

# **Zero Waste New Zealand Trust**

## **Market Study for Recycled Glass in the South Island**

### **Written By**

Chris Thomas  
Timaru

### **Published by**

Zero Waste New Zealand Trust  
PO Box 33 1695 Takapuna  
Auckland New Zealand  
Telephone 09 4860738 Fax 09 4893232  
[www.zerowaste.co.nz](http://www.zerowaste.co.nz)

**May 2005**

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# 1 Introduction

Glass is an important industrial material, with its main uses in glazing and packaging of foodstuffs.

NZ consumes an estimated 250,000t of glass each year. About 185,000t is container glass (bottles and jars). Glass consumption has increased significantly over the past decade, and continues to trend upwards.

ACI, New Zealand's only commercial glass container manufacturer supplies about 64% of the total NZ market. ACI can manufacture glass bottles and jars ranging from 250ml to 1.0 litre.

Other distributors and brand owners import the balance 36% (68,000t). This is mainly wine bottles (from Europe), soft drink bottles (from Middle East) and beer bottles (from Asia).

ACI announced in late 2004, that it would reduce the price it paid to purchase used glass (cullet). Media reports indicate that pricing will fall to around \$10/t for flint (clear) cullet and \$75/t for green or amber cullet. In addition, several glass collectors reported 70% rejection of shipments due to colour or other contaminations.

These decisions have had a significant impact on glass collection, particularly in the South Island where the lower cullet prices plus increasing transportation costs, make it uneconomic to ship cullet to Auckland for recycling. This has led to many South Island areas stockpiling recovered glass in anticipation of future markets.

## 1.1 The Glass Market Study Project

Zero Waste Trust commissioned this project with funding provided by the Labour Department.

The objective of the study is to identify the status of glass recovery in the South Island and to evaluate market and enterprise opportunities for recovered glass.

Initial research focused on consultation with key stakeholders affected by glass issues to establish some facts and figures:

- Who has glass recovery operations and how much glass is being collected?
- Of the glass recovered, what quantity is being reused, reprocessed or stockpiled?
- What is the estimated quantity currently sent to landfill?

The preliminary facts and figures were presented at the Zero Waste Conference in Kaikoura, April 2005. This presentation included a peer evaluation workshop where additional areas of interest and information were obtained.

Since the conference further consultation and research has been carried out to evaluate potential used glass markets, mainly focusing on the output from the peer group evaluation workshop. The project has included a review of literature from various sources including Clean Washington Centre (CWC USA), Waste and Resources Action Programme (WRAP - UK) and Ministry for the Environment (MFE - NZ).

## 2 The Status of Glass Collection in the South Island

### 2.1 Glass Recovery

Over the past decade there has been a significant growth in the quantity of glass recycled in NZ. Glass collection has increased from 30,000t in 1994 to 90,000t in 2004 (Packaging Council).

All major cities, most larger towns and many rural communities now have some form of recycling service through kerbside or drop-off collection systems. The Packaging Council estimates that recycling facilities are now available to more than 60% of New Zealanders and it is estimated that nationally, 48% of container glass is recovered.

In 2004 ACI purchased nearly all of the post consumer glass recovered (90,000t). As this tonnage was more than the capacity of the ACI plant, some of the recovered glass was exported.

About 1,000t – 2,000t of recovered glass was used to supply markets developed by the Christchurch based Recovered Materials Foundation and other small local markets.

ACI announced in late 2004, that it would reduce the price for used glass packaging. Newspaper articles have reported that pricing will fall to around \$10/t for flint (clear) cullet and \$75/t for green or amber cullet. Flint prices have fallen nearly 90% and coloured glass around 12%.

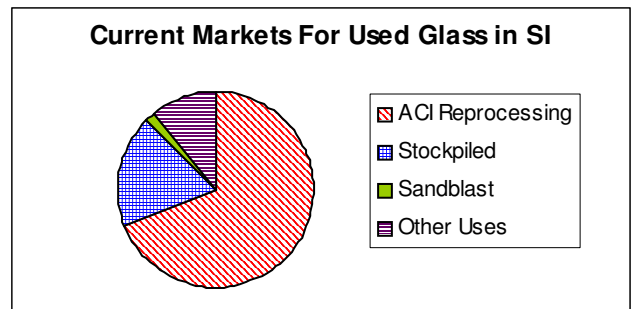
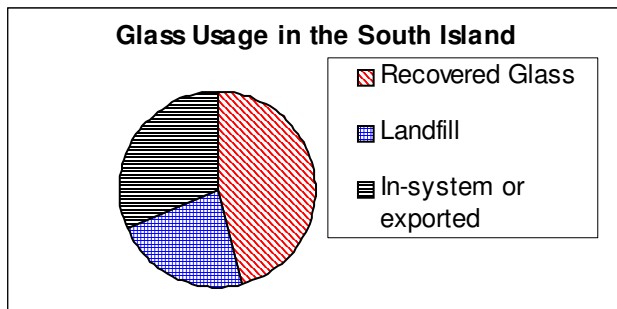
These decisions have had a particularly significant impact in the South Island where the lower cullet prices, plus increasing transportation costs, make it uneconomic to ship cullet to Auckland for recycling. This has led to many South Island areas stockpiling recovered glass in anticipation of future markets.

Another factor is the low level of landfill charges in the South Island. With fees as low as \$20/t, some councils provide minimal or no glass recovery services. In other cases, glass collected from kerbside or drop off recycling is sent to landfill.

The figures below show the current status of glass recovery (estimated 2004 tonnages).

Glass consumed in the South Island	33,300t - 44,400t <sup>1</sup>
Glass collected through recycling and recovery systems	16,000t
Glass being reused, reprocessed or recycled for other markets	13,000t
Used glass sent to ACI for reprocessing	11,000t
Glass Crushed for use as Sandblasting Abrasive	250t
Glass or whole bottles used for other markets	750t-1,750t
Recovered glass stockpiled in 2004	3,000t
Total glass stockpiles	5,000-10,000t
Recoverable glass going to landfill	6,000t – 10,000t
Glass in use or exported (mainly as filled wine bottles)	11,300t and 18,400t

<sup>1</sup> No reliable figures are available. Estimate of total South Island glass consumption is between 33,300t and 44,400t. The low figure is calculated from the total used glass collected in the South Island (16,000t) multiplied by national glass recovery rate of 48%. The high figure is calculated by taking the South Island proportionate population 24% multiplied by the total container glass consumption 185,000t.



## 2.2 Glass Recovery Table by Region (Tonnes)

Location	Doing What	Collected annually	Stockpile totals	Landfill
Nelson	Sort, compact, send to ACI – intend to stockpile flint from 5/05	800-1200		
Tasman	New recycling operators, have established local glass crushing operations, markets for industrial abrasive	Unknown	Minimal	
Greymouth	Minimal recycling, community group collection, sold to sandblasting operator	150		150
Kaikoura	Roller crush and use as filter, landfill cover or give away as builders fill	240		
Christchurch, Ashburton, Selwyn, Waimakiriri	RMF sort, compact, send to ACI Local markets – tiles, sandblasting	7000 1000-2000		
Stewart Island	Stockpile, crush and use as walkway gravel	Unknown		
Westland	Collect at landfill/transfer station and stockpile	800	1500	400
Central Otago	Kerbside and drop off centre	250	1000	100
Dunedin	Kerbside – stockpile owned by contractor – crushing some and using for landfill cover	1000	1000 +	
Queenstown Lakes	Collect at transfer stations	300	80	
Waitaki	Collect at landfill/transfer stations	Unknown	Unknown	
Timaru	Collect at landfill and drop centres	300	500	1290
McKenzie	Kerbside recycling	150	450	
Invercargill Southland	Kerbside recycling	500	1000	
Marlborough	Kerbside recycling	450	450	
Gore	No recycling facilities			

Some areas are faced with specific issues:

- The high level of used wine bottles in the high wine growing areas of Marlborough and Central Otago.
- There are large tourism areas including Queenstown, Wanaka, West Coast, and Stewart Island where there is a proportionately higher volume of glass container beverages.

## 2.3 Bottle Reuse

There is a general unwillingness by the alcohol industry to use reusable bottles, and apart from a few exceptions the industry uses only new bottles. Reasons include:

- Cost of new bottles versus washed reusable bottles
- Risk of contaminants in reusable bottles
- Quality assurance issues with reusable bottles, in particular scratches, marks and chips on bottles<sup>2</sup>

A limited quantity of glass wine and beer bottles are collected, washed and sterilized for reuse. The Christchurch based Recovered Materials Foundation (RMF) has invested in a bottle washing plant, but this is currently mothballed. Markets have included local niche artists and exports to the Pacific Islands.

The two major brewers DB and Lion Breweries both use a standard size reusable quart beer bottle. This accounts for approximately 12-15% of the total packaged glass beer market. Auckland Bottling Company (ABC) runs this reusable bottle service, providing both bottles and wooden crates. Bottles continue to be reused until they become damaged or are no longer fit for purpose (too scratched etc.).

Wanaka Beers Works, a micro-brewery, uses imported reusable bottles. About 50% are returned each year (approximately 55,000 bottles or 20t of glass).

Reusable milk bottles are still in use in a number of South Island locations but these represent a small and declining percentage of total milk sales.

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<sup>2</sup> For example at DB Mainland Breweries in Timaru, new bottle waste is about 0.7% versus reusable bottle waste of 2%.

## 3 Markets for Recycled Glass

### 3.1 Introduction

A number of NZ and international studies have researched and identified potential markets.

Glass is by nature a very hard and durable material with many unique and interesting properties.

Glass can be recycled indefinitely by remelting<sup>3</sup> and forming into new products – this is known as primary recycling. This could potentially be carried out indefinitely and is referred to as ‘closed loop’ recycling. Returning glass to the glassmaking process makes a great deal of sense in environmental terms, since it saves energy and primary mineral resources, as well as reducing waste and pollution emissions.

Secondary markets such as aggregates, generally involve a single use of the product and are sometimes know as ‘open loop’ recycling.

The steps to prepare glass for reprocessing vary depending on the application but will generally include some or all of the following steps:

- Colour sort and remove contaminants
- Crushing using hammer mill or barmac – also known as breaking, compacting or pulverising
- Screening and possible drying to create final graded products.

A critical success factor to developing markets for recycled glass is to ensure cullet is screened and graded accurately to meet customer specifications. Every application for used glass has different specifications relating to particle size, colour and levels of contamination.

- Reprocessing applications tend to require the highest quality levels.
- Generally, higher value markets require low volumes of consistent, high quality feedstock.
- Lower value markets have the potential to consume large quantities with significantly lower quality requirements but generally they are competing against well-established commodity products.

The Christchurch based Recovered Materials Foundation (RMF) is a leader in the development of potential NZ markets. RMF has carried out product and market development work in a range of markets including Sandblasting, Glass Artwork, Glass Flooring, Waste Filtration, roading and construction.

### 3.2 Reprocessing into New Glass Containers

ACI, New Zealand’s only commercial glass container manufacturer supplies about 64% of the total market. ACI can manufacture glass bottles and jars ranging from 250ml to 1.0 litre.

Glass cullet (crushed waste glass) is an important ingredient in the manufacture of new glass containers. ACI relies on a mixed input of both raw materials and cullet. This cullet

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<sup>3</sup> Glass can be recycled indefinitely by re-melting and forming it into new products. Most glass manufacturers use a mixture of virgin raw materials and cullet to make new products. Not all glass can be re-melted. For example pyrex and other heat resistant glass is not suitable for re-melting.

comprises ACI's own recycled glass, internally generated from the glass melting process, and external consumer and commercial recycled glass.

The principal reasons for substituting raw materials with cullet are:

- Reduction in materials cost – cullet can be purchased at lower cost than imported raw materials.
- Energy savings – glass manufacture is a high-temperature energy-intensive process. The energy required to melt glass cullet is significantly lower than the energy required to produce glass from virgin raw materials.
- Environmental benefits – reduced CO<sub>2</sub> and other emissions, plus the diversion of waste stream (used glass) from landfill.
- Furnace Life – increasing the cullet content of the raw materials allows glass furnaces to be operated at lower temperatures prolonging furnace life.

The disadvantages of using recycled glass all relate to impurities in the cullet feedstock.

ACI's facilities, located in Auckland, include two furnaces for manufacturing container glass. ACI has stated it has plans to expand capacity at some time in the future.

Under the existing capacity and market conditions, ACI can currently use 70,000t of recovered container glass annually. Under the Packaging Accord Glass Sector Action Plan<sup>4</sup>, ACI is committed to a recycled glass market maximum of 80,000t prior to capacity extension and a market of between 80,000 and 100,000 tonnes after capacity extension.

Also under the Accord, ACI has committed to continuing to provide a dependable market for container glass collectors (absorbing supply/demand fluctuations etc).

In 2004 ACI purchased an estimated 90,000t of post consumer glass from its principal suppliers. This is over 95% of the total NZ market for used glass. Some of the recovered glass was exported, as this tonnage was more than the capacity of the ACI plant.

In 2004, an estimated 11,000t of recycled container glass was transported to ACI from the South Island. Due to the reduced cullet prices, high rejection rates and increasing transportation costs, the quantity sent to ACI is expected to significantly decrease in 2005 to below 3,000t.

### **3.3 Fibre Glass Insulation**

As with glass container manufacturers, recycled glass is an important ingredient in the manufacture of fibre glass insulation products (also known as glass wool insulation). Tasman Insulation is the major NZ manufacturer of glass wool and glass wool products, with plants in Auckland and Christchurch.

While the Auckland plant uses recycled container glass as feedstock, the Christchurch plant can only use waste flat (window) glass. The Christchurch plant furnace does not operate at the higher temperatures required to melt used container glass.

The Christchurch plant currently consumes 2,400t – 3,600t flat glass annually. The company expects to increase demand for scrap flat glass, as the company modifies its glass wool formula from 70% scrap inputs to as high as 80% scrap inputs.

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<sup>4</sup> The New Zealand Packaging Accord 2004 is a voluntary initiative to cut down on wasteful packaging. The Glass Sector Action Plan was prepared by ACI.

Currently the scrap glass supply comes exclusively from commercial glass distributors in Christchurch. Waste flat glass from other areas is generally sent to land fill. There may be an opportunity to investigate transporting waste scrap from other areas to the Christchurch plant.

### **3.4 Foam Glass Insulation**

Finely crushed glass, mixed with a foaming agent produces foam glass, or cellular glass. Foam glass has a number of applications in the construction industry mainly as insulation material. It can be produced as aggregate pellets or pre-shaped bricks, blocks or sheets. Foam glass has low density, is strong and resistant to fire.

There are no NZ manufacturers of foam glass. Christchurch plastic recycling firm, Orvco have stated they have plans to establish a facility to manufacture foamed glass insulation products. Orvco estimate the capital investment required is \$2M. They do not have a timetable for implementation. Orvco estimate that at full capacity the plant could use 3,000t of mixed colour waste glass annually. The employment opportunities are not known.

### **3.5 Flat Glass**

The quality requirements for flat glass are much higher than those for container glass. Flat glass manufacturers will only recycle material that originates from their own downstream processing so they can be certain of quality and composition.

There are no flat glass manufacturers in NZ. Most flat glass is imported from Australia.

### **3.6 Construction and Roading Aggregate**

#### **3.6.1 Overview**

Glass is a relatively new construction aggregate material. Glass aggregate can include up to 100% glass cullet. The term "glass aggregate" includes, 100% glass cullet, or a mixture of cullet and natural aggregate or glass-soil mixtures. It may also be called sand, gravel, chip, GAP (General All Passing) or Crusher Dust/Fines.

Glass aggregate is durable, strong, and easy to place and compact.

Testing and trials in the USA and UK have demonstrated that crushed recycled glass can be successfully used in a variety of aggregate applications.

This is supported by projects in Christchurch and Invercargill, which have confirmed that recycled glass can be used in a variety of non-structural fill applications, generally as a blend with natural aggregates for use in making asphalt.

The key activities involved with creating aggregates are mining/extraction, crushing, screening and grading, drying and transportation.

Market entry costs are low to moderate with the key capital requirements being crushers, screening and grading equipment and transportation systems. Existing machinery and equipment can usually be easily adapted to glass crushing operations. Glass crushing could easily be contracted out to existing aggregate manufacturers or second-hand machinery could be acquired.

#### **3.6.2 Advantages of glass cullet aggregates**

In general, glass aggregate is durable, strong, easy to place, and easy to compact making it suitable for a wide range of construction applications.

### **3.6.3 Disadvantages**

The two major disadvantages of using glass are the health and safety issues associated with handling glass and potential movement of the compacted glass sub-base material with heavy traffic loads.

### **3.6.4 The Market Structure and Size**

The aggregate industry is mature, with a large number of well-established local, national and international suppliers and uniform application of standards and product specifications. Many suppliers have their own quarrying and crushing operations.

Crushed glass aggregate is a substitute for these natural aggregates and therefore aggregate suppliers are potential competitors to marketers of glass aggregates. However, they are also obvious industry partners and wholesale customers for glass aggregates.

The size of the market is unknown, but is substantial. For example a single medium-to-large commercial crusher could process up to 1,000t per day. There are at least 10 crushers of this size. plus numerous other small machines operating in the South Island. This indicates the entire SI used glass market would be less than 0.5% of the total South Island aggregate market.

Glass cullet can be used in various applications including general backfill, roadways, utility backfill, drainage media, and miscellaneous uses such as landfill cover.

For each application, the material should be specified based on the cullet content, gradation, debris level, and compaction level. Criteria for developing the specifications for any aggregate rely on a combination of technical data and practical historical experience.

Generally minus 20mm grading is required to eliminate major safety hazards from sharp edges. Most aggregate applications can tolerate higher contamination levels from ceramics, pyrex, lightbulbs etc without affecting the quality.

### **3.6.5 Pricing**

In most areas of the South Island, natural aggregates (sand and shingle) are readily available at relatively low cost, around \$10 - \$25 per tonne.

The costs of crushing, screening and blending glass for aggregate applications vary, with rates as low as \$10-15 per tonne and as high as \$100 per tonne.

### **3.6.6 Market Barriers**

There are two major barriers to increased use of glass in aggregates for road/highway construction:

#### **3.6.6.1 Lack of Standards, Specifications and General Information**

Glass cullet can be processed to conform to existing standards for gradation, debris level and compaction level. However there is a lack of agreed standards as to the level of cullet content for specified applications. Standards are being developed overseas based on testing and field trials, but standards have generally not yet been applied in NZ.

Transit NZ set roading construction standards and support waste minimisation. Transit would support moves to incorporate glass cullet into roading aggregate specifications.

### **3.6.6.2 Competing natural products - low cost alternatives**

Aggregate products are proven, reliable and meet existing standards and specifications. Glass is generally more expensive to process and blending increases the cost.

In most cases it is unlikely that recycled glass could be collected, processed, and delivered to a construction site and compete with the cost of natural aggregate. However, if the right kinds of economic incentives are in place, glass aggregate could be a “relief valve” for excess collected material.

If the cost savings (i.e. landfill charges) and other benefits of waste diversion are taken into account, then glass and other processed aggregates can compete with natural aggregates.

One approach here is to take account of the total cost of glass waste. Waste glass sent to landfill incurs dumping charges. If the contractor or council does not incur these charges, due to waste diversion there is a cost saving. The cost of reprocessing waste glass could take account of this cost saving.

There are specific exceptions where local market conditions make glass economically viable. For example, nature tourism, particularly hiking, is a major economic activity on Stewart Island generating a demand for aggregates to build and maintain walking tracks. However, there is a shortage of natural aggregates on the island and natural aggregates have to be shipped from the mainland at considerable expense. At the same time, the high level of tourism generates a high level of glass waste. Trials are under way to collect this waste and reprocess it into aggregates suitable for use on walking tracks.

In the UK the Aggregate Tax imposes a duty on sand, gravel or crushed rock used as an aggregate. As the tax is only applied to virgin quarried materials it encourages the use of recycled materials. The tax at around 15% is a significant driver to the use of recycled materials for aggregate applications (in particular glass).

### **3.6.7 General Fill and Backfill**

Crushed used glass cullet can be used as fill material for general construction uses such as site grading, filling under slabs, backfilling beside foundations, utility trenches, behind retaining walls, and landscaping.

Projects involving up to 100% cullet have been used in many USA construction projects..

For fluctuating loads and heavy, stationary loading conditions, CWC Best Practice guidelines recommend a maximum cullet content of 15% for fill and backfill with satisfactory results. Load-supporting backfill includes fills that support heavy stationary loads such as fill beneath footings and slabs, fluctuating loads such as those beneath reciprocating pumps, compressors or other machinery, and light-loaded conditions such as fill, placed beneath pedestrian footpaths.

For drainage applications such as retaining wall backfill and drains, the permeability of minus 7mm cullet material is about the same as that of natural sand and the permeability of the minus 20mm cullet material is about the same as that of natural gravel. Therefore, fill material made of 100% cullet can be used for construction of drainage facilities.

Fulton Hogan in Christchurch has carried out trials using crushed glass. From this research, Fulton Hogan is developing a fill material that includes about 4% crushed glass.

### **3.6.8 Road/Highway Construction**

Over half of the NZ aggregate production goes into road/highway construction, making it a potentially large market for recycled glass.

Road/highway applications include the use of cullet aggregate in base course, sub-base, sub-grade, and embankments. Cullet can be added to natural aggregate and the mixed material will have adequate strength and resistance to abrasion and traffic loads.

Based on the USA and UK test data, a maximum 15% cullet content is recommended for base aggregate and a higher cullet content, up to 30%, is recommended for sub-base aggregate and for the construction of roadway embankments. Particle sizes need to be below 20mm.

There do not appear to be any previous or current NZ projects using cullet in road/highway construction.

### **3.6.9 Asphalt (Glassphalt)**

Asphalt containing glass cullet as an aggregate is sometimes called “glassphalt”. Glassphalt is basically the same as conventional hot-mix asphalt, except that 5% to 40% of the rock and/or sand aggregate is replaced by crushed glass.

When properly installed, glassphalt presents no danger to humans, nor does it damage vehicle tires. Due to its glass content, glassphalt will hold heat longer than conventional asphalt. This characteristic could prove useful in situations where roadwork is conducted in cold weather, or when long periods of post-mix transportation are necessary. In addition, glassphalt surfaces appear to dry faster than traditional paving after rain because the glass particles do not absorb water. Glassphalt surfaces are also more reflective than conventional asphalt, and may improve night time road visibility.

The cost-effectiveness of substituting glass for conventional aggregate is highly dependent on the location and cost of local natural aggregates.

Trials in Christchurch demonstrated that using a 10% crushed glass asphalt met Transit New Zealand and Christchurch City Council specifications. Invercargill City Council used a 15% glass cullet mix for their annual footpath programme in 2004. While both projects were technically successful neither has been continued as the costs of using glassphalt is more expensive than asphalt based on natural aggregates. This is mainly due to the costs of screening and drying the glass and then blending it with natural aggregates.

In the case of Invercargill City, the costs of using glassphalt were around \$20,000 higher than using natural aggregates. This is based on 500t of glass i.e. \$40t. Interestingly, this is lower than the Invercargill City landfill cost of \$45/t.

### **3.6.10 Concrete (Glasscrete)**

Glass can be used to substitute some of the aggregates used in concrete production. Concrete containing glass cullet as an aggregate is sometimes called “glasscrete”

The major drawback of using recycled glass is that chemical reactions occur which may reduce the strength of the concrete or cause it to crack. These chemical reactions include sugar contamination and the alkali in the cement can react with the silica in the glass.

Various processing strategies can be implemented to manage these problems, but generally these make the glasscrete more expensive than concrete manufactured from natural aggregates.

### **3.6.11 Pipe Bedding**

Fine sized crushed glass (< 5mm) can be used as a substitute for bedding sand (or crusher dust), for applications such as block paving and pipes.

## **3.7 Landfill Cover**

Glass aggregate is a suitable media for landfill cover. It has been successfully used overseas both mixed in with topsoil and natural aggregates and as 100% used glass.

Many landfills apply a daily landfill cover of coarse sand/aggregate. Frequently they use clean fill from excavations, road or construction waste. Many landfills charge a tipping fee to receive clean fill suitable for landfill cover. Crushed glass would probably not be suitable for final cover, which is usually a mixture of levels of sand, clay and topsoil.

Some locations from time to time have a shortage of suitable cover materials and quarry, process and transport their cover. Examples are Dunedin and Timaru. This presents an opportunity to use waste glass for landfill cover.

Typically glass used for landfill cover would require minimal reprocessing – either coarse crushing or rough breaking using landfill machinery/vehicles. The glass can tolerate a high level of contaminants and does not have to be colour sorted, so this could be a good use for cullet unsuitable for other applications

A provincial landfill will utilise from 50,000t to 250,000t of landfill cover per annum. Large metropolitan landfills could use much more than this. Landfill cover is a low value use for glass, however it could be economically viable if the costs take account of waste diversion.

## **3.8 Sports Turf and Golf Bunkers**

Several overseas studies have demonstrated that glass sand is a suitable substitute for natural sand for sports turf applications, especially golf courses.

A typical golf course will use 2,000 – 3,000 tonnes of sand per year for bunkers, divot repairs, and dressing of fairways, greens and tees. UK and USA trials have shown that a significant proportion of this could be replaced by glass sand. In particular glass sand is suitable for root zone construction and conforms to USGA specifications although it requires careful management of pH levels.

Specifications require a minimum of fines (minute sand particles), so the glass needs to be screened with the fines removed. These fines could be separated through screening and used for other applications such as pipe or block paver bedding.

Discussions with the NZ Sports Turf Research Institute indicate a shortage of good quality sand for golf courses and other turf applications in the Marlborough and Wellington region. Golf courses in these areas “import” sand from the Waikato River at up to \$80 per tonne.

## **3.9 Sandblasting and Abrasives**

Processed recycled glass has been used as an abrasive blasting medium throughout the USA and UK for a number of years and more recently in New Zealand.

Glass beads are manufactured from new or recycled glass. They are spherical in shape and are especially suitable where fine surface finishing is required. Manufacturing glass beads requires a substantial capital investment and there are no commercial production facilities in NZ. Glass beads are not widely used in NZ.

Finely sized crushed glass is a suitable blasting abrasive, but tight gradation requirements must be met, and the glass must be relatively clean of contaminants, dry and dust-free.

Simply crushing and rough grading the glass will produce poor quality, low value product. Finely-sized crushed glass has an angular grain shape, meaning it removes paint and scale quickly, but depending on the grading size the surface finish may not be as fine when compared to other abrasives.

RMF has been instrumental in developing the South Island markets, and supply a wide South Island customer base. Several other South Island manufacturers crush glass for sale or for their own use.

Around 250t of recycled glass was used for industrial abrasive applications in 2004. Costs vary between \$90/t and \$200/t. One major engineering company in Greymouth organises their own bottle collection, carries out their own crushing and uses the resulting cullet in their sandblasting operations.

### **3.9.1 The Market Structure**

Shot blast/sandblasting is a mature industry, with a large number of established contractors, typically employing less than 5 people. The contractors include specialists through to general engineering companies that carry out their own shot blast activities.

### **3.9.2 Competition**

Garnet – imported from Australia or India. Costs \$500/t but can be reused a number of times before it disintegrates to powder. Provides a good quality finish, especially on new steelwork.

### **3.9.3 Barriers to Market Development:**

There is misinformation within the abrasive processing industry about the health risks of using crushed glass. Many operators are aware of the disease silicosis, caused by using sand or silica sand as an industrial abrasive. Despite the risks many operators still use sand. However other operators believe that glass sand presents the same health risk and will not use it. During manufacturing crystalline silica is converted to an amorphous state and tests have shown that recycled container glass contains less than 1% crystalline silica, which is well below health and safety standards and with correct protective equipment and procedures, glass presents minimal risks<sup>5</sup>.

Within the industry there is a general consensus that blasting be at as high a pressure as possible to finish the project quickly. However test findings have shown that improved results can be achieved by carefully adjusting the metering rate, nozzle size and pressure levels, in order to achieve the maximum level of performance.

The lack of suitable glass processing facilities and technical knowledge to manufacture higher value clean, finely sized crushed glass. This has led to two issues: (1) Operators may have tried recycled glass, but have been disappointed by the results when compared to alternative abrasives. Often this is due to the quality of product supplied and its suitability for the particular type of shot-blasting application (2) Shot blast operators find the price uneconomic, because they use the glass in an identical manner to other abrasives, whereas glass has its own characteristics and optimum usage standards.

RMF and other manufacturers have developed their own proprietary data and specifications, but due to commercial sensitivity keep this information confidential. This makes it more difficult for new operators to enter the market.

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<sup>5</sup> Reference: Recycled Glass Market Study & Standards Review – 2004 Update, p45, WRAP (UK) May 2004 and

### **3.9.4 Advantages**

Sandblasting is not colour sensitive, so there is no need to colour-sort the glass. This means sandblasting may be a suitable higher-value application for stockpiles of mixed-colour glass.

Cost effective. Finely crushed glass is very good for off-site and outdoor work, where the abrasive medium will not be collected for recycling e.g. bridges, storage tanks, farm equipment and machinery.

### **3.10 Landscaping and Decorative Aggregates**

Glass can be used as a decorative mulch and landscaping aggregate. It is usually crushed, graded and then tumbled.

The crushed glass can be used as a substitute for other garden decorative products such as natural or polished stones/chips or bark/wood chips. Stephenz Marketing from Christchurch import and sell a range of Indonesian glass chip made from tumbled glass. They sell less than 2 tonne per year in 1kg or 20kg bags at around \$1.50 - \$2.00 per kg mainly into independent garden centres and home/interior decorating stores.

The South Island market is small and, according to Stephenz Marketing, very resistant to change. However their marketing was very low key and did not focus on the product being made from recycled glass.

The major chains that supply landscaping products (Warehouse, Mitre 10, Buntings etc.) do not stock glass chip.

There is an opportunity to manufacture decorative glass chip, made from local recycled glass. The key to a successful enterprise would be developing effective marketing strategies and a strong distribution network. It requires a good quality feedstock, accurately colour sorted and largely free from contaminants.

### **3.11 Filtration and Drainage**

Natural sand is one of the most common products used in water filtration systems.

Crushed glass is a potential substitute that can be used for filtration applications such as in the treatment of potable water, municipal wastewater, industrial wastewater, swimming pool water and various aquaculture and fish farming applications.

UK firm Dryden Aqua Ltd has developed AFM – a highly successful recycled glass filter media. It is used in a number of sites including swimming pools and wastewater treatment facilities in the UK and Europe. Jonkers Filtration in Auckland is the NZ importer and distributor for AFM products in NZ. Jonkers have supplied AFM filtration media to Kelly Tarltons (aquarium tourism attraction), aquaculture and wastewater treatment. There is potential for an AFM manufacturing plant to be established in Australia, but it is unlikely the proprietary AFM product will be manufactured in NZ.

RMF have developed an effective recycled glass filtration product. This is being marketed for use in swimming pools and wastewater treatment systems.

#### **3.11.1 Swimming Pools**

A municipal swimming pool could have up to 40t of sand that typically needs to be changed every 3-5 years. The potential South Island Market is unknown but could be as high as 500t per annum. Swimming pool filtration media sells for \$300-\$350/t.

For swimming pools the key advantages of using recycled glass include reduced filter clogging, reduced requirement for additional chemical treatments and reduced backwashing mean less waste and significant cost savings.

There is potential to develop this market, possibly through technology transfer from UK or through extension of the work currently being carried out by RMF.

### **3.11.2 On-site Domestic Wastewater Systems**

On-site domestic wastewater systems such as septic tanks and land-application are covered by AS/NZS 1547:2000. This standard does not preclude the use of any material, including recycled glass, provided the completed system and installation meet the performance requirements of this Standard. Many on-site domestic wastewater systems include filters, trenches and beds constructed with natural sand. Recycled glass sand could be substituted for these natural sands.

The use of glass sand as an alternative to conventional filter sand may lower construction costs and improve the overall performance of the treatment system.

It is not known how many septic tank systems exist in the South Island but it is estimated there may be at least 20,000. With each system requiring 1-2t of sand filter media, the potential market could be as high as 40,000t. Current prices for conventional sand are \$20-\$25 tonne.

### **3.11.3 Municipal Wastewater Systems**

Sand filtration may be used as a tertiary stage in municipal wastewater treatment, particularly in small wastewater treatment plants.

Queenstown Lakes District Council has plans to use recycled glass in drainage fields for new wastewater treatment plants to be established in Queenstown and Wanaka. This would require significant quantities of glass sand – potentially 500t per drainage field.

## **3.12 Ceramics**

RMF have been working for a number of years to develop tiles manufactured from recycled glass. They are currently at the stage of developing a pilot to commercialise production. Reports indicate that at full capacity they could consume up to 3,000t of used glass per year. There are indications that commercial tile manufacturers in the North Island are keen to use glass as a raw material.

Innolasi Oy, a Finnish company, has developed Ekolaatta (exterior wall-cladding tile) made from recycled glass. Over 95 % of the raw material for this tile is waste glass. This product is marketed as a premium material and is expensive compared to other cladding materials.

## 4 Economic Analysis

### 4.1 Glass Recycling Costs

The scope of this study does include and an analysis of glass recycling costs. However it is worth noting that under the current arrangements, the full cost of post-consumer glass recycling is borne by ratepayers. Producers and consumers do not contribute directly to this cost. Recycling, like waste collection, is generally not considered a free service, but is paid for as a community service through rates. For recycling glass markets to be sustainable, there has to be money set aside for the collection, recycling and marketing of glass.

### 4.2 The Economics of Sending Recovered Glass to ACI

ACI purchases cullet from its Principal Supplier Network. The prices paid by ACI to suppliers are commercially confidential information. However publicly available information suggest the prices paid for clear cullet are \$10/t and for green or amber cullet between \$75/t and \$85/t.

Shipping of glass cullet from the South Island is usually done in open top containers or coal wagons. These 20 foot containers hold 16-20 tonne of compacted glass.

The following are the quoted costs to transport a container to ACI in Auckland. This includes pickup, delivery and container return.

Place of origin	Container Price	Cost per tonne
Christchurch	\$1,600.00	\$80 - \$100
Timaru	\$2,000.00	\$100 - \$125
Invercargill	\$3,840.00	\$192 - \$240

Using these figures it is clear a best outcome would be to break-even for coloured cullet. A worst-case scenario would be for the glass to be rejected, and the full container returned to place of origin.

### 4.3 The Economics of Crushing Recovered Glass

One of the essential steps to converting recovered glass into a resource suitable for use in other applications and markets is crushing or pulverising the glass, then screening or grading the glass to meet customer specifications.

Glass can be crushed using a variety of methods depending on the proposed applications. Generally speaking, lower cost crushing methods produce a lower value resource, which in turn can only be used for low value applications.

Following is an analysis of several different approaches as an indication of the economics of crushing recovered glass.

#### 4.3.1 Breaking Glass Using Heavy Machinery

This approach produces a very coarse, ungraded crushed glass suitable for low value applications such as landfill cover. Large heavy earthmoving machinery such as that used at landfill sites, for road construction or construction excavation is driven over crushed glass stockpiles, until glass is crushed to the desired level. Using equipment such as vibrating rollers, glass can be crushed to finer levels.

The advantages of this approach are high throughput and low cost – less than \$2/tonne. Also there are minimal issues with contamination or colour sorting.

The disadvantages are the limited markets and the low value, plus potential health and safety issues.

### 4.3.2 Crushing Glass Using Portable Crushing Equipment

There are a variety of portable crushing systems available specifically designed for glass or designed for other uses, but easily adapted to glass usage. Many of the larger aggregate supply companies have portable crushing and screening equipment that can produce graded crushed glass.

There are several variables with crushing glass using a portable crushing system.

- The required specification for the crushed cullet – what level of screening is required. A higher specification means higher costs
- The location of the waste glass stockpile (transport costs to move crusher to stockpile).

#### Examples

The following examples are based on indicative figures provided by South Canterbury Screening and Crushing. Examples do not take into account other handling or waste disposal costs.

Fixed cost of using portable crusher \$3500

Transport Cost to move crusher to site \$5/km

Processing cost to crush and screen to minus 7mm \$25/t

1. Cost to process a 500t stockpile in Timaru (no transportation charge) is:  
 $\$3500 + (500t \times \$25/t) = \$16,000$ . This equates to \$32/t.
2. Cost to process a 1000t stockpile in Central Otago (700km round trip) is:  
 $\$3500 + (700km \times \$5/km) + (1500t \times \$25/t) = \$44,500$ . The equates to \$29.67/t

### 4.3.3 Crushing Glass Using Fixed Crushing Equipment

The aggregate industry uses a variety of aggregate crushing systems that can be adapted for crushing glass. Some aggregate suppliers will provide a crushing service on a per tonne or hourly basis. As these have a fixed location, it is necessary to transport waste glass to the crusher.

There are several variables associated with crushing glass using a fixed crushing system.

- The required specification for the crushed cullet – what level of screening is required. A higher specification means higher costs
- The location of the glass stockpile (transport costs to move stockpile to the crusher).

#### Examples

The following example is based on figures provided by South Canterbury Screening and Crushing and Fulton Hogan, Timaru. Examples do not take into account other handling or waste disposal costs.

Fixed cost of using portable crusher From \$0

- |  |   |
|--|---|
| Transport Cost to move glass to crusher site     | \$0.115/t per km includes return <sup>6</sup> |
| Processing cost to crush and screen to minus 7mm | \$15/t  |
3. Cost to process a 500t stockpile in Timaru (assume 50km one way trip) is:  
 $\$0 + (500t \times 50km \times \$0.115) + (500t \times \$15/t) = \$10,375$ . This equates to \$20.75/t.
  4. Cost to process a 1000t stockpile in Central Otago (assume 700km round trip) is:  
 $\$0 + (1500t \times 700km \times \$0.115) + (1500t \times \$15/t) = \$143,250$ . This equates to \$95.50/t.

#### 4.3.4 Waste Diversion Savings

Following on from 4.2.1 and 4.2.4 above, it is possible to calculate the savings from diverting used glass from the waste stream.

Landfill charges in Timaru are \$64/t and in Central Otago \$84/t. Assuming the crushed glass was utilised for other applications, there would be potential waste diversion savings. Using the above examples savings identified would be:

1. Example 1 - potential waste diversion saving of \$32/t.
2. Example 2 - potential waste diversion saving of \$54.33/t.
3. Example 3 - potential waste diversion saving of \$43.25/t.
4. Example 4 - potential waste diversion cost incurred \$11.50/t.

This approach could lead to a council funding the cost or part-cost of reprocessing glass out of the landfill management budget. Taking example 1, the total waste diversion saving for a 500 tonne stockpile would be \$16,000. This could be used to fund the crushing costs.

These waste diversion savings do not take account of other costs such as handling, consents, waste disposal of contaminants e.g. tops, or marketing and transportation costs for the crushed glass cullet.

On the other hand they do not take account of the potential revenue streams from the sale of crushed glass material or products.

#### 4.3.5 Establishment Costs

The above strategies are based around contracting the glass crushing activities to existing aggregate supplier.

An alternative approach is to establish a purpose built glass crushing operation.

The entry costs depend on the scale of the glass crushing operations and whether new or second-hand equipment is used. Scale can range from small mobile systems that process 1 tonne per hour to 1000 tonne or more per day.

Streetsmart, the recycling contractor in Tasman have recently commissioned a modified, second hand glass crushing hammer mill. The actual capacity is unknown as yet, but it is probably in the 3-5 tonne per hour range. This system cost about \$25,000 and it produces graded glass cullet or sand at \$20-30/tonne.

RMF have constructed a much larger glass crushing and screening facility in Christchurch. This system has a capacity of 3-10 tonne per hour depending on customer requirements. The initial capital cost was \$336,000, but further capital has been spent since then to improve the efficiency and capabilities of the machinery.

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<sup>6</sup> Transport costs are based on 26tonne truck and trailer unit. This could be considerably reduced if the transport was on a lower cost back load. Other transport options such as rail or road/rail combination need to be investigated further.

Large portable systems such as the unit recently purchased by South Canterbury Screening and Crushing require multi-million dollar investments.

In considering costs, it is also important to take account of other capital and establishment costs such as licences and consents (dependent on the location), land and buildings, screening and drying equipment, handling equipment (front end loaders, conveyors, weighing systems) and transportation equipment as well as personnel training, commissioning testing and trials.

## **4.4 Employment Opportunities**

No figures are available for the number of people employed in the resource recovery and recycling industry in the South Island. However, we know that in the South Island that working in this area, there are an estimated 200 community groups, 45 commercial contractors along with 27 regional, city and district councils.

As more regions adopt kerbside recycling and establish resource recovery centres, employment in the recycling industries will continue to increase.

Generally those employed in the collection, sorting and recycling activities have low skills or are unskilled.

This profile is slowly changing as more community entrepreneurs such as RMF and Wastebusters Canterbury become established and expand into new markets.

Moving into new markets creates new employment opportunities in established firms (e.g. crushing machinery operators and recycling contractors) or new businesses (e.g. sorters, marketers, turf managers).

### **4.4.1 Jobs Created**

Each of the enterprise opportunities identified in section 5, has the potential to create new part and full-time jobs both in existing firms and start-up businesses. We have identified potential for up to 17 full time equivalent jobs.

New jobs are most likely in the following regions:

- Communities where glass has a competitive advantage over substitutes. Examples are
  - Marlborough – currently does not sort or stockpile glass, opportunity to market glass sand for golf courses and sports turf, potential for community group or contractor for 1-2 full time equivalent (FTE) jobs
  - Timaru – currently stockpiles glass, but does not have kerbside recycling, opportunity to crush glass for fill, landfill cover, glassphalt, potential for community group or contractor to add 0.5 – 1 full time equivalent jobs
  - Dunedin – currently stockpiles glass, opportunity to crush glass for landfill cover and other fill applications, potential for contractor to add 0.5 FTE.
  - Stewart Island – currently stockpile glass, opportunity to invest in crushing equipment to crush glass and sell to DOC as aggregate for walking tracks, potential for 0.5 FTE
- Communities where other recycling and resource recovery enterprises already exist. Examples are:
  - Ashburton (Wastebusters Canterbury), Christchurch (Recovered Materials Foundation), Alexandra (Central Otago Wastebusters), Wanaka (Wanaka Wastebusters), Streetsmart (Tasman and Nelson). Potential for 5-8 FTE
- Other communities – Potential for up to 3-5 FTE

## 5 Summary of Enterprise Opportunities

### 5.1 General Fill/Backfill

Market Opportunity	Use crushed glass as a substitute for natural aggregates used as general fill and backfill. Depending on the application can use 15% to 100% glass cullet. The proposed approach is to crush glass and market to aggregate supplier or crushing contractor or direct to building contractors, DIY, farmers etc.
Locations	All over the South Island, but will depend on the availability and cost of locally sourced natural aggregates
Market Size	Unknown but large
Capital Cost	Dependent on style of operation.
Operating Cost	Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km). A minimum charge would apply and a back-load could reduce charge.
Labour needs	Dependent on style of operation. 1-2 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$20/t - \$25t . To be economic would need to recognise the cost of waste diversion
Potential Industry Partners	Local Council, Glass Collection Contractor, Aggregate Suppliers or Crushing Contractor, Building/Construction Contractors
Market Development Strategies	Identify potential council or private projects that require fill. Build relationships with supportive builders and initiate trial. Source technical information and educate council, engineers and building contractors.

### 5.2 Road/Highway Construction

Market Opportunity	Use crushed glass as partial substitute for sub-base or base roading material.
Locations	All over the South Island
Market Size	Large
Capital Cost	Dependent on style of operation.
Operating Cost	Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km). A minimum charge would apply and a back-load could reduce charge.
Labour needs	Dependent on style of operation. 1-2 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$15/t - 20/t . To be economic would need to recognise the cost of waste diversion
Potential Industry Partners	Transit NZ, Local Council, Glass Collection Contractor, Aggregate Suppliers, Crushing Contractor, Roding Contractors
Market Development Strategies	Obtain information from Transit New Zealand and internet sites. Work with local contractor to specify and lab test glass aggregate mixture. If it meets requirements, then Transit will add to their standards as an approved mixture. Once approved then this mixture can be used in any roading application anywhere in NZ that meet the requirements.  Once approved, get local council to specify waste minimisation as part of green procurement contracts

### 5.3 Glassphalt

Market Opportunity	Use crushed glass as a substitute for up to 15% of the aggregates used in asphalt for footpaths, carparks, residential driveways etc. Crush glass and sell to existing asphalt contractor
Locations	All over the South Island
Potential Market	Large – example in Invercargill estimated 500t for one year footpath programme using 15% glassphalt mix.
Capital Cost	Dependent on style of operation.
Operating Cost	Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km). A minimum charge would apply and a back-load could reduce charge.
Labour needs	Dependent on style of operation. 1-2 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$20/t - \$25t . To be economic would need to recognise the cost of waste diversion
Potential Industry Partners	Local Council, Glass Collection Contractor, Aggregate Suppliers, Crushing Contractor, Roding Contractors
Market Development Strategies	Obtain information from Transit New Zealand and internet sites. Get support from the local council to specify glassphalt for a local contract. Does not have to be roadway – could be footpaths, driveways or carparks. Work with the contractor to adjust grading. Get local council to specify waste minimisation as part of green procurement policies.

### 5.4 Pipe and Paver Bedding

Market Opportunity	Use very finely crushed glass as a substitute for up to 100% of the aggregate/sand used in pipe or paver bedding. Crush glass and sell to drainlayers and other building contractors. Identify potential retail outlets for sale to home/DIY market by the trailer load.  “Crusher dust” could be produced in conjunction with other larger aggregates perhaps used for drainage or in sports turf applications.
Locations	All over the South Island
Potential Market	Unknown
Capital Cost	Dependent on style of operation.
Operating Cost	Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km). A minimum charge would apply and a back-load could reduce charge.
Labour needs	Dependent on style of operation. 1-2 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$20/t . To be economic would need to recognise the cost of waste diversion
Potential Industry Partners	Local Council, Aggregate Suppliers, Crushing Contractor, Plumbing and Drainage Contractors, Drainage and Irrigation Engineers
Market Development Strategies	Identify potential projects – either domestic or commercial e.g. repaving CBD/mainstreet etc. Get support from council to specify waste minimisation as part of green procurement policies.

## 5.5 Landfill Cover

Market Opportunity	Use crushed glass as a substitute for clean fill/natural aggregates used as daily land fill cover. Can use 100% broken mixed glass or mix glass with other clean fill. Suitable for markets where there is a shortage of clean fill suitable for daily landfill cover.
Locations	All over the South Island, will depend on policies of landfill operator and resource consent issues applicable to landfill.
Market Size	Unknown but potentially large – total glass in each location would be a small percentage of daily landfill cover requirements.
Capital Cost	Dependent on style of operation, but potentially minimal if use existing landfill equipment to rough break to a coarse cullet..
Operating Cost	Minimal crushing charges > \$2/tonne and use existing landfill staff
Labour needs	Machinery operator. 0.5 FTE per enterprise.
Potential revenue	Nil. But potentially cost savings if landfill operator has costs to acquire clean fill Potential loss of clean fill charges.
Potential Industry Partners	Local Council, Landfill Operator, Resource Recovery Contractor
Market Development Strategies	

## 5.6 Sandblasting and Abrasives

Description	Use crushed glass sand as a shot blasting abrasive. Industry requires uniformly sized glass. Crushing and screening system must be able to extract contaminants and meet accurate specifications.
Locations	All over the South Island, particularly in larger towns and cities
Potential Market	Unknown but RMF already provides 100t around the South Island, and Greymouth operator produces 150t glass sand per annum of own use. Potential to increase market
Capital Cost	Requires investment in crushing equipment or working closely with crushing contractor to ensure glass meets specification. Will take some time to establish best processes to meet customer requirements.
Operating Cost	Hire/crushing charges <\$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km) and labour Would need some areas to run trials, with ongoing evaluation and testing
Labour needs	Three major labour requirements. Quality control – glass preparation - colour sorting and extracting contaminants, Crushing operations and transport dependent on structure, Shot Blast Industry expertise would be beneficial. From 2-3 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$80 - \$100/t
Potential Industry Partners	Shot Blast Operators and Heavy Engineering companies
Market Development Strategies	Entry is inhibited by the existence of RMF as the incumbent market leader for recycled glass sand. RMF has understanding of market and customer requirements. RMF has spare capacity to meet increased demand. Best strategy is to focus on local markets – low volume, high value.

## 5.7 Golf courses

Description	<p>Use crushed glass as a substitute for sand used on golf courses for bunkers, repairing divots, and dressing of fairways, greens and tees.</p> <p>The proposed approach is to crush glass to requirements and sell to golf courses, or could sell to existing suppliers or through sports turf managers/green keepers</p> <p>Some colour sorting and removal of contamination may be required as some turf applications are colour dependent</p>
Locations	All over the South Island but in particular in Marlborough
Potential Market Size	<p>Over 100 golf courses in the South Island. Sand requirements 1,000 - 2,000t per annum. Potentially a very large market.</p> <p>Marlborough is known to have a shortage of sand suitable for golf courses dressing and bunkers. 3 full size golf courses and 6 half-size courses in the district. Potential market 5,000t per annum – compare this with total glass collected in Marlborough of only 450t per annum.</p>
Capital Cost	Dependent on style of operation.
Operating Cost	<p>Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km).</p> <p>Labour</p> <p>Would need some areas to run trials, with ongoing evaluation and testing</p>
Labour needs	<p>Three major labour requirements:</p> <ul style="list-style-type: none"> <li>• Quality control – glass preparation - colour sorting and extracting contaminants.</li> <li>• Crushing operations and transport dependent on structure. Need to remove fines and clean/dry-crushed glass.</li> <li>• Turf expertise beneficial</li> <li>• 1-2 FTE per enterprise in crushing, transportation and marketing.</li> </ul>
Potential revenue	\$20- \$80/t
Potential Industry Partners	<p>Golf Course Operators, Turf Managers/Green keepers, Sport Turf Research Institute and other professional turf associations.</p> <p>Plus local councils for publicly owned sports grounds</p>
Market Development Strategies	<p>Obtain information from Sports Turf Research Institute and internet sites. Use information to gain support from local golf course to run trials – start with simple applications such as repairing golf divots, or seeding tees, build up to fairways and greens. Work with the turf managers to adjust grading/colour specification. Full-scale trials may be required as a second step.</p> <p>Focus on market penetration one golf course/sports turf at a time.</p> <p>Once specifications and quality control are in place can sell to other areas</p>

## 5.8 Landscaping and Decorative Aggregates

Market Opportunity	<p>Use crushed glass as a substitute for natural decorative sand and stone. Can be used for general landscaping (medium value, high volume), niche decorative landscaping (high value, low volume), or ornate work such as aquariums/decorative vases, fountains etc. (high value, low/niche volumes).</p> <p>Quality control essential, with colour separation essential. Need to hand select bottles from main glass stockpiles. Glass is put through breaking process, tumbled and graded, then bagged as either.</p> <p>Ideal to work in with other resource recovery operations. Remainder of glass can be processed and used for other applications</p>
Locations	Major metropolitan areas, export to North Island.
Market Size	Small/Niche
Capital Cost	Small. Small size crusher required, plus a tumbler (concrete mixer) Market and packaging research.
Operating Cost	Labour intensive.
Labour needs	Sorting, machinery operator, packing, marketing. 2-3 FTE per enterprise.
Potential revenue	\$500/t - \$2500/t
Potential Industry Partners	Distributors e.g. Mitre 10, Warehouse, or suppliers that sell to these chains.
Market Development Strategies	<p>Undertake market research with major chains and independent nurseries and landscape centres. Need a good understanding of decoratives market.</p> <p>Need to be aware of branding, positioning (not a budget product), packaging and marketing (strong recycled glass message).</p>

## 5.9 Filtration and Drainage

Market Opportunity	Use crushed glass as a substitute for natural sand used as filtration and drainage media. Depending on the application can use 15% to 100% glass cullet. The proposed approach is to crush glass and market to aggregate supplier or crushing contractor or direct to building/drainage contractors.
Locations	All over the South Island, but will depend on the availability and cost of locally sourced natural aggregates
Market Size	Unknown but large
Capital Cost	Dependent on style of operation, but need good quality management to insure crushed glass meets specifications..
Operating Cost	Hire/crushing charges \$15 - \$25t. Transport charge around \$3/km for a 26t truck and trailer unit (\$0.12/t per km)
Labour needs	Dependent on style of operation. 1-2 FTE per enterprise in crushing, transportation and marketing.
Potential revenue	\$20/t - \$25t . May need to recognise the cost of waste diversion
Potential Industry Partners	Local Council, Glass Collection Contractor, Aggregate Suppliers or Crushing Contractor, Building/Construction Contractors
Market Development Strategies	Identify potential council or private projects that require filtration or drainage media. Build relationships with supportive builders and initiate trial. Source technical information and educate council, engineers and building contractors.

## 5.10 Ceramics

Market Opportunity	Crush glass and mix with bonding agents to prepare recycled glass tiles, benchtops , terroza flooring and bricks.
Locations	MajoAll areas, potential to export to North Island.
Market Size	Unknown, but would be competing in well established markets e.g. house cladding/flooring etc.
Capital Cost	Medium to large. Requires suitable crushing/screening equipment (although this could be hired/contracted), plus suitable ovens/kilns and molding equipment.. Market and packaging research.
Operating Cost	Capital intensive activities.
Labour needs	Sorting, machinery operator, packing, marketing. – 1-2 FTE per enterprise.
Potential revenue	\$500/t - \$5000/t
Potential Industry Partners	Building supply companies, importers and distributors.
Market Development Strategies	Extensive market and product research required to reach commercial stage. RMF have proprietary knowledge in this area. Need a good understanding of markets and manufacturing processes. Need to be aware of branding, positioning (not a budget product), packaging and marketing (strong recycled glass message).

## 6 Conclusions

In conclusion, it can be seen that the reduction in cullet prices paid by ACI, along with increased transportation costs will have a significant impact on glass recycling activities throughout the South Island. The likely major effects will be:

- Significant reduction in the quantity of glass sent to ACI for recycling.
- Significant increase in the quantity of glass stockpiled and land filled.

A number of viable opportunities to establish or expand markets for waste glass exist. These opportunities vary considerably:

- High value markets such as ceramics, decorative aggregates and sandblasting abrasives tend to have high quality requirements and consume low volumes of waste glass.
- Low value markets such as construction aggregates and filtration media, usually have lower quality requirements, but have the potential to consume higher volumes of waste glass.

There are some common barriers to market development.

- Lack of information.

An effective process is required to disseminate this information to potential market entrepreneurs.

It is not necessary to develop these markets from scratch. The USA, UK and Europe have all faced the issues of rising glass waste volumes and they have already implemented strategies and responses to deal with these problems. NZ can gain valuable insights from their research work and their product and market developments.

- Lack of technical expertise.

Waste glass is a relatively immature market and there is a shortage of appropriate expertise. Developing markets for waste glass requires industry knowledge (e.g. on crushing and screening glass for specific applications) and technical knowledge on target markets (e.g. roading, construction and sports turf management).

- Lack of marketing expertise

Effective marketing and distribution channels are a key to developing recycled markets. There is a shortage of skills and experience in this area – they are not seen as attractive markets to work in.

- Lack of standards and specifications

Glass cullet can be processed to conform to existing standards for gradation, debris level and compaction level. However there is a lack of agreed standards as to the level of cullet content for specified applications. Standards are being developed overseas based on testing and field trials, but standards have generally not yet been applied in NZ.

Establishing standards can be an expensive process. Financial support is required to assist companies and organisations willing to undertake projects to establish standards.

- Access to resource

Under some municipal waste and resource collection agreement, the contractor is responsible for collecting and disposing of the resource. While this may benefit the council and the contractor, it potentially excludes community entrepreneurs from easy access to the resource.

- Competing products

In most cases it is unlikely that recycled glass could be collected, processed, blended and delivered to a construction site or factory and compete with the cost of natural aggregate or sand. However, if the right kinds of economic incentives are in place, glass aggregate could be a “relief valve” for excess collected material. To make these markets viable requires the recognition of waste diversion i.e. landfill cost savings as the waste glass is used for other applications.

## 7 Recommendations

### **Add Glass Aggregate to Transit NZ Specifications**

Initiate a project to obtain approval for glass base or sub-base aggregate mixtures for use in the roading industry. There would likely be a three-stage process.

- (1) Enlist the cooperation of an aggregate supplier and roading engineer to design appropriate glass aggregate mixture based on overseas experience and specifications.
- (2) Enlist the cooperation of an aggregate supplier and roading engineer to design appropriate glass aggregate mixture based on overseas experience and specifications.
- (3) Have the mix tested through Transit NZ laboratory-testing procedures – funding may be available to assist with this step through Transit. Assuming the glass aggregate mixture passes required tests, it can be added as an approved formula to Transit specifications. This means engineers, councils, roading contractors etc. are permitted to specify and use this mixture.

### **Develop Glass Aggregate Specifications for Construction**

Develop and gain approval for specifications for glass aggregate mixtures for use in the building and construction industry.

### **Establish a Full-Scale Mobile Glass Crushing Trial**

Establish a full-scale mobile glass crushing trial. This would be used to verify the set-up and pack-out costs, transportation costs and the processing costs. It would also be used to identify the throughput volumes and any processing considerations. This trial will validate the economic viability of crushing glass and potentially assist with formulating a business case for mobile crusher circuit around the South Island. It is essential this project be linked with the establishment of markets for the crushed glass.

### **Expand study to include North Island**

This study has focused on the glass markets and opportunities in the South Island. There has been considerable interest and input from North Island groups also affected by the changing market for glass cullet. Expand the study to include the North Island.

### **Implementation Support and Coordination**

To develop *sustainable* glass markets, community groups, contractors and councils need support including:

#### **Information distribution**

Sourcing and distributing information to interested organisations and groups

#### **Sourcing and funding technical, business and marketing expertise**

Sourcing and potentially funding affordable technical and marketing expertise.

Financial support for market development including preparing business and marketing plans and for establishment costs.

Gaining access to glass resource e.g. where glass is owned and controlled by council or contractor.

## **Maximise use of overseas knowledge and experience**

Ensure maximum use is made of overseas knowledge e.g. acquire overseas research and experience, study overseas markets and models, undertake study tours and bring in overseas experts.

## **Coordinate market development activities.**

Some of the enterprise opportunities identified, such as the decorative landscaping, would be relatively easy to implement but is a very small market. If a number of groups focused their efforts on developing landscaping products, the market may quickly become overwhelmed in the rush and leading to a lack of enterprise sustainability.

## **Increased support for existing initiatives**

Some organisations have plans to develop recycled glass markets (Orvco – foam glass insulation) or have projects underway (RMF – glass tiles). Identify what can be done to support these organisations. What are the market development barriers they face? What can be done to minimise or eliminate these barriers?

## **Zero Waste – Ongoing Role**

Zero Waste should take an active and ongoing role to implement the above recommendations. This will require further funding and resources including project management and research.

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## Acknowledgements

Zero Waste New Zealand Trust and Chris Thomas gratefully acknowledges the time and valuable input given by the companies and individuals interviewed as part of this project. Special appreciation and gratitude would like to be expressed to the following:

Alan Buxton, Central Otago District Council
Alan McDonald, Fulton Hogan
Andrew James, Nelson City Council
Brendon Hannam, Sports Turf Research Institute (NZ)
Brett King, Fulton Hogan
Brian Court, Screening and Crushing Systems Ltd
Brian Gallagher, Timaru District Council
Bruce Irwin, Hydroponic Garden Supplies
Clare Higginson, Central Otago Wastebusters
Craig Bullivant, Toll Rail
Donna Peterson, Southland District Council
Dr. Andy Owen, Sports Turf Research Institute (UK)
Eddie Gray, Gray Brothers Engineering
Emma Guard, Gore District Council
Geoff Hemm, Streetsmart Tasman
Greg Arnold, Transit NZ
Greg Brosnahan, Hilton Haulage
Ian Gould, Hadlee & Brunton Plumbers
Ian Taylor, Orvco
Jeff Waters, Fulton Hogan
Jeffrey Hinton, The Sandblaster
John Cocks, Full Circle
John McGartland, MacKenzie District Council
John Patrick, Opus
John Ransley, Innovative Waste

John Ritchie, Envirowaste
John Trigg, Auckland
John Webber, Packaging Accord
Kelvin Strong, Aggregate and Quarry Association
Les Jonkers, Jonkers Filtration Systems
Linda Wright, Queenstown Lakes District Council
Louise Palmer, Full Circle
Mike Small, Blast Tech
Molly Anderson, Hurunui District Council
Murray Cleverley, Aoraki Development Trust
Paul Smith, South Canterbury Crushing and Screening
Peter Fredrickson, Materials Processing Ltd
Peter McConnell, Grey District Council
Richard Cotton, Westland District Council
Sarah Gordon, Recovered Materials Foundation
Sean Penrith, Green Glass Inc. (USA)
Sharron Jerrob, DB Breweries
Sheryl Stevens, Wastebusters Canterbury
Stephen Rhodes, Stephenz Marketing
Stephen Rooney, Marlborough District Council
Terry Baker, Dunedin City Council
Terry O'Neil, Waitaki District Council
Tom Greenwood, Invercargill City Council
Tony Robertson, Buller District Council