An examination of the acceptance of construction and demolition waste reduction measures by residential building contractors in Windsor and Essex County (Ontario).

Karl Dean. Tanner

University of Windsor

Follow this and additional works at: https://scholar.uwindsor.ca/etd

Recommended Citation

https://scholar.uwindsor.ca/etd/1031

This online database contains the full-text of PhD dissertations and Masters' theses of University of Windsor students from 1954 forward. These documents are made available for personal study and research purposes only, in accordance with the Canadian Copyright Act and the Creative Commons license—CC BY-NC-ND (Attribution, Non-Commercial, No Derivative Works). Under this license, works must always be attributed to the copyright holder (original author), cannot be used for any commercial purposes, and may not be altered. Any other use would require the permission of the copyright holder. Students may inquire about withdrawing their dissertation and/or thesis from this database. For additional inquiries, please contact the repository administrator via email (scholarship@uwindsor.ca) or by telephone at 519-253-3000 ext. 3208.
NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S’il manque des pages, veuillez communiquer avec l’université qui a conféré le grade.

La qualité d’impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l’aide d’un ruban usé ou si l’université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d’auteur, SRC 1970, c. C-30, et ses amendements subséquents.
An Examination of the Acceptance of Construction and Demolition Waste Reduction Measures by Residential Building Contractors in Windsor and Essex County

by

Karl D. Tanner

A Thesis Submitted to the Faculty of Graduate Studies and Research through the Department of Geography in Partial Fulfillment of the Requirements for the Degree of Master of Arts at the University of Windsor

Windsor, Ontario, Canada

1995

© Karl Tanner 1995
THE AUTHOR HAS GRANTED AN IRREVOCABLE NON-EXCLUSIVE LICENCE ALLOWING THE NATIONAL LIBRARY OF CANADA TO REPRODUCE, LOAN, DISTRIBUTE OR SELL COPIES OF HIS/HER THESIS BY ANY MEANS AND IN ANY FORM OR FORMAT, MAKING THIS THESIS AVAILABLE TO INTERESTED PERSONS.

THE AUTHOR RETAINS OWNERSHIP OF THE COPYRIGHT IN HIS/HER THESIS. NEITHER THE THESIS NOR SUBSTANTIAL EXTRACTS FROM IT MAY BE PRINTED OR OTHERWISE REPRODUCED WITHOUT HIS/HER PERMISSION.

ISBN 0-612-01491-6
**THE HUMANITIES AND SOCIAL SCIENCES**

**COMMUNICATIONS AND THE ARTS**
- Architecture: 0729
- Art History: 0737
- Communication: 0730
- Dance: 0738
- Fine Arts: 0730
- Information Science: 0732
- Journalism: 0791
- Library Science: 0799
- Mass Communications: 0708
- Music: 0413
- Speech Communication: 0459
- Theater: 0465

**EDUCATION**
- General: 0515
- Adult Education: 0514
- Adult and Continuing: 0516
- Agricultural: 0517
- Art: 0573
- Bilingual and Multicultural: 0525
- Business: 0588
- Community College: 0591
- Curriculum and Instruction: 0727
- Early Childhood: 0616
- Elementary: 0624
- Finance: 0627
- Guidance and Counseling: 0628
- Health: 0680
- Higher: 0745
- History: 0742
- Home Economics: 0778
- Industrial: 0521
- Language and Literature: 0260
- Mathematics: 0252
- Music: 0522
- Philosophy: 0523

**PHILOSOPHY, RELIGION AND THEOLOGY**
- General: 0525
- Religious: 0535
- Biblical Studies: 0537
- History of: 0539
- Ethics: 0541
- Philosophy: 0543
- Theology: 0547

**SOCIAL SCIENCES**
- American Studies: 0553
- Anthropology: 0554
- Anthropological: 0555
- Sociology: 0556
- Economics: 0557
- Geography: 0558
- History: 0559
- Political Science: 0560
- Population: 0561
- Urban: 0562
- Women's Studies: 0563

**THE SCIENCES AND ENGINEERING**

**BIOLOGICAL SCIENCES**
- Agriculture: 0473
- Anatomy: 0285
- Animal Culture and Management: 0475
- Animal Pathology: 0476
- Plant Science and Cultivation: 0477
- Forestry and Wildlife: 0478
- Plant Pathology: 0479
- Plant Physiology: 0480
- Range Management: 0481
- Biology: 0482
- General: 0483
- Anatomy: 0284
- Applied: 0285
- Animal: 0286
- Botany: 0287
- Zoology: 0472

**ENGINEERING**
- General: 0374
- Aerospace: 0375
- Agricultural: 0376
- Automotive: 0377
- Biomedical: 0378
- Chemical: 0379
- Civil: 0380
- Electrical: 0381
- Environmental: 0382
- Mechanical: 0383
- Oceanic: 0384
- Nuclear: 0385
- Packaging: 0386
- Petroleum: 0387
- Sanitary and Municipal: 0388
- System: 0389
- Textile: 0390

**PSYCHOLOGY**
- General: 0621
- Behavioral: 0622
- Clinical: 0623
- Developmental: 0624
- Experimental: 0625
- Industrial: 0626
- Personality: 0627
- Physiological: 0628
- Psychological: 0629
- Psychometrics: 0630
- Social: 0631
ABSTRACT

Within the field of urban planning there is a growing recognition that the discipline must incorporate within its existing framework an environmental component that is sensitive to environmental concerns and which takes a proactive role. It is no longer possible to consider development in isolation without first looking at the consequences development has upon the natural and physical environment. The residential construction industry is seen as an industry where opportunity exists to reduce, reuse, recycle and recover material wasted during the construction process. The purpose of this study was to survey new residential building contractors in the Windsor / Essex County area and determine how they had been affected by waste reduction and minimization measures.

After surveying 43 residential building contractors, analysis was conducted to determine the impact that waste reduction and minimization practices have had in the Windsor / Essex County area. The results suggest that the contractors surveyed do minimize waste on site for economic rather than environmental reasons. However, waste reduction and minimization literature designed specifically for contractors is not reaching them and the composition of new construction waste is quite different to previous studies done in other municipalities.

This study should prove useful to other researchers investigating the issue of construction and demolition waste reduction in Windsor and Essex County area and else where.
ACKNOWLEDGMENTS

I would like to express my thanks to Dr. Veronika Mogyorody, Dr. Malcolm Matthew, and Dr. Larry Kulisek for serving as my Thesis Committee Members. Their guidance, time, experience and encouragement throughout my thesis research was greatly appreciated. In addition I would like to thank the numerous building contractors in Windsor and Essex County who answered my questions and made my research possible.

I would also like to extend my appreciation to various friends and family members who encouraged me throughout my studies at the University of Windsor. A special thanks must be extended to my future wife Jennifer Harding, whose friendship and encouragement helped me to complete this endeavor.
# TABLE OF CONTENTS

ABSTRACT .............................................................................................................. iii

ACKNOWLEDGMENTS ............................................................................................. iv

LIST OF TABLES ....................................................................................................... viii

LIST OF FIGURES ...................................................................................................... viii

1.0 INTRODUCTION ................................................................................................ 1
   1.1 Introduction ........................................................................................................ 1
   1.2 Objectives ......................................................................................................... 3

2.0 LITERATURE REVIEW ...................................................................................... 5
   2.1 Introduction ........................................................................................................ 5
   2.2 Environmental and Eco-system Approaches to Urban Planning ................. 5
   2.3 Environmental Problems and Residential Development ......................... 6
   2.4 Environmental Concerns from Global Perspective ....................................... 8
   2.5 Environmental Concerns from A Canadian Perspective ............................ 9
   2.6 Residential Construction and the 3Rs .......................................................... 13
   2.7 Diverting C&D Waste ...................................................................................... 17
   2.8 Legislation Affecting the Disposal of C&D Waste ...................................... 22
   2.9 Summary .......................................................................................................... 24

3.0 AREA OF STUDY ............................................................................................. 26
   3.1 Study Area ....................................................................................................... 26
   3.2 Housing Starts in Windsor and Essex County ............................................. 26

4.0 METHODOLOGY ............................................................................................. 29
   4.1 A Priori Model ................................................................................................. 29

V
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Objectives</td>
<td>32</td>
</tr>
<tr>
<td>4.3 Thesis Questions and Hypotheses</td>
<td>32</td>
</tr>
<tr>
<td>4.4 Sampling / Survey</td>
<td>33</td>
</tr>
<tr>
<td>4.5 Data</td>
<td>35</td>
</tr>
<tr>
<td>5.0 RESULTS</td>
<td>36</td>
</tr>
<tr>
<td>5.1 Introduction</td>
<td>36</td>
</tr>
<tr>
<td>5.2 Profile of the Builders Surveyed</td>
<td>36</td>
</tr>
<tr>
<td>5.3 Hypotheses and the Results</td>
<td>41</td>
</tr>
<tr>
<td>6.0 DISCUSSION</td>
<td>53</td>
</tr>
<tr>
<td>6.1 Introduction</td>
<td>53</td>
</tr>
<tr>
<td>6.2 Contractor Perceptions of the Industry</td>
<td>53</td>
</tr>
<tr>
<td>6.3 Future Research</td>
<td>60</td>
</tr>
<tr>
<td>6.4 Summary</td>
<td>61</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>63</td>
</tr>
<tr>
<td>ADDITIONAL BIBLIOGRAPHY</td>
<td>66</td>
</tr>
<tr>
<td>APPENDIX A: STUDY QUESTIONNAIRE</td>
<td>68</td>
</tr>
<tr>
<td>APPENDIX B: LIST OF VARIABLES USED IN ANALYSIS</td>
<td>75</td>
</tr>
<tr>
<td>VITA AUCTORIS</td>
<td>78</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1 Residential development and environmental impacts ........................................7
Table 2 1988 Estimated Wood Waste Management Practices in Ontario ......................13
Table 3 Estimated Percentage of Residential Construction Waste by Volume .............15
Table 4 The Market Value of Recycled Products From Construction and Demolition
    Materials (1993) ...........................................................................................................18
Table 5 Legislation Affection Construction and Demolition Waste ............................23
Table 6 Total Number and Percentage of Single Family Housing Starts in CMHC
    Surveyed Population Centres in Essex County for 1994 ........................................28
Table 7 The Location of Contractors Surveyed Businesses in 1994 ..............................36
Table 8 The Location of New Dwellings Constructed By Surveyed Builders in 1994 ...37
Table 9 Number of Homes Built By Contractors Surveyed in 1994 ............................38
Table 10 Membership in a Professional Organization ..................................................39
Table 11 Perception That All Builders Should Belong to a Professional Organization 40
Table 12 Attended a Seminar on Waste Reduction ......................................................43
Table 13 The Perception of the Importance of the 3Rs in Residential Construction ....46
Table 14 Perception If Waste Reduction and Minimization are Important Issues ..........47
Table 15 Perception about Regulations for Dumping Construction Waste .................48
Table 16 Would Contractors Consider Recycling Construction Wastes ....................48
Table 17 Perception Municipalities Are Enforcing the 3Rs in Residential
    Construction ..............................................................................................................49
Table 18 Composition and Rank of Low-Rise Construction Waste in the Greater
    Toronto Area ..............................................................................................................50
Table 19 Response to Ranking C&D Waste Generation from New Residential
    Construction by Materials for Windsor and Essex County .....................................51

LIST OF FIGURES

Figure 1 Study Area ........................................................................................................27
Figure 2 A Priori Model ..................................................................................................30
1.0 Introduction

1.1 Introduction

The concept of sustainable development has become an important issue within the field of urban planning. According to Rydin (1992) there has been a shift towards environmentalism in the way we plan and manage our urban environment. Sustainable development is generally defined as using resources and the environment to meet the needs of the present population without compromising future generations' natural and physical environment (Slocombe, 1993; WCED, 1987). Within urban planning there is a growing recognition that the discipline must incorporate within its existing framework an environmental component that is sensitive to environmental concerns and which takes a proactive role. No longer is it possible to consider development and the built environment in isolation without first looking at the consequences development has upon both the human and natural environment (Braissoulis, 1989; Rydin, 1992; Slocombe, 1993). Braissoulis (1989) claims that environmental planning has emerged from the wider field of urban and regional planning specifically to deal with problems associated with society and environmental concerns. There is a desperate need for full integration of environmental and ecosystem approaches within mainstream planning in order to address the complex issues associated with sustainability, whether they be related to land use, wildlife or resource based problems (Slocombe, 1993).
There is a global concern about the mounting problems associated with our human settlements. Within our cities the necessity has emerged to use resources and technologies in a more efficient manor, particularly in the day to day practices of urban growth. The public and private sectors must address sustainability within the context of their own practices. Rydin (1992) has suggested several sources of environmental impact in the development process that are of concern to the planner and have a dramatic effect on sustainability. These include issues surrounding site location, site layout, infrastructure and building materials used in the construction of dwellings.

According to Briassoulis (1989) although the field of environmental planning is becoming more popular there is still little research done in this area. She recommends that there be an examination of environmental problems through in-depth case studies of issues that are associated with planning. One such issue is an examination of the residential construction industry and its impact on the environment. An environmental consciousness is evident in government policy toward the construction industry as seen by its current focus on recycling, reusing and reducing construction waste. The policy outlined by both provincial and federal government indicates an emphasis on innovation in building materials, building methods, building form and waste reduction.

In Ontario, it is estimated that construction and demolition (C&D) waste accounts for 16 to 30 percent of the total waste sent to landfills (OMEE, 1993(a)). This volume of waste material is problematic if one considers that in 1988 approximately 1.3 million tonnes of wood went to landfills in Ontario primarily from the C&D sector (OMEE, 1991). This raises the base price of housing through the cost of wasted materials and increased tipping costs that are then passed on to the consumer. The concern over continued and
possibly increasing C&D waste has resulted in municipalities banning the
dumping of certain types of materials and raising tipping fees in the
commercial and industrial sectors. Ontario's Waste Reduction Action Plan,
was announced in February 1991 which committed the province to a 50
percent waste reduction (based on 1987 levels) in solid, non-hazardous
waste by the year 2000. Five new regulations became law on March 3, 1994
under the Environmental Protection Act to help accomplish this task.
Regulation 102/94 requires that waste audits and waste reduction workplans
be completed by Industrial, Commercial and Institutional (IC&I) waste
generators which includes the construction and demolition industry.
According to OMEE (1993 (a)) the C&D industry generates the “... (largest
proportion) of non-hazardous solid waste,... efforts in these sectors to reduce
waste will, therefore, have the greatest potential for diverting materials away
from disposal into productive use.” One of the problems with Regulation
102/94 is that it only requires construction or demolition companies to
complete the required audits and reduction workplans if the structure is over
2000m². The result is that the regulation does not have an impact on the
majority of residential contractors despite the fact that the volume of waste
generated by this sector of the construction industry is substantial.

1.1 Objectives

Since little is known about residential building waste in Windsor and
Essex County, this study will focus on one aspect of the housing process, the
issue of minimizing residential waste. The study will specifically examine C&D
waste relative to new residential construction within Windsor and Essex
County. The objectives of this study will be to determine: whether residential
building contractors in Essex County have been affected by C&D waste
controls; the level of awareness of the building contractors about the problem of waste generation; what methods of waste reduction contractors are engaged in; the composition of Essex County's C&D waste; and whether government literature aimed at contractors is having any impact. This research project focuses attention on the issue of waste minimization within the residential construction industry from a local perspective and examines how contractors are dealing with this issue during the construction process. The study suggests that residential building contractors in Windsor and Essex County may need to adopt a new environmental awareness centred around the notion of sustainable development through waste reduction and minimization from the design stage through the construction process.
2.0 Literature Review

2.1 Introduction
The issue of waste minimization within the residential construction industry has evolved from a concern about maximizing the use of resources and insuring environmental sustainability. There has been little empirical research on the subject of waste minimization, which suggests the need for an investigation of the area and expansion of the research base. The review of the literature focuses on the environmental concerns associated with residential development, global interest in sustainable development, and national (Canadian) and provincial (Ontario) policy regarding the C&D industry. Provincial and local concerns about sustainable development are also examined as it applies to the residential construction industry. The problems and possible effects of greater control over the waste created in the process of building and renovating housing are outlined.

2.2 Environmental and Eco-system Approaches to Urban Planning
Briassoulis (1986, 1989) and Slocombe (1993) both argue that traditional planning approaches have failed to fully address environmental problems. Briassoulis (1989) in a discussion of the theoretical orientation of environmental planning suggests that disparities often exist between theoretical propositions and practical applications, as well as between plan formulation and implementation. Slocombe (1993) indicates that a hybrid approach may be required in developing new planning techniques to address
an environmental component and admits that this will not be easily achieved. Urban development and planning in the future will require that ecological considerations be considered and taken seriously through an adoption of the substantive concerns of environmental and ecosystem planning, and the process orientation of traditional planning practices (Slocombe, 1993).

2.3 Environmental Problems & Residential Development

Focusing on environmental problems within residential development, Rydin (1992) investigated the changing nature of the planning process and the implications of environmental issues on housing and residential development in the UK. The discussion raised by Rydin centred on the UK’s response to the Brundtland Report, the Pearce Report (Pearce et al., 1989) and The Department of Environment’s (UK) (1990) The Common Inheritance (White Paper) which were concerned with a greater awareness toward sustainable development, the use of both natural and physical resources and the effects of development. Rydin’s discussion of the environmental impacts affecting residential development included: the location of the development; site layout; infrastructure provision; building materials; building process; building design; and the effects on local planning for sustainable residential development. Table 1 traces the sequential process of residential development by relating it to sources of environmental impacts and the actors who are involved. The potential for environmental impacts is present from the very beginning of the building process and the ability of planners to limit the
impact of non-sustainable development practices is of great importance. In theory the site will be regulated by a number of officials working together as a team to ensure that the process involved in the production of housing is as efficient as possible.

<table>
<thead>
<tr>
<th>Sources of Environmental Impact</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Location</td>
<td>Landowner</td>
</tr>
<tr>
<td>Site Layout</td>
<td>Developer, including design professionals</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Site purchase finance Planners Infrastructure providers</td>
</tr>
<tr>
<td>Building materials</td>
<td>Developer, including design &amp; management professionals</td>
</tr>
<tr>
<td>Building design</td>
<td>Builder</td>
</tr>
<tr>
<td>Construction process</td>
<td>Production finance Building materials producer Building workers Inspectors: building, health &amp; safety Developer Exchange professionals</td>
</tr>
<tr>
<td>Dwelling use</td>
<td>Consumers Mortgage finance</td>
</tr>
</tbody>
</table>

Source: Rydin (1992)

Rydin points out that residential development has always been important to the planner and that planners are directly involved in the construction and development of the site. Also, there are a number of
measures that still need to be addressed involving research, choice and innovation in materials, combined with sustainable improvements during the construction process. Changes need to be made that facilitate waste reduction and improve site management during the entire planning and construction process.

2.4 Environmental Concerns from a Global Perspective

Canada’s growing awareness about the relationship between development and the environment was facilitated by The World Commission on the Environment and Development’s report *Our Common Future* (1987) (also known as the *Brundtland Report*). *Our Common Future* addressed the increasing problems associated with the environment and continued expansion of industry, population and development. The document linked the environment and the future of the planet in terms of sustainable development, and emphasized the reorientation of technology, as well as, the merging of environmental and economic issues in the decision making process. This report lead to increased dialogue on sustainable development in all parts of the world.

*Agenda 21* authored by the United Nations Conference on Environment and Development (1992) was the follow-up document to the *Brundtland Report*. It was a compendium of existing environmental and economic problems, and proposed solutions to their conflicts. It took a holistic approach to solving environmental problems, where sustainable
development was no longer considered to be an avoidable option in the
decision making process but a necessity. Two important suggestions came
out of Agenda 21 that can be applied to the study of C&D waste, they are: (a)
strengthening the role of business; and (b) making changes within the
scientific and technological community. The recommendation about
strengthening the role of business focuses on the necessity of "corporate
environmentalism" as an important force in business. This approach links
business and industry to environmental policy and encourages long term
environmental service and management. This can be done through efficient
use of materials, awareness and internalization of environmental concerns,
and responsible entrepreneurship where large business and government
encourage smaller firms to meet sustainable development guidelines.

The second component is making change within the scientific and
technological community. Agenda 21 points out that those associated with
the process of development (architects, planners, engineers, etc.) should be
held accountable for their actions. It was recommended that a move toward
improved communication, promotion of codes of practice and the transfer of
environmentally sound technology was a necessary precursor to sustainable
development.

2.5 Environmental Concerns from a Canadian Perspective

After the release of the Brundtland Report and Agenda 21 in Canada
the issue of sustainable development was integrated into Canada's Green
Plan (Government of Canada, 1990(b)). The focus here was to encourage public participation and dialogue on the issue of sustainable development. The document *A Report on the Green Plan Consultations* gauged public opinion on a number of issues including waste management. The following is a list of suggestions coming out of that report viewed as being relevant to the discussion of solid waste management and sustainable development, and provides business and government with new concerns about sustainable practices in the construction industry.

- Reduce waste generation at the source.
- Direct research and analysis toward development of technologies, infrastructure and economic instruments that minimize waste disposal.
- Examine subsidies, both hidden and overt, that apply to products manufactured from virgin material and adjust them to encourage the manufacture of products that use recycled material.
- Supply financial support for private research into waste reduction technologies.
- Develop information programs that identify waste minimization technologies, thereby avoiding the cost of disposal.

(Government of Canada, 1990 (a), p. 56 - 58)

Government’s role in the reduction and diversion of solid waste is seen as a necessary catalyst for real progress in this area. The ability of government to sponsor research and development in the area of waste management may be the deciding factor in creating future markets for today’s C&D waste. The recommendations of the consultations are repeated in the
OMEE's publications *The Physical and Economic Dimensions of Municipal Solid Waste Management in Ontario* (1991) and *Market Assessment of 3Rs Activities in Ontario* (1993(c)). Both articles suggest that secondary markets for waste have historically existed and that markets for many materials, such as paper and cardboard are not really new. The potential then to actually divert materials away from landfills is quite real. While the 1991 report outlines the type and quantity of waste produced in Ontario, the 1993 summary calls for the provincial government to stimulate markets for current and anticipated increases in the supply of secondary materials to existing markets. The report also calls for a substantial level of market development to occur not only in the IC&I sector but in all sectors of the solid waste stream.

The following are recommendations intended to stimulate the markets:

- Disseminating market information to suppliers and users of secondary materials.
- Provide financial incentives to private industry to assist in the development of viable end markets.
- Monitoring Ontario development activities to ensure that Ontario supplies of post-consumer material are given preference.
- Developing clear and equitable regulations for packaging and short term consumer goods waste diversion, including targets for recycling, reduction and reuse.
- Instituting procurement guidelines favouring products made from post-consumer secondary materials, and encourage other levels of government to do the same.

- Funding and encouraging research and development for innovative recycling technologies and means by which 3Rs activities may be enhanced.

Source: OMEE (1993(c)), iii.
In Market Assessment for 3Rs Activities in Ontario (OMEE, 1993) there are suggestions that waste management opportunities are open to certain materials currently being sent to landfills in Ontario. Table 2 shows the estimated diversion rates for wood waste in the province and although many of the industries categorized in the chart have relatively high diversion rates, between 45 and 94 percent, both the construction and demolition categories have very low diversion rates. It should be noted that manufacturing facilities which produce wood materials for the construction industry are also a component of the Secondary Wood Products and Generation Manufacturing category. It is important to remember when viewing the chart that these figures represent estimates and the actual diversion rate may be higher or lower. Also, these figures represent 1988 levels and there may be new Material Recovery Facilities (MRF) in municipalities that are actively diverting C&D wood waste. Unfortunately more recent data on wood waste management practices were not available.
## Table 2

<table>
<thead>
<tr>
<th>Sector</th>
<th>Est. Total Wood Generated</th>
<th>Recycled/reused/recovered</th>
<th>Disposed of waste material</th>
<th>Diversion from landfill %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Southern Ontario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Forest Industry</td>
<td>461,400</td>
<td>277,000</td>
<td>184,400</td>
<td>60%</td>
</tr>
<tr>
<td>Secondary Wood Products &amp; Generation</td>
<td>463,900</td>
<td>227,200</td>
<td>236,700</td>
<td>49%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Container Industry</td>
<td>600,000</td>
<td>360,000</td>
<td>240,000</td>
<td>60%</td>
</tr>
<tr>
<td>Residential Construction</td>
<td>70,900</td>
<td>5,000</td>
<td>65,900</td>
<td>7%</td>
</tr>
<tr>
<td>Demolition</td>
<td>369,600</td>
<td>0</td>
<td>369,600</td>
<td>0%</td>
</tr>
<tr>
<td>Municipalities</td>
<td>158,800</td>
<td>31,800</td>
<td>127,000</td>
<td>20%</td>
</tr>
<tr>
<td>Conservation Auth./ Prov. &amp; National Parks</td>
<td>900</td>
<td>850</td>
<td>50</td>
<td>94%</td>
</tr>
<tr>
<td>Commercial Landscaping</td>
<td>22,000</td>
<td>10,000</td>
<td>12,000</td>
<td>45%</td>
</tr>
<tr>
<td><strong>Total Southern Ontario</strong></td>
<td><strong>2,147,500</strong></td>
<td><strong>911,850</strong></td>
<td><strong>1,235,650</strong></td>
<td><strong>42%</strong></td>
</tr>
<tr>
<td><strong>Northern Ontario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary forest Industry</td>
<td>749,000</td>
<td>633,000</td>
<td>116,000</td>
<td>85%</td>
</tr>
<tr>
<td>Other</td>
<td>96,000</td>
<td>25,000</td>
<td>71,000</td>
<td>26%</td>
</tr>
<tr>
<td><strong>Total Northern Ontario</strong></td>
<td><strong>845,000</strong></td>
<td><strong>658,000</strong></td>
<td><strong>187,000</strong></td>
<td><strong>78%</strong></td>
</tr>
<tr>
<td><strong>Total - Ontario</strong></td>
<td><strong>2,992,500</strong></td>
<td><strong>1,569,850</strong></td>
<td><strong>1,422,650</strong></td>
<td><strong>52%</strong></td>
</tr>
</tbody>
</table>

Source: OMEE (1993 (C))

### 3.6 Residential Construction and the 3Rs
Other reports such as the Canada Mortgage and Housing Corporation (CMHC) and Greater Toronto Home Builders Association (GTHBA) (1991)
Making a Molehill out of a Mountain: implementing the 3Rs in residential construction, fostered an awareness of waste generation specifically within the construction industry by focusing on new construction, renovation, and demolition. The document encourages actors in the building industry to take a proactive approach to the issue of waste management in the construction industry. The three main principles presented in the report call for: reducing waste at the source; reusing materials that would normally be landfilled; and recycling materials for which there is no existing reuse. The initial argument centres around the notion that garbage in general is placing stress on our environment through the depletion of space in landfills, and the difficulty in finding and paying for new landfill sites. CMHC and GTHBA (1991) suggest that the residential construction industry can take advantage of opportunities available because of sound waste management plans. Monetary issues such as: reduction in the cost of materials, reduction in haulage fees, and the resale of used goods and materials are as important as environmental responsibility which may include: improved efficiencies through better C&D practices, and consumer preference for companies which adopt green approaches to business. The report also questions the quantity and type of waste that is produced in the construction process. Table 3 shows the composition of residential construction wastes by the estimated volume of materials.
**Table 3**

*Estimated Percentage of Residential Construction Waste by Volume*

<table>
<thead>
<tr>
<th>Material</th>
<th>% Volume of Total Waste Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensional Lumber</td>
<td>25</td>
</tr>
<tr>
<td>Manufactured Wood</td>
<td>15</td>
</tr>
<tr>
<td>Drywall</td>
<td>12</td>
</tr>
<tr>
<td>Masonry and Tile</td>
<td>10</td>
</tr>
<tr>
<td>Cardboard</td>
<td>10</td>
</tr>
<tr>
<td>Asphalt</td>
<td>6</td>
</tr>
<tr>
<td>Fibreglass</td>
<td>5</td>
</tr>
<tr>
<td>Other wastes</td>
<td>5</td>
</tr>
<tr>
<td>Metal wastes</td>
<td>4</td>
</tr>
<tr>
<td>Plastic and foam</td>
<td>4</td>
</tr>
<tr>
<td>Other packaging</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>


From these percentages it appears that the greatest benefit to waste management will come from the reduction or diversion of wood, drywall, masonry/tile and cardboard waste, all of which are potentially recyclable.

There have been a number of reports and documents which have attempted to inform the building industry about C&D waste such as the CMHC's *Challenge: reducing residential construction waste* (1992), and *Construction and the Environment* (CMHC, 1993), as well as, the OMEE's *Keeping C&D Materials Out of Landfills: conserving resources and minimizing waste in the construction industry* (1993 (a)). Many of the actors responsible for waste
generation within the industry have been examined in these reports and
encouraged to communicate amongst themselves. More importantly,
however, is that these documents are also intended to inform the builder or
renovator of methods and techniques which are appropriate for more efficient
use of materials and building construction. The CMHC's (1993) report claims
that few industries have as many "green" issues to worry about as the
construction industry and that builders and others involved in the construction
industry are proactive, seeking solutions to construction and waste
management problems.

The challenges facing builders and renovators come from six main
areas which include: waste management, resource conservation, land use,
building materials and the environment, healthy housing, and greening of the
construction industry. Waste management studies in Canada have shown
that the construction industry is a major contributor to the waste stream,
accounting for 16 to 30 percent of all waste, suggesting that changes need to
be made immediately (CMHC, 1993). While the amount of waste entering
landfills is an important issue, resource conservation has also become a
major concern of the residential building industry in Canada. Efforts have
been made not only to reduce the amount of energy consumed in the
production of a dwelling, but also in the everyday use within the structures by
making them more energy-efficient and less wasteful. Heating systems,
plumbing fixtures, windows and methods of insulation have dramatically
improved since the energy crisis of the 1970s to facilitate conservation (Grady, 1993).

The issue of selecting environmentally friendly building materials has also become an important factor. Several authors have raised the issue of embodied energy, which involves accounting for the total amount of energy required in the production, transportation, and installation of building materials (Rydin, 1992; CMHC, 1993; and Grady, 1993). By utilizing materials which are low in embodied energy often builders can reduce the indoor pollution associated with manufactured products used in residential construction. The effects of a wide range of toxins found in many household building materials, such as laminets in counter tops, chipboard in cabinets, and synthetic carpets has raised questions as to the building industry’s ability and interest in creating more environmentally friendly and healthy houses. The “greening” of the industry and the overall marketability of environmentally friendly housing is becoming an important building issue (CMHC, 1993). Grady (1993) and CMHC (1993) suggest that the quality and value of construction have remained important to the consumer, but in the past two decades they have become more environmentally aware which has culminated in the demand for a wide variety of environmental features in residential construction.

2.7 Diverting C&D Waste

Noticeable results in the greening of the construction industry will
come when locally based projects are aimed at making secondary markets available for potentially recoverable materials. Those materials may be in the form of waste by-products of the construction process or fixtures and other "white goods" discarded during the demolition or renovation of a project. Table 4 shows the potential at present for the recycling of a number of materials commonly discarded in construction.

**Table 4**

<table>
<thead>
<tr>
<th>Material</th>
<th>Existing Market Value</th>
<th>Recycled Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>asphalt shingle</td>
<td>low</td>
<td>paving material, currently few facilities exist</td>
</tr>
<tr>
<td>gypsum wallboard</td>
<td>low</td>
<td>new wallboard</td>
</tr>
<tr>
<td>wood</td>
<td>low</td>
<td>fibre or fuel</td>
</tr>
<tr>
<td>insulation</td>
<td>low</td>
<td>difficult to recycle, possible to reuse</td>
</tr>
<tr>
<td>plastic</td>
<td>medium</td>
<td>plastic feed stock</td>
</tr>
<tr>
<td>bricks and blocks</td>
<td>medium</td>
<td>roadbase / backfill</td>
</tr>
<tr>
<td>cardboard</td>
<td>low</td>
<td>cardboard fibre</td>
</tr>
<tr>
<td>metals</td>
<td>high</td>
<td>new metals</td>
</tr>
<tr>
<td>liquid wastes (paints &amp; solvents)</td>
<td>variable</td>
<td>refined &amp; remixed into new products</td>
</tr>
</tbody>
</table>

Source: CMHC (1993), 36.

The demand for the secondary materials at present and in the future will determine whether or not companies can process secondary materials
efficiently and in a cost effective manner to produce recovered materials such as: laminated wood beams, gypsum wallboard, carpet or recycled paints. It is possible that if raw, virgin materials such as wood and gypsum continue to escalate in price recovered materials will become more attractive to the builder in order to reduce their costs.

The success of diversion programs is based on the ability of contractors and waste haulers to kept the materials found on the job site separated to eliminate contamination. The issue of economic feasibility is often raised in the discussion of whether or not the collection of separated construction materials is viable. However, where tipping fees are substantially higher (the North-eastern United States and portions of Central Ontario) it may pay to transport materials considerable distances in order to actually save money on the disposal costs. In 1988, for example the cost of dumping construction waste in Rhode Island rose from $200 a ton to between $450 and $600 in two years (Setzer et al., 1990). Similarly, to dispose of a 30 cubic yard dumpster in New Jersey the tipping fee in 1987 climbed to $1000 as a result of limited landfill space the waste had to be shipped out of state to Pennsylvania and Ohio where they are susceptible to out of state tipping fees (Tuchman, 1987). Canadian examples of rising tipping fees are evident in Metro Toronto which rose from $18 per tonne in 1987 to $150 per tonne by 1991. The cost of disposing of construction waste is no where near
as high in Essex County, averaging about $47 per tonne at municipal landfills and anywhere from $53 to $85 per tonne for private waste haulers.

Curro (1991), Kalin (1991), Anonymous (1992), Grogan (1992), and Steuteville (1993) all contend that private enterprises in many forms are capable of diverting construction waste. Innovators in the C&D recycling sector have proven that processing construction waste can be done even when competing with low landfill tipping fees (Steuteville, 1994). C&D waste is seen as a value added resource capable of being converted into reusable products and materials using new methods and technologies. Grogan (1992) suggests that while it isn’t practical to assume that all C&D waste is recoverable the industry should be explaining methods of designing for recyclability in the future and begin to exploit materials entering the waste stream rather viewing C&D waste in a negative light. In effect we are continuing to design obsolescence into our buildings, yet, if it is taken one step further potentially recyclable materials can be incorporated into new structures.

A second method of diverting demolition waste comes from the collection of used fixtures, appliances, and materials to be sold or redistributed through non-profit organizations. Materials formerly destined for the landfill are collected and warehoused. The Loading Dock in Baltimore, Maryland, a non-profit group which has been in operation since 1985, diverted 7000 tons of usable supplies in 1991 with a retail value of
approximately $1 million. Through tax deductions in place of charging
disposal fees, The Loading Dock has between 200 and 250 regular donators.
In Canada, affiliates of a similar organization, Habitat For Humanity operate
resale stores in Winnipeg, Waterloo, London, and Toronto. Each affiliate
resells a collection of good quality usable supplies comprised of ceramic tiles,
doors, windows, lumber, moldings, plumbing fixtures, cabinets, sinks, and
bath tubs at reduced prices. Private enterprise has also entered the
marketplace, Envirocycle a profit oriented firm located in Edmonton
purchases whole structures, dismantles them, warehouses the materials, and
uses a database to find purchasers for a specific type and quantity of a
materials.

The literature seems to suggest that the environmental movement
which has grown substantially over the past two decades has not been as
well received by the C&D industry. Instead contractors in both the C&D
sectors have adopted a “shade of green” approach to building rather than a
full fledged green building practice (Grady, 1993; Austin, 1991; and OMEE,
1993). Often the reasoning behind the less than speedy shift has been
decreasing profit margins, economic uncertainty and failure of private waste
haulers to provide builders with methods of sorting waste by
compartmentalized bins or waste pickup based on the stage of the project.
Certain types of waste products are easily separated and removal can be
timed depending on the stage of construction. Materials such as wood,
drywall, plastic, and cardboard can be scheduled to be hauled away at fairly specific times in the production of a dwelling. The failure of C&D contractors to voluntarily adopt measures which go beyond the present practices of waste reduction suggests that government legislation may have to be used to force them to pay closer attention to meet environmentally acceptable waste levels.

2.8 Legislation Affecting the Disposal of C&D Waste

Table 5 indicates the wide range of government legislation currently aimed at controlling the problems associated with C&D waste. The Waste Management Act (1992) does allow municipalities to ban certain types of C&D waste such as: corrugated cardboard, scrap metal, clean wood, clean fill, concrete and rubble, white goods (refrigerators, water heaters, stoves, washers and dryers), and drywall. However, simply because a material is banned from being dumped in a particular county or region does not necessarily mean it will be recycled. Often C&D waste material is transported out of the province to neighbouring U.S. states where there are less restrictions and lower tipping fees. However, the last piece of legislation in Table 6, the U.S. Resource Conservation & Recovery Act may in the future put an end to the practice of out of province dumping by closing the border or dramatically raising the price of dumping C&D waste in the U.S. mid-west.

The pressure of new regulations is not seen as a welcome addition to the already considerable mass of federal, provincial, and municipal building codes and other legislation by the building industry. However, if one
<table>
<thead>
<tr>
<th>Legislation</th>
<th>Purpose</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Ontario Environmental Protection Act</td>
<td>used to control emissions to air, land and water</td>
<td>defines term &quot;waste&quot; &amp; empowers the OMEE to regulate the establishment of all waste disposal, transfer, and hauling systems</td>
</tr>
<tr>
<td>The Ontario Environmental Assessment Act</td>
<td>determines the environmental impact of public &amp; private sector projects while in the planning stage</td>
<td>designed to determine the environmental impact of a project</td>
</tr>
<tr>
<td>The Waste Management Act 1992</td>
<td>to reduce landfilled waste in Ontario by providing powers to provincial and municipal governments</td>
<td>commits Ontario to a 50 percent waste reduction by 2000</td>
</tr>
<tr>
<td>The Ontario Municipal Act</td>
<td>allows municipalities to enact waste bans to potentially recyclable materials</td>
<td>proposed amendments require waste separation</td>
</tr>
<tr>
<td>Municipal &amp; provincial building preservation laws</td>
<td>designed to protect historical structures</td>
<td>to encourage 3R's initiatives</td>
</tr>
<tr>
<td>Federal &amp; provincial building codes &amp; national standards</td>
<td>to require builders to utilize materials &amp; construction practices which meet health &amp; safety standards</td>
<td>increase penalties for non-compliance of municipal waste bans</td>
</tr>
<tr>
<td>U.S. Resource Conservation &amp; Recovery Act</td>
<td>to determine the availability of landfill sites within the United States</td>
<td>designation may require designers to re-use or incorporate existing structures into new projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>determine whether recycled materials can be used in new construction and meet existing standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>may end the practice of exporting C&amp;D waste from Ontario to U.S. border states</td>
</tr>
</tbody>
</table>

Source: adapted from OMEE (1993, pp 9-10)
considers that there were 1475 new single detached dwellings built in Essex County in 1994 and that there is a 10 percent waste rate of materials (CMHC & GTHBA, 1991) which equals around 2.5 tonnes per single detached residential dwelling, one begins to see the potential problem this waste poses. The case for increased regulations and establishment of reduction, reuse and recycling programs from a local municipality sounds reasonable when one starts to multiply the amount of waste generated in one sector of the industry over 10 or 20 years. Unfortunately, no figures are available for demolition due to the fact that reliable estimates are hard to calculate because the waste generated from each project is different and unique. However, by requiring firms to complete waste audits and workplans, it is hoped that within a few years accurate numbers will be generated indicating the scope of waste from this sector of the industry. From a residential demolition perspective, contractors when building a new dwelling on a lot currently occupied by a sound structure will occasionally sell the existing house for a reduced price (usually a dollar) to anyone willing to have the structure moved to another location. Rather than pay the high price of demolition and waste haulage the structure is removed at minimal cost to the contractor and client, keeping a sound dwelling in the housing stock.

2.9 Summary

When addressing the issue of C&D waste the question remains whether contractors who view themselves as being “green builders” are in
fact strictly following environmentally sustainable building practices. What may be the case is that a number of builders have adopted some "green" construction principles but still use traditional approaches in the majority of their work, thereby embracing a hybrid approach to residential construction. The environmental concerns introduced within the Brundtland Report and Agenda 21 are now viewed as important issues that need to be addressed. C&D waste generation has been targeted as an area in which waste produced in the construction process can and must be reduced. The potential for the reuse and recycling of materials has led to the belief that materials can be utilized in a more efficient manner. The result is both a better use of building materials in the production of housing and a method of reducing the amount of waste unnecessarily being landfilled. Government and professional organizations now see this as an area of opportunity to introduce the 3R's to the construction industry. This will not be an easy task considering the fragmented nature of the industry, the lack of training, and licensing requirements for the average residential contractor in Ontario. The changing nature of urban planning is forcing the need to address ecological and environmental concerns at all stages of the development process. The role of planners is changing and is forcing them to come to terms with new environmental aspects of urban development while taking into consideration a more process orientation of traditional planning practices.
3.0 Area of Study

3.1 Study Area

The area of study for this research project comprises the same area surveyed by the Canada Mortgage and Housing Corporation (CMHC) for housing related statistics in the Windsor and Essex County area. Figure 1 is divided into: (1) the Windsor Census Metropolitan Area (CMA) which includes the municipalities of Windsor, Anderdon Township (including Amherstburg), Belle River, Colchester North Township, Essex, LaSalle, Maidstone Township, Rochester Township, St. Clair Beach, Sandwich South Township, and Tecumseh, and (2) the Leamington Census Agglomeration (CA) which encompasses Leamington, Gosfield South Township, Kingsville, and Mersia Township. The study area does not include the townships of Tilbury North, Tilbury South, Malden, Colchester South, Gosfield North, and Sandwich West which each have a population of less than 10,000. The amount of new construction in those areas is minimal, and as a result the CMHC does not survey them for housing related statistics (Sumnall, 1995).

3.2 Housing Starts in Windsor and Essex County

The CMHC collects housing start statistics for the 15 municipalities in the study area as presented in Table 6. The number and percentage of 1994 housing starts are shown for each area. Of all new residential construction, 90.8 percent took place within the Windsor CMA, with the municipalities of Windsor, LaSalle and Maidstone being responsible for the majority of the new
Figure 1 - Study Area

List of Municipalities
1. Anderdon Twp.
2. Belle River
3. Colchester N. Twp.
4. Essex
5. Gosfield S. Twp.
6. Kingsville
7. LaSalle
8. Leamington
10. Mersia Twp.
12. St. Clair Beach
14. Tecumseh
15. Windsor

Scale
1 cm = 9.6 km

Source: Ministry of Transportation, 1976
starts (65.9 percent). The 12 remaining municipalities were responsible for 34.1 percent of new starts in 1994.

Table 6
Total Number and Percentage of Single Family Housing Starts in CMHC Surveyed Population Centres in Essex County for 1994

<table>
<thead>
<tr>
<th>Municipality/Township</th>
<th>Total Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windsor City</td>
<td>497</td>
<td>33.7</td>
</tr>
<tr>
<td>Anderdon</td>
<td>51</td>
<td>3.5</td>
</tr>
<tr>
<td>Belle River</td>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>Colchester North</td>
<td>23</td>
<td>1.6</td>
</tr>
<tr>
<td>Essex</td>
<td>30</td>
<td>2.0</td>
</tr>
<tr>
<td>LaSalle</td>
<td>334</td>
<td>22.6</td>
</tr>
<tr>
<td>Maidstone</td>
<td>142</td>
<td>9.6</td>
</tr>
<tr>
<td>Rochester</td>
<td>21</td>
<td>1.4</td>
</tr>
<tr>
<td>St Clair Beach</td>
<td>9</td>
<td>0.6</td>
</tr>
<tr>
<td>Sandwich South</td>
<td>114</td>
<td>7.7</td>
</tr>
<tr>
<td>Tecumseh</td>
<td>103</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Sub total excluding Windsor City</strong></td>
<td><strong>843</strong></td>
<td><strong>57.2</strong></td>
</tr>
<tr>
<td><strong>Windsor CMA</strong></td>
<td><strong>1340</strong></td>
<td><strong>90.8</strong></td>
</tr>
<tr>
<td>Leamington</td>
<td>60</td>
<td>4.1</td>
</tr>
<tr>
<td>Gosfield South</td>
<td>25</td>
<td>1.7</td>
</tr>
<tr>
<td>Kingsville</td>
<td>4</td>
<td>0.3</td>
</tr>
<tr>
<td>Mersea</td>
<td>46</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Leamington CA</strong></td>
<td><strong>135</strong></td>
<td><strong>9.2</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1475</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Source: Sumnall, 1995
4.0 Methodology

4.1 A Priori Model

The literature seems to suggest that there may be an appropriate model which is more inclusive and incorporates all aspects of the processes involved in the production of a residential building. Figure 1 represents such a model and shows the various stages involved in the construction of a residential structure. It is a useful model in that it provides a clearer understanding of C&D waste generation, disposal, and building professionals’ involvement in the building process.

The initial steps in the process are site selection and design development. During the design development process there is a continuous evaluation which includes: accountability between the builder, designer, client and the community; communication between involved parties including planners; and efficiency in delivery, budget and material utilization (White, 1983). There are also several factors which influence the process of design development such as: the design and building professionals, manufacturers, media, education and communication, market and economy, technology and R&D, and government and legislation. The market and general economy often dictate whether new methods and approaches can be used in construction, and are closely linked to the availability of new technology and research and development within the industry. Government and legislation influence the generation and disposal of C&D waste by providing acceptable
Figure 2 - A Priori Model

Site Selection → Design development

Design & building professionals
Manufacturers
Media
Education & Communication
Market & Economy
Technology / R&D
Gov't Legislation
Gov't Incentives

Design & material decision → Development of site & production of the dwelling

Traditional approach to building & waste management
Combined approach to building & waste management
Green approach to building & waste management

Creation of waste → Finished dwellings

Waste haulage

Waste transfer facilities
Material recovery facilities

Landfill
Energy from waste facilities
Material re-users
Manufacturers

environmental and building standards, such as, the National Building Code, The Ontario Waste Management Act 1992, or local waste bans by municipal government. Incentives offered by government can also encourage switching to environmentally sound building approaches or design principles such as Canada Home Insulation Program (CHIP) or the Super Energy Efficiency Home (SEEH or R2000) program. All of these factors impact on design decisions, material selection, site development and the actual physical construction of the dwelling.

Generally building production takes one of three approaches concerning environmental accountability: 1) a traditional approach which neglects environmental issues such as waste reduction and minimization; 2) a green approach where the builder adopts the latest techniques and materials to build an environmentally responsible house; or 3) a combination of the two where some “green” measures are utilized.

The housing production process inevitably leads to the creation of C&D waste, with a number of ways in which the waste can be disposed of. Three optional destinations are open to the builder regarding hauling waste: bringing it to a landfill; transferring it to a temporary waste storage facility; or a material recovery facility (MRF) where manufacturing of secondary materials may take place. Materials recovered from the MRF may be brought to recycling manufacturers or material re-users. These materials are returned to the housing construction process as new or used products, which impact
upon the design of the structure and selection of materials. The remainder of the discarded materials are converted into energy or placed into landfills. Ultimately the process ends with the creation of a finished dwelling and the return of the system to the site selection and design development process to produce another dwelling. This A Priori Model attempts to explain the complex system in which the actors, processes and goods involved in the construction of housing are related to waste generation and disposal.

4.2 Objectives
The objectives of this study are to determine: whether contractors in Essex County have been affected by C&D waste controls; the level of awareness of building contractors to the problem of waste generation; what methods of waste reduction contractors are engaged in; the composition of Essex County's C&D construction waste; and whether government literature aimed at contractors is being used by them.

4.3 Thesis Questions and Hypotheses
The initial thesis question seeks to examine the level of awareness of contractors concerning waste reduction and minimization in Essex County. The hypothesis proposed is that the level of awareness of contractors in Essex County about C&D waste reduction is dependent on the size of the contractor.

a. The majority of small contractors will have little awareness concerning waste reduction.
b. The majority of medium size contractors will have some awareness.
c. The majority of large contractors will have greater awareness than both the small and medium size contractors.
The second question will determine whether the claim in recent OMEE (1993 (c)) C&D waste studies, that building professionals view C&D waste as having an intrinsic economic worth, is the case in Essex County. The hypothesis is that the majority of building contractors in Essex County are not engaged in waste reduction and minimization measures.

The third question investigates the perceptions building contractors have about C&D waste. The hypothesis is that the majority of building contractors surveyed in Essex County do not perceive C&D waste reduction or minimization as a relevant issue in residential house construction.

The fourth question examines the proportion of materials which constitute Essex County’s C&D waste. The hypothesis is that the composition of Essex County’s waste is similar to that of other municipalities previously surveyed in Ontario.

4.4 Sampling / Survey

The initial sampling procedure proposed was a survey of fifty Essex County building contractors using a close ended questionnaire (Appendix A). By visiting the various new subdivisions in Windsor and Essex County a total of 86 contractors were found to be currently operating within the 15 municipalities. Of these 43 contractors agreed to participate in the research. The surveys were conducted over a nine day period, from February 23 to March 3, 1995. The majority of interviews took place on the job site talking to the general contractor or job foreman, and the remainder of the interviews
were completed over the phone during the evening when that was more
convenient for the contractor. The duration of the interview was between 10
and 15 minutes. The questionnaire was pretested with two contractors in
order to gauge the time required for subjects to respond, to ensure that all the
questions were relevant to contractors, and determine if there were any
omissions or further questions required. The pretest resulted in a slight
revision of three questions and the omission of a chart relating to demolition
waste.

The survey questions were broken into seven categories which related
to the contractor’s building operations. They included: the type of building
completed in 1994; the location of the residential building; affiliation with
professional organizations; the disposal of waste; information sources;
perceptions about the construction industry; and the composition of waste on
the building site. These categories relate to the principal objectives of the
study and hypotheses proposed.

Initially it was the intent of the research to divide the contractors
surveyed into the classifications of small, medium, and large firms based on
the number of projects completed during the 1994 calendar year. This was
not possible, however, because no existing criterion was available to
determine what constitutes a small, medium or large contractor. The fact that
the sample size was relatively small also created difficulties in using
categories where the statistical population would be extremely small. As a
result the data was divided into three new classifications: 1) Affiliation with Professional Organizations - Member/Non-member; 2) Contractors constructing more than the mean number of homes / Contractors below the mean number of homes; and 3) Contractors constructing above the mean house price/ Contractors below the mean.

4.5 Data

The data was entered into the SPSS for Windows statistical package. Each question in the questionnaire had a corresponding variable name (see Appendix A). All missing values for the responses were entered as 99. The analysis involved the use of frequency tables for each of the responses to the questionnaire, along with the calculation of Chi-square values between the classifications and variables related to contractors perceptions of waste reduction and minimization measures (see Appendix B for a list of variables).

The intent of the study was to expand the research surrounding the issue of waste minimization and the provision of housing, and attempt to generate discussion about sustainable development within the realm of single family residential housing. The analysis attempted to provide insight into Essex County contractors' understanding of waste reduction and corporate environmentalism. The study also determined whether contractors in Essex County have access to information on the subject of waste reduction and whether they have put their knowledge about the issue into practice on the job site.
5.0 Results

5.1 Introduction
This portion of the thesis describes some of the major findings. The chapter will first give a profile of the builders surveyed presenting some basic results about where they built, the number of units built during 1994 and information about their operations. This will be followed by an analysis of the results related to the proposed hypothesis.

5.2 Profile of the Builders surveyed
The 43 builders surveyed provided important insights into the operations of residential building contractors' in Windsor and Essex County.

Table 7 shows the location of the contractor's business by municipality for 1994. The majority of contractors run their business from their homes and, as Table 7 indicates, 67.5 percent do so from the municipalities of Windsor, Tecumseh and St.Clair Beach.

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderdon</td>
<td>3</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>LaSalle</td>
<td>4</td>
<td>9.3</td>
<td>16.3</td>
</tr>
<tr>
<td>Leamington</td>
<td>1</td>
<td>2.3</td>
<td>18.6</td>
</tr>
<tr>
<td>Maidstone</td>
<td>2</td>
<td>4.7</td>
<td>23.3</td>
</tr>
<tr>
<td>St.Clair Beach</td>
<td>3</td>
<td>7.0</td>
<td>30.2</td>
</tr>
<tr>
<td>Tecumseh</td>
<td>12</td>
<td>27.9</td>
<td>58.1</td>
</tr>
<tr>
<td>Windsor</td>
<td>14</td>
<td>32.6</td>
<td>90.7</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>9.3</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author, 1995
Table 8 indicates the number of projects the 43 builders were responsible for in 1994, the majority of which were located in the municipalities of Windsor, Tecumseh, and LaSalle.

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderdon</td>
<td>21</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Belle River</td>
<td>5</td>
<td>1.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Colchester N.</td>
<td>3</td>
<td>0.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Essex</td>
<td>6</td>
<td>1.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Gosfield S.</td>
<td>0</td>
<td>0</td>
<td>7.5</td>
</tr>
<tr>
<td>LaSalle</td>
<td>62</td>
<td>13.3</td>
<td>20.8</td>
</tr>
<tr>
<td>Leamington</td>
<td>0</td>
<td>0</td>
<td>20.8</td>
</tr>
<tr>
<td>Maidstone</td>
<td>47</td>
<td>10.1</td>
<td>30.9</td>
</tr>
<tr>
<td>Rochester</td>
<td>0</td>
<td>0</td>
<td>30.9</td>
</tr>
<tr>
<td>Sandwich S.</td>
<td>28</td>
<td>6.0</td>
<td>36.9</td>
</tr>
<tr>
<td>St.Clair</td>
<td>7</td>
<td>1.5</td>
<td>38.4</td>
</tr>
<tr>
<td>Beach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tecumseh</td>
<td>106</td>
<td>22.8</td>
<td>61.2</td>
</tr>
<tr>
<td>Windsor</td>
<td>180</td>
<td>38.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>465</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>


The results show that the mean number of single detached units built in 1994 per contractor was 10.86, with an average price of $179,302.33. Only one contractor built 30 semi-detached units with an average price of $170,000 and no contractor built any multi-unit dwellings during 1994. When asked if they did any renovation work in 1994 only 9 builders reported that they had, resulting in 30 renovation projects with a mean value of $31,111.11.
Table 9 displays the frequency distribution of single detached dwellings constructed by the contractors surveyed. The problem with the results is that no clear division exists between small, medium or large contractors. The majority of contractors surveyed built 10 or less dwellings in 1994.

<table>
<thead>
<tr>
<th>Number of Dwellings Constructed</th>
<th>Number of Contractors</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>7.0</td>
<td>11.6</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>14.0</td>
<td>25.6</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>4.7</td>
<td>30.2</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>7.0</td>
<td>37.2</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>9.3</td>
<td>46.5</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>2.3</td>
<td>48.8</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>14.0</td>
<td>62.8</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>2.3</td>
<td>65.1</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>4.7</td>
<td>69.8</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>2.3</td>
<td>72.1</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>2.3</td>
<td>74.4</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>4.7</td>
<td>79.1</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>2.3</td>
<td>81.4</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>2.3</td>
<td>83.7</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>4.7</td>
<td>88.4</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>2.3</td>
<td>90.7</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>2.3</td>
<td>93.0</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td>4.7</td>
<td>97.7</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>2.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Total 43 100.0

Table 10 indicates the number of contractors who belong to a professional organization. Those responding that they were affiliated with a professional organization totaled less than 50 percent of the sample. One possible reason for this is that many of the contractors did not consider the New Home Warranty Program (HUDAC) to be a professional organization when answering the question. It does imply that the majority of contractors do not belong to other professional building organizations such as the Greater Windsor Home Builders Association (GWHBA). The respondents indicated that 39.5 percent (17 contractors) belonged to HUDAC, only 18.6 percent (8 contractors) were members of the GWHBA, and 2.3 percent (one contractor) belonged to another organization.

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>18</td>
<td>41.9</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>58.1</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100.0</td>
</tr>
</tbody>
</table>


When contractors were classified by number of homes built above and below the mean of 10.96 houses, 56.3 percent of those builders above the mean agreed with the statement that “all builders should belong to a professional organization.” Those builders below the mean number of houses built in 1994 were also split on the issue. No significant difference was found between the two groups (see table 11).
Table 11
Perception That All Builders Should Belong to a Professional Organization

Statement: All contractors should belong to a professional organization.

<table>
<thead>
<tr>
<th>Count</th>
<th>Col Pct</th>
<th>Row Pct</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>N/A</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above the Mean</td>
<td>25.0</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Houses Built</td>
<td>40.0</td>
<td>40.0</td>
<td>12.5</td>
<td>41.2</td>
<td>33.3</td>
<td>37.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below the Mean</td>
<td>9.3</td>
<td>9.3</td>
<td>4.7</td>
<td>16.3</td>
<td>4.7</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Houses Built</td>
<td>60.0</td>
<td>60.0</td>
<td>22.2</td>
<td>11.1</td>
<td>14.8</td>
<td>62.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column Total</td>
<td>14.0</td>
<td>14.0</td>
<td>100.0</td>
<td>60.0</td>
<td>55.8</td>
<td>66.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The builders contacted indicated that 93.0 percent of them spend 75 to 100 percent of their time as a general contractor rather than a sub-contractor. They also indicated that 78.6 percent of them use private waste haulers for their waste disposal at least some of the time and spend an average of $521.15 per residential structure and generate 1.96 tonnes of waste per structure. The waste estimate seems to correspond to the CMHC's estimation of 2.5 tonnes per residential dwelling. Of those builders who transported some of their own waste in 1994 (37.2 percent), 22.2 percent used Colchester North Landfill, 11.1 percent used the Gosfield South Landfill, and 66.7 percent used the Maidstone Landfill. The contractors surveyed appear to be rather homogenous in their opinions about waste generation, reduction, and minimization. Their answers and the calculated frequencies
suggest that they have similar feelings about a number of issues despite the
classifications based on affiliation with a professional organization, the
number of houses built, or the sale price of the house.

5.3 Hypotheses and the results

The research project initially proposed four general hypotheses which
will be restated and examined relative to the data collected in the following
section. The first hypothesis was that the level of awareness of contractors in
Essex County about C&D waste reduction would be dependent on the size of
the contractor. The researcher speculated that:

a. The majority of small contractors have little awareness about
waste reduction and minimization in residential construction.
b. The majority of medium size contractors have some awareness
about residential construction waste reduction and minimization
concerns.
c. The majority of large contractors have greater awareness of
waste reduction and minimization measures than both the small
and medium size contractors.

The results of the survey do not allow for the classification of the
contractors into small, medium or large. Table 9 shows that the number of
projects in 1994 did not segregate the contractors surveyed into recognizable
classifications. The first hypothesis therefore, cannot be answered relative to
contractor size. The results do indicate, however, mixed responses as to
whether or not contractors are aware of waste reduction and minimization in
residential construction.
When looking at methods of reduction waste on site, a total of 86.0 percent of the contractors use centralized cutting areas for materials, 95.3 percent use “just in time ordering” for their lumber, 79.1 percent separate waste materials on site, 90.7 percent reuse materials on site, while only 65.1 percent order in bulk (for more than one project at a time). However, only 4.7 percent of the contractors (n=2) had completed a waste audit on a project. When the contractors were asked if they had ever attended a seminar on waste reduction in residential construction 7.0 percent (n=3) answered that they had. When the data were classified by Membership verses Non-membership in a professional organization, the only questions that showed a significant difference (p=0.03431) between group was if they had attended a seminar on waste reduction. Table 12 indicates that all those who attended a seminar on waste reduction were members of professional organizations, suggesting that awareness of waste minimization and reduction measures may be more easily communicated and encouraged through professional groups. However, these constitute only 7.0 percent of the total sample.

The response to whether or not they had received government documents on the subject of waste reduction was surprising. A total of 11.6 percent acknowledged receiving government documents from a list of six possible sources presented in the questionnaire. The following indicate the number of responses associated with the listed documents: A Guide to Waste Audits and Reduction Workplans for C&D Projects, 0; Keeping C&D Materials
Out of Landfills, 0; Construction and the Environment, 1; Challenge: reducing C&D waste, 1; Making a Molehill out of a Mountain, 1; and other government information, 4.

Table 12
Attended a Seminar on waste Reduction

Question: Have you attended a seminar on waste reduction?

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Row Pct</td>
<td>Col Pct</td>
<td>Row Total</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Member</td>
<td>3</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>16.7</td>
<td>83.3</td>
<td>41.9</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.0</td>
<td>34.9</td>
<td></td>
</tr>
<tr>
<td>Non-member</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>58.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>62.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>58.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column Total</td>
<td>3</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>7.0</td>
<td>93.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Author, 1995

Similarly, when asked what their sources for information about construction concerns were, contractors indicated that 51.2 percent received information from magazines, 34.9 percent from the provincial government (mostly about code changes), 34.9 percent from suppliers, 30.2 percent from professional organizations, and 11.6 percent from other sources. What was interesting was the fact that 23.3 percent indicated that they had received no information at all, only 7.0 percent indicated receiving information from
municipal government, and nc contractor indicated receiving information from the federal government.

These results suggest that contractors may not be aware of the problem of waste reduction and minimization from an environmental perspective. Instead they appear to address the issue as an economic concern. If they are aware of the problem it may be because of their need to minimize waste in order to keep the cost of construction down. What they may not be aware of is that the materials they throw away are potentially recyclable and under the right conditions may actually generate revenue for the builder.

The second hypothesis was that the majority of building contractors in Essex County would not be engaged in waste reduction and minimization measures. The analysis revealed that 48.8 percent of the contractors surveyed believed that the 3Rs were becoming important in residential construction, and 83.7 percent believed that waste reduction and minimization were important to their day to day operations. The results also show that 95.3 percent of the contractors were found to use “just in time ordering” for their lumber and other supplies, and 90.7 percent reused materials on site. A total of 86.0 percent of the contractors used centralized cutting areas for materials, 79.1 percent separated materials on site, and only 65.1 percent ordered materials in bulk.
When contractors were asked if they had attended a seminar on waste reduction in residential construction, 7.0 percent had and those who had participated in workshops did so outside of the Windsor and Essex County area. When asked if they had completed a waste audit on a project, 95.3 percent of the surveyed contractors replied that they had not done so for any of their projects. While 86.0 percent of the contractors indicated that they would consider separating waste on site, currently the vast majority of contractors (82.9 percent) separate materials between 0 and 25 percent of the time. The remainder of the time all the waste is simply thrown into the waste bin with no separation. Although, 90.7 percent of the contractors indicated they would consider reducing waste materials, less than half (44.2 percent) indicated they would consider recycling materials instead of dumping it, and then only if it was cost effective.

The majority of building contractors surveyed agree that the issue of waste reduction and minimization are becoming important in their day to day operations. Yet the majority of contractors rarely separate waste going into the waste bin. The result is that contractors may consider the issue to an important one, but they have not adopted green approaches to handling the waste they create in the construction process. Instead they tend to believe that until the sorting and recycling of construction waste becomes cost effective and widely done within the industry there is no reason to begin today.
The third hypothesis proposed was that the majority of building contractors in Windsor and Essex County would not perceive waste reduction and minimization as a relevant issue in the building industry. Table 13 shows that contractors' perceptions about “the 3Rs becoming important in residential construction” was mixed. While 60.4 percent believed that the issue was relevant and important, a little less than a third (27.9 percent) did not think this was the case and 11.6 percent were neutral about the issue. Similarly, when asked if waste reduction and minimization were important issues to their companies, the results shown in Table 14 reveals that 83.7 percent of the contractors believed the issue was important.

**Table 13**

*The Perception of the Importance of the 3Rs in Residential Construction*

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>12</td>
<td>27.9</td>
<td>27.9</td>
</tr>
<tr>
<td>Neutral</td>
<td>5</td>
<td>11.6</td>
<td>39.5</td>
</tr>
<tr>
<td>Agree</td>
<td>21</td>
<td>48.8</td>
<td>88.4</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>5</td>
<td>11.6</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 14
Perception If Waste Reduction and Minimization are Important Issues

Statement: Waste reduction and minimization are important issues to me in residential construction.

<table>
<thead>
<tr>
<th>Label</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>2</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>4.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Neutral</td>
<td>2</td>
<td>4.7</td>
<td>14.0</td>
</tr>
<tr>
<td>Agree</td>
<td>25</td>
<td>58.1</td>
<td>72.1</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>11</td>
<td>25.6</td>
<td>97.7</td>
</tr>
<tr>
<td>Not applicable</td>
<td>1</td>
<td>2.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>


Table 15 indicates how contractors classified as building residences above the mean dollar value of the sample or below the mean dollar value, felt about stricter regulations being needed concerning dumping construction waste. Significant group differences (p=0.02388) were found, with a noticeable split in the opinions of both groups on the issue. Those builders above the mean tended to disagree (77.3 percent) with the need for stricter regulations in dumping construction waste, while 52.4 percent of those builders below the mean said they believed there was a need for stricter regulations with only 38.1 percent disagreeing.
Table 15
Perception about Regulations for Dumping Construction Waste

Statement: Stricter regulations are needed for dumping construction waste.

<table>
<thead>
<tr>
<th>Count</th>
<th>Row Pct</th>
<th>Col Pct</th>
<th>Tot Pct</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>N/A</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above the Mean</td>
<td>4</td>
<td>13</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>18.2</td>
<td>59.1</td>
<td>13.6</td>
<td>4.5</td>
<td>4.5</td>
<td>51.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below the Mean</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.8</td>
<td>33.3</td>
<td>4.8</td>
<td>47.6</td>
<td>4.8</td>
<td>48.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>35.0</td>
<td>25.0</td>
<td>90.9</td>
<td>50.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3</td>
<td>16.3</td>
<td>2.3</td>
<td>23.3</td>
<td>2.3</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Column Total | 5 | 20 | 4 | 11 | 2 | 1 | 43 |
| Total | 11.6 | 46.5 | 9.3 | 25.6 | 4.7 | 2.3 | 100.0 |


When asked if they would use recycling facilities for certain types of waste rather than dumping the material, 55.8 percent of the contractors indicated they would consider recycling but only if it was cost effective (see Table 16). The general opinion was that at present it wasn’t worth recycling because there were no direct benefits for the contractors.

Table 16
Would Contractors Consider Recycling Construction Wastes

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19</td>
<td>44.2</td>
<td>44.2</td>
</tr>
<tr>
<td>No</td>
<td>24</td>
<td>55.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Contractors indicated that part of the reason why waste reduction and minimization were viewed as irrelevant may be due to the fact that they consider that the municipalities in Essex County do not enforce the 3Rs in residential construction. Table 17 shows a 79.1 percent negative response to the statement that municipalities are enforcing the 3Rs in residential construction.

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>6</td>
<td>14.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Disagree</td>
<td>28</td>
<td>65.1</td>
<td>79.1</td>
</tr>
<tr>
<td>Neutral</td>
<td>2</td>
<td>4.7</td>
<td>83.7</td>
</tr>
<tr>
<td>Agree</td>
<td>7</td>
<td>16.3</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>


Further, when asked if stricter regulations for dumping construction and demolition waste were needed, 11.6 percent strongly disagreed and 46.5 percent disagreed. Instead the general opinion was that regulations at present are strict enough and contractors don’t need to be further regulated on what they can throw in their waste bins.

The fourth hypothesis was that the composition of Essex County’s waste would be similar to that of other municipalities previously surveyed in
Ontario. Table 18 shows the percentage by volume and the rank of materials produced from low-rise residential construction in the Greater Toronto Area.

Table 18
Composition and Rank of Low-rise Construction Waste in the Greater Toronto Area

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage Volume</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Drywall</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Masonry and tile</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Cardboard</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Asphalt shingle</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Fibreglass</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Metal</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Plastic</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Other packaging</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Other wastes</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: adapted from OMEE (1993 (c)), p. 13.

The survey yielded quite different results, revealing that drywall was the major component in residential waste in the Windsor and Essex County area (see table 19). Approximately three quarters (76.7 percent) of the contractors ranked drywall as the number one contributor to waste. Roofing material was ranked 2 or 3 by 53.5 percent of respondents, followed by cardboard, (62.8 percent ranked it one, two or three) and then wood which was ranked two, three or four by 41.8 percent of respondents. Plastics also seemed to be a major component in the waste bin, 39.6 percent of respondents ranked it as three four or five. What was most unusual was that 34.9 percent of the respondents did not rank wood as a major component of
Table 19
Response to Ranking C&D Waste Generation from New Residential Construction by Materials for Windsor and Essex County

<table>
<thead>
<tr>
<th>Material</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
<th>Rank 4</th>
<th>Rank 5</th>
<th>No Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>frequency</td>
<td>%</td>
<td>frequency</td>
<td>%</td>
<td>frequency</td>
<td>%</td>
</tr>
<tr>
<td>Wood</td>
<td>4</td>
<td>9.3</td>
<td>9</td>
<td>20.9</td>
<td>5</td>
<td>11.6</td>
</tr>
<tr>
<td>Excavated</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Material</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Roofing Materials</td>
<td>4</td>
<td>9.3</td>
<td>12</td>
<td>27.9</td>
<td>11</td>
<td>25.6</td>
</tr>
<tr>
<td>Drywall</td>
<td>33</td>
<td>76.7</td>
<td>4</td>
<td>9.3</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Metal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Concrete</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Concrete Block</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Bricks</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Insulation</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Plastic</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
<td>5</td>
<td>11.6</td>
</tr>
<tr>
<td>Wiring</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carpet</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Glass/Ceramic</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paper</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>9.3</td>
</tr>
<tr>
<td>Cardboard</td>
<td>2</td>
<td>4.7</td>
<td>13</td>
<td>30.2</td>
<td>12</td>
<td>27.2</td>
</tr>
</tbody>
</table>

Source: Author, 1995
their waste. Instead they indicated that dimensional wood and wood products were far too expensive to waste, and any pieces that were not reused were used as firewood by workers or given away to other individuals, but certainly not thrown in the waste bin.

The composition of materials in residential construction bins in Windsor and Essex County was different from what was originally expected. The previous survey conducted in the Greater Toronto Area for low-rise residential construction indicated that wood was the major contributor to the waste stream, however in this study the results suggest that drywall, asphalt shingle and cardboard make up the majority of new residential construction waste. The literature and the initial hypothesis suggested that the composition of waste materials would be similar in Windsor and Essex County to the Greater Toronto Area, but the results do not support this.
6.0 Discussion

6.1 Introduction

The Brundtland Report and Agenda 21 both call for changes within the scientific and technological community which better facilitate the use of environmentally sustainable products and practices in all aspects of urban life. Attempts have been made by the federal and provincial governments in Canada to incorporate an environmental perspective within residential construction but with limited success. A number of documents have been produced by government to encourage environmentally sustainable practices, the incorporation of innovative building systems into residential construction, and the facilitation of discussion altering current wasteful practices. The need to educate builders, change current building practices, adopt sustainable use of resources, and find new markets for the waste produced from residential construction is becoming an important factor in residential development.

The objectives of the current study were to determine: whether contractors in Essex County had been affected by C&D waste controls; the level of awareness of building contractors concerning the problem of waste generation; what methods of waste reduction contractors were engaged in; the composition of Essex County’s C&D construction waste; and whether government literature aimed at contractors was being used by them.
6.2 Contractor Perceptions of the Industry

During the interview process with the contractors, it became apparent that a re-occurring topic in most discussions was how the residential construction industry had changed over the last twenty years. While the profit margins have slowly shrunk, regulations have become stricter, material costs have escalated, and the ability to provide a well-built house for a reasonable price has become much harder to accomplish. A certain apprehension about increased regulation surrounding the issue of waste reduction and minimization seemed to be present when talking to contractors. Many indicated that the issue of waste management was an on-going concern but not a major difficulty at this time. In fact many had not given the issue of waste reduction much thought beyond the belief that if they do the work themselves or sub-contract the work out to competent sub-trades those individuals responsible for building the dwelling automatically tend to maximize resources. Many contractors noted that they already use waste reduction methods on the job site such as: just in time ordering for materials, reusing off cuts of timber, and centralized cutting areas for materials. They believed that these were just good building and business practices, and that every time you throw something into the waste bin, you are throwing away potential profits. The general consensus was that at present, building materials such as dimensional and manufactured wood products were simply too expensive to throw away. It appears that those residential building contractors in Windsor and Essex County who are maximizing materials do
so primarily because of the economic constraints related to material costs, and profit margins, and not as a result of environmental concerns or codes of practice. While the research paper did not deal with the commercial construction industry, a number of contractors who were interviewed indicated little or no concern for waste reduction or minimization in that sector of construction, and gave examples of huge wastes of materials and resources on the commercial job site.

Most respondents believed that they were presently doing enough to reduce and minimize waste in residential construction. They felt that their waste levels were already low and anything thrown away was simply garbage. They knew that drywall was the major component to their waste stream, yet they did not feel the need nor were they inclined to start recycle programs in order to reduce the amount of waste that went into the landfill. At the moment they do not see an economic benefit of separating certain materials from the waste bin. The general perception is that the economic constraints outweigh the social and environmental benefits of recycling secondary materials. A few contractors suggested that those individuals responsible for the collection and haulage of construction waste should be included within the discussion of reducing and recycling waste that goes to landfills. The respondents indicated that waste haulers are seen as being partially responsible for the lack of on site separation of construction waste and the failure to encourage contractors to participate in recycling programs.
within the industry. Contractors inferred that waste haulers could easily incorporate scheduled pick ups of certain waste materials based on the phase of construction of a dwelling. By collecting certain types of waste during the framing, drywalling or roofing phases site separation and the reduction of contamination of construction waste could be easily accomplished for wood, drywall, cardboard, asphalt roofing and various plastics. Also, the use of compartmentalized waste bins could easily be incorporated on the job site. This would ensure that waste materials would be pre-sorted and uncontaminated on site in a cost effective manner.

Contractors indicated that price had become the major concern in new residential construction and new homeowners were purchasing homes based exclusively on price and not on quality or craftsmanship. Builders were struggling to sell homes and any builder would do anything to knock $10,000 or $15,000 off the final cost of the structure which frequently results in the use of lower quality materials. Many contractors indicated that the “fly-by-night” builders or those who were in the industry for a second income were becoming a major threat to the business. Several contractors discussed the problem of being undercut by these part time contractors and while contractors in general are against increased regulation within the industry, a number indicated that licensing of contractors would restore order and integrity to the industry. Often the part time builders and their sub-contracts work for cash, effectively leaving no paper trail. As a result, they avoid
paying Goods and Services Tax (GST) as well as, business and personal income taxes on the homes they build. Fennell (1995(b)) reports that a Canadian Home Builders Association (CHBA) study in January 1991 claimed that almost half (45 percent) of all renovation work was done under the table, resulting in the government’s tax loss of $2,820 on a $10,000 renovation. Those contractors interviewed suggested that quite often these new homes and renovation work are poorly constructed, and that by undercutting legitimate builders the industry was becoming extremely competitive forcing those who make their primary living at construction to focus on price rather than quality, encouraging the use of inferior components during construction.

The issue of using prefabricated materials in the construction of residential dwellings came up during the interview process with a number of contractors. Residential construction has historically been very slow to adopt innovations within the industry. Shaw (1987) estimated a lag time of 15 years in the United States before new products become acceptable within the industry. Many more products and building systems that may be beneficial to home construction never make it in the market due to poor reception by professionals in the trades or the homeowners themselves. Apprehension and concern about using new products was evident when talking to contractors in Windsor and Essex County. A number of products such as microlam and parralam beams, wood I-beams, steel stud construction and pre-engineered truss systems are structurally superior yet contractors do not
want to use them in new home construction. The reasons given by contractors for their non-acceptance of innovative materials were customer preference for items like steel beams and traditional stick building over pre-engineered wall systems, and concern that the materials may contain hazardous materials. Other contractors indicated that production lags with pre-engineered building systems lead to the use of conventional stick building especially with the truss systems in Essex County. Contractors claimed that there was often a time lag of up to eight weeks for truss systems, from the time of ordering to delivery at the job site. Despite the fact that building inspectors prefer to see pre-engineered building systems in new construction contractors found that the use of these systems was impractical at the moment. A few contractors also indicated they had to order items such as trusses from London and the Toronto area far in advance of when the ground was broken on the job site.

The composition of Windsor and Essex County's construction waste was quite different from what previous literature on the subject had suggested. Contractors indicated that the majority of their waste came from drywall and cardboard, contrary to what the OMEE and the CMHC had reported. The OMEE & CMHC (1991) and OMEE (1993 (a)) both estimated that wood waste on the construction site is about 40 percent, the results of this thesis indicate that wood waste for residential construction in Windsor and Essex County is much less than that previously indicated. Respondents
and Cochren (1995) claimed that costs of raw materials have dramatically increased in the past two to three years with wood being the most volatile and therefore is far too expensive to waste. Yet contractors do not consider other materials to be potential sources of revenue. At present the composition of new residential construction waste in Windsor and Essex County does not appear to be a major issue with contractors.

Probably the most disturbing discovery was that contractors may not be getting the information they may need about new construction practices, improved waste management, and instruction on more sustainable building practices. An indication of the lack of training programs for waste reduction and minimization was evident in 1993 when the CMHC canceled a seminar on such topics in Windsor. The reason for the cancellation is unclear but lack of interest from builders in the area may have been one of the causes. Contractors spoke of not receiving information in a timely fashion from federal, provincial or municipal governments. In fact, an anti-government / regulation sentiment was voiced by a number of contractors suggesting that problems exist between the small residential contractor and government. A number of builders said that they rarely received waste reduction or building information beyond building code changes from municipal government. It is possible that municipal government may be missing a prime opportunity to distribute information to contractors about the issue of waste reduction and minimization in residential construction. The fact that builders appear to be
quite homogeneous in their responses to questions regardless of how they are classified may offer an important advantage when considering the distribution of information about waste reduction. The similarities among contractors would suggest that government agencies and professional organizations can focus on a single educational campaign instead of developing numerous approaches to distributing information. Those parties responsible for distributing information to contractors about waste issues and innovations in the building industry should do so from a cost-benefit perspective. Builders seem to be more worried about the cost of reducing waste or recycling materials rather than the ideology of the “greening” of the industry.

6.3 Future Research

Future research surrounding the issue of residential construction waste in Windsor and Essex county can be expanded to include a number of other areas of study. Further surveying of not only the general contractors but also the sub-trades involved in the production of housing may lead to a greater awareness of how waste reduction and minimization measures are being integrated over time. By interviewing sub-contractors such as framers, plumbers, roofers, and concrete block layers one may gain in-sight into the quantities and types of waste produced on the job site. Cost-benefit analysis focusing on the ability to recycle certain types of construction waste in Windsor and Essex County may also be an option for future research. Also,
follow-up reports may include interviewing municipalities, provincial ministries and professional organizations to better determine how they go about the task of distributing information to contractors and the sub-trades. A closer examination of the information network presently in place may identify an important factor to why contractors fail to receive information that may be beneficial to their performance on the building site.

6.4 Summary

The study has added to the growing body of knowledge about the relationship between residential construction and environmental concern. The adoption of a proactive stance by planners, architects, and builders is necessary for the advancement of ecological construction methods and practices. The literature suggests the need to address sustainable development as a real and important issue in the late twentieth century. While there are a number of new approaches to residential construction which incorporate the notions of sustainable development through the wise use of materials during the construction process, the majority of residential builders in Windsor and Essex County have not yet adopted a proactive stance to the issue of waste reduction and minimization in residential development. Present building practices fail to address new environmental concerns surrounding sustainable development. Planners working with design professionals and builders are in a position to direct residential development to adopt sustainable building practices. The changes needed to
reduce construction waste and create new markets for the waste produced during the building process will not happen over night. Careful planning and discussions with all parties involved are required to come to a fair and reasonable solution to the problem. The need to build information networks and to distribute information to contractors will also take time. Many other industries and professions have licensing requirements; why not the residential construction industry? The ability of government to license and regulate contractors in the province of Ontario may be the solution to bring together this fragmented and independent group of individuals.
References


Additional Bibliography


APPENDIX A

STUDY QUESTIONNAIRE
Construction Waste Minimization Questionnaire

The following questionnaire is a part of a research project on waste reduction and minimization in the Essex County Construction and Demolition industry. The intent of the questionnaire is to determine the level of awareness and understanding of contractors in the area of waste minimization and availability of information surrounding the subject.

ALL RESPONSES ARE CONFIDENTIAL

In what city or town is the location of your office or business? LOCATION

Using the following three categories identify the number of projects and the average price in 1994 you were involved in for:

Residential Construction

- new construction
  - number of projects ______ average price $__________
  - renovation
    - number of projects ______ average price $__________
  - demolition
    - number of projects ______ average price $__________

Commercial Construction

- new construction
  - number of projects ______ average price $__________
  - renovation
    - number of projects ______ average price $__________
  - demolition
    - number of projects ______ average price $__________

What percentage of your new residential business is derived from the following three categories:

- Single detached
  - number of projects ______ average price $__________
- Semi-detached
  - number of projects ______ average price $__________
- Multi-unit dwellings
  - number of projects ______ average price $__________

Regarding your 1994 projects what was the number that were initiated by:

- You the contractor ______
- Future homeowner / developer ______

What percentage of your time was spent as:

- Contractor
  - □ 0-25% □ 26-50% □ 51-75% □ 76-100% TIMECONT
- Sub-contractor
  - □ 0-25% □ 26-50% □ 51-75% □ 76-100% TIMESUB

Do you belong to a professional building organization?
- □ yes □ no □ don't know MEMSHIP

If yes, which one:
- □ Greater Windsor Home Building Association PBGWHBA
- □ HUDAC PBPHUDAC
- □ Other PBOOHER

Karl Tanner 69 v.5.0 Feb. 20, 1895
## Construction Waste Minimization Questionnaire

If no, why not?
- [ ] Too expensive
- [ ] No organization in your area
- [ ] Do not meet your needs
- [ ] Other

In 1994 where did you conduct your building?

<table>
<thead>
<tr>
<th>Place</th>
<th># of new projects</th>
<th># of renovation projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amherstburg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anderdon Twp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belle River</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colchester N.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gosfield Twp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LaSalle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learnington</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maidstone Twp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mersia Twp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rochester Twp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Clair Beach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandwich S.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tecumseh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windsor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What percentage of your business do you sub contract out to others?
- [ ] 0-25 %
- [ ] 26-50%
- [ ] 51-75%
- [ ] 76-100%

Are your sub contractors required to dispose of their own waste?
- yes
- no
- don't know

Estimate what percentage of your total waste is generated by your sub contractors?
- [ ] 0-25 %
- [ ] 26-50%
- [ ] 51-75%
- [ ] 76-100%

What percentage of your waste do you dispose in the following manner?

- [ ] Self-haul
- [ ] Rented Disposal Bin
- [ ] Other

**Karl Tanner**

70

v.5.0

Feb. 20, 1995
Construction Waste Minimization Questionnaire

Do you use any of Essex County's landfills?
☐ yes  ☐ no  ☐ don't know  LANDFILL

If yes, which landfills do you use regularly and what is the tipping fee (per tonne)?
☐ Landfill 1 Colchester North  Tipping Fee $__________  LNDFILL1
☐ Landfill 2 Gosfield South  Tipping Fee $__________  LNDFILL2
☐ Landfill 3 Maidstone  Tipping Fee $__________  LNDFILL3

Do you use a licensed private waste hauler?
☐ yes  ☐ no  ☐ don't know  WSTHHAUL

If yes, what is the tipping fee (per tonne)?
☐ Private Haulage (per tonne)  Tipping Fee $__________  WSTHHAUL

Do you separate waste on site by materials into different bins, piles, etc.?
☐ yes  ☐ no  WSTSEP

if yes, what percentage of your waste is separated on site?
☐ 0-25 %  ☐ 26-50%  ☐ 51-75%  ☐ 76-100%  WSTSEPN

On average how much waste (in tonnes) do you produce for a single family detached home?

tonnes __________

On average how much do you spend on waste disposal for a single detached residential dwelling?

$____________________

On average how much waste (in tonnes) do you produce for a renovation project?

tonnes __________

On average how much do you spend on waste disposal for a renovation project?

$____________________

Have you ever attended a seminar on waste reduction?
☐ yes  ☐ no  ☐ don't know  SEMINAR

If yes, where:
☐ Windsor  SEMWIN
☐ Essex County  SEMESXC
☐ Outside Essex County  SEMOTHER
Construction Waste Minimization Questionnaire

Have you ever received government documents or pamphlets on waste reduction?

☐ yes ☐ no ☐ don’t know  INFOGOVT

If yes, were they any of the following:

☐ Keeping Construction and Demolition Materials Out of Landfills  INFOCD
   Ontario Ministry of Environment & Energy

☐ Making a Molehill out of a Mountain  INFOMOLE
   Canadian Mortgage & Housing Corporation (CMHC)

☐ Construction & the Environment  INFOCE
   CMHC - Builders Series

☐ Challenge: reducing residential construction waste  INFOCHG
   CMHC

☐ A Guide to Waste Audits and Reduction Workplans for Construction and  INFOAUD
   Demolition Projects
   Ontario Ministry of Environment and Energy

☐ Other:__________________________________________INFOOTH

Do you presently use any of the following methods of waste reduction or minimization?

just in time ordering for lumber and other materials ☐ yes ☐ no  METHJUST
re-use off cuts of dimensional lumber ☐ yes ☐ no  METHREUSE
site separation of waste ☐ yes ☐ no  METHSEP
centralized cutting areas for materials ☐ yes ☐ no  METHCEN
ordering materials in bulk (caulking, paint, nails, etc.) ☐ yes ☐ no  METHORD
covered storage of materials (wood) ☐ yes ☐ no  METHSTO
other _____________________________________________ ☐ yes ☐ no  METHOTH

Have you ever completed a waste audit?

☐ yes ☐ no ☐ don’t know  AUDIT

If yes, when do you complete a waste audit?

☐ per project ☐ monthly ☐ quarterly ☐ semi-annual ☐ annually  AUDITCOM

Would you consider any of the following measures:

☐ Recycling material  WSTRECYC
☐ Reusing material  WSTREUSE
☐ Reducing waste  WSTREDC
☐ Separating waste on site  WSTSPR

Which of the following is your source for information about construction?

☐ Municipal government  SINFOMUN
☐ Ontario government  SINFONT
☐ National government  SINFONAT
☐ Professional association  SINFOPROF
☐ Magazines/Journals  SINFOMAG
☐ Suppliers  SINFOSUP
☐ None  SINFONONE
☐ Other _____________________________________________ SINFOOTH
## Construction Waste Minimization Questionnaire

The following questions pertain to your perceptions about issues affecting the construction industry. Please check the appropriate box.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Disagree**

- When completing renovation projects homeowners don't mind the re-use of existing materials found on site during the demolition process. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- All contractors should belong to a professional building organization. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- Sorting waste materials on site results in lower tipping/haulage fees. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- The 3Rs are becoming an important issue in residential construction. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- Stricter regulations are needed for dumping construction waste. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- Municipalities are enforcing waste reduction and the 3Rs in home construction. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- There is a lack of training programs in the construction industry for waste reduction. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- When doing renovation work as a contractor one should only use new materials in construction. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- Municipal government and provincial governments are timely in distributing information to contractors about construction matters. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- Waste reduction and minimization are important issues to me in residential construction. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
- If there were recycling centres in Essex County for construction waste I would dispose of the materials there. □ 1 □ 2 □ 3 □ 4 □ 5 □ N/A
The two charts below indicate a number of building materials that are found in the construction and demolition process. Please rank the top 5 materials in your waste bin in the first column and if you try to re-use or reduce that material from going into the waste bin on the job site in the second column.

NOTE: write N/A in the space if you feel the material does not apply

### Waste Generation from New Residential Construction

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Rank Top 5</th>
<th>3Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOOD</td>
<td></td>
<td>NCWOOD</td>
</tr>
<tr>
<td>EXCAVATED MATERIAL</td>
<td></td>
<td>NCEXCAV</td>
</tr>
<tr>
<td>ROOFING MATERIAL</td>
<td></td>
<td>NCROOF</td>
</tr>
<tr>
<td>DRYWALL / PLASTER</td>
<td></td>
<td>NCDRYWALL</td>
</tr>
<tr>
<td>METAL</td>
<td></td>
<td>NCMETAL</td>
</tr>
<tr>
<td>CONCRETE</td>
<td></td>
<td>NCCONC</td>
</tr>
<tr>
<td>CONCRETE BLOCKS</td>
<td></td>
<td>NCCONCBLC</td>
</tr>
<tr>
<td>BRICKS</td>
<td></td>
<td>NCBRICKS</td>
</tr>
<tr>
<td>INSULATION</td>
<td></td>
<td>NCINSUL</td>
</tr>
<tr>
<td>PLASTIC</td>
<td></td>
<td>NCPLASTIC</td>
</tr>
<tr>
<td>WIRING</td>
<td></td>
<td>NCWIRING</td>
</tr>
<tr>
<td>CARPETING</td>
<td></td>
<td>NCCARPET</td>
</tr>
<tr>
<td>GLASS / CERAMIC TILE</td>
<td></td>
<td>NCGLASS/CER</td>
</tr>
<tr>
<td>PAPER</td>
<td></td>
<td>NCPAPER</td>
</tr>
<tr>
<td>CARDBOARD</td>
<td></td>
<td>NCCARDB</td>
</tr>
</tbody>
</table>

**COMMENTS / NOTES**
APPENDIX B

LIST OF VARIABLES USED IN ANALYSIS
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Statement / Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3RS</td>
<td>The 3Rs are becoming important in residential construction.</td>
</tr>
<tr>
<td>PINFOTIM</td>
<td>Municipal and Provincial governments are timely in distributing information to contractors about construction matters.</td>
</tr>
<tr>
<td>PLACK</td>
<td>There is a lack of training programs in the construction industry for waste reduction.</td>
</tr>
<tr>
<td>PMUN3RS</td>
<td>Municipalities are enforcing waste reduction and the 3Rs in home construction.</td>
</tr>
<tr>
<td>PRECYCLE</td>
<td>If there were recycling facilities in Essex County for construction waste I would dispose of the materials there.</td>
</tr>
<tr>
<td>PRESTRIC</td>
<td>Stricter regulations are needed for dumping construction waste.</td>
</tr>
<tr>
<td>PREUSE</td>
<td>When completing renovation projects homeowners don’t mind the re-use of existing materials found on site during the demolition process.</td>
</tr>
<tr>
<td>PREUSEH</td>
<td>When doing renovation work as a contractor one should only use new materials in construction.</td>
</tr>
<tr>
<td>PSORT</td>
<td>Sorting waste on site results in lower tipping / haulage fees.</td>
</tr>
<tr>
<td>PWSTIMP</td>
<td>Waste reduction and minimization are important issues to me in residential construction.</td>
</tr>
<tr>
<td>SEMINAR</td>
<td>Have you ever attended a seminar on waste reduction?</td>
</tr>
<tr>
<td>SINFORMUN</td>
<td>I have received information from municipal government.</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>WSTRECYC</td>
<td>Would you consider waste recycling?</td>
</tr>
<tr>
<td>WSTREDUC</td>
<td>Would you consider waste reduction?</td>
</tr>
<tr>
<td>WSTREUSE</td>
<td>Would you consider reusing materials?</td>
</tr>
</tbody>
</table>
VITA AUCTORIS

NAME: Karl Dean Tanner

PLACE OF BIRTH: Northampton, Northamptonshire, England

YEAR OF BIRTH: 1969

EDUCATION:

Riverside High School, Windsor, Ontario
1984-1988

University of Windsor, Windsor, Ontario
1988-1993 Bachelor of Arts
Urban Planning

University of Windsor, Windsor, Ontario
1994-1995 Master of Arts
Geography (Planning)