



APPENDIX M: MARKET JUSTIFICATION REPORT





Market Justification and Opportunities

Prepared by Ironstone Developments Pty Ltd

September 2021

**MARKET JUSTIFICATION FOR DEEP CREEK QUARRY,
LIMBURNERS CREEK NSW**

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1 Introduction

This report is prepared for the proposed Deep Creek Quarry (DCQ) located off The Bucketts Way at Limeburners Creek, New South Wales.

The purpose of this document is to articulate the potential value of the resource within the quarry materials market (beside the baseline economics assessed in the Economics Report by AEC 2021). This report highlights the potential uses and material properties confirmed during the project development.

1.1 The Author

This report has been prepared by Tim Mullaney working for Ironstone Developments Pty Ltd, the proponent of the proposed Deep Creek Quarry (DCQ). I have spent 35 years in the quarrying industry including working within several quarry pits as an operator in production through to quarry sales for the last 20 years. Quarry sales provides a unique view of the industry in what demands and specifications construction requires.

I have been working on the Deep Creek Quarry (DCQ) project since 2014 and can see real benefits to the local and wider community if this resource material is approved for extraction.

1.2 The DCQ Resource

VGT have estimated a quarry resource of approximately 12 million tonnes (refer to geological report). A high proportion of this resource is a rhyolite material.

During the last 20 years I have sold Rhyolite (when it was available) to customers from Canberra to Coffs Harbour and inland as far as Bathurst for its high grip (PAFV) and decorative qualities. This market was not fully catered for or developed due to the sporadic availability of the Rhyolite resources.

Rock core samples taken from the proposed pit area were crushed for testing which has shown the DCQ resource material is competent enough for use in the full range of engineering applications such as concrete and asphalt aggregates, manufactured sand, rail ballast, gabion and mattress rock for stabilisation of ground on projects, armour rock for riverbank and sea wall protection, specified road bases, select fill, general fill, drainage aggregates, non-spec road base, crusher dust as well as materials for decorative landscape applications such as rock, aggregates, road base and crusher dust, road base and crusher dust can also be used for rammed earth houses and unique buildings construction.

1.2.1 PAFV

An important property of rhyolite is the Polishing Aggregate Friction Value (PAFV). The PAFV refers to a test result for aggregates obtained through skid resistance testing in a laboratory. Within a technical commentary for the supply of pavement materials the South Australian roads authority DPTI provides an explanation of how high grip aggregates are important:

“Micro texture is a measure of the surface roughness of an aggregate particle and is significant in determining the frictional characteristics of an asphalt wearing course in which the aggregate particles lie flat to the surface. As a result, aggregates with a higher PAFV than for spray sealing are required for asphalt. Asphalts also tend to be used in urban or rural areas where traffic

loadings are high and so are subject to the polishing action of traffic during their service life. While dense graded asphalts also have a mastic of sand and bitumen that contributes to surface microtexture, open graded and stone mastic asphalts are more heavily reliant on the microtexture of the coarse aggregate for surface friction and so a higher PAFV is specified. Sites requiring a higher level of skid resistance, such as heavily trafficked sharp curves, or high stress braking areas may also warrant a higher level of polishing resistance. The specified values for PAFV for asphalt aggregates are intended to reflect the diversity of road geometry, traffic loading, asphalt mix types and performance, and available aggregate sources to ensure that aggregates selected for specific sites are fit for their intended purpose.” (DPTI 2017).

Transport for NSW (TfNSW) have specified high PAFV aggregates for use in intersections and roundabouts for over a decade. A PAFV of 48 is typically specified for general road construction, while a high grip material requires a PAFV of 58 to 65.

Queensland Transport and Main Roads (TMR) changed specification for PAFV following a fatal road accident in 2007, where the PAFV was raised from 45 to 48 for road surfacing (TMR 2007). While some changes to improve PAFV of a road surface can be made, the inherent properties of the rock can't be altered. Following this change in PAFV, several quarries were then unable to supply materials consistent with the specification (Geological Survey of Victoria, 2020). These changes show the increased focus on improving road safety, and where the DCQ resource can contribute to these improvements.

The PAFV test results for the Deep Creek Quarry rock cores range from 57 to 65. This high grip quality is an important value of the quarry that has the potential to substantially increase road safety.

1.3 Photographs of the DCQ Resource

Examples of the rhyolite material from the DCQ is shown from core samples in the photographs below.



Photograph 1: DCQ rhyolite from diamond drill core



Photograph 2: Drill core from DDH17 showing the lighter coloured nature of the material



Photograph 3: DCQ DDH19 Rock Core sample when dry and then wet, showing the good aesthetic values of the material.



Photograph 4: DCQ 20 mm aggregate (from a laboratory crushed core sample).



Photograph 5: DCQ Rhyolite Dust

2 PAFV – A visual representation of the current situation

In the photos below the rhyolite (high grip /PAFV) material is the lighter colour material adjacent to the normal duty asphalt or two coat seal road surface. TfNSW intersection or roundabouts constructed or upgraded in the last 10 years should have been constructed with high PAFV material. Where Rhyolite was not available Slag (an approved alternative reuse of a waste product from iron and steel production) would likely have been used and it will be a dark asphalt colour. Slag is heavier and I have been told from end users that it has also had supply issues. The age and condition of the surfaces requiring high PAFV aggregates is perhaps a good indication of the nature of the limited supply of these aggregates.



Photograph 6: Close up of the lighter coloured pavement, showing light coloured rhyolite aggregate within a bitumen matrix

2.1 Rhyolite on Roundabouts



Photograph 7: Rhyolite roundabout at Salt Ash 20-1-2021 in poor condition.



Photograph 8: Rhyolite roundabout at Tighes Hill 3-2-2021 in poor condition.



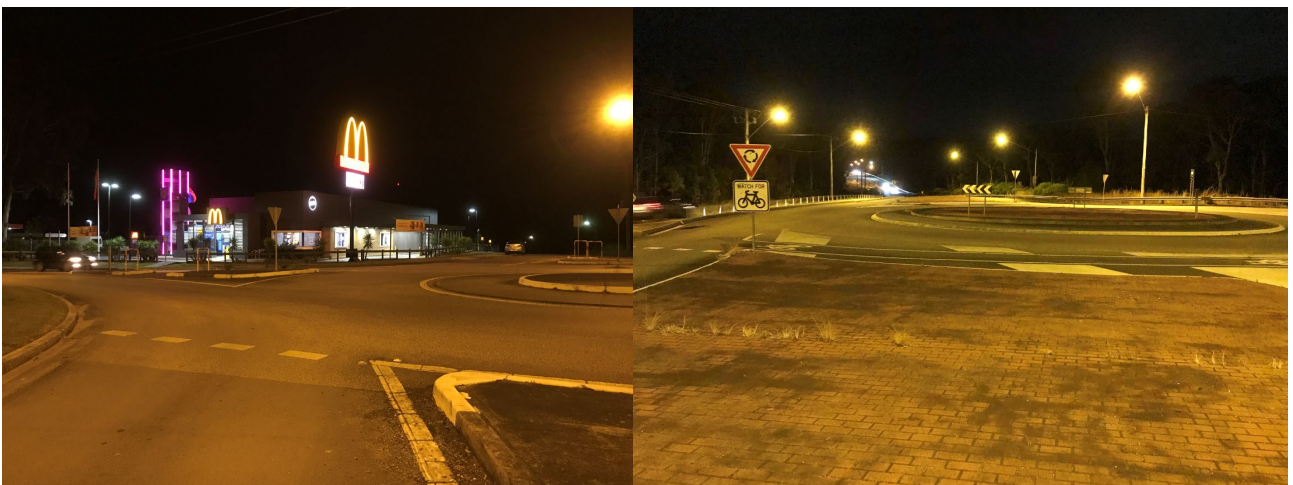
Photograph 9: Rhyolite roundabout at Warners Bay 11-6-2021 in poor condition.



Photograph 10: Rhyolite roundabouts on Victoria Street and Northcote Street, Kurri Kurri in poor or deteriorating conditions on 16-3-2021.



Photograph 11: Rhyolite on a roundabout at Manns Road, Wyoming 24-6-2021.



Photograph 12: Roundabout under lights Dora Street, Morisset, and Wangi Road, Rathmines on 24-6-2021, note the lighter materials improve the visibility of the road.

2.2 Rhyolite on Bends and Bridges



Photograph 13: Rhyolite on bends Warners Bay Road, Charlestown, sections are in poor condition or replaced with general asphalt (possibly slag) taken on 23-6-2021.



Photograph 14: Rhyolite on the Roseville Bridge 24-6-2021, the turning lane is a bit poor but the bridge is in good condition.

2.3 Rhyolite in Braking Areas



Photograph 15: Rhyolite turning lane Pacific Hwy A1, Wahroonga 24-6-2021 in poor condition.



Photograph 16: Rhyolite intersection Pacific Hwy A1, Pymble in poor condition and a Rhyolite turning lane, Warringah Road Forestville in poor condition (24-6-2021).



Photograph 17: Rhyolite in traffic lights braking area Barrenjoey Road, Avalon Beach 24-6-2021 in good condition. and on bends Barrenjoey Road, Bilgola Beach 24-6-2021 in reasonable condition.



Photograph 18: Rhyolite in the traffic lights braking area before a School Crossing on the Pacific Hwy A1, Wahroonga 24-6-2021.

2.4 Delineation lanes and Bus Stops

Rhyolite in delineation lanes and bus stops are an ideal application for a lighter/ different colour material and for the extra grip.



Photograph 19: Delineation lane on Pittwater Road Collaroy, and a bus stop in Bus Stop North Sydney.

3 Sales Markets

3.1 Concrete Roads and Paths

The DCQ material is suited for general concrete use, however, its more unique properties make the material better suited for areas requiring high grip aggregates, or more unique visual appearance as may be found in polished concrete surfaces.

Concrete in main roads and highways, intersections, bus stops and roundabouts, steep driveways and footpaths where a higher grip material is beneficial.

For highway applications a wet in wet paving method is a desirable option to apply high PAFV concrete in Australia. Typically, a cheaper (local to a project) blue metal quarry source can supply the lower layer concrete mixes and the usually dearer (due to limited availability and haulage distance) high grip aggregate concrete mix can be overlaid in a thinner layer on the surface minimising project costs.

The process involves a general concrete mix (lower layer) being poured through a paving machine and while it is still wet a concrete mix with high PAFV aggregates is laid over the top through a second paving machine travelling behind in a wet in wet paving method where it bonds to the general concrete mix below while still wet, once cured it is followed up with a Grinding process to improve ride quality, drainage, reduce noise and expose the aggregate to improve texture and grip for a wearing course.

In 2014 the RMS (now TfNSW) required a high PAFV concrete on the Hunter Expressway (a 39.5 kilometre long dual carriageway freeway), but at that time there were no suitable supplies. As an alternative, a new method called Next Generation Diamond Grinding (NGDG) was trialled (a two pass diamond grinding technique creating a flush surface than adding longitudinal grooves). This was also used in trials on the Pacific Highway near Taree, and on some Hume Highway exit and on ramps. NGDG has been primarily aimed at reducing road noise, but will also improve the grip qualities of the road by exposing the aggregate.

Ironstone Developments presented the DCQ resource information (including core test results and the resource material testing assessment) to eight members of the now TfNSW in Newcastle in 2015. Despite the success of NGDG, they continue to specify high PAFV aggregate for roadworks such as the Hunter Expressway in the hope that it will at some stage be more available. Given the limited supply of high PAFV materials TfNSW expressed significant interest in the potential for this high PAFV material to become available within the market.

Additional information on Wet in Wet Concrete Paving and Next Generation Grinding is available in the reference information section of this document.

3.2 Polished concrete floors and walls

The unique lighter colour and various tones of the DCQ material makes the material well suited to aesthetic applications. Decorative aggregates are selected by Architects for use in Concrete which is then ground and polished.

Numerous examples are available on the internet such as shown below.



Figure 1: Polished concrete used in domestic and commercial buildings as floor surface (various websites)

3.3 Steep Driveways and footpaths

Properties with steep driveways would benefit by increased availability of high PAFV aggregates to improve their grip and safety.



Photograph 20: Steep driveways where high PAFV materials would assist in a domestic environment.

3.4 Asphalt applications

The DCQ resource is suited to a range of asphalt applications including:

- General asphalt.
- High PAFV asphalt.
- Sealing aggregate for two coat seals.
- Light coloured asphalt and two coat sealed roads (see Section 5).

The high PAFV material is used in high grip critical areas such as black spot bends, traffic lights, intersections, bus stops and roundabouts, (Rhyolite has been used on the Sydney harbour bridge, in the harbour tunnel and throughout Sydney, it was applied many years ago so some areas of pavement are still in acceptable condition but most are deteriorating and need replacement. It would seem that the lack of a replacement high grip material, may be a underlying cause that leaves these roads to deteriorate.

- If the high PAFV material was readily available at a competitive price, it could be used for delineation lanes, the acceleration and deceleration lane lengths on roundabouts and intersections could be increased. It may also become a preferred option for general asphalt increasing the road safety and reducing street lighting requirements.
- After inspecting numerous intersections, roundabouts, bus stops and road bends where Rhyolite has been used it gives a clearer picture of the current situation and as only photos of sections where Rhyolite has been used are in this document you can imagine the possibilities if the material was readily available.

3.5 Landscaping and Architecture

3.5.1 Rhyolite Armour Rock

The DCQ resource can provide a beautiful alternative to the normal blue metal rock used in some areas for seawall, harbour, lake, dam or riverbank for wave protection. Images of various rock types used for this application are available on the internet such as the examples below.



Figure 2: Various rock types used for armour rock (photos from various websites).

3.5.2 Rhyolite Gabion and Rock

The lighter colour of the DCQ rhyolite resource can provide a beautiful addition to architecture and landscaping. Images of various rock types used for this application are available on the internet such as the examples below.



Figure 3: Hard rock used in architecture and landscaping (photos from various websites).

3.5.3 Rhyolite Road Base and Dust

The DCQ resource can be used for roads and general landscaping along with use in rammed earth building construction. Images for rammed earth with various rock types are available on the internet such as the examples below.



Figure 4: Rhyolite can be used in rammed earth building construction (photos from various websites).

3.5.4 Rhyolite Dust

Rhyolite dust has been used for its all-weather access benefits and decorative qualities on golf course golf buggy tracks and on pathways such as through the Hunter Valley Gardens in Pokolbin.



Figure 5: The DCQ rhyolite dust on left and rhyolite dust from another source when it was available was used in the Hunter Valley Gardens in Pokolbin for decorative pathways (Photo source Hunter Resort).

Rhyolite Dust was used on the Newcastle Paceway for many years, the light colour really show cased the horses on the track which was arguably one of the best presented in the world for its decorative and reflective nature in the daytime or at night under lights.



(sourced from a Maitland Mercury article).



(sourced from Australian Harness Racing)



(sourced from Australian Harness Racing)

Figure 6: The Newcastle Paceway showing the lighter coloured track when it used rhyolite dust (photos from various websites).

The track changed to another material approximately two years ago which was influenced by the difficulty in sourcing Rhyolite Dust and brings it in line with the other trotting tracks.



Figure 7: The Newcastle Paceway with current surface, change contributed by the lack of rhyolite dust availability (photos from HRNSW).

4 Climate Change and benefits of Light Coloured Roads

Another benefit of the DCQ resource material is its lighter colour compared to normal blue metal aggregates for use on roads and car parks, which collectively cover substantial areas of land surface in cities and in rural settings.

Trials have been done around the world including in Australia by laying light coloured asphalt in relation to cooling cities in the summer months, cooler streets reduce air conditioning requirements in adjacent buildings and create a better environment for trees to grow which also assist in cooling cities/ streets.

A light coloured asphalt / road surface can also provide a significant reduction in street lighting requirements whilst maintaining normal illumination at night for safety and provide a reduction in electricity use and greenhouse gases.

Due to the lower temperature light coloured asphalt pavements can also have a longer life expectancy.

A summary of a few of these trails is provided below.

4.1 Cooling cities

Lateline ran a story in 2014 discussing the issue and benefits to health, and a reduction in energy used for cooling from a range of measures which included light coloured roads and roofs also tree planting.

Lateline story: <https://www.abc.net.au/lateline/cities-need-adapt-to-deadly-heatwaves/5495392>

An article by Sourceable titled "Lighter pavement really does cool cities when it's done right" notes a similar benefit, an extract is produced below:

To estimate a pavement's reflectivity, we use a measure called albedo. Albedo refers to the proportion of light reflected by a surface. The lower a surface's albedo, the more light it absorbs and, consequentially, the more heat it traps.

Typically, the darker the surface, the lower the albedo. Conventional pavements such as asphalt have a low albedo of around 0.05-0.1, meaning they reflect only 5% to 10% of the light they receive and absorb as much as 95%.

When pavements instead use brighter additives, reflective aggregates, light-reflective surface coatings or lighter paving materials like concrete, they can triple the albedo, sending more radiation back into space.

Though the benefits of reflective pavements can vary across the nation's 4 million miles of roads, they are, on the whole, immense. An MIT CSHub model estimated that an increase in pavement albedo on all U.S. roads could lower energy use for cooling and reduce greenhouse gas emissions equivalent to 4 million cars driven for one year. And when materials are locally sourced, such as light-colored binders or aggregates, the crushed stone, gravel or other hard materials in concrete, these roads can also save money.

A link to the Sourceable article with information from The Conversation is <https://sourceable.net/lighter-pavement-really-does-cool-cities-when-its-done-right/> and <https://theconversation.com/au>.

4.2 Light coloured pavements

Pavement trials to cool cities due to global warming environmental concerns are being done around the world.

Sydney, New South Wales

The City of Sydney Council - Myrtle Street, Chippendale trial, the Daily Telegraph published an article on Myrtle Street, Chippendale: Some extracts are below:

City trials a lighter bitumen in Chippendale to reduce ambient temperature and save on energy costs

“Black-coloured roads and a lack of tree cover can increase the heat of cities by up to eight degrees.”

“Lighter coloured pavements may result in lower energy bills for surrounding buildings.”

Daily Telegraph article: <https://www.dailytelegraph.com.au/newslocal/city-east/city-trials-a-lighter-bitumen-in-chippendale-to-reduce-ambient-temperature-and-save-on-energy-costs/news-story/55ff1b0d7a18eab596ba82c4678e878f>

Additional information can be found on the Street Cooler website and a comment from their website site is

“Light-coloured roads can also lead to lower energy costs in nearby buildings and support the growth of trees by reducing nearby soil temperature around tree trunks and the evaporation of water that trees require.”

The Street Cooler website: <http://www.streetcoolers.com.au/home>

Adelaide, South Australia

An article written by Sourceable about the South Australian Government trial in Adelaide 2020, recognised the importance of the heat issue and explored lighter surfaces for roads.

Sourceable article on a South Australian Government trial in Adelaide 2020, https://sourceable.net/new-project-will-cool-adelaides-roads/?utm_source=Sourceable+News+Alerts&utm_campaign=d43f6e56f0-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_ea334d3ea4-d43f6e56f0-593745933

The Netherlands

The Netherlands 2016 research document provides an interesting article that notes a significant reduction in electricity and therefore greenhouse gasses can be achieved with the use of light coloured asphalt due to reduced lighting while still maintaining safety. Some extracts are below:

Light coloured asphalt has been used for many years for many reasons. It has an effect on:

- The public lighting Because of its lighter colour and optimized surface texture a better visibility of the road surface is obtained. As a result, public lighting can be dimmed. A reduction in light means a reduction in energy consumption and thus an emission reduction (such as CO₂). Furthermore the 'horizon pollution' is reduced for humans and animals.

- **Road safety** Better visibility of the road surface under all circumstances is likely to result in a reduction in the number of traffic accidents. At the entry and exit of a tunnel road safety may be improved by a less abrupt transition from daylight to artificial light. The reflection of light can also mean a more pleasant living environment (social security).
- **The thermal properties of an asphalt pavement** Due to the reflection of sunlight, the temperature of a light coloured asphalt pavement and the underlying asphalt layers is likely to be lower than in a standard dark coloured asphalt pavement. This can maybe lead to a longer life (less rutting).

Netherlands 2016 research document – re trials: <https://www.h-a-d.hr/pubfile.php?id=1119.pdf>

Berkeley, USA

The Berkeley Lab – Heat Island Group in the USA has a lot of information on the cooling the environment topic. Some extracts on the benefits are shown below:

- **“Energy savings and emission reductions.** Cool pavements lower the outside air temperature, allowing air conditioners to cool buildings with less energy. Cool pavements also save energy by reducing the need for electric street lighting at night.
- **Improved comfort and health.** Cool pavements cool the city air, reducing heat-related illnesses, slowing the formation of smog, and making it more comfortable to be outside. Pedestrians also benefit from cooler air and cooler pavements.
- **Increased driver safety.** Light-colored pavements better reflect street lights and vehicle headlights at night, increasing visibility for drivers.
- **Improved air quality.** By decreasing urban air temperatures, cool pavements can slow atmospheric chemical reactions that create smog.
- **Reduced street lighting cost.** Cool pavements can increase the solar reflectance of roads, reducing the electricity required for street lighting at night.
- **Reduced power plant emissions.** By saving energy on street lighting and A/C use in surrounding buildings, cool pavements reduce the emission of greenhouse gases and other air pollutants at power plants.
- **Improved water quality.** Cool pavements lower surface temperatures, thereby cooling storm water and lessening the damage to local watersheds.
- **Slowed climate change.** Cool pavements decrease heat absorbed at the Earth’s surface and thus can lower surface temperatures. This decrease in surface temperatures can temporarily offset warming caused by greenhouse gases.”

Berkeley Lab – Heat Island Group: <https://heatisland.lbl.gov/coolscience/cool-pavements>

Canada

Transportation Association of Canada paper on light coloured pavement for a 2018 conference, some extracts are below:

“There are coatings and epoxy binder mixes available in the market that can be used to increase the Solar Reflective Index (SRI) of asphalt pavements. However, these technologies are quite expensive, approximately five times more expensive than conventional asphalt.



The primary advantages of this technology, in addition to meeting the LEED SRI requirement, are the following:

- *Decreased heat high island effect in urban areas;*
- *Meeting the green standards being implemented by cities (e.g. City of Toronto), with a product that is cost comparable to the conventional product, and which provides equivalent performance;*
- *Improved long term durability and resistance to cracking due to decreased rate of oxidation;*
- *Enhanced frictional characteristics and macrotexture, at least early in the pavement life;*
- *Energy savings due to decreased requirements for lighting; and Protection of the permafrost in the northern climates."*

Transportation Association of Canada paper for a 2018 conference: https://www.tac-atc.ca/sites/default/files/conf_papers/uzarowski_-_reducing_urban_heat_island_effect_using_lcap.pdf

5 Quarry material availability

Quarry materials in general have been in high demand throughout the Hunter and wider regions for a few years, with some quarries supplying blue metal aggregates into the Sydney market to meet demand which has resulted in local contractors having difficulty obtaining materials particularly aggregates to meet their construction requirements.

5.1 Market Area

The material produced by DCQ is expected to be well suited to the local construction industry within the Mid-Coast, Dungog, Maitland, Port Stephens, Newcastle and Lake Macquarie local government areas, however the decorative and high PAFV products will travel further and have a wider market including:

- 196 kms to Sydney
- 297 kms to Lithgow
- 472 kms to Canberra
- 213 kms to Port Macquarie
- 340 kms to Coffs Harbour

5.2 Availability

Other quarries currently operating within the local and regional areas may have some supplies of rhyolite materials from time to time, however, the supply is often limited to only a small portion of the total production from the quarry given the limited resource. Proposed quarries such as Hillview Quarry to the north of DCQ are known to have a higher portion of rhyolite reserves, however, it is not operational.

The DCQ, has a high proportion of rhyolite within the quarry reserves, such that when operational, it is expected rhyolite will be a consistent material being supplied by the quarry.

More consistent supplies, lead to improved confidence in the market, the ability to meet material specifications and less variability in pricing.

It is important to note that while some sources may have a similar looking material which may also have a high PAFV it may not be durable enough for use in concrete, asphalt or two coat seals.

The DCQ resource material is quite unique as it is more durable than other Rhyolite material I have seen and sold previously therefore I believe the DCQ material will be desirable for high PAFV (high grip) applications in the marketplace.

5.3 Quarry material indicative pricing

Note: indicative prices are direct from the source, per tonne, excluding gst and vary from source to source due to individual geology and business situation.



The high demand limited availability situation is increasing quarry material prices in the marketplace which now makes the pricing used for the DCQ analysis more conservative. The assessment of viability has been made on the product range achievable from the DCQ resource.

The typical, and more widely available general blue metal quarry products have a market price of approximately:

- Drainage aggregates ranging from \$18.00 to \$32.00
- Concrete and Asphalt aggregates are the premium products and therefore the dearest ranging from \$35.00 to \$40.00
- Road Base (non spec to spec) ranges from \$12.50 to \$19.50
- Crusher Dust ranges from \$7.50 to \$20.00

For more decorative including high PAFV quarry products comparable to that proposed for the DCQ products are typically more expensive owing to the reduced availability:

- Aggregates \$36.00 to \$70.00
- Road Base \$20.00 to \$30.00
- Crusher Dust \$20.00 to \$30.00

Other decorative materials can be significantly more expensive depending on their individual deposit, availability and business situation.

6 References

SA, DPTI (August 2017), Technical Commentary on Part R15 and Part R15 Attachment A - Supply of Pavement Materials

THE STATE OF QUEENSLAND DEPARTMENT OF MAIN ROADS, 2007. Main Roads Presentation subtitle text 18 Investigation into the Fatal Crash on South-bound Ramp from Bruce Highway to Sunshine Motorway at Tanawha. TMR incident investigation report.

Concrete Highways.

Wet in Wet Concrete Paving:

<https://www.worldhighways.com/wh4/feature/novel-concrete-paving-method-used-germany>

Next Generation Concrete Grinding:

Australian Society for Concrete Pavements:

<https://concretepavements.com.au/resource/development-of-low-noise-diamond-grinding-in-nsw/>

International Grinding and Grooving Association: https://www.youtube.com/watch?v=o2n-B_ySxsw

Climate Change and benefits of Light Coloured Roads.

Cooling Cities:

Lateline story: <https://www.abc.net.au/lateline/cities-need-adapt-to-deadly-heatwaves/5495392>

The Daily Telegraph article on Myrtle Street, Chippendale:

<https://www.dailytelegraph.com.au/newslocal/city-east/city-trials-a-lighter-bitumen-in-chippendale-to-reduce-ambient-temperature-and-save-on-energy-costs/news-story/55ff1b0d7a18eab596ba82c4678e878f>

The Street Cooler website: <http://www.streetcoolers.com.au/home>

Sourceable article on a South Australian Government trial in Adelaide 2020,

https://sourceable.net/new-project-will-cool-adelaides-roads/?utm_source=Sourceable+News+Alerts&utm_campaign=d43f6e56f0-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_ea334d3ea4-d43f6e56f0-593745933

Sourceable information sourced from the conversation: <https://theconversation.com/au>

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Sourceable article on Lighter pavement really does cool cities when it's done right:

<https://sourceable.net/lighter-pavement-really-does-cool-cities-when-its-done-right/>

Sourcable information sourced from the Conversation: <https://theconversation.com/au>

Rammed Earth Houses

<https://www.earthscapewalls.com/about>

<https://www.plannedlivingarchitects.com.au/rammedearthhouse>

<https://www.yourhome.gov.au/materials/rammed-earth>

Rhyolite Dust

Hunter Valley Gardens Photo source: <https://www.hunterresort.com.au/hunter-valley-gardens/>

Maitland Mercury article photo source:

<https://www.maitlandmercury.com.au/story/6432387/partys-up-and-racing-for-paceways-30th/>

Photo source Australian Harness Racing: https://www.harness.org.au/media-room/news-article/?news_id=12608

Photo source: <https://www.hrnsw.com.au/trotstv/replays/47308>