Re Using the Construction Waste Remaind After Effect of Natural Disaster

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Abstract- *Our project deals with re using the construction waste remained after effect of natural disaster Construction and demolition (C&D) waste is a general term for a diverse range of materials that, when segregated, can include high-value materials and resources for new construction. The definition of C&D waste used in this report is from the National Waste Report 2010: ... waste produced by demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities. The C&D waste stream usually covers only some of the generation, disposal and recycling of C&D wastes, as these materials can also be found in the Municipal Solid Waste (MSW) and Commercial and Industrial (C&I) streams, or as hazardous wastes. There are many opportunities to extract value from the C&D waste stream as described within the material profiles below. Construction and demolition recycling and re-use—industry standard practice Re-use and recycling of some materials and resources is becoming industry standard practice. For example, landfill charges provide an incentive for high recycling rates of massive materials, such as masonry materials (asphalt, bricks and concrete). Reclamation rates for high-value materials, such as metals and hardwood timbers, have also increased. Material profiles The Australian Government recently carried*

I. INTRODUCTION

Governments worldwide have responded to the need to reduce waste with regulation and legislation that have framed a market for building materials and products derived from the construction and demolition (C&D) waste stream. There are now, more than ever, clear opportunities for business and industry to invest in activities that will create profit and improve environmental outcomes by extracting valuable resources from the C&D waste stream. The built environment of the future is being constructed at the beginning of a new ecological era where governments are framing markets with regulation and legislation that respond to the challenges of environmental sustainability, and where industry must respond to the challenges of low-carbon economies and resource depletion. Businesses that are profiting and growing are adapting to these new challenges and responding with innovations that turn waste into valuable resources to supply the construction industry, which has traditionally been adverse to behavioral change. This guide outlines the opportunities available for effective markets and presents 15 initiatives where companies are profiting and growing while contributing to a more ecologically sustainable built environment. Aim of the guide the aim of this guide

BUILDING ON RESEARCH AND CONNECTING TO THE MARKET

The Organisation for Economic Co-operation and Development found that globally buildings are responsible for about 30 per cent of raw materials used, 42 per cent of energy used, 25 per cent of water used, 12 per cent of land use, 40 per cent of atmospheric emissions, 20 per cent of water effluents, 25 per cent of solid waste and 13 per cent of other releases (Centre for Design RMIT, 2003). 2006–07 data from the National Waste Report 2010 showed that 22 707 000 tonnes or 52 per cent of Australia's waste was recycled. Of this, 42 per cent was from the C&D waste stream. In 2004–05 C&D waste generation in Australia (The Blue Book—Australian Waste Industry, 2008, p. 8) was 15.1 million tonnes, of which 7.6 million tonnes was recycled materials (timber, steel, concrete, rubble and soil) and 7.5 million tonnes was residual waste to landfill. In 2006–07, 43 777 000 tonnes of waste was generated, 38 per cent of which was from the C&D stream.

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AUSTRALIAN GOVERNMENT WASTE LEGISLATION

The Australian Government does not directly legislate management of C&D waste. Themanagement of environmental issues, including all waste streams, is largely the responsibility of Australian state and territory governments. Exceptions to this general principle are where international treaties are involved (for example, the Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal) or developments that are deemed to be of significant environmental importance to the nation.

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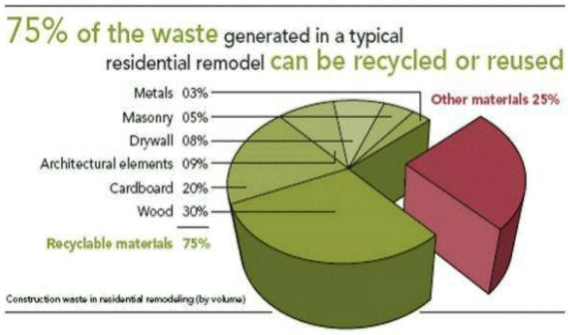
Waste management and resource recovery in Australia is dependent on the regulatory framework of the states and territories. Because of this, the approach commonly adopted by the Australian Government is one of multi-stakeholder engagement and multi-party agreements. These may be underpinned by legislative measures where all parties support the need for fall-back legislation at a jurisdictional level (The Blue Book—Australian Waste Industry, 2007–08 Industry Market Report).



REGULATION

Regulation frames markets for C&D waste recycling and re-use. As described in Table 1, state and territory governments are responsible for regulating waste issues. However, regulation and legislation only set minimum standards. To increase the rates of recycling and re-use of C&D waste, new materials and products must be derived, applications for these materials proven, and markets created. In some cases there are significant technical barriers—industry is required to invest in innovation, research and development to create new processes and products that can be sold into the building supply chain. This can take significant

effort and often involves business risk. Regulation and legislation alone will never be enough toachieve the required amounts of C&D waste recovery.

PRODUCT STEWARDSHIP INITIATIVES

Australian businesses across a range of sectors have been working to reduce the environmental impacts of their operations and products. In many sectors industries have, or are developing, voluntary product stewardship schemes. Product stewardship recognises everyone involved in the production, supply and use of products, sharing responsibility for the environmental impacts The complexity of the Green Star tools has increased since their inception. In February 2011 the GBCA made a commitment to a life cycle approach in rating building products and materials. This will encourage industry to research and develop products with lower embodied impacts and will contribute to the reduction of C&D waste. Australian Green Infrastructure Council rating tool The Australian Green Infrastructure Council (AGIC), a member-based industry association established in 2008, has been developing a green rating tool for infrastructure. Like the GBCA's building rating tool, the AGIC tool will rate aspects of infrastructure and includes a category for materials selection and use. This category gives credit for materials that have low embodied impacts relative to a standard. The materials selection and use category will take a life cycle approach to rating materials—the AGIC tool will rigorously measure a suite of environmental impacts embodied within the materials and give the material a rating.

If the material demonstrates lower embodied impacts than its alternative it will be awarded points towards an aggregated score (like Green Star for buildings). The AGIC tool's materials

1.1.1. PRODUCT STEWARDSHIP INITIATIVES

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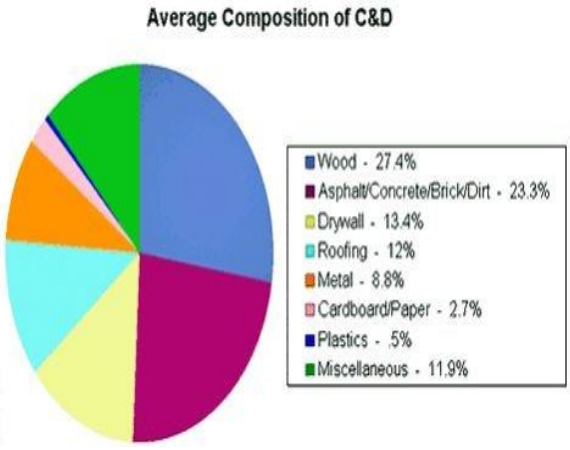
The Act fulfils a commitment by the Australian Government under the National Waste Policy, heralding a new, efficient and environmentally responsible approach to waste management in Australia. Green Building Council of Australia's Green Star building rating tools The Green Building Council of Australia (GBCA) is a national, not-for-profit organisation that has been driving sustainable outcomes in the property sector since 2002. The GBCA have developed a suite of Green Star tools that rate the sustainability of buildings, including materials used in construction and fit-out, and C&D waste reduction credits. Several of the case studies in this guide cite Green Star as a driver for their activities and two (commercial buildings) have Green Star ratings.



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CONCRETE AND BRICKS

Concrete reprocessing involves the use of relatively uncomplicated and well-established crushing techniques. Where high landfill fees exist (including levies), there is a

strong incentive to avoid weight-based disposal charges by recovering the heavy components of the C&D waste stream. Diversion also supports significant end markets for the recycled products in some metropolitan locations, where reprocessing sites can produce products that are commercially competitive with quarry products. Bricks are often presented as 'mixed masonry'or 'builders rubble'mixed with concrete and, like source-separated concrete, this component of the C&D waste stream is relatively simple to process, with similar end markets for aggregate products.

The key markets for crushed concrete and brick include use in all-weather applications (such as low-grade roads), and in pavement sub-bases (such as roads and nonstructural applications) as a substitute for virgin crushed rock. The advantage of recycled crushed concrete was highlighted as being associated with physical properties. This suggests that for the same product weight as certain crushed quarry rock, the crushed concrete alternative offered an additional 10–15 per cent product volume.

Asphalt Asphalt material is generated through the civil road construction sector.

Asphalt is potentially 100 per cent recyclable. This level of recycling and use of recycled content in pavements has not been fully realised in Australia, however there are efforts to improve this within the industry. Asphalt pavements on average are 4 per cent bitumen and 96 per cent aggregate. Generally the top layer of asphalt, known as the wearing course (which is generally between 25–40mm), is removed and re-laid every 10 to 15 years. This is done using a milling machine, which removes the wearing course. The recovered material is generally taken to an asphalt plant for sorting and batching to ensure that the physical properties of the mix include but not are limited to: the appropriate ratio of bitumen to aggregate; and the correct proportion of aggregate size and air voids. Reclaimed or recycled asphalt pavement (RAP) used in new asphalt is allowed in mixes in Australia.

Permissible levels vary across jurisdictions. Mixes generally include 10 to 15 per cent nrecycled asphalt content, however the level can be higher if the mix is appropriately managed.

Recycled asphalt can also go into the base course and road base layers but mostly goes back into the wearing course of pavements. In some jurisdictions there has been trialling not only of the percentage of RAP included in mixes but also of the inclusion of other recycled content such as glass fines (from beverage container recycling). There may also be energy efficiency savings in moving from hot mix to warm mix application of asphalt wearing courses.

Metals Scrap metal prices are subject to international forces and during the Global Financial Crisis there were reports of serious disruptions to the market for recovered scrap. While the price that re-processors pay for mixed steel scrap is highly variable, the current ballpark figure is around $250 per tonne. Coupled with the value of avoided landfill disposal costs, there is a strong economic incentive to recover this material stream. The majority (about 90 per cent) of metals recovered from the C&D sector comes from commercial demolition sites. Of this material, up to 95 per cent is steel and the remaining materials (about 5 per cent) are non-ferrous metals.

This non-ferrous component mostly includes aluminium (1 to 2 per cent), stainless steel and copper piping or wire. Ferrous metals like steel can be easily recovered from the waste stream using relatively inexpensive magnets. Timber Most timber is generated from the demolition sector, and nationally there is lower market demand for recovered timber compared to other components of the C&D waste stream. There is a high-value market for the re-use of quality hardwood timber, with prices over $1000 per cubic metre for some highgrade Australian timbers, although the volume of material recovered is relatively low. Nationally, the market for re-use of timber is estimated to be around 60 000 cubic metres. Indications from industry are that the salvage market for reusable timber is generally functioning well due to the potential for high economic returns. A barrier to growing the reuse market is the increasing mechanisation of demolition works (primarily due to time pressures and occupational health and safety requirements), which makes it more difficult for salvage operations to take place, and increases the potential for high-value timbers to be damaged. Another significant source of salvageable hardwood is 'infrastructure timber', such as power poles and railway sleepers, for which there is strong demand in landscaping applications.

Plastics The Plastics and Chemicals Industries Association's (PACIA) annual recycling survey provides a useful overview for all sectors, including C&D, for plastics recovery, recycling and market outlets. The PACIA report highlights that the construction (or building) sector is one of the key markets for plastics in Australia. The plastics used in construction fall across two distinct categories: (i) packaging and (ii) durables (nonpackaging). This categorisation of plastics is associated with the life-span of the plastic product. Even though there are broad applications for plastic products in construction, as outlined in Figure 9, the most common products are packaging films, waffle pods and pipes. The

PACIA study highlights that very little material is recovered from the C&D sector, but acknowledges that there is growing activity around recycling of used plastics from the industry.

1.1.2. Plasterboard

Diversion of plasterboard from landfill is mostly from construction activity because this friable material is not readily separated from mixed loads using mechanised demolition processes. Plasterboard is considered a contaminant when presented in recovered C&D materials. For this reason it is one of the most challenging materials when seeking to improve the recovery of mixed C&D loads, even though plasterboard itself is highly recyclable. Most plasterboard recovery is from construction sites and is often made through arrangements between the builder or construction company and the materialmanufacturer or supplier. Plasterboard manufacturers which supply construction sites regularly support the recovery of clean product from sites and support companies which purchase their materials. Rock and excavation stone This material is recovered when civil or site preparation works are undertaken.

Construction Waste Index

$$C_{i+ni} = \frac{\text{Total Quantity of C\&D Material/Waste Generated (tonne)}}{\text{Construction Floor Area } (m^2)}$$

$$C_i = \frac{\text{Total Quantity of inert C\&D Material Generated (tonne)}}{\text{Construction Floor Area } (m^2)}$$

$$C_{ni} = \frac{\text{Total Quantity of non-inert C\&D Waste Generated (tonne)}}{\text{Construction Floor Area } (m^2)}$$

Depending on the geology of an area, a great deal of excavated rock and stone can be produced as a byproduct. Excavated rock and stone comes mostly from the construction sector.

Again, the level of recovery of these materials and end markets for associated products has much to do with the geography of where the material is generated, the local market outlets for products, and landfill pricing which discourages the disposal of this heavy, voluminous material. Similar to crushed concrete and brick, excavated rock and stone is a source of inexpensive aggregate for a range of applications in pavement sub-base. In markets, like Melbourne, where there are significant volumes excavated rock and stone competes with recycled C&D concrete and brick products. Soil and sand Soil and sand is generated from site preparation and excavation works associated with construction activities. Large volumes of fine materials are generated through these activities and unless the material can be re-used on site it requires treatment and/or disposal. This includes soil and sand as well as other sub-4.75 mm particles from mixed skip-bin waste.

II. LITERARETURE REVIEW

The Old Leura Dairy (OLD) is a development of six luxury eco-friendly buildings built by the Hennessey Family providing corporate retreat and tourist accommodation in the Blue Mountains in New South Wales. Since inception 12 years ago, the OLD buildings have been constructed using the principles of ecologically sustainable development. The buildings use up to 95 per cent (by cost) locally sourced reclaimed and recycled materials. The materials have been incorporated into modern designs that achieve good thermal performance in the temperate climate of the Blue Mountains. The OLD has re-used a range of materials extracted from construction and demolition waste and has used reclaimed timbers from a variety of sources. Use of recycled and re-used material When the first two buildings of the OLD were built, re-use and recycling rates of 80 per cent were achieved. By buildings five and six, 95 per cent of all materials (by cost) were recycled building materials.

Using reclaimed materials can be more difficult from a tradesman's point of view. There is often an extra dimension to using reclaimed materials, where the tradesman needs to adapt materials or products to fit the purpose. This can take time and requires knowledge and experience. As demonstrated by the OLD's recycling rates rising from 80 per cent to 95 per cent, experience and knowledge allows greater opportunity for incorporating reclaimedmaterials into buildings. Solutions Increased supply—if the supply of reclaimed materials from demolition could be increased, the continuity of supply would improve and the opportunity for incorporating materials into designs would be greater. Increased knowledge— as tradesmen gain experience working with reclaimed materials, knowledge in the industry increases, new methods of construction can be tried and tested, and time savings can be achieved. There is a shortage of trades people who are able to work with the inconsistencies of reclaimed and recycled materials; training is required. Specifications and opportunities for other projects Reclaiming and re-using materials in the way that the OLD has, provides the opportunity to create unique buildings that benefit from the style that reclaimed and re-usedbuilding materials offer

REVIEW

In previous days construction materials are wasting a lot but in our study we are recycle that construction waste and re use that materials in constructions like sand and small partical type aggregate.

III. METHODOLOGY

Infrastructure and buildings The following 15 case studies have been selected from many to represent a broad range of construction and demolition waste recycling and re-use initiatives across Australia. They demonstrate a cross section of opportunities, using a range of materials at various stages in the building supply chain. Some are driven by small business, others by local government and industry associations. All are benefiting and profiting from innovation an The Sustainable Resource Centre returns C&D waste to the construction industry as new materials. Use of recycled and re-used material The Sustainable Resource Centre has recycled over 150 000 tonnes of material already in 2011 and is likely to recycle 170 000 tonnes by the end of the year. The Sustainable Resource Centre produces a series of new materials including crushed concrete products, recycled asphalt products and cement stabilised sands.

SOURCE SEPARATION

The basics of source separationare easy: each recyclable material should be mnsegregated as it is generated, and placed in the appropriate container. A few additional rules make source separation work smoothly: Keep as few containers as possible on site at any time. Containers take up space, and having too many containers increases the possibility of confusion and contamination. In general, aim to have one container on site for mixed debris, and one or two additional containers for the specific wastes generated during each phase of the job.

Match containers to the material. A wood container, for example, will typically hold 30 or 40 cubic yards. But scrap metal from wiring and plumbing may need only a 2- or 4-yard container. For something like concrete, you may have a lot of material, but container size may be limited by the weight that can be hauled over the road. Site layout and access also play a role in container selection. Place containers close to work locations. An advantage of source separation is that it doesn't rely on one big central container for all wastes. Smaller containers can often be placed close to the work. Also look for opportunities to use intermediate containers like hampers or rolling hoppers that can be placed right next to the work, then wheeled to a larger waste container at the end of the shift. Again, there may be surprising savings in labor and convenience. What makes source separation work is the fact that it's matched to the phase of the job. You only have on site the containers needed at a particular time for the specific wastes being generated. You collect, haul, and market these materials. When the job moves on, you recycle different materials, in different containers, and generally to different markets. It takes a little energy and thought to do this, but in most cases the financial savings and the advantage in recycling rates are more than worth it.

The business case identified the need to establish interest groups incorporating stakeholders from industry, Local Government Associations and associations such as the ARRB Group, APPA, Institute of Public Works Engineering Australia to 39 confirm the status of existing testing and research and develop specifications for further testing to increase acceptance of the crushed glass product. Solutions Behavioural change—the Institute of Public Works Engineering Australia has created a course to educate road engineers in how to use alternative materials in construction projects. Collaboration—this project was conceived and delivered by a group of 'champions'from organisations in different sectors whose goals aligned. Specifications and opportunities for other projects Before this project there was no general acceptance of crushed glass use in road construction. In August 2008, the Packaging Stewardship Forum of the Australian Food and Grocery Council commissioned a report by GHD entitled The Use of Crushed Glass as both an Aggregate Substitute in Road Base and in Asphalt. The GHD report identified that to gain acceptance for the use of crushed glass in pavement applications it must be demonstrated that an asphalt or road base mix can meet required properties and performance measures.

The list of opportunities for crushed glass includes:

- Aggregate in road base and sub-base
- Aggregate in asphalt, including 'glassphalt'
- Aggregate in tiles
- Aggregate in decorative concrete for architectural facades
- Alternative to mulch
- Filtration material
- Alternative to sand in golf courses
- Alternative to fill and bedding material
- Aggregate in concrete and cement
- Corrugated iron sheets from roofing used for cladding
- Sinks and toilets
- Windows and doors
- Light fittings
- 40 tonnes of bricks from the old Katoomba Ice Works

- Carpet used as additional insulation under floor. Drivers for re-use Local council regulations, such as waste management plans or local government guidelines, were not the main driver for re-use. Rather the goal was to create interesting buildings with character that would attract people and create a place with unique character. Michael Hennessey describes his principal driver as 'Mother Nature and my daughter'. The key driver could be said to be a philosophical commitment to ecological sustainability.

Good planning is the single most important part of construction waste management. Like anything else in construction, recycling is straightforward if you have a good blueprint, but becomes much more difficult and expensive if it's an add-on. Good planning allows you to identify all recyclable materials and know how you're going to manage them before the job starts. Good planning addresses how each waste material will be handled, what containers will be used and when they'll be on site, and where each material will be marketed. Good planning allows you to assess the costs and benefits of recycling and decide which materials to source separate, which to recycle as commingled debris, and which to discard as trash. Good planning covers communications, training, and troubleshooting, and lays out tracking and reporting procedures for LEED or other documentation. The Waste Management Plan is the document that lays out the start-tofinish strategy for job site recycling. It is prepared directly from the drawings and specifications for the job, and a good plan will closely follow these documents

The Waste Management Plan should:

- Estimate types and quantities of C&D wastes generated during each phase
- of the job
- Identify how each waste will be managed and marketed
- Provide an estimate of the overall job recycling rate
- Lay out plans for training, meetings, and other communications related to
- job-site waste management
- Provide troubleshooting instructions and contact information. All of this can (and should) be done before you break ground, so that recycling is
- incorporated seamlessly into overall performance of the job.
- It's best if the Waste Management Plan is written and signed off on by all parties (owner, architect, contractor) a month or more before groundbreaking or the first day of demolition.
- Because of its central role in construction waste management, more detailed information and a sample waste management plan are provided in Part Three, "The Waste Management Plan."

Potential benefits The benefits of reusing materials for OLD relate to the accommodation that is provided. The buildings are unique due to the materials that have been incorporated. Michael Hennessey states that the character of the OLD has been achieved by the assortment of materials bringing with them character from a previous life, and that the OLD buildings benefit from 'the ghosts'of their previous lives. Problems and challenges Reusing and recycling at the OLD has been a difficult but rewarding task. The Hennessey's built this way knowing that it would take more effort. The cost of labour to recycle many of the products was equal or more than the cost of using virgin materials or new products. Michael Hennessey estimates that the additional cost of building with recycled materials is between 50 –100 per cent. There are some excellent opportunities to create unique buildings with great character from reclaimed and recycled materials if the problems of quantity and continuity of supply can be dealtwith. Achieving the specified design of a house using reclaimed timbers for flooring, weatherboards, framing and other applications where a fixed quantity of consistent material is required can be challenging when relying on a supply of reclaimed product no alternative to visual inspection at the weighbridge.

DEMOLITION AND RENOVATION

Demolition and renovation projects are different from new construction, and often need some extra planning. For example, compared to new construction, demolition and renovation projects often involve:

- Much larger quantities of waste (often the entire building)
- Many high-value wastes, for example, furniture and furnishings, architectural salvage, and valuable commodities such as nonferrous metals
- Wastes that are difficult to separate and recycle (like painted gypsum wallboard, insulation, and shingles), and wastes that may be contaminated with hazardous materials.
- Automated demolition equipment like cranes and grapples, which don't lend themselves to the separation of one material from another.
- Tight and inflexible schedules; project value is in the new construction, while demolition is perceived

simply as a cost, with the goal to finish as quickly and cheaply as possible.

In addition, some amount of recycling is already ingrained in the demolition industry. Demolition contractors have been segregating wastes for many years, either to capture revenue (e.g., wiring, structural steel), or to reduce disposal costs (e.g., concrete, brick). This is both good and bad. It's good because demolition contractors are already aware of and practice some recycling. It can be bad when a demolition contractor thinks he knows all there is to know about recycling, and balks at suggestions to go beyond customary procedures. Contractors who are generating revenues from recycling may also be reluctant to relinquish this income, as they may if a Waste Management Plan clearly identifies these materials and revenue streams. Given these considerations, an on-site audit before work begins is a critical part of recycling from demolition or renovation.

This is not necessary in new construction, where recycling can be planned entirely from drawings and specifications. A team that includes the architect, contractor, and recycler should get on site to confirm what materials will be removed and how they will be handled (hand disassembly, removal by crane, etc.). Often it will be good to bring along a salvage specialist, who can identify opportunities to remove architectural materials such as flooring, doors and windows. High-value commodities like wiring, nonferrous metals, suspended ceilings and the like should also be catalogued, and plans made for their recovery separate from other wastes. The on-site audit also provides an opportunity to identify and resolve any conflicts between recycling and operations –and more specifically, any potential conflicts between the owner, architect, and contractor, whose goals and priorities at this stage may not be completely in alignment.

Perceptions—negative perceptions by the construction industry of recycled materials include that they are difficult to use and result in inferior constructions. These perceptions are changing as field trials show how to use these materials to their optimum performance and as virgin resources become scarcer. Solutions Fairfield City Council has conducted field trials of both the 95 per cent recycled concrete product and the 65 per cent recycled asphalt. These trials have shown how to achieve optimum results using recycled materials. With regards to contamination, visual inspection is currently the best available solution.

Specifications and opportunities for other projects Currently Fairfield City Council is using 95 per cent recycled concrete for all non-structural applications in the council area. Results of the field trial will be available from Fairfield City Council on completion of the trial in early 2012. The 65 per cent recycled asphalt is being used across 30 locations in the Fairfield City Council area.

Description of project Otter Modular Carpets have been designing and manufacturing modular carpet tiles in Australia since 1985.

The product is made of a fiberglass polymer matrix backing with nylon. Sixty-six fibers are embedded in the surface to create the carpet. Ontera implements the principle of ' recycling', whereby the original product is made more durable to maximize its first life to ensure that it is able to withstand additional life cycles. Ontera guarantees to take the product back at the end of its first life for re-use or recycling at no cost to the customer. The tangible benefit, above the direct cost saving, is the reassurance that the product is not ending its life in landfill, but entering a second life.

Use of recycled and re-used material Ontera's principle is to retain the energy embodied in their products as far as possible by extending products'life cycle and by not wasting the energy embodied in the products. Ontera's EarthPlus® environmental program provides an option to re-use any used Ontera carpet tiles without any destructive processes or measurable additional energy input. Used Ontera carpet tiles can be given a second (and possibly third) life through a proprietary process that 'supercleans'the surface, retextures it and superimposes a new design to refresh the appearance. This extends the warranted life of the carpet tile by a further seven years for the same end use. The EarthPlus® program is a reuse process, not a recycling process. Ontera's studies have shown this to be the most environmentally benign way to extend product life. All of the embodied energy used in the creation of the original product is retained, enabling the product life to be significantly extended without the need for Significant additional energy and resources. A summary of resource efficiency savings includes:

- take-back and re-use of over 120 000 m2 (approximately 600 tonnes) of used carpet tile

- saving of approximately 2000 litres of water per month in dye recycling
- incorporation of post-consumer recycled component of between 5–10 per cent of the backing using polymer component obtained by recycled used or waste carpet tiles
- Reduction of energy and water consumption by over 40 per cent per square metre of
- finished product
- Reduction of waste sent to landfill by 25 per cent
- Reduction of on-site CO^2 emissions by over 19 per cent
- Increase of recycled content in product by 50 per cent. 20 | Construction and demolition waste guide Drivers for re-use Ontera Modular Carpets have founded a business based on
- supplying a sustainable product to the market, and this is the main driver.

Re-use initiatives are recognized by the New South Wales Government through involvement and achievement in the Sustainability Advantage program, and this recognition is good for business. There is also inherent value in a re-used product, leading to worthwhile economic returns. Ontera have ensured that maximum available credit points can be achieved by specifying their product in the Green Building Council of Australia's Green Star rating tool. Ontera has a certified Environmental Management System, certified to ISO 14001, which requires ongoing environmental improvement. Benefits Each 1000 square metres of modular carpet re-used through the EarthPlus® process results in over 5 tonnes of waste being saved from landfill or incineration. In terms of product recycling, there will always be some process waste and post-consumer product that is not suitable for re-use. Ontera has developed and implemented a process which recovers all of the components of the product without the need for energy-intensive thermal processes.

The yarn is separated from the backing and sold to third-party polymer extruders, and the backing is ground into a fine powder form and re-used by Ontera as a post-consumerrecycled component of new carpet tile backing.

Ontera has made significant improvements in resource efficiency through the implementation of a range of programs and processes. As part of its ongoing ISO 14001 certification, it monitors monthly: its consumption of water, electricity and gas; and levels of waste to landfill, waste recycled, and greenhouse gas emissions. It reports its results against annual reduction targets. Ontera is Achieving a decreasing trend in all resource areas and is working towards achieving their sustainability targets.

Re-use and recycling delivers the following benefits for Ontera:

- Reputation and market stature
- improved economic returns
- increased staff engagement and loyalty
- reduced landfill costs

reduced utility costs. 21 Problems and challenges Challenges remain for greater re-use, which include availability of technical knowledge and expertise for further process improvements, local availability of equipment, and geographic diversity of product to be retuned for re-use or recycling. Solutions Ontera routinely uses external consultants to identify production and consumption efficiencies, some of which have been funded and provided through the New South Wales Office of Environment and Heritage Sustainability Advantage Program. Opportunities for other projects There are opportunities for Ontera to work with other manufacturers of products that use similar materials and Ontera are willing to explore opportunities for by-product exchanges with other companies. There areopportunities for greater process efficiencies, which include the development and up-scaling of an in-line recycling unit.

Michael Kennedy's business philosophy contributes to Kennedy's corporate sustainability profile and drives initiatives to enhance and increase the life cycle of timber products. Benefits

- Landfill avoidance
- Valuable resource recovery of Australian hard wood timbers
- Carbon savings for Energex
- Problems and challenges Initially there was significant resistance from Emerge and stakeholders in the supply chain to changing existing practice due to concerns about the health risk of processing the power poles.

These were valid concerns as there were no protocols or guides for the processes of recycling treated timbers. Solutions Kennedy's Timber, Energex and the New South Wales Office of Environment and Heritage worked together to develop protocols for recycling redundant utility poles and bridge timbers in New South Wales. Another outcome of this project has been the development of standards for the use of recycled timber.

Standards have now been developed under a project supported by Forest and Wood Products Australia and the

Queensland Department of Tourism, Regional Development & Infrastructure, with input and development from stakeholders, including industry associations, representatives of the recycled timber industry, government, researchers and specifies. Specifications and opportunities for other projects There is an opportunity for further recovery of timber fibre through research into the use of timber processing waste. Waste that is contaminated with timber treatment systems and is currently going to landfill offers an opportunity for other projects in the future.

Best practice waste management at Trevor Pearcey House Description of project Trevor Pearcey House is a 19-year-old building in the Fern Hill Technology Park, Bruce, in the Australian Capital Territory. The refurbished block has become the new head office for Australian Ethical Investment and has been designed to be an exemplary green building. Australian Ethical Investment (AEI) is an Australian investment company which specializes in environmental and socially responsible investment. AEI's philosophy is to promote Ecologically sustainable and socially just enterprises through careful investment and to improve the ethics of corporate Australia. Trevor Pearcey House is rated by the Green Building Council of Australia (GBCA) as a sixstar Green Star building, the first to achieve a six-star rating in the Australian Capital Territory and the third in Australia. One aspect of the project that resulted in a six-star rating was the commitment to re-use and recycle materials from the demolition phase of the project in the fit-out of the building. A recycling rate of greater than 80 per cent by weight was achieved and there was additional recognition for innovative ways of incorporating re-used and recycled materials into the building. Use of recycled and re-used material The architects and construction managers Cobul Constructions worked collaboratively to ensure as many materials as possible were re-used in the construction. This included:

- Electrical wiring
- ducted skirting
- Power point and switch face plates
- Partition wall studs
- Plasterboard and frames for windows and doors
- Internal doors, door handles, door stops and internal glass blocks
- Carpet tiles, which were re-used and supplemented with more recycled carpet tiles (Ontera
- Carpets)
- steel hanging frames and mesh found in the ceiling space which were re-used to make a bike enclosure
- 90 per cent of the joinery cupboards being made from old cupboards found in the building
- recycled timber used for feature floors and walls. Some of the recycling led to inspired elements within the building such as two walls made from old timber palettes and, most notably, art work made from old computer mother boards. 41 Drivers for re-use The keydriver for the sustainability of the building.

The overall philosophy of the client, Australian Ethical Investment. The GBCA's Green Star tool was used both as a driver and as a measure of achievement. Although the Australian Capital Territory Government does implement the 'No Waste by 2010'regulation as part of the development application process, the Green Star requirements were more stringent, set a higher standard and superseded the Australian Capital Territory Government regulation.

The main drivers for achieving high recycling and reuse rates were:

- Australian Ethical Investment's business philosophy and commitment to sustainability
- A target of six stars on GBCA's Green Star rating tool
- the Australian Capital Territory Government's 'No Waste by 2010'policy Benefits The main benefits for Australian Ethical Investment have been demonstrating their commitment to their philosophy and the attention they have received for being early adopters and innovators. Reclaiming and recycling materials is intuitively less costly, however the extra labour cost balances out the savings. The material cost savings, particularly from the carpet, were spent on other aspects of the sustainable design. Challenges The client's brief stipulated that costs must be balanced and that the cost must not exceed that of a conventional fit-out. In this way the challenge was to balance how far to go with recycling and re-use without affecting the budget. From the architect's point of view, specifying recycling of materials can be seen as a risk as it is hard to define the extent of recycling that can take place until the project is underway. Specifying recycled materials from the demolition requires that the design team accurately documents the demolition material as it comes out of the building, and that it is carefully handled and stored for re-use. This requires careful management of the project and close cooperation between the client, design team and contractors.

Solutions

Collard Clarke and Jackson Architects are experienced in recycling and re-using materials from

demolition. It has become standard practice for them to consider the opportunity for recycling and re-using materials from demolition. Commitment to recycling and re-use across the project team is key to delivering high recycling and re-use rates. Having an experienced and motivated project team who are willing to collaborate and apply innovative thinking delivers optimal recycling and re-use rates. 42 | Construction and demolition waste guide Specifications and opportunities for other projects Every building fitout project is different, with different construction and demolition waste products offering New opportunities for innovative re-use. The lessons learned by the project team responsible for this project will carry forward to future projects and enable the architects and builders to consistently achieve high construction and demolition recycling and re-use rates and to reduce costs and time during the design, specification and construction of a building

BUILT ENVIRONS

100 HUTT STREET, ADELAIDE DESCRIPTION OF PROJECT

100 Hutt Street is a commercial office building and the head office of Built Environs, the national building brand of McConnell Dowell. 100 Hutt Street was refurbished between 2007 and 2008 using the Green Building Council of Australia's (GBCA) Green Star building rating tool to demonstrate leading practice.

The refurbishment achieved an overall rating of five green stars. During the construction, 100 Hutt Street implemented a waste management plan and recycled or re-used 95.1 per cent of construction waste (by weight) from the construction activities, far exceeding the Green Star credit criterion. As well as showcasing Built Environs'environmental and sustainability credentials, the new head office has been designed to provide employees with a real time sense of their impact on the environment.

The completed project is a showcase for the company's capabilities in design and construction management and has been completed to a high level of detail. Use of recycled and re-used material the project re-used 95.1 per cent by weight of all construction waste. This included:

- Black caesar stone removed from a prominent South Australian public building as part of a
- previous refurbishment project
- Recycled mechanical spiral ductwork re-used for 295 pot plant sleeves
- Recycled timber used for all wall noggins for partition walls
- Recycled fire sprinkler pipework used for the PPE display
- Timber palettes used to deliver and store mechanical ductwork to create partitioning in the
- 'palette room'
- Surplus concrete reinforcing mesh which was powder coated and installed as part of the
- reception area
- re-used 40-gallon steel drums salvaged from Built Environs'plant yard used for seating in the break-out area
- re-used wire mesh from surplus stock on previous projects used in the stair balustrade design.

Drivers for recycling and re-use A flagship project—a key driver for the construction and demolition waste recycling and reuse was for Built Environs to demonstrate what their company could do. Lessons learned and experiences gained are being applied across their projects for clients. Pursuing a philosophy—the 100 Hutt Street project was founded on environmental design solutions and sustainable methodologies. The team ensured readily accessible waste materials would be re-used within the fit-out as an alternative to conventional materials. This commitment was taken as a corporate social responsibility and to increase knowledge among their 44 | Construction and demolition waste guide employees, future project consultancy teams, visiting subcontractors and general visitors. The team pursued this vision knowing that maximising the recycling of surplus or discarded items would ensure this project could:

- reduce landfill and waste generation
- conserve resources
- reduce pollution
- conserve energy (turning recycled material into new material takes less energy than turning raw material into new material)
- create further jobs Competition—the industry benchmark for levels of recycled and re-used

construction waste is 80 per cent (by weight). Built Environs exceeded this benchmark,

Demonstrating leading practice. Benefits Operational waste management—Built Environs has increased experience and knowledge within their company by striving to achieve leading practice.

This will flow on to economic benefit as clients choose the company to repeat their good work for clients. Staff engagement—there has been flow-on effect of the commitment to leading practice waste management to the daily operations of Built Environs staff. The project has instilled an ethic within the company of waste minimisation which has become a core part of the culture. Problems, challenges and solutions During the project Built Environs engaged staff by holding information sessions and stakeholder engagement workshops. This enabled them to anticipate and address challenges as, or even before, they occurred. The design team worked with the construction team to optimise opportunities for recycling and reuse. Specifications and opportunities for other projects

Implement a waste management plan for all construction works, no matter how minor When specifying products within a new build or refurbishment, the designer has the opportunity to nominate cladding and materials to be obtained from a reclaimed source within finishes schedule and specification requirements. The head contractor then can present opportunities to the designer and client that may enable materials and products to be re-used and diverted from landfill or elimination of use of virgin materials

All offices should develop a recycling and waste management plan to encourage improvements and waste minimisation 45 Fairfield City Council: a sustainable community building Description of project The Nalawala Hall, Fairfield City Council's Sustainability Hub, is Australia's largest straw bale community building and was designed with environmental sustainability as its core value. The hall and small seed shed containing an Indigenous plant nursery were constructed bale-by-bale by local residents and other volunteers fromSydney. The main body of the hall was built from straw bales and rendered with mud. The building uses recycled materials for doors, frames and fittings. Paints and finishes are also environmentally friendly. Nalawala Hall incorporates the world's first concrete load-bearing foundation slab which is 95 per cent recycled.

The recycled concrete used for the Nalawala Hall and seed shed has been produced by the council's own in-house construction material recycling operation in partnership with local concrete supply company Metromix. The hall has been in use since 2008 and the concrete slab is performing well. Use of recycled and re-used material The Nalawala Hall ('nalawala' is an Indigenous word for 'sit down') exemplifies the re-use of recycled concrete among other construction and demolition waste re-use. Recycled materials used in the project include:

- a 95 per cent recycled concrete load-bearing foundation slab, never before implemented anywhere in the world
- recycled window frames and doors
- Five tonnes of waste straw for the straw bale construction
- 800 milk bottles of plastic waste re-used as toilet partitions. Drivers for re-use The main driver for re-use was for Fairfield City Council to deliver on its commitment to sustainability and its work on Local Agenda 21 and Cities for Climate Protection. Fairfield City Council aimed to deliver a community building that would inspire the community to make more environmentally sustainable choices in their day-to-day routines. Potential benefits The environmental

Benefits of the Nalawala Hall straw bale construction include:

- Converting waste straw into a valuable building resource
- avoiding greenhouse gas generation, as straw is often burned
- 10 times the insulation factor of double-brick cavity wall
- An increase in the efficiency of solar-passive design

Walls that are estimated to be 30 times less energy intensive than wood frame walls. Construction and demolition waste guide The benefits associated with local government leadership include a demonstration to the community and other local councils on what can be done with recycled and re-used construction materials, and how it will promote further initiatives across community, industry and other local government areas. Challenges and solutions Pioneering the use of recycled concrete presented challenges. Since the mid1990s the construction industry was aware that concrete foundation slabs may provide the widest and most economical field of application for recycled concrete. In a 1999 CSIRO report for the building industry, a recommendation noted that a 30 per cent recycled concrete replacement of virgin aggregates might be trialled for domestic slab construction.

Fairfield City Council reported that 'the psychological barrier of 'who's first'presented a challenge for greater recycled concrete mixes being used in slab construction. However in the Nalawala project an environmental decision was made to specify a 95 per cent recycled concrete content in the foundation slab, and a calculated level of risk accepted.'The use of recycled concreteat such a high level has the capacity to give architects, builders, building inspectors and various stakeholders within the construction industry the confidence to move ahead with high recycled concrete content for foundation slab specification, knowing that benefits have been proven.

project exec to the last hourly worker will have to know and do something different. It can mean more space tied up for containers, more traffic to and from the site, more possibilities for late deliveries or missed pickups. It means more relationships, more information, more paperwork, more costs to track and balance. It means the GC will have to learn new information, maybe a lot of new information, about a subject that has nothing to do with delivering a construction project. It's no wonder many contractors hesitate, or find good reasons not to recycle. To maintain the strength of the owner/architect/contractor relationship, it's important to have strong and clear communications between all parties on the job:

- It should be made clear that recycling is a critical and valued aspect of the GC's overall performance
- It's important to build a relationship in which it's clear that the owner, architect, and contractor share a common interest in waste management performance. The owner and/or architect should be familiar with recyclable materials, procedures, and markets, and should be nable to suggest options and solutions.
- It's important to build in appropriate performance goals and guarantees. Recycling goals and standards should be made explicit in Requests for Proposals and other contract documents, along with reporting and recordkeeping requirements and expectations for recycling performance (see Appendix C).

It should be made clear that the contractor will be recognized for solutions that go beyond minimum standards. Andconversely,it should be made clear thatsub-par performance will not be tolerated without clear explanation, with appropriate penalties included in contract language. And finally, remember and take advantage of the fact that recycling is probably the most visible of all steps that can be taken toward sustainable building.

Unlike energy efficient HVAC or certified forest products, recycling is something that everyone understands. On the job site, use this fact to generate teamwork and motivation among workers and subcontractors. For the local community, a placard on the perimeter fence that highlights recycling performance is a great public relations tool, and a press release on recycling will almost always get picked up by local media. If you turn recycling into a shared mission that heightens camaraderie and teamwork among everyone on the job –GC, subcontractors, workers, architect, and owner –you can gain benefits that go far beyond the calculation of a recycling rate.

RECYCLING WAFFLE POD WASTE DESCRIPTION OF PROJECT

This project demonstrates industry best practice in the development and delivery of a product stewardship scheme targeting the reduction of expanded polystyrene (EPS) litter from waffle pod offcuts on building sites and the diversion of this material from landfill. The introduction of the Pod Scrap Bag Program has been an industry initiative of Expanded Polystyrene Australia (EPSA) and its Pod Group members. Scrap bags are supplied with all pod deliveries to building sites to assist with the separation of EPS offcuts from the general waste stream. The filled scrap bags are then collected and taken back to the EPS manufacturer where it can be granulated and recycled in new waffle pods and other building and construction products.

Use of recycled and re-used material EPS pods have become an important part of building concrete slabs, particularly for domestic dwellings. The lightweight and superior compressive strength of EPS pods deliver formwork for slabs that is uniform and consistent with ease, thereby reducing construction time and costs.

In addition, the thermal properties of EPS provide significant insulation benefits, making waffle pods popular in new-home construction where concrete slabs are used. The size of the waffle pod market in Australia is around 7000 tonnes per year. From this, around 600 tonnes of EPS pod offcuts are generated on building sites. It is estimated that where the Pod Scrap Bag Program has been implemented, the collection and recycling rate of EPS pod offcuts is extremely effective—around 90 per cent. Drivers for re-use As a result of the persistent waste on and around building sites from the use of waffle pods, there have been a threat to regulate against their use. The industry responded with the introduction of the Pod Scrap Bag Program. Potential benefits EPS pod manufacturers can incorporate up to 40 per cent recycled materials in the production of waffle pods—this offers

significant economic benefits through the reduction of virgin material required to manufacture the pods and environmental benefits, with all scrap and offcuts able to be recycled and re-used in new pods rather than going to landfill. Problems and challenges One challenge is to educate end users of waffle pods, such as builders and concreters, on the correct use of the pod scrap bags to ensure the EPS offcuts are segregated without contamination from other building site waste.

During research for this guide many stakeholders involved in projects related to re-use and recycling of construction and demolition waste were interviewed and asked about their views on the key challenges and barriers to markets. Four main challenges were ubiquitous. They are detailed below to highlight the need for time and resources to address these challenges. Knowledge across industry and requirement for training The Institute of Public Works Engineering Australia Limited have been developing a specifications course designed to help project managers and engineers responsible for public works understand thespecifications of new materials such as recycled aggregates and substitute materials, and to learn how to incorporate them into projects. particularly for domestic dwellings. The lightweight and superior compressive strength of EPS pods deliver formwork for slabs that is uniform and consistent with ease, thereby reducing construction time and costs. In addition, the thermal properties of EPS provide significant insulation benefits, making waffle pods popular in new-home construction where concrete slabs are used.

As the range of products and materials increases there will be a greater need for such courses to provide awareness of materials and, more importantly, knowledge of how to use them successfully in projects. Cross-contamination of wastes The recovery rate of useful material is hampered by cross-contamination with other materials, particularly in the mixed construction and demolition waste stream. Asbestos contamination is a well-documented problem and still presents a significant issue in waste derived from demolition and renovation works, not new construction.

High recovery rates for materials are achieved when materials are captured closer to the source, before there is opportunity for mixing with other wastes. This is clearly demonstrated in the case studies, where greatest recycling rates are achieved when the waste materials are captured early and segregated. Technological barriers.

There remain opportunities to recycle and re-use significant volumes of materials that are still being sent to landfill due to the inability to identify markets for the material as it is presented, or due to the lack of technology and/or equipment to sufficiently clean or segregate materials. This is particularly the case with the timber waste stream where there is contamination from treated timber products. There is a clear need for investment in research and development to overcome technological barriers. Design for deconstruction Designing for deconstruction, a practice that is gaining prominence, offers an opportunity for greater resource recovery at the end of a building's life. A building that is designed to be taken apart at the end of its life offers greater opportunities for resource recovery and, with time.

Haulers and markets are the most obvious and critical link in job site recycling. Without markets, recyclable materials are trash. Without haulers, recyclable materials are trash on the ground with nowhere to go. The best news in C&D recycling, and one thing that' s really changed in the past five years, is the great increase in the number and variety of recycling markets, and the number of haulers willing to handle C&D wastes. A few years ago, in the Boston area, there was one mixed debris recycler and (outside of the metal scrappers) perhaps a half dozen firms who offered recycling for a limited selection of source separated materials. There were perhaps the same number of haulers who offered the flexibility to handle C&D for recycling. Now, the number of C&D recycling markets has increased dramatically, and continues to increase. With many options now available, it's important to know what you're looking for in a hauler or end market for recycled commodities.

A checklist is provided on the next page. There are many sources of information on recycling markets and haulers. Most of the New England states'environmental agencies collect and post information to their web sites on solid waste haulers, and most also list markets for construction and demolition materials and other recyclables. Appendix B provides links to state-maintained and other generally reliable listings of haulers and recyclers. It's rare and not really necessary for the architect or owner to track and evaluate all of

the hauling and market options for 20 or more recyclable commodities. That task is best handled by the general contractor, who has on-site waste management responsibility, or a firm that specializes in managing and recycling job site wastes.

It is important, however, for the architect and owner to have a general familiarity with waste haulers and markets, in order to participate productively in planning and evaluating job site recycling options with the rest of the project team. TRAINING There's a simple rule in C&D recycling (which is the same as a simple rule in architecture and construction): If it doesn't meet specified requirements, it costs money to fix. Recyclers are set up to handle specific materials: wood, metal, gypsum wallboard, etc. If a load comes to their facility that's mixed with other materials, that's a problem that can increase recycling costs. Either the contaminating material has to be separated out, or the quality of the recycled product will be downgraded , or the entire load will be rejected and disposed of –all of which add cost that will be passed back to the contractor. It's much easier and less expensive to meet the specification in the first place. That means training.

IV. CONCLUSIOSN

This project demonstrates industry best practice in the development and delivery of a product stewardship scheme targeting the reduction of expanded polystyrene (EPS) litter from waffle pod off cuts on building sites and the diversion of this material from landfill. The introduction of the Pod Scrap Bag Program has been an industry initiative of Expanded Polystyrene Australia (EPSA) and its Pod Group members. Scrap bags are supplied with all pod deliveries to building sites to assist with the separation of EPS off cuts from the general waste stream. The filled scrap bags are then collected and taken back to the EPS manufacturer where it can be granulated and recycled in new waffle pods and other building and construction products.

Use of recycled and re-used material EPS pods have become an important part of building concrete slabs, particularly for domestic dwellings. The lightweight and superior compressive strength of EPS pods deliver formwork for slabs that is uniform and consistent with ease, thereby reducing construction time and costs. In addition, the thermal properties of EPS provide significant insulation benefits, making waffle pods popular in new-home construction where concrete slabs are used

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