study identified gross, systemic opportunities for potential facilities' optimization, the study could not provide the breadth of data and level of analysis that would support decisions to actually close or reconfigure the role of any existing facilities.

Stakeholders concurred with the study's finding that, based upon current throughput and permit circumstances and the observation that the majority of MRFs are operated on a 1 or at best 2 shift per day basis, it was highly probable that the current MRF network would have the capability to process the 1,000,000 tonnes per year capacity demand projected for year 2010.

Stakeholders were of the view that the unit cost information developed and cost curves portrayed were an appropriate representation of 'typical' facilities and were suitable for modeling systems for purposes of identifying optimization opportunities that might lie at the systemic (but not municipality or facility specific) level. Stakeholders were of the view that the unit cost information and curves could be employed as a starting point in 'benchmarking' type analyses, but that judgements on any specific facility's performance could only be concluded if the information/curves were kept updated to current and projected future circumstances. Stakeholders provided examples of many factors, which would have to be addressed in such a context.

Stakeholders concurred with the findings of the systems' modeling, namely that evolution of the existing MRF network towards use of fewer MRFs of larger capacity could yield economic cost savings. However, stakeholders strongly cautioned if the attendant increases in materials' transportation could not be mitigated through increased used of transfer haul, the environmental impact would have to be weighed strongly against any savings in MRF operations. Stakeholders repeatedly expressed the view that, while an evolution to a system comprised of MRRs was logical in the context of the findings of the system's modeling, and as such should generally be encouraged, any specific potential association of municipalities into an MRR, or specific decision on an existing facility's role (i.e., retain, expand, decommission or transform MRF into transfer station), must be rationalized through consideration of a broad range of factors including socio-cultural implications. Stakeholders provided examples of many such factors.

Stakeholders identified a broad range of initiatives that could be undertaken and mechanisms that could be employed to facilitate successful establishment of MRRs. Examples depicting the categories into which these suggestions fell include the following:

- financial incentives to reward municipalities who successfully evolve to MRR frameworks,
- regulatory policy initiatives to permit municipally owned MRFs to operate to greater economies of scale processing both residential and IC&I materials,
- use of 'strategic' service contract elements such as: longer contract time cycles to permit longer capital investment amortization times, and use of interim contracts and contract extensions to provide

'bridging' time to effect coordination among associating municipalities, including harmonizing collection elements having a direct bearing on haul and MRF processing costs (and revenues).

Stakeholders unanimously observed that there was a pressing need for greater collection and sharing of information on the existing MRF network and on the experiences of stakeholders who investigate and initiate optimization opportunities.

In consideration of the observations the stakeholders provided on the study's methodology and findings, the conclusions and recommendations outlined in the following section were drawn.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Study Process

From a consideration of the observations stakeholders provided on the study's methodology and manner of execution, it was concluded that the study provided a suitable basis upon which to draw conclusions on the questions of the capacity capability of the existing MRF network in Ontario and whether there were opportunities to improve on the performance of that network.

It was concluded that, on the basis of the data available for analysis, the study could only address the above questions on a systems level. The resources allocated to this study did not permit the assembly and analysis of the data that would be required to address the questions in terms of specific facilities or specific municipalities; nor was it envisioned at the time the study was initiated that this would occur. One of the recommendations below addresses the matter of data assembly pertaining to future potential analysis and decision-making at the municipalities/facilities specific vs. systems level.

6.2. Capacity Capability

Under conservative assumptions pertaining to the total permitted capacity of the existing MRF network in Ontario, it was concluded that the network would be capable of processing the approximately 1,000,000 tonnes per year of materials projected to be collected by year 2010.

Again, the study did not draw this conclusion from a consideration of the specific circumstances of each of the existing network's MRFs. There are a multiplicity of factors unique to each facility which might contribute to or constrain a facility's ability to increase actual material processing through-put capacity up to permitted levels. The information necessary for such an analysis was not available. However, the conservative approach of only factoring 'surplus' capacity for substantially less than the total number of MRFs in the network, consideration of anecdotal information available on a meaningful percentage of the network's MRFs and the fact that the analysis indicated that supply of processing capacity would exceed demand by a substantial margin, were all factors that supported the above conclusion being drawn with a high degree of confidence.

6.3. Opportunity to Optimize System's Performance

On the basis of the unit economic costs (annualized capital and operating costs of generic MRF and transfer station facilities and materials' transportation elements, it was concluded that economies of scale could play a role in defining a MRF system's total economic performance.

By comparing the economic costs and environmental impact (total truck kilometres traveled) of systems consisting of varying numbers of MRFs and varying transportation practices, an optimization trend was identified. The fewer the number of facilities comprising the MRF network, the lower the total system costs. The ability to reduce costs ('optimize') in this manner was identified as having practical limits. As a MRF network became more centralized, the few remaining MRF facilities would be required to process greater than 100,000 tonnes of material per year per facility. Current experience with MRF buildings, equipment and process operations indicates that economies of scale decline sharply as the 100,000 t/y rate is exceeded. Thus, with 'radical' consolidations, meaningful savings are no longer being generated at the MRFs, while cost increases are accruing due to the longer distances over which materials must be transported.

Potential cost savings in the range of 15 to 20% were identified. Within any system, use of transfer stations/transfer haul in place of direct haul could partially reduce the increase in total system truck kilometres traveled that would be caused by shifting to the use of a lesser number of larger MRFs.

It was recognized that the analysis, which identified the optimization opportunity, involved modeling systems using generic costs. In the context of the study's terms of reference, the analysis could not account for the multiplicity of specific circumstances which would in fact determine the municipalities which could (and would) associate to form the systems' MRRs, or those circumstances which would define which of the existing (or new) MRFs could most cost effectively serve those MRRs. It was further recognized that significant capital value could be resident in many of the existing MRFs. On the basis of the foregoing, it was concluded that movement to realize the optimization opportunity should be via a process of incremental, rather than wholesale, change. Progress should stem from decisions taken in the course of periodical evaluation of the status of a municipality's (and its neighbours') recycling program costs, including lifecycle cost analysis of the MRF (or MRFs) serving those municipalities.

Similar to the analysis of economic cost performance, environmental performance (as measured by total truck kilometres traveled) was only analyzed in generic terms. The generic systems' modeling indicated that total truck kilometres would increase significantly with system centralization, in some cases by greater than 200%. The specific potential impact of the numbers of trucks, their routes and schedules, in relation to actual road infrastructure, traffic and surrounding land use circumstances, must be considered as part of evaluating the 'total performance' implications of any apparent optimization opportunity.

6.4. Recommendations Pertaining to Means of Achieving the Optimization Opportunity

As presented in Section 5, above, stakeholders identified a wide range of mechanisms which could facilitate a process of evolving the existing MRF network towards greater use of MRRs and their attendant larger, more cost effective MRFs.

The principal recurring element in the stakeholders' advice was the call for a data assembly and analysis program. Stakeholders envisioned the program as providing a municipality that was contemplating making changes to its recycling program (e.g., including expanding or decommissioning its MRF in conjunction with potentially associating in an MRR, or facing a major equipment replacement requirement, etc.) with access to up to date, non-proprietary information on recycling program costs experienced by others. The program would allow a municipality to import knowledge of the relevant elements that underpinned other municipalities' cost success' into a model that would evaluate a range of options, including associating with neighbouring municipalities in the context of an MRR.

To be practical in its outcome findings, the model would have to allow municipalities, contemplating participating in an MRR framework, the ability to experiment with a wide variety of MRR configurations (ie differing municipalities variously participating in the use of a MRF of correspondingly varying capacity and located at differing geographic points and thereby defining differing materials' transportation infrastructure needs). The economic cost and environmental impact performance of these options must be quantified and expressed in the context of the system as a whole and from the contexts of each potentially participating municipality. Municipalities could then input this information to their broader, politically based decision-making processes, (e.g., five-year budget setting exercises). These processes would integrate the specific economic and environmental considerations associated with the MRR options into the broader, longer term frameworks of waste management master planning and other municipal works infrastructure and social program needs.

To reiterate, stakeholders strongly advised that the economic cost rationale for establishing an MRR, as might be identified through the modeling outlined above, would have to be 'tested' against a consideration of the social, cultural, broader environmental and other economic implications that could accrue with such a move.

Appendix 6 of this study outlines the elements of a possible data assembly and analysis program and indicates the elements of that program which are so far addressed by the MRF GIS 'tool' which was developed as a component outcome of this study.

As a final over-arching recommendation, stakeholders' observations on the findings of the study were interpreted to state that, while the establishment of some form of data assembly and analysis program would be an encouragement for municipalities to examine MRR options, an immediate economic incentive could significantly hasten municipalities towards undertaking such an examination. Stakeholders discussed the proposed WDO recycling program funding allocation formula in this regard. The potential for the program to be the forum through which could be funded the costs of establishing and sustaining a data assembly and analysis program was identified. Further, stakeholders identified that such a program could be the appropriate means through which to compensate a municipality that incurs economic costs, or other impacts, as a result of joining into an MRR structure. Where the resultant MRR yields cost savings to the system as a whole, a portion of those savings should be used to off costs incurred by participating municipalities. Similarly, municipalities could be penalized (say, through withholding of a portion of any future WDO recycling program operating support grant) for a decision not to joining an MRR structure and in so deciding, denying the other members of the MRR the opportunity to optimize the MRR's material-shed.

It is therefore the final recommendation of this study that the opportunity be further examined to use elements of the proposed WDO recycling program funding mechanisms to promote the timely examination of MRF network optimization opportunities, and further, to be a strong incentive to implement, in a fair and equitable manner, those optimization opportunities that are identified.

APPENDICES A-1 - A-6 follow

APPENDIX 1: MRF COST ASSUMPTIONS AND COST CURVES

Overview
To develop the cost curves used within this study, data on the cost and labour requirements for MRFs of 15,000, 30,000, 50,000 and 100,000 tonnes per year were requested from the following MRF equipment manufacturers:

Ambaco Recycling Technologies Inc.;
CP Manufacturing Ltd.; and
Van Dyk Baler Corporation.

The equipment manufacturers were not restricted in what they could propose. The only restriction that was applied was that the materials would be collected in two streams – fibres and containers.

Information was received from only one of the manufacturers. As a result, this limited information was supplemented with information on MRF equipment and labour costs available from datasets inhouse within the consulting team. Immediately following their consideration of the results of the MRF network systems' modeling which employed this information base, stakeholders met and reached consensus agreement to adopt a revised information base. The revised information base incorporated a greater break-out of the cost elements (e.g. site infrastructure, equipment, materials' processing functions, etc) and revised prices. This revised information was used to define new cost curves and the MRF systems were reevaluated. This Appendix presents the contents of the revised information base.

The costs presented represent reasonable estimates to operate facilities of the given sizes. Wherever possible, in order to maximize the value of the capital infrastructure, the MRFs were assumed to operate for a minimum of two shifts per day. This approach also ensured that the facilities were not overbuilt in terms of size or overcapitalized with equipment that would be required to run the designated throughputs over a period of only one shift.

The throughput estimations per day and per hour and the equipment used within each of the four facilities are outlined in Table A.1. These data formed the basis for the MRF cost curves, presented in Figure A.1., that were, in turn, used to develop the costs for each of the systems considered within this report.

Cost Assumptions: All MRF cost estimates assume 'core' blue box materials (ONP, OCC, Boxboard, Glass, HDPE & PET Containers, Steel & Aluminum Containers), processed to meet standard end-market specifications.

DATA LIMITATION: Due to the 'macro' nature of the cost information contained in the following tables, the data cannot be utilized to rationalize the costs of existing MRFs or to estimate the specific costs of new MRFs.

Table A.1. MRF Cost Data

100,000 Tonnes Per Year Throughput			
Material arriving - two separate streams - commingled fibers and commingled			
containers, set-out in ridged containers, i.e., not a bag-based program			
Delivery - both streams arriving on a daily basis (i.e., either 2 compartment trucks or			
portion of fleet collecting fibres and portion of fleet collecting containers)			
Material characteristics - mixed fibres @ 250 kg/m3 loose density and mixed			
containers @ 70 kg/m3 loose density			
MRF site size	30,000	m2	
	3.0	ha	
MRF building size	7,500	m2	
MRF throughput tonnes per year	100,000	tonnes	
Operating days per year	250	dpy	
Tonnes per day	400	tpd	
Percentage containers	25%	7.7	tph
Percentage fibres	75%	23.1	tph
Shifts per day	2	shifts each containers & fibres	
Effective hours per shift	6.5	hours	
Total Tonnes per hour	30.8	tph	
Fibres Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised, enclosed sorting platform	$100,000	$200,000	
Fixed bunkers, flat floor, doors	$125,000	$170,000	
OCC screen	$125,000	$200,000	
ONP screen	$125,000	$250,000	
Bunker conveyor	$35,000	$50,000	
Transfer/sorting conveyors	$250,000	$300,000	
Baler reclaim conveyor/infeed conveyor	$125,000	$200,000	
Baler	$300,000	$400,000	
Sub Total	**$1,285,000**	**$1,970,000**	
Containers Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised , enclosed sorting platform	$100,000	$200,000	
glass fines screen	$20,000	$40,000	
steel bunker cages, self emptying	$80,000	$120,000	
air classifier	$50,000	$100,000	
ferrous magnet	$40,000	$60,000	
eddy current separator	$70,000	$100,000	

Transfer/sorting conveyors	$250,000	$300,000	
Baler reclaim conveyor/infeed conveyor	$125,000	$200,000	
baler	$300,000	$400,000	
Sub-Total	**$1,135,000**	**$1,720,000**	
General Elements:			
fabricated steel items	$150,000	$250,000	
electric/process operations controls	$200,000	$300,000	
roll-off containers for residuals	$30,000	$45,000	
office equipment	$10,000	$25,000	
weigh scales (2)	$250,000	$350,000	
Shipping	$50,000	$75,000	
installation , contingencies & engineering	$250,000	$400,000	
Sub-Total	**$940,000**	**$1,445,000**	
Total of above equipment items	**$3,360,000**	**$5,135,000**	
Site/Building (highly variable on basis of			
municipalities' circumstances)			
	LOW	**HIGH**	
property acquisition and servicing - $/hectare unit cost for serviced land	$125,000	$2,000,000	
building -$/m2 unit cost for industrial building(includes interior walls, push walls, infeed pits, reinforced floor)	$640	$860	
site preparation costs (paving, landscaping, utilities in from street)	$500,000	$2,000,000	
site preparation and building construction contingencies and engineering (assume 15%)	$800,000	$1,270,000	
<u>Major Operating Cost Elements:</u>			
Labour: (costs cited include full burden, i.e., benefits etc)			
sorting - fibres line	18 per shift	23 per shift	
	$10/hr	$19/hr	
sorting - containers line	15 per shift	20 per shift	
	$10/hr	$19/hr	
baling	2 per shift	2 per shift	
	$12/hr	$20/hr	
rolling stock	7 per shift	7 per shift	
	$14/hr	$22/hr	
scale operator	1 per shift	1 per shift	
	$12/hr	$20/hr	
general labour	2 per shift	2 per shift	

	$10/hr	$19/hr	
Other Human Resources (costs cited include full burden, i.e., benefits etc):			
operations supervisory staff	1 per shift	1 per shift	
	$15/hr	$22/hr	
management staff	1 per day	1 per day	
	$25/hr	$30/hr	
maintenance staff (mechanic)	1 per shift	1 per shift	
	$22/hr	$25/hr	
Rolling Stock (not bought – leased):	**LOW**	**HIGH**	
front end loader (2) (total annual lease cost)	$90,000	$120,000	
skid steer (2) (total annual lease cost)	$20,000	$30,000	
forklift (3) (total annual lease cost)	$30,000	$45,000	
Miscellaneous:			
utility /energy costs	$150,000	$350,000	
administration e.g., insurance etc	$75,000	$150,000	
Disposal of residuals (assume 5% of incoming)	$60/te	$100/te	

Summary of Costs for 100,000 tonne per year MRF									
Building and Equipment Capital									
	Interest		Total Capital		Annual Cost		$/te		
tpy	Rate	Term (yrs)	low	high	low	high	low	high	
100,000	6.5%	10	$3,360,000	$5,135,000	$ 467,000	$ 714,000	$ 4.67	$ 7.14	**Equipment**
100,000	6.5%	20	$6,100,000	$9,720,000	$ 520,000	$ 828,000	$ 5.20	$ 8.28	**Building**
100,000	6.5%	25	$ 375,000	$6,000,000	$ 29,000	$ 462,000	$ 0.29	$ 4.62	**Land**
Labour									
	Number of Staff		# shifts	@ pay rate		Annual Cost		$/te	
tpy	low	high	per day	low	high	low	high	low	high
100,000	35	45	2	$ 10	$ 19	$1,400,000	$3,420,000	$ 14.00	$ 34.20
100,000	3	3	2	$ 12	$ 20	$ 144,000	$ 240,000	$ 1.44	$ 2.40
100,000	7	7	2	$ 14	$ 22	$ 392,000	$ 616,000	$ 3.92	$ 6.16
100,000	1	1	2	$ 15	$ 22	$ 60,000	$ 88,000	$ 0.60	$ 0.88
100,000	1	1	2	$ 22	$ 25	$ 88,000	$ 100,000	$ 0.88	$ 1.00
100,000	1	1	1	$ 25	$ 30	$ 50,000	$ 60,000	$ 0.50	$ 0.60
Total Labour						$2,134,000	$4,524,000	$ 21.34	$ 45.24
Other Costs - General Operating									
					Annual Cost		$/te		
tpy					low	high	low	high	
100,000	Property Taxes				$ 121,000	$ 242,000	$ 1.21	$ 2.42	
100,000	General Operating				$1,665,000	$2,695,000	$ 16.65	$ 26.95	
Totals					**$4,815,000**	**$9,223,000**	**$ 49.07**	**$ 90.03**	

50,000 Tonnes Per Year Throughput			
Material arriving - two separate streams - commingled fibers and commingled			
containers, set-out in ridged containers, i.e., not a bag-based program			
Delivery - both streams arriving on a daily basis (i.e., either 2 compartment trucks or			
portion of fleet collecting fibres and portion of fleet collecting containers)			
Material characteristics - mixed fibres @ 250 kg/m3 loose density and mixed			
containers @ 70 kg/m3 loose density			
MRF site size	27,000	m2	
	2.7	ha	
MRF building size	4,600	m2	
MRF throughput tonnes per year	50,000	tonnes	
Operating days per year	250	dpy	
Tonnes per day	200	tpd	
Percentage containers	25%	5.1	tph
Percentage fibres	75%	15.4	tph
Shifts per day	1.5	shifts (equivalent) containers and fibres	
Effective hours per shift	6.5	hours	
Total Tonnes per hour	20.5	tph	
Note: The 3rd shift must switch sortlines after half day on each stream (or at lunch time).			
Fibres Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised, enclosed sorting platform	$100,000	$200,000	
Fixed bunkers, flat floor, doors	$125,000	$170,000	
OCC screen	$125,000	$200,000	
ONP screen	$125,000	$250,000	
Bunker conveyor	$35,000	$50,000	
Transfer/sorting conveyors	$250,000	$300,000	
Baler reclaim conveyor/infeed conveyor	$125,000	$200,000	
Baler	$300,000	$400,000	
Sub Total	**$1,285,000**	**$1,970,000**	
Containers Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised , enclosed sorting platform	$100,000	$200,000	
glass fines screen	$20,000	$40,000	
steel bunker cages, self emptying	$80,000	$120,000	
air classifier	$50,000	$100,000	
ferrous magnet	$40,000	$60,000	
eddy current separator	$70,000	$100,000	
Transfer/sorting conveyors	$250,000	$300,000	

Baler reclaim conveyor/infeed conveyor	$125,000	$200,000	
baler	$300,000	$400,000	
Sub-Total	**$1,135,000**	**$1,720,000**	
General Elements:			
fabricated steel items	$150,000	$250,000	
electric/process operations controls	$200,000	$300,000	
roll-off containers for residuals	$30,000	$45,000	
office equipment	$10,000	$25,000	
weigh scales (2)	$250,000	$350,000	
Shipping	$50,000	$75,000	
installation , contingencies & engineering	$250,000	$400,000	
Sub-Total	**$940,000**	**$1,445,000**	
Total of above equipment items	**$3,360,000**	**$5,135,000**	
Site/Building (highly variable on basis of			
municipalities' circumstances)			
	LOW	**HIGH**	
property acquisition and servicing - $/hectare unit cost for serviced land	$125,000	$2,000,000	
building -$/m2 unit cost for industrial building(includes interior walls, push walls, infeed pits, reinforced floor)	$640	$860	
site preparation costs (paving, landscaping, utilities in from street)	$400,000	$1,600,000	
site preparation and building construction contingencies and engineering (assume 15%)	$500,000	$830,000	
<u>**Major Operating Cost Elements:**</u>			
Labour: (costs cited include full burden, i.e., benefits etc)			
sorting - fibres line	12 per shift	16 per shift	
	$10/hr	$19/hr	
sorting - containers line	10 per shift	13 per shift	
	$10/hr	$19/hr	
baling	2 per shift	2 per shift	
	$12/hr	$20/hr	
rolling stock	5 per shift	5 per shift	
	$14/hr	$22/hr	
scale operator	1 per shift	1 per shift	
	$12/hr	$20/hr	
general labour	2 per shift	2 per shift	
	$10/hr	$19/hr	

Other Human Resources (costs cited include full burden, i.e., benefits, etc.)**:**			
operations supervisory staff	1 per shift	1 per shift	
	$15/hr	$22/hr	
management staff	1 per day	1 per day	
	$25/hr	$30/hr	
maintenance staff (mechanic)	1 per shift	1 per shift	
	$22/hr	$25/hr	
Rolling Stock (not bought – leased):	**LOW**	**HIGH**	
front end loader (2) (total annual lease cost)	$90,000	$120,000	
skid steer (1) (total annual lease cost)	$10,000	$15,000	
forklift (2) (total annual lease cost)	$20,000	$30,000	
Miscellaneous:			
utility /energy costs	$150,000	$350,000	
administration e.g., insurance etc	$75,000	$150,000	
disposal of residuals (assume 5% of incoming)	$60/te	$100/te	

Summary of Costs for 50,000 tonne per year MRF									
Building and Equipment Capital									
	Interest		Total Capital		Annual Cost		$/te		
tpy	Rate	Term (yrs)	low	high	low	high	low	high	
50,000	6.5%	10	$3,360,000	$5,135,000	$ 467,000	$ 714,000	$ 9.34	$ 14.28	**Equipment**
50,000	6.5%	20	$3,844,000	$6,386,000	$ 328,000	$ 544,000	$ 6.56	$ 10.88	**Building**
50,000	6.5%	25	$ 337,500	$5,400,000	$ 26,000	$ 416,000	$ 0.52	$ 8.32	**Land**
Labour									
	Number of Staff		# shifts	@ pay rate		Annual Cost		$/te	
tpy	low	high	per day	low	high	low	high	low	high
50,000	18	23	1.5	$ 10	$ 19	$ 540,000	$ 1,311,000	$ 10.80	$ 26.22
50,000	3	3	1.5	$ 12	$ 20	$ 108,000	$ 180,000	$ 2.16	$ 3.60
50,000	4	4	1.5	$ 14	$ 22	$ 168,000	$ 264,000	$ 3.36	$ 5.28
50,000	1	1	1.5	$ 15	$ 22	$ 45,000	$ 66,000	$ 0.90	$ 1.32
50,000	1	1	1.5	$ 22	$ 25	$ 66,000	$ 75,000	$ 1.32	$ 1.50
50,000	1	1	1	$ 25	$ 30	$ 50,000	$ 60,000	$ 1.00	$ 1.20
Total Labour						$ 977,000	$ 1,956,000	$ 19.54	$ 39.12
Other Costs - General Operating									
					Annual Cost		$/te		
tpy					low	high	low	high	
50,000	Property Taxes				$ 74,000	$ 149,000	$ 1.48	$ 2.98	
50,000	General Operating				$ 995,000	$1,665,000	$ 19.90	$ 33.30	
Totals					**$2,793,000**	**$5,295,000**	**$ 56.82**	**$ 100.56**	

30,000 Tonnes Per Year Throughput			
Material arriving - two separate streams - commingled fibers and commingled			
containers, set-out in ridged containers, i.e., not a bag-based program			
Delivery - both streams arriving on a daily basis (i.e., either 2 compartment trucks or			
portion of fleet collecting fibres and portion of fleet collecting containers)			
Material characteristics - mixed fibres @ 250 kg/m3 loose density and mixed			
containers @ 70 kg/m3 loose density			
MRF site size	20,000	m2	
	2.0	ha	
MRF building size	3,800	m2	
MRF throughput tonnes per year	30,000	tonnes	
Operating days per year	250	dpy	
Tonnes per day	120	tpd	
Percentage containers	25%	4.6	tph
Percentage fibres	75%	13.8	tph
Shifts per day	1	shift each containers & fibres	
Effective hours per shift	6.5	hours	
Total Tonnes per hour	18.5	tph	
Fibres Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised, enclosed sorting platform	$100,000	$150,000	
Fixed bunkers, flat floor, doors	$100,000	$150,000	
ONP screen	$125,000	$200,000	
Bunker conveyor	$35,000	$50,000	
Transfer/sorting conveyors	$150,000	$200,000	
Baler reclaim conveyor/infeed conveyor	$100,000	$150,000	
Baler	$250,000	$350,000	
Sub Total	**$960,000**	**$1,450,000**	
Containers Sorting Line:			
infloor infeed conveyor	$100,000	$200,000	
raised , enclosed sorting platform	$100,000	$200,000	
glass fines screen	$20,000	$40,000	
steel bunker cages, self emptying	$80,000	$120,000	
air classifier	$40,000	$80,000	
ferrous magnet	$30,000	$50,000	
eddy current separator	$70,000	$100,000	
Transfer/sorting conveyors	$150,000	$200,000	
Baler reclaim conveyor/infeed conveyor	$125,000	$200,000	
Sub-Total	**$715,000**	**$1,190,000**	

General Elements:			
fabricated steel items	$150,000	$200,000	
electric/process operations controls	$150,000	$250,000	
roll-off containers for residuals	$10,000	$15,000	
office equipment	$5,000	$8,000	
weigh scales (2)	$100,000	$150,000	
Shipping	$40,000	$60,000	
installation , contingencies & engineering	$150,000	$250,000	
Sub-Total	**$605,000**	**$933,000**	
Total of above equipment items	**$2,280,000**	**$3,573,000**	
Site/Building (highly variable on basis of			
municipalities' circumstances)			
	LOW	**HIGH**	
property acquisition and servicing - $/hectare unit cost for serviced land	$125,000	$2,000,000	
building -$/m2 unit cost for industrial building(includes interior walls, push walls, infeed pits, reinforced floor)	$700	$950	
site preparation costs (paving, landscaping, utilities in from street)	$400,000	$700,000	
site preparation and building construction contingencies and engineering (assume 15%)	$460,000	$650,000	
<u>**Major Operating Cost Elements:**</u>			
Labour: (costs cited include full burden, i.e., benefits etc)			
sorting - fibres line	11 per shift	14 per shift	
	$10/hr	$19/hr	
sorting - containers line	10 per shift	12 per shift	
	$10/hr	$19/hr	
baling	1 per shift	1 per shift	
	$12/hr	$20/hr	
rolling stock	2 per shift	3 per shift	
	$14/hr	$22/hr	
scale operator	1 per shift	1 per shift	
	$12/hr	$20/hr	
general labour	1 per shift	1 per shift	
	$10/hr	$19/hr	
Other Human Resources (costs cited include full burden, i.e., benefits etc)**:**			
operations supervisory staff	1 per shift	1 per shift	

	$15/hr	$22/hr	
management staff	1 per day	1 per day	
	$25/hr	$30/hr	
maintenance staff (mechanic)	1 per shift	1 per shift	
	$22/hr	$25/hr	
Rolling Stock (not bought – leased):	**LOW**	**HIGH**	
front end loader (1) (total annual lease cost)	$45,000	$60,000	
skid steer (1) (total annual lease cost)	$10,000	$15,000	
forklift (1) (total annual lease cost)	$10,000	$15,000	
Miscellaneous:			
utility /energy costs	$150,000	$350,000	
administration e.g., insurance etc	$75,000	$150,000	
disposal of residuals (assume 5% of incoming)	$60/te	$100/te	

Summary of Costs for 30,000 tonne per year MRF									
Building and Equipment Capital									
	Interest		Total Capital		Annual Cost		$/te		
tpy	Rate	Term (yrs)	low	high	low	high	low	high	
30,000	6.5%	10	$2,280,000	$3,573,000	$ 317,000	$ 497,000	$ 10.57	$ 16.57	**Equipment**
30,000	6.5%	20	$3,520,000	$4,960,000	$ 300,000	$ 423,000	$ 10.00	$ 14.10	**Building**
30,000	6.5%	25	$ 250,000	$4,000,000	$ 19,000	$ 308,000	$ 0.63	$ 10.27	**Land**
Labour									
	Number of Staff		# shifts	@ pay rate		Annual Cost		$/te	
tpy	low	high	per day	low	high	low	high	low	high
30,000	22	27	1	$ 10	$ 19	$ 440,000	$ 1,026,000	$ 14.67	$ 34.20
30,000	2	2	1	$ 12	$ 20	$ 48,000	$ 80,000	$ 1.60	$ 2.67
30,000	2	3	1	$ 14	$ 22	$ 56,000	$ 132,000	$ 1.87	$ 4.40
30,000	1	1	1	$ 15	$ 22	$ 30,000	$ 44,000	$ 1.00	$ 1.47
30,000	1	1	1	$ 22	$ 25	$ 44,000	$ 50,000	$ 1.47	$ 1.67
30,000	1	1	1	$ 25	$ 30	$ 50,000	$ 60,000	$ 1.67	$ 2.00
Total Labour						$ 668,000	$ 1,392,000	$ 22.27	$ 46.40
Other Costs - General Operating									
					Annual Cost		$/te		
tpy					low	high	low	high	
30,000	Property Taxes				$ 61,000	$ 123,000	$ 2.03	$ 4.10	
30,000	General Operating				$ 680,000	$1,040,000	$ 22.67	$ 34.67	
Totals					**$1,984,000**	**$3,660,000**	**$ 67.53**	**$ 115.83**	

15,000 Tonnes Per Year Throughput			
Material arriving - two separate streams - commingled fibers and commingled			
containers, set-out in ridged containers, i.e., not a bag-based program			
Delivery - both streams arriving on a daily basis (i.e., either 2 compartment trucks or			
portion of fleet collecting fibres and portion of fleet collecting containers)			
Material characteristics - mixed fibres @ 250 kg/m3 loose density and mixed			
containers @ 70 kg/m3 loose density			
MRF site size	16,000	m2	
	1.6	ha	
MRF building size	2,400	m2	
MRF throughput tonnes per year	15,000	tonnes	
Operating days per year	250	dpy	
Tonnes per day	60	tpd	
Percentage containers	30%	2.8	tph
Percentage fibres	70%	6.5	tph
Shifts per day	1	shift each containers & fibres	
Effective hours per shift	6.5	hours	
Total tonnes per hour	9.2	tph	
Fibres Sorting Line:			
infloor infeed conveyor	$100,000	$150,000	
raised, enclosed sorting platform	$80,000	$150,000	
Fixed bunkers, flat floor, doors	$80,000	$120,000	
Transfer/sorting conveyors	$100,000	$150,000	
Baler reclaim conveyor/infeed conveyor	$80,000	$150,000	
Baler	$200,000	$300,000	
Sub Total	**$640,000**	**$1,020,000**	
Containers Sorting Line:			
infloor infeed conveyor	$100,000	$150,000	
raised, enclosed sorting platform	$80,000	$150,000	
glass fines screen	$20,000	$30,000	
steel bunker cages, self emptying	$60,000	$90,000	
air classifier	$30,000	$60,000	
ferrous magnet	$30,000	$40,000	
eddy current separator	$60,000	$80,000	
Transfer/sorting conveyors	$100,000	$150,000	
Baler reclaim conveyor/infeed conveyor	$80,000	$150,000	
Sub-Total	**$560,000**	**$900,000**	
General Elements:			

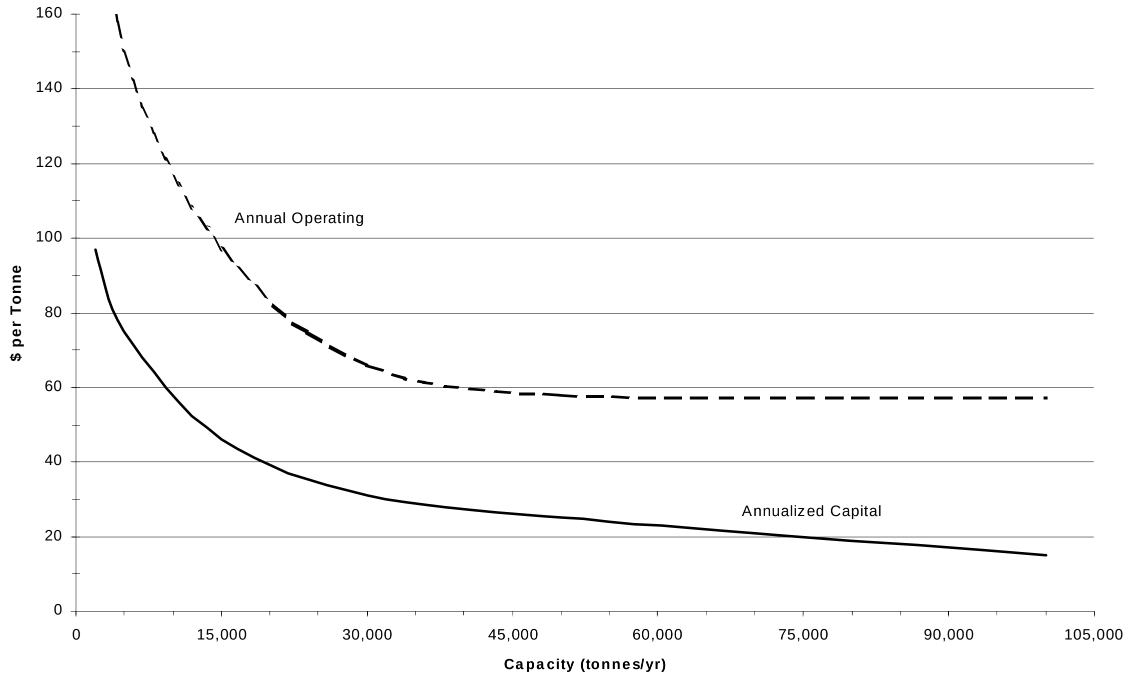
fabricated steel items	$70,000	$150,000	
electric/process operations controls	$100,000	$150,000	
roll-off containers for residuals	$5,000	$10,000	
office equipment	$3,000	$5,000	
weigh scales (2)	$80,000	$120,000	
Shipping	$35,000	$50,000	
installation , contingencies & engineering	$150,000	$200,000	
Sub-Total	**$443,000**	**$685,000**	
Total of above equipment items	**$1,643,000**	**$2,605,000**	
Site/Building (highly variable on basis of			
municipalities' circumstances)			
	LOW	**HIGH**	
property acquisition and servicing - $/hectare unit cost for serviced land	$125,000	$2,000,000	
building -$/m2 unit cost for industrial building(includes interior walls, push walls, infeed pits, reinforced floor)	$770	$1,050	
site preparation costs (paving, landscaping, utilities in from street)	$300,000	$650,000	
site preparation and building construction contingencies and engineering (assume 15%)	$320,000	$480,000	
<u>Major Operating Cost Elements:</u>			
Labour: (costs cited include full burden, i.e., benefits etc)			
sorting - fibres line	6 per shift	9 per shift	
	$10/hr	$19/hr	
sorting - containers line	7 per shift	10 per shift	
	$10/hr	$19/hr	
baling	1 per shift	1 per shift	
	$12/hr	$20/hr	
rolling stock	2 per shift	2 per shift	
	$14/hr	$22/hr	
scale operator	1 per shift	1 per shift	
	$12/hr	$20/hr	
general labour	0 per shift	1 per shift	
	$10/hr	$19/hr	
Other Human Resources (costs cited include full burden, i.e., benefits etc)**:**			
operations supervisory staff	1 per shift	1 per shift	
	$15/hr	$22/hr	
management staff	1 per day	1 per day	

	$25/hr	$30/hr	
maintenance staff (mechanic)	1 per shift	1 per shift	
	$22/hr	$25/hr	
Rolling Stock (not bought – leased):	**LOW**	**HIGH**	
front end loader (0) (total annual lease cost)	$0	$0	
skid steer (2) (total annual lease cost)	$20,000	$30,000	
forklift (1) (total annual lease cost)	$10,000	$15,000	
Miscellaneous:			
utility /energy costs	$150,000	$350,000	
administration e.g., insurance etc	$75,000	$150,000	
disposal of residuals (assume 5% of incoming)	$60/te	$100/te	

Summary of Costs for 15,000 tonne per year MRF									
Building and Equipment Capital									
	Interest		Total Capital		Annual Cost		$/te		
tpy	Rate	Term (yrs)	low	high	low	high	low	high	
15,000	6.5%	10	$1,643,000	$2,605,000	$ 229,000	$ 362,000	$ 15.27	$ 24.13	**Equipment**
15,000	6.5%	20	$2,468,000	$3,650,000	$ 210,000	$ 311,000	$ 14.00	$ 20.73	**Building**
15,000	6.5%	25	$ 200,000	$3,200,000	$ 15,000	$ 246,000	$ 1.00	$ 16.40	**Land**
Labour									
	Number of Staff		# shifts	@ pay rate		Annual Cost		$/te	
tpy	low	high	per day	low	high	low	high	low	high
15,000	13	20	1	$ 10	$ 19	$ 260,000	$ 760,000	$ 17.33	$ 50.67
15,000	2	2	1	$ 12	$ 20	$ 48,000	$ 80,000	$ 3.20	$ 5.33
15,000	2	2	1	$ 14	$ 22	$ 56,000	$ 88,000	$ 3.73	$ 5.87
15,000	1	1	1	$ 15	$ 22	$ 30,000	$ 44,000	$ 2.00	$ 2.93
15,000	1	1	1	$ 22	$ 25	$ 44,000	$ 50,000	$ 2.93	$ 3.33
15,000	1	1	1	$ 25	$ 30	$ 50,000	$ 60,000	$ 3.33	$ 4.00
Total Labour						$ 488,000	$ 1,082,000	$ 32.53	$ 72.13
Other Costs - General Operating									
					Annual Cost		$/te		
tpy					low	high	low	high	
15,000	Property Taxes				$ 39,000	$ 78,000	$ 2.60	$ 5.20	
15,000	General Operating				$ 450,000	$ 770,000	$ 30.00	$ 51.33	
Totals					**$1,392,000**	**$2,771,000**	**$ 94.40**	**$ 173.53**	

Figure A.1.

MRF - Annualized Capital & Operating Costs Curves



APPENDIX 2: TRANSFER STATION COST ASSUMPTIONS AND COST CURVES

Unit cost curves were developed based on specific capital and operating costs for four transfer stations from 10,000 to 40,000 tonnes per year (in 10,000 t/yr. increments).

Assumptions

The following assumptions were adopted in order to develop capital and operating costs for the four transfer stations:

- Fibres density of 200 kg/m^3;
- Containers density of 66 kg/m^3;
- Fibres (combined A & B) and containers separated (fully co-mingled) in the collection vehicle;
- Split between fibres and containers 60/40;
- 260 days per year of operation;
- Vehicle/equipment maneuvering factor equals the combined floor space for each of the 2 materials times three;
- A single scale and scale house has been provided to weigh all in and out bound vehicles. Included in the estimate for the scale house is an allowance for a washroom, change room and lunch area. The building will be approximately 20 ft. x 20 ft. All necessary equipment and associated foundations and earthworks have been included in the estimate for the scale house and scale;
- A 2-acre parcel of land is required for all tonnage ranges due to maneuvering requirements of the transfer tractor-trailers. The cost of land has not been included in the analysis;
- The recyclables will be top loader into 76m^3 (100yd^3) trailers, with a separate compartment (in the trailer) for the containers and fibres. (The capital and operating cost for the transfer tractors and trailers has not been included in the transfer station costs. These truck costs have been included in the transportation costs analysis - see Appendix 3.);
- A single front end loader is required for all four of the tonnage ranges;
- The transfer station operates on a single shift up to 20,000 tonnes per year. Operations above 20,000 tonnes per year required, a second shift;
- For tonnage ranges above 20,000 tonnes/year, two employees are required per shift. One loader operator and a single laborer. For tonnages below 20,000 tonnes per year, a single employee is required to operate the scale and the loader;
- Salary rates, (including benefits) are $30/hr. and $20/hr. respectively for the loader operator and the labourer.
- Allowances have been included in the operating costs for equipment maintenance and fuel, building heat, hydro and insurance.

Description of the Building

Based on the assumptions outlined above, the building footprints for the range of tonnages are as follows:

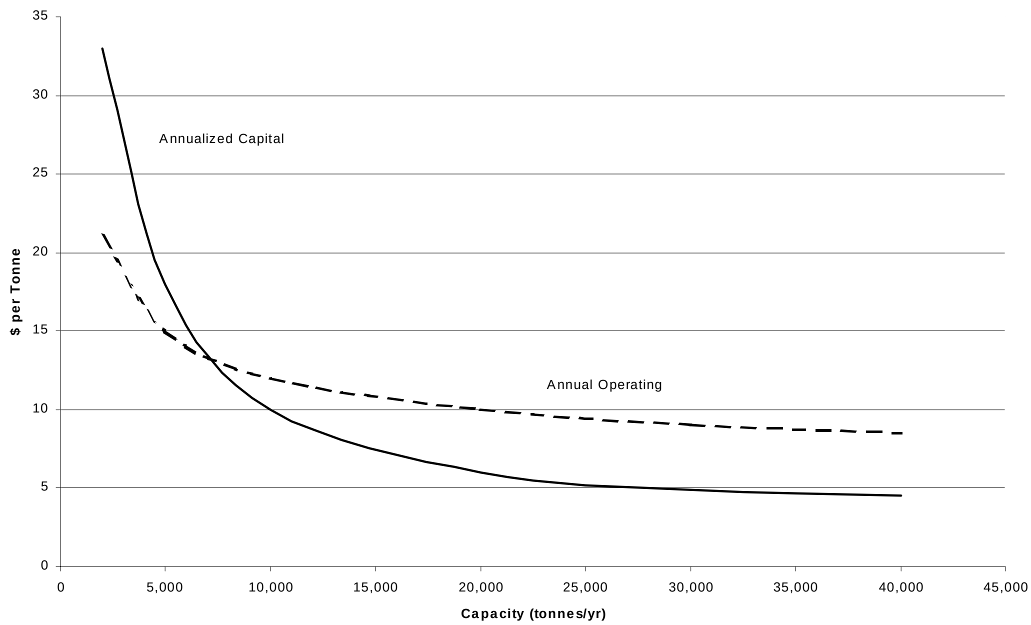
- 10,000-tonnes per year, the building dimensions are 20 X 20 metres – 400 sq. metres (65-ft. X 65-ft., 4,225 sq. ft.);
- 20,000-tonnes per year, the building dimensions are 27.5 X 27.5 metres - 756 sq. metres (90-ft. X 90-ft., 8,100 sq. ft.);
- 30,000-tonnes per year, the building dimensions are 32 X 32 metres - 1,025 sq. metres (105-ft. X 105-ft., 11,025 sq. ft.);
- 40,000-tonnes per year, the building dimensions are 36.5 X 36.5 metres – 1,332 sq. metres (120-ft. X120 ft. 14,400-sq. ft.);
- Main building will be a pre-engineered structure forming clear open span with a minimum 27' clearance;
- Building as a whole will be self-supporting. The roof will be un-insulated standard metal decking, which will require a lower pitch to the roof and provide greater height at the eaves;
- Superstructure is a conventional steel beam/column design with steel cladding;
- Foundations consist of reinforced concrete spread or strip footings with reinforced concrete push walls;
- Perimeter foundation walls will be poured in place, approximately twelve feet above grade (perimeter push walls);
- Tipping floor consists of a poured reinforced concrete slab on compacted granular fill. There is no accessible space under the slab;
- An allowance for three overhead doors is provided;
- Building will be sprinkled. The only HVAC accommodations in the buildings will be roof mounted exhaust fans. The extent of electrical work has been limited to power supply and overhead lighting;
- In order to make the loading operation more efficient, the tractor-trailer will be positioned in a depressed pit. The transfer vehicle will back into the building via a ramp (which is external to the building);
- There will require an asphalt access roadway as well as truck turning and staging area and some parking. The rear of the facilities will be graveled. The front of the properties will have sod. Water service will be provided from a domestic well. The sites will require septic tile beds. There will be minimal signage required for each of the sites. Each site will be fenced with access through a double gate, set back from the roadway to allow for a cueing of the trucks.

Cost Curves

Figure A.2. graphs the capital and operating costs for the transfer stations defined by the assumptions cited above.

The capital and operating costs for the 5,000 tonne per year transfer station were extrapolated from the data points for the four tonnages noted above

Figure A.2. Transfer Station - Annualized Capital & Operating Costs Curves



APPENDIX 3: TRANSPORTATION COST ASSUMPTIONS AND COST ESTIMATES

Transportation, or the term "haul", is defined as transportation of recyclable materials *after* collection is completed. There are two basic options, direct haul and transfer haul**.**

Direct Haul

Direct haul is based on the collection trucks, utilized for curbside collection of recyclables and/or servicing depots, directly hauling their contents to the MRFs. Since the trucks must also perform a collection function during the day, there is a practical limit to the distance and time that can be spent in the direct haul mode. It is assumed that, in a system that is based on greater centralization of MRFs, direct haul occupies roughly 3 hours of the day, with a typical day being 8 hours. Furthermore, it is assumed that the cost per minute of a collection vehicle, once calculated, applies to both the collection mode and the direct haul mode.

To identify the cost (operating, maintenance and capital depreciation) of direct haul, first on a $/minute basis, the following assumptions are made:

- Driver labour rate of $30/hr (including benefits, insurance, etc.);
- Truck fuel consumption is approximately 4-6 L/hr (on route, 5 hours/day) and 12-14 L/hr (off route, 3 hours/day), thus averaging about 8 L/hr; fuel cost of $0.75/L;
- 35-yd^3 sideloader truck capacity assumed. (Note: Marginally smaller or larger capacity trucks are assumed to be proportional in both cost and capacity, thus choice of truck capacity is somewhat arbitrary.);
- 35-yd^3 sideloader capital cost of $170,000 ($85,000 for chassis and $85,000 for body);
- Amortized capital at 6.5%;
- Truck maintenance costs estimated at $10/hr (excluding "system" overheads such as yards, fuel stations, etc.);
- For estimating purposes, collection truck (including body) is depreciated to zero after 7 years. In practice, depending on vehicle condition, chassis and/or body may be rebuilt to extend life or sold for minimal amount. 7-year life represents average or typical conditions;
- Total cost calculated includes an allowance for administration and profit of 15%.

The operation and maintenance costs and the capital depreciation costs for direct haul are calculated to be as follows:

Item	Calculation	$/minute
Labour	$30/hr x 1 hr/60 minutes	0.50/min
Fuel	8 L/hr x $0.75/L x 1 hr/60 minutes	0.10/min
Maintenance	$10/hr x 1 hr/60 minutes	0.17/min
Amortized Capital	$170,000 @ 6.5% = $30,600/yr x 1 yr/260 days x 1 day/ 8 hrs x 1 hr/60 minutes	0.25/min
Administration & Profit Allowance	15% of above costs	0.15/min
	Total:	**1.17/min**
	Total (assuming 70 km/hr avg haul speed attained)**:**	**1.00/km**

The cost *per tonne*-km is dependent on the material being hauled and in particular, its density. The following table summarizes for the material streams under consideration in this study, the loose density of the material, the calculated payload applicable for that material in a 35-yd^3 (27 m^3) collection truck and the resultant haul cost on a $/tonne-km basis (using the $/km derived).

Material	Loose Density (kg/m3)	Payload in 27 m^3 truck (tonnes) [1]	Direct Haul Cost ($/tonne-km)
Mixed Fibre	250	4.89	0.20
Mixed Containers	70	1.37	0.73
Fibres & Containers (Rural areas: 35/65 weight split)	133	2.59	0.39
Fibres & Containers (Urban areas: 50/50 weight split)	160	3.12	0.32
Fibres & Containers (Southern Ont. average) [2]	149	2.91	0.34

1. When calculating payload in the direct haul system, it is assumed that on average only 70-75% of the available volume of the truck (i.e., approximately 19.5 m^3) is utilized.

2. Average figures based on an approximate rural/urban split in southern Ontario of 40/60.

Transfer Haul

Transfer haul involves tractor-trailers transporting recyclables from transfer stations to the MRFs.

The cost of establishing and operating transfer stations has been developed separately, (see Appendix 2) To identify the unit cost (operating, maintenance and capital depreciation) of the tractor-trailer component of transfer haul, first on a $/minute basis, the following assumptions are made:

- One driver/truck, transfer hauls for 8 hrs/day (round trip). It is assumed that typically 1.5 hrs/day is spent filling and emptying the materials and 6.5 hrs/day is actual driving. Average speed attained is 75 km/hr (mostly highway) or 60 km/hr average over 8-hour day (accounting for only 6.5 hours of actual driving);
- Driver labour rate of $30/hr (including benefits, insurance, etc.);
- Truck fuel consumption is approximately 30 L/100 km (typical highway with small amount of urban travel required) or 18 L/hr; fuel cost of $0.75/L;
- 100-yd^3 "walking floor" truck capacity assumed. (Note: Marginally smaller or larger capacity trucks are assumed to be proportional in both cost and capacity, thus choice of truck capacity is somewhat arbitrary.);
- Truck capital cost of $230,000 ($130,000 for tractor and $100,000 for trailer);
- Tractor/trailer maintenance costs estimated to be 50% higher than a collection truck, or $15/hr (excluding "system" overheads such as yards, fuel stations, etc.);
- For estimating purposes tractor is depreciated to zero after 5 years (roughly 800,000 km). In practice, depending on vehicle condition, tractor may be rebuilt to extend life, or sold for minimal amount. 5-year life represents average or typical conditions;
- For estimating purposes trailer is depreciated to zero after 8 years. Amortized capital at 6.5%.
- Total cost calculated includes an allowance for administration and profit of 15%.

The operation and maintenance costs and the capital depreciation costs for the tractor-trailer component of the transfer haul cost are calculated to be as follows:

Item	Calculation	$/minute
Labour	$30/hr x 1 hr/60 minutes	0.50/min
Fuel	18 L/hr x $0.75/L x 1 hr/60 minutes	0.23/min
Maintenance	$15/hr x 1 hr/60 minutes	0.25/min
Amortized Tractor Capital (5 year life)	$130,000 @ 6.5% = $31,200/yr x 1 yr/260 days x 1 day/ 8 hrs x 1 hr/60 minutes	0.25/min
Amortized Trailer Capital (8 year life)	$100,000 @ 6.5% = $16,000/yr x 1 yr/260 days x 1 day/ 8 hrs x 1 hr/60 minutes	0.13/min
Administration & Profit Allowance	15% of above costs	0.20/min
	Total:	**1.56/min**
	Total (assuming 60 km/hr avg haul speed attained)**:**	**1.56/km**

The cost *per tonne*-km is dependent on the material being hauled and its density. The following table summarizes for the material streams under consideration in this study, the loose density of the material, the calculated payload applicable for that material in a 100-yd^3 (76 m^3) trailer and the resultant haul cost on a $/tonne-km basis.

Material	**Loose Density (kg/m3)**	**Payload in 76 m^3 Trailer (tonnes)** [1]	**Transfer Haul Cost ($/tonne-km)**
Mixed Fibre	250	17.00	0.09
Mixed Containers	70	4.76	0.33
Fibres & Containers (Urban or rural: 50/50 weight split)	160	10.88	0.14

1. When calculating payload in the transfer haul system, it is assumed that on average only 90% of the available volume of the truck (i.e., 68 m^3) is utilized.

APPENDIX 4: MRF NETWORK SYSTEMS EVALUATED – SYSTEM MAPPING AND DETAILED FULL COSTS AND TOTAL KILOMETRES OF HAUL CALCULATIONS

Overview

To investigate whether the current MRF infrastructure in the Province is optimized, a trade-off analysis was conducted. The analysis examined the impact of reducing the number of MRFs, thus realizing economies of scale with the centralized, larger capacity facilities, at the expense of increased haul costs. Nine systems, each having a different number of MRFs and transfer stations, were modeled. The MRF and transfer facilities' costs and haul costs associated with these systems were graphed to form a cost curves. These curves indicate how the economic performance of Ontario's existing MRF network would compare with any other configuration of MRFs, transfer stations and materials' transportation patterns.

The nine systems that were modeled were constructed with the capacity to manage the same amount and type of material. The locations of the systems' MRFs and transfer stations were chosen based on "decision guidelines" which had been adopted by the Study Steering Committee. Facility locations were restricted to the current MRF locations, in recognition that a movement to a more optimized system (if one exists) would likely involve the use of "scaled-up" existing facilities.

The modeling exercise was intended to demonstrate the trade-off of processing facility economies of scale versus increased haul. It was *not* intended to identify specific existing facilities that should, for example, be expanded or closed. Therefore the MRF and transfer station locations have been identified anonymously in this report.

For each system modeled, the quantity of material "feeding" the individual facilities, the round trip haul distance to the facilities from the material generation areas and the round trip haul distance from transfer stations to MRFs, were all used to calculate a total measure of haul, expressed in "tonne-km".

The systems were modeled using a "full cost" approach. Under this approach, annualized capital and operating costs were developed for various capacities of MRFs and transfer stations. Similarly, materials' transportation distances and related costs were calculated. The total cost for each system was calculated by summing the facility capital and operating costs with the haul costs. Capital and operating costs were determined for each facility by multiplying the facility capacities by the appropriate unit capital and operating costs (taken from the cost curves discussed earlier). Similarly, haul costs were determined by multiplying the "tonne-km" of haul for each facility by the unit haul costs ($/tonne-km).

The total truck-kilometers of haul under each system was also expressed as being a representation of the potential environmental impact of a system.

It was recognized that there are unique circumstances in northern Ontario, which is characterized by small quantities of materials and long haul distances. In recognition of this uniqueness, Southern and Northern Ontario were modelled separately.

Six different systems were modeled for southern Ontario, as follows:
57 MRF System (Current System)(with 0 transfer stations);
9 MRF System (with 4 transfer stations);
21 MRF System (with 2 transfer stations);
33 MRF System (with 16 transfer stations);
14 MRF System (with 4 transfer stations); and
21 MRF System (with 28 transfer stations); a variation on the 21 MRF system above.

Based on the information provided to the consultant team as a result of the data call phase of this project, the existing network of MRFs in southern Ontario system was assumed to be represented by the system termed the '57 MRF System'. The other five southern Ontario systems modeled have progressively fewer, larger capacity, MRFs and with greater centralization, inherently more haul.

Three different systems were modeled for northern Ontario, as follows:
12 MRF System;
5 MRF System; and
3 MRF System (with 2 transfer stations).

The “current” system in the north was represented by the '12 MRF System'.

Figures A4.1 - A4.3 have been taken from the MRR GIS model which was developed during the course of the study. The figures are incorporated into this Appendix in order to provide pictorial demonstrations of the geographic configurations of certain of the MRF systems that were modeled. The MRR GIS program is in electronic file form and is a component product, outcome from this study. (Refer to Appendix 6.)

Figure A4.1: 57 MRFs System

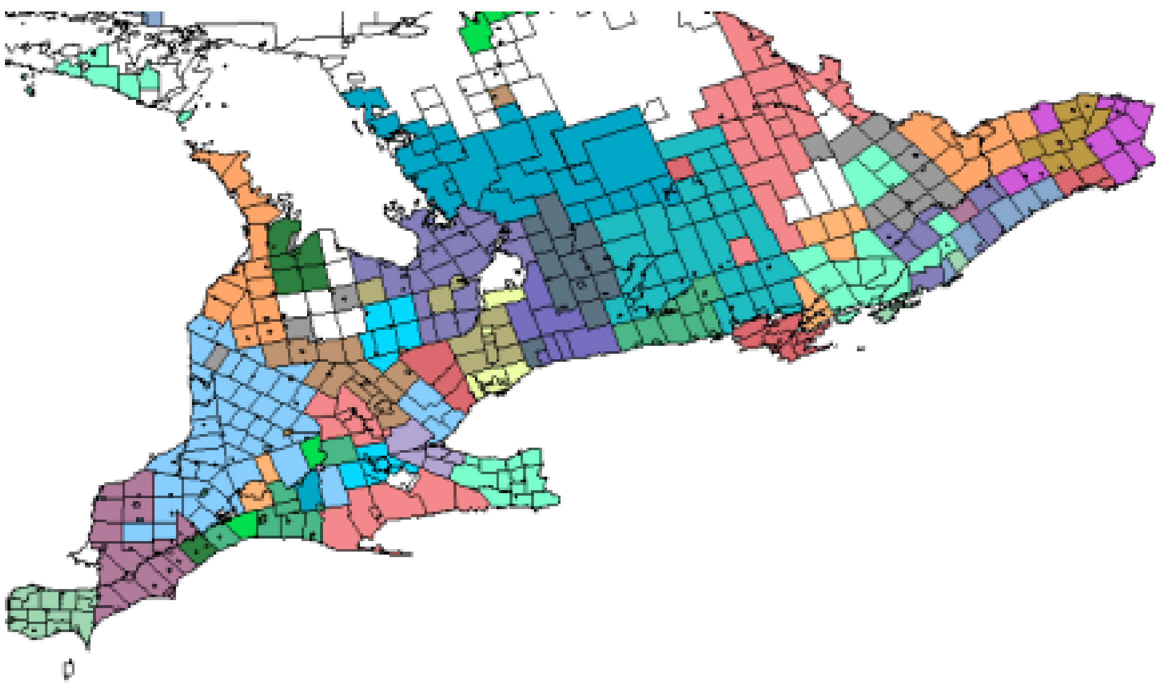


Figure A4.2: 14 MRFs System

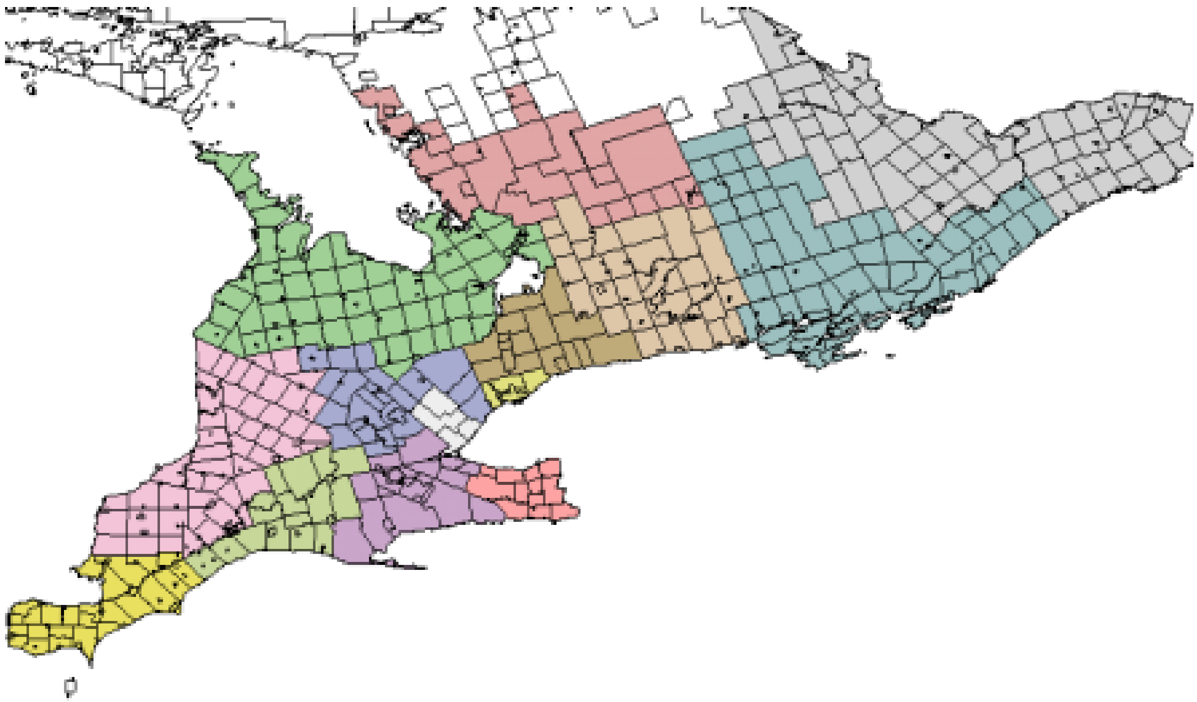


Figure A4.3: 9 MRFs System

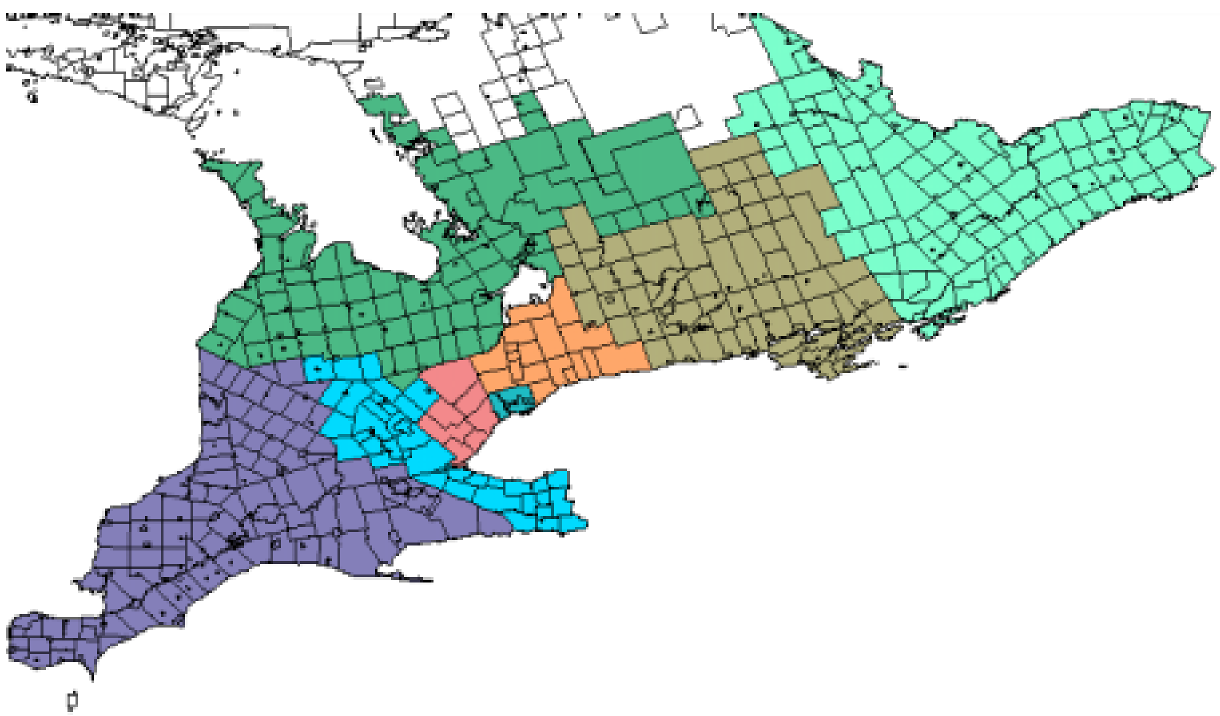


Table A4.1. provides a summary of the cost and truck-kilometers of haul for each of the systems modeled.

Table 4.2 Summary of MRF System Costs and Transportation Requirements:

Southern Ontario (total quantity processed: 1,000,000 t/y)

System	(Excludes Revenues)		Capital	Operating	Haul	Direct	Transfer	**Total**
	($)	($/tonne)	($/tonne)	($/tonne)	($/tonne)	(truck-km/yr)	(truck-km/yr)	(truck-km/yr)
57 MRF System	$116,800,000	117	34	76	7	7,200,000	0	7,200,000
33 MRF System (with 16 Xfer Stns)	$105,700,000	106	30	68	8	6,900,000	500,000	7,400,000
21 MRF System (with 2 Xfer Stns)	$99,000,000	99	25	61	14	13,200,000	400,000	13,600,000
14 MRF System (with 4 Xfer Stns)	$95,800,000	96	20	59	17	16,200,000	1,200,000	17,400,000
9 MRF System (with 4 Xfer Stns)	$93,800,000	94	14	58	23	20,100,000	1,800,000	21,900,000
21 MRF System (with 28 Xfer Stns) (Transportation Impacts Minimized)	$99,000,000	99	27	63	10	6,900,000	2,200,000	9,100,000

Northern Ontario (total quantity processed: 44,000 t/y)

	Full Cost		**Cost Breakdown**			**Total Km of Haul**		
	(Excludes Revenues)		Capital	Operating	Haul	Direct	Transfer	**Total**
System	($)	($/tonne)	($/tonne)	($/tonne)	($/tonne)	(truck-km/yr)	(truck-km/yr)	(truck-km/yr)
12 MRF System	$10,818,000	246	74	150	22	962,000	0	962,000
5 MRF System	$9,352,000	213	55	110	47	2,057,000	0	2,057,000
3 MRF System (with 2 xfer stns)	$8,741,000	199	45	89	65	2,057,000	502,000	2,559,000

APPENDIX 5: DOCUMENTATION FROM STAKEHOLDERS CONSULTATION WORKSHOPS

Workshop #1; November 30, 2000
WDO MRF Optimization Project Public Sector Workshop
Held in the Quebec Room of the International Centre, Mississauga, Ontario concurrently with the Canadian Waste Expo

November 30, 2000 – 1:00pm to 3:00pm

Introduction by Dan Lantz, Project Leader

- Currently 65-70 MRFs in the province handling residential materials.
- Full cooperation to date public sector, limited from the private sector, nothing from the big three.
- Seeking alternative means to get the information.
- No estimate yet on current efficiency of the program, level of capacity or how many MRFs we need.
- Phase Two of project will have more detailed discussion; today's session for issue identification.
- There will be a full-day session in Phase Two and a half-day at the end of the project.
- Report goes to the WDO project steering committee - up to them what happens then.
- This exercise could feed into the calculations for optimum cost projections and hence funding.

Question from one attendee: What are perceived inefficiencies?
Answer: Too many MRFs, too little tonnage.
Comment: Old MRFs die off through market forces.

Summary of Global Issues Identified

1. Need to clarify the types of materials this study will look at, and the breadth of materials an ideal MRF would handle. If brand owners are paying they will want their materials in the blue box. This can affect "efficiencies".
2. Need to clarify the way these materials will be collected (i.e., fibres and containers separately, fully commingled only options being reviewed at this time).
3. Need to identify the operations costs for fibres and containers separately.
4. What are the variables for efficiency? Union versus non-union labour; throughput; landfill rate; where are the markets; can haulers bulk?
5. How will this study affect the cost formula, which the WDO will hopefully offer soon?
6. Markets are an integral part of the whole picture and should be part of any optimization study. For example, a map showing the MRFs and the markets in Ontario and elsewhere should be drawn.
7. What about IC&I tonnage going through municipal MRFs? How much double counting is there? How is the IC&I tonnage going through municipal MRFs being examined relative to their ability to accept more material (i.e., their utilization)?
8. What about the materials you have to pay to market? (Note: indicated that the study is not looking at markets).
9. More equipment hours of operations a means higher equipment maintenance and replacement costs.
10. Existing contracts must be considered. There would need to be a transition period.
11. We need to be looking at available tonnages.

12. How will the programs that are not the 'norm' (e.g., Guelph) be dealt with through this project?
13. Participants would like to see the results of the MRF proposals from the 3 large MRF equipment suppliers.
14. Steering committee list should be made available to the workshop participants.
15. Participants would like to see the terms of reference for this project.
16. A copy of the MRF map should be made available to participants.

Summary of Issues Related to MRF Optimization in Ontario

Political Issues:

- Some municipalities may choose not to work with other municipalities due to politics, personal differences of individuals and competing priorities.
- Some municipalities may feel that their community needs a MRF to foster a sense of community pride and education (i.e., group/school tours).
- The Municipal Act will require 'report cards' to be filled out on municipal activities, which have private sector like activities.
- Perception that the final report from this project will indicate, by inference, which MRFs should close and which should stay open - and that this will foster tension all around the province. Note: It was indicated that the study would not identify specific MRFs that should/could close as a means of increasing the efficiency of the system.
- Some municipalities have current contracts with 'organizations' of which they are members (i.e., in the North there is NORA) and may choose to start to withdraw from that organization or become in conflict with it due to its own optimizing agenda. This may put the larger organization's viability in jeopardy and threaten the viability of its other members.

Social / Planning Issues:

- Some communities may find that the costs of operating a MRF which is deemed not to be in the optimal place or operational condition is necessary to keep jobs in the community or provide jobs for special job training programs.
- Some communities may have specific Economic Development plans for "Green Parks" of which the MRF is an integral part.
- Reduced competition may occur as a result of optimizing the system in Ontario. This may affect the contract prices.
- Reduced competition could also result in potential instability should foreign head offices of the major players call for business closures in Ontario, for reasons not related to the performance of those MRFs.

Geographic Issues:

- Distances travelled for pickup of materials and delivery to transfer site or MRF will vary. Cities, rural and northern areas will each need to be treated differently.
- Travel distances of markets from MRF sites will vary across the province - but it is the most significant in the North.
- Local weather conditions will have an impact on the durability of collection equipment (unpaved roads, high snow areas...)
- Quality of the materials collected may also vary due to geography: materials from tourist areas, depot areas which are generally rural, and areas that get more rain or snow than the average in Ontario may be penalized by the markets.

Operational Issues:

- Municipal programs will vary (i.e., wet/dry; numbers and types of materials collected) and some municipalities may have to modify their programs if mergers are to be created (therefore costs related to program changes, P&E, equipment etc).
- Some facilities may have unionized labour, which may oppose shutdowns or increased workloads.
- The current collection vehicles may have to be modified / changed if programs change.
- Concern that the data obtained on the MRFs for residential processing are misleading.
    1. IC&I contractors who supply materials to the MRFs but collect residentially are currently classified as IC&I materials.
    2. IC&I tonnage currently supports the viability of MRFs.
- How materials currently arrive at the MRF is an issue with respect to the cleanliness of the materials. Examples include: glass breakage, contamination from depot areas, commingling of products not normally commingled at receiving MRF, etc.
- MRFs that are not currently set up to handle the mixture of materials, which may become the standard and cannot afford to but new equipment will be at a disadvantage.
- Technological changes will dictate the efficiencies of tomorrow - this is a moving target and how will a moving target be incorporated into this project? A MRF built even two or three years ago, while state of the art at the time, may now be considered inefficient.
- Recovery rates will vary between facilities - what is considered the acceptable target for this project?

Financial Issues:

- Smaller municipalities do not have the budget (manpower or time) to address these issues or defend their positions.
- Labour rates in different facilities and regional areas will vary.
- Need to ensure that the municipalities who close their MRFs and still incur the costs of collection are subsidized like those municipalities who are doing the processing. This may occur from one public sector to another through their contracts.
- In the process of becoming ‘optimal’ a municipality could incur substantial equipment costs. Is there any assistance forthcoming for these costs especially in those communities who just have not budget designated for this at all?
- The way municipalities collect and report on their financial data varies - in some communities there is no monies put aside for capital purchases and no amortized costs are tabled.
- Whatever the wisdom of setting aside reserve for capital it doesn’t always happen, because of other priorities and/or different accounting practices.

Workshop #2: May 23, 2001
WDO MRF Optimization Project Workshop
Held at the Holiday Inn Express, Burlington

May 23, 2001 – 10:00pm to 4:30pm
Introduction by Jay Stanford.
Overview of Study Findings (copies to be made available)
Comments by Geoff Rathbone re: Funding Formula. The funding formula does include opportunities to drive efficiencies. It tries to encourage additional efficiencies in the system. Therefore there is a linkage with the formula group. Steps to encourage efficiency will be rewarded in the funding formula.

Questions and answers (from study teams reps):
Q. There is no transfer haul in the current system, correct?
A. Correct.
Q. Is this report based on municipal tonnage?
A. Yes. Where we had IC&I tonnage reported, it was included.
Q. Are the MRFs in the study just municipal MRFs?
A. If a MRF handles residential tonnage, it is included.
Comment. The private MRFs could handle residential tonnage.
A. That's right. But we couldn't get the data on private MRFs.
Comment. I have the same equipment. I could handle residential tonnage.
A. You are not in the report because OWMA couldn't get the data.

Q. If one is not a member of OWMA, how can one contribute data/information?
A. All private MRF s were asked to complete the survey, including non-members. If you give us the information we could include it. If you can suggest any other forum that we could use to obtain the data we would welcome that.
Q. How many MRFs are municipally owned and operated?
A. We didn't focus on that.
(Later it was suggested that there are 15 municipally owned and operated MRFS. Other are municipally owned but privately operated).
Q. How many municipalities replied to the survey.
A. We got very detailed information form about half and some information from all.
Obviously there is room for improvement. What else could we do? We would welcome the information.
Q. The prices seem close. Maybe more data would affect the ranking of the options. The environmental and social impacts and potential costs can be significant. How sound is the data?
A. Our findings are averages. We feel comfortable in the findings at a provincial level. There may be opportunities for savings. Some trucks do pass each other in opposite directions. We don't have enough data to tell any one municipality what to do. We have good tonnage data for the residential sector (through the data call). But if half of the tonnage is IC&I it could affect the cost data (i.e. some programs cold be more efficient, with lower rates per tonne, than suggested by the current data.).
Q. We could probably have come to these conclusions at the start. What will be the conclusions of the report?
A. We cannot say.
A. There will be tools to help you look at your area. Some are already doing this- working towards efficiency and trying to work with their neighbours.
Q. That's right. These discussions do occur. My concern is, are the conclusions going to be specific?
A. We recognize these discussions do occur. We also recognize that many municipalities are trying to do this already. We just want to give you the tools to accelerate the process.
A. We want to give you the tools and a direction for policy for example for council.

Q. Was Toronto included?
A. The model includes Toronto.
Q. What are the tools?
A. They are soft tools. To help you nudge your neighbours. The GIS mapping will allow municipalities to enter in data to create various scenarios they would like to explore.
Q. What were the capital costs annualized?
A. It ranged from $30 per tone for the smaller MRF to about $10/tonne for the larger MRF.
Q. Was there any consideration of single-family homes versus multi-residential?
A. It's not that specific
Q. Was there any consideration of packaging trends (i.e. density of materials)?
A. We used what four consultants agreed was the current understanding of density. One of the other WDO groups looked at density issues. Trends were not looked at.
Q. We are in the 11th hour of planning for our facility and would like to know if any of these tools would be available within the next 4 weeks
A. They will not be available in this time frame.

Notes from the breakout groups on barriers and solutions to implementation
Notes are consolidated into several sections and listed here as presented to the plenary session after the break-out group session.

These remarks are divided into three sections: Considerations, What We Need and Other

Considerations:

Collection method:

- the degree of curb-sorting will affect the level of sorting required at the MRF.
- co-collection can mean vehicles also serve a landfill/transfer station or composting site.

Material split in the MRF:

- you cannot use the same performance criteria on an expanded program MRF, a basic program MRF , a fibre and containers-only MRF.

Social, environmental and other implications (like congestion) of moving to fewer MRFs with greater transportation

- some of these may not be able to be expressed in dollar terms but they are key considerations which should be given top billing

Social and environmental considerations at the local level

- some MRFs also have a social role such as providing employment for various "challenged" groups.

- Local political issues, inter-municipal rivalry, level of co-operation could be impeded by non-co-operation on other initiatives, personality politics, local commercial/institutional interests versus recycling efficiencies

Level of jurisdiction

- current trend to upper tier presents opportunities for regional co-operation/planning. Extending this to inter-regional co-operation (or even province wide) merely adds to the possibilities (although the political barriers may increase, accordingly).

Flow control

- whether this took the form of formal legislation or informal practice, flow control policies could hamper regional co-operation or cross-border opportunities

We Need:

Private sector information

- we are not getting the true picture of what is out there. There may be enough capacity.

Better data

- the study team has minimal private MRF information and does not have the full picture on the municipal MRFs - such as C of A coverage.

Transparency in the process

Comfort with the assumptions

- assumptions (and thus resulting conclusions) need to be based on widely-agreed baseline data and method

Buy-in from The Province, the private sector, municipalities, environmental and citizens' groups, packaging industry and organized labour.

General Issues:

- With a $7/tonne split between the existing situation and the super-MRF option, and the high price to be paid for all the added transportation in environmental, social and congestion impacts,
  - (1) The status quo, generally, looks pretty good;
  - (2) The added costs of the other items mentioned above could significantly alter the overall costs presented– especially costs related to more transportation and the associated environmental costs
- While organics and HHW are not part of this exercise, we have to ignore the fact that they could be part of a collection/processing system and could have impacts on the analysis.
- The private sector wants the playing field to be leveled when they compete against public forces for contracts. Similarly, public forces need to be able to look at opportunities to increase their efficiencies by having access to IC&I tonnage.
- How will the funding formula be applied as a result of this report? There is discomfort at the municipal level with this process.
- If the environmental and social costs are not added into the equation then we need very strong wording to say that these issues/costs should be considered as part of the whole picture.

APPENDIX 6: MRR GIS MODEL OUTLINE

A MRR GIS model was developed under the WDO MRF Optimization Study for the purposes of portraying the alternative MRF networks, which were evaluated. The model served the immediate needs of the study and is viewed as useful "tool" which stakeholders could employ in initial evaluations of potential MRR configurations.

Stakeholder consultation during the study identified a need for a more "powerful" tool that would enable a comprehensive analysis of MRRs' options, integrating material generation and transportation information relative to individual municipalities. The following presents an outline of the characteristics of the future vision of the model.

Material Generation Data

At present, because of the way service is provided, the material generation data currently available to populate a model has a number of municipal-specific data inconsistencies. For example:

- The Region of Halton is treated as a single municipality;
- The Region of York is broken down into its individual area municipalities and;
- The Region of Ottawa-Carleton, now the City of Ottawa, is treated as a single municipality with the exception of the Township of Osgoode, which is broken out as a separate municipality.

To increase the utility of the system, it would be useful to create individual records for the smallest possible geographic area for which demographic information such as population or number of households is available. For most of the province this is the township (or former township) level. Having data at this level, even if it is estimated, would allow large regional municipalities to be split when evaluating alternative Municipal Recycling Regions (MRRs). It is understood that actual reporting on recycling quantities may be based on a larger geographic area (e.g., Bluewater Service area). However, it should be possible to later take those data and prorate them back to the individual townships on the basis of population. Alternatively, the current municipal structure, as set out in the 2001 municipal directory, could be used as the fabric for the generation database.

The fields for the material generation database could include:

- Municipal Tonnes Containers: net generated (i.e. net of processing residue)
- Municipal Tonnes Fibre: net generated;
- Total Municipal Tonnes: net generated;
- The Upper tier municipality to which the generation area belongs;
- Recycling association to which this generation area belongs;
- Processing location for container (the link to processing data);
- Processing location for fibres (link to processing data);
- Level of service (depots, curbside or some of each);
- Local haul distance (our estimate of distance to get material to local MRF, note: if MRF is located in material generation area then we assume the local haul distance is 0 km);
- Population of generation area;
- Number of Households in generation area;
- Municipal contract information (info from the "contracts" spreadsheet?);
- Name
- Title
- Street
- Municipal
- Province
- Code

- Phone
- Fax
- Email
- Other info/fields from the data call?

From a policy perspective, responsibility for reporting on the municipal quantities generated should rest with the "corporate" municipality that provides the recycling service to its citizens. In the future, the requirement to submit these data could be tied to the provision of Product Stewardship Ontario (PSO) funding. In practice the quantity data will actually be provided by the recycling association to which the municipality belongs or by private sector firm that provides the service to the municipality.

At present, there are data constraints because:

- Some MRF operator (both private and public sectors) will not provide information on their individual sources and quantities of materials (both municipal and IC&I materials); and
- Some municipalities do not have quantity data because it is picked up and processed by a private sector contractor who does not provide reporting on specific quantities.

Under the above-proposed approach, the municipality could require the private sector contractor to provide reporting on the quantities (either actual or estimated) of public sector material collected from within the municipality and this information could become public.
In addition to the above discussion of material generated by the public sector, there is the whole issue of material generated by the private sector. How should the private sector generation information be gathered? For example, could it be calculated as a simple percentage of public sector generation?

Material Processing Data
From a geographical reference perspective the material processing data should be linked to a point (GIS polygon), i.e.:

- Included in the geographically referenced set of communities in the GIS; and
- As close as possible to the actual location of the MRF.

The link between the "material generation data" and the "material processing data" is that all the material generated must be processed. The basic fields for the processing data could include:

- Name of MRF;
- Location of MRF;
- Street
- City
- Contract Information (sometimes the contract info is different from the MRF location);
- Name
- Title
- Organization/Company
- Street
- Code
- Phone
- Fax
- Email
- Sector (public or private)
- Municipalities (material generation areas) being served and associated public sector quantities (multiple fields) (these are the links back to the material generation data); and
- CofA Information

- Approved capacity
- Approved service area
- Other details from CofA

In addition to the above information that would be available in the public domain, there is a lot of additional information that would be useful, but because of their proprietary nature, would have to be managed in a confidential manner.

This additional information includes:

- Quantity of IC&I material actually processed at facility;
- Total quantity of material actually processed at facility;
- Actual practical processing capacity of facility (assuming multiple shafts);
- Input material receiving options/capabilities (1-, 2-, 4-stream);
- Details on actual processing operation and capabilities (number and nature of material sorts);
- Residue, quantities and processing efficiency; and
- Actual costs (operating and capital).

The MRF operators would provide the above cited information.

Transportation Distances Option

It is possible to construct a GIS model that is capable of determining distances from the areas of material generation to potential MRF locations. Within each of the material generation polygons (referenced previously) a source point (one of the communities in the GIS) would be identified. In practice, this would likely be the largest community, or for completely rural polygons, a community closest to the centre of the polygon. Routing software could then be used to calculate the distance from the point of generation to the selected MRF location. This tool would allow municipalities to really identify the transportation distances associated with alternative MRR options.

Use of GIS

Once the GIS system described above has been established, it will fulfill two main functions:

- Provide a tool for accessing information (from future data calls) on recycling in Ontario; and
- Provide a tool to help in investigating the potential benefits of creating additional municipal recycling Regions (MRRs) and thus contribute to developing a more efficient infrastructure.

In order to keep the GIS tool useful, it must be linked to the latest "data call" information. The steps for the use of the GIS in investigating alternative MRRs would be as follows:

1. Produce/generate a base map of the potential study area that illustrates the fabric of the material generation databases within the area of interest.

2. On the base map, define a particular MRR to be investigated.

3. From the GIS extract:

- the relevant individual quantities of materials;
- the assumed point source of material generation; and
- the total quantities of material generated within the defined MRR.

4. Select a MRF location within the MRR area and have the GIS generate the relevant number of kilometers from the various point sources of generation to the selected MRF location.

5. Use of cost curves to estimate the gross cost of processing the total quantity of material generated within the MRR. (Assume material sales revenue will be common to all alternatives.)

6. Use the generated quantities, kilometers of haul (twice the distance to the MRF) and unit haul costs to estimate the haul cost associated with the particular alternative.

7. Add the processing cost and the haul cost to estimate the cost of the alternative.

8. Define additional MRRs, including the current system, and repeat the above steps to determine the costs associated with other alternatives

9. Review the results to ensure they are consistent with expectations in the larger context and identify the other issues associated with each of the alternatives.

10. Decide if it is worthwhile to pursue the investigated MRR approach.