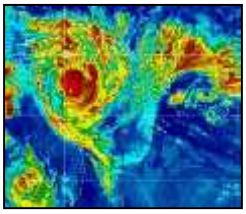
AFTER THE RAINS – RE PAVING PARADISE




Opportunities, constraints and challenges for the quarrying sector in re-building Queensland's flood and cyclone-damaged road infrastructure.

The paper draws on the findings from a survey and study of the hard rock quarrying industry conducted across Regional Queensland from December 2011 and reported to Queensland's Department of Transport and Main Roads in February 2012.

The study is titled *Ecoroc (2012) "Assessment of Constraints to Supply of Extractive Materials in Critical Demand Areas – Queensland flood and cyclone damaged road reconstruction program", prepared for Queensland Dept. of Main Roads and Qld Reconstruction Authority, February 2012.*

Thanks are extended to Queensland Department of Transport and Main Roads, Queensland Reconstruction Authority and fellow collaborators on the study - Graham Shorten, Alan Robertson, Mike Cooper, Ken Granger, Carl Morandy, Bronco Johnston and Mick O'Sullivan.

ABSTRACT:

Following the unprecedented flood and cyclone natural disasters which struck Queensland over the summer months of 2010-11 and again in 2012, a massive program of infrastructure renewal and recovery within disaster-affected communities is underway.

For road reconstruction alone an estimated 27 million tonnes of additional roadbase and aggregates are required, and quickly. Much of this demand is inland, across regional Queensland, where coal, gas and infrastructure projects are also competing for construction materials, labour and even for a roof over a worker's head.

In critical demand areas, the need for quarry products for the reconstruction effort has quickly exposed supply-side constraints including the myriad planning and green and red tape constraints that limit output and discretionary supply from quarries. These are constraints imposed in the name of sustainability, but which can significantly increase costs and reduce the resilience and capacity of the community to re-build after natural disaster.

The reconstruction of Queensland's road and transport networks is being undertaken across an area twice the size of Texas. In the aftermath of Queensland's natural disasters, this paper highlights the constraints reported by the quarrying sector in mobilising to respond to an additional 40% increase over 3 years in total regional demand for quarry materials to re-build flood and cyclone-damaged roads.

Using the Queensland flood recovery context, the paper identifies the issues and constraints to increasing discretionary supply from hard rock quarries during times of peak demand and urges for some remedial solutions.

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1.0 Introduction

1.1 Background

Operation Queenslander is the largest reconstruction effort in Queensland's history.

The entire state was declared a natural disaster area following the devastating floods and cyclones which struck and inundated Queensland over the summer months of 2010-11. In 2012 the floods returned adding to the destruction of 2011.

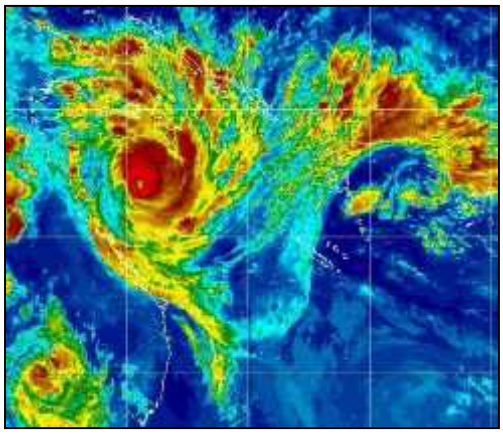

FIGURE 1: CYCLONE YASI HITS QLD COAST (Source BOM)

A massive program of infrastructure renewal and recovery within disaster-affected communities is underway across Queensland. The impact on GDP is estimated at $30 billion.

For Queensland Department of Transport and Main Roads (DTMR), the reconstruction of the state road network is the largest program of works in the Department's history with $4.2b budgeted to reconstruct over 6,700 km of roads.

In addition to State controlled roads are the hundreds of thousands of kilometres of un-paved and gravel roads across regional Queensland, damaged by erosion and inundation from the flood and storm events.

Flood damage occurred across most of Queensland and the reconstruction program is being delivered across an area twice the size of Texas.

FIGURE 2: QLD and TEXAS

The Queensland flood and cyclone recovery program is being administered by the Queensland Reconstruction Authority (Qld RA).

Funding is under the Natural Disaster Relief and Recovery Arrangements (NDRRA), a joint (75%) Federal and (25%) State government initiative to repair and re-build Queensland's flood and cyclone-damaged infrastructure, particularly its road, rail, airport and port infrastructure.

Queensland of course was not the only state affected by severe flooding as the contents of an extraordinary La Nina cycle disgorged across Eastern Australia, inundating and infiltrating the eastern continent from north to south. A total of 35 people died in the Queensland floods - 21 people in the Toowoomba and Lockyer Valley regions and 12 people in the small town of Grantham nestled in the Lockyer Valley below Toowoomba's Main Range.

Elsewhere in parched areas the rains were described as a 'once in a lifetime flood to break a once in a lifetime drought'. In north Queensland, as western Pacific Ocean surface temperatures soared to near record levels, Cyclone Yasi became the most intense cyclone to hit Queensland in a hundred years.

Photos: Qld Reconstruction Authority 'Operation Queenslander ' website

Works programs are being packaged to try and minimise impacts on tourism, agriculture and the resources sectors. This includes fast-tracking and bringing forward other complementary road and connecting infrastructure works in order to minimise net impacts and delays to road users.

1.2 Resource Requirements for Reconstruction Effort

The material, human resource and plant and equipment requirements for such a reconstruction effort are huge.

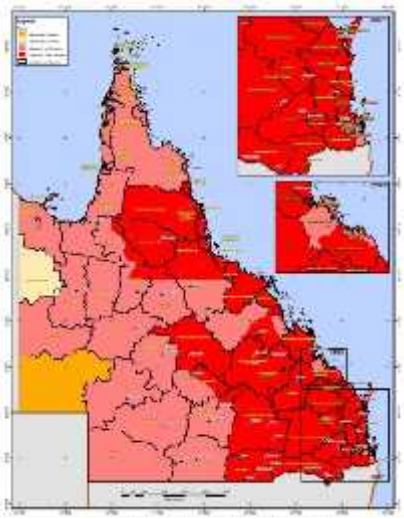

FIGURE 3: QLD DISASTER ACTIVATED AREAS to April 2011, Qld RA

Out of ten (10) regions across the state, DTMR have identified eight (8) as Critical Demand Areas (CDA's) where a combination of competing and peak levels of demand along with constraints to supply of quarry materials is evident. The regions are:

- Fitzroy (FTR)
- Central West (CWR)
- Far North (FNR)
- South West (SWR)
- Mackay/Whitsunday (MWR)
- North West (NWR)
- Darling Downs (DDR)
- Wide Bay/Burnett (WBR)

Each of the regions is composed of several Local Government Areas. The critical demand areas for quarry materials (crushed rock products) cover all of Queensland except the South East and Townsville.

Of the materials required for Queensland's road reconstruction program, quarry materials are the largest component as shown in Figure 4.

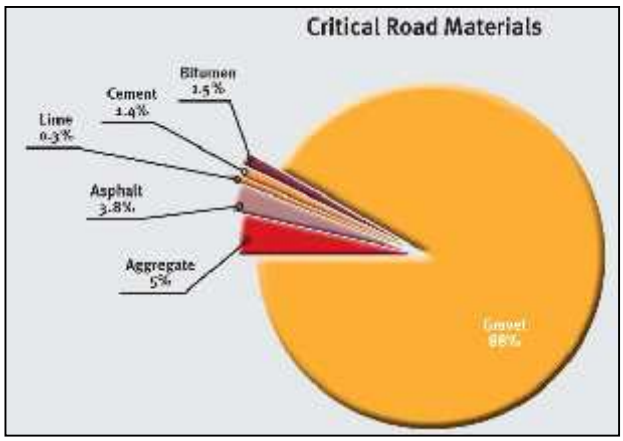

FIGURE 4: FIGURE 4: CRITICAL ROAD MATERIALS

Figure 4 indicates gravel or roadbase (88%) and aggregates (5%) collectively account for 93% of road construction needs.

Much of this demand is inland in regional Queensland where labour, plant, materials, even accommodation resources are preferentially consumed by competing coal, gas and infrastructure projects.

In western Queensland because of geological constraints there is little suitable rock for aggregates.

Higher performance aggregates (e.g. cover or road surfacing aggregates) are sometimes imported up to 300km. At a nominal direct transport cost of $0.20 per tonne kilometre, this adds considerably to road construction and repair costs.

1.3 Quarry Material Demand from Road Reconstruction Works 2011-2014

Approximately 27 million tonnes of gravel (roadbase) and road surfacing aggregates are required for the road reconstruction works. Because of the widespread nature of the damage and distances involved, hundreds of quarries across regional Queensland will have to supply the materials.

Two principal quarry material types, Type 2.1 roadbase (CBR 80) and cover aggregates for road surfacing are critical to the road reconstruction program. Total demand estimates for quarry materials for State road reconstruction projects are:

- 14 Mt (million tonnes) of roadbase materials (sometimes referred to generically as 'gravel') and
- 1.5 Mt of aggregate (cover aggregate for road surfacing).

In addition to demand for repair of State Roads, local government road reconstruction works across the state is estimated to require at least 11Mt of mainly roadbase and gravel road re-sheet materials.

For Queensland roads overall, about 85% of quarry material required is roadbase and 15% is aggregate, mainly cover aggregate.

Of concern to the reconstruction authorities is the potential for a shortfall in supply of quarry materials in the critical demand areas where because of coincident and high demand from major projects (e.g. port, rail, mining, gas related infrastructure) demand for quarry products could outstrip supply.

'Hotspots' include Gladstone, Mackay and the Fitzroy and Bowen Basin regions. Queensland Department of Transport and Main Roads (DTMR or 'Main Roads') commissioned Ecoroc to investigate the available supply of hard rock resources in regional Queensland for road reconstruction needs. The study required the identification of suitable quarry sites, assessment of supply-side constraints and recommendations for addressing or overcoming constraints to supply of critical quarry materials.

2 Ecoroc Study Findings – Assessment of Constraints to Supply

2.1 Overview

A primary purpose of the study was to produce an up to date database of hard rock quarries for Queensland, which though such information existed across several departments of government, was different, incomplete and sites duplicated. With a drift in wider government focus and interest away from identifying future extractive resources, it was not clear if all suitable extractive resources were known.

In addition, the maximum supply capabilities of quarries in areas of coal, gas and port infrastructure development was also unknown. This made it difficult at a strategic level to properly plan the road reconstruction program and so because of the urgency of the task at hand, the solution was to ask the industry.

With locations and resource characteristics better understood, the project would then assess quarries' capabilities to supply the desired quarry materials to the Critical Demand Areas (CDA's) for State road reconstruction works. The project and reporting consisted of 3 parts:

i. **Supply Side Analysis** - Create a Queensland 'All Quarries' database (hard rock quarries and resources) to inform the reconstruction authorities of quarry locations, status and supply capabilities. The database has 35 general fields and a further 7 addressing production capacity and product capabilities;

ii. **Demand Side Analysis** – Provide an assessment of projected demand for quarry materials from flood and cyclone reconstruction works and other projects over the period 2012 to 2014 for the 8 critical demand areas. This was to include an estimate of the impact of mining, gas, rail and port projects and related infrastructure; and

iii. **Supply Side Constraints Analysis** - Assess demand v supply imbalances in CDA's for suitable quarries and hard rock resources; Appraise and evaluate constraints to

discretionary supply of roadbase and aggregates from these hard rock quarries; and present recommendations and suggestions to help address or overcome supply constraints.

2.2 Supply Side – All Quarries database

The Ecoroc study and investigations were conducted over the December 2011 to February 2012 period and consulted widely with extractive industry, industry suppliers, government, firms that undertake campaign or project-specific contract crushing, industry and professional organisations and quarrying industry consultants.

A total of 406 hard rock quarry sites (16 as 'greenfield' sites) were identified across Queensland that had the potential (not necessarily the capacity or the approvals) to produce crushed rock products to the required technical standards. The study found that only about 40% of actual hard rock quarry sites in Regional Queensland are suitable or able to supply the road reconstruction works.

This is mainly because of constraints such as source rock type and technical suitability (geology), but also approvals, licensing restrictions, pre-commitments to supply, product mix, contestability (e.g. council pits often not suppliers to the wide market), and capital budgeting issues.

Of the hard rock quarry sites across Queensland, 288 or 71% are located in the eight (8) critical demand areas on which the study primarily focussed.

Of these 288 quarry or resource sites, 80 have been identified as 'Strategic Quarries' for the reconstruction of State roads and an additional 75 quarries are 'Quarries of Interest'.

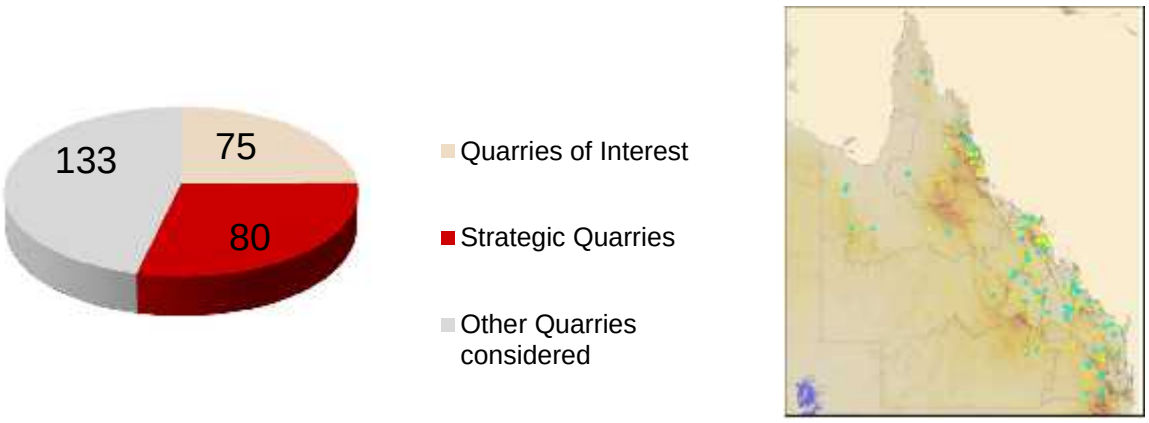

FIGURE 5: HARD ROCK QUARRIES IN CRITICAL DEMAND AREAS

There are important conditions or constraints to supply from Strategic Quarries which need to be overcome, but Strategic Quarries represent those quarry sites which are expected to supply the 'lion's share' of quarry materials for road reconstruction over the 2011 to 2014 reconstruction period.

'Quarries of Interest' are candidate sites drawn from the Queensland 'All Quarries' database where discretionary capacity is less well-known, but there is good potential for some discretionary supply of roadbase (CBR 60 or greater) and/or road surfacing aggregates.

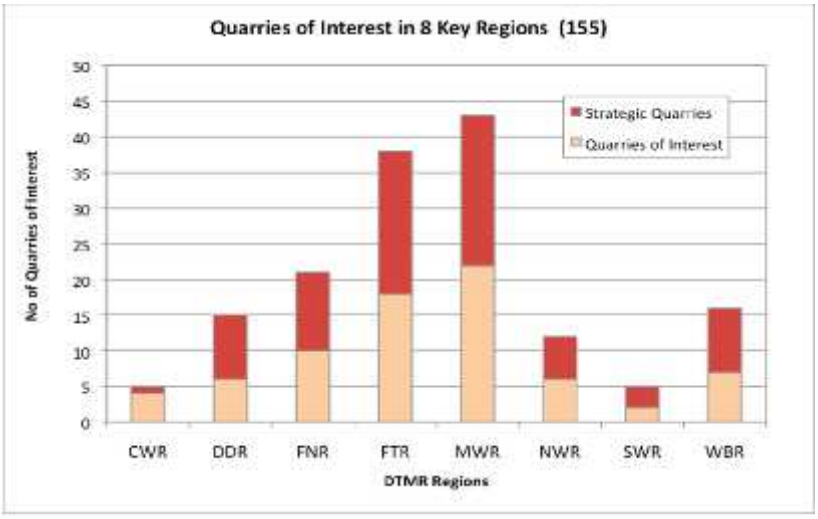

FIGURE 6: STRATEGIC QUARRIES AND QUARRIES OF INTEREST BY CDA

Figure 6 shows a distribution by critical demand area of those quarries (or known resources) which could or which have the potential to supply Type 2.1 (or 2.2) roadbase and /or cover aggregates for the road reconstruction program.

Note that some of the areas of high demand such as MWR and FTR have an adequate resource inventory and are not geologically constrained but rather the planning and approval process is excruciatingly slow and uncertain.

For other areas such as SWR which includes oil and gas projects the number of candidate sites is much smaller because of geological constraints and importation of aggregates from further east (eg DDR) is likely.

The study found that amongst the Strategic Quarries and Quarries of Interest only 20% were in Key Resource Areas (KRA's). Key Resource Areas form the basis of a Queensland State Planning Policy that recognises and provides planning protection for extractive resources against sterilisation from incompatible development.

The Ecoroc survey found that 48% of Strategic Quarries have pre-coated aggregate plants and only about 10% have cement treated base / pugmill plants.

2.3 Demand Side Analysis – Projected Demand for Quarry Materials

The study also reviewed demand data for roadbase and aggregates from all sectors of the economy and sought to identify supply side constraints and assess impacts and/or potential supply bottlenecks for crushed rock products.

Reported production from quarries in Queensland is compiled by Department of Natural Resources and Mines. Aggregated data for quarry materials production sold, whilst the best available to government, is not particularly useful in in critical demand areas for predicting short-term demand. There are two principal reasons for this:

i. Firstly, historical time series of quarry production whilst useful for long term planning, cannot predict volatility in demand (production) over the short run; and

ii. Secondly, not all quarry production across Regional Queensland is reported.

This latter factor occurs for some quarries close to or exceeding production limits set by Development Approvals (DA's) or license conditions. But it also applies to quarries where the production is project specific and not necessarily servicing the open market (e.g. civil projects, mine sites) where not all such production is reported.

The difficulty of using the past consumption patterns to predict the immediate future is evident from Figure 7 which shows a recent time series of hard rock quarry production across regional Queensland. The demand spike for hard rock materials in 2011 is not apparent from any trend in the historical time series data for the preceding 5 years.

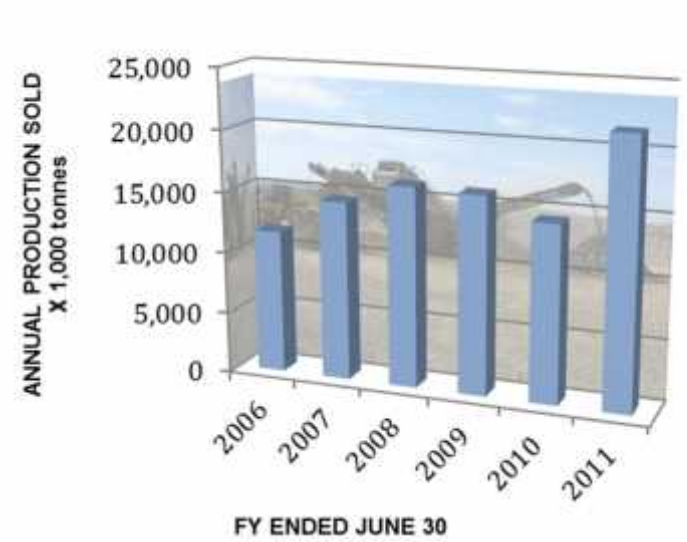

FIGURE 7: HARD ROCK QUARRY PRODUCTION IN REGIONAL QLD (Excludes SEQ)

Source data: DNRM

At a more localised level, Figure 8 below shows a doubling in demand for hard rock quarry materials over the past 3 years for the Mackay Whitsunday Region (MWR), which covers the coastal and inland towns of Bowen, Proserpine/Airlie Beach, Mackay, Moranbah and Clermont. It also includes the Bowen Basin coal mines, rail and port infrastructure.

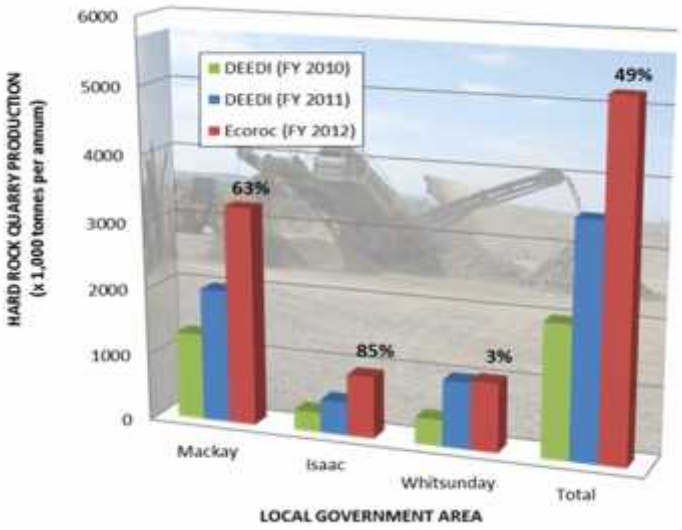

FIGURE 8: COMPARISON OF YEAR ON YEAR QUARRY 'PRODUCTION SOLD' FOR MACKAY WHITSUNDAY REGION

The percentages in Figure 8 represent the projected annual increase from FY 2011 to FY 2012 in hard rock quarry production sold. Variations locally are evident. In the Whitsunday local government area (LGA) quarry production overall has been static. In Mackay, output increased by an estimated 63% from 2011 to 2012.

Given the difficulties of using long term per capita demand estimates for short term planning, demand modelling focussed on assessing additional demand and the corresponding discretionary supply capabilities of quarries to meet projected additional demand.

Demand from coal mines and oil and gas projects was researched and analysed. It is estimated that a new coal mine development requires 250-350 kt (kilotonnes) of crushed rock products and a coal mine producing 10 Mt/a of coal typically uses about 400 ktpa of crushed rock (quarry) materials for roadways, ramps, hardstand areas and stemming of blastholes.

Only a handful of coal mines have hard rock resources readily available to them, usually as fresher basalts as overburden or within the mining lease. Beyond the mining lease much of the land in regional and more remote parts of Queensland is leasehold in which case Queensland's Forestry Act applies and provides the state with authorisation to issue sales permits for quarry materials on these lands.

Figure 9 shows the additional demand for quarry materials from new coal projects in Queensland forecast to come on line over the period 2013 to 2015. Demand is shown in Mt/a (million tonnes per annum).

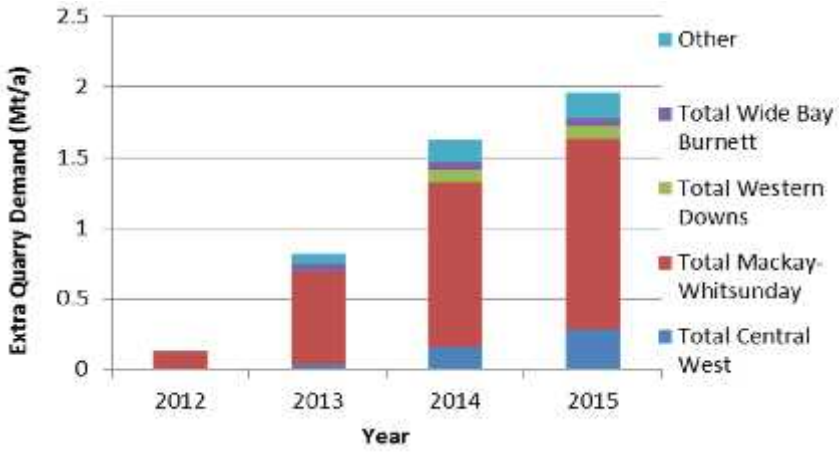

FIGURE 9: ESTIMATED ADDITIONAL DEMAND FOR QUARRY MATERIALS FROM NEW COAL PROJECTS IN QLD 2012 TO 2015

An excel worksheet tool was developed to model and predict demand and supply of hard rock quarry materials for LGA's and critical demand areas. This worksheet tool enabled scenario and shortfall analysis to be conducted for roadbase (>CBR 60) and cover aggregate materials in the critical demand areas.

Figure 10 below shows an example of the use of the worksheet tool for demand and supply modelling. The graph is for cover (road surfacing) aggregate for the South West Region (SWR) of Queensland which includes Roma, Charleville, Quilpie and down to the NSW border.

Several towns in Central and South West Queensland were inundated several times aggravating the human misery and damage. In addition to scour damage from initial flood waters, the

inundation of road pavements sometimes for many weeks also caused more subtle degradation of pavement and subgrade materials.

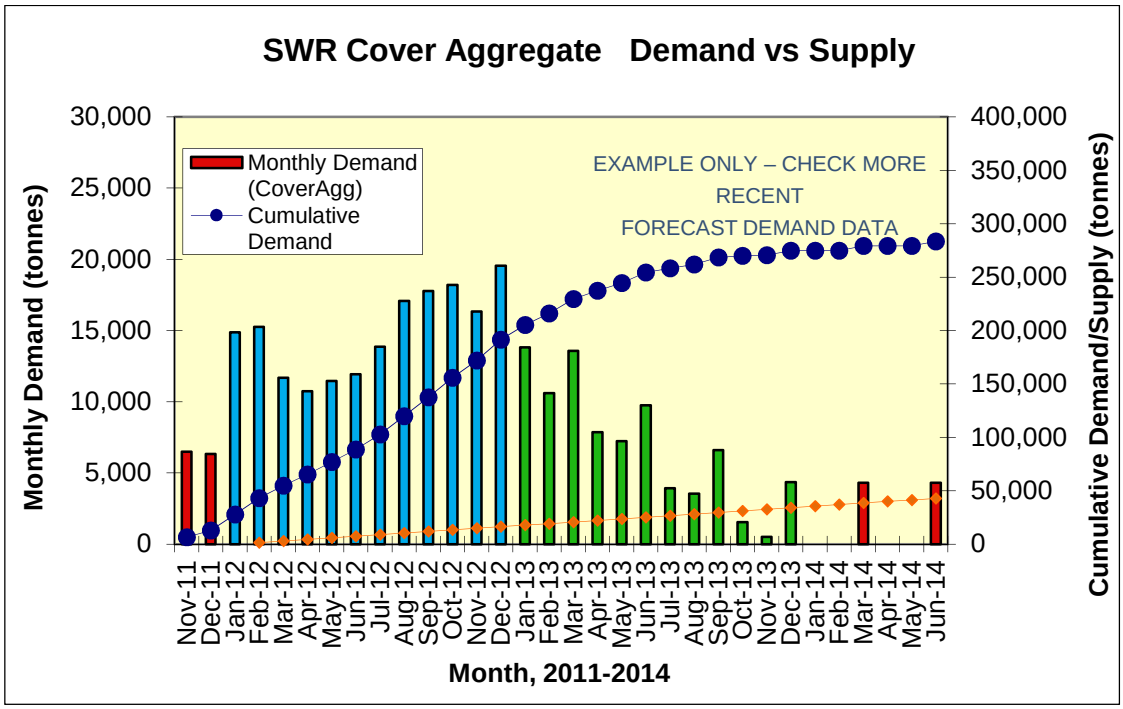

FIGURE 10: SOUTH WEST REGION - MONTHLY DEMAND for COVER AGGREGATE WITH 'DO NOTHING' SCENARIO

Figure 10 shows predicted monthly demand for cover aggregate for the South West Region to 2014 peaking at 20 kt per month. The chart also shows the cumulative demand curve (RHS axis) for cover aggregate in this region of Queensland for the road reconstruction.

A 'Do Nothing' scenario assumes that existing constraints are not overcome and production remains at current supply levels, as shown by the lower curve. The difference between projected cumulative demand and 'Do Nothing' in this scenario is about 250,000 tonnes.

To overcome such shortfalls in the rate of supply, either existing quarries will need to produce more, or new extractive resources brought quickly into production, or the aggregate material imported from quarries to the east in the Darling Downs region.

For scenario modelling, and by adding a 'Constraints Addressed' curve, the worksheet tool was used to observe the remedial effect of realistic measures that could be achieved to alleviate potential bottlenecks in supply.

2.4 Constraints Analysis

It would be fair to say that there has been a growing technical disconnect between government and extractive industry in Queensland over the past decade largely brought about by State government priorities focussing on higher level planning and coal mining rather than extractive resource identification and ease of operations for the quarrying sector.

The exception has been in the Mines Inspectorate where considerable resources have been dedicated to improving OH&S performance amongst small mines and quarries. The supply-side

constraint issues for extractive industry in the CDA's were analysed according to a risk assessment framework for extractive resources and quarries based on the 'modifying factors' from the Australasian "JORC" code (see Figures 11 and 12 below).

The modifying factors include legal, economic, marketing, operational, environmental, social and governmental elements and along with resource characteristics collectively influence the economic viability of a resource or the commercial performance of a quarry.

Using this method to detail the causal factors of a shortfall in supply, any systemic problems could be identified, analysed and compared across the CDA's to assist with targeting of remedial measures to help overcome potential bottlenecks.

Figure 11, adapted from the Mineral Industry's "JORC" Code, shows the relationship between an extractive resource and an extractive reserve of quarryable material (analogous to a mineral occurrence v ore reserves in the JORC Code).

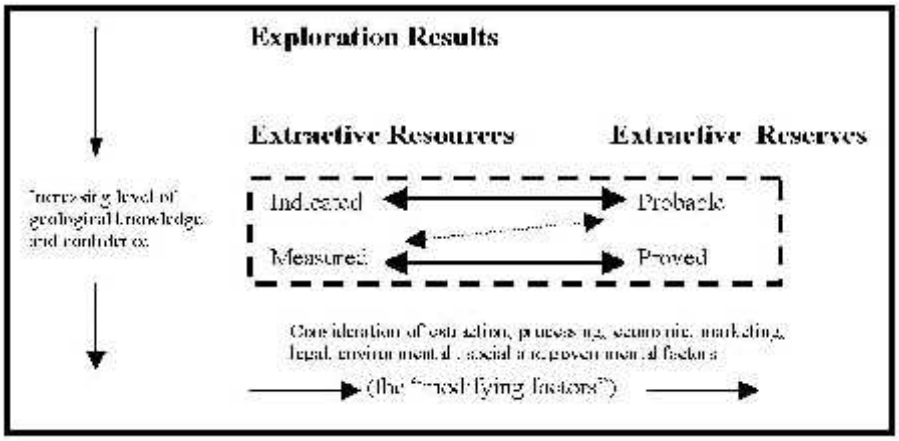

FIGURE 11: RELATIONSHIP BETWEEN EXTRACTIVE RESOURCES AND EXTRACTIVE RESERVES

(adapted from the Minerals Industry JORC Code, 2004)

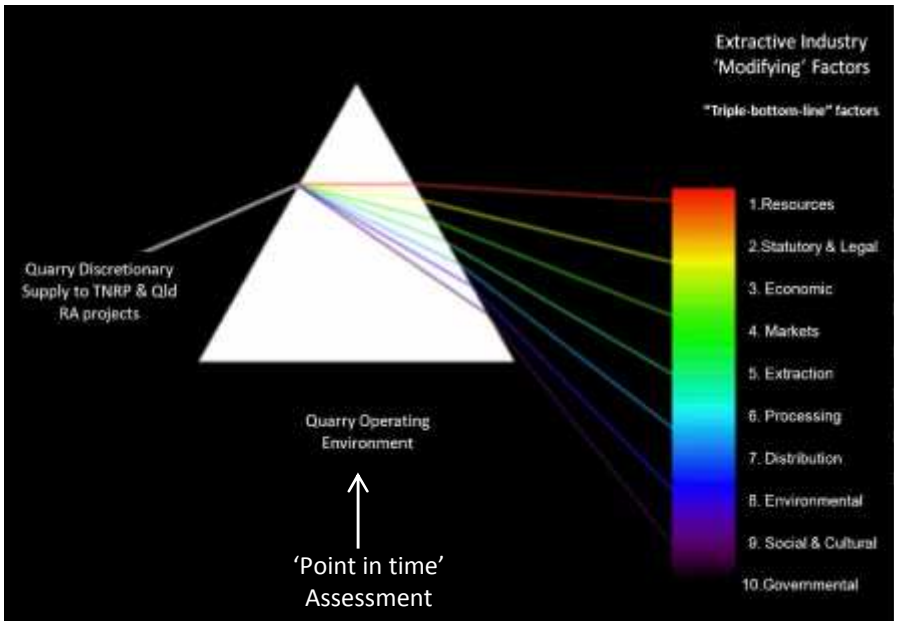

FIGURE 12: QUARRY and SUPPLY ASSESSMENT FRAMEWORK

The 'modifying factors' provide a useful evaluation framework for extractive resource/quarry risks and constraints and are represented graphically in Figure 12. The framework focusses the issues that impact on quarry performance and resource viability as a 'point in time' assessment.

In Critical Demand Areas such as the Bowen Basin (Mackay ~ Fitzroy Region), annual per capita consumption of crushed rock is estimated at 15 tonnes, almost twice the historical long term average. In areas such as Mackay and the northern Bowen Basin the supply of quarry materials is constrained and quarries are producing at maximum output.

Quarries in coal mining regions report a preference to supply roadbase and aggregate to the mines, because the specifications are not as tight, margins are good, supply is long-term and there is less commercial risk.

Costs of production are typically 30% higher than those in metropolitan areas, skilled labour is in short supply, there are delays in the supply chain and a new quarry application can take between 3 and 5 years, cost up to $ 0.5M, with no guarantee of success. It is extraordinarily difficult and complex to gain planning approval even for a small accommodation camp to house quarry workers.

Limits to further production can therefore be summarised as being set by (i) existing customer commitments; (ii) competitive strategy; (iii) processing plant capacity, (iv) stockpile constraints (no stock or limited room), (v) production or sales limits set by license conditions, (vi) difficulty in gaining development approvals and access to new resources and (vii) labour (accommodation) shortages and (viii) truck (cartage) shortages during periods of peak demand.

The effect of these constraints can be illustrated using a set of traditional demand and supply curves.

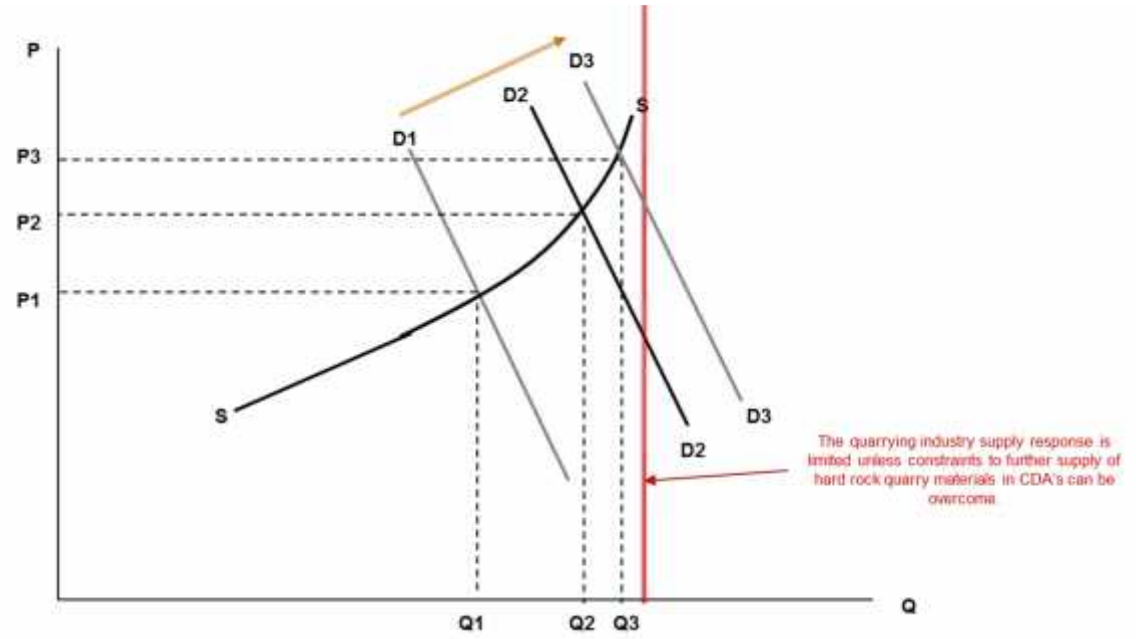

FIGURE 13: DEMAND v CONSTRAINED SUPPLY FOR EXTRACTIVE MATERIALS

Figure 13 is a model of the demand versus supply of hard rock quarry materials in for example the Mackay or Gladstone regions. The red vertical line shows the effect of 'hitting the wall' where existing constraints to supply of quarry materials combine to constrain maximum output.

In the diagram, 'P' indicates price and 'Q' indicates quantity sold or consumed in a period of time (e.g. tonnes sold per year). With the mining and related infrastructure boom, the demand curve for quarry products shifts from D1 to D2 (current position) and thence to D3 when the new coal mine and gas infrastructure projects as well as additional demand from the road reconstruction and repair program, take effect.

As demand drives up the production of crushed rock products, additional further supply becomes limited (or severely constrained) because of limits to processing plant capacity, stockpile capacity, production and sales limits in license conditions, difficulty in gaining approvals and labour and truck (haulage capacity) shortages.

The combined and worsening effect of these constraints is illustrated in the model by the "upwards" curving supply curve S-S. The limit of theoretical output from hard rock quarries is represented by the vertical red line which defines the maximum quantity of quarry materials that the industry can supply under current conditions.

The challenge insofar as the flood reconstruction road program is concerned is to find ways to 'push' the red vertical constraints line in Figure 13 further to the right of the chart.

2.5 Supply Side Constraints – Conclusions and Recommendations

The constraints to supply have been expressed against the 'modifying factors' for quarries as shown in Table 1. The use of the modifying factors as a constraints and risk management framework can help visualise issues from the quarry's perspective and provides an understanding of the depth of resource and quarry-specific 'economic' issues in the triple-bottom line inter-relationship between modifying factors.

For Queensland's road recovery program and supply of hard rock quarry materials, both economic and regulatory factors are potent constraints in a practical sense. In mining regions, the mining boom competes for similar human resources and services to the quarrying sector leading to the so-called "dutch disease", where resources are preferentially consumed by mineral, gas and related infrastructure projects and other sectors and skills squeezed out.

Coupled with labour (and some plant and material constraints) are planning and environmental licensing laws. These are inflexible in coping with sudden but necessary changes in derived demand for quarry materials that can be expected to be generated in the aftermath of natural disasters.

Both Main Roads and CCAA encouraged the industry to contribute to the study. Feedback from the Queensland quarrying industry and its supply chain was co-operative and candid and was compiled for each CDA. Table 1 provides a summary of the combined results for all the CDA's and shows the modifying factors and their relative impact on constraining supply from Strategic Quarries and Quarries of Interest.

A summary of these factors with recommendations and suggestions to help reduce the impact of the constraint is provided in Appendix 1.

TABLE 1: SUPPLY SIDE CONSTRAINTS IN CRITICAL DEMAND AREAS

No.	Modifying Factor	Relative Impact	Constraints
1,5	Resource, extraction constraints	8%	• Lack of pit planning (e.g. campaign sites); • Overburden or stripping ratio; • Blast logistics; • Variability of source rock quality (e.g. Secondary Mineral Content etc; efficacy of source tests); • Poor sampling/testing knowledge
2	Approvals and Licensing	8%	• Access to reserves - only 20% of target quarries are Key Resource Areas; • Difficult to increase ERA thresholds (extraction and crushing output) and modify DA's (eg extended hours of operation); • Sales of quarry materials from mining leases; • Access road/entrance requirements; • Native title requirements; native vegetation clearing
3,4	Markets - customer/competitive choice/scheduling	55%	• Quarries in CDA's with discretionary supply capacity need forewarning – eg 1-3 months notice of supply • Can then add extra shift, schedule campaign crushing, help secure access to labour and C&S plant, arrange road haulage contractors etc • Not all quarries want to supply
6	Processing plant and stockpiling	10%	• Reliance on mobile plant and campaign crushing which has lower availability compared with fixed plant (plant availability of 50% not uncommon in more remote regional areas; • Insufficient room to carry large stockpiles on site; • Capabilities of contract crushing firms (labour; skills; expertise, capacity to manage growth); • Shortage of CTB and pre-coat plants ; • Product yield – e.g. rail ballast, undersize, single sized aggregate gradings
7	Distribution - truck transport (Cartage)	15%	• Insufficient truck availability during peak demand-problem reduces with production and delivery in advance of projects; • Cartage price increases during term of supply contracts; • Access for road trains, haulage restrictions; • Driver experience / driver fatigue; • Larger loaders needed for peak supply
8,9,10	Other – Environmental, Social & Cultural, Governmental	4%	• Not acting to constrain output in the short run; • Government support for need for quarries to supply reconstruction effort presents as an opportunity

From Table 1 economic, market, processing, distribution and approval /licensing factors exert the most significant influence on the capacity of quarries to increase discretionary supply to road reconstruction works over the period 2012 to 2014.

Perhaps unsurprisingly, in the coal mine and gas/port networks and hubs, and in more remote areas subject to seasonal (wet season) impacts such as FNQ and NWR, industry emphatically reported that the most effective initiative to improve discretionary supply capability in the immediate to short term is to ensure quarries are provided with advanced notice of supply to reconstruction projects. In CDA's with high demand, a minimum notice of 1-3 months has been suggested as a notification target.

With forewarning, quarries can plan to reduce the effect of other constraints – e.g. by arranging for additional mobile crushing plant to arrive and be fit for purpose, by adding a second shift, or locking in cartage contractors in advance of projects, installing a pre-coat plant, undertaking stripping of overburden in anticipation of higher levels of demand, opening up a second face, extending stockpile areas (if room available), and recruiting labour.

The ease and cost of implementation of measures to increase discretionary supply is of course crucial to success. Figure 14 provides a comparison of the 'cost' (ease of implementation) versus the 'benefit' (increase in discretionary supply) for Strategic Quarries.

Constraints acting within modifying Factor 4 (market factors) were the 'low hanging fruit' - indeed, the market research indicated that something as relatively simple as a government-initiated proper forewarning and communication program with quarries which also addressed contractual and point of delivery issues, could collectively increase discretionary supply by over 50% across regional Queensland – not enough to prevent shortfalls in all areas, but a pretty good start.

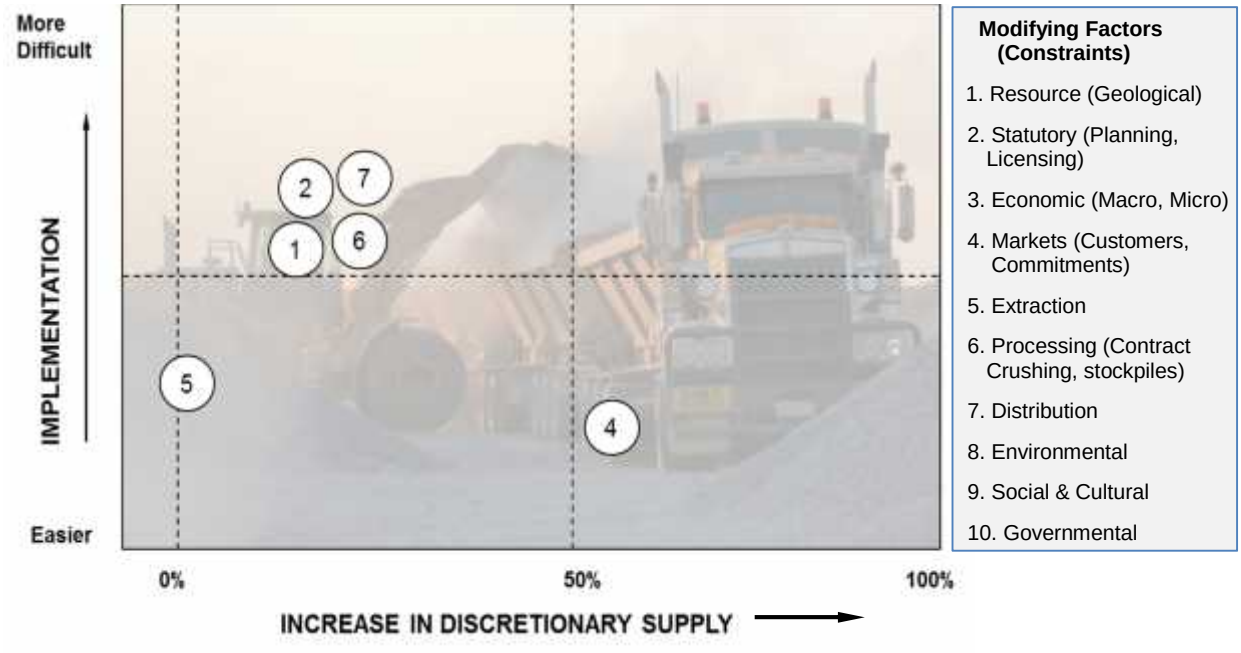

FIGURE 14: EASE OF IMPLEMENTATION v INCREASE IN DISCRETIONARY SUPPLY

Other constraints in Figure 14 appear as a 'cluster' (i.e. modifying factors 1,2,6,7). They are more intractable, but need to be tackled and at least moderated if discretionary supply to current road re-construction projects is to be maximised and there is better resilience against future events.

The more intractable factors affecting supply include truck shortages, difficulties in varying production thresholds in environmental licenses, delays and uncertainty in gaining development

approvals, skills shortages, low levels of availability of production for regional mobile crushing plants, shortages of pre-coating facilities, reserve constraints and quarry development factors.

Notwithstanding these, there are a range of suggested initiatives, some short term some long term that can be implemented and developed to redress supply imbalances (Refer Appendix 1).

The costs, difficulties and time required for quarry approvals and licensing is a universal industry complaint and the myriad planning and green and red tape constraints that have evolved in Queensland over the past decade have most certainly driven up the costs and constrained the discretionary supply of quarry materials on an aggregated basis.

Ironically, the planning and licensing conditions (particularly those that cap output) imposed in the name of certainty and sustainability by local and state government can have the reverse effect. They can significantly increase costs and reduce the resilience and capacity of the community to re-build after natural disaster.

One solution would be to make provision in development permits or environmental licensing for a 3 year average in production or sales limits or thresholds, so that a quarry could exceed for example a 100,000 tpa of sales limit in order to respond to a spike in demand from a flood or cyclone event.

At local government level, planning schemes more often than not reflect mechanisms to protect extractive resources but few provide any proper guidance or certainty of outcome about an application to vary an extractive industry, yet alone approve one.

In regional areas, where urban development is not a sterilising issue for quarries, more code assessable variations to short term changes in the output of extractive industry output should be able to be reasonably accommodated, without compromising environmental, social or cultural values and without the need for a 1 to 3 year planning re-application and approval process.

In addition to initiatives to streamline quarry approvals and licensing, the maintenance of proper industry standards of productivity and risk management is paramount. New or previously dormant hazards emerge in boom times – for example, no local accommodation results in driving up to five hours per day to and from a quarry site – bad enough to fatigue any quarry worker but even worse when it's the shot-firer!

Be it more effective safety management systems that zero in on hazards and controls, or how to produce and maintain a simple quarry development plan, or regular quarry materials training courses to redress a lack of proper knowledge on sampling and testing, there are a range of fairly simple, low cost technical initiatives that can mitigate risk and improve productivity for regional and more remote quarries in critical demand areas.

APPENDIX 1: SUPPLY SIDE CONSTRAINTS

CONSTRAINT (RISK) FACTORS
1. **GEOLOGICAL, EXTRACTIVE RESOURCE FACTORS** Reserves not particularly well-known; Industry has a low degree of exploration expenditure; DTMR specifications provide little latitude for variability of source rock quality e.g. SMC; Efficacy of empirical tests and influence on specs; Gradings; Poor sampling/testing knowledge in CDA's.
2. APPROVALS, REGULATORY AND COMPLIANCE FACTORS Time & cost for DA's; DERM ERA thresholds – MCU and impact assessable triggers under IDAS/SPA; DA's for accommodation camps; Approval to use mine owned roads and sell quarry materials from mine sites; Extended hours of operation; Traffic restrictions; Access road/entrance infrastructure requirements; Native title requirements and exemptions; Wild Rivers declaration (Coopers Creek) impact on gravel (borrow) pits in Western Qld.
3. ECONOMIC FACTORS Demand from major projects in CDA's – e.g. coal mines, CS gas and related pipeline, rail and port infrastructure; QldRA LGA road reconstruction program; Labour (skills) shortages; Building & construction activity; Local economic conditions; (e.g. tourism downturn).
4. MARKET FACTORS Existing customers; Lack of notice of DTMR work; Long term v short term customers; Risk v Return in determining product (sales) mix; Degree of competition and competitive strategy, Degree of contestability in the market to produce Type 2.1 roadbase and cover aggregates.
5. EXTRACTION and SITE INFRASTRUCTURE FACTORS O/B or stripping ratio; Legacy sites requiring re-development; Poor pit planning (e.g. some campaign sites); DEEDI OH&S requirement for a Quarry Development Plan; Blast logistics.
6. PROCESSING / MANUFACTURING FACTORS Reliance on mobile plant & campaign crushing (cf fixed plant); Capabilities of contract crushing firms (labour; skills; expertise); Less than 50% of key quarries have pre-coat plants and only 10% have CTB/pugmill plants.
7. HAULAGE AND DISTRIBUTION FACTORS Insufficient truck availability during peak demand; Reduce with production and delivery in advance of projects; Cartage price increase during term of supply contracts; Access for road trains; Haulage restrictions (eg school zones, bridge limitations); Driver experience / driver fatigue.
8. ENVIRONMENTAL FACTORS Eg. Air, water, noise, blast (vibration) emissions, water quality impacts, remnant vegetation, site rehabilitation.
9. SOCIAL FACTORS e.g. Community opinion (amenity, external impacts, land values etc); Cultural heritage.
10. OTHER Eg. Government attitude; Weather and seasonal effects; Royalty increases; Commercial performance of contract crushing operators.

APPENDIX 1: SUPPLY SIDE CONSTRAINTS

Constraints Area Modifying Factors	Constraints Description	Relative Impact	Suggestions & Recommendations to Mitigate Constraints
4. **Market Factors –e.g. Customer and Competitive Choice**	Lack of forewarning - Quarries in CDA's with discretionary supply capacity need 1-3 months' notice for supply; Allows quarries time to prepare, produce they are given adequate notice - eg Can add extra shift, schedule campaign crushing, help secure access to labour and C&S plant, arrange road haulage contractors	55%	• Establish permanent communication channel(s) with extractive industry (e.g. website on TNRP/Qld RA) on locality and timing of need for quarry materials • Provide quarries with forewarning of need to supply • Regularly update discretionary supply capabilities of Strategic Quarries in CDA's • Allow product supply in crucial areas into project stockpile before project commencement
7. **Haulage and Distribution**	Insufficient truck availability during peak demand; Problem reduces with production and delivery in advance of projects; Cartage price increases during term of supply contracts; Access for road trains; Haulage restrictions; Driver experience / driver fatigue; Larger loaders needed for peak supply (eg Multiple Road Trains)	15%	• Can reduce by providing sufficient notice to quarries so they can organise/recruit/schedule trucking prior to project; but is fairly intractable • Check Strategic Quarries for Road Train access • Trucks from interstate program?
6. **Processing**	Reliance on mobile plant & campaign crushing (cf fixed plant); Capabilities of contract crushing firms (labour; skills; expertise); Most quarries don't have pre-coat plants	10%	• Engage with contract crushing firms to assist in mitigating relevant supply constraints • Suggest road contractors have pre-coat agg. contingencies
2. **Approvals & Licensing**	Access to reserves; DERM ERA thresholds; DA's currently under assessment; DA's for accommodation camps; Extended hours of operation; Sales of quarry materials from mining leases; Access road/entrance requirements; Native title requirements & exemptions	8%	• Accelerate DA approval process for Strategic Quarries and Quarries of Interest • Consider rolling average for DERM ERA thresholds; allow code compliance for strategic quarries • Simplify/fast track small accommodation camps
1, 5 **Resource & Extraction**	Lack of pit planning (e.g. campaign sites); Quarry dev. plans (DEEDI OH&S requirement); blast logistics; O/B or stripping ratio; Variability of basalt quality (SMC etc; efficacy of specs.); Poor sampling/testing knowledge in CDA's amongst quarries and some labs	8%	• Update Strategic Quarries List • Investigate Quarries of Interest • 'Activate' dormant strategic quarries • Consider case by case basis for marginal quarry products from Strategic Quarries • Initiate basic sampling & testing courses