NERIMBERA QUARRY NEEDS ASSESSMENT & ECONOMIC IMPACT ASSESSMENT

HOLCIM AUSTRALIA PTY LTD

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EXECUTIVE SUMMARY

BACKGROUND

Holcim (Australia) Pty Ltd (Holcim) operates the Nerimbera Quarry located on Arnold Drive, Nerimbera, Queensland. The quarry commenced operations in the 1960s, producing a range of products including oversize rock, aggregates and manufactured sand for use in concrete, asphalt, road base, ballast, drainage and fill applications. Based on forecast demand, the expected remaining life of the quarry (without any extension) is less than 10 years. Without any extension, the Nerimbera Quarry will cease operations once these reserves are exhausted. As such, Holcim is proposing to extend the existing quarry pit in the south-easterly direction into Lot 605 on LIV40155, making accessible a further 70 Mt of quarry material to supply the region with quarry materials well into the future.

PURPOSE & APPROACH

This report has been developed as a technical document supporting a development application for the extension of Nerimbera Quarry into Lot 605 on LIV40155 (the Project). The report provides both:

- An assessment of the need for the Nerimbera Quarry extension into Lot 605.
- An assessment of the economic impacts and commentary on economic benefits.

In undertaking the needs assessment and economic impact assessment, the following was undertaken: a literature review, analysis of socio-economic/ demographic environment, overview of existing quarry and proposed extension, analysis of existing supply/ market and demand/ need for the project, examination of community need and strategic alignment, and an economic impact assessment of construction and annual operating activity.

KEY FINDINGS

Nerimbera Quarry is a major contributor to extractive material supply and economic development in the Livingstone and Rockhampton areas (i.e., the Catchment), providing:

- **Security and longevity of supply:** Historically (over the past five years), the Nerimbera Quarry has generated product catering to up to almost 50.0% of inferred demand estimates for the Catchment. The other two major hard rock quarries operating within the Catchment (Peak Hill and Quarry at Midgee) likely generate production for the majority of the remaining 50.0%, supplemented by the other 12 minor hard rock quarries. Notably, Peak Hill, one of the other major hard rock quarries, is not considered a direct competitor to Nerimbera Quarry due to differences in product quality (discussions with Holcim indicate Nerimbera Quarry produces higher grade product that primarily serves different markets than Peak Hill). With no quarries currently identified as proposed for extension or development within the Catchment, coupled with Peak Hill ceasing operations by 2035, this indicates the Catchment will continue to be reliant on Nerimbera Quarry as the primary supplier into the future. Potential alternative or substitute materials for hard rock quarry product have not been identified as having a major impact on competition in the future, with limited identified production/ use of these materials within the Catchment.
- **High quality products for the local construction, mining, and transport sectors:** Population growth, economic growth and specific major projects will continue to drive demand for quarry product into the future. Population driven demand for quarry product is estimated to require between approximately 1.2 Mt and 1.5 Mt by 2041, under the central population growth scenario. This assumes an average annual rate of demand each year based on historical estimates and does not consider industry activity or specific major projects which are scheduled to or may occur. Nerimbera Quarry itself has a capacity (i.e., the upper limit of production) to produce up to 1.2 Mt per annum, which could supply to meet the majority of demand by 2041 itself and, if supplemented by the other major and minor quarries in the region, could support any further industry activity or specific major projects that may occur.
- **Lower costs than would be achieved via the import of similar materials:** Given the significant existing market share of Nerimbera Quarry, the extension of operations may assist in moderating any price increases

resulting from demand outpacing supply. This increased availability of supply, coupled with the reduced requirements for imported quarried materials due to local availability, will likely result in lower costs of products for businesses and infrastructure projects.

- **Continuation of local economic activity and employment opportunities generated through the quarry:** The Project is anticipated to result in activity relating to construction and capital replacement in the order of $4.7 million in Gross Regional Product (GRP), $3.3 million in incomes, and 32 FTEs (through both initial and flow-on activity). The Project is also anticipated to result in activity relating to ongoing operations, which was assessed for three production scenarios, namely Scenario 1 (0.4 Mt per annum), Scenario 2 (0.8 Mt per annum), and Scenario 3 (1.2 Mt per annum). These scenarios indicate the Project could support between $6.1 million and $22.5 million in GRP, between $2.1 million and $3.0 million in incomes, and between 39 FTEs and 56 FTEs.
- **Support for local supply chain businesses:** The Project will extend quarrying and processing activities in the Catchment and thereby support and create opportunities for suppliers in the Catchment and Queensland, providing additional security and longevity of business incomes (and employment). The Project will also create opportunities to secure new contracts and increase sales to supply and service the needs of the Project through flow-on impacts in the supply chain, during all phases of the Project.
- **Greater government taxation revenues through a variety of taxes and duties:** The Project will provide a lift in federal, state, and local government taxation revenues through a variety of taxes and duties. These additional revenues can be used by government to provide additional infrastructure and services to support business and households throughout Australia.'
- **Support for local, regional, state, and national economic development, industry, and community strategies:** The Project aligns closely with a wide array of existing strategic planning documents and is of critical importance for a number of these policy goals to be achieved.

Overall, by extending the operational life of Nerimbera Quarry, the Project represents sustainable local economic development due to the quarry's important role in the economy as a supplier to key sectors, as well as its role in ensuring the viability for other businesses and major projects.

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1. INTRODUCTION

1.1 BACKGROUND

Holcim (Australia) Pty Ltd (Holcim) operates the Nerimbera Quarry located on Arnold Drive, Nerimbera, Queensland. The quarry commenced operations in the 1960s, producing a range of products including oversize rock, aggregates and manufactured sand for use in concrete, asphalt, road base, ballast, drainage and fill applications. Based on forecast demand, the expected remaining life of the quarry (without any extension) is less than 10 years. Without any extension, the Nerimbera Quarry will cease operations once these reserves are exhausted. As such, Holcim is proposing to extend the existing quarry pit in the south-easterly direction into Lot 605 on LIV40155, making accessible a further 70 Mt of quarry material to supply the region with quarry materials well into the future.

1.2 PURPOSE & APPROACH

This report has been developed as a technical document supporting a development application for the extension of Nerimbera Quarry into Lot 605 on LIV40155 (the Project). The report provides both:

- An assessment of the need for the Nerimbera Quarry extension into Lot 605.
- An assessment of the economic impacts and commentary on economic benefits.

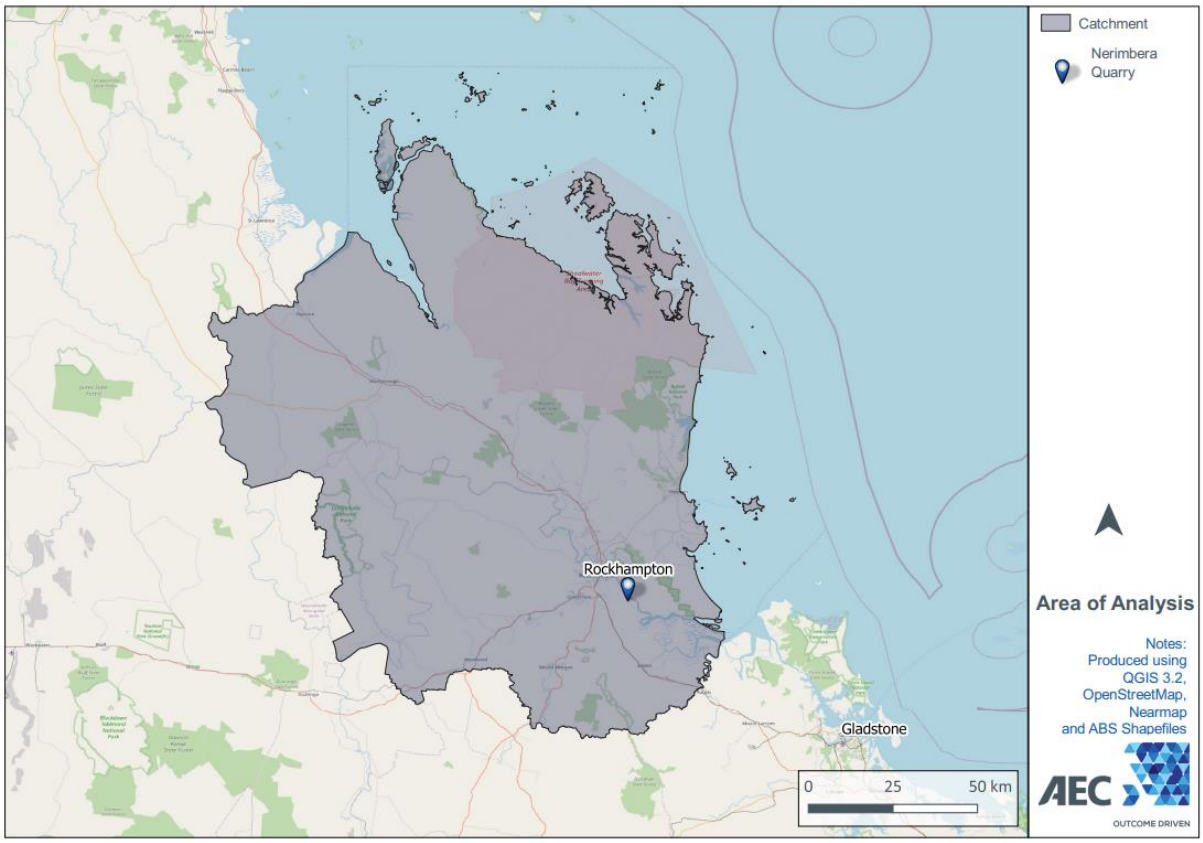
In undertaking the needs assessment and economic impact assessment, the following was undertaken:

- Literature review of existing extractive industries in the region; relevant plans, strategies, and studies relevant to the industry; infrastructure projects; and key influencing factors and trends.
- Analysis of the relevant socio-economic, demographic and resource sector data for the region and relevant peer comparison to build a profile and understanding of the region's strengths, opportunities, and relative competitive advantages.
- Development of a description of the existing quarry, including location, background and history, annual production, markets for products, employment, and description of proposed extension.
- Analysis of the existing supply/ market and demand/ need for the project, including analysis of existing competitors, future supply, development of demand projections, and implications for the Project.
- Examination of the demand/ need in consideration of local, regional, state-wide, and federal plans and strategies to understand how the Project meets government stated direction.
- Economic impact assessment to identify the potential economic activity supported during construction of the quarry extension and the ongoing operations that result in the regional economy.

1.3 STUDY AREA

The study area used in the needs assessment and EIA is defined as the Rockhampton Statistical Area 3 (SA3), hereafter referred to as the "Catchment". This Catchment was chosen as the Project will primarily support precoat/ road base to local subdivisions/ road construction projects across this region, all quarry staff and contractors live within the local areas (e.g., Rockhampton, Yeppoon, Emu Park), and all goods and services are sourced locally where available (otherwise may be required to be sourced regionally/ interstate). A map of the Catchment is presented in Figure 1.1.

Figure 1.1. Catchment Map



Source: AEC.

2. PROJECT OVERVIEW

2.1 EXISTING OPERATIONS

This section provides an overview of the existing quarry, including location, background and history, annual production, markets for products, and employment.

2.1.1 Background and History

Holcim currently operates the Nerimbera Quarry located on Arnold Drive, Nerimbera, Queensland (Lot 11 on LN2839 and Lot 120 on SP113182). Holcim owns or leases land surrounding the Nerimbera Quarry, largely to the southeast. The quarry is also located within the Nerimbera Key Resource Area (KRA). Further information of the implications of the KRA are discussed in Section 4.2.2.

Figure 2.1. Nerimbera Quarry Location

Source: AEC.

The quarry commenced operations in the 1960s, producing a range of quarry products including oversize rock, aggregates, and manufactured sand for use in concrete, asphalt, road base, ballast, draining and fill applications. The main areas of the quarry site are the quarry pit, sales floor workshop, and plant area. Plant and equipment held and utilised at the quarry site includes a tip head, jaw crusher, primary crusher, secondary crusher, tertiary processing plan, pug mill, blender, bitumen foam plant, road haulage trucks, front-end loaders, mobile crushers, dump (haul) trucks, loaders and excavators, rock drills and rock hammers.

2.1.2 Production & Employment

Due to the commercially sensitive nature of production and sales data specific to Nerimbera Quarry, average annual production or sales rates have not been presented in this report. The Nerimbera Quarry's current statutory approval does not apply an upper limit on production. As such, the site's upper limit of production is dictated by the capacity of plant to produce. In this case, the upper limit of production for Nerimbera Quarry is 1.2 Mt per annum

(Holcim, unpublished). The quarry currently employs 18 direct staff plus contractors (approximately 40) (Holcim, unpublished).

Based on forecast demand, the expected remaining life of the quarry (without any extension) is less than 10 years. Without any extension, the Nerimbera Quarry will cease operations once these reserves are exhausted.

2.1.3 Market Segments & Resource Uses

Sales by market is not presented due to the commercially sensitive nature of the information, however, in general the products supplied by Nerimbera Quarry include aggregates, fill, filter medium, rock, dust/ manufactured sand, and scalps. The below table provides an overview of the uses of products provided by Nerimbera Quarry, to provide an indication of the beneficiaries of the resource.

Table 2.1. Nerimbera Quarry Products and Applications

Product	Application
Aggregates	Aggregates are granular materials that act as key ingredients in the manufacturing of concrete, mortar, and other construction materials. These products typically go on to be used in construction and maintenance of structures such as highways, walkways, parking lots, airport runways, and railways. In the context of Nerimbera Quarry, aggregates have the following uses: • Precoated aggregates used for sealing works and are supplied to subdivisions and road construction. • Concrete and asphalt aggregates supplied to manufacturers. • Aggregates used for cement treated road base and used in high use/ heavy load road types (e.g., State Controlled Roads, highways). • MRS 2, X UBO used for unbound pavements and supplied for road construction.
Fill	Fill material is used to 'fill' or 'expand' an area, with common uses being inclusive of artificial mound, grade, and elevation development (such as when building up highway shoulders, low-lying construction sites, and levelling building foundations). In the context of Nerimbera Quarry, fill is supplied to various projects such as road embankments and subdivisions.
Scalps	Scalps are a by-product of the crushing process and can be used as select fill (see above description). Scalps are used in driveways, building sites, concrete pads, and other applications where a certified blended road base is not required. In the context of Nerimbera Quarry, scalps is supplied to various projects such as road embankments and subdivisions.
Filter Medium	Filter medium/ drainage aggregates works by facilitating the movement of water in an area. Filter medium has both residential and commercial uses, used primarily during landscaping projects (such a behind retaining walls or underneath gardens to allow water to run freely with little resistance). In the context of Nerimbera Quarry, drainage aggregate is typically provided for infrastructure projects, such as linear infrastructure (e.g., pipeline, electrical) construction and maintenance, more so than for residential use.
Oversize Rock	Used in flood protection and remediation works, breakwater walls and riverbank protection.
Ballast	Ballast forms the track bed upon which railroad ties (sleepers) are laid and requires replacement to maintain the safety and stability of rail tracks. In the context of Nerimbera Quarry, ballast rock is produced for use in the construction and maintenance of local and regional railway corridors.
Dust/ Manufactured Sand	Dust/ manufactured sand is commonly used to backfill trenches, pipe bedding, packing under concrete slabs, building up low areas, and creating paths and other hard base areas. Dust/ manufactured sand is a type of aggregate with a fine composition, used for the construction of roads or the manufacture of concrete (as a partial alternative to natural sand), as well as for electrical conduits, plumbing pipes, horse arenas and stables. In the context of Nerimbera Quarry, dust/ manufactured sand is used for concrete production, as well as general fill, in drainage, house slab fill, and road construction.

Source: Holcim (unpublished).

These products are primarily supplied to markets within the Catchment.

As the primary hard rock resource in the region, Nerimbera Quarry has supplied a number of major projects in the Catchment, which have historically included major transport projects and other key local projects such as local marinas, asphalt manufacturers, concrete suppliers, rail ballast, Department of Transport and Main Roads and local Council road repairs/ maintenance. Other key projects the Nerimbera Quarry has supplied in the past includes:

- **Rockhampton Northern Access Upgrade:** 350,000 tonnes of road base, drainage aggregates and cement treated road base supplied to the Department of Transport and Main Road's $121 million widening of the Bruce Highway north of Rockhampton.
- **Etna & Angela Bruce Highway Upgrade:** 100,000 tonnes of cement treated road base and 2.1 mm and 2.3 mm road base supplied to the project.
- **Yeppoon Floodplain Bruce Highway:** 400,000 tonnes of A1 75 mm fill and concrete aggregates supplied to the project.
- **Thompson Point Boat Ramp & Keppel Bay Marina:** 20,000 tonnes of 500 mm nominal armour rock to Livingstone Shire Council's community project (Holcim, unpublished).

2.2 PROPOSED EXTENSION (THE PROJECT)

This section provides an overview of the proposed extension, with detail on both the construction and operations phases.

2.2.1 Description of the Project

With reserves coming to an end, Holcim is proposing to extend the existing quarry pit at Nerimbera Quarry in a south-easterly direction into Lot 605 on LIV40155, making accessible a further 70 Mt of quarry material to supply the region with quarry materials well into the future.

- Maintain existing annual production volume, with a capacity (i.e., the upper limit of production) of 1.2 Mt per annum.
- Maintain existing operational hours.
- Utilise existing processing and stockpile areas at the north of the site and transport route via Nerimbera School Road, the defined KRA transport route. Some components of plant will be replaced in the coming years due to age/ repair requirements, however, the configuration plant will remain largely the same.
- Not increase truck or light vehicle traffic numbers to and from the quarry.
- Incorporate water management, vegetated buffers, and progressive rehabilitation.
- Where possible, locate ecological offsets required for the Project within Holcim's existing landholdings.

As indicated, extending the existing quarry pit rather than developing a new, greenfield quarry elsewhere will minimise impacts to the environment and community, whilst ensuring security of the high-quality quarry materials for the region and allow local construction costs to continue to be optimised.

2.2.2 Construction

There is no defined construction phase of the Project, as the development into the extension area will essentially occur through quarry operations (i.e., blasting and movement of material to access the area and produce product). Despite this, there are some preliminary construction works as well as capital replacement of existing infrastructure required due to the end of the useful life of various assets. Some of these costs include:

- Quarry extension design, totalling $0.1 million.
- Exploration drilling, totalling $0.25 million.
- Approvals, totalling $0.5 million.
- Replacement of existing plant and equipment totalling between $8.5 and $10.0 million.
- Additional plant and equipment requirements, including 1x additional haul truck and 1x front end loader, totalling $3.0 million (AECOM, unpublished; Holcim, unpublished).

Beyond the costs listed above, there are also anticipated to be costs relating to engineering. Given this, it can be assumed initial construction and capital replacement costs will be around $14.0 million in total. Some of this has

already occurred in 2021 and 2022 (i.e., that associated with exploration drilling, extension design, and approvals), with the majority anticipated to largely occur between 2025 and 2026 (pending approval).

2.2.3 Operations

Operations for the Project will commence shortly after approval, given there is no defined construction phase. The Nerimbera Quarry's current statutory approval does not apply an upper limit on production, and as such, the site's upper limit of production is dictated by the capacity of the plant to produce (i.e., 1.2 Mt per annum).

Historical revenues, production levels, and operating costs were provided by the proponent for use in modelling (see Section 6.2), however, are not presented in this report due to the commercially sensitive nature of the information. Importantly, the proposed extension is anticipated to maintain operations at the existing level, with an existing annual production rate of up to 1.2 Mt per annum (depending on market/ customer demand) and existing operational hours (production being 6am to 6pm Monday to Friday, and 6am to 4pm Saturday and maintenance only on Sunday). Approximately 18 FTE quarry staff, 2 FTE truck drivers, 2 FTE sub-contractors, 15 part time/ casual truck drivers, and 20 part time/ casual maintenance staff (e.g., electricians, tyre fitters, boiler makers, etc.) are currently employed during quarry operations, the majority of which are sourced from within the Catchment (i.e., Rockhampton, Yeppoon, Emu Park) (Holcim, unpublished). Goods and services supporting operations will be sourced from within the Catchment where available, however, other goods (such as large plant and equipment) may be sourced interstate or overseas depending on availability.

It is assumed the average annual rate of production will be consistent with historical levels, with production up to the 1.2 Mt capacity (i.e., the upper limit of production) expected to be produced only when major projects are occurring (e.g., for the Rockhampton Ring Road).

3. REGIONAL OVERVIEW

This section provides a summary of the current economic environment of the Catchment, where impacts of the Project are expected to primarily be felt, with comparisons to Queensland provided where relevant. Additional details of the existing economic environment are provided in Appendix A.

The following are key attributes of the Catchment's existing environment:

- **Population supporting sectors are the key drivers of the Catchment economy:** The Catchment includes the major regional centre of Rockhampton as well as a number of other surrounding towns, providing a critical mass of residents to support population-serving sectors of the economy. In 2019-20 the Catchment's key industries were comprised of population-serving sectors, with healthcare and social assistance the largest contributor to industry value add (IVA), comprising 11.1%, followed by construction (9.2%), and electricity, gas, water, and waste services (8.7%). This supported a Gross Regional Product (GRP) of $7.5 billion in 2019-20.
- **The Catchment has typically recorded lower population growth than the State over the past decade:** Over the ten years to 2020, the Catchment recorded lower population growth by comparison to the State, averaging 0.8% per annum, to reach approximately 120,616 residents by 2020 (ABS, 2021). Average annual population growth was half that of the State over this period.
- **Population growth is closely tied to fluctuations in construction activity in the Catchment:** Whilst recording growth over 1.0% per annum between 2001 and 2014, the Catchment experienced a period of population decline in 2016 before growth recovered to just under 1.0% in 2020. These population growth trends are correlated with fluctuations in construction activity, which accounted for 9.2% of IVA and 9.4% of employment (by place of work) in 2019-20. The correlation between population growth and construction activity is typical of the construction sector, with growth in construction activity often linked with periods of population growth (to provide the required infrastructure to support the population) while workers often move around the State in line with where the work is occurring.
- **Population growth in the Catchment is anticipated to trend towards similar levels recorded by the State over the next 20 years:** The Catchment's resident population is anticipated to grow by approximately 1.3% per annum on average over the 20 years to 2041, only 0.3 percentage points lower than the State (QGSO, 2019). This will see the Catchment recording a population of around 156,650 residents by 2041.
- **Though small, non-metal mineral mining (i.e., extractive industry) has accounted for an increasing share of economic activity in the Catchment over the past decade:** Non-metal mineral mining activity in the Catchment has seen consistent growth over the ten years to 2019-20, recording an increase in share of total employment of 0.34 percentage points (AEC, unpublished a). This demonstrates the increasing importance of quarries within the region.
- **COVID-19 and border closures resulted in a slowdown in the Catchment:** Over the past decade, the Catchment has recorded similar economic growth to that of the broader State (2.0% per annum on average compared to 2.1%, respectively). As has been experienced throughout Australia, the Catchment's economy was impacted by COVID-19 and subsequent measures by the Australian and Queensland Governments to slow the spread of the virus. This resulted in a 1.5% decline in GRP in 2019-20, slightly higher than the 1.2% decline recorded across the broader State.
- **Unemployment in the Catchment has recovered from peak levels in 2015:** The Catchment has generally recorded higher unemployment rates than the State with a 5-year average of 6.8% compared to 6.3% for the State (DoESE, 2022). Unemployment in the Catchment peaked at 9.0% in the September quarter of 2015, however, has generally be on a downward trend since. The peak in unemployment in 2015 coincided with a downturn in the construction industry, whilst higher levels of unemployment in early 2020 (peaking at 7.0% in June 2020 post onset of the COVID-19 pandemic) coincided with the initial impacts from COVID-19 and the closing of Australia's borders on the national economy.
- **The Catchment's labour force has trended upwards since late 2017:** Whilst experiencing volatility from December 2010, the Catchment's labour force generally trended upwards since March 2018. Labour force

trends in the Catchment have generally reflected the inverse of the unemployment rate, suggesting that as people lose work or have difficulty acquiring work, they leave the Catchment's labour force.

- **Following a period of decline, residential building approvals in the Catchment have been increasing since 2017-18:** The number of residential building approvals in the Catchment declined from 900 approvals in 2012-13 (valued at approximately $260,700,000 in total[1]) to under 400 approvals each year between 2017-18 and 2019-20 (valued at $126,000,000 in total on average during those years) (ABS 2021f). This decline in residential building approvals closely aligns with the Catchment's population growth trends which, following moderate annual growth to 2012, entered a period of annual decline from 2013 to 2016. Residential building approvals have slightly increased in recent years, reaching over 500 approvals in 2020-21, in line with population growth. Similarly, the State recorded a decline since 2015-16, before increasing again by 2020-21. The value of non-residential building approvals has significantly fluctuated year on year, typical of the nature of the timing of large non-residential building projects.

[1] This refers to the total value of all residential building approvals in 2012-13.

4. SUPPLY & DEMAND ANALYSIS

4.1 HISTORIC DEMAND

This section provides an overview of current and future anticipated demand for the extractive industry for both the Catchment (as defined in Section 1.3) and Queensland more broadly (where relevant).

4.1.1 Demand Drivers

Demand for hard rock quarry product is considered derived demand, i.e., demand for its use is derived by the demand for the goods or services that the products provide. As the majority of hard rock materials are used as inputs into construction materials, its demand is primarily driven by:

- **Population growth**, which will result in further demand for residential/ commercial buildings, transport infrastructure (roads, highways, railways), health, education, and retail infrastructure, etc.
- **Economic activity**, relating to manufacturing and construction which is primarily generated by the mining sector and transport sector (for industrial roads, ports, commercial railways).
- **Specific major projects**, such as that related to the 2032 Olympics,

The following local contextual factors reflect the expected level of demand for hard rock quarry product within the Catchment:

Table 4.1. Local Influencing Factors

Demand Driver	Detail
Population Growth[(a)]	The Catchment has historically expanded at a slower rate than that of the broader State, growing by 1.2% per annum on average over the past two decades (compared to 2.0% for Queensland) to reach approximately 121,600 residents (ABS, 2021). The highest period of growth for the Catchment was between 2001 and 2012, before recording negative growth in 2016 and recovering to lower-than-average levels of growth by 2021. Population projections suggest the Catchment's resident population is expected to experience increasingly similar growth to that of the State, with average annual growth of 1.3% projected over the next two decades (compared to 1.6% for Queensland) (ABS, 2021a, 2021b; QGSO, 2018, AEC). This strengthening population growth will continue to place increased pressure on demand for residential properties, transport, health, education, and retail infrastructure.
Residential Building Construction	Residential building activity depends on many variables within the economy, including interest rates, availability of mortgage funds, government spending, business investment, short-term construction projects, etc. The number of residential building approvals provides an indication of future anticipated population growth. Whilst declining to the lowest levels recorded in 2018-19, the number of residential building approvals within the Catchment has since grown by a significant 38.2% per annum on average to 2020-21 (compared to 12.2% for Queensland) (ABS, 2020). This suggests there is anticipated to be a lift in the population in the region over the coming years (supported by the population projections above).
Non-Residential Building Construction	Non-residential building construction (including office, education, warehouse, short-term accommodation, etc.) provides an indication of future anticipated population growth. Non-residential building approvals in the Catchment have increased by 9.1% per annum over the two years to 2020-21; comparatively the broader State recorded a decline over the same period (ABS, 2020). This supports increasing demand for quarry materials in the coming years.

Demand Driver	Detail
Economic Activity	In 2019-20, the Catchment's economy recorded GRP of approximately $7.5 billion in chain volume terms (AEC, unpublished). Between 2006-07 and 2019-20, the economy recorded moderate growth of approximately 1.9% per annum on average, slightly lower than the 2.2% recorded for the State. During 2019-20, economic activity dipped in both the Catchment and broader State resulting from the policy implications of the COVID-19 pandemic. Key industries demanding quarry product includes mining, construction, and transport, postal and warehousing, which represented 24.3% of industry value added activity within the Catchment in 2019-20 (slightly lower than the 27.7% for Queensland). Over the past few years', construction and transport, postal and warehousing activity has declined as a share of total industry value add within the Catchment, whilst mining activity has increased in share. Activity across Queensland has demonstrated similar trends. This indicates recent demand for quarry materials has not been at its highest levels, however, future development of major projects (see below) is likely to assist in heightening activity and hence demand.
Major Projects	Quarry activity will be supported by the significant developments in the Catchment over the coming years. Quarrying activity is driven primarily by demand for heavy and civil engineering construction activities. There are a significant number of developments in various stages of development and planning of this nature, which will support growth of the heavy and civil engineering construction sector and consequently quarrying activity over the coming years (see Appendix A).

Note: (a) The medium growth scenario from QGSO has been reported as the central scenario.
Sources: ABS (2020), ABS (2021a, 2021b), AEC, QGSO (2018), AEC (unpublished), various.

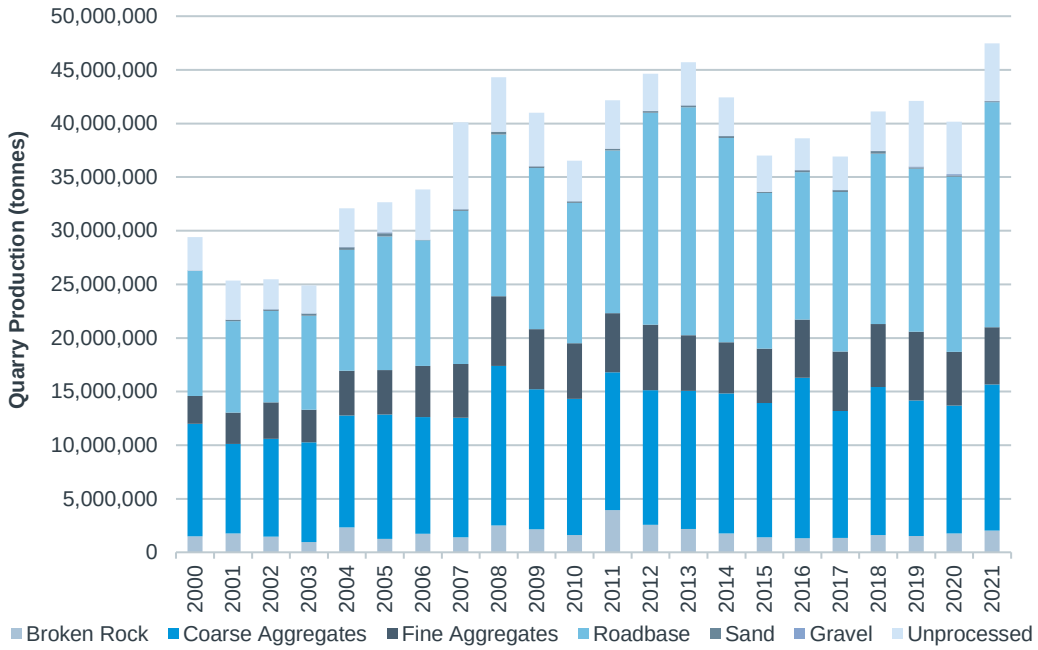
Whilst there is a significant level of demand from industry within the Catchment, with industries requiring quarry product representing a quarter of total industry activity, this has been discussed qualitatively. As such, the demand estimates in the following sections are solely based on population driven demand, which is likely a conservative estimate.

4.1.2 Existing Demand & Production

4.1.2.1 State & Regional Demand

The Queensland hard rock extractive industry has produced approximately 41.6 Mt per annum on average over the past five years (i.e., 2017 to 2021) (Queensland Government, 2022). The majority of this production has been for road base (40.1%), followed by coarse aggregates (30.7%), fine aggregates (13.6%), unprocessed rock (11.2%), broken rock (4.0%), sand (0.3%) and gravel (0.1%). Production across the State has generally increased over the past two decades in line with population and industry growth, however, declined over the five years to 2020 relative to the previous highs between 2011 and 2014. Production in 2021 increased to a new historical peak, due to increased investment in and support for the minerals and exploration sector as part of the Queensland Government's COVID-19 Economic Recovery Plan (Queensland Government, 2021d).

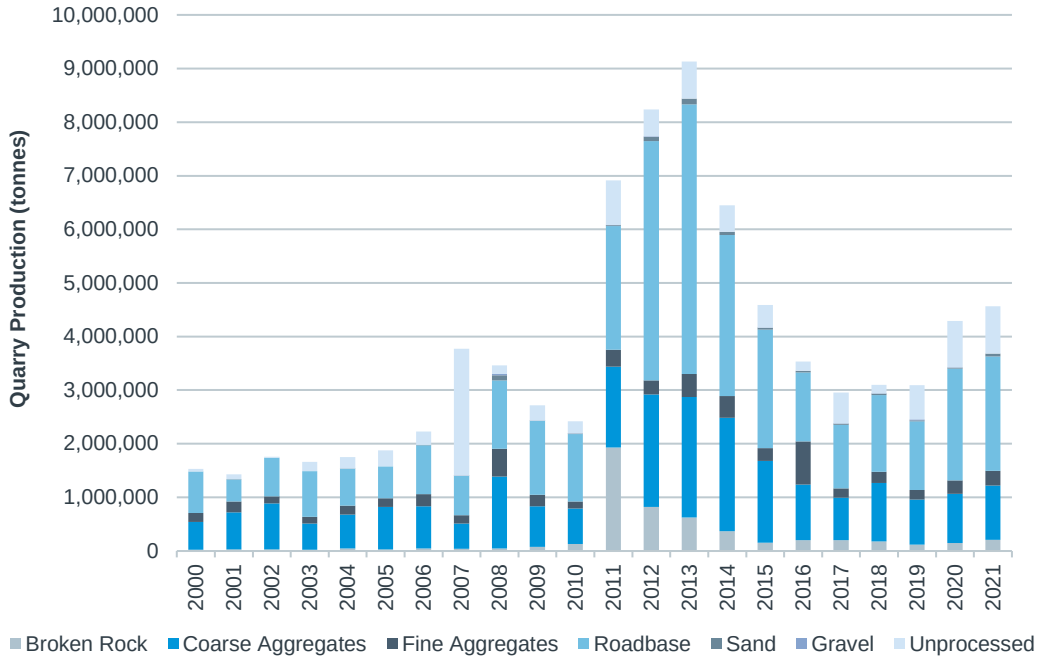
Figure 4.1. Queensland Quarry Production (tonnes), 2000 to 2021



Source: Queensland Government (2022).

The Central Queensland hard rock extractive industry has produced approximately 3.6 Mt per annum on average over the past five years (i.e., 2017 to 2021), representing approximately 8.7% of the State's production (Queensland Government, 2022). Production by product across Central Queensland is similar to that across the State. Production in Central Queensland peaked between 2011 and 2014 (coinciding with a period of strong investment and development in the region, including development of LNG facilities), reaching over 9 Mt in 2013, but has since returned to annual production of between 3 and 5 Mt per annum. During 2020 and 2021, production increased year on year in line with activity across the State.

Figure 4.2. Central Queensland Quarry Production (tonnes), 2000 to 2021



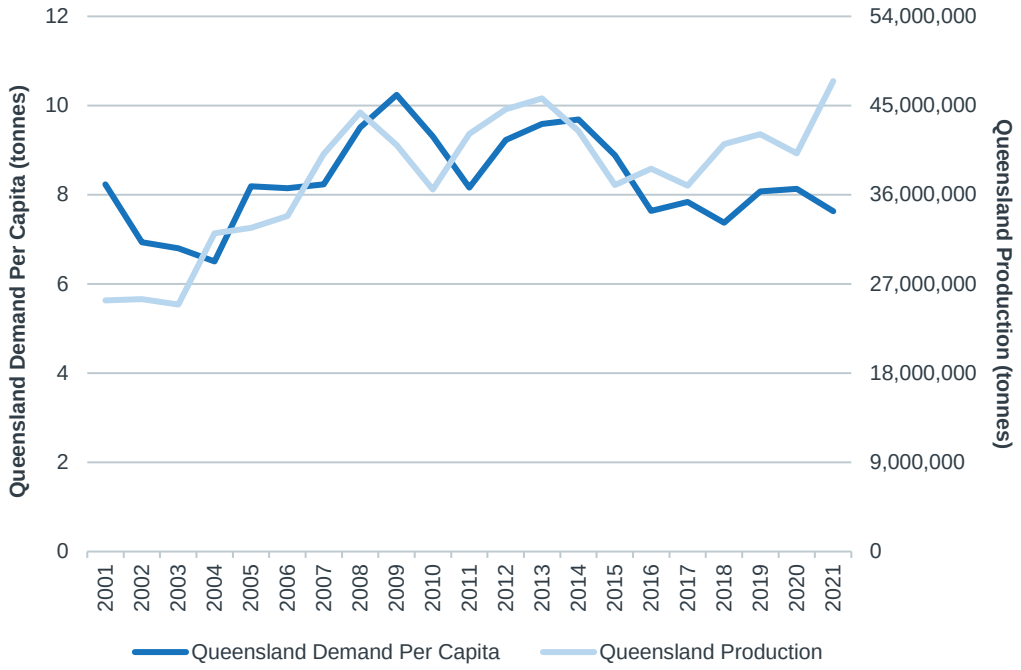
Source: Queensland Government (2022).

4.1.2.2 Demand Per Capita

Demand per capita has been evaluated at the State level, as it is considered a more appropriate proxy for per capita demand for the Catchment than that of Central Queensland. Central Queensland (in total) has a significantly lower population density than the Catchment, which results in significantly higher per capita production estimates than considered appropriate for the Catchment (given the population level, existing supply, and existing known production rates (see Section 4.2)).

Analysis of demand compared to population growth shows there is a strong historical correlation between population growth and production, but with demand lagging production by around one year (i.e., production of quarried materials typically precedes demand for quarried materials by approximately one year). This is highlighted in the following figure which shows Queensland demand for quarried materials per capita (where Queensland population is divided by Queensland production) against annual Queensland quarry production rates. On a per capita basis, demand has equated to a median of 8.2 tonnes of quarry product per capita since 2001.

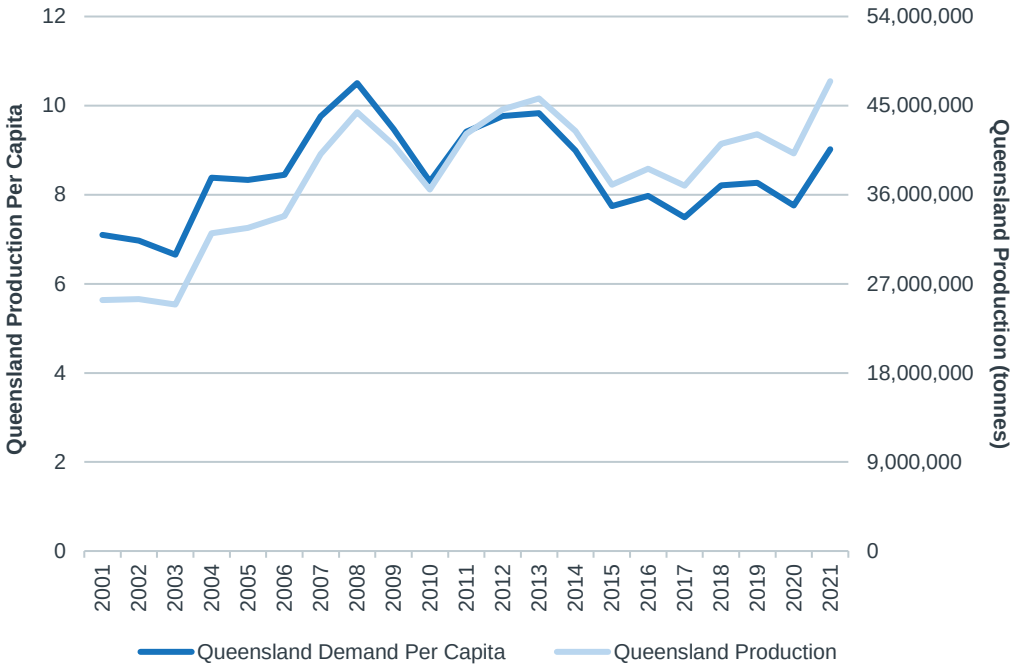
Figure 4.3. Queensland Demand Per Capita vs. Production



Source: ABS (2022).

The figure below demonstrates how closely production aligns with demand where the one-year lag in demand is taken into consideration (i.e., with production levels pushed forward one year in the demand per capita calculation to account for a one-year lag in demand).

Figure 4.4. Queensland Demand Per Capita vs. Production (Accounting for Lag in Demand)



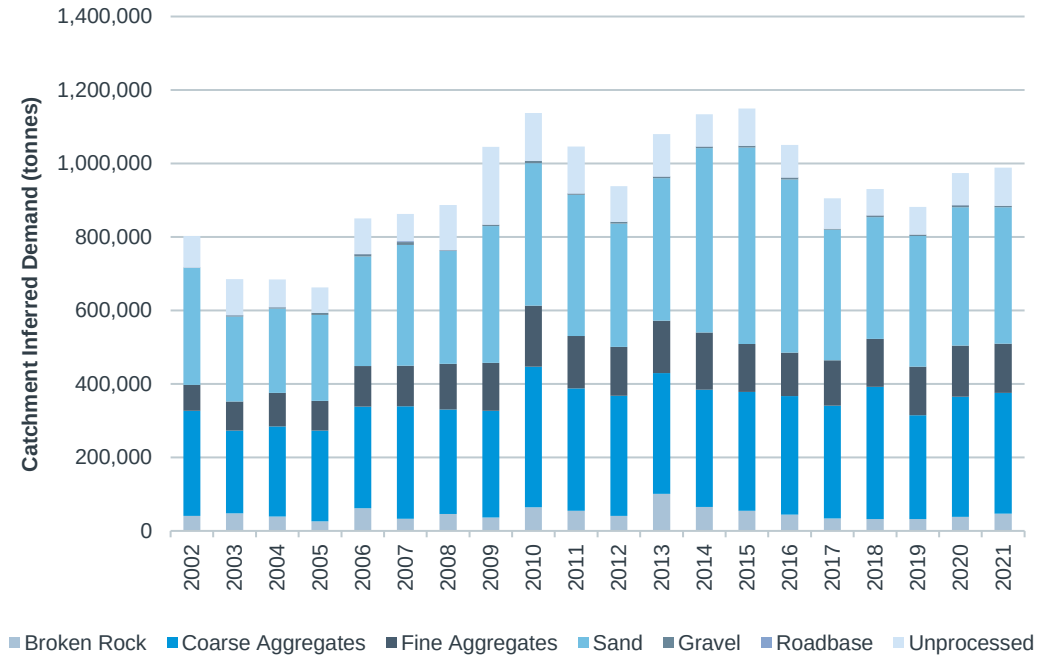
Source: Queensland Government (2022), ABS (2021a, 2021b), AEC, QGSO (2018).

Catchment production data is not currently publicly available, and as such, inferred historical production estimates have been developed by applying Queensland's above demand per capita rates of production (8.2 tonnes per capita) to historical population estimates (and accounting for a 1-year lag in demand compared to production). This assumes that all hard rock extracted outside the Catchment is not supplied to the region, as hard rock is a low value-high volume product and transportation costs form a major component in the end price. Quarry products are typically transported relatively short distances due to these transportation and cartage costs.

4.1.2.3 Catchment Inferred Demand

The inferred demand estimates indicate that over the past five years demand within the Catchment has averaged between approximately 0.9 Mt and 1.0 Mt per annum. This represents inferred average annual demand; however, demand will have fluctuated year to year particularly in line with major projects/ industry demand. Based on this, Nerimbera Quarry is estimated to serve close to half of the market in the Catchment, with the capacity to produce up to 1.2 Mt to meet fluctuations in demand.

Figure 4.5. Catchment Inferred Demand



Source: Queensland Government (2022), ABS (2021a, 2021b), AEC, QGSO (2018).

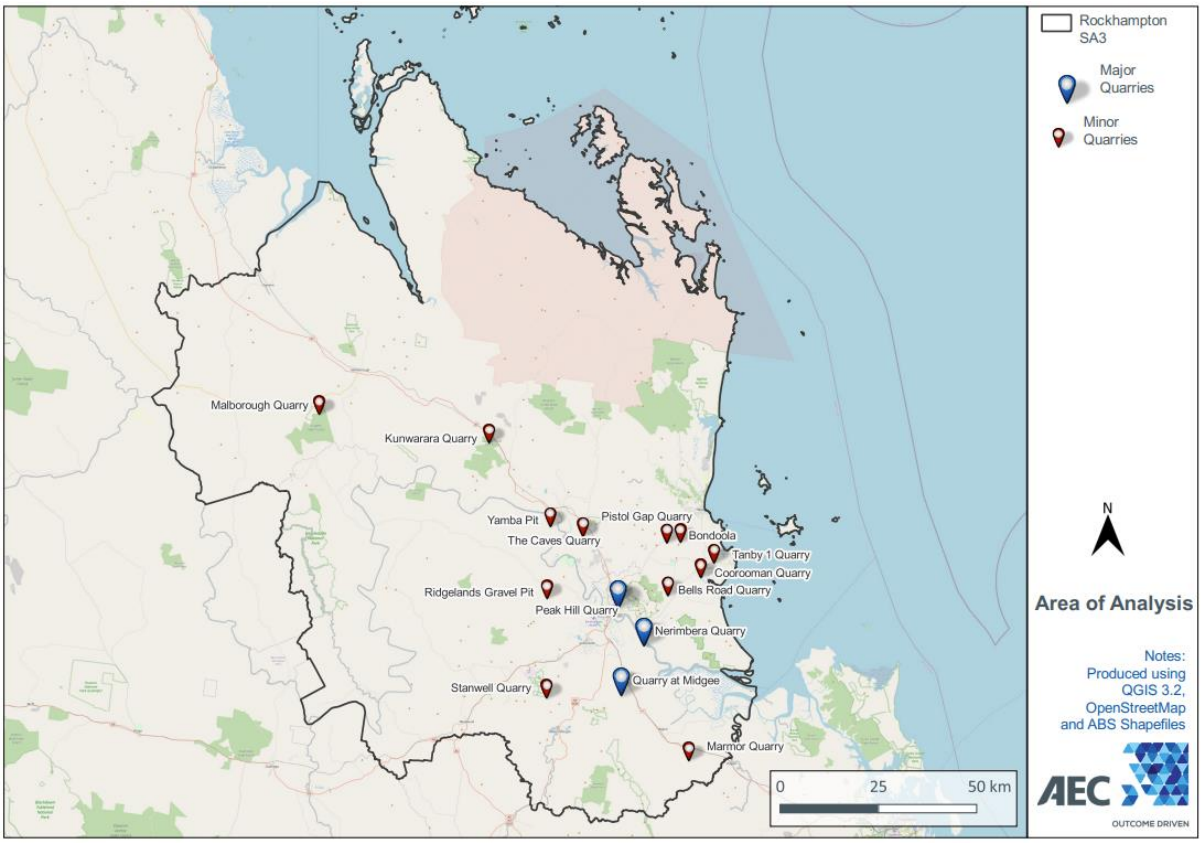
4.2 SUPPLY/ MARKET

This section provides an overview of current and future anticipated supply within the extractive industry for both the Catchment (as defined in Section 1.3) and Queensland more broadly (where relevant). For the purposes of this assessment, only hard rock quarries have been considered, as this aligns with the predominant product groups of Nerimbera Quarry (see Section 2.1.3).

4.2.1 Current Supply

Across Queensland there are over 180 hard rock quarries, 15 of which are located within the Catchment (Department of Transport and Main Roads, 2022a; Queensland Globe, 2022). Desktop analysis suggests over 70 of the quarries operating within Queensland are major hard rock quarries, whilst the Catchment has three, including Nerimbera Quarry, Peak Hill Quarry and Quarry at Midgee (Department of Resources, 2015; Department of Resources, 2020; Quarry Magazine, 2020; Courier Mail, 2017). Major hard rock quarries are defined as those producing greater than 200,000 tonnes per annum on average. Peak Hill, one of the other major hard rock quarries, is anticipated to continue to operate until about 2035 but is not considered a direct competitor to Nerimbera Quarry due to differences in product quality (discussions with Holcim indicate Nerimbera Quarry produces higher grade product that primarily serves different markets than Peak Hill), whilst the remaining life of Quarry at Midgee is unknown (Queensland Government, 2016). Figure 4.6 presents the location of each of these quarries within the Catchment.

Figure 4.6. Active Hard Rock Quarries, Catchment



Source: Department of Transport and Main Roads (2022a), Queensland Globe (2022), Department of Resources (2015), Department of Resources (2020), Quarry Magazine (2020), Courier Mail, 2017.

Historically (over the past five years), the Nerimbera Quarry has generated product catering for approximately 50% of inferred demand estimates for the Catchment. The other two major hard rock quarries operating within the Catchment (Peak Hill and Quarry at Midgee) likely generate production for the majority of the remaining 50%, supplemented by the other 12 minor hard rock quarries.

4.2.2 Future Supply

Future supply of hard rock quarries is limited by the finite nature of the resource itself. As such, the Queensland Government has developed a planning tool, KRAs, to protect resources from being rendered inaccessible by urban expansion (Queensland Government, 2020). KRAs ensure the supply of construction materials located close to markets remains available for development when required. According to the *State Planning Policy (2017)*, KRAs are identified based on one or more of the following criteria:

- **Size:** The size of the extractive resource is equal to or greater than annual demand for the commodity type in its region.
- **Production:** The resource is capable of producing 5% of annual demand for the commodity type in its region.
- **Market:** The resource can supply more than 1 significant part of the region.
- **Scarcity:** The resource has particular physical properties that are scarce in the region.
- **Specialised:** The resource is a specialised resource needed for strategic infrastructure (Queensland Government, 2020).

There are four areas defined as KRAs by the above definition within the Catchment, three of which contain hard rock resources (see Table 4.2). One of the three KRAs is currently being quarried at full capacity, therefore, the potential supply from KRAs is confined to partially or unutilised KRAs (namely Benedict Road and Nerimbera).

Table 4.2. Key Resource Areas, Catchment

Name	Number	Detail
Benedict Road	18	This resource area consists of basalt up to 35 meters thick, which overlies conglomeratic and sedimentary rocks. The area has the potential to provide aggregate and other construction materials for use by the eastern side of the Central Queensland region. There are no active quarries positioned within this key resource area.
Nerimbera	21	The resource consists of hardened argillite and greywacke. The northern part of the resource is the site of a major quarry (Nerimbera) supplying a full range of crushed rock products. The available resource is very large and is the prime source of high-quality crushed rock products for the Rockhampton and wider Central Queensland region. The volume of material present will enable continuity of this supply for the long term.
Peak Hill	98	The resource consists of andesitic tuff and small diorite and gabbro intrusion. An operating quarry is sited on the resource, producing a considerable proportion of the hard rock consumed in Rockhampton city and the surrounding region. From 2016, the resource was identified to continue for over twenty years at its present rate of production. Peak Hill's longevity in the market is understood to be compromised, particularly due to the increasing urban encroachment surrounding the quarry.

Source: Queensland Government (2016), Department of State Development, Infrastructure, Local Government and Planning (2021), Livingstone Shire Council (2018).

With no identified new quarries within the major projects pipeline for the Catchment and only one unused KRA and one partially used KRA, the future supply of hard rock in the Catchment is anticipated to be limited if Nerimbera does not extend and if any of the existing quarries cease operations in the coming years. The Project will extend production and supply for the Catchment into the future and ensure appropriate levels of competitive tension are retained in the local sector; the benefits of this are detailed in Section 6.3.

4.2.3 Alternative or Substitute Materials

The finite nature of resources, including quarry materials, has meant that attention has increasingly been placed on alternative, sustainable, sources that can be used in place of materials derived from natural quarry resources. Several products are commonly proposed in place of natural hard rock, namely:

- **Iron & Steel Slag:** These products are generated as by-products in the manufacture of iron and steel, providing opportunity to use the recycled product in road construction and maintenance. The effective utilisation of slag materials in a productive or economically beneficial way (thus avoiding disposal in landfill) has increased from 30.0% to 35.0% in 1990 to 75.0% by 2000 (ASA, 2000). The Australian Iron and Steel Slag Association (2006) recognises that there are some environmental and health hazards associated with the use of iron blast furnace slag, particularly relating to trace metals leaching into the environment. The availability of local slag is confined to the Port Kembla region in New South Wales, though is imported into all mainland Australian states for use (Cement Concrete and Aggregates Australia, 2018). Specifications for the use of slag in Queensland include use in pavement stabilisation (cement or cementitious blends), plant mixed heavily bound (cemented) pavements, plant-mixed pavement layer stabilisation (foamed bitumen), plant-mixed lightly bound pavements, lean mix concrete sub-base for pavements, concrete pavement base, concrete, and fillers for asphalt (Department of Transport and Main Roads, 2020). Slag is not commonly used as an aggregate in Queensland.
- **Coal Ashes:** Coal ash is created primarily by burning coal in coal-fired power stations. Typically coal ash is disposed into purpose-built emplacement facilities, with over 400 million tonnes of fly-ash currently stored in dump sites across Australia (Public Works Committee, 2021). Recycled coal ash has the potential to be used for construction, with up to 97.0% of coal ash recycled for use in some overseas jurisdictions. Across Australasia, only approximately 47.0% of ash generated was reused, including in cement and non-cement construction material. Coal ash is typically used in the same way as discussed above for iron and steel slag, and not as an aggregate. It is understood this material is not yet widely used in the Catchment.
- **Recycled Construction Material:** Construction materials that are currently permitted (within specified limits/ uses) to be recycled for use includes crushed concrete, crushed brick, crushed glass, reclaimed asphalt pavement, crumb rubber, fly ash and slag (covered above), and insitu material (Department of Transport and Main Roads, 2020). The majority of these have been approved for use in unbound pavements, for stabilisation, for earthworks, draining and backfill, whilst some are approved for sprayed sealing, asphalt, and concrete. The amount of construction and demolition waste that has been landfilled declined by 15% over the four years to

2018-19 in Queensland, demonstrating the increasing utilisation of recycled materials. The market for recycling in the catchment is anticipated to continue to growth in line with this trend. Nerimbera Quarry already recycles waste concrete, generating environmental benefits and a prolonged life for the natural resource.

- **Geosynthetic Aggregates:** Geosynthetics are predominantly used in stabilisation applications to facilitate construction works. There is not a large presence of geosynthetic providers in the catchment.

Other providers of aggregate materials (including sand, gravel, and crushed stone) exist within the Catchment, which provides products that may compete with the same clientele as Nerimbera Quarry. There are eight providers of these products, including Pink Lily Sands, Hardcore Sands, Kinka Beach Sand Pit, River Paddock Quarry, Rockhampton Sands, Tanby, Yammba, Fitzroy River (Department of Transport and Main Roads, 2022a; Queensland Globe, 2022). Given that sand, gravel, and crushed stone cannot replace hard rock products, it is unlikely these providers will assist in meeting industry demand.

4.3 PROJECTED FUTURE DEMAND

Historical and existing trends in per capita demand for hard rock quarry product provides a reasonable measure in forecasting the future need for these materials. Three population growth scenarios were assessed, in line with the Queensland Government Statisticians Office (2018) projections:

- **Low Population Growth Scenario:** Under this scenario, the Catchment's population is anticipated to grow by 0.9% per annum on average to reach approximately 144,900 people by 2041.
- **Medium Population Growth Scenario (Central Scenario):** Under this scenario, the Catchment's population is anticipated to grow by 1.3% per annum on average to reach approximately 156,600 people by 2041.
- **High Population Growth Scenario:** Under this scenario, the Catchment's population is anticipated to grow by 2.5% per annum on average to reach approximately 199,800 people by 2041.

For each of the above population growth scenarios, three different per capita assumptions were applied, utilising Queensland per capita historical production rates as a proxy. The per capita rates were estimated on an individual product basis, with the final totals presented below along with the proportional breakdown by product:

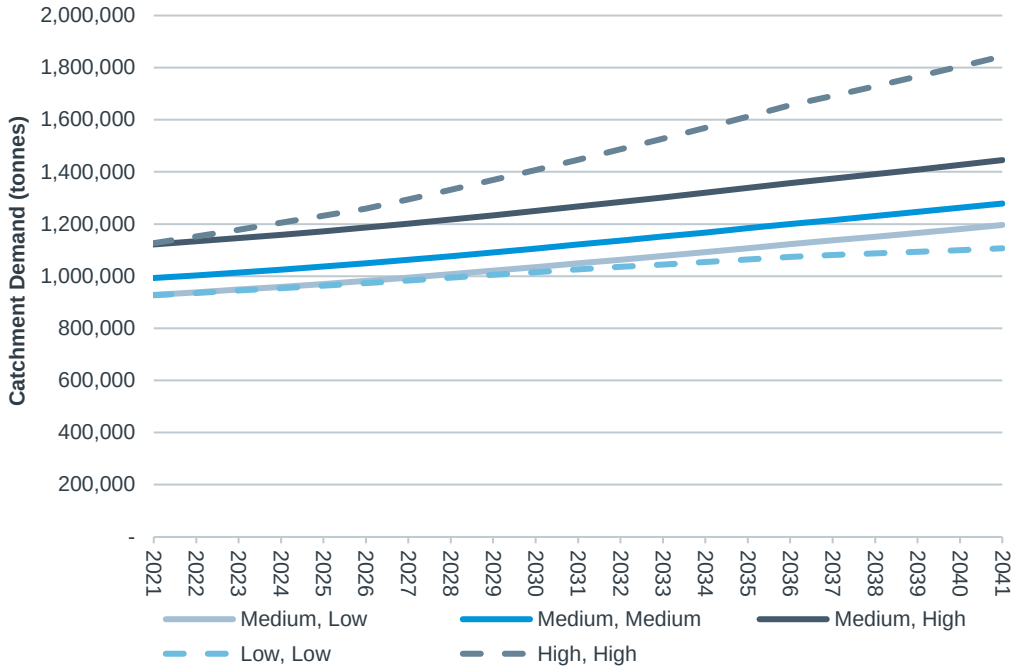
- **Low Per Capita Scenario:** Assumes the Catchment's overall demand for quarry product equates to 7.6 tonnes per resident (the first quartile value of the Queensland historical annual rate), with varying rates for each product type. Road base is assumed to comprise 37.6% of total demand, followed by coarse aggregates (32.0%), fine aggregates (13.1%), unprocessed rock (9.4%), broken rock (4.1%), sand (0.4%) and gravel (0.0%).
- **Medium Per Capita Scenario:** Assumes the Catchment's overall demand for quarry product equates to 8.2 tonnes per resident (the median value of the Queensland historical annual rate), with varying rates for each product type. Road base is assumed to comprise 38.0% of total demand, followed by coarse aggregates (33.0%), fine aggregates (13.5%), unprocessed rock (10.5%), broken rock (4.6%), sand (0.4%) and gravel (0.1%).
- **High Per Capita Scenario:** Assumes the Catchment's overall demand for quarry product equates to 9.2 tonnes per resident (the third quartile value of the Queensland historical annual rate), with varying rates for each product type. Road base is assumed to comprise 36.7% of total demand, followed by coarse aggregates (30.8%), fine aggregates (12.9%), unprocessed rock (10.8%), broken rock (5.3%), sand (0.4%) and gravel (0.1%).

Applying these above per capita assumptions to the population growth scenarios reveals the demand estimates as provide in Figure 4.7 below. The medium population growth scenario is used as the central scenario upon which reporting is focused, with a low population growth with low per capita demand and high population growth and high per capita demand also reported to provide an indication of the potential lower and upper bounds. It is important to note that these projections represent anticipated average annual demand; however, demand is likely to fluctuate year to year particularly in line with major projects/ industry demand.

Under the central scenario, the demand projections suggest the Catchment is anticipated to record demand for between approximately 0.9 Mt of quarried material (medium population growth, low per capita) and 1.1 Mt (medium,

high) in 2021 increasing to between approximately 1.2 Mt (medium, low) and 1.5 Mt (medium, high) by 2041. Under the low assumptions for both population growth and per capita demand, the Catchment is anticipated to record demand of approximately 0.9 Mt in 2021 increasing to approximately 1.1 Mt by 2041. Under the high assumptions, the Catchment is anticipated to record demand of approximately 1.1 Mt in 2021 increasing to 1.8 Mt by 2041.

Figure 4.7. Catchment Demand Projections



Source: Queensland Government (2020a), ABS (2021a, 2021b), AEC, QGSO (2018).

The above demand projections assume an average annual rate of demand each year based on historical estimates and does not consider industry activity or specific major projects which may occur. Nerimbera Quarry itself has a capacity (i.e., the upper limit of production) to produce up to 1.2 Mt per annum, which could meet the majority of demand by 2041 itself and if supplemented by the other major and minor quarries in the region could support any further industry activity or specific major projects that may occur (see Appendix A).

Overall, the supply and demand analysis determined that the Nerimbera Quarry is an important supplier of quarry product within the Catchment and is anticipated to continue to be so into the future.

5. NEED FOR THE PROJECT

5.1 STRATEGIC ALIGNMENT

This section assesses the alignment of the Project with current Council, Queensland, and Australian Government policies, strategies, and initiatives. As shown in Table 5.1, the project aligns closely with a wide array of existing strategic planning documents and is of critical importance for a number of these policy goals to be achieved.

Table 5.1. Strategic Alignment by Level of Government

Strategic Document	Policy	Alignment
Livingstone Shire Council		
Livingstone Corporate Plan	The plan outlines several goals for future infrastructure development/ provision, including: • Community Plan Goal 1.2, 1.2.3: Plan, design and delivery community infrastructure which connects communities and encourages non-vehicular transport. • Community Plan Goal 2.3, 2.3.2: Council provides and maintains infrastructure which encourages business and tourism growth. The above infrastructure goals will require adequate extractive resources to support construction.	The Project supports the goals of the plan through providing extractive materials for use in infrastructure development.
Rockhampton Regional Council		
Rockhampton Corporate Plan	The plan outlines several infrastructure related outcomes to aim for over the 2017-2022 period, including: • Provision of safe, accessible, reliable, and sustainable infrastructure and facilities. • Infrastructure services are driven to deliver future economic growth. To be achieved, the above infrastructure outcomes will require adequate extractive resources to support construction.	The Project supports the goals of the plan through providing extractive materials for use in infrastructure development.
Queensland Government		
Queensland Resource Industry Development Plan	The plan provides coordination direction to achieve growth across the Queensland resources sector. The plan outlines several actions/ strategies related to the extractive industry, including the development of a fit-for-purpose framework for extractive industry assessment to balance the impacts of extractive industries with needs for construction materials to support infrastructure priorities.	The Project supports the goals of the plan through providing extractive materials for use in infrastructure development. The Project is located within a KRA, ensuring the extractive resource is protected.
State Infrastructure Strategy	The strategy presents a vision for infrastructure requirements and development over the next two decades. There are four key objectives the infrastructure plan aims to achieve: • Encourage jobs, growth, and productivity • Development regions, places, and precincts • Enhance sustainability and resilience • Adopt smarter approaches. Furthermore, there are five key infrastructure focus areas for the medium-term: • Renewable energy superpower • Connecting our regions • Creating liveable communities • Building a 2032 Games legacy • Driving infrastructure performance.	The Project supports the key focus areas of the strategy through extending the retention of jobs and economic activity within the region and providing supply of key materials required for infrastructure development.

Strategic Document	Policy	Alignment
State Planning Policy – Mining and Extractive Resources	For extractive resources, the policy first requires that KRAs are identified and then protected by ensuring that: • Development within a KRA is compatible with the use of land in a KRA for an extractive industry. • Appropriate separation distances between the resource/ processing area/ transport route of the KRA to minimise land use conflicts with extractive industry. Proposed development in or surrounding the KRA that is contrary to achieving these two policy outcomes must demonstrate an overriding community benefit and that the development cannot be reasonably located elsewhere.	The Project supports the State Planning Policy through the extension of extractive industry operations on a site within a KRA and, therefore, dedicated to and protected for extractive industry.
Central Queensland Regional Plan	The Central Queensland Regional Plan (2013) outlines the maximisation of the productive use of key resources (including rock, sand, gravel, mineral, coal, petroleum, and gas) and co-existence with agricultural land use as a key priority for the region.	Given the need to access extractive resources close to markets, the sector creates relatively fewer instances of land use conflict with the agricultural industry. The Project supports the maximisation of the productive use of quarry resources whilst not impacting upon agricultural lands.
Australian Government		
National Resources Policy Framework	The framework aims to achieve five key goals: • Delivery of the most globally attractive and competitive investment destination for resources projects • Development of new resources, industries, and markets • Investment in new technologies and approaches • Creation of well-paid, secure jobs • Support for communities to ensure they receive benefits from the development of Australian resources. The framework builds upon and incorporates the recommendations within the following other strategies: • Australia's Critical Minerals Strategy • Australia's National Hydrogen Strategy • Australia's National Resources Workforce Strategy • Australia's Global Resources Strategy.	The Project supports the key focus areas of the framework through extending the retention of jobs and economic activity within the region and providing supply of key materials required for infrastructure development top ensure the community benefits from Australian resources.

Source: Department of State Development, Infrastructure and Planning (2015), Department of Infrastructure, Local Government and Planning (2017b), Queensland Government (2009), Livingstone Shire Council (2020), Rockhampton Regional Council (2017), Queensland Government (2021c), Department of Resources (2021), Department of Industry, Science, Energy and Resources (2021).

5.2 COMMUNITY/ BUSINESS NEED & CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

This section highlights the need for the project from the local community and business perspective as well as the associated consequences of not proceeding with the Project. The need for further extractive industry activity within the Catchment from the community and businesses largely arises due to the following reasons:

- **Current and future population growth will continue to require increasing infrastructure development:** The Catchment's population is anticipated to grow by 1.3% per annum on average over two decades to 2041. This will require continued infrastructure investment to ensure population serving infrastructure (such as roads, bridges, highways, healthcare, retail, education, etc.) is meeting the level of anticipated demand. This will place significant pressure on demand for extractive resources within the Catchment if the Project does not proceed, with Nerimbera Quarry currently supplying up to half of inferred population driven demand.

- **Up-coming committed and planned major infrastructure projects will require local supply of material:** The quarried materials supplied by Nerimbera Quarry will also support development of a range of infrastructure projects occurring or planned within the Catchment (see Appendix A). Other major projects outside of the Catchment that are likely to impact upon demand for quarries more regionally include Rookwood Weir, Bowen, and Galilee Basin Coal projects, and that related to the 2032 Olympics.
- **Timely and affordable materials are required for infrastructure development:** Without Nerimbera Quarry, while it is still expected the projects outlined in Appendix A would still proceed, it may reasonably be expected that unless other quarries are developed elsewhere in the Catchment the supply of materials may be sourced from further afield at potentially a greater cost and with higher time requirements.
- **Downstream industries and plants are reliant on continued operations of local extractive industries:** Without the Project, future demand for quarried materials may require supply from outside the Catchment and further afield, which may place increased cost pressures on input costs for these customers due to longer transport distances. To this end the Project can be seen as important for the longer-term security of supply of domestic production, while also supporting transport and logistics business for the transport of products to customers.

Historically (over the past five years), the Nerimbera Quarry has generated product catering for approximately 50% of inferred demand estimates for the Catchment, highlighting the importance of Nerimbera Quarry as a local supplier for hard rock quarried products.

Demand in the Catchment is projected to grow over the next 20 years to between 1.13 Mt and 1.85 Mt per annum on average by 2041, which could fluctuate to higher levels on a year-to-year basis depending on when specific major projects may occur. Nerimbera Quarry itself has a capacity (i.e., the upper limit of production) to produce up to 1.2 Mt per annum, which could meet the majority of demand by 2041 itself and if supplemented by the other major and minor quarries in the region could support any further industry activity or specific major projects that may occur (see Appendix A).

With no quarries currently identified as proposed for extension or development within the Catchment, coupled with Peak Hill anticipated to cease operations by 2035, this indicates that without extension of the Nerimbera Quarry there will be a considerable shortage in the local market to support infrastructure projects moving forward. Given the significant existing market share of Nerimbera Quarry, the extension of operations can be anticipated to assist in moderating any potential price increases that may otherwise result from demand outpacing supply. The Catchment is highly reliant on Nerimbera Quarry as a primary supplier of high-quality hard rock quarried material and this is anticipated to continue into the future.

6. ECONOMIC IMPACT ASSESSMENT

6.1 APPROACH

Economic modelling in this section estimates the economic activity supported by the construction activity related to the Project, as well as economic activity supported post construction (during operations). Economic modelling has been undertaken for the entire construction phase and on an average annual basis for the operations phase.

Input-Output modelling is used to examine the direct and flow-on[2] activity expected to be supported within the Catchment's economy. A description of the Input-Output modelling framework used is provided in Appendix B.

Input-output modelling describes economic activity by examining four types of impacts:

- **Output**: Refers to the gross value of goods and services transacted, including the costs of goods and services used in the development and provision of the final product. Output typically overstates the economic impacts as it counts all goods and services used in one stage of production as an input to later stages of production, hence counting their contribution more than once.
- **Gross product**: Refers to the value of output after deducting the cost of goods and services inputs in the production process. Gross product (e.g., Gross Regional Product (GRP)) defines a true net economic contribution and is subsequently the preferred measure for assessing economic impacts.
- **Income**: Measures the level of wages and salaries paid to employees of the industry under consideration and to other industries benefiting from the project.
- **Employment**: Refers to the part-time and full-time employment positions generated by the economic stimulus, both directly and indirectly through flow-on activity, expressed in full time equivalent (FTE) positions[3].

The following assumptions have been used in assessing the construction and operations phase impacts of the project.

6.1.1 Construction Phase

As discussed in Section 2.2.2, there is no defined construction phase of the Project, as the development into the extension area will essentially occur while quarry operations are ongoing. There are, however, some preliminary construction works as well as capital replacement of existing infrastructure required, assumed to total approximately $13.5 million (excluding spend that has already occurred). The proponent has advised the following breakdown by component, which has been applied to the assumed total remaining cost of $13.5 million and disaggregated into relevant industries represented in the Input-Output model (based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) categories). A summary broken down by relevant industry is outlined in the table below.

Table 6.1. Construction Cost by Industry ($M) [(a)]

Component	IO Industry	Share (%)	Spend ($M)
Engineering & Project Management	Professional, Scientific and Technical Services	10.0%	$1.4
Equipment	Specialised and other Machinery and Equipment Manufacturing	10.0%	$1.4
Steel Work	Iron and Steel Manufacturing	30.0%	$4.1
Civil Work, Site Installation	Heavy and Civil Engineering Construction	20.0%	$2.7
Civil Work, Site Installation	Construction Services	10.0%	$1.4
Electrical Works	Construction Services	20.0%	$2.7
Total	**-**	**100.0%**	**$13.5**

Note: (a) Items may not sum to the total due to rounding.
Source: AEC, AECOM (unpublished), Holcim (unpublished).

[2] Both Type I and Type II flow-on impacts have been presented in this report. Refer to Appendix B for a description of each type of flow-on impact.
[3] Where one FTE is equivalent to one person working full time for a period of one year.

Only the construction activity expected to be undertaken within the Catchment's economy has been included in the economic impact assessment. For the purposes of this assessment, it was assumed:

- Approximately 25.0% of professional, scientific, and technical services is assumed to occur within the Catchment (through the placement of a Project Manager on-site during the replacement of plant), though all will be sourced from outside the Catchment (primarily from Brisbane).
- All heavy and civil engineering construction related to construction activity will be undertaken and sourced from within the Catchment.
- All construction services relating to civil works and site installation will be undertaken and sourced from within the Catchment, whilst 90.0% of construction services relating to electrical works will be sourced from within the Catchment.
- Approximately 50% of specialised and other machinery and equipment manufacturing will be undertaken and sourced from within the Catchment.
- All iron and steel manufacturing related to construction activity will be undertaken and sourced from outside the Catchment, likely from an overseas contractor.

6.1.2 Operations Phase

Due to the commercially sensitive nature of the operations data provided by the proponent for the Project, as well as acknowledging that production can vary year to year, the following production scenarios have been modelled:

- **Scenario 1:** Production of 0.4 Mt per annum
- **Scenario 2:** Production of 0.8 Mt per annum
- **Scenario 3:** Production of 1.2 Mt per annum (the maximum).

It is important to note that these scenarios provide an indication of what operations could look like on an average annual basis, however, are likely to fluctuate year to year with major projects and industry activity.

As discussed in Section 2.2.3, revenues, production levels, and operating costs were provided by the proponent, however, are not presented in this report due to the commercially sensitive nature of the information. Revenue associated with each production level was based on revenue per tonne of production historically. Operating expenditure and labour associated with each production level was provided by the proponent, assuming a 20.0% increase in operating labour and operating expenses on Scenario 1 for Scenario 2, and a further 20.0% increase on Scenario 2 for Scenario 3. It was also assumed that 85.0% of goods and services and labour is sourced from within the Catchment, with repairs/ maintenance, fuel and tyres mainly sourced from outside of the Catchment.

Estimates of flow-on activity in the Catchment's economy have been modelled based on the operating expenditure provided by the proponent, allocated to the sector of Non-Metallic Mineral Mining in the Input-Output model, with direct operational activity based on the estimated/ assumed revenue, operating costs, employment, and incomes associated with each level of production.

6.2 ECONOMIC IMPACT ASSESSMENT

6.2.1 Construction Phase

The economic impact of the construction and capital replacement works for the Project to the Catchment's economy is presented in Table 6.2. Input-Output modelling indicates the Project is anticipated to support an estimated 32 full time equivalent (FTE) jobs in the Catchment, comprised of 18 FTE jobs through initial activity, as well as 15 FTE jobs supported through flow-on activity. Jobs supported by the project are estimated to pay $3.3 million in wages and salaries, including initial and flow-on jobs. The Project is estimated to produce $4.7 million in Gross Regional Product (GRP), including $2.7 million in GRP through initial activity and $2.0 million through flow-on activity. These results represent the economic impact of the project within the Catchment.

Table 6.2. Aggregate Economic Impact of Project, Construction Phase, Catchment

Impact	GRP ($M)	Incomes ($M)	Employment (FTEs)
Direct Activity			
Initial Stimulus in Local Economy	$2.7	$2.0	18
Flow On Activity			
Direct Requirements Impacts	$0.7	$0.5	6
Industry Support Impacts	$0.3	$0.2	2
Household Consumption Impacts	$1.0	$0.5	7
Total Impacts in Local Economy	**$4.7**	**$3.3**	**32**

Note: Totals may not sum due to rounding.
Source: AEC.

6.2.2 Operations Phase

The average annual economic impact of the Project to the Catchment's economy under each of the three scenarios assessed is presented in Table 6.3. Input-Output modelling indicates operations of the Project could support the following impacts:

- An estimated 39 full time equivalent (FTE) jobs in the Catchment per annum under Scenario 1, 47 FTEs under Scenario 2, and 56 FTEs under Scenario 3 (including through initial and flow-on activity).
- Jobs supported by operations of the Project are estimated to pay $2.1 million in wages and salaries annually under Scenario 1, $2.5 million under Scenario 2, and $3.0 million under Scenario 3 (including through initial and flow-on activity).
- Approximately $6.1 million in GRP per annum in the Catchment's economy under Scenario 1, $14.4 million under Scenario 2, and $22.5 million under Scenario 3 (including through initial and flow-on activity).

These results represent the average annual economic impact of the operations of the Project within the Catchment each year under each of the specified scenarios in Section 6.1.2, though are likely to fluctuate in line with major projects occurring within the Catchment.

Table 6.3. Average Annual Economic Impact of Project, Operations Phase, Catchment

Impact	GRP ($M)	Incomes ($M)	Employment (FTEs)
Scenario 1 (production = 0.4 Mt per annum)			
Direct Activity			
Initial Stimulus in Local Economy	$5.3	$1.7	34
Flow On Activity			
Direct Requirements Impacts	$0.1	$0.1	1
Industry Support Impacts	$0.0	$0.0	0
Household Consumption Impacts	$0.6	$0.3	4
Total Impacts in Local Economy	**$6.1**	**$2.1**	**39**
Scenario 2 (production = 0.8 Mt per annum)			
Direct Activity			
Initial Stimulus in Local Economy	$13.4	$2.0	41
Flow On Activity			
Direct Requirements Impacts	$0.2	$0.1	1
Industry Support Impacts	$0.0	$0.0	0
Household Consumption Impacts	$0.7	$0.4	5
Total Impacts in Local Economy	**$14.4**	**$2.5**	**47**
Scenario 3 (production = 1.2 Mt per annum)			
Direct Activity			
Initial Stimulus in Local Economy	$21.4	$2.4	48
Flow On Activity			
Direct Requirements Impacts	$0.2	$0.1	1
Industry Support Impacts	$0.1	$0.0	0
Household Consumption Impacts	$0.9	$0.5	6
Total Impacts in Local Economy	**$22.5**	**$3.0**	**56**

Note: Totals may not sum due to rounding. See Appendix A for definitions of Type I and Type II flow-on impacts.
Source: AEC.

6.3 OTHER IMPACTS NOT MODELLED

Other key beneficial impacts of the Project within the Catchment includes the following:

- **Support for development of infrastructure to support population and economic growth:** With population growth anticipated to strengthen over the two decades to 2041, and various major infrastructure projects planned for the region, the Project will provide high quality products for the significant anticipated demand from the local construction, mining, and transport sectors. Nerimbera Quarry is anticipated to continue to supply major transport projects and other key local projects such as local marinas, asphalt manufacturers, concrete suppliers, rail ballast, Department of Transport and Main Roads and local Council Road repairs/ maintenance.
- **Support for supply chain businesses:** The Project will extend quarrying and processing activities in the Catchment and thereby support and create opportunities for suppliers in the Catchment and Queensland, providing additional security and longevity of business incomes (and employment). The Project will also create opportunities to secure new contracts and increase sales to supply and service the needs of the Project through flow-on impacts in the supply chain, during all phases of the Project.
- **Government revenues:** The Project will provide a lift in Australian, State and Local government taxation revenues through a variety of taxes and duties. These additional revenues can be used by government to provide additional infrastructure and services to support business and households throughout Australia.'
- **Enhanced competition resulting in lower cost of supply of quarried materials:** The Project will contribute to the ongoing supply of materials for the Catchment and broader Queensland region. This continued availability of supply, coupled with the reduced requirements for imported quarried materials due to local availability, will likely result in lower costs of products for businesses and infrastructure projects than if the Project were not to proceed.

7. CONCLUSION

Nerimbera Quarry is a major contributor to extractive material supply and economic development in the Livingstone and Rockhampton areas (i.e., the Catchment), providing:

- **Security and longevity of supply:** Historically (over the past five years), the Nerimbera Quarry has generated product catering to up to almost 50.0% of inferred demand estimates for the Catchment. The other two major hard rock quarries operating within the Catchment (Peak Hill and Quarry at Midgee) likely generate production for the majority of the remaining 50.0%, supplemented by the other 12 minor hard rock quarries. Notably, Peak Hill is not considered a major competitor of Nerimbera Quarry, with Nerimbera Quarry offering higher grade products. With no quarries currently identified as proposed for extension or development within the Catchment, coupled with Peak Hill ceasing operations by 2035, this indicates the Catchment will continue to be reliant on Nerimbera Quarry as the primary supplier into the future. Potential alternative or substitute materials for hard rock quarry product have not been identified as having a major impact on competition in the future, with limited identified production/ use of these materials within the Catchment.
- **High quality products for the local construction, mining, and transport sectors:** Population growth, economic growth and specific major projects will continue to drive demand for quarry product into the future. Population driven demand for quarry product is estimated to require between approximately 1.2 Mt and 1.5 Mt by 2041, under the central population growth scenario. This assumes an average annual rate of demand each year based on historical estimates and does not consider industry activity or specific major projects which are scheduled to or may occur. Nerimbera Quarry itself has a capacity (i.e., the upper limit of production) to produce up to 1.2 Mt per annum, which could supply to meet the majority of demand by 2041 itself and, if supplemented by the other major and minor quarries in the region, could support any further industry activity or specific major projects that may occur.
- **Lower costs than would be achieved via the import of similar materials:** Given the significant existing market share of Nerimbera Quarry, the extension of operations may assist in moderating any price increases resulting from demand outpacing supply. This increased availability of supply, coupled with the reduced requirements for imported quarried materials due to local availability, will likely result in lower costs of products for businesses and infrastructure projects.
- **Continuation of local economic activity and employment opportunities generated through the quarry:** The Project is anticipated to result in activity relating to construction and capital replacement in the order of $4.7 million in GRP, $3.3 million in incomes, and 32 FTEs (through both initial and flow-on activity). The Project is also anticipated to result in activity relating to ongoing operations, which was assessed for three production scenarios, namely Scenario 1 (0.4 Mt per annum), Scenario 2 (0.8 Mt per annum), and Scenario 3 (1.2 Mt per annum). These scenarios indicate the Project could support between $6.1 million and $22.5 million in GRP, between $2.1 million and $3.0 million in incomes, and between 39 FTEs and 56 FTEs.
- **Support for local supply chain businesses:** The Project will extend quarrying and processing activities in the Catchment and thereby support and create opportunities for suppliers in the Catchment and Queensland, providing additional security and longevity of business incomes (and employment). The Project will also create opportunities to secure new contracts and increase sales to supply and service the needs of the Project through flow-on impacts in the supply chain, during all phases of the Project.
- **Greater government taxation revenues through a variety of taxes and duties:** The Project will provide a lift in federal, state, and local government taxation revenues through a variety of taxes and duties. These additional revenues can be used by government to provide additional infrastructure and services to support business and households throughout Australia.
- **Support for local, regional, state, and national economic development, industry, and community strategies:** The Project aligns closely with a wide array of existing strategic planning documents and is of critical importance for a number of these policy goals to be achieved.

Overall, by extending the operational life of Nerimbera Quarry, the Project represents sustainable local economic development due to the quarry's important role in the economy as a supplier to key sectors, as well as its role in ensuring the viability for other businesses and major projects.

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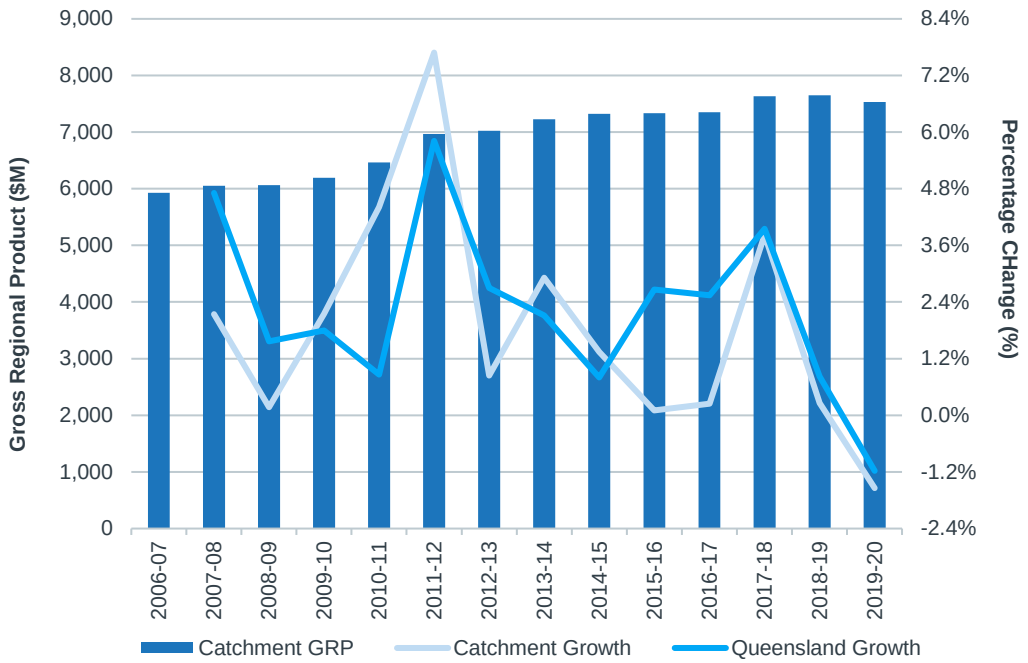
APPENDIX A: REGIONAL OVERVIEW DETAIL

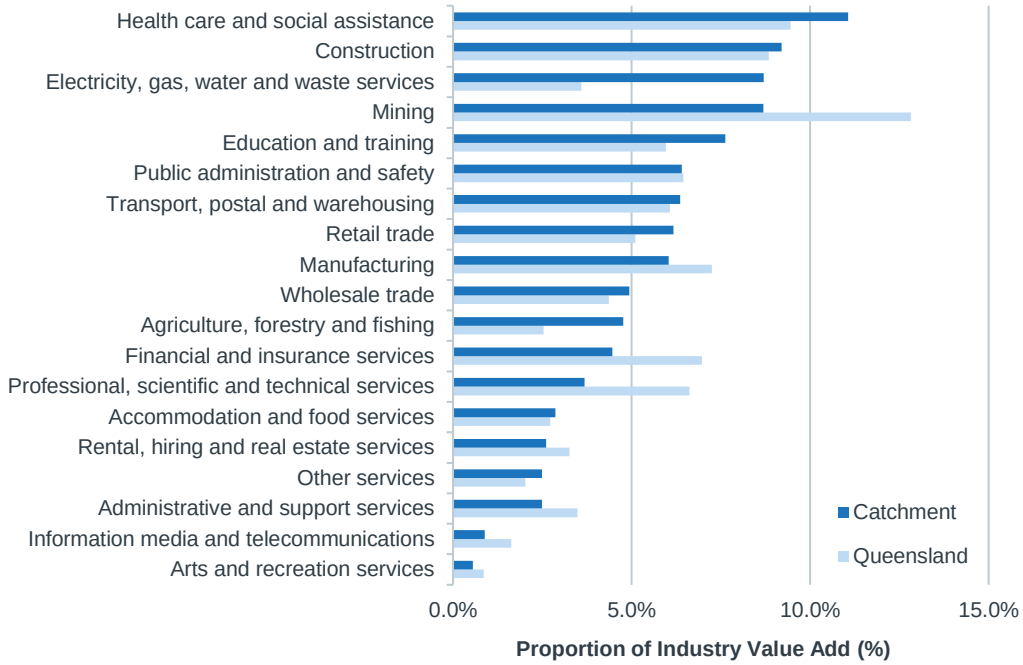
INDUSTRY ACTIVITY

Figure A. 1. Gross Regional Product, 2006-07 to 2019-20



Source: AEC (unpublished a)

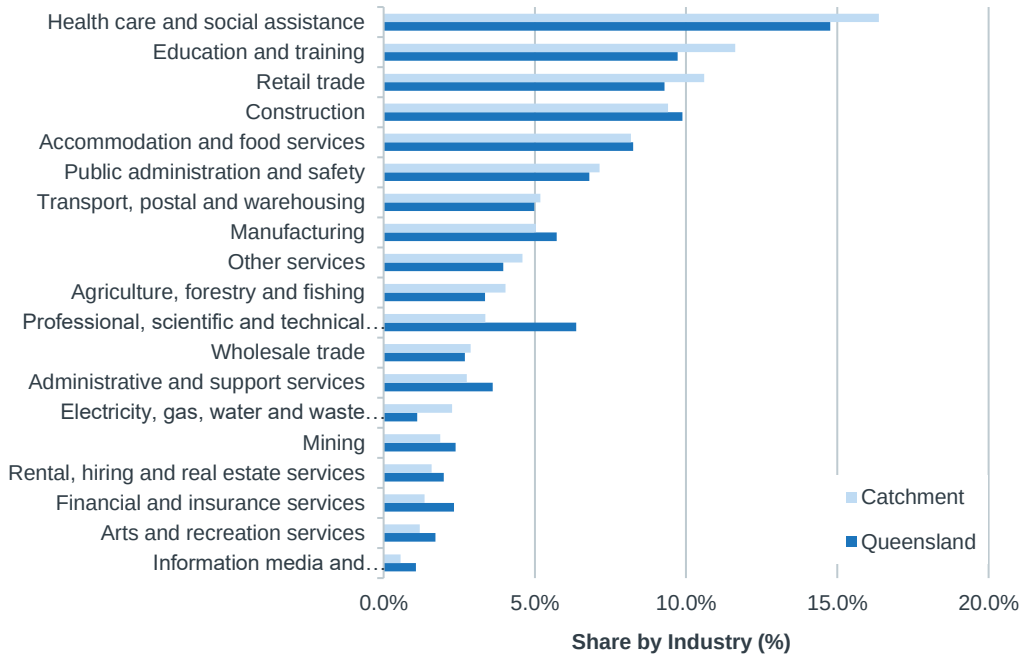
Figure A. 2. Industry Value Add by Industry, 2019-20



Source: AEC (unpublished a)

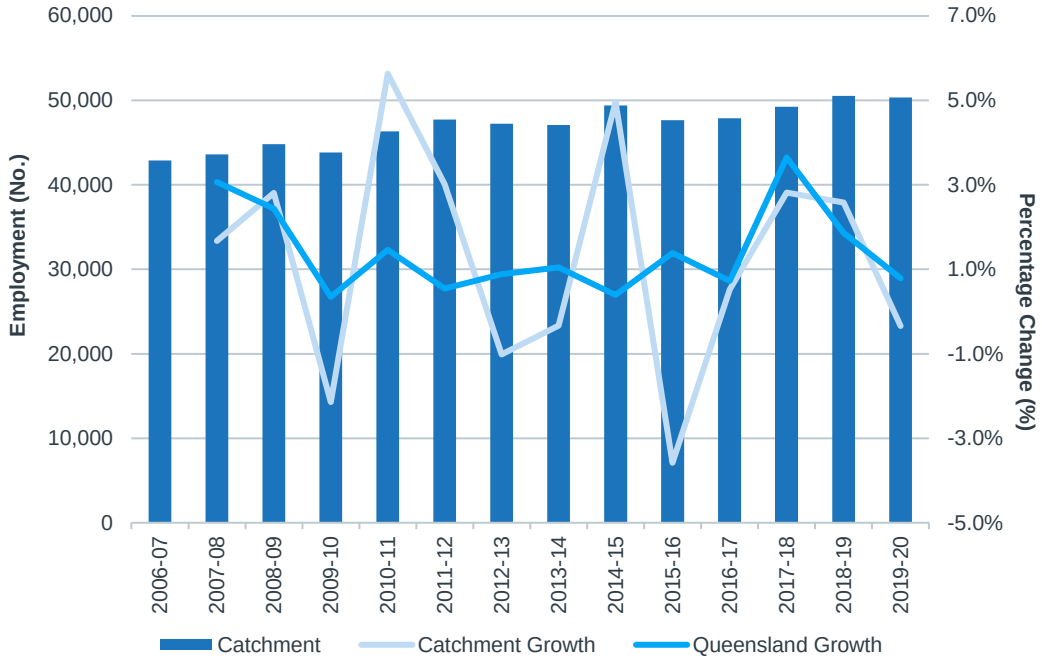
LABOUR FORCE

Figure A. 3. Employment by Industry, Catchment, PoW 2019-20



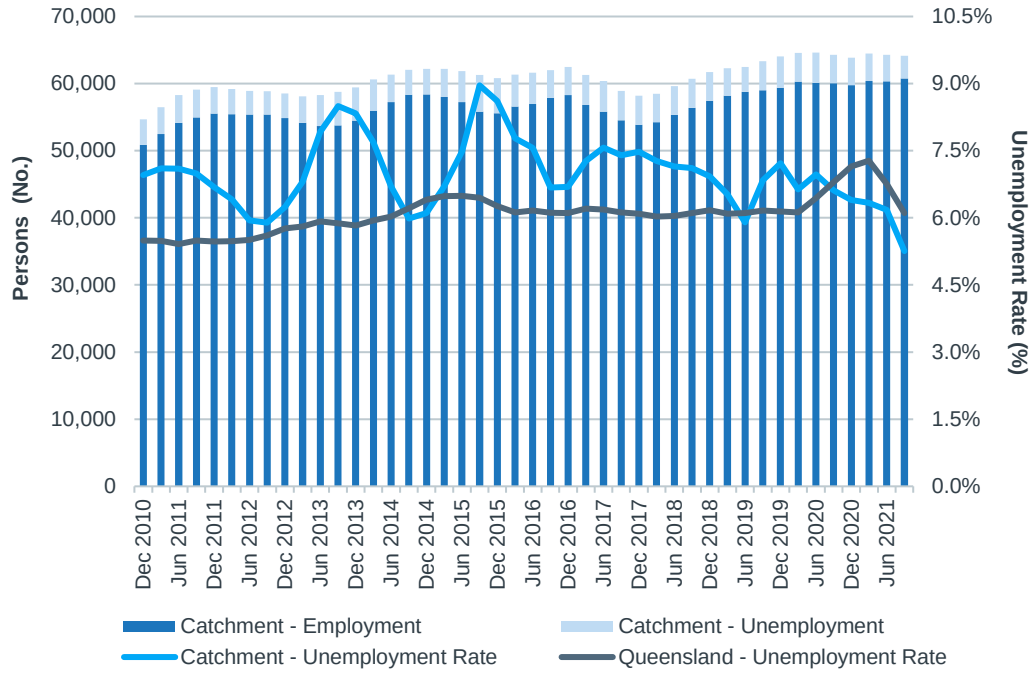
Source: ABS (2012), ABS (2017)

Figure A. 4. Employment by PoW, 2006-07 to 2019-20



AEC (unpublished b).

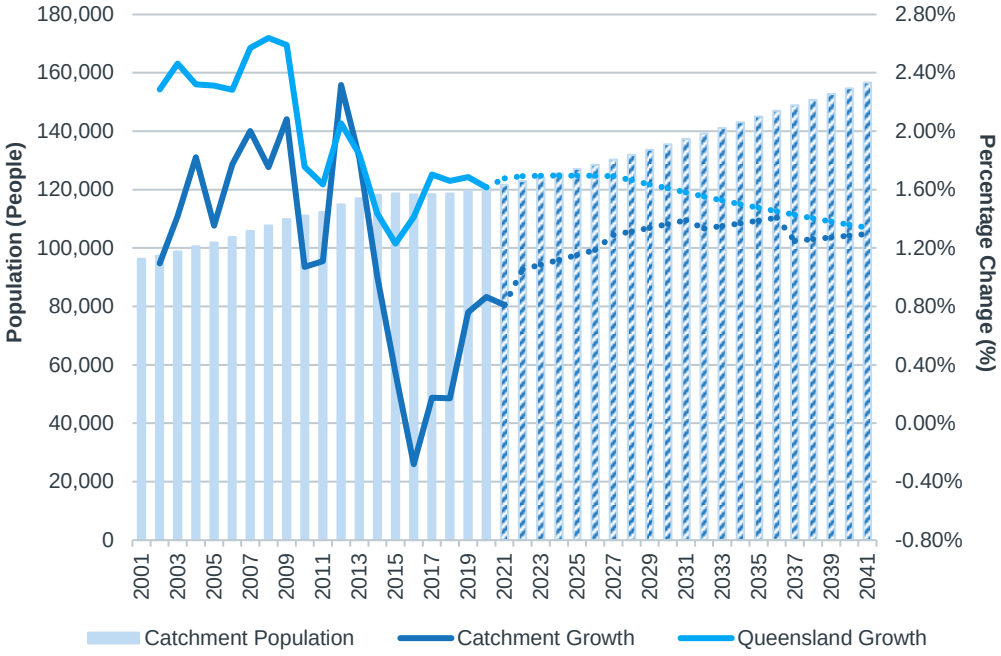
Figure A. 5 Unemployment and Labour Force, 2010 to 2021



Source: DoESE (2022)

POPULATION

Figure A. 6. Historical and Projected Population (Medium Growth Scenario), 2001 to 2041



Source: ABS (2021a, 2021b), AEC, QGSO (2018).

BUILDING APPROVALS

Table A. 1. Residential Building Approvals, Values ($000s) and Volumes (No.)

Financial Year	Catchment	Queensland
Value		
2012-13	$263,707	$8,779,993
2013-14	$180,918	$11,039,799
2014-15	$159,370	$13,074,881
2015-16	$153,608	$15,026,871
2016-17	$143,890	$14,017,421
2017-18	$121,656	$13,920,857
2018-19	$104,958	$11,876,597
2019-20	$153,371	$11,145,092
2020-21	$323,578	$16,040,409
Average Annual Growth (2012-13 to 2020-21)	**2.6%**	**7.8%**
Number		
2012-13	900	30,702
2013-14	609	39,259
2014-15	530	46,689
2015-16	450	50,721
2016-17	487	43,217
2017-18	372	43,167
2018-19	268	33,292
2019-20	356	30,206
2020-21	512	41,928
Average Annual Growth (2012-13 to 2019-20)	**-6.8%**	**4.0%**

Source: ABS (2021f).

Table A. 2. Non-Residential Building Approvals, Values ($000s)

Financial Year	Catchment	Queensland
2012-13	$185,361	$8,572,042
2013-14	$54,138	$6,475,428
2014-15	$95,993	$6,072,864
2015-16	$87,531	$7,334,251
2016-17	$64,652	$8,147,859
2017-18	$414,358	$7,409,745
2018-19	$95,905	$8,433,562
2019-20	$98,485	$9,089,842
2020-21	$114,241	$7,812,075
Average Annual Growth (2012-13 to 2020-21)	**-5.9%**	**-1.2%**

Source: ABS (2021f).

MAJOR PROJECTS

The following table presents a list of identified existing projects and future projects proposed to be carried out within the Catchment, which may provide demand for quarried material.

Table A. 3. Major Projects, Catchment

Project	Description	Cost ($M)	Phase/ Timing
Transport			
Bruce Highway – Rockhampton Ring Road	The new 14.7-kilometre ring road will be delivered with a total of 17.4 kilometres of new road constructed. The ring road will link the Bruce Highway through Rockhampton extending from the Capricorn Highway (Nelson Street) to the Rockhampton-Yeppoon Road/ Bruce Highway intersection, including a new crossing over Fitzroy river.	$1,100.0	Commencing in 2021-22 with the majority of works occurring between 2022-23 and 2024-25, before finishing in 2025-26.
Rockhampton – Yeppoon Road, Yeppoon Road Upgrade	Three sections of the Rockhampton – Yeppoon Road, approximately 35.6 kilometres in length), will be upgraded, including: • Artillery Road/ Dairy Inn Road intersection with Yeppoon Road • Iron Pot Road east to Artillery Road/ Dairy Inn Road intersection • Artillery/ Dairy Inn Road towards Hedlow Creek	$80.0	2021-22 to 2024-25 and beyond
Stanage Bay Road	Upgrades to the key road corridor are required to support efficient heavy vehicle movements and improved connectivity within the region. Completion of the upgrade will provide a fit for purpose road corridor, appropriate for the scale and volume of vehicles (particularly military and associated heavy transport vehicles) that are currently using the Council maintained road.	$21.6	2020-21 to 2023-24
Matthew Flinders Drive (Stage 2)	The project includes renewal of the road pavement and upgrade to stormwater pipes, pits, kerbs, and channels.	$1.7	2021-22
Bruce Highway (Rockhampton – St Lawrence), Neilsen Avenue to Plentiful Creek, safety improvements	Safety improvements, including a wide centre line treatment, shoulder widening and removal of hazards. The project is being delivered in three packages.	$32.3	2022
Gavial – Gracemere Road (Lawrie Street)	Construction will upgrade the street from two to four lanes.	$35.0	2022
Taranganba Road and Carige Boulevard Intersection Upgrade	This will provide traffic improvements adjacent to the Taranganba State School by means of construction of a roundabout at the intersection.	$0.8	2021-22
Queen Street Upgrade	Reconstruction of the street between two recently constructed roundabouts adjacent to St Ursula's High School.	$1.0	2021-22
Werribee Creek Timber Bridge Replacement	The project involves the design and construction of a new concrete bridge to replace the existing timber bridge on Werribee Road, Canal Creek. The existing timber bridge has reached the end of its serviceable design life, with load restrictions put in place until the new structure is built.	$0.6	2022
Rockhampton Airport Masterplan	The masterplan delivers a roadmap for development of the entire site over the next 20 years. The phases of the masterplan are as follows: • Phase 1: Reconfiguration of the passenger terminal, development of FIFO processing facility, initial relocation of the BOM's MET equipment, flood mitigation projects, creation of the military precinct.	Unknown	Phase 1: 2017 to 2022 Phase 2: 2022 to 2027 Phase 3: 2027 to 2032 Phase 4: 2032 to 2037

Project	Description	Cost ($M)	Phase/ Timing
	• Phase 2: Completion of relocation of MET equipment. • Phase 3: Development of an additional aircraft parking stand. • Phase 4: Initial preparation for expansion of the passenger terminal building. • Market Driven Activities: creation of additional GA Lease Lots to keep pace with demand, and development of a new cargo precinct in response to demand.		
Defence			
Singapore Force Posture Initiatives – Shoalwater Bay / Singapore Force Posture Initiatives – Shoalwater Bay / Shoalwater Bay – Remediation	The initiative will see increased investment and development of Australia's military training areas to meet the needs of the Australian Defence Force and facilitate and increased presence of Singapore Armed Forces personnel training in Australia. The existing Shoalwater Bay Training Area will be expanded, and a new training area is being established near Greenvale. The remediation project will provide critical infrastructure upgrades to support joint and multinational training activities for the military. The project includes a new 1,000 troop urban operations training facility, field hospital site and military campsite, along with upgrades and remediation to an airfield, internal roads, creek crossings and beach landing sites.	$1,100.0 $135.0	2021-22
Renewable Energy			
Bouldercombe Solar Farm	The Bouldercombe Solar Farm will have capacity of 200MW, involving the placement of a series of solar panels across the site, as well as two transformers and a site office.	$240.0	2022-23 to 2023-24
Boulder Creek Wind Farm	The project will involve the installation of up to 60 wind turbines and associated infrastructure.		Commencing end of 2022, with a construction period of 18-24 months
Clarke Creek Wind and Solar Farm	This project includes up to 195 turbines, 200MW to 400MW of solar power and battery energy storage facilities. Once operational, the project will power approximately 590,000 Queensland homes.	$1,500.0	2019 to 2022
Resources			
Central Queensland Coal Project (Styx)	The project, if approved, would produce up to 10 million tonnes per annum of semi-soft coking coal and high-grade thermal coal from an open-cut mine for 18 years.	$300.0	2022-23 to 2023-24
Stanwell Power Station overhauls and other sustaining projects	The project will involve the replacement and refurbishment of existing infrastructure to ensure the continued reliability of electricity supply to the Queensland and National markets.	$74.4	2021-22
Waste and Water			
Glenmore Water Treatment Plant Upgrade	The upgrade incorporates a range of electrical, mechanical, building, and structural works to renew and/ or upgrade parts of the plant. This will refurbish the plant, improve reliability, and extend the life for another 30 to 40 years.	$17.1	2023
Livingstone Resource Recovery Centre	This project will involve the establishment of a resource recovery centre as part of the Yeppoon landfill site, providing bays for customers to	$3.0	2021-22 to 2022-23

Project	Description	Cost ($M)	Phase/ Timing
	separate waste and increase recovery of recyclables.		
Emu Park Reservoir	The project involves the construction of a portable water supply system, to reduce water supply shortages, particularly during droughts and fires.	$2.5	2021-22
Mt Charlton Reservoir Refurbishment	The project involves the remediation of the reservoir, including removal of existing stairs and replacement with new compliant stairs, new entry door, internal and external crack repair, and leak sealing.	$1.4	2022

Source: QMCA (2021), Livingstone Shire Council (2022a), Rockhampton Regional Council (2022). Department of Transport and Main Roads (2022b), Downer Group (2020), Livingstone Shire Council (2022b), Epuron (2021), Queensland Government (2021a), Queensland Government (2021b).

Other major projects outside of the catchment that are likely to impact upon demand for quarries more regionally include:

- **Rookwood Weir:** This is a $367 million water storage project, which will create considerable water securing and generate extensive agricultural development (Department of Regional Development, Manufacturing and Water, 2021). The project will involve the construction of a weir as well as enabling works that will upgrade existing infrastructure to support both the construction of the weir and its operations (upgrading and widening of roads, installation of intersections, building of bridges/ crossings). There is anticipated to be significant demand for quarry materials, plant and equipment hire and fencing during construction form the broader Fitzroy region. The project is expected to be commissioned and operational in 2023.
- **Bowen and Galilee Basin Coal:** Rockhampton is strategically located as a services Hub for the mines of the Bowen and Galilee Basins, with over 45 coal mines operating and a number of mines currently awaiting approval. The Adani Carmichael mine and rail project is anticipated to source demand for quarry product from the broader Fitzroy region (including the catchment) (Rockhampton Regional Council, 2021).
- **Olympics 2032:** Rockhampton is well placed to host a number of events for the 2032 Olympic Games, with existing world class facilities/ natural assets such as the Fitzroy River for rowing, Kalka Shades hockey field, and Mt Archer and Mt Morgan for mountain biking. It is estimates approximately 16% of venues associated with the 2032 Olympic Games will be new, whilst 84% will be venues that are already built but require refurbishment or upgrades. This is likely to increase demand for quarry products for Olympic infrastructure as well as associated transport infrastructure upgrades.

APPENDIX B: INPUT-OUTPUT METHODOLOGY

Input-Output analysis demonstrates inter-industry relationships in an economy, depicting how the output of one industry is purchased by other industries, households, the government and external parties (i.e. exports), as well as expenditure on other factors of production such as labour, capital and imports. Input-Output analysis shows the direct and indirect (flow-on) effects of one sector on other sectors and the general economy. As such, Input-Output modelling can be used to demonstrate the economic contribution of a sector on the overall economy and how much the economy relies on this sector or to examine a change in final demand of any one sector and the resultant change in activity of its supporting sectors.

The economic contribution can be traced through the economic system via:

- **Initial stimulus (direct) impacts**, which represent the economic activity of the industry directly experiencing the stimulus.
- **Flow-on impacts**, which are disaggregated to:
    - **Production induced effects (type I flow-on)**, which comprise the effects from:
        - Direct expenditure on goods and services by the industry experiencing the stimulus (direct suppliers to the industry), known as the first round or direct requirements effects.
        - The second and subsequent round effects of increased purchases by suppliers in response to increased sales, known as the industry support effects.
    - **Household consumption effects (type II flow-on)**, which represent the consumption induced activity from additional household expenditure on goods and services resulting from additional wages and salaries being paid within the economic system.

These effects can be identified through the examination of four types of impacts:

- **Output**: Refers to the gross value of goods and services transacted, including the costs of goods and services used in the development and provision of the final product. Output typically overstates the economic impacts as it counts all goods and services used in one stage of production as an input to later stages of production, hence counting their contribution more than once.
- **Gross product**: Refers to the value of output after deducting the cost of goods and services inputs in the production process. Gross product (e.g., Gross Regional Product) defines a true net economic contribution and is subsequently the preferred measure for assessing economic impacts.
- **Income**: Measures the level of wages and salaries paid to employees of the industry under consideration and to other industries benefiting from the project.
- **Employment**: Refers to the part-time and full-time employment positions generated by the economic shock, both directly and indirectly through flow-on activity, and is expressed in terms of full time equivalent (FTE) positions.

Input-Output multipliers can be derived from open (Type I) Input-Output models or closed (Type II) models. Open models show the direct effects of spending in a particular industry as well as the indirect or flow-on (industrial support) effects of additional activities undertaken by industries increasing their activity in response to the direct spending.

Closed models re-circulate the labour income earned as a result of the initial spending through other industry and commodity groups to estimate consumption induced effects (or impacts from increased household consumption).

MODEL DEVELOPMENT

Multipliers used in this assessment are derived from sub-regional transaction tables developed specifically for this project. The process of developing a sub-regional transaction table involves developing regional estimates of gross production and purchasing patterns based on a parent table, in this case, the 2018-19 Australian transaction table (ABS, 2021c).

Estimates of gross production (by industry) in the study areas were developed based on the percent contribution to employment (by place of work) of the study areas to the Australian economy (ABS, 2012; ABS, 2017; ABS, 2021d; DoESE, 2021), and applied to Australian gross output identified in the 2018-19 Australian table.

Industry purchasing patterns within the study area were estimated using a Flegg Location Quotient approach, as described in Flegg *et al*. (2021), with a fixed degree of convexity applied to the regional size scalar. Regional final demand estimates (except exports) developed based on the regional inter-industry sales estimated using the Flegg Location Quotient relative to national inter-industry sales and final demand estimates for each industry (noting regional exports are assumed to reflect the remainder of total uses).

Employment estimates were rebased from 2018-19 (as used in the Australian national Input-Output transaction tables) to current year values using the Wage Price Index (ABS, 2021e).

MODELLING ASSUMPTIONS

The key assumptions and limitations of Input-Output analysis include:

- **Lack of supply-side constraints**: The most significant limitation of economic impact analysis using Input-Output multipliers is the implicit assumption that the economy has no supply-side constraints so the supply of each good is perfectly elastic. That is, it is assumed that extra output can be produced in one area without taking resources away from other activities, thus overstating economic impacts. The actual impact is likely to be dependent on the extent to which the economy is operating at or near capacity.
- **Fixed prices**: Constraints on the availability of inputs, such as skilled labour, require prices to act as a rationing device. In assessments using Input-Output multipliers, where factors of production are assumed to be limitless, this rationing response is assumed not to occur. The system is in equilibrium at given prices, and prices are assumed to be unaffected by policy and any crowding out effects are not captured. This is not the case in an economic system subject to external influences.
- **Fixed ratios for intermediate inputs and production (linear production function)**: Economic impact analysis using Input-Output multipliers implicitly assumes that there is a fixed input structure in each industry and fixed ratios for production. That is, the input function is generally assumed linear and homogenous of degree one (which implies constant returns to scale and no substitution between inputs). As such, impact analysis using Input-Output multipliers can be seen to describe average effects, not marginal effects. For example, increased demand for a product is assumed to imply an equal increase in production for that product. In reality, however, it may be more efficient to increase imports or divert some exports to local consumption rather than increasing local production by the full amount. Further, it is assumed each commodity (or group of commodities) is supplied by a single industry or sector of production. This implies there is only one method used to produce each commodity and that each sector has only one primary output.
- **No allowance for economies of scope**: The total effect of carrying on several types of production is the sum of the separate effects. This rules out external economies and diseconomies and is known simply as the “additivity assumption”. This generally does not reflect real world operations.
- **No allowance for purchasers’ marginal responses to change**: Economic impact analysis using multipliers assumes that households consume goods and services in exact proportions to their initial budget shares. For example, the household budget share of some goods might increase as household income increases. This equally applies to industrial consumption of intermediate inputs and factors of production.
- **Absence of budget constraints**: Assessments of economic impacts using multipliers that consider consumption induced effects (type two multipliers) implicitly assume that household and government consumption is not subject to budget constraints.

Despite these limitations, Input-Output techniques provide a solid approach for taking account of the inter-relationships between the various sectors of the economy in the short-term and provide useful insight into the quantum of final demand for goods and services, both directly and indirectly, likely to be generated by a project.

In addition to the general limitations of Input-Output analysis, there are three other factors that need to be considered when assessing the outputs of sub-regional transaction table developed using the above approach, namely:

- It is assumed the sub-region has similar technology and demand/ consumption patterns as the parent (Australia) table (e.g., the ratio of employee compensation to employees for each industry is held constant).
- Intra-regional cross-industry purchasing patterns for a given sector vary from the national tables depending on the prominence of the sector in the regional economy compared to its input sectors. Typically, sectors that are more prominent in the region (compared to the national economy) will be assessed as purchasing a higher proportion of imports from input sectors than at the national level, and vice versa.
- The size of the regional economy is assumed to have an inverse relationship with the requirement to import goods/ services to meet its needs (i.e., the smaller the economy, in general the greater the reliance on imports).

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