Construction and Demolition Waste Reduction SMF 4194

SECTOR GROUP WASTE REDUCTION - ISSUES AND OPTIONS

- Task 6
- Final
- May 2004

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Executive Summary

The Ministry for the Environment has identified construction and demolition waste as a key waste stream in the *New Zealand Waste Strategy*[1]. The specific target in the Strategy relating to waste reduction is as follows:

> *By December 2008, there will have been a reduction of construction and demolition waste to landfills of 50% of December 2005 levels measured by weight.*

To provide the industry with tools to address this target, the Construction and Demolition Waste Reduction Project aims to develop best practice guidelines for waste reduction for seven sector groups:

- Architects / designers.
- Engineers.
- Developers / builders.
- Sub-contractors.
- Home renovators.
- Product suppliers.
- Demolition contractors.

The purpose of this report is to document the issues and options with waste reduction with each of the sector groups, as a result of feedback from industry workshops, interviews and desktop research. An overview of the industry context within which the best practice guidelines should be framed has indicated the following industry drivers:

- There is no legislation or regulations that adequately address resource use efficiencies or waste reduction, therefore the industry is not encouraged or enforced to consider the issues.
- The waste market acts in its own interests, sending signals that do not necessarily support resource use efficiency or waste reduction. Recycling services are not as reliable as waste transportation services.
- The construction and demolition industry is driven primarily by cost, time, quality and safety, rather than environmental concerns.
- Regulations, specifications, standards and grading are integral part of materials and methods used in construction.
- Clients are responsible for driving a project and their prime motivators are functionality, trends and cost.

Key issues and options with designers, architects and engineers to reduce waste in the design and project management phase include:

- Efficient design and design for deconstruction.
- Influencing client choices.
- Including waste management in project management.

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1 MfE, LGNZ. 2002. The New Zealand Waste Strategy. Towards zero waste and a sustainable New Zealand.

Key issues and options with developers, builders and subcontractors to reduce waste during the construction phase include:

- Efficient materials planning and management.
- Resource efficient construction methods.
- Waste storage and collection systems to improve waste diversion.

Key issues and options with home renovators to reduce waste during the project concept, design, construction and demolition phases include:

- Use of second hand and recyclable materials.
- Use of professionals and tradespeople.
- Resource efficient construction methods.
- Considering alternatives to renovation.

Key issues and options with product suppliers to reduce waste during the project design and construction phases include:

- Minimising waste in packaging and transportation.
- Address recyclability and recycled content of products.
- Specifications for efficiency in product use.

Key issues and options with demolition contractors to reduce waste during the project concept, design, construction and demolition phases include:

- Deconstruction rather than demolition.
- Improve the information on second hand markets.
- Improve storage of salvage.

The ability for each sector group to control or influence waste reduction is affected by their role in the project phase and the decisions and influences of the other sector groups, as illustrated in Table 1 below. For each part of the project phase that influences waste production, each sector group either:

- can control or directly contribute to waste reduction,
- is influenced or affected by decisions made by other sector groups, or by the project phase, and has little control on waste reduction, or
- is not influenced or affected by others and / or does not contribute to waste.

Table 1 Summary of Sector Group Influences on Waste Reduction

	Sector Groups						
Waste reduction influences	Designers / Architects	Engineers	Developers / Builders	Sub - contractors	Home Renovators	Product Suppliers	Demolition Firms
Design details	C	C	C / A	A	C / A	A	A
Project management / contractual requirements	C	C	C / A	A	C		A
Client demands	A	A	A	A	C	A	A
Construction / demolition methods	C	C	C / A	C / A	C	A	C
Site management practices			C	A	C		C
Product selection (including second hand products)	C	C	C / A	C / A	C	C / A	A
Product design, packaging and delivery	A	A	C / A	C / A	A	C	A
Resource recovery services			C / A	A	C / A		C / A

Key

C = Control. The sector group can control waste reduction.

A = Affected. The sector group is affected by other groups or outside influences and cannot directly control waste reduction.

Blank. The sector group does not contribute waste or is not affected by outside influences.

This summary, and the recommendations of the report, identifies where best practice guidelines are best targeted, and are the foundations for a literature review of best practice in each of the seven sector groups. Best practice guidelines are best targeted in the areas where sector groups have the most control.

Ongoing consultation with sector group representatives is required to analyse methods of waste reduction identified in the literature review against the contextual framework of the industry. This report will be circulated to sector group representatives in the industry.

1. Introduction

1.1 Background

Construction and demolition (C & D) waste is a major contributor to the quantity of waste sent to landfill, accounting for about 17% of all landfill waste nationally[2]. This 1997 estimate is considered conservative and does not include the C & D waste that ends up in cleanfill.

The Ministry for the Environment has identified C & D waste as a key waste stream in the *New Zealand Waste Strategy*[1]. The specific target in the Strategy relating to waste reduction is as follows:

> *By December 2008, there will have been a reduction of construction and demolition waste to landfills of 50% of December 2005 levels measured by weight.*

The Strategy has not provided specific national guidelines, policies, regulations, training, tools or resources. While the onus is on local government to address this target, it is clear that C & D related industries must also participate in providing solutions. One of the aims of the C & D Waste Reduction Project, of which this work is a part, is to work with the industry to develop best practice guidelines that aim to address the Strategy target.

The industry has been broken up into seven sector groups, recognising that each sector is responsible for creating building related waste in a different way:

- Architects / designers.
- Engineers.
- Developers / builders.
- Sub-contractors.
- Home renovators.
- Product suppliers.
- Demolition contractors.

The overall outcome of this project is a set of best practice guidelines for reducing waste disposal for each sector group.

Best practice can be simply defined as:

> *"An industry accepted way of doing something, that works. Best practice is the best identified approach to a situation based upon observation from effective organisations in similar business circumstances. It is all about not 're-inventing the wheel', but learning from others and implementing what has been shown to work".* [3]

The first step in the project is to identify the issues and options for each sector group, to establish how and why waste is created, and where the opportunities are to reduce waste disposal. The second step is to review examples of waste minimisation in New Zealand and off shore and determine what is best practice, and thirdly to write and launch guidelines for each sector group.

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2 Mfe. 1997. Then National Waste Data Report.

3 www.itsmf.com/bestpractice/aboutbp/asp

1.2 Purpose of this Report

The purpose of this report is to achieve the first step of the project. The report documents and analyses the issues and options raised by the industry through workshop sessions, interviews and desktop research. The issues and options relate to how, and why, waste is produced by each of the sector groups and approaches the industry can take to reduce waste. The outcome is a recommended direction for the development of waste reduction guidelines that are best practice.

1.3 Methodology

To understand the issues and options for waste management, industry participants were recruited to attend discussion workshops. Further research was done through interviews and literature reviews.

1.3.1 Industry representation

Participation has been sought from:

- Industry associations.
- Centres of research (governmental and non-governmental).
- Industry representatives from each of the seven sector groups.
- Councils, non-profit organisations and waste exchanges with experience in C & D waste.

Recruitment occurred in the sponsor's regions of Auckland, Waikato and Canterbury, unless there was a valid reason to include participants from another part of New Zealand.

An introductory media article was published in industry magazines and newsletters informing the industry of the project and calling for participants. Key organisations and individuals that were known to have the skills and commitment were invited directly, along with industry leaders and industry associations.

1.3.2 Workshops

Three workshops were run in Auckland, Hamilton and Christchurch, in late March and early April 2004. Local representatives from each of the seven sector groups were invited to each workshop. The participants were introduced to the C & D waste reduction project, C & D waste and the *New Zealand Waste Strategy*.

Sector groups then participated in facilitated group sessions to discuss the issues with waste production and waste reduction and to identify potential options for waste reduction in their part of the industry.

Between seven and 20 industry representatives attended each workshop. Architects, engineers, builders and product suppliers were well represented however there was low representation of subcontractors, demolition firms and home renovators.

1.3.3 Interviews and research

To further develop the issues and options raised in the workshop, waste practitioners and industry representatives were interviewed. Desktop research of the internet and published material was also undertaken for completeness.

1.4 Structure of this Report

An overview of the industry context is first given to understand the regulatory, market and business framework within which the seven sector groups operate. The key waste issues and waste reduction options for each sector group is then provided with an analysis against the industry context.

Architects and engineers have been grouped together as the issues and options for the designers are very similar, although their roles are quite separate. Developers, builders and subcontractors are also grouped together for the same reason. Home renovators, product suppliers and demolition contractors are discussed independently.

Recommendations for the next steps to develop best practice guidelines are proposed in each of the sector group sections.

2. The Industry Context

Waste issues need to be analysed within the current industry context. The culture of the industry, the business motivations, drivers for change, client demands, the waste market, and the regulatory, policy and economic frameworks all contribute to the industry context. These parameters will affect the approaches to waste reduction and what each sector group can achieve in terms of best practice.

What follows first is an overview of the process of a construction or demolition project, to provide a framework for identifying where each of the sector groups participate. Secondly, an overview of the regulatory framework, the waste market and the industry drivers is given to set the industry context prior to the review of issues and options with the seven sector groups.

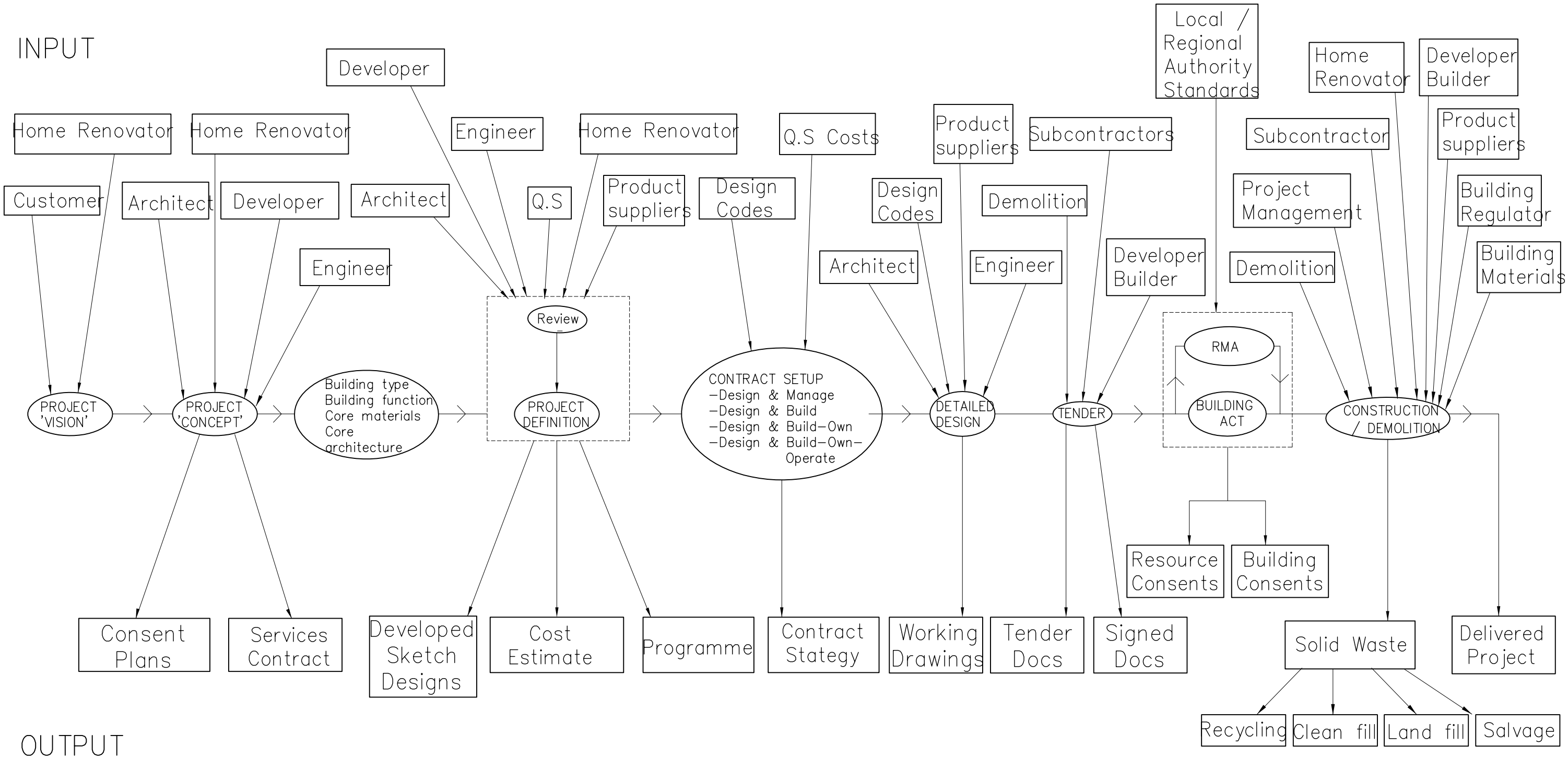
2.1 The C & D Project Process

The C & D industry has been broken up into seven sector groups in recognition that each sector is responsible for creating building related waste in a different way, in a different part of the building life cycle. At each stage of the process decisions are made that result in waste being created, from the client concept (‘what type of building do I want?’), to product and design specifications and the construction or demolition methods used on the site.

Figure 1 illustrates the C & D project programme, and shows the stages where each of the sector groups are involved in the project.

FIGURE 1

INPUT



OUTPUT

CONSTRUCTION & DEMOLITION PROCESS

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2.2 Regulatory Framework

There is no legislation that directly controls or effects waste production or reduction[4]. Nor is there legislation that enforces or encourages sustainable design of buildings or sustainable urban design, although the Building Bill (2003) may change this in the near future. Indirectly, the Local Government Act 2002 gives territorial authorities the power to manage waste in their districts and gives provisions to influence waste reduction, recycling and recovery as alternatives to disposal.

The Resource Management Act 1991 is effective at controlling the environmental effects of waste, but the purpose is not to control waste reduction or resource use efficiency. In many cases the local council rules and planning can hinder waste minimisation in a project. The Building Act 1991 has no provisions for requiring resource use efficiency with materials in design or construction, or for managing waste produced as a result of construction or demolition.

2.3 The Waste Market

The waste market in urban centres is dominated by the private sector who now own or operate most of the infrastructure to collect, transport, sort, store, recycle and dispose of waste. Some territorial authorities still have control over landfills and transfer stations (i.e. Christchurch City), and some have delegated the management of resource recovery centres to non-profit organisations (i.e. Ashburton).

It is relatively cheap to dispose of waste to landfill in New Zealand, compared to the cost of recycling or other forms of diversion. It is even cheaper to dispose waste to cleanfills. It was mentioned in the workshops and is well documented that the financial drivers are not strong enough for most businesses to find alternatives to waste disposal[7, 18].

Private industry in the waste market make profits from owning and operating infrastructure, and the drivers are to remain competitive and increase productivity, which to date has meant increasing waste collection while keeping costs down.

These drivers affect the provision of services to the C & D industry, although most demolition contractors own, or have contracts directly with, cleanfills and haul their own waste. C & D companies receive most of their information about waste management from the private operators in the waste market because of the well developed business relationships. Because of this, the waste operators can influence the C & D industry to meet their own needs through pricing and choice of services offered, rather than to meet a council's, or the national, waste strategy.

Converse to the well-established waste market, the recycling markets for many C & D waste materials fluctuate in stability and many operators can enter and exit the market in the start up phase. Because of this, many operators cannot be relied on for the efficient waste removal services that the construction industry demands..

2.4 C & D Industry Framework

The C & D industry has several key characteristics and drivers that influence the way business is done. Firstly, every project is directed by a client. Clients' motivators are varied but, beyond the need for functionality in a building, choices are driven by trends and fashion[5], and it is generally considered that new is better than old[18]. Presently the client demand for sustainable buildings,

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4 For more information on waste management regulatory tools, refer to Sinclair Knight Merz. 2004. Construction and Demolition Waste Reduction – SMF 4194. Inventory of Regulatory Tools.

5 As noted in the workshops by designers.

waste minimisation, or any other environmental considerations, is on the fringe of the industry[5]. There are reports that this is changing, and the request for energy efficiency and other environmental design features are becoming more common[6].

In many cases clients dictate time frames, budgets or other constraints that do not allow for greater resource recovery, design for deconstruction, space for waste bins or other barriers to recycling and reuse.

Secondly, quality, time, cost and safety are key considerations in any project, by every sector group. There is a strong culture of tendering for professional and trade services, and for tenders to be selected on these key considerations. Profit margins are tight in the competitive environment[7,8]. Waste reduction would need to identify benefits in one of these four areas in order for it to be considered a priority.

Regulations, specifications, standards and grading are an integral part of the materials and methods used in construction. This emphasis is driven by safety and quality, which is validated through the Building Act 1991, the role of the Building Industry Authority and Standards New Zealand and the services of BRANZ Ltd (Building Research Association of New Zealand). Most recycled and second hand materials do not have standards or specifications, compared to virgin materials, which reduces their appeal to designers.

The size of businesses and the type and skill level of the labour force affect the ability for the industry to be educated and to effect change. There are a variety of sizes of businesses in the design, construction, trades and demolition sectors, from national or international companies to sole operators, indicating methods to affect change may not be a 'one-size-fits-all'. Much of the labour force is unskilled or skilled to a low level, and the participants are transient.

Finally, the context of the manufacture and supply of construction materials is relevant. The majority of construction materials used in New Zealand are manufactured in New Zealand from a mix of imported and local raw materials. The industry is dominated by two companies, The Fletcher Group and Carter Holt Harvey. Between them they manufacture a large percentage of the cement, concrete, roofing, cladding, wallboards and timber products produced in New Zealand and each own nation wide retail outlets servicing trades and the public. They also own aggregate quarries, forestry and construction companies.

The oligopoly of many parts of the industry, the vertical integration of many companies and the comparatively low cost of raw / new materials compared with recycled and second hand materials, has an impact on the choice of materials used in a construction project or salvaged from a demolition project. The final issue with product suppliers is that there is presently no concept of extended producer responsibility for waste in New Zealand[9].

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6 Stonewood Homes. pers. com. January 2004.

7 Rose. 1999. Options for waste minimisation in New Zealand's non-domestic construction industry. Victoria University of Wellington. Thesis.

8 As discussed in the workshops.

9 The concept of extended producer responsibility (EPR) is in its infancy in New Zealand. The *New Zealand Waste Strategy* identifies it as a tool for addressing special wastes. In future there may be potential for this approach to be extended to other product / waste categories such as product suppliers.

3. Designers, Architects and Engineers

The design sector groups in the building industry include interior designers, architects, architectural draftspeople and structural engineers. The influence of design professionals on the building cycle is predominantly at the design and specifications phase of the construction process. They also retain influence during the construction phase through project management and contractual arrangements with builders and demolition contractors.

This section provides a review of the issues and options surrounding waste production with designers and analyses these within the industry context to make recommendations for the next stage of best practice guideline research.

3.1 Issues with Waste

Creating waste through design

The approach taken in the design phase of the project can affect the amount of waste produced during construction or demolition.

CIRIA and DETR (1998)[10] lists ways that design contributes to waste production:

- *Design requiring greater use than necessary of materials in the permanent works.*
- *Design that requires the contractor to use more temporary works.*
- *Design that does not allow the use of reclaimed materials.*
- *Design that increases wastage through off-cuts or damage.*
- *Design that restricts reuse or recycling opportunities after demolition at the end of the projects life.*
- *Specification of inappropriate design lives and/or design performance.*
- *Design errors and change.*

Industry representatives in the workshop sessions identified with some of the above issues. Designing buildings with a view to reduce the amount of wasted material is not commonly factored into the overall design approach. Designing in the use of recycled or second hand materials is also not commonplace, and usually only done in restoration projects or to make a statement[11].

Industry representatives identified that incomplete design specifications are often presented to tradespeople, due to time and budget constraints in the design phase, or through design error. This can lead to subcontractors over-ordering materials, ordering the wrong materials, or making mistakes in construction, all leading to a greater potential for wastage. The outcomes of the workshop are aligned with the findings in Jaques (1999)[12]. Architects in the study identified detailed design and complete working drawings as the two most popular considerations for designers to reduce waste on a construction site.

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10 CIRIA and DETR (1998) Waste Minimisation and Recycling in Construction – design Manual Special Publication 134.

11 Storey, J., Charleson; A., Gjerde, M and Pedersen, M. 2003. The State of Deconstruction in New Zealand. Victoria University of Wellington.

12 Jaques, R. 1999. Construction Site Waste Generation. The Influence of Design and Procurement in Auckland. BRANZ Study Report 88.

Participants in the workshops indicated that architects, in particular, do not commonly design to modules, as this can be quite restrictive and there is a perception amongst the industry that this will influence 'artistic' flair in design.

Lack of demand or incentives for waste reduction

Design is largely driven by market demand and regulation. As discussed in Section 2, the current industry lacks either in terms of waste reduction.

Knowledge about waste reduction

There is a lack of knowledge about the issues of waste and the skills to address waste reduction in design. It could be argued that this is due to the point raised above, that there is no market, nor regulation, to create a demand for the skills. Conversely, designers have not taken the initiative to lead the market.

It was acknowledged in the workshops that waste reduction is not part of formal training at school or university. It was also discussed that there is no readily available information or support through councils, internet, consultants or industry organisations regarding waste minimisation or the availability of recycled or reusable products and outlets.

Perception that waste reduction is more expensive

Industry representatives identified at the workshops that the overriding problem designers face is the cost of pursuing an option that relates to waste reduction. Practices will not be pursued if there is a potential for it to cost more, particularly when cost is a key driver for the client. Costs are incurred when designers need to do extra research, certification or detailed specifications to accommodate waste reduction principles.

No responsibility for waste

Designers are not responsible for waste on a construction site, and therefore there is no direct financial impact or otherwise on the amount of waste created as a result of design or project management.

3.2 Analysis

The practical issues of design that lead to waste are clearly defined, and therefore the options for waste reduction can be easily identified. For example if lack of detail in design creates waste in construction, then improving the detail of design may lead to efficiencies in materials use in construction. It follows that the guidelines should address such practical design issues.

However best practice guidelines must also consider the context within which designers operate. Design professionals are not currently driven by client demand or regulatory mechanisms to consider waste reduction, and have no responsibility for the waste they inadvertently create. This situation is unlikely to change in the near future. Low levels of knowledge and understanding about sustainable design or waste issues, or the cost of implementation, are a symptom of this lack of demand.

Best practice guidelines cannot overcome these issues, but must allow for them in addressing waste reduction initiatives. For example initiatives that also appeal to key client drivers (time, cost, quality, trend) are more likely to be successful. The guidelines will have to be pitched at the right level of understanding of waste reduction principles.

The ability and desire for designers to take the initiative with waste reduction concepts and influence clients and contractors should also be considered.

3.3 Waste Reduction Options

A number of options were identified by designers at the workshops that are achievable during design and project management to help reduce waste.

Design for multiple and changing uses

Designing for building re-use, in particular commercial buildings, through the use of partitions and flexible spaces.

Design for Deconstruction

Another important aspect of design is designing for de-construction. This will ensure that when the building has reached the end of its useful life, a greater volume of components is able to be salvaged from the site.

Build to standard modules

If there was more design focused on module sizes then residual waste would be substantially reduced. This could also potentially relate to a reduced cost to the client as less material is used.

Use of recycled or second hand materials in design

Architects at the Auckland meeting identified how they (as an industry group) could potentially have a positive influence on the use of recycled products. This equates to creating a demand for the product by designing recycled materials into buildings.

Efficiency of design

More detailed design could lead to less wastage during construction.

Allow time for deconstruction rather than demolition

Deconstruction leads to greater salvage of components compared to demolition because the building is taken apart piece by piece, rather than by complete destruction. Greater salvage leads to reduced waste to landfill or cleanfill. Deconstruction is more time consuming than demolition, which must be considered in the project time line.

Client mentoring

'Educating' or influencing the client on the benefits of waste reduction may identify many successful design and project management options. Participants at the Hamilton workshop discussed the ability to affect a clients decision to renovate or relocate rather than demolish and rebuild.

Waste management specifications in contracts

Designers can influence on-site waste management through the specifications for a project. Within the contract between the contractor and designer there could be inclusion of a waste management plan requiring waste reduction and recycling. Christchurch City Council and Waitakere City Council have both pursued on-site waste management specifications with a number of developments where the councils were clients.

Sustainable Design Briefs

Designers can assist clients and developers to write design briefs encompassing waste reduction initiatives. CIRIA and DETR (1998)[10] identifies how one might initiate waste minimisation at the project level.

- *Challenge the brief at an early stage. Issues to address should include:*
  - *loadings*
  - *design life*
  - *use of reclaimed materials*
  - *waste reduction opportunities*
  - *use of prefabrication and off-site preparation of materials*
  - *undertaking a waste review at key design stages*
  - *use of standardised components.*

3.4 Conclusions and Recommendations

A number of the ideas put forward by the industry representatives within the workshop relate to research by CIRIA and DETR (1998)[10], which documents key improvements that designers could seek to encourage:

- *Minimisation of waste produced during both C & D activities.*
- *Maximisation of the use of reclaimed materials that are generated on site.*
- *Maximisation of the use of reclaimed materials in the works.*

This manual identifies that this can be done in three principle ways:

- *Through improving design practices generally.*
- *Through giving advice to clients and peers.*
- *Through initiating waste reduction at a project level.*

The information obtained in the workshops gives local context to the above mentioned issues. Overall there is considerable potential for participation from this industry group in waste reduction, due to the influence at the design / construction management stage of the construction process.

Research for the best practice guidelines should focus on:

- Developing a further understanding of the drivers for design professionals and the context within which guidelines should sit.
- Design practices for reducing waste.
- Waste reduction through specifications, contracts, design briefs and project management.
- Managing client expectations and the project vision.

4. Developers, Builders and Subcontractors

Developers, builders and subcontractors are all primarily involved with the construction phase of a building life cycle, although each sector group can also be involved in the project concept, design and project management. Each sector group may also have some demolition tasks within the construction process, but are not likely to undertake major demolition projects.

This section provides a review of the issues and options surrounding waste production in the construction phase only, and analyses these within the industry context to make recommendations for the next stage of best practice guideline research.

4.1 Issues with Waste

Waste creation and disposal is a low priority

Safety, budgets, programme and quality are all higher in priority on most building sites than environmental issues and resource use efficiency. Participants in the workshops indicated that small businesses and owner / operators are more efficient with materials than labourers in larger companies where the financial implications of wastage are not as strong. Tight profit margins were quoted in the workshop as the main barrier to builders and subcontractors undertaking waste separation and recycling.

Practicalities of on-site waste management

Waste is generally managed by the builder, and included in their costs. Practical issues raised in the workshop include:

- Little incentive exists for subcontractors to minimise waste if the builder is paying the disposal fees.
- Many construction sites lack adequate storage space for waste skips and so struggle to keep piles or bins of materials around the site for reuse or recycling. It is also difficult to set up a sorting system without double handling, which is perceived as time consuming and costly.
- Continual training of staff and subcontractors is difficult (see comments below).

Education and skills of staff and subcontractors

The number and type of subcontractors and staff vary greatly within one construction project and between projects. Additionally the industry has a large number of unskilled and immigrant labour with low levels of formal education and in many instances a poor understanding of English. The requirement to train each person up on the waste management protocol is time consuming and in many cases considered futile by site managers. Many builders struggle with the education of higher priorities such as quality work and safety issues.

Unskilled labour can lead to mistakes and poor construction methods, which can in turn lead to more waste on a construction site.

Service provided by waste / recycling companies

Waste removal services must meet the needs of builders. Due to the priorities of budgets and programme, and the lack of space on many sites, bins or skips need to be picked up and replaced on demand. Builders mentioned in the workshops and interviews that they have been let down by recycling operators, non-profit organisations and other waste removal services who have not been able to provide a service when required.

Some operators will not pick up loads under a certain size, creating an economy of scale issue. Some recycling companies will not provide a pick up service, which means a third party must transport the waste material. This adds prohibitive costs to the process.

A final issue is the inconsistency of options in the market place for recycling and reuse for materials. Builders in the workshops have found they cannot be guaranteed that services will be provided from one month to the next. An example given was the provision of off-site sorting of waste by companies in Christchurch, which was offered for around 18 months but has recently ceased due to market forces[13].

Product specifications, design and packaging

Builders often create waste due to the design of the building or the particular materials that have been specified by the client or designer. For example, a wall height or roof design inconsistent with standard product lengths will create more offcuts than usual. Specified materials that cannot be readily recycled means the builder creates more waste to landfill and cleanfill. Treated timber framing is an obvious example.

Product packaging is a growing waste issue that builders consider out of their control[7].

C & D methods

The quality of the builder or subcontractor and the methods they employ can contribute waste. Mistakes, inefficient product use, time pressures and poor project planning can lead to more waste produced. Many products are installed to manufacturer specifications, which may not take into account the efficient use of the product.

Material ordering and storage

Waste is created by product damage during on-site storage. This can happen through incidents such as machinery accidents, weather or dust contamination. It was also discussed at the workshops that waste occurs where there is oversupply of material. In many cases the client has already paid for materials, subcontractors and builders do not have an incentive to be efficient with resource use and oversupply is often disposed of rather than being taken back to the supplier or on to another project. Where 'just enough' product has been ordered, and builders and subcontractors are more likely to be resource efficient[14].

4.2 Analysis

Builders, developers and subcontractors are the 'people on the ground' producing the waste. Waste occurs as a result of design specifications, offcuts and installation methods, or through lack of skill, product damage or oversupply. As with the designers, best practice guidelines must be able to offer successful, practical advice, within the context of the building industry.

Firstly, commercial drivers will always overshadow environmental considerations. Therefore the guidelines must be able to appeal by providing practical solutions that also address cost reduction, time efficiency, safety and maintenance or enhancement of quality. Because these sector groups bear the cost of waste disposal, opportunities to reduce waste are perceived to be easier to assess in terms of financial benefits than the designers or product suppliers. Secondly, the transient and low skill level of the work force is an indication that change is difficult to augment and solutions must be simple to translate.

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13 Waste Management. pers com. March 2004.

Thirdly on-site waste management requirements differ with the type and scale of project and solutions will not be 'one-size-fits-all'. Guidelines must be adaptable and recognise limitations such as space for bins, material types, labour, council requirements and other issues. Issues regarding the improvement of trade skills and resource use efficiency can only be partially addressed in the guidelines in broad conceptual terms. The guidelines are not training guides, nor expected to replace product supplier and designer specifications.

These sector groups cannot resolve the issues regarding the provision of waste and recycling services, nor the specifications for products and building methods, from designers. For areas where guidelines cannot directly resolve these issues, they may consider options for reducing the impact on waste.

4.3 Options for Waste Reduction

Plan for waste management

Diverting waste from the landfill and cleanfill requires planning and management. Identifying which materials are likely to be waste, which can be recycled, by whom, and setting up a system with each service provider will assist in a sustainable waste diversion effort.

Resource efficient construction methods

Adopt methods of construction that takes into consideration the most efficient use of materials. General principles suggested in the workshops apply such as ordering the right size of product, 'measure-twice-cut-once', and using products fit for purpose. Trades, designers and product suppliers can develop specific methods of installation or fixing for particular products, which reduce the overall amount of product required.

Materials management

Better management of materials can lead to reduced wastage from damage, oversupply and offcuts. Ordering 'just-in-time', ordering prefabricated components, and arranging credits for unused materials are some options. Some builders state that tight estimations lead to more efficient use of materials compared to deliberate oversupply[14].

4.4 Conclusions and Recommendations

The key issues regarding waste on construction sites have been identified by the industry as follows:

- Waste is low priority, compared to quality, budgets, programme and safety.
- Training of staff and subcontractors is difficult.
- Service from recycling operators is not consistent or adequate and on-site sorting is often difficult.

Research for the best practice guidelines should focus on:

- Developing a further understanding of the drivers for developers, builders and subcontractors and the context within which guidelines should sit.
- Material supply planning and management.
- Waste storage and waste collection services.
- Resource efficient construction methods.

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[14] Golden Homes Tauranga. pers. com. March 2004.

5. Home Renovators

Home renovators are involved in all stages of the C & D life cycle, although most operate on a smaller scale than commercial projects. Renovations are generally planned and executed by homeowners, although professionals can be involved in the design stage and tradespeople (builders and subcontractors) during construction or demolition. 'DIY'[15] is entrenched in New Zealand culture and varies from one-off projects to a lifestyle hobby, and from redecorating to building alterations.

There are differences in the amount and type of waste produced in home renovations managed by professionals and tradespeople and DIY, due to such things as the different levels of skill, drivers for resource efficiency, time pressures and knowledge of second hand markets.

This section provides a review of the issues and options surrounding waste production from DIY home renovation only, and analyses these within the industry context to make recommendations for the next stage of best practice guideline research. The professional and trade waste issues are considered elsewhere in this report.

5.1 Issues with Waste

Motivations to renovate

Renovation may stem from maintenance requirements, changing needs of the homeowners (i.e. additional bedrooms) or to improve an investment (i.e. building a garage). However renovation is often driven by design and decorative trends, or an interest or hobby, and in these instances the decision to renovate could be considered wasteful. For example, a kitchen or bathroom may be renovated several decades before the useful end life of the joinery and fixtures to suit current trends.

Knowledge and use of second hand material markets

Demand for second hand building materials and components in renovation supports the salvage industry and prevents waste to landfill and cleanfill. Reuse of second hand materials is popular for a number of reasons such as:

- Where consistency with the original architecture is desirable.
- Where the second hand material has novel appeal such as art deco fire surrounds or stained glass windows.
- Where products are no longer available as new (such as native timber flooring).

The time, skills and knowledge required to find second hand material outlets, find specific materials and assess their quality is an issue.

Knowledge and use of these markets is also essential to reduce the disposal of demolition material from renovation projects. Many home renovators may not know there is a market for their waste, or time, practicalities and lack of clear financial advantage may lead to disposal as the easy option.

[15] Do it yourself.

Waste removal services

Four options are available for waste (and recycling) removal:

- Weekly kerb side collection (where available).
- Commercial waste removal service.
- Delivery by the home renovator to the transfer station or recycling / reuse end use.
- Advertise in trade magazines, newspapers and internet sites.

Some commercial recycling or salvage operators will not pick up or otherwise accept loads under a certain size, creating an economy of scale issue.

There are limited residential C & D waste recycling opportunities. Kerbside recycling services do not pick up home renovation waste materials and many municipal transfer stations do not have a C & D salvage or recycling area. Therefore C & D recyclables tend to end up in the waste stream.

Second hand markets for materials are inefficient due to imperfect information. Selling can be time consuming and not guaranteed to be successful. Conversely there is a lack of knowledge by many home renovators regarding the market for waste materials or components, or who to contact.

Unskilled labour

Untrained home renovators can produce more mistakes or be more inefficient with materials during construction, and reducing the quality of salvage materials during demolition, creating more waste than necessary. Even skilled renovators may not be aware of the most resource efficient methods of construction or deconstruction.

5.2 Analysis

Home renovators are the only sector group that deals with the 'client' in the project. To be effective, best practice guidelines must take into account the client drivers for home renovation; i.e. the desire to be trendy and that 'new is better', or that DIY is a hobby compared to a necessity. Within this context, and the inefficiencies with residential waste collection, the guidelines need to provide successful solutions for closing the waste market knowledge gaps and provide general methods of identifying waste for recycling versus. disposal.

5.3 Waste Reduction Options

Use of second hand materials and recyclable materials.

While the second hand markets are imperfect, home renovators already make good use of them. Further reuse of second hand materials and building components, and choosing recyclable materials, would achieve an overall reduction in waste to landfill and cleanfill. Improving knowledge about options to reuse and recycle waste would also assist the second hand market.

Use of professionals and tradespeople

Recommending employing skilled people to avoid mistakes and wastage.

Resource efficient construction methods

As detailed in the builders, developers and subcontractors section.

Alternatives to renovation

Options such as moving house, reducing the scale of renovation, renovating for durability rather than fashion, and other project concept decisions will assist in reducing waste from home renovation.

5.4 Conclusions and Recommendations

In this section we refer to the home renovator as client, designer and tradesperson. Home renovators have similar issues to commercial C & D sites, but on a smaller scale, and typically with less skill than trades and professionals. One key issue is the rate of renovation associated with trends and lifestyle, where desires for fashion rather than necessity dictates renovation plans. Another is the lack of information regarding recycling opportunities and diffuse second hand markets.

Research for the best practice guidelines should focus on:

- Developing a further understanding of the drivers for home renovators and the context within which guidelines should sit.
- Resource efficient construction and deconstruction methods.
- The choice of building materials (ie. recyclable or second hand).
- Planning renovation to reduce waste created – including considering alternatives to renovation.

6. Product Suppliers

The term 'product supplier' includes both the manufacturers and retailers of building components. Product suppliers contribute to the construction life cycle in the concept and detailed design stage, tendering and construction stage. For this purpose of this project waste issues and options are only considered at the construction stage where most of the waste is created. Suppliers of salvage product are included in Section 7, Demolition Firms.

This section provides a review of the issues and options surrounding waste production from product use and analyses these within the industry context to make recommendations for the next stage of best practice guideline research.

6.1 Issues with Waste

Product suppliers are not responsible for waste

The primary issue is that waste created on a construction site is not the responsibility of the product supplier. Once a product arrives on the construction site, any waste is usually the responsibility of the lead contractor. There are currently no drivers, regulatory or otherwise, that enforce or encourage product suppliers to take responsibility for packaging, oversupply of materials or other product wastage (see comments in Section 2.4 regarding extended producer responsibility).

Packaging

Product suppliers directly contribute to the waste stream with packaging. Packaging includes the immediate packaging around a product such as plastic tubes, buckets, drums and bags, and also the shipping packaging, including film wrap, cardboard, wooden crates and pallets. This packaging is considered necessary to protect product during transport and while on site. Some packaging is returnable (i.e. pallets), but most is disposed as waste.

Most product suppliers in the workshops did not consider the fate of their packaging, and most did not specifically use recyclable or reusable packaging.

Types of building materials

The types of materials used in a building component and the way materials are fastened contribute to the amount of waste disposed to landfill and cleanfill compared to recycling or reuse. Products are designed primarily for functionality and image in a building, and waste reduction during construction or demolition is not taken into account in design or manufacture. There are limited building products on the market made out of recycled materials[16].

Building materials are generally supplied in standard lengths, volumes or sizes that allow efficiencies in manufacture but not necessarily in installation.

Products are often not labelled sufficiently to identify the specifications for recycling or reuse. For example treated versus non-treated timber, or types of plastic pipes or spouting. If in doubt, builders and home renovators will dispose of these materials.

Materials use specification

Training, specifications and advice to industry relating to product installation is generally focused on quality and durability, and not resource use efficiency. There is no evidence that product suppliers are training contractors to reduce waste during installation.

6.2 Analysis

Because there are currently no drivers, economic or otherwise, for product suppliers to be responsible for waste on a construction site, there is little imperative for them to utilise best practice guidelines. Coercion by customers or other industry players may change attitudes over time. Guidelines must be developed in recognition of this major barrier, while providing for companies who wish to take the initiative.

Issues with packaging and product specifications can be rectified with practical solutions in the guidelines. Solutions will be successful where a financial or other business benefit can be achieved. More difficult to address is the issue of recycled or recyclable materials in building products, as functionality, durability, style, quality and other industry demands currently drive product design.

6.3 Waste Reduction Options

Packaging and transport

Providing reusable or recyclable packaging and reviewing the requirements for packaging, including product delivery.

Product design

Designing and manufacturing products with recycled content or recyclable materials, and labelling the products for easy identification. Designing products for durability and long life to delay renovations. Product suppliers at the Hamilton workshop also suggested designing building

[16] Sinclair Knight Merz. 2004. Market Assessment for C & D Waste Materials.

components that could easily be updated in-situ. Custom orders for products can also reduce waste on site. Some firms already provide this service[17].

Manufacturers at all three workshops discussed taking responsibility for recycling waste product back into new product.

Materials specification

Consider waste minimisation in the materials specification, including minimising use, installing correctly first time, and installing methods for easy deconstruction. Develop training packages to pass this information on to sub contractors.

Product delivery services

Retailers and manufacturers can deliver 'just in time' to reduce product damage during storage. They can also provide credit and a pick up service for oversupply to avoid oversupply being disposed to ground.

6.4 Conclusions and Recommendations

The greatest issue with this sector is that construction waste is not their responsibility. Waste issues in product design, packaging and methods of use are most likely where financial or other commercial benefits to the company could be made.

Research for the best practice guidelines should focus on:

- Developing a further understanding of the drivers for product suppliers and the context within which guidelines should sit.
- Packaging alternatives.
- Product specifications for installation, use and recycling.
- Product delivery to site and retrieval of oversupply.

7. Demolition Firms

Demolition is the final stage in a building's life cycle. Constituents are salvaged for reuse in their original form, recycled into new forms, recovered for energy or disposed to landfill and cleanfill. Small scale demolition as part of a building renovation may be undertaken by builders or home renovators, however large scale demolition is done by specialist firms. Demolition firms may also operate second hand yards to retail building components.

The demolition industry is focussed on maximising profits from the clearance of buildings. Profit potential drives the amount of materials, building components and whole buildings that are retrieved for reuse or recycling. Various factors restrict the level of resource recovery and these are discussed below.

The waste produced by demolition activity are often of a high volume and weight, materials commonly encountered include the following:

- Wood (treated, non-treated, manufactured wood products ie. plywood, etc)
- Bricks and blocks.

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[17] Resene Paint. Winstone Wallboards.

- Plasterboard.
- Metals (pipes, wire, conduits, structural beams, etc.).
- Miscellaneous plastics (PVC, HDPE, etc.).
- Land clearing debris.
- Concrete (with or without re-bar).
- Salvageable components (i.e. windows, doors, fixtures, etc.).

This section provides a review of the issues and options surrounding waste production from demolition and analyses these within the industry context to make recommendations for the next stage of best practice guideline research.

7.1 Waste Issues

Resource recovery efficiency may vary significantly in the demolition of buildings from very low effort demolition with high proportions of waste to deconstruction, which maximises material recovery. There are a number of issues that affect the amount of material that is recovered from a demolition site. The most significant of these are listed below.

Land availability for storage

High property value especially in Auckland often makes storage for resale uneconomical for smaller operators. This lack of space makes separation and accumulation of materials difficult and may contribute to the proportion of materials that are dumped.

Cost of transporting materials

The margins of profit versus effort decrease, as higher levels of recovery are achieved[18]. This leads to selective recovery of valuable materials and the disposal of high volume / low value materials, especially among the smaller operators, as recovery of these low cost materials is only economic on a large scale.

Labour intensive processes and requirement for specialist equipment

Deconstruction and / or the separation of demolition materials is mostly performed manually, and requires more skilled labour[18]. Labour costs makes up a large proportion of the cost of recovery of material. Many of the operators expressed concerns about labour shortage of good reliable staff.

Specialist equipment is also needed for some types of deconstruction. This creates more cost to a project and can make it prohibitive where cost is a greater driver than recovery of material.

Lack of design specifications and regulations

There is a general consensus especially among larger operators that competing with virgin material markets is difficult due to a lack of standards and grading by government. This barrier is compounded by the difficulty in getting building consents approved by councils for the use of second hand materials without specifications[18].

There is no legislation or regulatory drivers to encourage or enforce better building component recovery or more reuse of components in new buildings or renovations.

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[18] Storey, J.; Pedersen, M. 2003. Overcoming the Barriers to Deconstruction and Materials Reuse in New Zealand. Unpublished.

Mind set of potential users / buyers of material

Generally a perception that recovered materials are of an inferior quality to new materials. This is a world wide problem[18]. Designers tend to only use second hand materials to make a design statement and is a fraction of the market[18]. The lack of specifications contributes to this mind set.

Contrary to this, markets for low volume, high value, rare, unique or antique architectural components appear to be well established or developing, and are largely self supporting economically[18]. Supply cannot often meet demand.

Competition with virgin materials

Price, availability, perceptions of quality, confidence of supply, logistics and specifications all contribute to virgin materials having market advantage over second hand components / materials.

Aggregate in Canterbury is cheap and easy to access and subsequently an aggregate processor for concrete recycling has found it uneconomical to date to process concrete from demolition. The restricted markets for reusable materials creates a barrier for recovery.

Information in the market

Overall lack of knowledge in the market place regarding supply and demand of volumes and types of materials and building components leads to inefficiencies.

Industry framework

The fragmentation, localised nature of contracting and high competition in the industry leads to waste minimisation or environmental responsibility being a low priority compared to business survival and making money[18].

Building design and construction

Greater salvage would occur if buildings were designed and constructed to be deconstructed. The methods of installation, the fixing of materials, the choice of materials and the design of the building can all hinder the amount of materials or components salvaged from a building.

Damage of salvage during storage

Materials and building components stored at salvage yards are prone to damage from weather, machinery, customers and staff.

7.2 Analysis

The demolition contractor cannot address many of the issues raised because they relate to project concept and design or to market demand because they are decisions made at project concept or design phase, or they are dictated by the market demand for materials. Best practice guidelines will need to reflect this. Issues regarding the quality of building materials within the building are beyond the control of the demolition contractor, but the method of removal is within their control. Best practice for deconstruction planning and removal of components is likely to be the key focus of the guidelines.

While best practice guidelines cannot influence the market, options may include improving market information and branding.

7.3 Waste Reduction Options

Deconstruction

Deconstruction leads to greater salvage of components compared to demolition because the building is taken apart piece by piece, rather than by wholesale destruction. Greater salvage equals reduced waste to landfill or cleanfill.

Improve second hand market information

Increased access to second hand markets may lead to an increase in demand for salvaged components. This includes improving the information on available materials and components through trade sites and magazines, but also by operating well-managed salvage yards and increasing salvage marketing.

Improved storage

The sorting and storage of materials at salvage facilities can improve sales and reduce damage.

7.4 Conclusions and Recommendations.

The demolition industry is highly competitive and resource recovery is only practically viable if it is financially viable. It is often more viable to large operators to recover material than smaller operators. The level of salvage depends on markets, the labour skills and the time frame given for demolition or deconstruction. Demand for salvaged materials is low compared to the demand for virgin materials, apart from some niche areas such as antique architectural features and native hardwood.

Research for the best practice guidelines should focus on:

- Developing a further understanding of the drivers for demolition contractors and the context within which guidelines should sit.
- Methods for deconstruction and more efficient removal of materials.
- Planning for deconstruction and salvage.
- Improving the storage and sale of salvage.
- Improved information dissemination of second hand products to the consumer.

8. Summary and Recommendations

The summary and recommendations for each sector group is detailed in the sections above. From the analysis of each sector group, and the various construction phases, it is evident that some sector groups have more control of waste reduction at each phase. Furthermore, each sector group is influenced by the decisions made by other sector groups.

For each part of the project phase that influences waste production, each sector group either:

- can control or directly contribute to waste reduction,
- is influenced or affected by decisions made by other sector groups, or by the project phase, and has little control on waste reduction, or
- is not influenced or affected by others and / or does not contribute to waste.

Table 2 Summary of Sector Group Influences on Waste Reduction

	Sector Groups						
Waste reduction influences	Designers / Architects	Engineers	Developers / Builders	Sub - contractors	Home Renovators	Product Suppliers	Demolition Firms
Design details	C	C	C / A	A	C / A	A	A
Project management / contractual requirements	C	C	C / A	A	C		A
Client demands	A	A	A	A	C	A	A
Construction / demolition methods	C	C	C / A	C / A	C	A	C
Site management practices			C	A	C		C
Product selection (including second hand products)	C	C	C / A	C / A	C	C / A	A
Product design, packaging and delivery	A	A	C / A	C / A	A	C	A
Resource recovery services			C / A	A	C / A		C / A

Key

C = Control. The sector group can control waste reduction.

A = Affected. The sector group is affected by other groups or outside influences and cannot directly control waste reduction.

Blank. The sector group does not contribute waste or is not affected by outside influences.

This summary, and the recommendations of the report, identifies where best practice guidelines are best targeted, and are the foundations for a literature review of best practice in each of the seven sector groups. Best practice guidelines are best targeted in the areas where sector groups have the most control.

Ongoing consultation with sector group representatives is required to analyse methods of waste reduction identified in the literature review against the contextual framework of the industry. This report will be circulated to sector group representatives in the industry.

9. Acknowledgements

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- Architectus
- Arrow International
- Avoca
- BRANZ
- Canesis Network
- Carter Holt Harvey Panels
- Carters
- Cement and Concrete Association of New Zealand
- Centre for Advanced Engineering, University of Canterbury
- Chas S Luney
- Christchurch City Council
- City Care
- Craig Craig Moller Architects
- Creative spaces
- Design Construction
- Dimensions Limited
- Engineers for Social Responsibility
- Environment Waikato
- Firth Industries
- Fletcher Construction
- Fulton Hogan
- Golden Homes
- Hames Sharley Architects
- Hamilton City Council
- Institute of Professional Engineers of New Zealand
- Jasmax Architects
- John Storey, Victoria University of Wellington
- Master Builders Association
- Master Painters Association
- Ministry for the Environment
- MSM Architects
- Natural Home Builders
- New Zealand Construction Industry Council
- New Zealand Frame and Truss Association
- New Zealand Institute of Architects
- Nikau Contractors
- North Shore City Council
- Plaster Options Limited
- Plastics New Zealand
- Resene Paints
- Rexel NZ Electrical Suppliers
- Recycling Operators of New Zealand
- Standards New Zealand
- Stonewood Homes
- The Estimator
- The Laminex Group (Fletcher Building Limited)
- Troake Group
- UNITEC
- Waitakere City Council
- Ward Demolition
- Winstone Wallboards Limited
- YHA

Appendix A Industry Feedback on External Issues

In Section 2 an overview of the industry context was given to demonstrate the framework within which the sector group waste reduction best practice guidelines must fit. It included commentary on the regulatory framework, the waste market and the C & D industry framework. During the workshops and interviews, industry representatives highlighted many issues external to the C & D industry that impact on the ability of their sector group to reduce waste.

These external issues are beyond the scope of the C & D Waste Reduction Project to address, but need to be considered as constraints when developing best practice guidelines for the sector groups. Feedback from industry is summarised is the list below;

- There is a need to increase disposal charges nationwide, at both cleanfill and landfill at a level that encourages waste diversion.
- Financial incentives / disincentives are required to divert material from landfill and cleanfill.
- Central government legislation is needed to promote recovery across different regions.
- Development of standards and grading for recovered materials is needed, through Standards NZ, The Building Act or BRANZ.
- There also needs to be more research into recycled products at a national level.
- Set aside land in district plans for resource recovery industry (offer subsidised leases or similar).
- Councils should provide sorting stations or storage facilities.
- There is a need to develop a culture that is not driven by fast moving fashions, that demands waste minimisation and durability in design and function, and where second hand or recycled is fashionable.
- Improving information and education in the public and in the industry.
- Green procurement policies to adjust the market.

Education of designers and clients

Within the workshops education was looked upon as fundamental to achieving a reduction in waste. This education should be pursued not only at university but should focus on the wider community, as there is a need to alter the mind set of people in this regard and get them thinking in terms of waste reduction. There should be a celebration of successes, hence informing the general public on good waste minimisation practices.

Industry standards and rating systems

Industry standards and rating systems was another potential initiative that both architects and engineers believed could have a positive impact on the industry. The environmental branding associated with a rating or standards tool was also seen as beneficial for marketing and for third party verification. Examples currently exist such as BRANZ's Green Home Scheme and Green Star in Australia but knowledge and use of either in New Zealand is still low.