

WA Construction Resources- Recovered Construction and Demolition Materials Resource Guide

August 2020



Foundations
Research

Since 2015



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Foreword by the authors

Good news, there ARE plenty of recovered construction materials available that are fit for reuse in WA!

We encourage you to take up your opportunity to use recovered materials from construction and demolition (C&D).

Through our industry research we have found there is an abundance of recovered material available that is typically cheaper than virgin products, and can perform better when used correctly.

We also found in a recent survey¹ (available on request) that there is a lack of knowledge about the properties of recycled materials, so we've covered off on testing requirements and other performance qualities of recycled materials in this guide too.

By using recovered materials, you can also share your environmentally friendly choices with your customers.

So, take the time to consider your needs when procuring for your next project and take advantage of the stockpiles of wasted construction materials in WA.

We've also done the work to identify what's available and who can supply these materials in WA – these are listed in this guide. We hope to continue to further develop this list for WA businesses in future projects to boost recycled C&D material markets.

Yours sincerely.



David Beyer – ACTIVESUSTAINABILITY



Geoff Cooper – FOUNDATIONS RESEARCH

¹ Expanding reuse opportunities for recycled construction materials - Development Industry Professionals Survey (11 June 2020)

Who's this GUIDE for?

This Guide is focused predominantly on the opportunities to reuse and recycle materials from C&D in development projects, with a focus on the civil works, site development, landscaping and building construction.

It is intended this Guide will address information gaps between WA developers, builders, consultants and recycling contractors.

The targeted audience for Guide is: Commercial developers – land and building, Builders, Landscape architects/landscapers, Civil engineers, Civil works contractors, Local Government Authorities and State Government procurement agencies and authorities.



Image supplied by Capital Recycling.

Why this GUIDE?

The purpose of this guide is to increase awareness of opportunities to reuse excess construction materials in WA projects. It will:

- increase awareness and knowledge to enable a better uptake of recovered C&D materials;
- lead to a reduction in virgin material usage; and
- divert valuable resources currently going to landfill.

The C&D waste sector is the largest volume of waste resources diverted from landfill. It is also the largest volume of waste generated of any material type. With over 1.5 million tonnes of C&D materials processed annually in WA², there is a large supply of usable materials, and recently there have been some successes developing new markets for these recycled materials. Recycling waste provides economic and environmental solutions for WA developers, builders and contractors.

But there remains excess supply of these materials that are suitable for use in many additional WA projects. It persists that large proportion of the processed C&D waste in WA is unable to find suitable markets: thus, stockpiles continue to grow – currently at approx. 1,000,000m³.

This is due to a general lack of knowledge and information of the potential uses, as well as an apprehension about the availability, quality, cost and content of recovered C&D materials.

² Recycling Activity in Western Australia 2017-18, Waste Authority, published August 2019

An increased awareness of the products that are available and their applications, as well as case studies of where they have been successfully used, will assist in incorporating recovered materials in development projects.

Our recent survey of 68 construction sector professionals found:

- 3 in 5 construction industry practitioners have no, limited, or only some understanding of recovered or recycled materials available in WA.
- 2 in 5 respondents were not able to identify any projects where they were aware of recycled products construction being used.
- Awareness of recycling of sand, soil, bricks, tiles and pavers is higher than less frequently recycled materials such as plastics, metal, timber, and rock and stone.
- The main perceived barriers to recycling are environmental specifications, structural specifications, cost and availability.
- 71% of respondents are very likely to or will definitely use recycled construction materials in future projects.
- A majority of respondents want more information on the more commonly recycled materials.

1. Terminology:

Terminology for recovered, recycled, and/or reused materials and products can be ambiguous and confusing.

This Guide has elected to use 'Recovered Materials' which includes:

- Reused – does not require processing; and
- Recycled – processed to make the same or different products.

Waste-derived as a term has mostly been avoided to mitigate confusion regarding when a material ceases to be waste.

DWER is developing a legislative framework for waste-derived materials which will seek to provide certainty around the definition of “waste” and its subsequent use – refer to Section 6.

2. Why use recovered construction materials?

2.1 Ample supplies of tested, recovered materials are available in WA

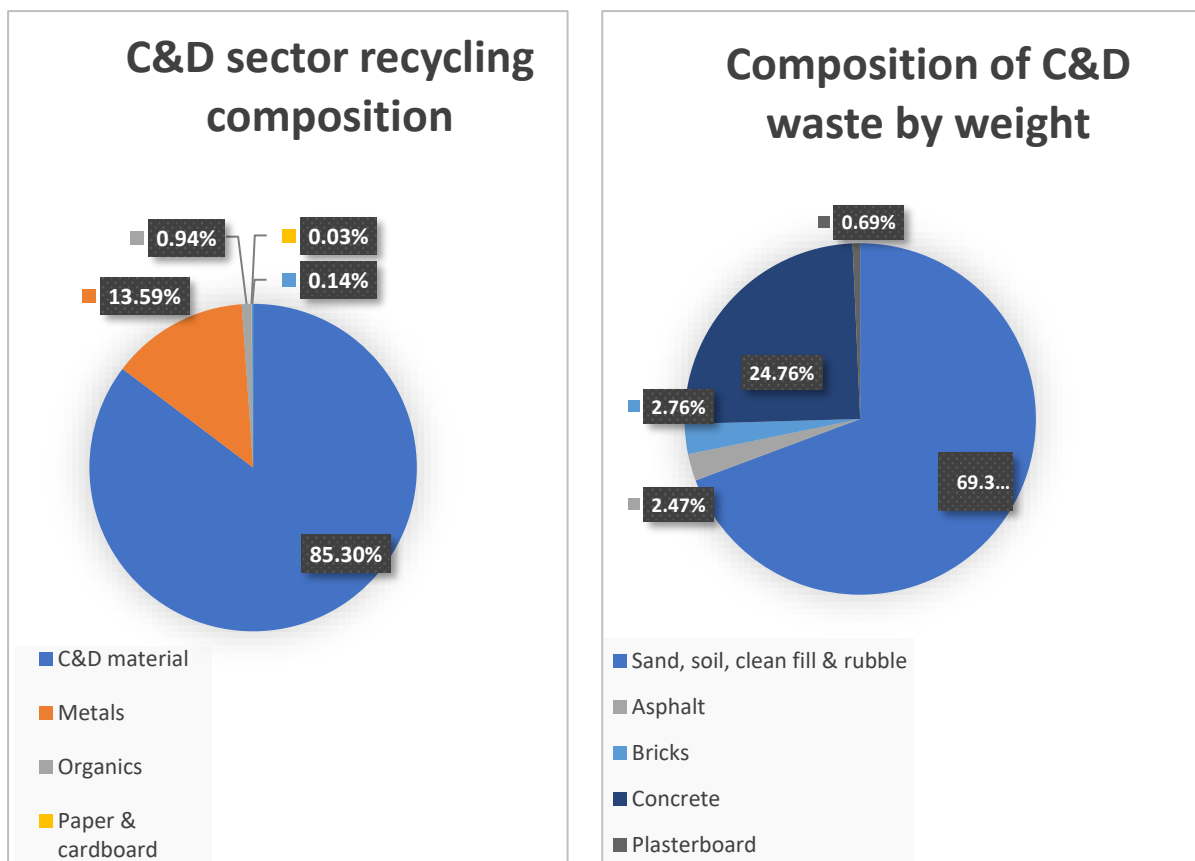
C&D Recyclers in the Perth metropolitan region supply the following recovered aggregates and masonry materials:

- Asphalt
- Road base
- Concrete aggregate
- Crushed aggregates
- Drainage aggregate
- Structural fill sand and general mixed sand
- Bricks and pavers

Table 1 shows the main waste streams and potential reuses

Table 1: Potential reuses for C&D waste material streams

C&D waste materials	Availability for reuse	Opportunities for the reuse of recycled C&D waste materials
Sand, soil, clean fill & rubble	689,400 tonnes	Sand: metal casting, brick making and road construction. Soil: Conditioners or mixed with organic material to improve soil structure. Clean fill: Alternative to traditional fill materials
Bricks, tiles * & pavers *	Brick - 27,500 tonnes	Clean or render for reuse, crushed fill, levelling materials, drainage layers, crushed for landscape and drainage uses.
Concrete	246,300 tonnes	Crushed fill, levelling materials, drainage layers, road pavement sub-base, irrigation & landscape applications.
Asphalt	24,600 tonnes	Adaptive to new asphalt mixture
Rock & stone *		Road pavement sub-base, drainage, irrigation & landscape applications. Concrete production for non-structural applications such as kerbs and gutters.
Plastics	1,600 tonnes	Pipe fittings, steel mesh level chairs for concrete slabs etc.
Timber	Organics - 10,700 tonnes including timber	Jarrah timber: Flooring, roof framing, fencing & furniture. Structural timber (Excluding treated pine): Formwork, bridging, propping, blocking, mulch for use in landscaping
Cardboard & paper	300 tonnes	Recycled
Metal	154,400 tonnes	Recycled or reused for wide variety of applications. e.g. sculpture art.
Plasterboard	6,900 tonnes	Crush and use in compost, soil conditioner or as a gypsum replacement.
<p>Note: Material available as recycled product in WA is based on the recovery figures of recycled C&D materials. *Tiles, pavers, rock & stone availability fall under the sand, soil, clean fill & rubble availability.</p>		



Adapted from information given in the following source:

https://www.wasteauthority.wa.gov.au/images/resources/files/2019/10/Recycling_Activity_in_WA_2017-2018.pdf

2.2 Cost savings

- ✓ On-site recovery - reuse and recycling - of existing road materials, masonry (concrete, bricks, pavers, tiles etc) and sand saves time.
- ✓ Transport and material cost savings apply for many materials. See text box below*.
- ✓ Avoids impact of increased landfill levy in WA.

By using recovered materials that are fit-for-purpose you can choose cheaper materials than higher grade virgin products on the market. Those with a large portion of concrete can provide superior performance.

* C&D recyclers report their certified road-base products are valued at \$5-6 / tonne, whereas virgin quarried materials are valued at up to \$20/tonne.

Crushed Recycled Concrete is cost competitive with limestone, especially when crushed on-site. Also, current limestone stocks within easy access in the metro area are generally of poor quality, resulting in more civil processing during installation to get road base up to specification.

Certified clean-fill products are valued at \$3 / tonne – if markets can be found, whereas virgin sand is valued at approximately \$10 /tonne.

2.3 Department of Water and Environmental Regulation (DWER) licensed recyclers and suppliers

- ✓ Information about licenced recyclers is available from the DWER Licences and Works Approvals website: <https://www.der.wa.gov.au/our-work/licences-and-works-approvals/current-licences> (Refer Category 13 Crushing Building Materials; and 62 Solid Waste Depot)

2.4 Recovered materials provide environmental benefits

- ✓ Reduced reliance and pressure on land fill and possible ground-water contamination.
- ✓ Acts as an alternative to open pit excavation that disturbs the natural environment in many ways. e.g. wildlife habitat and loss of vegetation etc.
- ✓ Supports closed-loop production and contributes to the development of a circular economy.
- ✓ Compared to extraction and transportation of virgin materials and disposal of recyclable materials, the greenhouse gas emissions will be significantly reduced³.

2.5 Help meet government targets

- ✓ Specifying recovered (reused and recycled) products ‘helps to build confidence in recycled products, increase their demand and develop relevant markets (while protecting the environment)’ contributing to the WA Government’s Waste Avoidance and Resource Recovery Strategy 2030 recycling target - which in turn supports increased C&D material recovery and sustainable procurement practices⁴.
- ✓ Headline targets include:
 - By 2025 – increase material recovery to 70%; and by 2030 – Increase material recovery to 75%; and by 2030 – no more than 15% of waste generated in Perth and Peel region is landfilled, and all waste is managed and/or disposed to better practice facilities.

“C&D waste represents a significant opportunity for waste avoidance and material recovery. As a waste generator, the construction industry can play a role in avoiding the amount of waste generated – for example through more efficient building processes – while waste managers can maximise recovery of waste that is generated.”

(Waste Avoidance and Resource Recovery Strategy 2030, page 22)

³ Life Cycle Assessment research by RMIT shows using recycled materials can result in a 65% reduction in carbon emissions, in addition to significant cost savings through density benefits:

www.alexfraser.com.au/section/Products_and_Services/Carbon_Footprint

Work done by (McLellan et al., 2011) noted that fly ash replacement of Portland cement has up to a 64% reduction in the overall CO2 footprint – based on typical Australian feedstocks:

www.researchgate.net/publication/251624337_Costs_and_carbon_emissions_for_geopolymer_pastes_in_comparison_to_ordinary_Portland_cement

⁴ www.wasteauthority.wa.gov.au/publications/view/strategy/waste-avoidance-and-resource-recovery-strategy-2030

2.6 Recovered C&D materials can be chosen for a variety of purposes

- ✓ Recovered C&D materials can be flexibly integrated into a diverse range of applications such as:
 - Land fill
 - Roadbase
 - Soakwells
 - Carparks
 - Dam construction
 - Ground cover – coarse recycled aggregates, mulches and soils
 - Garden features – gabion walls, reclaimed recycled metal for sculptures and reclaimed pipe to create planter boxes.
 - Paths – compacted fine aggregates (crushed bricks and concrete) as ‘soft’ landscape paths
 - Concrete and aggregates incorporated in concrete batching

- ✓ Recovered C&D products in landscaping and gardening can provide:
 - Low maintenance ground cover or fill
 - Low water usage
 - No nutrient wash-off that effects water bodies (unlike fertilizers)
 - Lower capital and maintenance costs compared to virgin aggregates, lawn, mulches and soils.
 - Minimal fire risk in a fire-prone environment.

3. Recovered resources – what’s available in WA?

The current uses for recovered C&D materials are mostly limited to road construction, site work and clean fill and landscape applications. When compared to other jurisdictions, it’s evident that there is room for further reuse and recycling of C&D material in development projects.

Applications for recycled masonry products include:

- **Structural recycled sand:**
 - Fill sand
 - Driveway cross-overs
 - Car parking
 - Construction retaining blocks
- **Crushed Recycled Concrete (CRC)**
 - Roads and road shoulder work
 - Carparks and truck parking
 - Driveways and kerbing
 - Rammed earth walls and Construction blocks
 - Building construction ground development
 - Concrete batch aggregate substitute (Eco-Concrete)⁵
- **Mixed masonry (crushed aggregated such as bricks, pavers, tiles):**
 - Base and sub-base materials for roads
 - Track material and temporary access roads
 - Hard stand
 - Fine aggregates for reconstituted retaining blocks, pavement and pavers, rammed earth walls and wall panel construction
 - Building construction ground development.
 - Coarse aggregate for drainage and soak-wells,
 - Concrete batch aggregate substitute (Eco-Concrete)
- **Recycled separated masonry products (red and cream brick, pavers, concrete):**
 - Landscape treatment and features –
 - paving and pavements,
 - gabion walls and retaining walls,
 - nature play-grounds,
 - public features, public art and installations.
 - Civil contracting works
 - Railway ballast
 - Building blocks
 - Retaining walls
 - Dams
 - Embankment fill

⁵ Curtin University research shows initial strength gain is comparable, but long term strength is higher due to post hydration - <https://www.wastenet.net.au/Assets/Documents/Content/Information/WALGA-ARRB-Report-Final-160410.pdf>; <https://espace.curtin.edu.au/handle/20.500.11937/41929>

- **Clean brick and pavers**

- Packs and bricks and pavers directly reused (instead of being crushed)

Other construction materials that can be recycled and reused include:

- Timber:
 - Direct reuse on new builds
 - Re-purposed for pallets
 - On-sold to the public
 - chipped and mulched - untreated
 - waste to energy fuel - treated
- Plastic strapping:
 - On-sold for recycling
- Cardboard and paper waste:
 - On-sold for recycling
- Metal:
 - On-sold and recycled, or deconstructed for direct reuse
- Plasterboard:
 - Easily recycled but currently limited facilities in WA⁶



Timber stockpiles re-purposed as pallets (Images supplied by Earthcare Recycling)



Excess bricks and bagged cement to be on-sold for direct reuse (Images supplied by Earthcare Recycling)

⁶ C-WISE currently recycles waste plasterboard to produce agricultural products - <https://www.cwise.com.au/>

4. The Recycling Sector in WA

4.1 Recyclers in Metro Perth

A recent survey dated June 2020 targeted the main C&D waste recyclers operating in metropolitan Perth. The survey focused on understanding the main materials collected through the construction and/or demolition process, and the main uses and/or end-markets for the product. Of the 9 recyclers contacted, 8 completed the questionnaire.

All recyclers (who responded to the survey) reported the following similarities:

- Their recycling facilities are DWER licensed.
- All materials processed for recycling and reuse comply with environmental regulations, and well and specific standards and specifications for end-use applications.
- All undertake National Association of Testing Authorities (NATA) testing.
- They recover, recycle or make available for reuse a range of materials and also produce a range of products.
- All have some form of in-take quality control procedures to monitoring in-bound loads, including:
 - Only receiving own-loads, or known and trusted customers
 - Visual and photo/x-ray imaging of in-bound loads;
 - Pricing to match quality of separated/sorted materials vs. co-mingled loads;
 - Rejecting contaminated loads (to be sent to landfill)
- All have on-site processing facilities – i.e. primary sorting and crushing, screening and handpicked sorting, secondary crushing and then stock-piled for testing as required.

Summary of the main findings:

- Most of the recyclers are generally focused on a particular market sector and/ or products development.
 - Some solely receive demolition waste.
 - Others focus on building materials from new construction.
- There are varying approaches to separating and sorting materials:
 - Some have highly controlled vetting processes to receive individual sorted materials, or prioritise separation-at-source from company own vehicles and known customers.
 - Others receive mixed co-mingled materials from multiple customers which are then sorted and processed on-site.
- Where asbestos testing is required, none of the recyclers reported that asbestos had been found in tested materials.
 - Some recyclers stated that some asbestos had been found in in-bound loads but these loads were rejected and sent to approved facilities.

4.2 Products received and recycled:

The largest portion of products received and processed for reuse are:

1. Sand – site scrapes, excavated footings, soak wells and drainage, excess brickies' and plasterers' sand.

2. Concrete – residual loads and excess batching, direct from demolition sites.
3. Mixed masonry materials – clay and concrete bricks, clay and concrete pavers, concrete, roof tiles, interior tiles, fibre-cement sheets.

These 3 materials types are also the ones that are most commonly processed for a range of uses within development projects.

Other common materials that are recycled but are not directly reused within the development projects include:

- Timber
- Metal
- Paper and cardboard
- Plasterboard/Drywall sheets/Gyprock
- Green waste and organics

Table 2 is a summarised list showing the main products received and the end-market product. Different recyclers focus their products toward different markets: hence the variety of end uses and the variance of low and high percentages processed.

Table 2: Products received, percentages processed and main end market uses

Products Received	Percentage of total product processed	Main use(s) and end-market(s) for the recycled product
Fill Sand	High – 65% Average – 35% Low – 20%	- Civil developments and building construction - Construction Blocks
Crushed Recycled Concrete	High – 80% Average – 35% Low – 5%	- Roads and road shoulder work - Carparks and truck parking - Driveways - Construction site and ground development - Rammed earth walls and Construction blocks - Concrete batch aggregate substitute
Mixed Masonry Material (Blended rubble - concrete, bricks, tiles, pavers)	High – 20% Average – 35% Low – 90%	- Road base - Track material - Subgrade works - Hardstands - Construction site and ground development
Recycled Asphalt / Bitumen	Average ~10%	- Roads - Hard stands - Car parks
Drainage Stone (Crushed aggregates)	Average ~3%	- Subsoil drainage for car park run off - Garden bed drainage
Concrete Cracker Dust / Fines	~2%	- Concrete batch substitute - Compacted pavements
Crushed Bricks – Red, Cream, Blended	~1%	- Ground cover for courtyard settings - Garden landscaping and placement around plants - Rockeries and around pathway stepping-stones
Brick Fines – Red, Cream, Blended	~1%	- Walkways - Verge parking areas, and driveways - Inside shade houses, and horse arenas

Table 3 shows additional products received by the recyclers that do not have direct end-market uses directly in the development project, but some of which are recycled for other uses.

The variation between materials being recycled or landfilled is influenced by:

- The focus of the recyclers and the materials received;
- Processing capabilities; and
- Identification of secondary recyclers and/or end-markets.

Table 3: Products received by recyclers that do not necessarily have direct market uses

Products Received	Average % of total product processed	Main use(s) and end-market(s) for the recycled product
Timber (Structural, Packaging)	~5%	- Pallets - Landfill
Timber (Untreated) – Native hard wood		- Mulch and soils substitutes - Landfill - Waste-to-energy plant
Gyprock	~3%	- Blended into base material - Landfill
Metal (roofing, gutters, lintels) -	~5%	- Sent to Metal Recyclers - 100% recycled
Plastics (Strapping, Packaging)	~1%	- Landfill - Previously recycled (via CLAW Environmental)
Cardboard / Paper	~2%	- Recycled - Landfill
Green Waste	~5%	- Recycled
Other – carpet, fibreglass	~1%	- Landfill (Class 1)

5. Successful recent WA case studies of recycled C&D material

There have been a number of good examples of the application of recycled C&D materials in WA development projects. Below is a selection of more recent contemporary case studies that highlight the viable application of recovered C&D materials in WA.

5.1 Roads to Reuse Pilot (Main Roads WA)

About the project

Initiated in early 2019, the Roads to Reuse (RtR) Pilot committed to the reuse of 25,000 tonnes of recycled C&D material in MRWA projects such as the widening of the Kwinana Freeway and the Murdoch Drive Connection. The RtR project is a state Government initiative, administered by the Waste Authority.

As of June 2020:

- 24,263 tonnes of Crushed Recycled Concrete and demolition waste was used as subbase under full depth asphalt⁷.
- > 5,000 tonnes of recycled C&D material used on the Murdoch Drive connection – exceeding the initial commitment to use 4,000 tonnes⁸.

Recycled material

Some of the requirements listed in the specification are:

- 150mm of crushed recycled concrete (CRC) used as road sub-base under full depth asphalt (250mm).
- CRC is a granular material mixture of fine grained and coarse soils and crushed aggregate up to 20mm in size.
- Products containing concrete with a pH > 9 should not be used within 100m of any wetland, water course or on land subject to flooding.
- Road base containing concrete with the same pH limit may only be used when sealed with asphalt.

Notes:

So far, the following outcomes have been observed from the RtR project:

- CRC considered to be a high strength and durable material by MRWA.
- The scheme is working so well that more product is being used than originally committed to.
- The auditing processes is working, ensuring a quality product is being supplied, showing that recyclers are doing the right thing, as well as providing MRWA confidence in the process.
- Recycled material is good to work with. Some of the benefits include;
 - reduced risk of delamination; and

⁷ <https://project.mainroads.wa.gov.au/home/Documents/Kwinana%20Freeway%20Northbound%20Widening%20-%20Construction%20Update%20June%202020.docx>

⁸ Roads to reuse pilot project case study by the Waste Authority, November 2019.

- up to 13% less water in the construction process due to the product requiring less moisture for compaction (since it retains moisture) which impacts the dry-back period allowing for the product to be trimmed within a day of placement⁹.

5.2 Cedar Woods Bushmead Estate

About the project

The Bushmead Estate by Cedar Woods Properties is a new sustainable development situated amongst 185 hectares of retained natural bushland. The project holds a prestigious six leaf certification under the UDIA EnviroDevelopment Program. Implementing the reuse of recycled C&D materials is part of the environmental sustainability initiative:

- At least 60% of the construction waste generated within the estate is reused or recycled;
- Mandating a minimum of 20% of reused or recycled materials to be incorporated into construction projects¹⁰.

Recycled material

- Pavement construction with recycled materials - crushed recycled concrete sub-base specification.
- In 2018 Cedar Woods also worked with the Waste Authority to create a landfill landscape project delivered by The Forever Project and ActiveSustainability. The Forever Project, which set out to use recycled products in the footpaths and recycled mulches in the garden landscape. In addition to this, many of the garden features such as gabion walls and art sculptures were also made from recycled material.
- Red Sand Supplies provided white and red fines respectively¹¹.



Landfill landscape showcase at the Bushmead estate. Supplied by The Forever Project.

⁹ Roads to reuse product specification by the Waste Authority, September 2018.

¹⁰ Bushmead awarded top honours for environment development, September 2018.

¹¹ Amounts supplied by Red Sands Supplies

5.3 Jandakot Volunteer Fire Station

About the project

In 2019 The Forever Project was approached by the City of Cockburn to design and install a firewise garden demonstration at the Jandakot Volunteer Fire Station in Banjup. A primary objective for the project was to use recycled C&D materials in the landscaping to construct a functional, waterwise and visually pleasing low maintenance firewise landscape.

Recycled material

The entire landscape garden features a range of recycled products, including:

- Masonry aggregates and fines products as mulch, paving and paths (54.5 tonnes)
- Recycled bricks, pavers and concrete for gabion walls (1.5m³)
- Recycled Jarrah timber as seats on gabion walls
- Repurposed recycled steel as artists features in the garden



Various red & cream crushed brick aggregate grades, supplied by Red Sand Supplies, were used for different applications at the JVFS project site. Sourced from <https://www.redsandssupplies.com.au/products/>.

5.4 The Amble Estate

About the project

The Amble estate in Girrawheen set out to transform 4.2 hectares of the former Hainsworth primary school site into a modern and affordable residential community. The project was separated into 3 stages for 106 lots, each of which involved different civil contractors. The construction period was from November 2017 to May 2019¹².

The project implemented an array of environmental initiatives to achieve the One Planet Living certification. The initiatives related to the reuse of recycled C&D materials include:

- Recycled road base in road construction,
- Recycled asphalt in pavement,
- Recycled material in limestone blocks,
- Recycled materials in concrete paths.

Other Initiatives include:

- Retention of trees – trees that were cleared were mulched for reuse,
- Blending topsoil into the road reserves and public open space (POS).

Recycled material:

Recycled road products – Independent product testing was required to ensure that the recycled materials used (CRC) met the limits set in the IPWEA/ WALGA specification for the supply of recycled road-base.

Asphalt and paths:

- 10% recycled asphalt **product** (RAP) was used in asphalt layer.
- Recycled sand and concrete were used in the paths – no visible difference from virgin products.
- Approximately 10% recycled products were used.

Limestone walls – The EcoCream¹³ product, made from recycled sand, crushed limestone and other recycled materials, was used to build the limestone walls. This product has the same strength and weight as virgin limestone blocks.

Notes

- Fine surface cracking in the asphalt was observed in one stage. The hypothesised problem was that the clay brick content in the road was too high which resulted in either expansion or shrinkage which was reflected in the surface layer. It is unclear if a 2-coat primer seal would have prevented this from happening – more trials using recycled material are required to determine and evaluate the problems and solutions associated with using recycled materials in this setting.

¹² New The Amble estate will be doing things differently by The West Australian, December 2017.

¹³ Stoneridge Quarries WA - <https://stoneridge.net.au/products/eco-products/eco-cream/>



Tree reuse to create a playground at The Amble Estate. (Image supplied by Porter Consulting Engineers)



Topsoil screening for direct on-site reuse at The Amble Estate. (Image supplied by Porter Consulting Engineers)



Recycled road-base, The Amble Estate. (Image supplied by Porter Consulting Engineers)



Path and pavement incorporated recycled product – concrete, sand, and asphalt. The Amble Estate (Images supplied by Porter Consulting Engineers)

5.5 Calleya Community Garden

About the project

In 2019 Earthcare Recycling (ECR) and the associated Earthcare Landscapes company were approached by Stockland to develop and construct the Calleya Community Garden (CCG). The design process focused on incorporating recycled materials into all aspects of the garden construction.

ECR was responsible for waste management recycling services for 50% of the Calleya residential houses, which led to the opportunity to demonstrate how recycled material can be integrated into the Calleya development and showcase how a separation at source model enables the company to capture and recycle over 97% of all the material from the residential construction sites.

Recycled material¹⁴

Paths – 40 tonnes of recycled builder waste road base with cement stabilisation was used. The recycled road base was made from crushed brick and concrete products.

Planters:

Brick – Approximately 1,250 bricks used from the 500 full packs of unused bricks ECR collects each year from construction sites. The on-site collection of unused bricks allows for an efficient 'ready for reuse' approach. This potentially reduces over ordering, which in turn reduces waste produced.

Gabion Walls – 7.2 tonnes of reclaimed brick and tile was used. Damaged mixed builder waste was intercepted prior to crushing to demonstrate the level of quality control ECR incorporates into their process of producing usable products.

Timber:

Covered shelter

- Jarrah timber bearers were made from recycled timber. The roof frame was made from pine timber collected and sorted from the ECR builder site.
- Pine timber was also used for an arbour.
- Reclaimed tuart timber was used to build seating for an outdoor classroom.

Other recycled materials:

- Salvaged limestone blocks and recycled jarrah timber were used to create benches.
- Enviro-pipe off cuts were salvaged and used as herb beds.



Salvaged Enviro-pipe plant beds used at the CCG.
(Image supplied by Earthcare Landscaping)

¹⁴ Information and amounts supplied by Earthcare Landscaping



Recycled material used in the paths and recycled bricks used in planter boxes at the CCG. (Image supplied by Earthcare Landscaping)



CCG covered shelter and outdoor classroom seating built from recycled and reclaimed timber. (Image supplied by Earthcare Landscaping)

5.6 City of Fremantle

In 2018 the City of Fremantle used the equivalent of 2640 recycled glass bottles to resurface the North Fremantle Post Office carpark. 10% crushed glass was incorporated into a warm asphalt mix. The recycled glass was used as a substitute for traditional crushed granite aggregate. In addition to this, recycled road-base was also used.

Other benefits of using recycled glass:

- Less greenhouse gas emissions are produced since glass asphalt is made at a lower temperature, requiring less energy.
- Using recycled glass in asphalt for roads and carparks can help create a local market¹⁵.

5.7 City of Canning

For the past 12 years the City of Canning has been involved in fostering projects assessing new pavement materials such as various grades of road base manufactured from C&D materials. Between the years 2008 – 2016, 95% of all road base was recycled and over 10 years ago (YEAR) the asphalt specification mandated 5% glass and 10% RAP¹⁶.

In 2008, the upgrade of Welshpool Road between Leach Highway and Sevenoaks Street demonstrated that road base made from recycled concrete can result in significant economic and environmental benefits such as savings in transportation costs and reducing natural material assets, conserving landfill sites and greenhouse gas emissions.

¹⁵ City of Fremantle uses recycled glass in road resurfacing by the Waste Management Review, December 2018.

¹⁶ Use of recycled crushed demolition materials as base and sub-base in road construction by Collin Leek, 2008 - https://sustainableaggregates.com.au/docs/field_trials/WA_Demo_Leek.pdf

Further findings conclude that for low volume roads or high-volume roads with minor truck traffic, recycled materials can be safely used as a base and sub-base. Furthermore, it is noted that the risk of using recycled materials as a base in heavy traffic conditions is minimal. It is expected that the analysis of the long-term performance monitoring of the trial sections of Welshpool Road should confirm this.

5.8 Other Examples

Appendix 2 shows a range of projects in WA that have incorporated recovered materials. These projects were supplied by respondents to a survey released in June 2020 (full report available upon request).

This list obtained from survey responses is provided to highlight the breadth of reuse options and opportunities and is not intended to be a complete or definitive list of reuse examples in WA.

6. Regulatory requirements for the use of recovered waste

Feedback from industry has indicated that there is uncertainty around whether material is “waste” under the *Environmental Protection Act 1986* (EP Act), the *Waste Avoidance and Resource Recovery Act 2007* (WARR Act), the *Waste Avoidance and Resource Recovery Levy Act 2008* (WARR Levy Act) and their associated regulations. This can inhibit the uptake of and market development of recovered and waste-derived materials, and is potentially driving a preference for the use of virgin raw materials, and resulting in valuable non-virgin resources being sent to landfill.

This is notwithstanding 2018 regulatory changes to the *Environmental Protection Regulations 1987* (EP Regulations) to support the use of clean fill and uncontaminated fill that meets environmental and health thresholds, and the expansion of uses for recycled aggregates in selected civil works projects.

Users of material produced from waste should be clear on whether their material is “waste” and hence whether it will require a licence and potentially payment of the waste levy.

Current legislation does not prescribe when waste-derived materials will cease to trigger the licensing and waste levy regimes under the EP Act, WARR Act, WARR Levy Act and their regulations made under these Acts (with the exception of clean fill and uncontaminated fill). Industry should refer to the below documents to determine if their use of waste may trigger licensing or levy requirements:

Guidance on relevant matters to consider when determining if material is waste is provided in:

- [Factsheet: Assessing whether material is waste¹⁷](#).

Information on the use of clean fill and uncontaminated fill in accordance with EP regulations is detailed in the

- [Factsheet: - amendments to the Environmental Protection Regulations 1987 - clean fill and uncontaminated fill¹⁸](#).

Legislative framework for waste-derived materials:

DWER is developing a legislative framework for waste-derived materials which would provide certainty around the definition of waste and permissible uses.¹

Submissions to the review have supported the development of a legislative framework that provides more certainty about when waste-derived materials will cease to trigger licensing and waste levy provisions under the EP Act, the WARR Act, WARR Levy Act and their associated regulations.¹

DWER is currently finalising a preferred approach for this legislative framework, which will support and encourage the use of fit-for-purpose waste-derived materials and Western Australia’s move to a circular economy.

¹⁷ <https://www.der.wa.gov.au/images/documents/your-environment/waste/Factsheet-Assessing-waste.pdf>

¹⁸ https://www.der.wa.gov.au/images/documents/our-work/licences-and-works-approvals/factsheet/Factsheet_-_amendments_to_EP_Regulations_-_final.pdf or <https://www.der.wa.gov.au/your-environment/waste>

7. Properties of recycled materials & testing requirements

Often the impediments linked to the reuse of recycled C&D products are derived from misconceptions linked to a lack in knowledge or education. Below this guide considers the properties of recovered construction materials.

7.1 Asbestos

7.1.1 Testing

The DWER guideline for the management of asbestos at C&D waste recycling facilities includes an intensive testing regime which is to be facilitated by the supplier. Additionally, DWER undertakes independent auditing to ensure the recycled product is safe by assessing whether the level of hazardous contaminants is below the limit set by the Department of Health and to ensure the reliability of supplier testing and operation processes.

Below is a summary of the asbestos testing and supply requirements of recycled C&D products used in the MRWA RtR project.

The asbestos limit, applicable to fibrous asbestos and asbestos fibres, of any recycled product must not exceed 0.001% (w/w) under these standards.

A 0.01% limit applies to asbestos containing materials (ACM) in soils at contaminated sites, which is a screening assessment level only. The 0.001% limit also applies in contaminated sites assessment, but is applicable to fibrous asbestos and asbestos fines.

Table 4 below summarises some typical testing and sampling requirements taken from the 'Guidelines for managing asbestos at construction and demolition waste recycling facilities' (2012). Refer to most current guidelines for detailed requirements.

Table 4: Recycled product testing & supply

Recycled product testing & supply		
Product specification	The asbestos limit of any recycled product must not exceed 0.001% (w/w) Other guidance for civil applications for CRC used in base-coarse has a tolerance limit of absolute zero.	
Sampling & inspection requirements	Stockpile inspection & sampling	Conveyer sampling
	The minimum sampling rate of recycled road-base and screened sand products is 14 samples per 1,000m ³ of product.	The minimum sampling rate of recycled road-base and screened sand products is 1 sample per 70m ³ of a product output.
	<i>Note: No sampling required for recycled drainage rock unless laboratory analysis is required to assess if a suspect fragment is asbestos.</i>	
Reduced sampling criteria	Once it's been demonstrated that the supplier is able to consistently produce a recycled product that meets the product specification, DWER may authorise a reduced product testing rate down to 1 sample per 600m ³ of product.	
Sample analysis method	Minimum sample size is 500mL. Asbestos analysis must be undertaken by an independent NATA certified laboratory. The only method that currently has NATA certification in WA is AS4964-2004 - the polarized light microscopy method (PLM).	

Interpreting inspection & sampling results	If the testing results identify asbestos above the 0.001% w/w limit, then: 1. That stockpile should be deemed contaminated and considered for off-site disposal, or 2. Subject to additional actions to demonstrate its acceptability through further assessment or further actions to remediate the product.
Product supply	Recycled products supplied must come from stockpiles that have been sampled and tested to ensure the product conforms to the product specification.
Sourced from <i>Guidelines for managing asbestos at construction and demolition waste recycling facilities</i> , 2012. https://www.der.wa.gov.au/images/documents/our-services/approvals-and-licences/final-guidelines-asbestos-in-cd-recycling--version-1.pdf	

7.1.2 The Great Eastern Highway project – What went wrong & why?

Many adverse preconceptions in recycled construction materials appear to have come about from a Great Eastern Highway works project in 2011. The use of recycled C&D material in that road construction project was suspended due to concerns about traces of asbestos. Testing showed that some traces of asbestos were in fact present, but the sample was taken from a source stockpile that was never intended to be used on the project. As a result, a review was conducted to ensure that there were no health and safety issues. This severely impacted the market for C&D products, as the perceived risks were now viewed as being ‘too high’¹⁹.

Following this incident, reforms were implemented to minimise the asbestos risks linked to the reuse of recycled C&D products.

In 2012 the *Guidelines for the management of asbestos at C&D waste recycling facilities*²⁰ were released by DWER, which included a sampling and testing regime that recycling facilities have to comply with. In addition, an independent auditing and reporting process was also incorporated to ensure that the risk of asbestos contamination has been addressed by material suppliers.

Despite these reforms, there is still a lack of confidence amongst some practitioners in the market for the reuse of recycled C&D products. This is a negative perception that requires continued effort to be resolved – though education, case studies and pilot projects²¹.

7.2 Durability properties of C&D products

7.2.1 Permeability

Permeability is a major concern associated with the use of recycled sand as a general clean fill due to the higher proportion of fines that can lead to blockages in the pore spaces, restricting the flow of water through the medium. i.e. recycled materials have a greater porosity than virgin materials.

¹⁹ Concern over asbestos in roadworks material by ABC news, May 2012.

²⁰ Guidelines for managing asbestos at construction and demolition waste recycling facilities by IRLB, December 2012 - <https://www.der.wa.gov.au/images/documents/our-services/approvals-and-licences/final-guidelines-asbestos-in-cd-recycling--version-1.pdf>.

²¹ Meeting with WMRR C&D Working group, 4th February 2020.

According to a study done by the U.S. Army Corps of Engineers²² it was found that recycled fine aggregates are not suitable for use in drainage layers beneath the pavement because soluble minerals rich in calcium salts can be transported as the water percolates through the medium. The calcium minerals tend to bind to the drainage structure, which reduces the permeability of the drainage system over time.

If recycled aggregates are intended to be used in the drainage layer, it is recommended that the material be thoroughly washed to remove fines and dust.

However, there are other more suitable uses for recycled sand and fine crushed aggregates where permeability is not considered a structural factor – such as for sealed roads above water table levels, compacted fill for building sites, landscape paving and as a fine aggregate in building block and rammed earth walls.

7.2.2 Cracking

Some minor cracking has been observed in the surface layer of roadwork construction when recycled material is used. This is due to the reactivation of cement – depending on the percentage included.

It is generally accepted that CRC will shrink and give a cracking risk. However, this risk can be minimised by:

- Using RCC as base and subbase
- Place base before subbase has dried back
- Allow longer periods of base dry-back to allow shrinkage to occur
- Apply 2 coat primer seal

7.2.3 Leaching

Recycled aggregates are not recommended to be used as a drainage material because of the concerns with permeability, particularly with respect to sulphate attack from impurities in the groundwater or leachate being filtered.

Recycled concrete sources from demolition sites may be contaminated by sulphate from plaster and gypsum which induces the possibility of sulphate attack if the recycled aggregates used in concrete are accessible to moisture²³.

The RtR product specification states - to prevent leaching into the environment, recycled road base should not be used on land that is used for human food crop cultivation²⁴.

7.2.4 Organic matter levels

The allowable limit for organic matter in the IPEWA/ WALGA specification for the supply of recycled road base is 0.5%. A higher percentage may impact on durability and cracking. The presence of

²² Reuse of concrete materials from building demolition by U.S. Army Corps of Engineers, September 2004.

²³ Durability studies on the recycled aggregate concrete in China over the past decade by Yangzhou University, July 2019.

²⁴ Roads to reuse product specification by the Waste Authority, June 2020 -

https://www.wasteauthority.wa.gov.au/images/resources/files/2020/Roads_to_Reuse_product_specification_updated_June_2020.pdf

organic matter may also be responsible for the perspective that recycled C&D products have ‘poor visual presentation’ compared to virgin products.

In a study done by Swinburne University²⁵, it was found that the organic matter content for reclaimed asphalt pavement was high. The study suggested that this is due to the presence of bitumen which is rich in carbon. This is an area that requires further investigation.

7.3 C&D waste recycling facilities

The process operations of C&D waste recycling facilities have been criticised for their contribution of excess noise and dust pollution. C&D waste recycling facilities are subject to risk -based assessment to ensure there is no unacceptable risks of harm to public health or the environment from the construction and operation of C&D recycling sites.

Table 5 below includes common mitigation measures to combat the common environmental issues that C&D waste recycling facilities impact. These are provided as general guidance only.

Anyone wishing to establish a new C&D recycling facility should contact DWER for advice. Further information on DWER’s licensing approach can be found in the Department’s *Industry Guide to Licensing*.²⁶

Table 5: Mitigation measures to combat the common environmental issues at C&D recycling facilities

Environmental Issues		Suggested remedy
Noise	C&D waste recycling facilities use an array of machinery as well as host a large amount of traffic which generate noise.	<ul style="list-style-type: none"> - Facility should be situated within a zoned industrial area. - Implement noise reduction measures such as acoustic muffling strategies that an acoustic engineer can offer. - Pre-treatment of waste can reduce noise impacts.
Air quality	Dust is mostly generated during the transportation of material and during the recycling process.	<ul style="list-style-type: none"> - Internal dust suppression systems on processing operations. - Moistening of roadways and operating areas. - Dust suppression plan. - Vegetated buffer zone.
	Asbestos is most commonly found in products such as formwork for concrete, exterior wall cladding and roofing. Asbestos fibres can become airborne during transportation, unloading and processing of C&D waste.	<ul style="list-style-type: none"> - Signing of a declaration form by drivers. - Quality control process implemented by the recycling facility to unload and inspect incoming loads. - Rejected loads should be taken to licenced facilities.

²⁵ Geotechnical and geoenvironmental properties of recycled construction and demolition materials in pavement subbase applications by Swinburne University, 2012.

²⁶ <https://www.der.wa.gov.au/our-work/licences-and-works-approvals/540-guideline-industry-regulation-guide-to-licensing>

Water	Poor stormwater management at a recycling facility can lead to surface run-off contaminating the watercourse via contaminants entering the local drainage network.	<ul style="list-style-type: none"> - The reprocessing site should not be located within close proximity to major water bodies or rivers. - Stormwater management measures should be implemented to effectively manage surface runoff around the operating areas. - Install and maintain filters/ sediment traps where required. - Vegetation buffer zones should be established & maintained.
Land	Contaminants from stockpiles can leach into the soil. Additionally, oil spills from onsite machinery can also lead to contaminated soils if left to accumulate over time.	<ul style="list-style-type: none"> - Implementing hard stand or sealed surfaces for stockpiling/ operations. - Regularly maintain facility operating equipment & machinery. - Spill incident plan should be established. - Events of contamination must be reported to DWER.
Flora & Fauna	The local native biodiversity can be threatened due to plant diseases, unwanted seeds and pests that can be present in green waste loads.	<ul style="list-style-type: none"> - Source separated loads should be encouraged in the acceptance criteria. - Wood in mixed loads should be isolated and inspected. These materials should be stored on hardstand areas. - Sound site and buffer zone design will reduce impact of disease spread.
Litter	Windblown litter from a recycling facilities operation can be spread to neighbouring properties, public areas and the natural environment.	<ul style="list-style-type: none"> - Perimeter fencing to capture windblown litter - Program to regularly collect and appropriately dispose of litter. - Covering of vehicle loads entering/ leaving the facility enforced.
<p>Information gathered from: http://www.sulo.com.au/wp-content/uploads/2013/07/Environmental_Guidelines_for_Construction_Demolition_Recycling_Facilities_Sep_2009.pdf</p>		

7.4 Recovered C&D materials in road construction – risks and benefits

The IPWEA/WALGA Specification for the supply of recycled road base²⁷ states:

“Recycled pavement materials based largely on recycled crushed concrete have been well researched and have been shown in many studies to be superior in structural properties when compared to virgin crushed road base;” and
 “The material shall consist of a uniformly blended mixture of coarse and fine aggregate resulting from the crushing of recycled concrete and other hard materials from C&D material. It may contain other materials such as clay brick and tile, sand and glass according to the limits specified.”

The Town of Kwinana undertook a trial incorporating recycled materials in the construction of Gilmore Avenue. The results are summarised in a report – “Performance of Recycled Concrete

²⁷

https://secure.ipwea.org/Web/WA_Resources/Specifications_and_Guidelines/Web/WA_Resources/Specifications_and_Guidelines_page.aspx

Aggregate as a Base Course Material in Road Pavements.”²⁸²⁹

Some considerations for the use of recycled C&D products for the construction of roads are:

- On lightly trafficked local roads CRC should be used as a sub-base or as full depth pavement below the asphalt layer. Some transverse shrinkage cracking can occur where full depth CRC is used. This however is not a structural concern and only impacts the aesthetic and contract compliance ramifications.
- CRC used on heavy trafficked roads can be used as a sub-base with adequate granular base thickness or sufficient asphalt to suppress micro cracking induced by traffic loading. It is however recommended that CRC be treated as bound materials when designing heavily trafficked road pavements.

The RtR product specification³⁰ states the following end uses for the recycled road base and recycled drainage rock:

- Recycled road base is authorised to be used as sub-base or basecourse in road and pavement construction, including other hardstand areas such as carparks and footpaths.
- Recycled drainage rock is authorised to be used as sub-surface pipe bedding and as drainage rock in civil projects.
- It is listed that both of these products are to be used only for urban residential, public open space, commercial and industrial land uses only³¹.

Table 6 summarises the and benefits identified by MRWA and the Waste Authority for the reuse of recycled C&D products in road construction.

Table 6: Benefits for the reuse of recycled C&D products in road construction-

Benefits of using recycled material in road construction
<ol style="list-style-type: none"> 1. Recycled C&D material has self-cementing properties which when used as a sub-base provides a stiff supporting layer that plays a role in extending the life of various road pavements. 2. The initial costs of using recycled C&D material with geotextile seals in the basecourse under local roads are offset by the longer life expectancy of recycled material. 3. Since recycled material is more consistent than virgin limestone, less mixing is required resulting in time and labour savings. 4. Using recycled material results in water savings since less water is required for compaction when compared to virgin materials. 5. Recycled material is more durable than virgin material which is likely to breakdown to a greater degree under certain traffic conditions.
<p>Information adapted from https://www.wasteauthority.wa.gov.au/publications/view/case-study/roads-to-reuse-pilot-project-case-study</p>

²⁸ The use of recycled materials for pavements in Western Australia by G. Cocks, C. Leek, M. Bondietti, H. Asadi, S. Deilami, R. Leach, M. Sicoe, R. Clayton, R. Keeley & C. Maekivi. November 2016 - <https://walga.asn.au/getattachment/Policy-Advice-and-Advocacy/Infrastructure/Roads/Green-Book-2016-11-06.pdf.aspx?lang=en-AU>

²⁹ https://www.wastenet.net.au/Assets/Documents/Content/Information/Colin_Leek_Presentation.pdf;

³⁰ Roads to reuse product specification by the Waste Authority, September 2018 - <https://www.wasteauthority.wa.gov.au/programs/view/roads-to-reuse>.

7.4.1 Comparison of the MRWA specification 501: pavements with the IPEWA/ WALGA specification for the supply of recycled road base

The *MRWA specification 501: pavements* specifications are being viewed by some as the forerunner 'go to' specification by local governments and other tendering organisations. It seems that many specifications are simply being copied and pasted from old tendering documents. Engineers and some local government officers are reluctant to take the 'risk' of adopting a different standard to previous practices. This results in outdated MRWA specifications being preferred to the *IPEWA/ WALGA specification for the supply of recycled road base* as a simple risk management strategy for industry and developers³².

Another reason for the MRWA specification being favoured is lack of knowledge of the IPEWA/ WALGA specification. Some industry sources have suggested that only half the local governments are using the *IPEWA/ WALGA specification*. The MRWA specification 501: Pavements does not encourage the reuse of recycled C&D material in road construction and states that recycled crushed concrete is only suitable for use in the sub-base layer under full depth asphalt³³.

A major difference between the two specifications is that the IPEWA/ WALGA specification focuses on the supply of recycled crushed C&D materials for both class 1 & 2 roads. This class 1 and 2 classification defines the material quality in reference to its end use traffic volume - as shown in the table below. Class 1 is therefore the higher quality material.

Table 7: Application of class 1 & class 2 materials in the WALGA specification

Level in pavement	Traffic (ESA/day)			
	>500	<500	50-100	<50
Base < 50mm asphalt or spray seal	Class 1	Class 1	Class 1	Class 1
Base ≥ 50mm asphalt	Class 1	Class 1	Class 1	Class 2
Subbase	Class 2	Class 2	Class 2	Class 2

Sourced from

https://secure.ipwea.org/Web/WA_Resources/Specifications_and_Guidelines/IPWEA_WALGA_Specification_for_the_supply_of_recycled_road_base.aspx

Some key points from the IPEWA/ WALGA specification include³⁴:

- Recycled pavement materials may consist of; crushed recycled concrete and other hard materials, such as such as clay brick and tile, sand and glass.
- The product must achieve a uniformly blended mixture of coarse and fine aggregate
- For class 1 the maximum percentage by weight for crushed recycled concrete is 95%. For class 2 the upper limit is 95% for base and 100% for sub-base.
- The maximum percentage by weight for Recycled Asphalt Pavement (RAP) is 10% and 15% for class 1 and class 2 respectively.
- All testing to be undertaken by a NATA accredited laboratory.

³² Meeting with Colin Leek.

³³ Specification 501: Pavements by Main Roads Western Australia, 2012.

³⁴ Specification for the supply of recycled road base by IPWEA/ WALGA, May 2016.

8. WA supplier contact list

The following list of producers / suppliers of recovered C&D products were identified in a survey of recyclers in June 2020.

This list, and the recyclers surveyed, was prepared in liaison with the WA Construction & Demolition Working Group – a state based sub-committee working group of the Waste Management and Resource Recovery Association of Australia.³⁵

This list is not intended to be a complete or definitive list of all C&D businesses or recyclers nor their list of Recovered Materials Product range: rather it focusses on companies that are both recyclers of construction and/or demolition waste and who then produce recycled and reused materials for an end-market application.

Contact the recyclers direct for more current and detailed information.

Table 8: WA supplier recycled & reuse product range

Company	Recovered Materials Product range
Capital Recycling https://www.capitalrecycling.com.au/	<ul style="list-style-type: none"> ▪ Road base ▪ Remanufactured aggregate (drainage rock) ▪ Fill sand ▪ Recycled asphalt ▪ Concrete aggregate ▪ Concrete cracker dust
EarthCare Recycling http://earthcarerecycling.com.au/	<ul style="list-style-type: none"> ▪ Road base ▪ Remanufactured aggregate - Drainage stone ▪ Fill sand ▪ Track material ▪ Timber
Resource Recovery Solutions https://www.resourcerecovery.solutions/	<ul style="list-style-type: none"> ▪ Recycled fill sand ▪ Remanufactured aggregate ▪ Road base ▪ Drainage rock
Red Sand Supplies https://www.redsandsupplies.com.au/	<ul style="list-style-type: none"> • Bitumen road base • Concrete road base • Concrete drainage stone • Decorative brick aggregates and brick fines • Track material road base
Encore Recycling and Resource Recovery (ERRR)	<ul style="list-style-type: none"> • Sand • Masonry rubble

³⁵ <https://www.wmrr.asn.au/>

https://www.thebinguys.com.au/	
M8 Sustainable Limited https://m8sustainable.com.au/	<ul style="list-style-type: none"> ▪ Road Base ▪ Remanufactured aggregate ▪ Fill sand
Stoneridge https://www.stoneridgewa.net.au/	Reconstituted wall and construction blocks from recovered C&D materials - concrete, bricks, concrete products and aggregates.
Urban Resources https://www.urbanresources.com.au/	Crushing and processing of waste concrete for use as a Main Roads WA approved road base.
Waste Stream Management https://wastestream.com.au/products	Crushing and processing of waste concrete for use as a Main Roads WA approved road base.
Peel Resource Recovery www.peelresource.com.au/	<ul style="list-style-type: none"> • Road Base • Remanufactured aggregate • Fill sand • Recycled asphalt
Eco Resources https://ecoresources.net.au/	<ul style="list-style-type: none"> ▪ Road Base ▪ Remanufactured aggregate ▪ Fill sand ▪ Track material ▪ Timber

Table 9: Additional reported organisations with reprocessing facilities

This additional list is not intended to be a complete or definitive list of all C&D business or recyclers – it is a list of recyclers named in a construction industry survey dated 20 June from a pool of 68 respondents.

- | | |
|---|--|
| <ul style="list-style-type: none"> • All Earth Care • Asphalt Recyclers Australia • Asphaltech - RAP • Austim - • BCG / BGC Asphalt / BGC precast • Boral - • Brajkovich Demolition • CSR • C-Wise • Downer • EMRC • Fremantle Timber Traders | <ul style="list-style-type: none"> • G & G Corp / WA Recycling • Hanson • Holcim • Moodie products • Recycled Timber Company • Re-plas • Richgro • S&L Salvage • The Green Pipe • WA Brick Match • WA Brick Recycling |
|---|--|

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Beneficial outcomes in a project such as this can only be achieved with support from industry stakeholders through assistance in undertaking meaningful engagement across the interested sectors and stakeholders.

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- Carmen Williams, WA Manager, Australian Institute of Landscape Architects
- Chris Green, Director Policy and Research Urban Development Institute Association (WA)
- Colin Leek, Principal Engineer, Talis Consultants
- David Markham, Chair, WA Construction & Demolition Waste Recycling Working Group
- Fiona Hogg, Assistant Director, Department of Finance
- Jake Hickey, State Resource Development Manager, Instant Waste
- Karl White, Senior Manager, Planning and Sustainability, Cedar Woods
- Matthew Lunn, Executive Officer, Landscape Industries Association of WA
- Michael McGowan, WA Commercial Manager, Housing Industry Association
- Michael Norriss, Smart Waste consultant
- Nadja Kampfenkel, Sustainability Manager WA, Lendlease
- Rebecca Brown, Manager, Waste & Recycling WA Local Government Association
- Department of Communities
- DevelopmentWA

10. About the project team

ActiveSustainability, run by David Beyer, believes that the quality of life for current and future generations depends on the implementation of sustainable business solutions, and all our products and services are designed to achieve this end. ActiveSustainability has done numerous EnviroDevelopment accreditations around Western Australia which has given this consultancy a thorough understanding of the current practical challenges of recycling - and insights into the cultural changes required to increase the uptake of recycled C&D materials in developments in WA.

Foundations Research is an independent consultancy run by Geoff Cooper for industry and government clients. Geoff Cooper has extensive experience conducting industry consultations, coordinating funded projects, and preparing publications. He's been involved in waste management promotion since 2007 and utilised his broad industry, government and media contacts to assist with the delivery of this project.

11. Additional resources

11.1 APPENDIX 1 – Case Studies:

Listed below are a range of projects in WA that have incorporated recycled and reused materials.

These projects were supplied by respondents to a survey released in June 2020 (full report available upon request).

This list is provided to highlight the breadth of reuse options and opportunities. It is not intended to be a complete or definitive list of project or reuse examples.

<ul style="list-style-type: none"> - Alkimos Beach and Alkimos Vista: by Lendlease and DevelopmentWA <ul style="list-style-type: none"> o Builders waste from participating builders was recycled by Earthcare Recycling, o Sand from lots used as deep fill, with the rest sent to recyclers, o Crushed material (recycled sand, concrete, bricks, asphalt) used for commercial builder's drainage works
<ul style="list-style-type: none"> - Amberton estate <ul style="list-style-type: none"> o Construction waste being used in footpaths.
<ul style="list-style-type: none"> - The Amble <ul style="list-style-type: none"> o Crushed concrete and aggregate as road base; o Recycled sand for fill, o Recycled materials in retaining wall backing blocks
<ul style="list-style-type: none"> - Aveley North Primary school – <ul style="list-style-type: none"> o Green waste mulch
<ul style="list-style-type: none"> - Brownlie Towers
<ul style="list-style-type: none"> - Bushmead Estate – <ul style="list-style-type: none"> o Recycled concrete pavement and aggregate used in road base, o Recycled concrete eco-block for retaining wall construction, o Recycled timber used in play equipment. o Mulch, clay, gravelly sand reused on site or stockpiled for future reuse.
<ul style="list-style-type: none"> - Busselton Playspace – <ul style="list-style-type: none"> o Recycled timber to custom play equipment.
<ul style="list-style-type: none"> - East Village: <ul style="list-style-type: none"> o Recycled steel from another site re-purposed in shade structures, o Recycled aggregate in road base. o Recycled concrete in use in boundary and retaining walls. o E3 Living Lab materials and potential reuse,
<ul style="list-style-type: none"> - Golden Bay <ul style="list-style-type: none"> o Recycled sand, bricks, plastic strapping
<ul style="list-style-type: none"> - Hamilton Senior High School, Hamilton Hill <ul style="list-style-type: none"> o Targeting 100% reuse of demolition materials (concrete, bricks, asphalt, glass, trees / timber.). o Imported RAP (Recycled Asphalt Pavement) being investigated for road surfaces o Recycled materials included bricks tiles, concrete and other demolition materials for use on site as road base and landscape elements. o Used for civil and landscape items including road base, paving, drainage aggregate, shelters, walls, art / interpretation.

- Harrisdale North Primary School
○ Crushed recycled brick/concrete as a mulch
- Cockburn / Port Coogee
○ Roads sealed with 750m ² of Reconophalt made from 40,000 plastic bags, 900 toner cartridges, 210kg of crumb rubber from tyres, and seven tonnes of recycled asphalt.
○ https://www.cockburn.wa.gov.au/About-Cockburn/News/Latest-News/Two-new-roads-paved-with-recycled-waste-products
- Kingsford
○ Recycled brick, tiles etc for landscape elements
- Kwinana Freeway upgrade-
○ Sub base material
- Kwinana power station
○ Crushed Recycled Concrete
- New Perth Stadium
○ Site salvaged trees and recycled timber used in playground and through parkland
- Pear Tree Cafe in Hamilton Hill – Pop-Up Community space
○ Recycled aggregates for mulch and pavements
○ Broken bricks reuse in gabion walls
- Reid Hwy over Swan River
○ Embankment Fill
○ Recycled Tyres in noisewall
- NatureScape - recycled timber to walkway structures
- Subiaco Oval
○ Re-use of concrete from the grandstands as road base by MRWA Roads to Reuse.
- Sunset Park
○ Extensive use of recycled material in gabions, furniture etc
- TAFE Greenskills Facility
○ Recycled timber for internal fitout
- Whiteman Edge
○ Recycled asphalt made partly from plastic bags, ink containers and glass bottles
- Yanchep Golf Estate
○ Recycled timber, plastic strapping, sand

