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External Research Program

Residential Deconstruction Manual

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RESIDENTIAL DECONSTRUCTION MANUAL

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RESIDENTIAL DECONSTRUCTION MANUAL

CANADA MORTGAGE AND HOUSING EXTERNAL RESEARCH PROJECT

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PURPOSE

The intent of this manual is to provide project managers (architects, engineers, interior designers, associated technicians and technologists, contract administrators, contractors, and site supervisors) involved in residential (single family and multi-unit) demolition with a reference tool to assist them in the economic feasibility assessment, planning and supervision of deconstruction.

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EXECUTIVE SUMMARY

To be useful as a reference tool, the manual has been structured to reflect the sequential approach typical of any residential deconstruction project. The manual is divided into the following sections: Overcoming the Barriers; Preparation; On-Site; Post Project; and Looking Ahead.

"Overcoming the Barriers" attempts to enhance the awareness among project managers of the existing barriers to the process. Each project requires the implementation of situation-specific solutions to ensure that the barriers do not significantly impede the successful salvage of reusable and recyclable materials. Barriers addressed include: inadequate markets; current regulations, specifications and codes; time constraints; unforseen delays; lack of understanding about costs and benefits; and high labour rates.

The "Preparation" section attempts to address all matters associated with the planning elements of the deconstruction process. Key to this section is the development of an economic feasibility analysis. It is emphasized that if deconstruction cannot be proven to be economically viable, it simply does not make sense. To help project managers assess the economic feasibility, emphasis is placed on understanding the variables which are unique to deconstruction and how these variables affect the costs and benefits of each project.

Where appropriate, small check-lists and action items are provided to perform the schematic cost analysis at the end of this section. The schematic cost analysis is provided to illustrate a method by which deconstruction's economic feasibility could be assessed based on the information obtained regarding each of the variables.

Once economically feasibility has been determined, the section entitled "On-Site" describes the process of deconstruction as it occurs on site. Remaining true to the sequence of actions, the following items are described in detail: tools; disassembly; processing; flow of materials; and storage and transport.

Like any successful undertaking, the deconstruction process benefits from strong project management. Due to the commitment required by the entire workforce to salvage materials in good condition, proper flexibility, innovation, communication, and supervision are all intricate elements of residential deconstruction project management. To reflect the need strong project management, the "On-Site" section covers: flexibility and innovation; communication; workforce supervision; health and safety; on-site sale of materials; and material tracking.

The final part of the manual addresses the need for continual improvement. The "Post Project" section looks at the benefits of performing a post-project analysis and conducting a post project meeting. In addition, the manual touches briefly on how the process can be improved in the "Looking Ahead" section. By applying the lessons learned and spreading the word within the industry it is hoped that the process will continue to be refined and prove to economically viable under the proper circumstances. The goal is to encourage industry practitioners to continue to contribute towards the standardization of a process that has proven to be good for the economy as well as the environment.

SOMMAIRE

Afin de pouvoir être utilisé comme outil de référence, le manuel a été conçu de façon à refléter l'approche séquentielle type d'un projet de déconstruction résidentielle. Le manuel est divisé en plusieurs sections: Surmonter les obstacles, Préparation, Sur place, À l'issue du projet, L'avenir.

La section «Surmonter les obstacles» tente de sensibiliser davantage les chefs de projet aux barrières que comporte le processus. Chaque projet requiert la mise en œuvre de solutions adaptées à la situation afin de s'assurer que les obstacles ne viennent pas mettre en péril la récupération des matières réutilisables et recyclables. Les obstacles rencontrés sont les suivants: marchés inadéquats, réglementation en vigueur, spécifications et codes, contraintes de temps, retards imprévus, manque de compréhension concernant les coûts et les bénéfices, et taux élevés.

La section «Préparation» tente de décrire toutes les questions liées aux éléments de planification du processus de déconstruction. L'élaboration d'une analyse de faisabilité économique constitue un point clé de cette section. Il est bien entendu que le projet de déconstruction n'a aucune raison d'être s'il n'est pas économiquement viable. Pour aider les chefs de projet à évaluer la faisabilité économique, on met l'accent sur la compréhension des variables propres à la déconstruction et sur l'effet de ces variables sur les coûts et les bénéfices de chaque projet.

Le cas échéant, des petites listes de vérification et des éléments d'action sont fournis pour effectuer l'analyse schématique des coûts à la fin de cette section. L'analyse schématique des coûts sert à illustrer une méthode selon laquelle la faisabilité économique de la déconstruction peut être évaluée d'après les renseignements obtenus pour chaque variable.

Une fois que la faisabilité économique est démontrée, la section «Sur place» décrit le processus de déconstruction tel qu'il se déroule sur les lieux. Fidèles à la séquence d'actions, les éléments suivants sont décrits en détail: les outils, le démontage, le traitement, le flux de matériels, le stockage et le transport.

À l'instar de tout projet réussi, le processus de déconstruction tirera avantage d'une gestion solide. Étant donné l'engagement requis de la part de toute la main d'œuvre pour récupérer les matériels en bon état, la souplesse, l'innovation, la communication et la supervision sont tous des éléments indispensables à la gestion des projets de déconstruction résidentielle. Afin de refléter ce besoin de gestion solide, la section «Sur place» aborde les éléments suivants: la souplesse et l'innovation, la communication, la supervision de la force de travail, la santé et la sécurité, la vente des matériels sur place et le suivi des matériels.

La dernière partie du manuel aborde la nécessité d'amélioration continue. Dans la section «À l'issue du projet», il est question des avantages qu'il y a à effectuer une analyse et à tenir une réunion à la fin du projet. De plus, le manuel s'attarde brièvement sur la façon dont le processus peut être amélioré, dans la section «L'avenir». En appliquant les leçons apprises et en passant le mot au sein de l'industrie, il faut espérer que le processus sera davantage amélioré et qu'il s'avérera économiquement viable dans les circonstances adéquates. L'objectif est d'encourager

les membres de l'industrie à poursuivre leurs efforts de normalisation d'un processus qui s'est déjà avéré favorable pour l'économie et l'environnement.

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GLOSSARY OF TERMS

Deconstruction: The economically viable and environmentally sustainable removal of a building or structure through the careful and systematic dismantling of building components so as to maximize the reuse and recycling of salvaged building materials.

Disassembly: The separation of a building into its component parts and/or materials. Disassembly may be accomplished through the use of specialized equipment or physical labor (e.g. prying, pulling, cutting, unscrewing) and/or a combination thereof.

Hazardous Wastes: Dangerous substances, goods and products such as asbestos, polychlorinated biphenyls, chlorofluorocarbons, lead paint, underground storage tanks, molds, mercury, or any other material that can endanger human health or the environment if handled improperly.

Processing: Tasks that are subsequent to disassembly, which include moving materials, de-nailing, crushing, grinding, cleaning, separating, stripping, stacking, etc.

Project Manager: The individual(s) responsible for overseeing the deconstruction of a structure. Could include: architects, engineers, interior designers, associated technicians and technologists, contract administrators, contractors, and site supervisors.

Quantify: The counting of materials. Generally done by either unit count (number of each, lineal dimension, area), volumetrically (by volume) or gravimetrically (by weight).

Recyclable Material: A product that can be diverted or recovered from the waste stream and used in the processing or manufacture of new products or raw materials.

Recycling: Any process by which waste and recyclable materials are transformed, or collected for the purpose of being transformed into new products or raw materials.

Reuse:	Repeated use of a product in the same form but not necessarily for the same purpose.
Salvage:	The removal of building materials in a condition which makes them suitable for reuse and/or recycling.
Tipping Fees:	Disposal fees charged by landfills or recycling facilities to dispose of or accept materials for recycling.

1.0 INTRODUCTION

1.1 BACKGROUND

The intent of this manual is to provide project managers (see "Glossary of Terms" for definition) involved in residential (single family and multi-unit) demolition with a reference document to assist them in the economic feasibility assessment, planning and supervision of deconstruction.

The motivation for this manual has been a manifestation of two things. Firstly, *by dEsign consultants'* involvement on several deconstruction projects have provided insight into the possibilities and benefits of selectively demolishing and salvaging materials for reuse and recycling. Secondly, feedback from project managers from within the industry who are interested in the possibilities, but who currently lack the tools to employ deconstruction due to the need for further research and standardization of the process.

Based on this expression of industry need and the experience *by dEsign consultants* have gained, the research undertaken for this manual has allowed the firm to take a first (albeit small) step towards developing a framework for the standardization of the deconstruction process. With this manual it is hoped that project managers with the desire to salvage demolition materials for reuse and recycling will approach each project with a reference document which helps them to critically evaluate the opportunities for deconstruction on certain projects.

It is important to understand that the manual is not intended to provide strict deconstruction procedural guidance. Nor should it be considered an exhaustive compilation of all of the information relevant to the deconstruction process. It is designed, rather, as a document to reference when seeking general information related to the economic feasibility assessment, planning, and supervision of residential deconstruction.

Due to the national nature of the manual's target audience it has been difficult to focus the research on the specifics of any one region. Although the manual is a culmination of data and information gathered from across Canada and the United States, the recommendations included herein are structured to be general enough to be useful to a Canadian national audience.

1.2 ENVIRONMENTAL BENEFITS

Of relevance to the research, but which is not elaborated on in the manual (due to a conscious emphasis on economics) are the environmental benefits that can result from the deconstruction process To avoid losing sight of the significance of possible reduced environmental impacts of salvaging building materials for reuse and recycling, a brief summary is included here.

- ❑ Reduced consumption of natural resources.
- ❑ Reduced waste generation.
- ❑ Reduced energy consumption at the raw material acquisition, transport and manufacturing stages.
- ❑ Reduced emissions (ozone depleting and greenhouse gas) associated with the raw material acquisition, transport and manufacturing stages.
- ❑ Extended life of landfills.

1.3 HOW TO USE THIS MANUAL

It is important to keep in mind that this manual is intended to provide a framework upon which project managers can apply the specifics of each particular situation to adequately assess, plan and supervise residential deconstruction. Currently, it is not a stand-alone tool. Project managers, as a result, should understand that substantial, additional external research is required to increase the effectiveness of the manual for each and any specific project. Research into the specifics of each situation, project and location should be performed in conjunction with this manual to obtain all of the necessary information which will affect deconstruction.

To be useful as a reference tool, the manual has been structured to reflect the sequential approach typical of any deconstruction project. The manual is divided into the following sections: overcoming the barriers; preparation; on-site; post project; and looking ahead.

The manual is designed in such a way that it is intended to be a reference tool prior to, during, and after each deconstruction project. It has been compiled to be relevant and of interest to all types of project managers. It may be found, however, that the "preparation" and "post project" sections are more relevant to architects, engineers and contract administrators whereas the "on-site" section is more relevant to contractors.

Wherever appropriate, check-lists, tables and action items are included to facilitate the active use of the manual. The appendices supply valuable supporting information and materials which should also be referenced, but which are too lengthy to include in the body of the manual.

2.0 OVERCOMING THE BARRIERS

There are a number of barriers to deconstruction which currently exist that need to be overcome on each project. Although the situation varies from region to region, the following are brief descriptions of barriers which will likely be encountered to some degree on deconstruction projects.

The barriers are included here to enhance the awareness of their existence among project managers considering the deconstruction of residential buildings. Each project will require the implementation of situation-specific solutions to ensure that the barriers do not significantly impede the successful salvage of reusable and recyclable materials.

2.1 INADEQUATE MARKETS

Because the success of deconstruction depends on the sale of salvaged materials, the lack of markets for reusable and recyclable materials is considered by most to be single largest barrier to effective deconstruction. Certain impediments to the consistent marketability of materials include: fluctuating market value; lack of reuse and recycling facilities; inconsistent supply and demand; lack of awareness of the availability; and consumer preference for new products.[1]

Sources of material markets assistance include: used building material, waste management and recycling associations; municipal solid waste management departments; waste management consultants; and waste exchanges.

2.2 CURRENT REGULATIONS, SPECIFICATIONS AND CODES

Regulations, specifications and codes often do not accommodate the procedures involved in deconstruction. For example, regulations in many jurisdictions presently prohibit the selling, stockpiling or processing of any materials on demolition sites.[2] In addition, many current demolition project specifications restrict the use of methods which encourage the salvage of materials.

Currently, most municipalities do not have a separate deconstruction permitting process.[3] As a result, the permitting and inspection processes may in some cases be geared towards demolition procedures that do not involve extensive and systematic material salvage. In addition, building codes can make the use of used materials in new construction a cumbersome and costly process.[4] Although work is being done by research bodies to improve the information and mechanisms available, the extensive use of reusable materials in new construction is still a relatively unprecedented process.

2.3 TIME CONSTRAINTS

Deconstruction requires proper time and planning. To be successful, time is needed to identify markets, conduct a materials inventory, train the workforce, and create an on-site strategy. At present the removal of buildings is often delayed as long as possible and then expected to happen as quickly as possible (some municipalities will not issue demolition permits for certain properties until a building permit for new development is in place).[5] Due to its meticulous nature, tight time lines make deconstruction virtually impossible.

Owners and developers often rush the demolition portion of projects to maximize their return on investment. On certain projects the time commitment needed for deconstruction may not be equal to the value output by the owner/developer.[6] For example, the interest on borrowed money or lost revenues from tenants may not warrant the required additional time to deconstruct.

To accommodate its duration, consideration should be given (wherever possible) to the re-structuring of project financing to off-set financial losses. Providing such incentive may serve to increase the viability and attractiveness of deconstruction.[7]

2.4 UNFORESEEN DELAYS

Unforeseen delays are another reason adequate time should be allowed for deconstruction. Because material assemblies and connections are usually well hidden it is difficult to accurately forecast what might be encountered once deconstruction begins. Because building practices have changed over time, older construction can present problems which require innovative disassembly and processing solutions.[8]

It is important to keep in mind that unforseen dynamics are inevitable, which will require flexibility and innovation to overcome. Proper planning and experience will contribute to the salvage of materials in good condition, regardless of the complexities which arise.

2.5 LACK OF UNDERSTANDING ABOUT COSTS AND BENEFITS

Currently, there are few reliable precedents from which to draw tangible deconstruction cost-benefit lessons. As a result, unfounded assumptions are often made about the economic feasibility of the process. Although case studies (keep in mind that many documented case studies have been subsidized with public funds, which results in an inaccurate picture of costs and benefits) are a good way to learn from the experiences of others, nothing will prepare project mangers better than experience itself.

Deconstruction includes many dynamic variables which affect its economic feasibility for each region, project type, size and age. To be viewed objectively, these variables should be well understood within the context of each specific project. The bottom line is that deconstruction must be economically feasible to make sense.

2.6 HIGH LABOUR RATES

Due to its labour intensity, industry has expressed that deconstruction can not be viable if high labour rates must be paid.[9] Depending on certain variables, such as the proximity of facilities and the value of the salvaged materials, this may be true in some cases. High labour rates should not, however, predetermine the economic viability of any given project. For example, case studies exist which indicate that profit was made even though labourers were paid $30 - $40 per hour.[10]

3.0 PREPARATION

3.1 ASSESSING ECONOMIC FEASIBILITY

As a first step on any deconstruction project, it is extremely important to assess the economic feasibility. In other words, owners and clients will generally want to know the bottom line implication of employing deconstruction. For this reason, it is crucial to have a firm understanding of the variables which affect economic feasibility and how each of the variables combine to produce a cost analysis to justify or discourage deconstruction.

The following is a description of many of the variables affecting deconstruction. Each should be analyzed carefully when approaching any project to understand how costs and benefits are affected by each. Where appropriate, a small check-list is provided as well as an action item stating the information needed to perform the schematic cost analysis at the end of this section. The schematic cost analysis is provided to illustrate a method by which the economic feasibility could be assessed based on the information obtained regarding each of the variables.

3.1.1 Status of Markets

The feasibility of deconstruction depends largely on the ability to market (sell) materials once they are salvaged. The ability to market salvaged materials will depend greatly on the status of local reuse and recycling markets.

Before assessing which materials are salvageable it is important to gain an understanding of the supply and demand of and for used materials. The following methods can be employed to develop this understanding.[11]

- ❑ Researching what reuse and recycling facilities/options exist and what types of materials are accepted. Finding out also what condition the materials must be in to be accepted.
- ❑ Checking with the landfill to find out what (if any) materials are banned. Materials banned from landfill sites generally have a strong reuse or recycling infrastructure.
- ❑ Consulting waste management firms, haulers, solid waste management departments, demolition contractors, waste management consultants; and scrap dealers to gain a sense of the nature of local markets.

ACTION:
Determine what types of materials can be marketed locally.

3.1.2 Materials Inventory

In order to properly assess the economic feasibility of deconstruction, it is critical to have a comprehensive understanding of the types of materials involved on each project. Although for most projects it is not necessary to take an inventory of all of the materials in a building, materials known to be of value (and marketable) should be quantified to permit accurate determination of their worth.

Generally, a quick "walk through" does not allow for a comprehensive enough assessment of the types of materials involved in any given project. If permitted, the following methods can be employed to compile an inventory of salvageable materials.[12]

- ❑ Partially uncovering material assemblies and plumbing and electrical components to estimate quantities and determine quality.
- ❑ Visiting all areas of the building, including the attic, crawl spaces and other hard to reach places.
- ❑ Carefully examining how materials are fastened to gain an understanding of what level of effort will be involved in trying to salvage them in good condition.
- ❑ Examining "as built" or construction drawings if they are available. Although the drawings will not provide any sense of the condition of the building's materials, they will facilitate a thorough understanding of what types of materials are involved.

ACTION:
Estimate the quality, quantity and types of salvageable materials.

3.1.3 Value of Used Material

Once a materials inventory has been performed, effort should be made to find out what the materials designated for salvage are worth. Without having extensive experience in the sale of used material, this will require research into the markets available locally for each of the materials. If proximate, functional reuse and recycling facilities to which the material can be transported and sold do not exist, other end destinations will have to be sourced out.

Other sources for the purchase and consumption of used materials include:[13]

- ❑ Home and cottage owners.
- ❑ Renovation contractors.
- ❑ Not-for-profit organizations (i.e. *Habitat for Humanity*) and community centres.

The following are possible sources to consult when determining the market value of used materials:

- ❑ Reuse and recycling facilities.
- ❑ Renovation and demolition contractors.
- ❑ Scrap dealers.
- ❑ Used building material and recycling associations.
- ❑ Construction associations.
- ❑ Waste management companies and haulers.
- ❑ Waste management consultants.

ACTION:
Estimate how much the salvageable materials are worth.

3.1.4 Labour Productivity

Due to the fact that deconstruction is often labour intensive, it is essential to properly estimate labour costs in order to confidently price a deconstruction job. To do this it is important to determine the productivity of any given crew assigned to deconstruct a residential building. If previous experience is insufficient to determine productivity, external sources must be relied upon. Although research indicates that little work has been done to compile standard productivity factors for deconstruction, the following sources will provide a basis for insight.

- ❑ Deconstruction case studies (see "References" for examples).
- ❑ Industry costing tools such as R.S. Means Building Construction Cost Data and Yardstick.
- ❑ Renovation and demolition contractors with experience salvaging materials.

ACTION:
Estimate the crew's labour productivity rates.

To provide an **example** of the type of information currently available in industry costing tools, the following data is taken from the "Selective Demolition" section of R.S. Means Building Construction Cost Data.[14] This data should not be used in isolation, nor should it be relied upon to form the basis of any project-related decisions. Project managers are encouraged to consult the source for further context, information and instructions on its use.

Table 1:
R.S. Means Selective Demolition Productivity Rates

DESCRIPTION	CREW	DAILY OUTPUT[a]	LABOUR - HOURS[b]	UNIT[c]
Gut residential building interior, including disposal, dumpster fees not included	1 Labour Foreman 2 Labourers 1 Truck Driver (heavy) 1 Dump Truck (16 ton)	400	0 080	Sqft. Flr

[a] Indicates the number of square feet (of floor space) the stated crew can selectively demolish in one day.
[b] Indicates the number of hours it takes the stated crew to selectively demolish 1 square foot (of floor space) based on the stated daily output.
[c] Denotes square feet of floor space

To provide **example** of the type of information currently available in case studies, the following data is taken from the Cape Dorset, NWT Deconstruction Project Case Study.[15] This data should not be used in isolation, nor should it be relied upon to form the basis of any project-related decisions.

Table 2:
Cape Dorset, N.W.T. Deconstruction Project Case Study Productivity Rates

			Disassembly		Processing		Total	
Building Component[a]	Quantity	Unit	Man Hours[b]	Sqft./Man Hour	Man Hours[b]	Sqft./Man Hour	Man Hours[b]	Sqft./Man Hour
Total Project	1,100	sqft.	141	7.80	135	8 15	276	3.99

[a] The building was a wood framed single family dwelling resting on wood pads on grade (due to perma-frost)
[b] The building was deconstructed entirely by hand without the use of power tools or heavy machinery

3.1.5 Labour Rates

Due to the fact that deconstruction is often labour intensive, labour rates play a key role in assessing economic feasibility. It should be realized however that the increased need for manual labour does (to some degree and in some cases) reduce the need for heavy equipment operators

If the knowledge is not possessed in-house, the following sources can be consulted to determine the labour rates for any given crew:

- ❑ Employment office.
- ❑ Trade associations.
- ❑ Renovation and demolition contractors.

ACTION:
Estimate labour costs as well as any savings from reduced machine hours.

- Industry costing tools such as R.S. Means Building Construction Cost Data and Yardstick.

To provide **example** of the prevailing national labour rates for general construction and demolition labourers, the following figures are gathered from Human Resources and Development Canada, current to October, 1998.[16] Certain listings did not have provincial averages. For these cases, the labour rates are listed for the cities bracketed. This data should not be used in isolation, nor should it be relied upon to form the basis of any project-related decisions.

Table 3:
National Labour Rates

PROVINCE	LABOUR RATE UNION ($ low - high/hour)	LABOUR RATE NON-UNION ($ low - high/hour)
Alberta/Northwest Territories	n/a	9 50 - 12.75
British Columbia/Yukon	10.00 - 20 00	7.00 - 14.00
Manitoba (Winnipeg)	11.50 - 24 24	8.00 - 15.00
Newfoundland[a] (St John's)	11 65 - 13 57	10.40 - 11.80
New Brunswick (Moncton)	n/a	5.50 - 17.50
Nova Scotia (Halifax)	9 73 - 21 36	5 50 - 19.00
Ontario (Ottawa)	21 30 - 27 61	7.50 - 16 00
Prince Edward Island	13 27 - 15 30	7.50 - 11.00
Quebec (Quebec City)	7.00 - 20 00	n/a
Saskatchewan (Regina)	n/a	10 00 - 17.83

[a] Closest occupational wage rate listed was for carpenters.

From the figures it is evident that wage rates vary from region to region. What is worth noting is the potential implication of union employees on the economic feasibility of deconstruction.

To provide an **example** of the type of information currently available in industry costing tools, the following data is taken from the "Selective Demolition" section of R.S. Means Building Construction Cost Data.[17] Note that all costs are in U.S. dollars. This data should not be used in isolation, nor should it be relied upon to form the basis of any project-related decisions. Project managers are encouraged to consult the source for further context, information and instructions on its use.

Table 4:
R.S. Means Selective Demolition Labour Rates

	BARE COSTS		COST PER LABOUR - HOUR	
CREW	**HOUR**	**DAILY**	**BARE COSTS**	**INCL. O&P[a]**
1 Labour Foreman	$22.65	$181 20	$21 41	$33.49
2 Labourers	$20.65	$330 40		
1 Truck Driver (heavy)	$21 70	$173.60		
1 Dump Truck (16 ton)		$431 50	$13 48	$14 83
32 Labour Hours Daily Totals		$1116 70	$34 89	$48.32

[a] Denotes Overhead and Profit.

3.1.6 Processing and Storage

Often materials salvaged from buildings must in some way be processed in order to be marketed. Examples of processing procedures include: de-nailing; stripping adhesives, paints or coverings; separating re-bar from concrete; crushing masonry and concrete; grinding wood; separating mortar from masonry etc.[18] During the materials inventory it is important to take note of what materials will require processing.

Often materials cannot be marketed immediately upon salvage but must be stored for a period of time until a buyer is found.[19] In order to properly determine economic feasibility, storage requirements should be anticipated as best possible. The site logistics will play a large part in determining storage requirements. For example, if the site is small and/or located in an urban setting, on-site storage of materials may not be possible.

ACTION:
Based on the examination conducted during the inventory of materials, determined labour rates, and the site logistics, estimate processing and storage costs.

Examples of temporary storage facilities include:

- ❑ Adjacent lots.
- ❑ Vacant properties (lots and buildings).
- ❑ Storage rental facilities.
- ❑ Company yards.
- ❑ Rural properties.

3.1.7 Transport and Disposal

In order to assess the economic feasibility it is important to know whether any transport and disposal costs savings will result from the salvage and sale of materials. Based on the total quantity of materials for the project and the quantity of salvageable materials (and the proximity of identified markets) it is possible to estimate the total traditional transport and disposal costs versus deconstruction transport and disposal costs.

Sources of transport and disposal costing information include:

- ❑ Reuse and recycling facilities.
- ❑ Landfills.
- ❑ Waste management companies and haulers.
- ❑ Municipal solid waste management departments.

it is important to also determine whether deconstruction will result in any increase in the cost of transport as a result of additional shipping to storage facilities.

ACTION:
Estimate the transport and disposal savings (if any) realized as a result of material salvage and the additional cost of transport to storage facilities

3.1.8 Schematic Cost Analysis

Based on each of the described variables the following is an **example** of how a schematic cost analysis could be performed to help assess the economic feasibility of the project. Note that this should not be considered a detailed cost-benefit analysis of all aspects of any given project, but rather an assessment of the variables which are unique to and affect the deconstruction process. In simplistic terms, if the result is *positive*, the project may be economically feasible.

Essentially, the task is to determine whether the revenue from sold materials coupled with the machine, transport and disposal savings (if any) can offset the increased labour, processing, transport, and storage costs.

Table 5:
Schematic Cost Formula

(VALUE OF SALVAGED MATERIAL + MACHINE HOURS SAVINGS + TRANSPORT & DISPOSAL SAVINGS)
-
(LABOUR + PROCESSING + TRANSPORT TO STORAGE FACILITIES + STORAGE)
=
?

It should also be stated here that an alternative method of determining economic feasibility would be to cost the job based on traditional demolition methods (may include some degree of salvage) and disposal practices and compare that to the total cost of the project using deconstruction methods.

3.2 PLANNING

The success of deconstruction relies heavily on the effort spent during the planning stage leading up to work on site. To achieve optimum salvage of materials, project managers should prepare by carefully assessing each building and its site.[20] A thorough investigation to determine the disassembly, storage and marketing logistics should be done to make informed choices about where and how salvage efforts should be concentrated.

3.2.1 Degree of Implementation

Prior to the start of work the degree to which deconstruction will be implemented on the project (i.e. total or partial) should be determined.[21] Factors which will influence this decision include (not listed in any particular order):

- ❑ Time available.
- ❑ Labour, transport and disposal costs.
- ❑ Degree of hazardous material contamination.
- ❑ Quantity, condition and value of salvageable materials.
- ❑ Type and size of the building(s).
- ❑ Site logistics (i.e. processing and storage space).
- ❑ Experience of available labour.
- ❑ Room for the operation of machinery.
- ❑ Status and proximity of reuse and recycling markets.
- ❑ Client demands.
- ❑ Project specifications.

3.2.2 Making the Time

Salvaging materials for reuse and/or recycling necessitates longer project durations.[22] Wherever possible adequate time should be allocated to carefully disassemble, process, stockpile, and identify markets for materials. Mechanisms available to help ensure larger windows of time for deconstruction can include:[23]

- ❑ Convincing the owner of the cost-effectiveness and environmental benefits so they advocate deconstruction techniques.
- ❑ Introducing deconstruction concept early in the project planning to get all contractors and consultants on-side.
- ❑ Phasing the project to allow for deconstruction without compromising the overall schedule.
- ❑ Being sensitive to the fact that warmer weather enhances the salvage of materials in good condition.

It should be kept in mind that deconstruction time lines are sometimes difficult to predict. Deconstruction can take two to ten times longer than traditional demolition.[24] Unanticipated material assemblies, difficult material connections, and undeveloped reuse and recycling markets can all lead to delays.

3.2.3 Required Skill Sets

It is beneficial to have the right blend of skill sets on site during a deconstruction project. Having the following workers on site will help ensure that project schedules are maintained and that materials are salvaged in a condition which preserves their estimated value.[25]

- ❑ Site supervisor with construction and deconstruction experience.
- ❑ Trades (i.e. carpenter, electrician, plumber) with construction and deconstruction experience.
- ❑ Skilled machine operators with construction and deconstruction experience.

3.2.4 Workforce Training and Commitment

If deconstruction is new to the workforce it is important that they are thoroughly briefed on the process. This is most effective if it is done prior to the workforce arriving on site. If this is not possible, training should take place at a job-start session before work begins. Items to address during the briefing or job-start session can include:

- ❑ Introducing individuals in charge and those who workers should speak to regarding any problems or questions.
- ❑ Identifying locations of all activities (i.e. processing and storage).
- ❑ Outlining the responsibilities of each subcontractor.
- ❑ Clearly stating the reuse and recycling goals of the project.
- ❑ Describing the deconstruction process if workers have no previous experience.
- ❑ Touring the site to identify salvage priorities.

Labourers without experience may, in some cases, have some trouble adapting their methods to techniques suitable for salvaging materials. For this reason it is beneficial to have personnel on site with deconstruction experience who can demonstrate techniques to workers unsure of how to disassemble certain assemblies or equipment.[26]

It does take time to change pre-conceived notions of the value of used building materials. Through training and demonstration, workers new to deconstruction can be exposed to the benefits of deconstruction. Over time the effort spent to educate the workforce may contribute to the cost-effectiveness of projects in the long run.[27]

3.2.5 Permits and Regulatory Compliance

Deconstruction requires proper permits and compliance with all applicable regulations. To ensure regulatory compliance, research should be done into which municipal and provincial regulations and guidelines apply to deconstruction activity. For reference, the following is a list of current federal legislation which applies to the process:[28]

- ❑ Canadian Environmental Protection Act.
- ❑ Canadian Environmental Assessment Act.
- ❑ Workers Compensation Act.
- ❑ Transportation of Dangerous Goods Act.
- ❑ Motor Vehicle Safety Act.

The following permits and approvals should be obtained during the planning stage of a deconstruction project:[29]

- ❑ Demolition permit (municipalities do not typically distinguish between deconstruction and demolition for permitting purposes).
- ❑ Hazardous waste related abatement, transport and disposal permits from appropriate federal and/or provincial Ministry authorities and Workplace Safety and Insurance Board.
- ❑ Utility and service shut-off locations/approval.
- ❑ Required inspections by municipal officials and utility companies.

3.2.6 Hazardous Materials

Where possible, all hazardous materials should be identified, properly removed and disposed of by qualified persons prior to the start of any work on site.[30] The necessary steps for compliance with the above stated legislation as well as any municipal and provincial regulations and guidelines should be thoroughly researched during planning.

3.2.6.1 Identification

Testing for and identification of hazardous materials should precede all deconstruction work.[31] Appropriate measures should be taken to identify all substances designated to be hazardous by regulatory bodies with proper authority (see Appendix A for a listing of provincial authorities).

Lists of substances designated to be hazardous should be obtained from the authorities having appropriate jurisdiction. To provide example, substances commonly encountered during deconstruction which typically require special removal, handling and disposal procedures include:[32]

- ❑ Asbestos based materials.
- ❑ Materials with lead content.

- ❑ Flourescent light ballasts manufactured prior to 1978 containing polychlorinated biphenyls (PCBs).
- ❑ Electrical transformers containing PCBs.
- ❑ Flourescent lamps containing mercury.
- ❑ Thermostats containing mercury.
- ❑ Heating and refrigerant equipment containing chlorofluorocarbons (CFCs).
- ❑ Fire protection system equipment containing ozone depleting substances.

Mold found on materials exposed to moisture is also increasingly being recognized as a threat to worker health and safety. Guidelines suggest that if large amounts of mold (bacteria and/or fungi) are found on site, workers should wear HEPA filters in full face masks. When black or dark grey mold is found on drywall or other cellulose materials, workers should also use disposable Tyvek® suits, plus vinyl or rubber gloves under their construction gloves.

Other areas of potential concern on deconstruction projects include:[33]

- ❑ Underground storage tank removal.
- ❑ Toxic spill containment.
- ❑ Contaminated site remediation.
- ❑ Toxic emission levels.
- ❑ Wastewater treatment.

3.2.6.2 Handling, Treatment and Disposal

Guidelines for the handling, treatment and disposal of hazardous wastes should be obtained from regulatory bodies with proper authority prior to the start of any work. To provide example, the following are general points which typically require consideration:[34]

- ❑ All parties involved in the removal, hauling or disposal of hazardous wastes should possess all required permits and Certificates of Approval.
- ❑ All parties responsible for hazardous waste management must fulfill all regulatory reporting and manifest requirements.
- ❑ If hazardous wastes are encountered unexpectedly during the course of work, workers should be instructed to cease working, take precautionary measures necessary, and notify the proper authorities for instruction on how to proceed.

3.2.7 Promotion and Marketing

Depending on the status of local markets, the success of deconstruction can largely depend on the promotion and marketing strategies used to sell the salvaged materials. In addition to sourcing out established reuse and recycling facilities, the following are further strategies to help market materials:[35]

- ❑ Contact media to gain coverage and create an awareness of the project and availability of materials.
- ❑ Contact local officials as a vehicle of communication to citizens of the municipality.
- ❑ Contact construction and home builders' associations as a vehicle of communication to renovation contractors.
- ❑ Advertise sale of materials in community papers.
- ❑ Designate an area of the site to display salvaged materials and encourage public visitation during designated hours (ensure proper safety procedures are in place and be aware of all associated liability issues).

3.2.8 Creating an On-Site Strategy

As a final step in planning for deconstruction it is beneficial to create a strategy to prepare for all aspects of the work on site. An on-site strategy would typically include the following items (not listed in any particular order):[36]

- ❑ Creation of site log, material tracking forms, worker time sheets, and productivity charts. (See Appendix B for samples)
- ❑ Creation of a project schedule.
- ❑ Assembly of a competent and willing workforce.
- ❑ Sequencing material removal and dismantling.
- ❑ Allocation of machines and manpower.
- ❑ Coordination of subcontractors.
- ❑ Development of job-start training session for labourers and subcontractors unfamiliar with the deconstruction process.
- ❑ Material storage and site sale logistics preparation.
- ❑ Bin locations and hauling schedule.
- ❑ Setting goals with respect to landfill diversion (i.e. % reuse, % recycling).
- ❑ Photographing building(s).
- ❑ Posting of a site plan, which details the location of all activities (i.e. processing, storage, site sale, bin locations etc.)

4.0 ON-SITE

4.1 THE PROCESS

The process of deconstruction is, essentially, the reverse of construction. Once equipment, finishes and furnishings have been removed deconstruction typically begins on the roof and proceeds downward to the foundation.[37] With careful attention paid to connections and assemblies, the building is disassembled in a manner which minimizes damage to materials and equipment, thus permitting maximum salvage.

4.1.1 Tools

Like construction, the use of proper tools is important. The disassembly of certain components often requires an element of brute force, but the right tools can make all the difference. The following is a recommended check-list of deconstruction tools:[38]

- ❑ hard hats
- ❑ dust masks
- ❑ duct tape
- ❑ work boots
- ❑ spray paint
- ❑ barricades
- ❑ pry-bars
- ❑ reciprocating saws
- ❑ flagging tape
- ❑ wire
- ❑ step-ladders
- ❑ generator
- ❑ chain saw
- ❑ cordless drills
- ❑ extension cords
- ❑ flat-bars
- ❑ hammers
- ❑ sledge hammers
- ❑ gloves
- ❑ fall protection
- ❑ wire cutters
- ❑ wrenches
- ❑ screw drivers
- ❑ nail pullers
- ❑ circular saws
- ❑ scaffolding
- ❑ hack saws

4.1.2 Disassembly

The intent of deconstruction is to employ disassembly techniques which will allow for the salvage of materials in the best condition possible. With a firm understanding of what materials and equipment are worth salvaging, the skills possessed by the workforce should be properly utilized. For example, those with carpentry experience would concentrate on finishes and millwork, whereas those with plumbing experience would focus on the dismantling of mechanical fixtures.[39]

Throughout the course of deconstruction it is important to pay close attention to connections and material assemblies and employ workmanship procedures which minimize damage to materials and equipment, thus permitting maximum salvage.

Although no formal procedures or standards presently exist for structural disassembly, the sequence must be such that the collapse of the structure is prevented and all workers must be aware of critical supports, both existing and temporary. For safety, it may be necessary to clearly identify the specific locations (beforehand) where temporary supports are required.[40]

The following can be considered a schematic sequence of disassembly applicable to most residential deconstruction projects:[41]

- ❑ Disconnection of all utilities (i.e. gas, hydro, cable, telephone, water etc.)
- ❑ Removal and disposal of all hazardous wastes.
- ❑ Systematic removal of all interior and exterior finishes, insulations, furnishings, and mechanical and electrical equipment.
- ❑ Careful removal of all windows and doors (this may be done later if project is done during cold weather).
- ❑ Disassembly of all non-loadbearing interior partitions and removal of materials from the structure.
- ❑ Disassembly (in sequence) of: roof, interior loadbearing partitions, exterior walls, floors, and foundation.

Other considerations to keep in mind during disassembly include:

- ❑ Wherever possible, material assemblies should be transferred from heights to the ground where they can be more easily disassembled.
- ❑ Materials designated for salvage should be separated from the waste stream.

4.1.3 Processing

Processing is an important step in material salvage. Wherever possible adequate and readily accessible space on site should be allocated to properly process materials. The size of the site and the building's proximity to property lines, pedestrian and vehicle traffic and adjacent buildings will all play a role in determining processing logistics.

The following are considerations to keep in mind when determining processing logistics:[42]

- ❑ Determination (beforehand) of which materials will require on site processing.
- ❑ Designation of a convenient location for the processing of materials which eliminates double handling and provides adequate space to maintain an efficient flow of materials.
- ❑ Supply of separate, clearly marked disposal bins for all categories of recyclable materials.
- ❑ De-nailing, stripping, separating, (etc.) materials in a manner which ensures best possible condition of salvaged materials.

- ❑ Keeping processing area clean and free of excess debris at all times to avoid confusion, minimize waste and ensure worker safety.
- ❑ Separating processed materials into organized piles for storage.
- ❑ Providing collection area for all processed materials.
- ❑ Piling materials on pallets to facilitate transport off-site or to storage area(s).

4.1.4 Flow of Materials

The efficiency of the deconstruction process depends on a good flow of materials through disassembly and processing.[43] Whether materials are sold on site or transported elsewhere, consideration must be given to the logistics involved in handling and stockpiling. Adequate resources should be expended to maintain a clean, organized site. Depending on the size of the project, it may be beneficial to post a site plan and signs which indicate to workers, haulers and the public the location of such things as processing, stockpiling of each material, waste containers, and the site sale.

4.1.5 Storage and Transport

Proper storage will help maintain the value of salvaged materials. Sites with storage space restrictions will require project managers to coordinate storage and hauling more carefully than if the site is a large, unrestricted property. Depending on the specifics of the project, a full-time attendant may be required to sell materials, monitor visits by the public and coordinate storage and transport (if this is the case, it should be considered as a cost when performing the economic feasibility assessment).

The following are considerations to keep in mind when determining storage and transport logistics:[44]

- ❑ Clearly labeling all stockpiles, indicating material type and quantity.
- ❑ Designating appropriate security resources/measures to prevent vandalism, damage and theft.
- ❑ Stockpiling materials in a location which will eliminate double handling.
- ❑ Stockpiling salvaged materials in a location which will facilitate removal from site, examination by potential end markets, and which does not impede disassembly, processing, or hauling procedures.
- ❑ All salvaged materials should be transported by reputable haulers to approved reuse and recycling facilities.

4.2 PROJECT MANAGEMENT

Like any successful undertaking, the deconstruction process benefits from strong project management. Due to the commitment required by the entire workforce to salvage materials in good condition, proper flexibility, innovation, communication, safety, and supervision are all intricate elements of residential deconstruction project management.

4.2.1 Flexibility and Innovation

Flexibility should be maintained in the day to day operations of a deconstruction site. Unanticipated material assemblies and connections are commonplace in many older buildings. Project managers must understand that there are currently few precedents, and as a result the process is continually being developed. Innovative thinking has proven, to date, to go a long way on deconstruction projects.[45]

4.2.2 Communication

Depending on the specifics of the project and site, project managers should spend time at the start of a project to explain site logistics, dismantling techniques and to instill the fact that the value of material depends greatly on the condition in which it is salvaged.

The success of deconstruction relies on the maintenance of open lines of communication.[46] Project managers should be aware of the importance of communication with the workers and subcontractors. Large projects will likely require regular meetings. Part of clear communication and delegation may also require the development of agreements or contracts which specifically outline the responsibilities of all involved parties (see sample agreement in Appendix C).

Make sure language is not a barrier. When necessary, ensure that a member of the project management team is able to speak and write in both official languages. The local authorities should be consulted to ensure that all signage requirements are fulfilled. Depending on the size of the project, managers may also want to post signs to indicate the location of activities on site. It is important that the entire workforce, and perhaps the public, are able to read these signs. This may mean posting them in both official languages.

4.2.3 Workforce Supervision

The supervision that is required will depend largely on the experience the workforce possesses. In addition, the commitment of the workforce to the process will also be a measure of the amount of supervision which is required. Experience indicates that to ensure the salvage of materials in good condition, adequate resources should be allocated to on-site supervision.[47]

4.2.4 Health and Safety

Due to the fact that deconstruction can be labour-intensive, the potential for injury should be taken seriously.[48] To help ensure the well-being of workers, project managers must be familiar with and enforce the following organizations' health and safety procedures, guidelines and regulations on deconstruction projects:

- ❑ Workplace Safety and Insurance Board.
- ❑ Ministry of Labour.
- ❑ Trade unions and associations.
- ❑ Professional associations.
- ❑ Construction and demolition associations.
- ❑ Financial lending institutions and bonding companies.

4.2.5 On-Site Sale of Materials

Selling materials on site is an excellent way to generate revenues but requires planning and coordination. The location of the sale must be such that it does not interfere with the deconstruction activities, nor does it endanger the safety of the visiting public. This may require the erection of temporary fencing or barricades and the posting of signage indicating areas of restricted access.

Prior to making the building materials available for public sale, every effort should be made to ensure they do not contain hazardous substances. To provide an example, doors removed from older buildings may contain a layer of lead-based paint. In all cases, the public should be made explicitly aware that certain types of materials may possess harmful substances.

Depending on the size of the project and the volume of materials being sold, it may be necessary to appoint an attendant to deal with the on-site sale logistics. The sale will have a better chance of going smoothly if the following logistics are all resolved before the project starts:[49]

- ❑ Coordination of material storage and display.
- ❑ Security.
- ❑ Advertising.
- ❑ Pricing.
- ❑ Liability and insurance coverage.
- ❑ Addressing public inquiries.
- ❑ Retailing materials.
- ❑ Delivery.
- ❑ Documenting sales transactions.

To facilitate organization, the sale of materials should be restricted to times which are convenient and do not interfere with deconstruction. For example, public admittance could be limited to afternoons during the week and all day on weekends. Alternatively, if the site is large enough, an area could be secured and designated as a "show room" for the materials.

Project managers should also give consideration to the security aspects involved in stockpiling materials. Depending on the location and value of the materials, it may be necessary to post a guard during the evenings for the duration of the project.

4.2.6 Material Tracking

Each deconstruction will elicit results which can be analyzed for use when preparing for subsequent projects. By keeping track of information such as the status of markets, the reuse and recycling value of materials, and labour productivity, project managers will eventually be able to develop reliable operational standards which can be used to cost, schedule and forecast.[50] An understanding of the process and the capabilities of the workforce will also give project managers a competitive edge when bidding projects.

Please see Appendix B for samples of documentation which can help to keep track of valuable deconstruction project information.

5.0 POST PROJECT

5.1 POST PROJECT MEETING

To review performance it is beneficial to conduct a meeting immediately after the project has been completed.[52] All personnel who were involved in project management related aspects of the project should be required to attend. Key participants would include: client, project managers (architect, engineer, interior designer, general contractor), site supervisor, and waste management company representatives. Topics of discussion should address (but not be limited to) the following issues:

- ❑ A review of the reuse and recycling performance results.
- ❑ The successes and failures of the approaches undertaken.
- ❑ Addressing any concerns regarding on-site logistics, workmanship, communication, and contractual issues.
- ❑ The capabilities of local reuse and recycling markets.
- ❑ The economic viability of the deconstruction strategies employed.

5.2 CONTINUAL IMPROVEMENT

It is important to strive for continual improvement on each project. Continual improvement relies on dedication to the following four steps:[51]

- ❑ Plan.
- ❑ Implement.
- ❑ Check.
- ❑ Review.

5.2.1 Post Project Analysis

It is essential to analyze the performance and results of every project to gain a firm sense of what initiatives taken were effective and which were unrealistic. Consider the following items to help ensure continual improvement.

- ❑ Examination of the results to acquire a better understanding of the capabilities of local markets and the value of materials.
- ❑ Performance of a rough cost-benefit analysis to determine anticipated cost projections versus actual costs.
- ❑ Review of site logs to determine the difficulties and achievements encountered throughout the project.
- ❑ Assessment of labour productivity for disassembly and processing to incorporate results into similar, subsequent projects.

- ❑ Keeping a database of useful contacts and information acquired throughout the project.
- ❑ Creation of rules of thumb for use on future projects.
- ❑ Making note of what worked and what did not work for reference on future projects.

6.0 LOOKING AHEAD

6.1 APPLYING THE LESSONS LEARNED

It is important to view each deconstruction project as a learning experience. Proper post-project analysis will allow for an evaluation of the successes and failures. Each material salvage strategy will elicit valuable results which can be applied to subsequent projects. It is important to review the progress made throughout each project. Becoming aware of what is feasible and what is not will eliminate repetition of mistakes and allow for the development of a practical and effective deconstruction process.

From the lessons learned and post-project analysis the next step is to develop a strategy which suits the needs of specific operations, workforce, regulatory structure, and market status. It is important to keep in mind that factors such as market status, value of materials and labour rates are variable. To maintain an effective strategy, effort must be made during the planning stages of each project to assess how each variable affects the project in question.

6.2 SPREADING THE WORD

One way to help ensure that deconstruction is a viable process is to spread the word throughout the local industry about its potential to elicit economic and environmental benefits.[53] This can be accomplished, in part, by encouraging industry members to get the facts and figures surrounding past case studies. Deconstruction projects that have proven to be economically viable are motivational "how-to" examples of the process.

Techniques to spread the word include:

- ❑ Media exposure of projects.
- ❑ Publication of articles and case studies in industry journals, newsletters and Internet sites.
- ❑ Formal recognition by trade and professional associations.
- ❑ Word of mouth on job sites and during site meetings.
- ❑ Project specifications and contracts.

The markets for reusable and recyclable materials depend on supply and demand.[54] Often the supply outweighs the demand, weakening the infrastructure. Promoting the existence and availability of deconstruction and used building materials can go a long way towards strengthening the markets and sustaining this environmentally responsible demolition process.

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26. Cape Dorset, NWT Deconstruction Project Case Study, by dEsign consultants, 1997, page 5.

27. Ibid.

28. "Deconstruction of Structures", National Master Specification, 1998.

29. Cape Dorset, NWT Deconstruction Project Case Study, by dEsign consultants, 1997, page 3.

30. "The Construction, Renovation and Demolition Resource Management Training Course", The Environmental Management Institute, April 1998 Draft, page 7.

31. Deconstruction - Building Disassembly and Material Salvage: The Riverdale Case Study, NAHB Research Center Inc., 1997, page 3.

32. "The Construction, Renovation and Demolition Resource Management Training Course", The Environmental Management Institute, April 1998 Draft, page 8.

33. Demolition and Salvage: A Guide for Developers & Renovators. Greater Vancouver Regional District. 1998, page 10.

34. "The Construction, Renovation and Demolition Resource Management Training Course", The Environmental Management Institute, April 1998 Draft, page 9.

35. Ninety Percent Diversion of Demolition Wastes: Defence Construction Canada's Harvey Barracks Decommissioning, Alberta Environmental Protection, 1998, page 3.

36. Ibid, page 4.

37. Building for the Future: Strategies to Reduce Construction and Demolition Waste in Municipal Projects, Inform, 1998, page 49.

38. Cape Dorset, NWT Deconstruction Project Case Study, by dEsign consultants, 1997, page 6.

39. Ibid.

40. Demolition Contractors Manage and Dispose of Waste Responsibly, The National Association of Demolition Contractors, 1995, page 4.

41. "Deconstruction of Structures", National Master Specification, 1998.

42. Ibid.

43. "Difficult Logistics lead to an Environmental Solution", Case Study, King County Solid Waste Division, April 14, 1998.

44. "Deconstruction of Structures", National Master Specification, 1998.

45. "Flexibility Saves $6,500", Case Study, King County Solid Waste Division, August 13, 1997.

46. "Turning Waste Into Profit", Constructor, September 1994, page 46.

47. Cape Dorset, NWT Deconstruction Project Case Study, by dEsign consultants, 1997, page 7.

48. "Demolition Materials Diversion Symposium Summary Report", Demolition Materials Diversion Symposium Steering Committee, BC Environment, May 1998, page 10.

49. Cape Dorset, NWT Deconstruction Project Case Study, by dEsign consultants, 1997, page 9.

50. Deconstruction - Building Disassembly and Material Salvage: The Riverdale Case Study, NAHB Research Center Inc., 1997, page 5.

51. "The Construction, Renovation and Demolition Resource Management Training Course", The Environmental Management Institute, April 1998 Draft, page 15.

52. "Administrative, Temporary and Procedural Requirements for Deconstruction of Structures", National Master Specification, 1998.

53. "Difficult Logistics lead to an Environmental Solution", Case Study, King County Solid Waste Division, April 14, 1998.

54. "Demolition Materials Diversion Symposium Summary Report", Demolition Materials Diversion Symposium Steering Committee, BC Environment, May 1998, page 22.

APPENDIX A: HAZARDOUS WASTE AUTHORITIES

Alberta

Alberta Environmental Protection
Petroleum Plaza, South Tower
9915 - 108th Street
Edmonton, AB
T5K 2G8
(403) 427-2739

Alberta Special Waste Management Corporation
Pacific Plaza, Suite 610
10909 Jasper Avenue NW
Edmonton, AB
T5J 3L9
(403) 422-5029

British Columbia

Ministry of Environment Lands and Parks
810 Blanshard Street, 4th Floor
Victoria, BC
V8V 1X4
(604) 387-1161

Waste Reduction Commission Soils and Hazardous Waste
770 South Pacific Blvd., Suite 303
Vancouver, BC
V6B 5E7
(604) 660-9550

Manitoba

Manitoba Environment
Building 2, 139 Tuxedo Avenue
Winnipeg, MB
R3N 0H6
(204) 945-7100

The Clean Environment Commission
284 Reimer Avenue Box 21420
Steinback, MB
R0A 2T3
(204) 326-2395

New Brunswick

Department of the Environment
364 Argyle Street, Box 6000
Fredericton, NB
E3B 5H1
(506) 453-3700

Newfoundland

Department of Environment
Confederation Building, Box 8700
St. John's, NF
A1B 4J6
(709) 729-2664

Northwest Territories

Department of Renewable Resources, Wildlife and Economic Development
Scotia Centre Building, Box 215102
50th Avenue
Yellowknife, NT
X1A 3S8

Nova Scotia

Department of the Environment
5151Terminal Road, 5th floor Box 2107
Halifax, NS
B3J 3B7
(902) 424-5300

Ontario

Ministry of Environment and Energy
135 St. Clair Avenue West
Toronto, ON
M4V 1P5
(416) 323-4321

Prince Edward Island

Department of Environmental
Resources
11 Kent Street, 4th Floor, PO Box 2000
Charlottetown, PE
C1A 7N8
(902) 368-5000

Quebec

Ministère de l'Environnement et de la
Faune
150 boul. René-Lévesque
Québec, QC
G1R 4Y1
(418) 643-3127

Commission de la Santé et de la
Securité au Travail
730 boul. Charest Est
Québec, QC
G1K 7S6
(418) 643-5850

Saskatchewan

Saskatchewan Environment and
Resource Management
3211Albert Street
Regina,SK
S4S 5W6
(306) 787-2700

Yukon

Yukon Renewable Resources
PO Box 2703
Whitehorse, YT
Y1A 2C6
(403) 667-5683

APPENDIX B: TRACKING SAMPLES

SAMPLE

DAILY JOB-SITE LOG

DATE: _____

WEATHER: _____

TEMPERATURE: _____

PRESENT ON SITE: _____

_____

STAGE OF DECONSTRUCTION: _____

_____

TODAY'S PRODUCTION GOALS: _____

_____

SCHEDULED MEETINGS & APPOINTMENTS: _____

_____

_____

STATUS OF WASTE DIVERSION: _____

_____

_____

PROBLEMS/DELAYS: _____

_____

COMMENTS: _____

_____

INITIAL: _____

SAMPLE

SAMPLE
TIMESHEET

NAME:

DATE	TASK	# HOURS

USED BUILDING MATERIAL RECEIPT
SAMPLE

DATE	
TIME	
MATERIAL(S)	
QUANTITY(S)	
RECIPIENT	
SIGNATURE	
REVENUE/COST	
AUTHORIZATION:	
	Receipt Number:

WASTE REPORT
SAMPLE

DATE	
TIME	
MATERIAL(S)	
QUANTITY(S)	
VEHICLE #	
DESTINATION	
HAULER'S NAME:	
	Report Number:

SAMPLE PRODUCTIVITY TRACKING RECORD

EXTERIOR WALL SYSTEMS

QUANTITY	UNIT	TIME START DISASSEMBLY	TIME END DISASSEMBLY	# OF WORKERS	LABOUR HOURS/UNIT	TIME START PROCESSING	TIME END PROCESSING	# OF WORKERS	LABOUR HOURS/UNIT	TOTAL LABOUR HOURS/UNIT

NOTES & ASSEMBLY SPECIFICS:

INTERIOR PARTITIONS

QUANTITY	UNIT	TIME START DISASSEMBLY	TIME END DISASSEMBLY	# OF WORKERS	LABOUR HOURS/UNIT	TIME START PROCESSING	TIME END PROCESSING	# OF WORKERS	LABOUR HOURS/UNIT	TOTAL LABOUR HOURS/UNIT

NOTES & ASSEMBLY SPECIFICS:

APPENDIX C: SAMPLE WASTE REDUCTION AGREEMENT

SAMPLE WASTE REDUCTION AGREEMENT

This Waste Reduction Agreement shall be recognized on _____day of _____ , 19 ____ by and between

Company Name_____
Address_____
Phone / Fax_____
(hereinafter called the *General Contractor*)

and

Company Name_____
Address_____
Phone / Fax_____
(hereinafter called the *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler*)

The *General Contractor* will have entered into an agreement (hereinafter called the *Prime Contract*) dated the _____ day of _____ , 19 ____ with _____
_____
hereinafter called the *Owner* for the deconstruction of _____
_____
hereinafter called the *Project*. The *General Contractor* appointed _____, hereinafter called the *Consultant* as an agent of the *General Contractor*. The *Prime Contract* includes the work to be performed under this Waste Reduction Agreement.

The *General Contractor* appointed _____ , a qualified individual hereinafter called the *Waste Management Coordinator*.

1

SAMPLE WASTE REDUCTION AGREEMENT

The *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler*, in carrying out the work of the project, agrees to the following terms:

1) Workmanship shall adhere to all conditions of the Waste Reduction Workplan as prepared by the *General Contractor* in cooperation with the *Consultant*.

2) The *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler* appoints _____ _____, who will report to the *Waste Management Coordinator* and who shall report to the job site meetings on all matters concerning waste reduction activity where all related problems will be discussed and resolved.

3) The *Waste Management Coordinator* will communicate to the *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler* workforce the correct procedures for waste reduction and will clearly mark all bins as outlined under term number one above.

4) The *Waste Management Coordinator* will communicate any problems, difficulties or alternatives to carrying out the work under this agreement to the *Client* and *Consultant* immediately. All alternatives will require the consent and approval of the *Client* and *Consultant*.

5) The *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler* will assure that waste materials are placed in the properly marked bins. In the event that this term is not met, the *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler* will correct the situation at their own expense.

6) The *Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler* agrees to be bound by all terms and conditions, specifications and drawings in the *Prime Contract* between the *Owner* and the *General Contractor*.

2

SAMPLE WASTE REDUCTION AGREEMENT

IN WITNESS WHEREOF the parties hereto have executed this Agreement under their respective corporate seals and by the hands of their proper officers hereunto duly authorized.

SIGNED, SEALED AND DELIVERED

General Contractor	*Subcontractor* **OR** *Salvage Dealer* **OR** *Recycler*
Name	Name
Title	Title
Signature	Signature
Witness	*Witness*
Name	Name
Title	Title
Signature	Signature

SAMPLE

3

FINAL REPORT REVIEW

Principal Investigator: Derek Badger

Project Officer: Darrel Smith

I have evaluated the final report received from the above-mentioned principal investigator:

[x] it is acceptable and no changes are required.

[ ] it is not acceptable, and required changes have been communicated to the principal investigator (see file).

Completion of this sheet and evaluation form will be carried out following submission of a revised final report by the principal investigator.

Completed Reports

1. The principal investigator has submitted a suitable abstract.

   [x] yes (see Executive Summary in report) [ ] no

2. The principal investigator has submitted necessary invoice and statement of expenses associated with the release of final payment on the agreement.

   [x] yes (see file) [ ] no

3. I have completed a one-page summary of the project.

   [ ] yes (see attached) [x] no Refer to the Executive Summary in the report

4. I have completed the Sector Management's evaluation form.

   [x] yes (see attached) [ ] no

5. I authorize final payment of $5,500.00 based upon the principal investigator's invoice and the agreement.

   February 26, 1999 (signature)
   (date)

Comments

This consultant has taken this work very seriously throughout the project and was very conscientious of meeting the schedule. The report is well written and presented.

° A Research & Development Highlight is warranted on this research report (These appear in both languages).

Yes No x

° I anticipate a significant demand for this report and recommend translation of this report.

Yes No x

Research highlight may suffice unless there is demand once highlight is available

° This report has the potential to become a CMHC publication.

Yes No x (The information in the report will be used in new and revised publications where applicable. It will also be available in a Construction, Renovation and Demolition Resource/Waste Management Course which is currently under development.)

° This research report has a regional focus.

| x | no | | Atlantic | | Quebec | | Ontario

| | B.C. | | Prairies | | Y. & NWT | | Other

° The quality of the final report is:

| | excellent | x | good | | average

| | poor | | very poor

Additional comments, identification of potential audiences for publications, recommendations for distribution: The consultant is well tapped into this industry and will be promoting the research. Copies can be distributed through CHIC.

CR FILE NO. : 6585-B125

EVALUATION OF RESEARCH PROJECTS AND CONTRACTOR PERFORMANCE

CIDN NO.: 2022 0200001

DIVISION: Research

PROJECT TITLE: Residential Construction Manual (final title) Standardizing the Process of Residential Deconstruction (initial title)

PROJECT OFFICER: Darrel Smith, Research

CONTRACTOR: Derek Badger

CONTRACT AMOUNT: 19 500,00$

FINAL PAYMENT AMOUNT: 5 500.00 $

A. EVALUATION OF FINAL OUTPUT

Project objectives: The objective of this research was to produce a useful and practical reference handbook for project managers considering deconstruction as an alternative to traditional renovation or demolition activities.

Findings of project: A reference manual was produced which will assist the user to do an economic feasibility assessment, plan and supervise a deconstruction project.

Did the project meet objectives? Yes

B. CONTRACT MANAGEMENT

Were all the terms of the contract met by contractor? Yes

List amendments (if issued): None

Are you satisfied with contractor performance? Yes, the contractor completed the work in a professional manner and in conformance with the proposed schedule.

C. REQUIRED FOLLOW-UP

Are there research issues, generated from this project, that must be followed up?

No. Convincing one to deconstruct is not an easy task. This manual will help, but what would be useful is the collection and dissemination of more proof of the viability of deconstruction through past case studies.

Should the report be published, and in what form? The report should be published as a gray covered research report and distributed through CHIC.

D. ADDITIONAL COMMENTS:

Please attach a one page summary of the report including project objectives, the nature of the work undertaken, and conclusions for CHIC (note: Research and Development Highlights are acceptable).
See Executive Summary included in the final report.

E. COMPLETION DATE:

Met x **Unmet**

If unmet, explain why?