TECH PROJECT ECONOMIC IMPACT ASSESSMENT

QUEENSLAND PACIFIC METALS

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EXECUTIVE SUMMARY

BACKGROUND

Queensland Pacific Metals (QPM) is a listed Australian company (ASX: QPM) that is developing a sustainable high-purity critical minerals refinery 45 kilometres (km) south of Townsville. Known as the Townsville Energy Chemicals Hub (TECH) Project (the Project), the refinery will be located within Townsville City Council's Lansdown Eco-Industrial Precinct, near Woodstock.

QPM's TECH Project will position Townsville (and by extension, Queensland and Australia) as a global leader in the carbon negative production of nickel sulphate, cobalt sulphate, high purity alumina (HPA), hematite, magnesia and other co-products.

QPM has in place all major approvals required to begin construction of the TECH Project. An Advanced Feasibility Study has also been completed for Stage 1 of the TECH Project with offtake agreements secured for 100% of nickel and cobalt sales over the life of the TECH Project.

QPM is now in the process of finalising a Bankable Feasibility Study (BFS) and securing the necessary financing for Stage 1 of the TECH Project.

PURPOSE AND APPROACH

This report examines and analyses the expected beneficial and adverse economic impacts of the TECH Project on the Townsville, Northern Queensland, Queensland and Australian economies. The focus of this report is on Stage 1 of the TECH Project and the economic impacts delivered by Stage 1.

The report has been developed as a technical document for use by QPM to support internal decision making and applications for debt financing, including an application to the Northern Australia Infrastructure Facility (NAIF). To this end, in addition to assessing the economic impacts of the TECH Project, a key purpose of this report is to address the need of NAIF for assessment of the public benefit delivered by the TECH Project to northern Australia. Separate, graphically designed documents have also been produced summarising the key findings and analysis from this technical document for use in advocacy work.

Economic modelling using Computable General Equilibrium (CGE) modelling techniques was undertaken to analyse, assess and discuss the economic and public benefit impacts of the Project. The analysis provides interpretation of the modelling outputs in the context of the regional, state and national economies. In assessing the public benefit of the Project, benefits to the proponent have been removed in line with standard assessment guidelines from NAIF.

A cost benefit analysis (CBA) was conducted in line with Queensland and Australian Government guidelines, examining the stream of relevant economic, social and environmental costs and benefits anticipated from the Project to assess the net present value of the Project to the Queensland community.

CONTRIBUTION TO THE ECONOMY

Economic Growth

The Project will contribute to economic growth in the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies through increased industry output and Gross Regional/ State/ Domestic Product (GRP/ GSP/ GDP) during construction and operations, flowing from both direct and flow-on impacts.

In total, between 2023-24 and 2056-57:

- The Local Catchment economy is estimated to record an increase in GRP valued at $6.1 billion in present value terms (at a 7% discount rate) relative to what would otherwise be expected to occur without the Project.
- The Northern Queensland Catchment economy is estimated to record an increase in GRP valued at $6.2 billion in present value terms (at a 7% discount rate) relative to what would otherwise be expected to occur without the Project.

- The Queensland economy is estimated to record an increase in GSP valued at $6.6 billion in present value terms (at a 7% discount rate) relative to what would otherwise be expected to occur without the Project.
- The Australian economy is estimated to record an increase in GDP valued at $6.8 billion in present value terms (at a 7% discount rate) relative to what would otherwise be expected to occur without the Project.

Employment

The Project will support jobs in the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies during construction and operations, compared to what would occur without the Project, flowing from both direct and flow-on impacts.

Overall, between 2023-24 and 2056-57, the Project is estimated to support:

- An average of 463 FTE jobs per annum in the Local Catchment, with a peak of 634 FTE jobs in 2025-26.
- An average of 507 FTE jobs per annum in the Northern Queensland Catchment (inclusive of the Local Catchment), with a peak of 665 FTE jobs in 2025-26.
- An average of 507 FTE jobs per annum in Queensland (inclusive of the Northern Queensland Catchment), with a peak of 658 FTE jobs in 2025-26.
- An average of 347 FTE jobs per annum in Australia (inclusive of Queensland), with a peak of 481 FTE jobs in 2024-25.

The lower number of FTE job years supported in Queensland and Australia relative to the Northern Queensland Catchment reflects some movement of labour to the Local Catchment and Northern Queensland Catchment to support the Project (thus producing a negative value for FTE job years in the rest of Queensland and rest of Australia).

Household Incomes

The increase in employment will also deliver increased incomes in the Local Catchment, Northern Queensland Catchment, Queensland and Australia, both directly as a result of the jobs supported as well as through a small lift in real wages generated by increased competition for labour.

Between 2023-24 and 2056-57, the Project is estimated to support a total of:

- $1.3 billion in additional wages and salaries in the Local Catchment in present value terms (7% discount rate), with real wages growth of 0.67% per annum on average (i.e., the average employee income is estimated to be 0.67% higher in the Northern Queensland Catchment with the Project than would be expected without the Project).
- $1.7 billion in additional wages and salaries in the Northern Queensland Catchment in present value terms (7% discount rate), with real wages growth of 0.24% per annum on average relative to what would occur without the Project.
- $2.3 billion in additional wages and salaries in Queensland (inclusive of the Northern Queensland Catchment) in present value terms (7% discount rate), with real wages growth of 0.05% per annum on average relative to what would occur without the Project.
- $3.2 billion in additional wages and salaries in Australia (inclusive of Queensland) in present value terms (7% discount rate), with real wages growth of 0.02% per annum on average relative to what would occur without the Project.

PUBLIC BENEFIT

Guidelines from NAIF (and other programs) outline a requirement to extract the public benefit of a Project only (i.e. excluding the benefit to the proponent) to understand whether investment in a Project will deliver a net public benefit to the community. In this instance, the public benefit can be measured by subtracting QPM's gross operating profits from the estimated GRP/ GSP/ GDP supported by the Project, to provide a measure of the net benefit to the economy excluding benefits to QPM.

The table below provides an estimate of the GRP/ GSP/ GDP supported by the Project, excluding gross operating profits to QPM. Excluding the benefit to the proponent, the undiscounted public benefit delivered by the Project to Australia (i.e. gross profit to businesses in the supply chain and incomes paid to workers) is estimated to be $6.1 billion.

Table ES.1. Present Value of Public Benefit ($M)

Impact	Undiscounted	Discount Rate		
		4%	7%	10%
After 5 Years of Operation				
Local Catchment	$851.8	$703.0	$614.4	$540.8
Northern Queensland Catchment	$900.6	$743.8	$650.3	$572.8
Queensland	$1,113.5	$928.9	$818.5	$726.6
Australia	$1,157.6	$965.5	$850.9	$755.6
After 10 Years of Operation				
Local Catchment	$1,509.5	$1,130.7	$927.9	$773.1
Northern Queensland Catchment	$1,583.3	$1,187.8	$976.0	$814.1
Queensland	$1,926.0	$1,457.0	$1,205.6	$1,013.3
Australia	$2,037.3	$1,537.2	$1,269.8	$1,065.8
After 20 Years of Operation				
Local Catchment	$2,848.6	$1,782.7	$1,317.9	$1,011.1
Northern Queensland Catchment	$2,956.2	$1,856.5	$1,376.1	$1,058.3
Queensland	$3,666.6	$2,302.4	$1,710.4	$1,320.9
Australia	$3,950.6	$2,465.9	$1,824.2	$1,403.5
Total Project Benefit				
Local Catchment	$4,203.8	$2,227.8	$1,518.1	$1,103.8
Northern Queensland Catchment	$4,344.4	$2,312.3	$1,581.0	$1,153.2
Queensland	$5,608.2	$2,936.7	$1,994.7	$1,452.0
Australia	$6,091.3	$3,167.5	$2,139.1	$1,549.0

Source: Prime Research (unpublished), QPM (unpublished a), AEC.

OTHER PUBLIC/ ECONOMIC BENEFITS

An array of other public/ economic benefits are expected to be generated as a result of the Project. These are summarised below.

- **Contribution to Government Revenue:** The Project will provide a lift in State and Australian government taxation revenues through a variety of taxes and duties. The Queensland Government is expected to receive approximately $831.4 million in net additional revenue ($288.9 million in present value terms at a 7% discount rate), through payroll tax and GST pass-through, over the life of the Project. The Australian Government is estimated to receive approximately $3,089.6 million in net additional revenue ($1,089.0 million in present value terms at a 7% discount rate) through various taxes over the life of the Project. These additional revenues can be used by government to provide additional infrastructure and services to support businesses and households throughout Australia and Queensland.
- **Contribution to Greenhouse Gas Emissions Targets:** The Project will contribute to achieving government greenhouse gas (GHG) emissions reduction targets by directly reducing total carbon emissions in Australia and Queensland. Through QPM Energy's Carbon Abatement Hub and the Moranbah Gas Project, total carbon emissions will directly be reduced by harvesting waste metallurgical coal mine gas from mines in the Northern Bowen Basin for productive use, which would otherwise be flared or directly emitted into the atmosphere as a fugitive emission of methane. At peak production, the Project is expected to generate an annual reduction of 989,200 tonnes of carbon dioxide-equivalent emissions, delivering saleable carbon credits.

- **Supporting Development of Electric Vehicles:** The Project will support the development of electric vehicles (EVs) through the establishment of a sustainable, high-purity critical minerals refinery that will produce the necessary materials required for the manufacture of batteries used to power EVs. The use of Project outputs in downstream production will support the current global transition being observed away from petroleum vehicles and towards lower carbon footprint transport that EVs facilitate (and thereby further support a reduction in GHG emissions and progress towards emissions targets).
- **Waste Reduction:** By employing the proprietary Direct Nickel (DNi) Process™ during production, the Project will significantly reduce waste product that would otherwise be produced via traditional High Pressure Acid Leaching (HPAL) processes. This occurs primarily via the recovery of additional valuable metals from the ore, elimination of tailings waste materials, harvesting of residue for productive use as engineering landfill, elimination of process liquid discharge and recycling of acid for future production.
- **Supporting Local Business:** The Project will support an increase in economic activity for local Woodstock and Townsville businesses throughout Project operations, increasing their revenues and generating a positive impact to downstream suppliers through increased expenditure on operational inputs than would otherwise occur without the Project. The potential establishment of a construction camp for Project workers would also create a significant economic injection for local business, with a vast array of goods and services typically procured for the operation of worker camps. This would support direct and flow-on activity locally across a range of industries.
- **Indigenous Employment:** The employment of Indigenous persons will also be supported as a result of the Project. Estimates of Indigenous employment supported by the Project were derived by estimating the shares of Indigenous employment within each industry using ABS 2021 Census data (ABS, 2022 b). The Project is expected to support an average of 25 Indigenous FTE jobs per annum in the Local Catchment, and 29 Indigenous FTE jobs per annum in the Northern Queensland catchment (inclusive of the Local Catchment).
- **Development of Public Infrastructure:** Located within Townsville City Council's Lansdown Eco-Industrial Precinct, the Project supports the development of an array of public infrastructure which has the potential to be shared by other projects or users on site. This includes a range of trunk and site infrastructure to support facility operations, such as energy and gas pipeline infrastructure. Upgrades to the local road network as a result of the Project will also provide key shared transport benefits to both users of the site and general through traffic, enhancing overall transport efficiency within the local area.
- **Catalyst for Future Development:** Stage 1 of the TECH Project will initiate potential future development stages of the TECH Project, with Stage 2 expected to effectively double the capacity of Stage 1 and result in sizable levels of future development on site in order to deliver future project outputs. This raises the potential to attract production activities on other major downstream points of the battery supply chain and potential supporting industry to Townsville. As an initial large industrial project located in Townsville's Lansdown Eco-Industrial Precinct, the TECH Project has the potential to anchor the entire eco-industrial project, encouraging further industrial development and investment in the precinct to establish a hub of advanced manufacturing and technology.
- **Building Northern Australia's, Queensland's and Australia's Reputation:** The Project will provide reputational benefits to Townsville, Queensland and Australia via a significant investment in the region, raising business and community investor confidence and interest. The Project is likely to earmark Townsville, Queensland and Australia as a market leader in green technology development.
- **Supporting State and National Strategic Directives:** The Project aligns with a number of existing state and national strategic directives, and is of great significance in achieving the objectives and policy goals they outline. These include, but are not limited to, the *Australian Critical Minerals Strategy*, the *Australia-United States Climate, Critical Minerals And Clean Energy Transformation Compact* and the *Queensland Critical Minerals Strategy*.
- **Reducing Economic Impact of Glencore Mount Isa Mine Closure:** The project will create new FTE job opportunities in Townsville, helping to compensate for the loss of jobs by Townsville-based workers from the closure of the mine in Mount Isa. This will enable stable household incomes which will help to minimise the negative economic and employment effects caused by the mine closure on the Townsville community.

COST BENEFIT ANALYSIS

Cost benefit analysis (CBA) examines the net (or incremental) impacts (benefits and costs) of the Project (the 'Project Case' scenario) compared to a 'Base Case' scenario of what would be expected to occur without the Project. In the CBA, only the incremental difference in activity (benefits and costs) between the Project Case and Base Case scenarios was modelled.

The CBA examined the impacts of the Project between the financial year ending June 2024 (2023-24) to financial year ending June 2057 (2056-57), incorporating the construction period, the operational life of the Project, as well as decommissioning activities. All values were discounted back to 2022-23 values.

The following costs and benefits were examined:

- Costs:
    - Initial construction costs for the Project.
    - Sustaining capital costs for the Project.
    - Operating costs for the Project (including decommissioning activities).
    - Costs associated with additional transport movements attributable to the Project.
- Benefits:
    - The value of production revenue attributable to the Project.
    - The value of reduced GHG emissions attributable to the Project.

The table below outlines the present value of the incremental additional costs and benefits associated with the Project Case relative to the Base Case, between the financial year ended June 2024 and financial year ended June 2057. Values are presented with no discounting, as well as at discount rates of 4%, 7% and 10%.

The Project is estimated to return a Net Present Value (NPV) of $3,006.1 million over the assessment period (discount rate of 7%) with a Benefit Cost Ratio (BCR) of 1.37. The Project returns a desirable result across each of the discount rates examined, with the BCR ranging between 1.26 (10% discount rate) and 1.48 (4% discount rate). The CBA is insensitive to the discount rate used with minimal change in BCR across discount rates examined. The Project has an internal rate of return (IRR) of 18.4%.

Table ES.2. Summary of CBA Results

Impact	Undiscounted ($M)	Present Value ($M)		
		4% Discount Rate	7% Discount Rate	10% Discount Rate
Costs				
Initial Construction	$2,109.9	$1,962.4	$1,862.7	$1,771.2
Sustaining Capital	$962.2	$493.4	$324.0	$225.4
Operations	$16,688.3	$8,739.5	$5,844.6	$4,143.3
Traffic Generation	$263.7	$146.3	$103.4	$78.1
Total Costs	***$20,024.1***	***$11,341.6***	***$8,134.8***	***$6,218.0***
Benefits				
Revenue	$31,233.9	$16,233.8	$10,785.4	$7,593.8
Reduction in GHG Emissions	$1,021.7	$533.3	$355.5	$251.1
Total Benefits	***$32,255.6***	***$16,767.1***	***$11,140.9***	***$7,845.0***
Summary				
Net Present Value (NPV)	**$12,231.4**	**$5,425.5**	**$3,006.1**	**$1,626.9**
Benefit Cost Ratio (BCR)	**1.61**	**1.48**	**1.37**	**1.26**

Source: AEC

Sensitivity analysis at a discount rate of 7% shows there is a 90% probability the Project will provide an NPV between $962.6 million and $5,032.1 million. Sensitivity testing returned a positive NPV across 99.2% of the 5,000 iterations run in Monte Carlo analysis, with the analysis most sensitive to Project revenue.

ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym/ Unit	Term
Abbreviations/ Acronyms	
ACCU	Australian carbon credit unit
AEC	AEC Group Pty Ltd
BCR	Benefit cost ratio
CAH	Carbon Abatement Hub
CAGR	Compound annual growth rate
CBA	Cost Benefit Analysis
CGE	Computable General Equilibrium
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNi	Direct Nickel
ESG	Environmental, Social and Governance
EV	Electric vehicle
FTE	Full time equivalent
GDP	Gross Domestic Product
GHG	Greenhouse gas
GM	General Motors
GRP	Gross Regional Product
GSP	Gross State Product
GST	Goods and services tax
HPA	High purity alumina
HPAL	High pressure acid leaching
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
LED	Light emitting diode
LGA	Local Government Area
MHP	Mixed hydroxide precipitate
MIT	Massachusetts Institute of Technology
NAIF	Northern Australia Infrastructure Facility
NPV	Net present value
NQGP	North Queensland Gas Pipeline
pCAM	Precursor cathode active material
PV	Present value
RSA	Residual storage area
QPM	Queensland Pacific Metals
TECH	Townsville Energy Chemicals Hub
Units	
$M	Million dollars
c/L	Cents per litre
c/km	Cents per kilometre
CO2-e	Carbon dioxide equivalent
dmt	Dry metric tonnes
kg	Kilograms
km	Kilometres
PJ	Petajoules
t	Tonnes
wmt	Wet metric tonnes

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1. INTRODUCTION

1.1 BACKGROUND

Queensland Pacific Metals (QPM) is a listed Australian company (ASX: QPM) developing a sustainable high-purity critical minerals refinery 45 kilometres (km) south of Townsville. Known as the Townsville Energy Chemicals Hub (TECH) Project (the Project), the refinery will be located within Townsville City Council's Lansdown Eco-Industrial Precinct, near Woodstock.

QPM's TECH Project will position Townsville (and by extension, Queensland and Australia) as a global leader in the carbon negative production of nickel sulphate, cobalt sulphate, high purity alumina, hematite, magnesia and other co-products.

QPM has in place all major approvals required to begin construction of the TECH Project. An Advanced Feasibility Study has also been completed for Stage 1 of the TECH Project with offtake agreements secured for 100% of nickel and cobalt sales over the life of the TECH Project.

QPM is now in the process of finalising a Bankable Feasibility Study (BFS) and securing the necessary financing for Stage 1 of the TECH Project.

1.2 PURPOSE OF THIS REPORT

This report examines and analyses the expected beneficial and adverse economic impacts of the TECH Project on the Townsville, Northern Queensland, Queensland and Australian economies. The focus of this report is on Stage 1 of the TECH Project and the economic impacts delivered by Stage 1.

The report has been developed as a technical document for use by QPM to support internal decision making and applications for debt financing, including an application to the Northern Australia Infrastructure Facility (NAIF). To this end, in addition to assessing the economic impacts of the TECH Project, a key purpose of this report is to address the need of NAIF for assessment of the public benefit delivered by the TECH Project to northern Australia. Separate, graphically designed documents have also been produced summarising the key findings and analysis from this technical document for use in advocacy work.

1.3 APPROACH

Economic modelling using Computable General Equilibrium (CGE) modelling techniques was undertaken to analyse, assess and discuss the economic and public benefit impacts of the Project. The analysis provides interpretation of the modelling outputs in the context of the regional, state and national economies. In assessing the public benefit of the Project, benefits to the proponent have been removed in line with standard assessment guidelines from NAIF. The results of the CGE modelling are presented in section 4, while a description of CGE modelling is provided in **Appendix A**.

A cost benefit analysis (CBA) was conducted in line with Queensland and Australian Government guidelines, examining the stream of relevant economic, social and environmental costs and benefits anticipated from the Project to assess the net present value of the Project to the Queensland community. The results of the CBA are presented in section 5, while additional details regarding the assessment method used for the CBA is provided in **Appendix B**.

2. PROJECT OVERVIEW

2.1 PROJECT DESCRIPTION

2.1.1 Overview

The TECH Project involves the design, construction and operation of a sustainable, high-purity critical minerals refinery, developed to meet the strong forecast growth in demand for nickel and cobalt sulphates from the lithium-ion battery manufacturing sector for use primarily in electric vehicles (EVs).

The TECH Project will be located approximately 45km south of Townsville, near Woodstock, within Townsville City Council's Lansdown Eco-Industrial Precinct – Northern Australia's first environmentally sustainable advanced manufacturing, processing and technology hub, funded under the Townsville City Deal.

QPM has proposed two stages to the TECH Project, with Stage 1 of the TECH Project estimated to cost in the order of $2.109 billion (including contingency) to construct, with a nameplate capacity for processing of 1.57 million wet metric tonnes (wmt) of high-grade nickel laterite ore per annum (1.05 million dry metric tonnes (dmt)) to produce nickel sulphate, cobalt sulphate, high purity alumina (HPA), hematite pellets, magnesia and other co-products. The second stage of the TECH Project would effectively double capacity. This study focuses on the economic impacts of Stage 1. The design life of Stage 1 of the TECH Project is 30 years.

When fully operational, Stage 1 of the TECH Project will process 1.57 million wet metric tonnes (wmt) per year of high-grade nickel laterite ore imported from New Caledonia, annually producing in the order of:

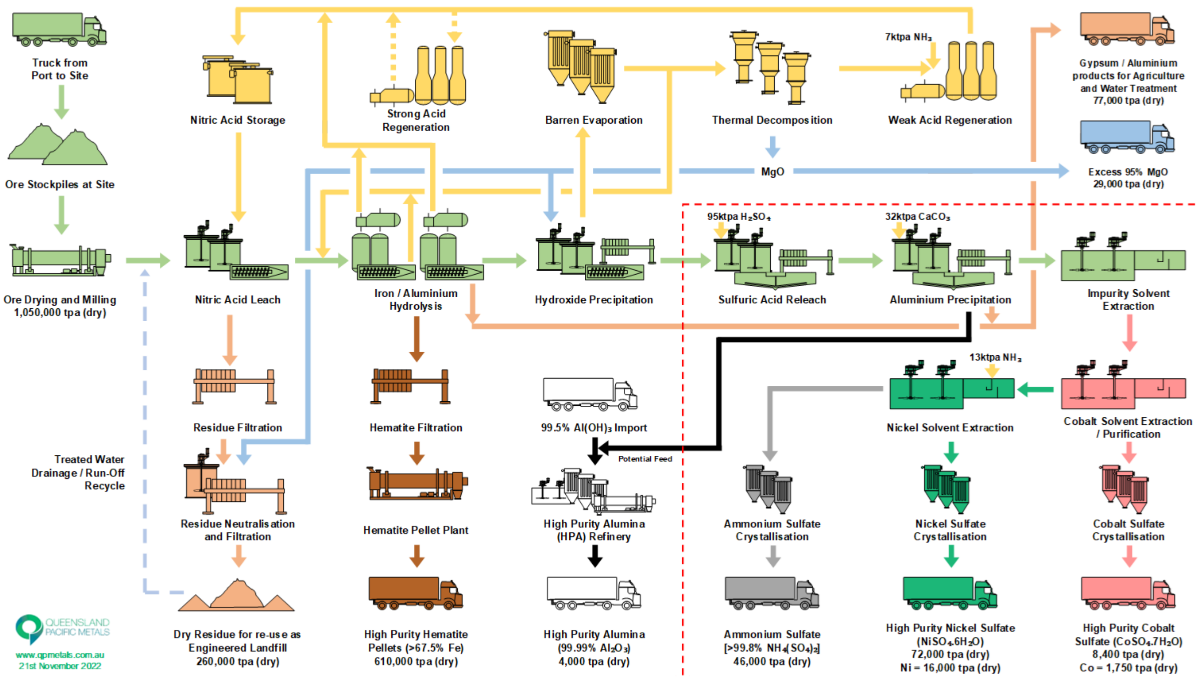
- 16,000 dry metric tonnes (dmt) of nickel sulphate; expressed as tonnes of contained nickel metal.
- 1,750 dmt of cobalt sulphate; expressed as tonnes of contained cobalt metal.
- 4,000 dmt of HPA.
- 607,400 dmt of hematite pellets.
- 28,850 dmt of magnesia.
- 6,000 dmt of zinc sulphate.
- 46,000 dmt of ammonium sulphate.
- 12,500 dmt of ammonium nitrate.
- 85,000 wmt of gypsum.
- 353,700 wmt of engineered landfill.

2.1.2 Direct Nickel (DNi) Process™

The TECH Project will employ the proprietary Direct Nickel (DNi) Process™ in the production process. The DNi Process™ is a patented nickel processing technology developed in Australia in collaboration with the CSIRO. Owned by the Altilium Group, QPM has obtained the rights to use the DNi Process™ from Altilium. The DNi Process™ is based on nitric acid leaching of ore and subsequent acid regeneration, producing high-purity battery materials.

A flow diagram of the TECH Project's production process using the DNi Process™ is presented in Figure 2.1 below.

Figure 2.1. TECH Project Process Flow



Source: QPM (undated).

The traditional processing option for limonite ores is High Pressure Acid Leaching (HPAL), employing sulfuric acid. This process has historically had several technical and commercial failures, including many significant capital cost overruns. The DNi Process™ offers an alternative, where sulfuric acid is replaced by nitric acid, a more aggressive reagent that achieves almost total dissolution of the ore feed. Silica and chromite are the main minerals not dissolved. This means there is a minimal generation of residues, with most non-nickel and cobalt materials being recovered as marketable co-products.

The table below highlights the key differences between HPAL (employed by existing and new Indonesian plants) and the DNi Process™ (employed by the Project).

Table 2.1. Key Differences Between HPAL and the DNi Process™

Factor	DNi Process™	High Pressure Acid Leaching
Ore feed	Full lateritic ore profile.	Only limonite or low magnesium saprolite.
Acid consumption	Between 25 kg and 55 kg of nitric acid (68%) per tonne of dry ore processed.	Between 250 kg and 500 kg of sulfuric acid (98%) per tonne of ore processed.
Acid recovery	At least 98.5% of nitric acid recycled.	Most reagents consumed and converted to waste products.
Product	Direct to nickel/ cobalt sulphate.	Mixed precipitates, then to nickel/ cobalt metal.
Co-products	Hematite, magnesia, ammonium sulphate. All valuable metals recovered from the ore.	Ammonium sulphate. Other metals wasted as tailings.
Tailings dam	Not required.	Required.
Waste materials	• None. • The residue is approximately 70% silica and is suitable as an engineered landfill material. • Represents approximately 20% of original ore mass.	• Tailings over four times the mass produced by the DNi Process™. • Requires neutralisation, containment and indefinite monitoring. • Produces 1.2 to 1.4 tonnes of tailings for every tonne of ore processed.
Liquid discharge	Zero process liquid discharged.	Significant contaminated process water discharged into tailings.
GHG emissions	Net negative GHG emissions profile – approximately -39.5 t CO_2-e per tonne of nickel.	Approximately 19 t CO_2-e per tonne of nickel.

Source: QPM (unpublished a)

2.1.3 Key Site Components

Key site components for the TECH Project are outlined below.

Table 2.2. Key Site Components

Site Component	Description
Stockpiles	The Project will use five stockpiles. Of these, four are for ore where it is stored prior to treatment in the main process plant. The fifth stockpile is for hematite. All stockpiles are located close to the main process plant for ease of access. A conveyor links the stockpiles and main process plant.
Main Process Plant	Laterite ore is processed at the main processing plant.
Sulphate Refinery	Refinery adjacent to the main process plant where the mixed hydroxide precipitate (MHP) output from the main process plant is refined to nickel and cobalt sulphate.
Acid Plant	The acid plant recycles nitric acid for use in the process plant.
HPA Refinery	Aluminium hydroxide will be purchased and used as a feedstock to the refinery to produce HPA using a conventional hydrochloric acid/ aluminium chloride flowsheet.
Residue Storage Area (RSA)	The dry residue will be temporarily stored on-site, including capturing and recycling all drainage and run-off. Test work from James Cook University has confirmed that adding a binder makes the residue suitable for commercial use as engineered landfill. QPM has applied for End of Waste Approval and has had positive discussions regarding the application with the Queensland State Government Department of Environment and Science.
Water Infrastructure	Cooling water will be circulated through evaporative cooling towers and the various process cooling equipment in the main process plant. A portion of condensate return will be bled to provide process water. The process water tank has two pump systems; the process water pumps, which distribute water to counter current decantation wash water, iron hydrolysis dilution water and nitric acid plant scrubber water, vent scrubber water and flocculant mixing water.
Ancillary Infrastructure	Ancillary infrastructure required to support the plant includes: • Administration buildings. • Warehousing. • Truck wash station. • Two truck scales. • Diesel storage tank and refuelling station. • Gas letdown facility. • Mobile equipment service areas. • Access roads through the site. • A central pipe rack which runs east-west through the plant; typically, the services and ductwork will run along this pipe rack as the main services and process transfer corridor.

Source: EMM (2022 a).

2.1.4 Gas Supply

The Project will be a large gas consumer due to its need to process steam (circa 11.5 petajoules (PJ) per annum), thus a secure supply of large volumes of gas forms a critical component of the Project. Given the significant gas consumption required, QPM made the strategic decision to form QPM Energy as the gas supplier to the Project. QPM Energy, a wholly owned (but independently managed) subsidiary of QPM, will own and manage QPM's gas supply chain as part of QPM's vertical integration strategy to secure a gas supply chain for the TECH Project. Vertical integration of the gas supply chain ensures QPM can secure gas required for the TECH Project and will open up opportunities for gas sales to third parties.

QPM Energy are seeking environmental approval for the Carbon Abatement Hub (CAH) Project, a greenfield gas processing and collection facility located approximately 40km north of Moranbah that will collect waste metallurgical coal mine gas from mines in the Northern Bowen Basin with a direct connection to the existing North Queensland Gas Pipeline (NQGP) for transport to the TECH Project and other customers. The CAH Project will be Australia's first multi-user, waste gas collection and processing facility.

Once operational, the CAH Project will create a hub that will allow the capture and beneficial use of this large gas resource, abating significant quantities of carbon emissions and simultaneously facilitating industrial growth in North Queensland by establishing a new gas supply chain.

While not directly forming part of QPM's TECH Project, the TECH Project is critical to the establishment of the CAH Project (and vice versa). At full production, the TECH Project's demand for 11.5 PJ of gas per annum will effectively provide baseload demand for QPM Energy and the CAH Project.

QPM Energy (through its subsidiaries) plan to develop a portfolio of waste mine gas supply in the Northern Bowen Basin. These supply sources will come from a combination of:

- Wholly owned and operated gas reserves (i.e., the Moranbah Gas Project).
- A collection of waste coal mine gas currently being drained from operating underground metallurgical coal mines.
- Pre-drainage of waste mine gas from operating and planned (open cut and underground) steel-making coal mines under an operating or co-development agreement with the miner.

Once commissioned, this gas will be processed, compressed, and delivered into the NQGP through the existing Moranbah Gas Project infrastructure and supplemented by the CAH Project.

2.2 PROJECT RATIONALE

2.2.1 Need for the Project

In 2018, the Intergovernmental Panel on Climate Change (IPCC) estimated that human activities have caused approximately 1.0°C of global warming above pre-industrial levels (i.e. the average temperature over the period 1850 to 1900) and on current trends this would likely reach greater than 1.5°C above pre-industrial levels between 2030 and 2052 (IPCC, 2018). Global warming is already observed to have resulted in increased risks of extreme weather events and adverse impacts on biodiversity and ecosystems; where temperatures increase beyond 1.5°C above pre-industrial levels, these impacts are predicted to be significantly worse. Avoiding an increase beyond 1.5°C above pre-industrial levels will directly depend upon future rates of global carbon emissions reduction (IPCC, 2018). In order to mitigate the adverse environmental effects associated with rising global mean temperatures, the world is subsequently transitioning to a low carbon emissions future.

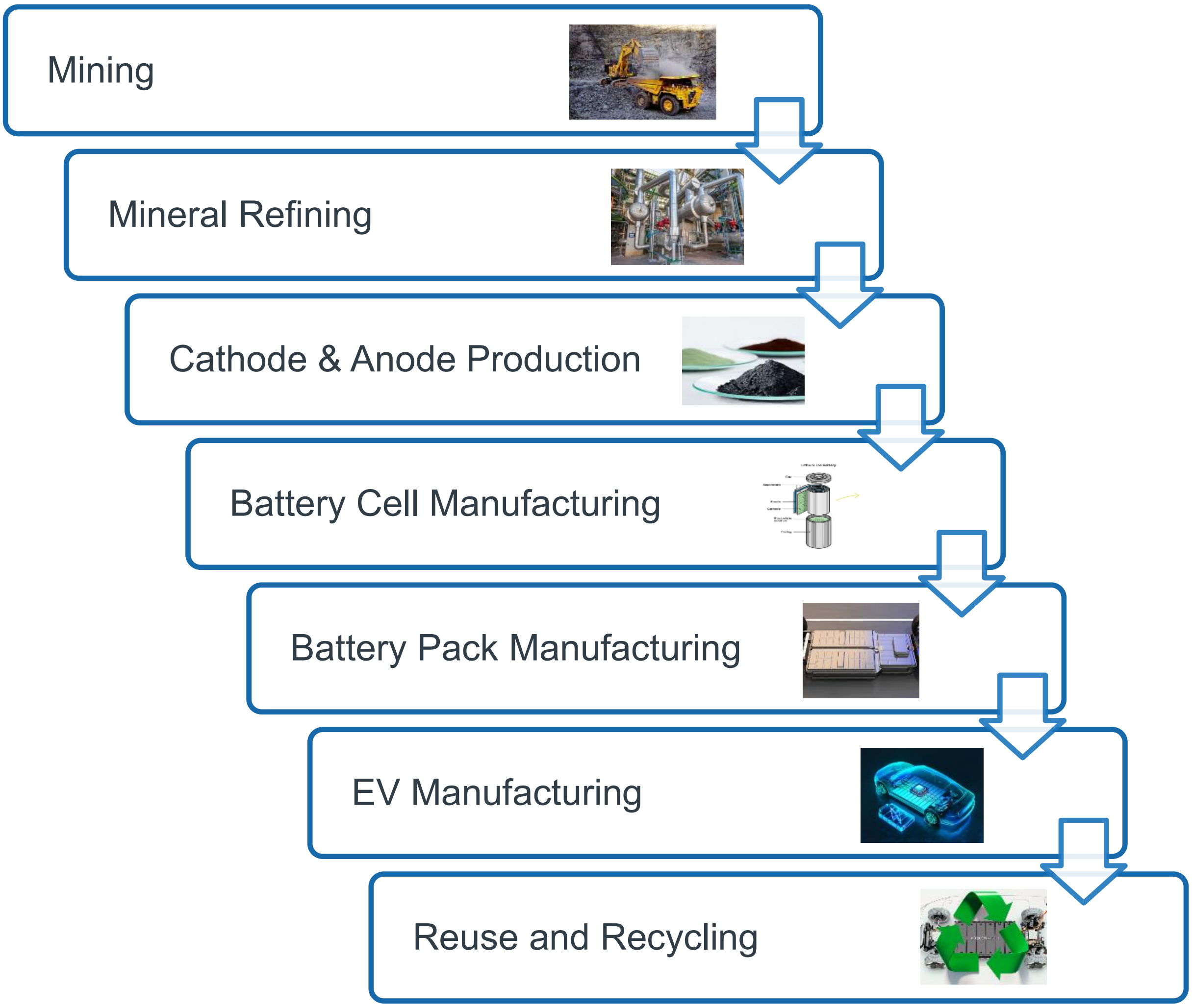
A key part of this transition across the world involves a shift away from fossil fuels which have high emissions intensities. This includes a move away from petroleum powered vehicles towards battery powered vehicles. A vehicle that uses petrol is powered by an internal combustion engine, while battery powered vehicles do not produce any tailpipe emissions (Australian Government, 2023 a). According to a study undertaken in 2019 by Massachusetts Institute of Technology (MIT), on average, traditional petroleum powered vehicles emit over 350 grams of carbon emissions per mile driven over the lifetime of the vehicle, in comparison to approximately 200 grams for battery powered electric vehicles (EVs) (MIT Climate, 2022).

In 2022, aside from advancements in renewable energy technologies, the overall rise in global carbon emissions would have been significantly greater were it not for major developments and uptake of EVs around the world (IEA, 2022 a). In 2021, global sales of EVs doubled on levels from the previous year to a record 6.6 million vehicles, accounting for nearly 10% of global car sales (IEA, 2022 b). This compares to just 120,000 EVs sold worldwide in 2012. Growth in the production of EVs across the globe is anticipated to increase substantially over the next few decades. A Bloomberg New Energy Finance report projected global passenger EV sales to rise to at least 66 million vehicles by 2040 (S&P Global, 2021).

Rising production of battery powered vehicles will require considerable volumes of materials suitable for battery manufacturing, including nickel and cobalt. While the supply of these materials is largely abundant, the manufacture of batteries requires a high purity class of material, necessitating additional resources in the processing stages than is commonly used in the production of these materials. The TECH Project will produce materials of a suitably high purity level to support the manufacture of batteries to be used in the production of EVs.

There are seven major links within the battery supply chain, as highlighted in the figure below.

Figure 2.2. Major Links in the Battery Supply Chain



Source: QPM (unpublished b)

The TECH Project will enable three of these major links in the battery supply chain for Australia, which are detailed below (QPM, unpublished b).

- **Mineral Refining:** The Project establishes a $2.1 billion net carbon-negative advanced manufacturing project in Townsville, producing critical minerals for the lithium-ion battery manufacturing sector to enable increased downstream production. The critical minerals refinery will diversify Australia's economy by expanding the manufacturing sector.
- **Cathode and Anode Material Production:** Stage 2 of the TECH Project is expected to double the capacity of Stage 1, producing nickel of sufficient scale to enable the development of a precursor cathode active material (pCAM) plant for production of key cathode materials used in EVs. There is potential for this to be established adjacent to the TECH Project refinery.
- **Reuse and Recycling:** The TECH Project will recycle "black mass" waste byproduct produced at various points along the supply chain, including at the point of collection and disassembly of EVs once their batteries reach end of life. The recycling of this waste product will recover nickel, cobalt and potentially lithium for productive reuse in battery manufacturing.

2.2.2 Demand/ Markets for Products

One of the key commodities in the manufacture of batteries for EVs is nickel. The production of nickel-rich cathodes in lithium ion batteries for EVs requires a grade of nickel greater than 99.8% purity as feedstock for the key product of nickel sulphate (S&P Global, 2021). Nickel also increases an EV's energy density and subsequently the overall driving range. With improved battery energy density, battery configurations have evolved from a roughly even split of nickel, manganese and cobalt to the latest batteries with a composition containing around 80% nickel (S&P Global, 2021). The material is expected to play an essential role in the growing demand for EVs. However, as markets adapt to rising demand for battery metals, concerns have escalated within the industry surrounding the availability of high-grade nickel supply. Global demand for nickel sulphate is forecast to rise at a compound annual growth rate (CAGR) of 13.6% between 2022 and 2032, increasing from 526,000 tonnes to 1.89 million tonnes over this period (QPM, unpublished c).

Cobalt, and by extension cobalt sulphate, is another primary material in the manufacture of batteries for EVs. Batteries containing cobalt are a technology of choice for a substantial number of vehicle manufacturers, largely due to superior energy density, safety and performance of the vehicle ensured by the presence of the material (Cobalt Institute, 2022). Cobalt demand from EVs overtook other battery applications to become its largest end-use sector for the very first time in 2021, with cobalt-containing battery chemistries accounting for approximately 74% of the global EV battery market (Cobalt Institute, 2022). As the transition to EVs continues, roughly 70% of global cobalt demand is expected to be attributable to the EV sector in the next five years (Green Car Congress, 2022). Flowing on from this, cobalt sulphate demand is forecast to grow rapidly from 93,000 tonnes in 2022 to 264,000 tonnes in 2032 (QPM, unpublished c).

Supply of nickel sulphate and cobalt sulphate in the global market is currently dominated by countries with low ESG compliance (QPM, unpublished c). With high hurdles to clean up their battery supply chain to reach compliance with Western ESG standards, production in these countries has a poor reputation for human rights and work practices and is far below the requirements of European and North America EV manufacturers. Structural changes towards more transparent compliance and adherence with ESG standards is estimated to generate a deficit of ESG-compliant production as large as 829,000 tonnes of nickel sulphate by 2034 and 117,000 tonnes of cobalt sulphate by 2032 (QPM, unpublished c). This is likely to increase demand for Australian-produced nickel sulphate and cobalt sulphate, which poses much lower potential ESG risks and thereby expected to result in a pricing premium compared to other global benchmarks.

HPA is also seeing an increasing demand for use in lithium-ion batteries, where it is used as a ceramic coating on the cathodic separator sheets placed between the battery anode and cathode (Critical Minerals Group, undated). Utilising the material's exceptional insulation properties and strength, HPA has been found to perform this function effectively and economically in lithium-ion batteries for over a decade (Scandium International, 2021). The global HPA market is estimated to demonstrate a CAGR of 18.6% from 2021 to 2026, attributable to its use in batteries required for EVs as well as from the growing preference for LED bulbs and medical bio-ceramics for orthopaedic and dental implants (Critical Minerals Group, undated).

The Project will produce a range of other co-products in addition to the above as outlined in section 2.1.1, which also have their own demand markets and uses. Most notably, hematite is commonly supplied for the production of iron and in steelmaking projects, of which there are a projected $US11 billion worth in India alone over the next five years (Australian Government, 2023 b). The EV market is also a key growth area for magnesium demand, as vehicle manufacturers seek to utilise the high strength-to-weight properties of the material to reduce the weight of EVs (Stockhead, 2022).

Contracts are already in place with various battery manufacturers for products from Stage 1 of the TECH Project, including secured offtake agreements for 100% of nickel and cobalt sales over the life of the TECH Project. This highlights the strong and verified market demand for key project outputs.

3. PROJECT SCENARIO AND ASSUMPTIONS

This section will outline the project-specific scenario and assumptions used in modelling, based on information from QPM (unpublished a).

Note: In line with best practice for undertaking economic analyses, unless otherwise specified, all dollar values presented in this section are:

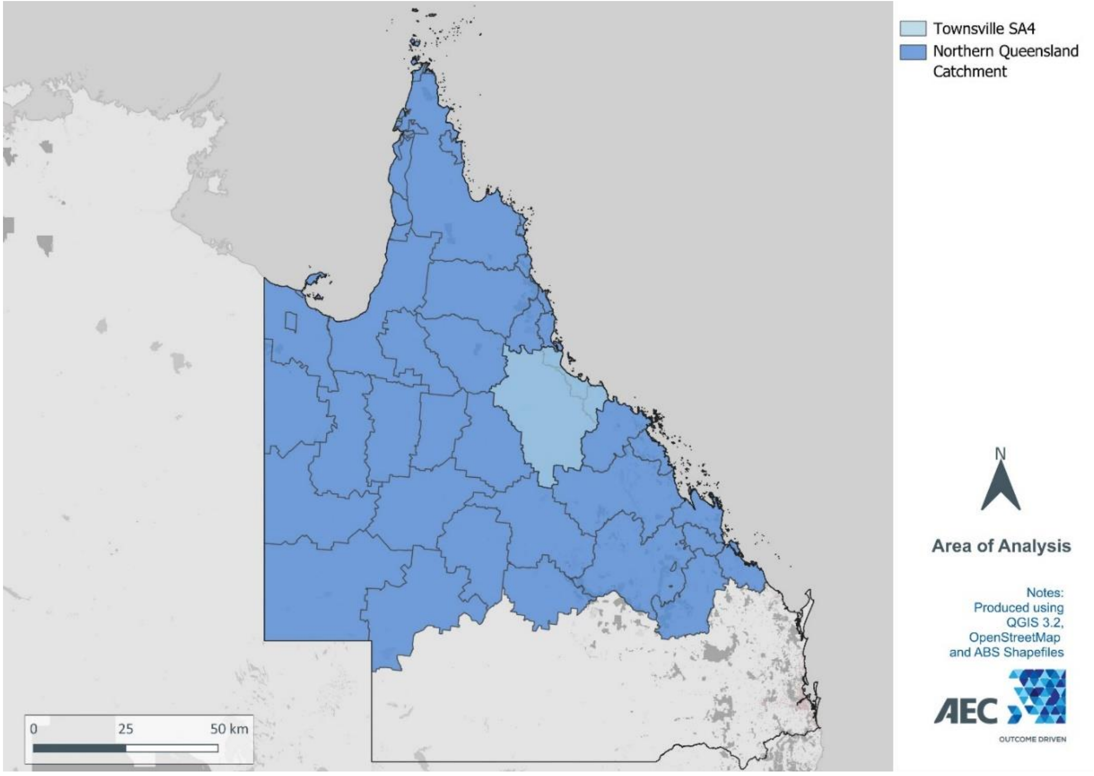
- Non-escalated.
- In 2023 dollar terms.
- In Australian dollar terms.

3.1 STUDY AREAS

A number of study areas have been defined for examining the economic impacts of the Project. The Local Catchment has been defined as the Townsville SA4, as this area captures the local economy that will be most impacted by the Project. The Northern Queensland Catchment has been defined as all LGAs in Queensland that fall within NAIF's Northern Australia boundary[1], which is relevant for submissions to NAIF for loan and equity arrangements. Economic modelling will primarily focus on impacts to these catchments.

Impacts at the State and national level will also be provided, relevant for discussions with and submissions to the Queensland and Australian Governments, as well as for State-based and national funding programs.

Figure 3.1. Local and Northern Queensland Catchments



Source: AEC

[1] The NAIF Northern Australia boundary incorporates the following LGAs: Aurukun, Banana, Barcaldine, Barcoo, Blackall-Tambo, Boulia, Burdekin, Burke, Cairns, Carpentaria, Cassowary Coast, Central Highlands, Charters Towers, Cloncurry, Cook, Croydon, Diamantina, Doomadgee, Douglas, Etheridge, Flinders, Gladstone, Hinchinbrook, Hope Vale, Isaac, Kowanyama, Livingstone, Lockhart River, Longreach, Mackay, McKinlay, Mapoon, Mareeba, Mornington, Mount Isa, Napranum, Northern Peninsula Area, Palm Island, Pormpuraaw, Richmond, Rockhampton, Tablelands, Torres, Torres Strait Island, Townsville, Weipa, Whitsunday, Winton, Woorabinda, Wujal Wujal and Yarrabah.

3.2 INITIAL CONSTRUCTION

3.2.1 Construction Costs and Timing

Initial construction costs for the Project are estimated to be approximately $2.1 billion (including contingency), occurring over an approximately three-year period. Construction expenditure is split by approximately $1.4 billion in direct costs and $496.4 million in indirect costs over the construction period, with an additional 10% contingency estimated. Approximately 29.0% of costs are expected to occur in 2023-24, 56.5% in 2024-25 and 14.5% in 2025-26.

Table 3.1. Initial Construction Costs and Timing ($M)

Item	2023-24	2024-25	2025-26	Total
Direct Costs				
Materials Handling	$2.0	$2.9	$0.5	**$5.4**
Extraction Plant	$167.1	$501.2	$127.3	**$795.5**
Sulphate Refinery	$73.5	$182.3	$38.2	**$294.0**
High Purity Alumina Plant	$24.7	$47.7	$9.9	**$82.2**
Power and Steam	$2.0	$5.9	$1.5	**$9.3**
Site Wide Utilities	$17.9	$53.6	$13.6	**$85.0**
Site Wide Infrastructure	$102.1	$48.1	$0.0	**$150.2**
Total	**$389.1**	**$841.5**	**$190.9**	**$1,421.6**
Indirect Costs				
Temporary Construction Facilities & Equipment	$27.8	$40.1	$13.9	**$81.9**
Travel & Accom (Indirect Staff)	$2.2	$3.4	$1.3	**$7.0**
Spares & First Fills	-	$34.3	$10.8	**$45.1**
Freight	$30.6	$41.1	$8.9	**$80.5**
Engineering Services	$64.8	$44.8	$8.2	**$117.8**
Integrated Delivery Team & Owners Costs	$41.0	$78.8	$44.3	**$164.1**
Total	**$166.5**	**$242.4**	**$87.5**	**$496.4**
Contingency				
Direct Costs	$38.9	$84.2	$19.1	**$142.2**
Indirect Costs	$16.6	$24.2	$8.7	**$49.6**
Total	**$55.6**	**$108.4**	**$27.8**	**$191.8**
Grand Total	**$611.2**	**$1,192.4**	**$306.3**	**$2,109.9**

Note: Port facilities, hematite and offsite infrastructure costs will be incurred by other parties.
Source: QPM (unpublished a)

3.2.2 Construction Labour

An average of 578 full-time equivalent (FTE) jobs per annum are estimated to be required over the approximately three-year construction period, peaking at 880 FTE jobs in 2024-25. Approximately 63.1% of total construction labour is for direct construction activities and 36.9% for indirect construction activities (e.g. engineering, development of temporary construction facilities, procurement, integrated delivery team, owner's costs) across the construction period.

Table 3.2. Initial Construction Labour (FTEs)

Labour	2023-24	2024-25	2025-26	Average	Total (1)
Direct Construction Labour	280	600	215	**365**	**1,095**
Indirect Construction Labour	240	280	120	**213**	**640**
Total	**520**	**880**	**335**	**578**	**1,735**

Note: (1) The total column represents the total FTE job years supported over the three years of construction, where one FTE job year is equivalent to one person working full time for a period of one year.
Source: QPM (unpublished a)

Construction labour costs associated with these workers are estimated to be approximately $524.6 million in total over the three years of construction and are included within the capital cost estimates presented in section 3.2.1. Approximately 46.3% of total construction labour costs are attributable to direct construction and 53.7% to indirect construction across the construction period.

Table 3.3. Initial Construction Labour Costs ($M)

Labour	2023-24	2024-25	2025-26	Total
Direct Construction Labour	$62.1	$133.2	$47.7	**$243.0**
Indirect Construction Labour	$105.6	$123.2	$52.8	**$281.6**
Total	**$167.7**	**$256.4**	**$100.5**	**$524.6**

Source: QPM (unpublished a)

3.2.3 Source of Goods, Services and Labour

For the purposes of the economic impact assessment, assumptions regarding where goods and services for construction will be sourced from were developed collaboratively by AEC and QPM in consideration of the types of goods and services required and capacity within the local economy.

Construction will use labour from the Local Catchment where feasible, with the rest of the construction workforce supplemented by workers outside the Local Catchment.

Table 3.4. Initial Construction Source of Goods, Services and Labour (%)

Item	Local Catchment	Rest of Northern Queensland Catchment	Rest of Queensland	Rest of Australia	Overseas	Total
Source of Goods and Services Purchased (Excluding Labour)						
Materials Handling	5%	0%	5%	10%	80%	**100%**
Extraction Plant	2%	0%	3%	10%	85%	**100%**
Sulphate Refinery	2%	0%	3%	10%	85%	**100%**
High Purity Alumina Plant	2%	0%	3%	10%	85%	**100%**
Power and Steam	2%	0%	3%	10%	85%	**100%**
Site Wide Utilities	5%	0%	5%	10%	80%	**100%**
Site Wide Infrastructure	60%	10%	15%	10%	5%	**100%**
Source of Labour Service Provider						
Direct Construction Labour	15%	5%	15%	65%	0%	**100%**
Indirect Construction Labour	20%	5%	40%	25%	10%	**100%**
Source of Labour						
Direct Construction Labour	80%	10%	5%	5%	0%	**100%**
Indirect Construction Labour	20%	5%	40%	25%	10%	**100%**

Note: Port facilities, hematite and offsite infrastructure costs will be incurred by other parties.
Source: QPM (unpublished a), AEC

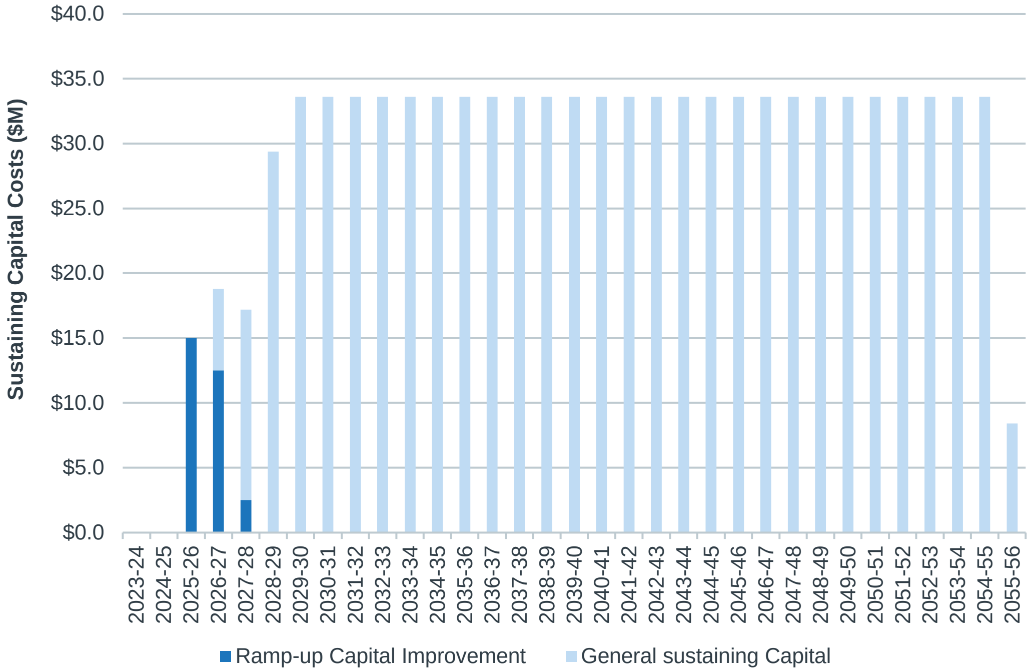
3.3 SUSTAINING CAPITAL

3.3.1 Sustaining Capital Costs and Timing

In addition to the initial construction costs for project development outlined in section 3.2, the Project will require additional sustaining capital investment as a result of the additional infrastructure required throughout the duration of the Project.

In total, it is estimated approximately $962.2 million in sustaining capital will be required as a result of the Project from 2023-24 through to 2055-56, primarily consisting of general sustaining capital. An indicative timeline for the additional sustaining capital expenditure as a result of the Project is presented below.

Figure 3.2. Annual Sustaining Capital Costs ($M)



Source: QPM (unpublished a)

3.3.2 Sustaining Capital Labour

The labour component of sustaining capital expenditure was estimated based on standard industry structures in the CGE economic modelling.

3.3.3 Source of Goods, Services and Labour

For the purposes of the economic impact assessment, assumptions regarding where goods and services for sustaining capital will be sourced from were developed collaboratively by AEC and QPM in consideration of the types of goods and services required and capacity within the local economy.

Sustaining capital works will use labour from the Local Catchment where feasible, with additional labour requirements supplemented by workers outside the Local Catchment.

Table 3.5. Initial Sustaining Capital Source of Goods, Services and Labour (%)

Item	Local Catchment	Rest of Northern Queensland Catchment	Rest of Queensland	Rest of Australia	Overseas	Total
Goods and Services	8%	1%	4%	10%	76%	**100%**
Sustaining Capital Labour	50%	5%	5%	15%	25%	**100%**

Source: QPM (unpublished a), AEC

3.4 OPERATIONS AND DECOMMISSIONING

3.4.1 Production and Timing

The TECH Project will process high-grade nickel laterite ore imported from New Caledonia, with a nameplate capacity for processing of 1.57 million wet metric tonnes (wmt) and 1.05 dry metric tonnes (dmt) of high-grade nickel laterite ore per annum. Production is expected to commence in 2025-26. Estimates of annual production from the processed ore are presented below.

Table 3.6. Annual Production

Product	2025-26	2026-27	2027-28	2028-29 to 2054-55	2055-56	Total
Ore Processed (1)						
Wet (wmt)	598,386	1,381,295	1,561,376	1,567,164	391,791	**46,246,280**
Dry (dmt)	400,918	925,468	1,046,122	1,050,000	262,500	**30,985,008**
Processing Production						
Nickel Sulphate (2) (dmt)	5,378	13,835	15,933	15,992	3,998	**470,934**
Cobalt Sulphate (3) (dmt)	587	1,510	1,739	1,746	436	**51,408**
Hematite (dmt)	231,920	535,357	605,152	607,395	151,849	**17,923,951**
Magnesium (dmt)	11,018	25,433	28,749	28,856	7,214	**851,519**
HPA (dmt)	1,345	3,460	3,985	4,000	1,000	**117,791**
Zinc (t)	2,288	5,281	5,970	5,992	1,498	**176,814**
Ammonium Sulphate (dmt)	15,456	39,765	45,795	45,965	11,491	**1,353,550**
Ammonium Nitrate (dmt)	4,214	10,841	12,485	12,532	3,133	**369,030**
Gypsum (wmt)	32,498	75,018	84,798	85,113	21,278	**2,511,635**
Engineered Landfill (wmt)	135,045	311,733	352,374	353,680	88,420	**10,436,929**

Note:

(1) Ore throughput moisture = 33.0%.
(2) Expressed as tonnes of contained nickel metal.
(3) Expressed as tonnes of contained cobalt metal.

Source: QPM (unpublished a)

3.4.2 Commodity Prices

Economic modelling has been undertaken assuming the commodity prices outlined below. These prices have been sourced from QPM's Advanced Feasibility Study, as per the ASX announcement dated 5 December 2022 (QPM, 2022).

Within the Advanced Feasibility Study, a range of assumptions were formulated as part of the financial analysis, including price assumptions for key Project commodities. Base case assumptions were based on QPM management's forecasts of key macroeconomic inputs, incorporating consideration of the current market for these commodities including that outlined in section 0. The base case assumes an exchange rate of 1.00 AUD = 0.70 USD and prices held constant for the duration of the Project.

These base case assumptions have been applied to the economic modelling results. In addition, offtake agreements secured with LG and General Motors (GM) for the sale of nickel and cobalt over the life of the Project were agreed with discounts applied to the sales price of these products.

Table 3.7. Commodity Prices

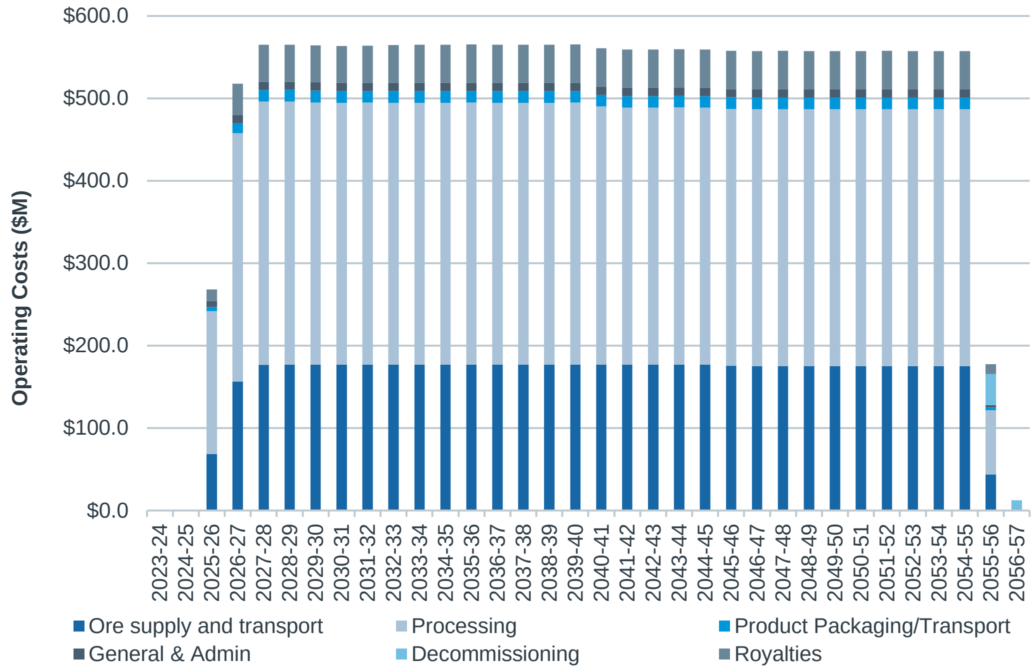
Product	Price (USD)	Price (AUD)
Nickel ($/t)	$25,000	$35,714
Cobalt ($/t)	$62,500	$89,286
Hematite pellets ($/dmt)	$145	$207
Magnesia ($/dmt)	$595	$850
HPA ($/t)	$25,000	$35,714
Zinc Sulphate ($/t)	$120	$171
Ammonium Sulphate ($/dmt)	$217	$309
Ammonium Nitrate ($/dmt)	$279	$398
Gypsum ($/wmt)	$35	$50
Engineered Landfill ($/wmt)	$11	$15

Source: QPM (2022)

3.4.3 Operating Expenditure

Estimates of operating costs and their timing over the life of the Project are presented below.

Figure 3.3. Annual Operating Costs by Year ($M)



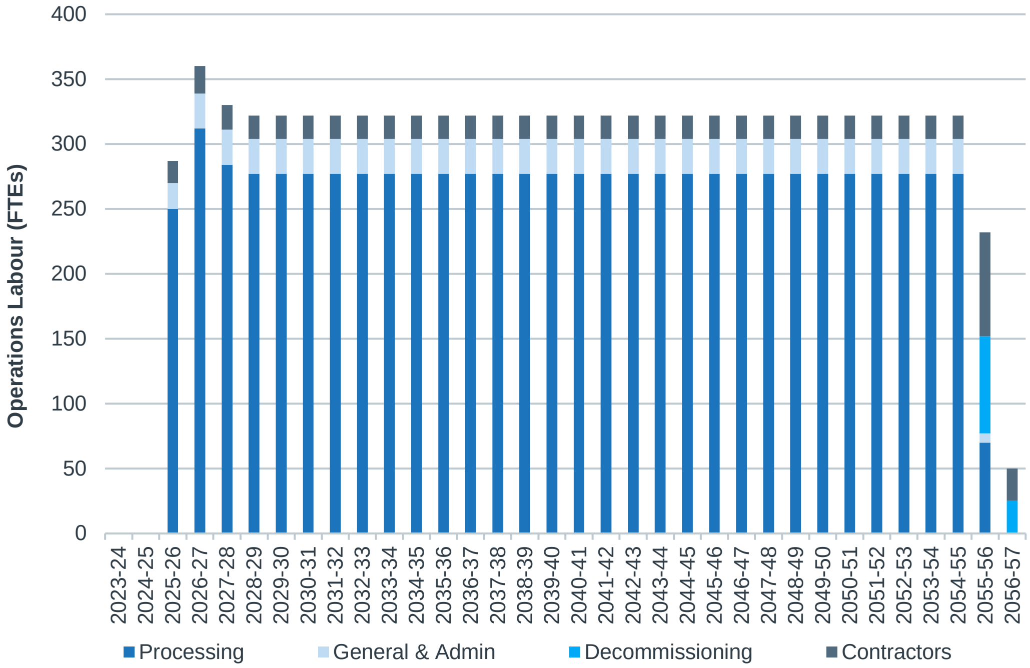
Source: QPM (unpublished a)

As noted in section 2.1.4, the TECH Project will also utilise gas and energy produced from the CAH and Moranbah Gas Project, which is expected to produce cost offsets/ alternative revenue streams for the TECH Project in the form of carbon credits and a rebate for power from the Townsville Power Station. However, these offsets are not included in the figure above. For the purposes of the economic assessment, these offsets/ rebates are excluded from the operating expenditure/ activity of the TECH Project on the basis that they represent a subsidy, and thereby effectively represent a transfer payment. Benefits from the reduction of emissions due to using energy from the CAH Project is examined in section 4.3.2 as well as a separate benefit in the CBA (section 5.2.2.2).

3.4.4 Operations Labour

Annual estimates of the operational workforce of the Project are presented below. Labour associated with the purchase of ore and transport to ore stockpile and product packaging/ transport to port will be outsourced.

Figure 3.4. Annual Operations Labour by Year (FTEs)



Source: QPM (unpublished a)

3.4.5 Source of Goods, Services and Labour

For the purposes of the economic impact assessment, assumptions regarding where goods and services for operations will be sourced from were developed collaboratively by AEC and QPM in consideration of the types of goods and services required and capacity within the local economy. Ore supply and ocean freight will be sourced overseas, with all other goods and services to be sourced from within Australia, prioritising sources from the Local Catchment wherever possible.

QPM will also aim to source operational labour required for the Project from within the Local Catchment wherever possible. Operational labour is expected to be sourced entirely from the Northern Queensland Catchment.

4. CONTRIBUTION TO THE ECONOMY

The following section examines the economic impacts of the Project within the Local Catchment, Northern Queensland Catchment, as well as impacts to Queensland and Australia for context.

This analysis uses economic modelling as well as findings from the literature review to inform the assessment of economic impacts as appropriate. **All modelling outcomes are presented in 2022-23 Australian dollar values** unless otherwise specified. Computable General Equilibrium (CGE) modelling has been used in modelling impacts to the Local Catchment, Northern Queensland Catchment, Queensland and Australia.

4.1 MODELLED ESTIMATE OF CONTRIBUTION TO THE ECONOMY

The Project will contribute to the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies by supporting business/ industry output, gross product, jobs and employee incomes, both:

- Directly, through construction activity, sustaining capital purchases, the production of high purity battery materials during operations, and decommissioning activity.
- Indirectly, through flow-on impacts from additional demand for goods and services to support the Project, household consumption effects as a result of additional wages and salaries paid, and government expenditure through additional taxation revenues.

The following sub-sections examine the Project's impact on the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies during construction, operations and decommissioning, as estimated using CGE modelling.

The modelling outcomes identified throughout this section depict the value and percent change in a range of economic indicators anticipated as a result of the Project. These estimates represent the net change in the respective indicators compared to projected growth in the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies without the Project proceeding.

The direct activity associated with each phase (construction, operations and decommissioning) is outlined in chapter 3. CGE modelling outlines how this direct activity will deliver impacts to the Local Catchment, Northern Queensland Catchment, Queensland and Australian economies both directly and through flow-on activity (e.g. supply chain impacts as well as increased consumption by households). However, CGE modelling does not examine separate phases of project activity (e.g. construction versus operations) or disaggregate impacts between direct and flow-on activity; rather it examines the direct and flow-on impacts of the Project in aggregate across all relevant phases of the Project lifecycle each year.

Additional details of the CGE model and general assumptions used is provided in **Appendix A**.

Economic activity supported by the Project has been estimated across the following measures:

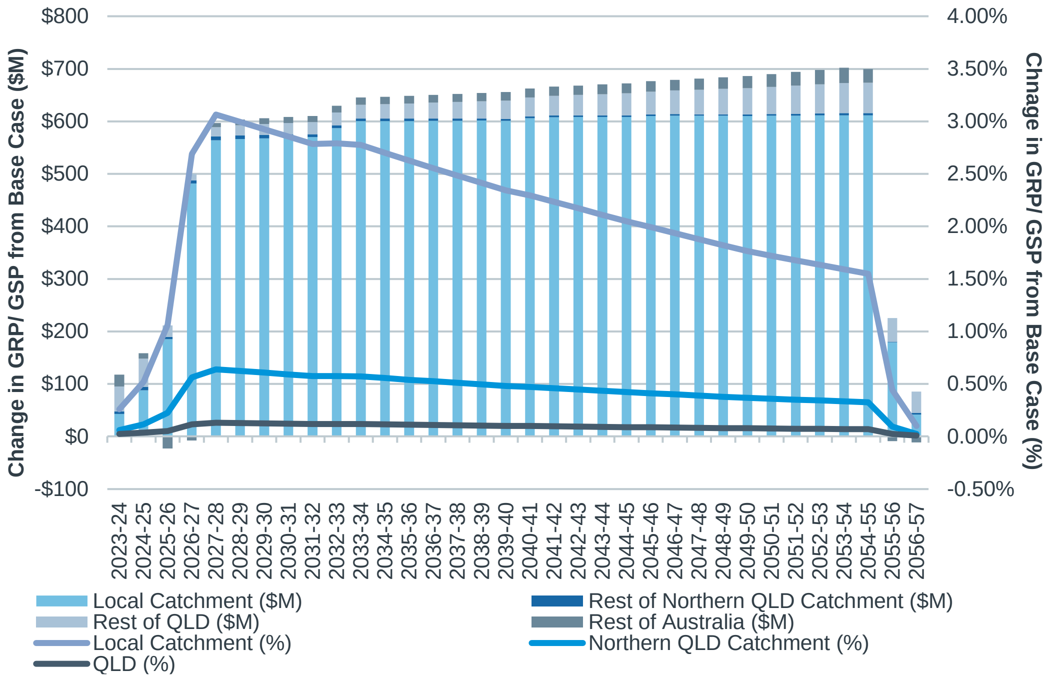
- **Output:** Output as a measure of economic activity refers to the gross value of goods and services transacted, including the costs of goods and services used in the development and provision of the final product.
- **Gross regional/ state/ domestic product (GRP/ GSP/ GDP):** Refers to the value of output after deducting the cost of goods and services inputs in the production process. Gross product thereby defines the true net economic contribution of the Project, whilst estimates of industry output represent the overall increase in economic transactions, and thereby, industry production and activity.
- **Employment/ jobs:** Refers to the part-time and full-time employment positions generated by the Project, both directly and indirectly through flow-on activity, and is expressed in terms of full time equivalent (FTE) positions.
- **Incomes/ wages and salaries:** Measures the level of wages and salaries (and other incomes) paid to employees of the industry under consideration and to other industries benefiting from the Project. Impacts on the real wage (i.e. movements in average wages and salaries over time excluding inflation) have also been estimated.

4.1.1 Impacts on GRP/ GSP/ GDP

Modelling outcomes of the impacts of the Project on the Local Catchment GRP, Northern Queensland Catchment GRP, Queensland GSP and Australia GDP between the commencement of construction through to decommissioning (2023-24 to 2056-57) are presented below:

- The Local Catchment economy is estimated to record an increase in GRP of $17.8 billion over the 34 years examined relative to what would otherwise be expected to occur without the Project, with a present value of $6.1 billion (at a 7% discount rate). This reflects an average annual contribution of 2.02% per annum to total GRP in the Local Catchment over this period.
- The Northern Queensland Catchment economy (inclusive of the Local Catchment) is estimated to record an increase in GRP of $17.9 billion over the 34 years examined relative to what would otherwise be expected to occur without the Project, with a present value of $6.2 billion (at a 7% discount rate). This reflects an average annual contribution of 0.42% per annum to total GRP in the Northern Queensland Catchment over this period.
- The Queensland economy (inclusive of the Northern Queensland Catchment) is estimated to record an increase in GSP of $19.2 billion over the 34 years examined relative to what would otherwise be expected to occur without the Project (inclusive of the contribution to the Northern Queensland Catchment), with a present value of $6.6 billion (at a 7% discount rate). This reflects an average annual contribution of 0.09% per annum to total GSP in Queensland over this period.
- The Australian economy (inclusive of Queensland) is estimated to record an increase in GDP of $19.7 billion over the 34 years examined relative to what would otherwise be expected to occur without the Project (inclusive of the contribution to the Northern Queensland Catchment), with a present value of $6.8 billion (at a 7% discount rate). This reflects an average annual contribution of 0.02% per annum to total GDP in Australia over this period.

Figure 4.1. Annual Impact on GRP/ GSP, Deviation from Base Case



Source: Prime Research (unpublished)

4.1.2 Impacts on Industry Output

Modelling outcomes of the average annual impacts of the Project on industry output in the Local Catchment, Northern Queensland Catchment, Queensland and Australia between the commencement of construction through to decommissioning (2023-24 to 2056-57) are presented below.

On average, between 2023-24 and 2056-57, the Project is estimated to deliver the following annual impacts on industry output:

- The Local Catchment is estimated to record an increase of $997.8 million per annum in industry output relative to what would otherwise be expected to occur without the Project.
- The Northern Queensland Catchment is estimated to record an increase of $916.9 million per annum in industry output relative to what would otherwise be expected to occur without the Project. While the industry output in the Local Catchment is expected to be considerably greater than would occur without the Project, the rest of the Northern Queensland Catchment is estimated to produce approximately $81.0 million less in industry output per annum relative to what would be expected to occur without the Project, reflecting a combination of some transfer of activity to the Local Catchment as well as some shifts in industry mix as supply chains grow to support the Project.
- Queensland is estimated to record an increase of $965.2 million per annum in industry output relative to what would otherwise be expected to occur without the Project. This indicates an approximately $48.2 million increase in output per annum in the rest of Queensland (i.e. outside of the Northern Queensland Catchment) due to the Project.
- Australia is estimated to record an increase of $838.5 million per annum in industry output relative to what would otherwise be expected to occur without the Project. This indicates the rest of Australia (i.e. outside of Queensland) is estimated to produce approximately $126.4 million less in industry output per annum relative to what would be expected to occur without the Project. As with the rest of the Northern Queensland Catchment, this reflects a transfer of some activity (and jobs, see section 4.1.3) to Queensland to support the Project.

Notably, while the rest of Northern Queensland Catchment and the rest of Australia is expected to produce less in output, the contribution to GRP/ GDP in these regions is projected to increase (see section 4.1.1), reflecting the Project will attract activity to higher value adding industries.

As expected, impacts on industry output are anticipated to be highest for the manufacturing industry in all catchments, averaging $831.0 million per annum in the Local Catchment, $682.9 million in the Northern Queensland Catchment and $762.9 million in Queensland. This reflects the direct manufacturing activities supported by the Project. The next largest increases in industry output are estimated to be:

- The construction industry ($93.0 million in the Local Catchment, $97.2 million in the Northern Queensland Catchment, $105.0 million in Queensland), primarily reflecting direct activities associated with initial construction activities, with smaller contributions to activity for the industry during Project operations.
- Business services ($44.1 million in the Local Catchment, $144.5 million in the Northern Queensland Catchment, $43.8 million in Queensland), reflecting a combination of demand for businesses services to supply the Project during construction and operations as well as flow-on demand for business services throughout the supply chain.

While overall the Project will deliver an increase in industry output, both directly and through flow-on activity, some industries are expected to record lower levels of industry output relative to what would otherwise occur in the base case (without the Project). This lower level of activity from the base case for some industries is largely a reflection of factors such as competition for constrained labour resources and increased costs of businesses as competition for resources drives input prices up (including labour).

The mining industry is expected to experience the largest adverse impacts from the Project in terms of lower levels of industry output compared to what would be expected to occur without the Project. The mining industry provides a lot of similar skills as used in manufacturing and construction and typically operates in global markets competing with international producers, making it a price taker with limited capacity to increase price beyond global market rates to accommodate rising input costs without losing market share. It should be noted that while the mining industry is estimated to experience lower levels of industry output compared to what would otherwise occur, the contraction in percentage terms is small relative to the overall size of the industry (i.e. less than 0.01% in Queensland).

On a percent basis, the manufacturing industry will have the largest industry output change, increasing by approximately 10.12% in the Local Catchment and 2.44% in the Northern Queensland Catchment on average per annum relative to what would otherwise occur without the Project.

Table 4.1. Average Annual Impact on Industry Output, Deviation from Base Case

Industry	Local Catchment	Northern Queensland Catchment	Queensland	Australia
Change in Industry Output ($M)				
Agriculture, Forestry & Fishing	-$1.9	-$6.3	-$4.1	-$12.8
Mining	-$4.3	-$114.8	-$2.4	-$57.8
Manufacturing	$831.0	$682.9	$762.9	$591.3
Electricity and Water	$6.7	$21.4	$6.0	$33.9
Construction	$93.0	$97.2	$105.0	$109.9
Trade[1]	$5.3	$19.5	$12.4	$29.5
Transport and Storage	$23.7	$66.1	$23.2	$25.5
Communication[2]	-$2.9	-$7.4	-$4.1	-$7.4
Finance and Insurance	-$3.9	-$11.2	-$2.9	$18.4
Business Services[3]	$44.1	$144.5	$43.8	$24.2
Public Services, Health and Education[4]	$2.5	$7.0	$7.8	$34.7
Recreation and Other Services[5]	-$1.8	-$6.4	-$2.5	-$5.2
Ownership of Dwellings	$6.3	$24.4	$20.0	$54.2
Total Change ($M)	**$997.8**	**$916.9**	**$965.2**	**$838.5**
Change in Industry Output (%)				
Agriculture, Forestry & Fishing	-0.15%	-0.09%	-0.02%	-0.01%
Mining	-0.40%	-0.19%	0.00%	-0.01%
Manufacturing	10.12%	2.44%	0.50%	0.08%
Electricity and Water	0.23%	0.25%	0.01%	0.02%
Construction	1.91%	0.62%	0.08%	0.02%
Trade[1]	0.09%	0.09%	0.01%	0.00%
Transport and Storage	0.68%	0.45%	0.03%	0.01%
Communication[2]	-0.28%	-0.28%	-0.01%	0.00%
Finance and Insurance	-0.32%	-0.32%	-0.01%	0.01%
Business Services[3]	1.04%	1.04%	0.04%	0.00%
Public Services, Health and Education[4]	0.03%	0.03%	0.00%	0.00%
Recreation and Other Services[5]	-0.15%	-0.15%	-0.01%	0.00%
Ownership of Dwellings	0.23%	0.23%	0.03%	0.01%
Total Change (%)	**2.13%**	**0.41%**	**0.09%**	**0.01%**

Note:
(1) Includes wholesale trade, retail trade, accommodation and food services.
(2) Includes postal and courier services and telecommunication services.
(3) Includes services to mining, property and business services, professional services, administrative services and personal/ household goods hiring.
(4) Includes public administration, defence, education and training, health care and social services.
(5) Includes arts, recreation services, gambling services and other services.

Source: Prime Research (unpublished).

4.1.3 Impacts on Employment

A summary of modelling outcomes of the Project on employment in the Local Catchment, Northern Queensland Catchment, Queensland and Australia between the commencement of construction through to decommissioning (2023-24 to 2056-57) are presented below.

Overall, between 2023-24 and 2056-57, the Project is estimated to support:

- An average of 463 FTE jobs per annum in the Local Catchment, with a peak of 634 FTE jobs in 2025-26.

- An average of 507 FTE jobs per annum in the Northern Queensland Catchment (inclusive of the Local Catchment), with a peak of 665 FTE jobs in 2025-26.
- An average of 507 FTE jobs per annum in Queensland (inclusive of the Northern Queensland Catchment), with a peak of 658 FTE jobs in 2025-26. A slightly lower number of total FTE job years supported in Queensland than in the Northern Queensland Catchment reflects some movement of labour to the Local Catchment and Northern Queensland Catchment to support the Project (thus producing a negative value for FTE job years in the rest of Queensland).
- An average of 347 FTE jobs per annum in Australia (inclusive of Queensland), with a peak of 481 FTE jobs in 2024-25. As with Queensland, the lower number of total FTE job years supported in Australia than in Queensland reflects movement of labour from the rest of Australia to Queensland to support the Project.

In percent terms, the peak year of employment in the Local Catchment, Northern Queensland Catchment and Queensland (2025-26) is estimated to result in total employment in the Local Catchment being 0.60% higher than would be anticipated to occur without the Project, as well as 0.15% higher in the Northern Queensland Catchment and 0.03% higher in Queensland.

Table 4.2. FTE Job Years Supported, Deviation from Base Case

Indicator	Total FTE Job Years (1)	Average Annual FTE Jobs	Peak Annual FTE Jobs	Peak Year
Employment (FTEs)				
Local Catchment	15,750	463	634	2025-26
Northern Queensland Catchment	17,251	507	665	2025-26
Queensland	17,236	507	658	2025-26
Australia	11,788	347	481	2024-25
Employment Change (%)				
Local Catchment	N/A	0.36%	0.60%	2025-26
Northern Queensland Catchment	N/A	0.09%	0.15%	2025-26
Queensland	N/A	0.02%	0.03%	2025-26
Australia	N/A	0.003%	0.004%	2024-25

Note: (1) An FTE job is equivalent to one person working full time for a period of one year. An FTE job year is used as an equivalence measure of the total number of FTE jobs that would be required to complete an activity in one year, or the number of years it would take one FTE employee to complete an activity.
Source: Prime Research (unpublished).

A breakdown of the average annual employment impacts from the Project between 2023-24 and 2056-57 by industry in the Local Catchment, Northern Queensland Catchment, Queensland and Australia is presented below.

As can be expected, the manufacturing industry is estimated to record the largest average annual increase in jobs as a result of the Project, averaging 179 additional FTE jobs per annum in the Local Catchment, 186 additional FTE jobs per annum in the Northern Queensland Catchment and 107 additional FTE jobs per annum in Queensland. Notably, in Australia the manufacturing industry is estimated to see an overall contraction in manufacturing jobs, which partially reflects a transfer of labour to Queensland and partially reflects impacts of the Project (which will export products) on exchange rates, which can adversely impact on other export-focused manufacturing businesses that are price takers.

Business services is estimated to record the next largest increase in the Local Catchment (107 FTE jobs per annum), while mining is estimated to record the next largest increase in the Northern Queensland Catchment (97 FTE jobs per annum) and Queensland (115 FTE jobs per annum).

The Queensland agriculture industry is estimated to record the largest decline in employment due to the Project (contraction of 30 FTE jobs per annum in Queensland) relative to what would otherwise be expected to occur in the base case, which can largely be attributed to agricultural jobs transferring to other sectors to support the Project.

On a percent basis, the manufacturing industry is estimated to record an increase in employment in the Local Catchment of 2.48% relative to what would otherwise occur without the Project, as well as 0.67% in the Northern Queensland Catchment and 0.06% in Queensland.

Table 4.3. Average Annual Impact on Employment (FTEs) by Industry, Deviation from Base Case

Industry	Local Catchment	Northern Queensland Catchment	Queensland	Australia
Change in Industry Employment (FTEs)				
Agriculture, Forestry & Fishing	-8	-18	-30	-62
Mining	-13	97	115	72
Manufacturing	179	186	107	-81
Electricity and Water	6	3	3	40
Construction	43	24	50	59
Trade[1]	46	49	73	108
Transport and Storage	48	38	35	25
Communication[2]	-2	-8	-9	-18
Finance and Insurance	-1	-4	0	14
Business Services[3]	107	86	89	44
Public Services, Health and Education[4]	56	56	77	157
Recreation and Other Services[5]	1	-2	-2	-11
Ownership of Dwellings	0	0	0	0
Total Change (FTEs)	**463**	**507**	**507**	**347**
Change in Industry Employment (%)				
Agriculture, Forestry & Fishing	-0.17%	-0.06%	-0.04%	-0.018%
Mining	-0.66%	0.17%	0.13%	0.023%
Manufacturing	2.48%	0.67%	0.06%	-0.010%
Electricity and Water	0.23%	0.02%	0.00%	0.026%
Construction	0.40%	0.07%	0.02%	0.005%
Trade[1]	0.19%	0.05%	0.01%	0.004%
Transport and Storage	0.90%	0.16%	0.03%	0.005%
Communication[2]	-0.09%	-0.12%	-0.01%	-0.003%
Finance and Insurance	-0.06%	-0.06%	0.00%	0.003%
Business Services[3]	0.97%	0.20%	0.03%	0.003%
Public Services, Health and Education[4]	0.11%	0.03%	0.01%	0.004%
Recreation and Other Services[5]	0.04%	-0.01%	0.00%	-0.002%
Ownership of Dwellings	0.00%	0.00%	0.00%	0.000%
Total Change (%)	**0.36%**	**0.09%**	**0.02%**	**0.003%**

Note:
(1) Includes wholesale trade, retail trade, accommodation and food services.
(2) Includes postal and courier services and telecommunication services.
(3) Includes services to mining, property and business services, professional services, administrative services and personal/ household goods hiring.
(4) Includes public administration, defence, education and training, health care and social services.
(5) Includes arts, recreation services, gambling services and other services.

Source: Prime Research (unpublished).

4.1.4 Impacts on Wages and Salaries

The increase in jobs due to the Project will result in additional incomes in the Local Catchment, Northern Queensland Catchment, Queensland and Australia relative to what would occur without the Project, both directly as a result of the jobs supported as well as through a small lift in real wages generated by increased competition for labour.

Modelling outcomes of the impacts of the Project on employee incomes (i.e. wages and salaries) between 2023-24 and 2056-57 indicate:

- A total of $3.4 billion in additional wages and salaries are estimated to be paid to employees in the Local Catchment over the 34 years examined, averaging $99.2 million per annum, with a present value of $1.3 billion (at a 7% discount rate). Real wages growth of 0.67% per annum on average is estimated over the 34 years, indicating that the average employee income is estimated to be 0.67% higher in the Local Catchment with the Project than would be expected without the Project.

- A total of $4.6 billion in additional wages and salaries are estimated to be paid to employees in the Northern Queensland Catchment (inclusive of the Local Catchment) over the 34 years examined, averaging $136.2 million per annum, with a present value of $1.7 billion (at a 7% discount rate). Real wages growth of 0.24% per annum on average is estimated across the Northern Queensland Catchment relative to what would occur without the Project.
- A total of $6.2 billion in additional wages and salaries are estimated to be paid to employees in Queensland (inclusive of the Northern Queensland Catchment) over the 34 years examined, averaging $183.1 million per annum, with a present value of $2.3 billion (at a 7% discount rate). Real wages growth of 0.05% per annum on average is estimated across Queensland relative to what would occur without the Project.
- A total of $9.0 billion in additional wages and salaries are estimated to be paid to employees in Australia (inclusive of Queensland) over the 34 years examined, averaging $264.3 million per annum, with a present value of $3.2 billion (at a 7% discount rate). Real wages growth of 0.02% per annum on average is estimated across Australia relative to what would occur without the Project.

Table 4.4. Annual Increase in Employee Incomes and Real Wages Growth, Deviation from Base Case

Indicator	Average Annual Incomes Paid ($M)	Total Incomes Paid ($M)	Present Value of Incomes Paid ($M) – 7% Discount Rate	Average Annual Real Wages Growth (%)
Local Catchment	$99.2	$3,373.9	$1,258.6	0.67%
Northern Queensland Catchment	$136.2	$4,630.8	$1,672.9	0.24%
Queensland	$183.1	$6,226.8	$2,271.1	0.05%
Australia	$264.3	$8,987.4	$3,200.0	0.02%

Source: Prime Research (unpublished)

4.2 PUBLIC BENEFIT

Guidelines from NAIF (and other programs) outline a requirement to extract the public benefit of a Project only (i.e. excluding the benefit to the proponent) to understand whether investment in a Project will deliver a net public benefit to the community.

Assessing public benefit can be undertaken a number of different ways, with the best approach dependent on the type of Project. For example, the public benefit from a community infrastructure project such as a hospital may be best measured based on the value of improved health outcomes and lives saved. Conversely, for projects that involve the manufacture of goods such as the TECH Project, the public benefits of the Project are typically best measured in terms of the GRP/ GSP/ GDP they deliver, as this represents the additional value delivered to an economy by the Project. GRP/ GSP/ GDP includes both the gross operating surplus (i.e. gross profits) made by business, the wages and salaries paid to employees, as well as some taxes paid to government.

The above analysis in section 4.1.1 outlines the total GRP/ GSP/ GDP that will be delivered by the Project from 2023-24 onwards, including benefits to QPM (i.e. proponent gross operating profits) through facility operation and production, benefits to businesses in the supply chain (i.e. gross profits to businesses through production induced impacts), benefits to businesses from increased household consumption (i.e. gross profits to businesses through household consumption impacts), and benefits to the workers engaged both directly and indirectly (i.e. incomes across direct and flow-on activity). As the modelling was undertaken using CGE modelling, it also incorporates consideration of transfer/ loss of activity from some sectors to meet the resource requirements of the Project (as opposed to Input-Output modelling, for instance, which does not account for this transfer).

In this instance, the public benefit can be measured by subtracting QPM's gross operating profits from the estimated GRP/ GSP/ GDP supported by the Project, to provide a measure of the net benefit to the economy excluding benefits to QPM. The table below provides an estimate of the GRP/ GSP/ GDP supported by the Project, excluding gross operating profits to QPM. Excluding the benefit to the proponent, the undiscounted public benefit delivered by the Project to Australia (i.e. gross profit to businesses in the supply chain and incomes paid to workers) is estimated to be $6.1 billion.

The annual additional economic (GRP/ GSP/ GDP) impacts from the public benefit activity delivered by the Project (i.e. excluding gross profit to the proponent) have been provided at undiscounted values and present values at discount rates of 4%, 7% and 10%, over 5, 10 and 20 year operational periods as well as in total for the Project.

Table 4.5. Present Value of Public Benefit ($M)

Impact	Undiscounted	Discount Rate		
		4%	7%	10%
After 5 Years of Operation				
Local Catchment	$851.8	$703.0	$614.4	$540.8
Northern Queensland Catchment	$900.6	$743.8	$650.3	$572.8
Queensland	$1,113.5	$928.9	$818.5	$726.6
Australia	$1,157.6	$965.5	$850.9	$755.6
After 10 Years of Operation				
Local Catchment	$1,509.5	$1,130.7	$927.9	$773.1
Northern Queensland Catchment	$1,583.3	$1,187.8	$976.0	$814.1
Queensland	$1,926.0	$1,457.0	$1,205.6	$1,013.3
Australia	$2,037.3	$1,537.2	$1,269.8	$1,065.8
After 20 Years of Operation				
Local Catchment	$2,848.6	$1,782.7	$1,317.9	$1,011.1
Northern Queensland Catchment	$2,956.2	$1,856.5	$1,376.1	$1,058.3
Queensland	$3,666.6	$2,302.4	$1,710.4	$1,320.9
Australia	$3,950.6	$2,465.9	$1,824.2	$1,403.5
Total Project Benefit				
Local Catchment	$4,203.8	$2,227.8	$1,518.1	$1,103.8
Northern Queensland Catchment	$4,344.4	$2,312.3	$1,581.0	$1,153.2
Queensland	$5,608.2	$2,936.7	$1,994.7	$1,452.0
Australia	$6,091.3	$3,167.5	$2,139.1	$1,549.0

Source: Prime Research (unpublished), QPM (unpublished a), AEC.

4.3 OTHER PUBLIC/ ECONOMIC BENEFITS

4.3.1 Contribution to Government Revenues

4.3.1.1 Approach

Estimates of taxation revenue to the Queensland and Australian Government have been developed based on benchmarks of taxation revenue received compared to relevant Queensland and Australian measures, and applied to results from CGE modelling for Queensland and Australia.

The following benchmarks were applied by taxation item:

- **Personal income tax (Australian Government):** Total income tax received (ABS, 2023 b) compared to total wages and salaries paid to Australian employees (ABS, 2023 c; ABS, 2023 d) between the financial years of 2012-13 and 2021-22. This was applied to estimates of incomes paid in Australia from the modelling.
- **Fringe benefits tax (Australian Government):** Total fringe benefits tax received (ABS, 2023 b) compared to total wages and salaries paid to Australian employees (ABS, 2023 c; ABS, 2023 d) between the financial years of 2012-13 and 2021-22. This was applied to estimates of incomes paid in Australia from the modelling.
- **Company income tax (Australian Government):** Total company tax received (ABS, 2023 b) compared to total gross profit of businesses in Australia (i.e., total GDP less total wages and salaries paid to employees) (ABS, 2022 a; ABS, 2023 c; ABS, 2023 d) between the financial years of 2012-13 and 2021-22. This was applied to estimates of GDP less incomes paid in Australia from the modelling.

- **Goods and services tax (GST) (Australian Government):** Total GST received (ABS, 2023 b) compared to total Australian GDP (ABS, 2022 a) between the financial years of 2012-13 and 2021-22. This was applied to estimates of GDP for Australia from the modelling. Given the pass-through of GST by the Australian Government to the Queensland Government is close to dollar-for-dollar, this has been included in the analysis as Queensland Government revenue.
- **Payroll tax (Queensland Government):** Total payroll tax received (ABS, 2023 b) compared to total wages and salaries paid to Queensland employees (ABS, 2023 c; ABS, 2023 d) between the financial years of 2012-13 and 2021-22. This was applied to estimates of incomes paid in Queensland from the modelling.

Both direct and flow-on impacts are included in the estimation of the above taxation revenues. Government revenues were discounted to present value terms using a discount rate of 7%.

4.3.1.2 Tax Revenues

Estimates of anticipated taxation revenue (undiscounted and at a 7% discount rate) from both direct and flow-on activity associated with the Project are summarised in the table below.

The Queensland Government is estimated to receive approximately $831.4 million in net additional revenue ($288.9 million in present value terms), through payroll tax and GST pass-through, over the life of the Project. The Australian Government is estimated to receive approximately $3,089.6 million ($1,089.0 million in present value terms) in various taxes over the life of the Project.

It should be noted that a portion of Australian Government revenues are likely to provide benefits to Queensland, with the State allocated a large portion of GST revenue as well as through the subsequent expenditure and redistribution of Australian Government revenues to provide services and infrastructure throughout Australia (including in Queensland). Revenue to Government Owned Corporations in Queensland such as Powerlink and Port of Townsville are not included, but are also significant.

Table 4.6. Aggregate Government Revenues Supported by the Project ($M)

Tax	After 5 Years of Operation	After 10 Years of Operation	After 20 Years of Operation	Total Project Impact
Undiscounted				
Queensland Government				
Payroll Tax	$35.0	$57.7	$108.0	$164.5
GST	$114.2	$222.0	$446.5	$666.9
Total	**$149.2**	**$279.6**	**$554.5**	**$831.4**
Australian Government				
Personal Income Tax	$432.8	$731.3	$1,407.7	$2,172.1
Fringe Benefits Tax	$9.9	$16.7	$32.2	$49.7
Company Income Tax	$142.7	$297.4	$602.0	$867.8
Total	**$585.4**	**$1,045.5**	**$2,041.9**	**$3,089.6**
Total Government Revenue	***$734.7***	***$1,325.1***	***$2,596.4***	***$3,921.0***
7% Discount Rate				
Queensland Government				
Payroll Tax	$26.3	$37.1	$51.6	$60.0
GST	$79.2	$130.5	$195.8	$228.9
Total	**$105.5**	**$167.6**	**$247.4**	**$288.9**
Australian Government				
Personal Income Tax	$322.3	$464.4	$659.8	$773.4
Fringe Benefits Tax	$7.4	$10.6	$15.1	$17.7
Company Income Tax	$94.9	$168.6	$257.6	$297.9
Total	**$424.6**	**$643.6**	**$932.4**	**$1,089.0**
Total Government Revenue	***$530.0***	***$811.2***	***$1,179.8***	***$1,377.9***

Note: Totals may not sum due to rounding.
Sources: ABS (2022 a, 2023 b, 2023 c, 2023 d), Prime Research (unpublished), AEC.

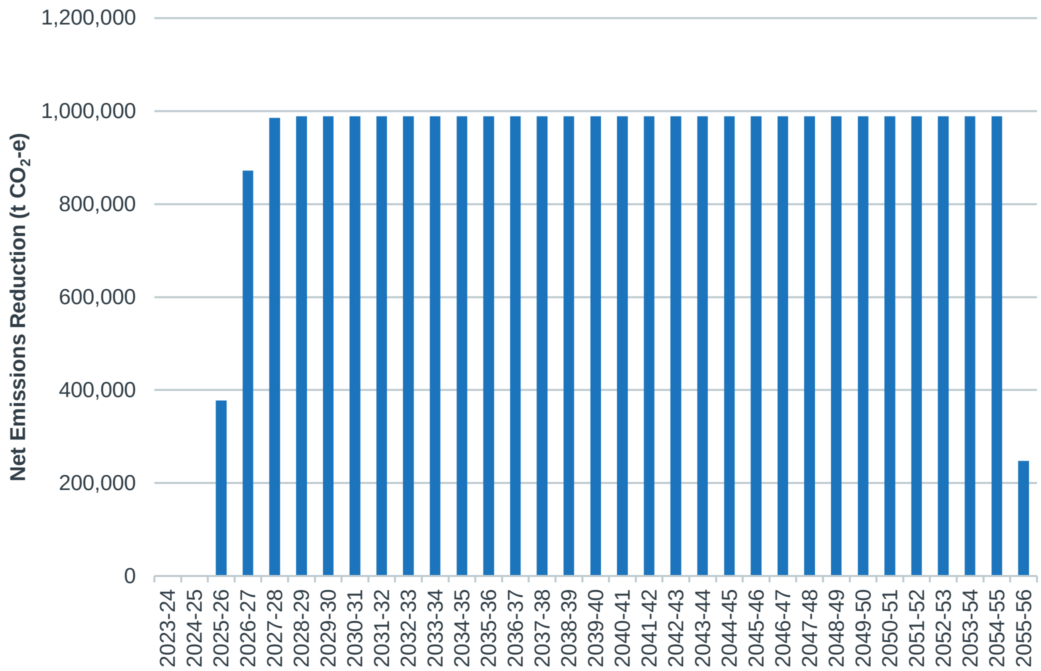
4.3.2 Contribution to Greenhouse Gas Emissions Targets

Australia has committed to achieving net zero emissions by 2050, with an interim target to reduce GHG emissions by 43% below 2005 levels by 2030 (Australian Government, 2022). Queensland has also committed to achieving net zero emissions by 2050 in line with the national target, with an interim emissions reduction target of 30% below 2005 levels by 2030 (Queensland Government, 2023 a). The Project will contribute to achieving these government targets by directly reducing total carbon emissions in Australia and Queensland.

Through QPM Energy's CAH and the Moranbah Gas Project (refer to section 2.1.4), total carbon emissions will directly be reduced by harvesting waste metallurgical coal mine gas from mines in the Northern Bowen Basin for productive use, which would otherwise be flared or directly emitted into the atmosphere as a fugitive emission of methane. Through this process, the Project will be net carbon negative and deliver saleable carbon credits.

Estimates of the annual net reduction in GHG emissions for Stage 1 of the TECH Project is presented below.

Figure 4.2. Project Annual Net GHG Emissions Reduction (t CO_2-e)



Source: QPM (unpublished a)

In developing the above annual estimates, the peak production of processed ore was assumed to correspond with peak net carbon emissions reduction. The level of net carbon emissions reduction for other years was estimated based on the percentage of processed ore in comparison to the production in peak years, as per the annual production outlined in Table 3.6.

The value of saleable carbon credits delivered by the Project was based on the value of Australian Carbon Credit Units (ACCUs), which was found to be approximately $35 per tonne of CO_2-e as of 13 June 2023 (Jarden, 2023). The undiscounted value of anticipated saleable carbon credits delivered over the life of the Project was estimated at approximately $1.0 billion, with a present value of approximately $355.5 million at a 7% discount rate.

4.3.3 Supporting Development of Electric Vehicles

The Project will support the development of EVs through the establishment of a sustainable, high-purity critical minerals refinery that will produce the necessary materials required for the manufacture of batteries used to power EVs. Specifically, development of the refinery is expected to meet the strong forecast growth in demand for nickel and cobalt sulphates, which are critical inputs to the lithium-ion battery manufacturing sector and any subsequent EV development that occurs as a result.

Petroleum vehicles are powered by an internal combustion engine which produces tailpipe emissions, while battery powered vehicles such as EVs do not produce any tailpipe emissions (Australian Government, 2023 a). Studies have demonstrated the reduced level of carbon emissions that EVs emit over the lifetime of the vehicle in comparison to petroleum vehicles (MIT Climate, 2022). The use of Project outputs in downstream production will support the current global transition being observed away from petroleum vehicles and towards lower carbon footprint transport that EVs facilitate (and thereby further support a reduction in GHG emissions and progress towards emissions targets).

4.3.4 Waste Reduction

By employing the proprietary DNi Process™ during production, the Project will significantly reduce waste product that would otherwise be produced via traditional HPAL processes. HPAL most commonly uses sulfuric acid leach under high temperature and pressure conditions, while the DNi Process™ is based on nitric acid leaching of ore and subsequent acid regeneration.

Table 2.1 outlines the numerous production and environmental advantages that the DNi Process™ provides in comparison to traditional HPAL processes. Amongst other factors, the DNi Process™ directly reduces the production of waste product that would otherwise occur via HPAL, primarily via the:

- Recovery of additional valuable metals from the ore (including saleable co-products).
- Elimination of tailings waste materials (thus not requiring neutralisation or a tailings dam for storage).
- Harvesting of residue for productive use as engineering landfill.
- Elimination of process liquid discharge.
- Recycling of acid for future production.

Through the implementation of this process, the Project will not only reduce waste, but create new green product for use in other industrial applications. Due to the groundbreaking nature of these outcomes, the Project has the potential to facilitate future waste reduction in other instances beyond the Project both domestically and internationally, by acting as an exemplar for a practical application of the technology.

4.3.5 Supporting Local Business

A significant land use change on the Project site, from undeveloped grazing land to the development of a major manufacturing facility, will provide a considerable injection for local businesses as well as the local supply chains these businesses support. The Project will support an increase in economic activity for local Woodstock and Townsville businesses throughout Project operations, increasing their revenues and generating a positive impact to downstream suppliers through increased expenditure on operational inputs than would otherwise occur without the Project. Potential benefits to local businesses in terms of increased revenues is highlighted through the business output supported by the Project in the Local Catchment (Townsville) as outlined in section 4.1.2. Outside of the manufacturing industry (which predominantly represents operations of the TECH Project), other industries are estimated to average an increase in business output of approximately $166.8 million per annum in aggregate.

The potential establishment of a construction camp for Project workers would also create a significant economic injection for local business. A vast array of goods and services are typically procured for the operation of worker camps, supporting direct and flow-on activity locally across a range of industries. With an average of 578 FTE jobs per annum estimated to be required over the approximately three-year Project construction period (QPM, unpublished a), the attainment of supply contracts by local suppliers for such a facility can generate a large and immediate increase in their revenues and boost the local economy.

4.3.6 Indigenous Employment

The employment of Indigenous persons will also be supported as a result of the Project. Estimates of Indigenous employment supported by the Project were derived by estimating the shares of Indigenous employment within each industry using ABS 2021 Census data (ABS, 2022 b) as in the table below. These shares were applied to the modelling outcomes of the Project on employment detailed in section 4.1.3.

Table 4.7. Share of Indigenous Employment by Industry, 2021 Census

Industry	Indigenous Employment	Total Employment	Share of Indigenous Employment
Agriculture, Forestry and Fishing	1,093	24,546	4.5%
Mining	2,672	38,593	6.9%
Manufacturing	921	24,913	3.7%
Electricity and Water	402	7,060	5.7%
Construction	2,596	40,240	6.5%
Trade	5,775	89,793	6.4%
Transport and Storage	1,438	23,835	6.0%
Communication	119	2,222	5.4%
Finance and Insurance	139	4,807	2.9%
Business Services	2,309	38,957	5.9%
Public Services, Health and Education	11,894	143,881	8.3%
Recreation and Other Services	1,575	24,347	6.5%

Source: ABS (2022 b)

A summary of Indigenous employment supported by the Project is shown in the table below. The Project is expected to support an average of 25 Indigenous FTE jobs per annum in the Local Catchment, and 29 Indigenous FTE jobs per annum in the Northern Queensland catchment (inclusive of the Local Catchment).

Table 4.8. Average Annual Impact on Indigenous Employment (FTE), Deviation from Base Case

Catchment	Indigenous Employment
Local Catchment	25
Northern Queensland Catchment	29
Queensland	32
Australia	28

Source: ABS (2022 b), Prime Research (unpublished).

4.3.7 Development of Public Infrastructure

Located within Townsville City Council's Lansdown Eco-Industrial Precinct, QPM's TECH Project will be Northern Australia's first environmentally sustainable advanced manufacturing and processing facility which can support the development of a technology hub. Acting as an important cornerstone of the precinct, the Project supports the development of an array of public infrastructure which has the potential to be shared by other projects or users over the life of the Project and beyond.

The Project will involve the development of a range of trunk and site infrastructure to support facility operations, including energy and gas pipeline infrastructure required to supply gas and power to the Project. This infrastructure has the potential to be utilised to transport gas and power to other future consumers that also undertake operations within the precinct. Likewise, indirect development of and/or upgrades to other key utilities such as water supply, wastewater and telecommunications infrastructure can be harnessed by other users on site once established.

In addition, upgrades to the local road network as a result of the Project will provide key shared transport benefits to both users of the site and general through traffic. This is particularly the case in terms of heavy and oversized vehicle accessibility to the site for future users, as well as for enhancing overall transport efficiency within the local area.

4.3.8 Catalyst for Future Development

Stage 1 of the TECH Project will initiate potential future development stages of the TECH Project, with QPM currently having proposed two stages. The second stage of the TECH Project is expected to effectively double the capacity of Stage 1, and result in sizable levels of future development on site in order to deliver future project outputs. This includes a potential expansion of the TECH project refinery to cater for increased capacity and development of a pCAM plant adjacent to the refinery for cathode material production. The catalytic nature of the Project raises the potential for the development of a battery critical minerals ecosystem, attracting production activities on other major downstream points of the battery supply chain (refer to Figure 2.2) and potential supporting industry.

The Project also provides a robust foundation in the case for including nickel on Australia's Critical Minerals List. Nickel is used in several high-energy density applications such as long-range EVs, commercial trucks and emerging aviation platforms, which act as critical components in decarbonising the economy (QPM, unpublished d). By establishing a key initial step of the battery supply chain locally, the addition of nickel on the Critical Minerals List would significantly increase the ability to attract investment into ESG-compliant lithium-ion battery manufacturing in Australia, posing significant potential for future development opportunities.

As an initial large industrial project located in Townsville's Lansdown Eco-Industrial Precinct, the TECH Project has the potential to anchor the entire eco-industrial project, encouraging further industrial development and investment in the precinct to establish a hub of advanced manufacturing and technology. Proponents of other industrial development projects are considerably more likely to invest in future development within the precinct with the presence of the TECH Project due to the range of co-locational benefits offered.

4.3.9 Building Northern Australia's, Queensland's and Australia's Reputation

The Project will provide reputational benefits to Townsville, Queensland and Australia via a significant investment in the region, raising business and community investor confidence and interest. Due to the groundbreaking nature of the Project and associated environmentally positive outcomes it is expected to provide over a sustained time period, the Project is likely to earmark Townsville, Queensland and Australia as a market leader in green technology development.

4.3.10 Supporting State and National Strategic Directives

The Project aligns with a number of existing state and national strategic directives, and is of great significance in achieving the objectives and policy goals they outline. These include, but are not limited to, those outlined below.

Table 4.9. Alignment of Project with Key Strategic Directives

Policy	Alignment
National	
Australian Critical Minerals Strategy	The Strategy establishes a framework to grow Australia's minerals sector, setting out how the Australian Government will work with an array of key stakeholders to seize strategic opportunities. The Project directly aligns with its objectives to: • Create diverse, resilient and sustainable supply chains through strong and secure international partnerships • Build sovereign capability in critical minerals processing • Use critical minerals to help become a renewable energy superpower • Create jobs and economic opportunity, including for regional and First Nations communities. In addition, the Project particularly supports the Strategy's focus areas of: • Developing strategically important projects • Promoting Australia as a world leader in ESG performance • Unlocking investment in enabling infrastructure and services • Growing a skilled workforce.
Australia-United States Climate, Critical Minerals And Clean Energy Transformation Compact	The Compact observes a commitment to enhance bilateral cooperation and strengthen ties between Australia and the United States. The Compact establishes a framework that intends to coordinate policies and investments to support, amongst other factors, the expansion and diversification of responsible clean energy and critical minerals supply chains. The Project directly supports intended actions of the Compact, including: • Accelerate the expansion and diversification of end-to-end clean energy supply chains • Promote responsible, sustainable and stable supply of critical minerals • Drive the development of emerging battery technologies.

State	
Queensland Critical Minerals Strategy	The Strategy seeks to provide targeted directives which will achieve Queensland's ambition to transform the state, national and global economy through the responsible use of critical minerals and create sustained economic prosperity. The Project supports objectives of the Strategy, including: • **Maximise investment:** Promote Queensland as a highly attractive investment destination, with growing processing and advanced manufacturing industries. • **Build value chains:** Develop supply chains and build onshore processing and manufacturing capabilities. • **Foster research and ESG excellence:** Establish strong corporate and social governance practices, with proponents demonstrating their operations will help achieve Queensland's decarbonisation ambitions and contribute to meeting climate targets at state and federal levels.

Source: Australian Government (2023 d, e), Queensland Government (2023 b).

5. COST BENEFIT ANALYSIS

5.1 METHOD AND APPROACH

The cost benefit analysis (CBA) presented in this section represents a socio-economic or social welfare CBA, designed to understand the net benefit (or cost) of the TECH Project to society as a whole. The CBA includes consideration of economic, social and environmental costs and benefits associated with the TECH Project. The CBA uses a framework that applies discounted cash flow techniques in accordance with the guidelines set out in the Queensland Government Business Case Development Framework (Queensland Government, 2021) and Australian Government Cost Benefit Analysis Guidance Note (Australian Government, 2023 c).

The CBA assesses the impact of the Project scenario outlined in chapter 3 compared to a scenario without the Project, examining the stream of relevant economic, social and environmental costs and benefits anticipated from the Project to assess the net present value of the Project to the Queensland community.

Decision Criteria:

The Net Present Value (NPV) and Benefit Cost Ratio (BCR) will be the primary decision criteria for the economic appraisal.

The NPV of a project expresses the difference between the present value (PV) of future benefits and PV of future costs:

$$NPV = PV\ Benefits - PV\ Costs$$

The BCR provides the ratio between the PV of benefits and PV of costs:

$$BCR = \frac{PV\ Benefits}{PV\ Costs}$$

Where the economic appraisal results in a:

- Positive NPV and BCR above 1: The project will be deemed as being desirable.
- NPV equal to zero and BCR of 1: The project will be deemed neutral (i.e., neither desirable nor undesirable).
- Negative NPV and BCR below 1: The project will be deemed undesirable.

The Internal Rate of Return (IRR) indicates the discount rate which would return an NPV of $0 and a BCR of 1, and is also reported.

The methodology used in conducting the CBA is outlined in **Appendix B**. Other key considerations for the CBA are outlined in the sections below.

5.1.1 Modelling Timeframes

The CBA examined the impacts of the Project between the financial year ending June 2024 (2023-24) to financial year ending June 2057 (2056-57), incorporating the construction period, the operational life of the Project, as well as decommissioning activities.

All dollar values are presented in 2022-23 Australian dollar terms and discounted to 2022-23 present value terms.

5.1.2 Discount Rates

A base discount rate of 7% has been used for demonstration purposes (in line with State and national standards for real discount rates used in economic appraisal of projects), with additional discount rates also examined (4% and 10%). As all values used in the CBA are in real terms, the discount rate does not incorporate inflation (i.e. it is a real discount rate, as opposed to a nominal discount rate).

5.1.3 Scenarios Examined

The CBA examines the net (or incremental) impacts (benefits and costs) of the Project (the 'Project Case' scenario) compared to a 'Base Case' scenario of what would be expected to occur without the Project. Note that the assessment has examined the net change between the Project Case and Base Case, rather than separate analyses of the two scenarios.

For the purposes of this CBA, the Project Case and Base Case are defined according to the below.

Project Case

The Project Case scenario is as per the information presented in chapter 3. Under this scenario, development of the critical minerals refinery proceeds and the production of economic outputs occurs.

Base Case

The Base Case scenario assumes the Project is not developed. Under this scenario, development of the critical minerals refinery in Townsville does not proceed and no other similar facility is assumed to be developed in Queensland or Australia. While this is not anticipated to materially impact the overall delivery of EV batteries or EVs globally, without the Project it is assumed Australia would not benefit from production of EV battery components to support the industry as expected from the Project.

5.2 COSTS AND BENEFITS EXAMINED

5.2.1 Costs

5.2.1.1 Initial Construction Costs

Initial construction costs and timing is as per that outlined in section 3.2.1.

5.2.1.2 Sustaining Capital Costs

Sustaining capital costs and timing is as per that outlined in section 3.3.1.

5.2.1.3 Operating Costs

Operating costs and timing, including decommissioning activities, is as per that outlined in section 3.4.3.

5.2.1.4 Traffic Generation Costs

The Project will generate additional transport movements than would otherwise occur without the Project for the movement of labour to and from the site, as well as transport associated with general freight movements of final products, input materials, fuel and supplies. This will result in increased vehicle fuel and maintenance costs, road damage costs as well as increase the risk of accidents due to increased travel.

Estimates of peak daily vehicle movements generated by the Project during construction and operations were developed by EMM (2021) and are summarised in the table below. Note that the table presents round trip vehicle movements (i.e. journeys to and from the site are counted as one vehicle movement). Assumptions used in developing these traffic estimates are presented in the *Transport Impact Assessment* (EMM, 2021).

Table 5.1. Peak Daily Vehicle Movements to/ from Site (No.)

Vehicle	Movements
Construction	
Light vehicle (car)	170
Tip Truck	139
Light Truck	55
Semi-trailer	24
Oversized Vehicle	2
Total	**390**
Operations	
Light vehicle (car)	16
Bus	12
Semi-trailer	13.5
Double Road Train	19.4
Triple Road Train	102.2
Total	**163.1**

Note: Round trip vehicle movements.
Source: EMM (2021)

Annual estimates of vehicle movements during construction were sourced from QPM (unpublished a) and are presented below. These estimates were based on the peak daily vehicle movements during construction outlined above.

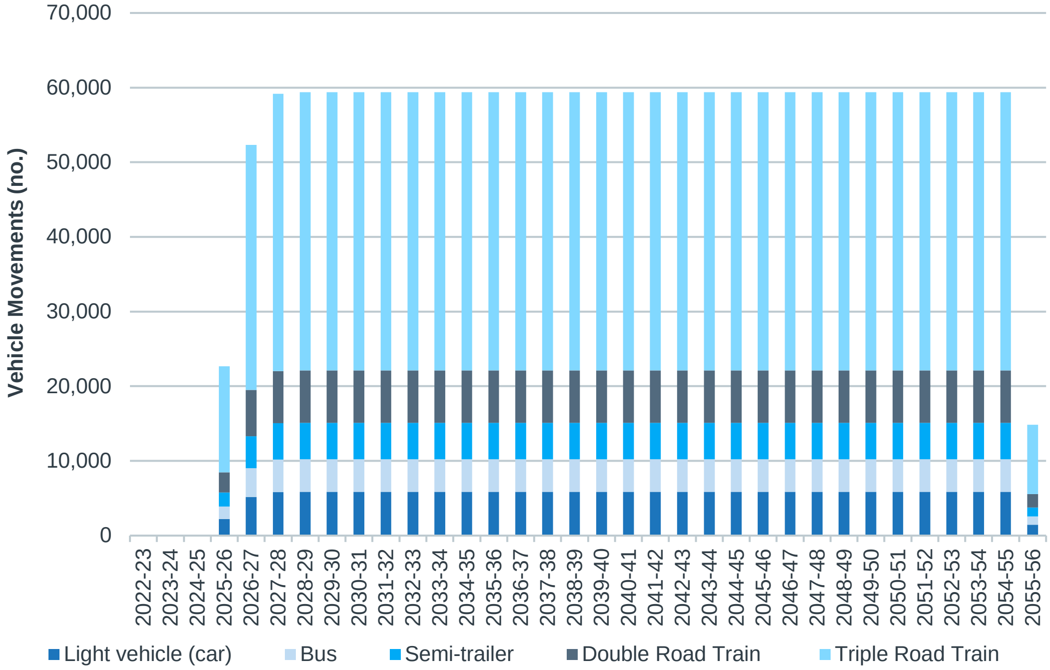
Table 5.2. Annual Vehicle Movements to/ from Site During Construction (No.)

Vehicle	2022-23	2023-24	2024-25	Total
Light vehicle (car)	36,666	62,050	23,622	**122,338**
Tip Truck	27,595	46,500	7,317	**81,412**
Light Truck	10,919	18,399	2,896	**32,214**
Semi-trailer	4,765	8,029	1,264	**14,058**
Oversized Vehicle	398	670	106	**1,174**
Total	**80,343**	**135,648**	**35,205**	**251,196**

Source: QPM (unpublished a)

Annual estimates of vehicle movements during operations (presented below) were based on the peak daily vehicle movements during operations outlined above. Daily vehicle movements were converted to annual estimates assuming the site operates for 365 days a year. The peak production of processed ore was assumed to correspond with peak operations vehicle movements. The number of vehicle movements for other years during operations was estimated based on the percentage of processed ore in comparison to the production in peak years, as per the annual production outlined in Table 3.6.

Figure 5.1. Annual Vehicle Movements to/ from Site During Operations (No.)



Source: EMM (2021)

For the purpose of the assessment adopting a conservative approach, it was assumed that all project-related light and heavy vehicles will travel to/ from Townsville (EMM, 2021). Estimates of the total vehicle kilometres travelled each year were developed based on an average distance of approximately 40 km each way for travel between Townsville and the site.

The cost of additional traffic generation due to the Project has been measured through additional:

- Vehicle operating costs (associated with fuel and vehicle maintenance).
- Road damage costs (associated with increased vehicle movements on roads).
- Road safety costs (associated with the increased risk of accidents due to increased travel).

These costs are examined below.

Vehicle Operating Costs

Estimated fuel costs were based on an average price in Woodstock for unleaded petrol (used for light vehicles) of approximately 185.9 c/L and an average price for diesel (used for light commercial vehicles, articulated trucks and buses) of approximately 187.9 c/L (PetrolSpy, 2023). These prices reflect the average cost for fuel in Woodstock as of 26 June 2023. GST of 10% and a fuel excise rate of 47.7 c/L (ATO, 2023) were subtracted from these prices to provide the resource cost for unleaded petrol and diesel. Average kilometres travelled per litre of unleaded petrol was estimated at 0.12 for light vehicles, while average kilometres travelled per litre of diesel was estimated at 0.13 for light commercial vehicles, 0.76 for articulated trucks and 0.28 for buses (ABS, 2020).

Estimates of vehicle repair and maintenance costs are presented in the table below (ATAP, 2016), accounting for inflation between June 2013 and June 2023 (ABS, 2023).

Table 5.3. Vehicle Repair and Maintenance Costs (c/km)

Vehicle	Cost (c/km)
Utility Vehicle – 4WD Mid-Size Petrol	10.8
Rigid Truck – Light (2 axle, 4 tyre)	8.0
Bus – Heavy Bus	17.2
Articulated Truck – 5 axle	29.2
Combination Vehicle – Rigid (3 axle) + dog trailer (5 axle)	33.1
Combination Vehicle – B-Double	34.8
Combination Vehicle – B-Triple	46.4

Source: ATAP (2016)

These fuel consumption rates and cost values were applied to the travel distances as estimated above.

Road Damage Costs

Estimates of road damage costs are presented in the table below (TfNSW, 2020), accounting for inflation between June 2019 and June 2023 (ABS, 2023).

Table 5.4. Road Damage Costs (c/km)

Vehicle	Cost (c/km)
Cars and Motorcycles	5.42
Rigid Truck – Light	5.42
Articulated Truck – 5 axle	20.44
Combination Vehicle – Rigid 3 axle plus trailer	20.29
Combination Vehicle – B-Double	31.13
Combination Vehicle – B-Triple	43.96
Bus – Light bus 2 axle	5.42

Source: TfNSW (2020)

These cost values were applied to the travel distances as estimated above.

Road Safety Costs

The *Transport Impact Assessment* (EMM, 2021) outlines the routes anticipated to be used, including whether the roads are sealed or unsealed and road widths. Data from ATAP (2016) provides average crash rates on non-urban roads for a range of road types and widths. Based on the preferred routes, the following average estimated crash rates per 100 million vehicle kilometres travelled were used:

- 1.24 crashes resulting in a fatality.
- 24.75 crashes resulting in a serious injury.
- 45.49 crashes resulting in minor injuries/ property damage.

The following estimated casualty costs were used, based on value estimates from ATAP (2016) and accounting for inflation between June 2013 and June 2023 (ABS, 2023). Values are inclusive of medical costs, insurance, workplace production losses, legal costs, vehicle and property repair costs, as well as other costs such as travel delays and emergency service provision.

- $2.9 million for crashes resulting in a fatality.
- $656,600 for crashes resulting in a serious injury.
- $25,700 for crashes resulting in minor injuries/ property damage.

These crash rates and cost values were applied to the travel distances as estimated above.

5.2.2 Benefits

5.2.2.1 Value of Production

The value of production has been estimated based on production rates of processed materials provided by QPM as summarised in section 3.4.1, combined with the assumed prices for these products as outlined in section 3.4.2.

5.2.2.2 Reduction in GHG Emissions

The Project will be net carbon negative, directly reducing total carbon emissions to deliver saleable carbon credits. These carbon credits were estimated at a value of $35 per tonne of CO_2-e, which represents the spot price of one ACCU as of 13 June 2023 (Jarden, 2023). Net annual carbon emissions reduction is as per that outlined in section 4.3.2.

5.2.3 Impacts That Have Not Been Quantified

The Project will generate a number of impacts in addition to those assessed in the above costs and benefits, including but not limited to ecological, geochemical, surface water, groundwater, erosion, air quality and noise impacts. These impacts were assessed as part of the Environmental Impact Statement undertaken in 2021 (EMM, 2022 b) and were assessed to be either negligible or of low impact or consequence, and thus have not been valued for inclusion in the CBA.

5.3 CBA RESULTS

5.3.1 Summary of CBA

The table below outlines the present value (PV) of the identified costs and benefits associated with the Project, between the financial year ended June 2024 and financial year ended June 2057. Values are presented with no discounting, as well as at discount rates of 4%, 7% and 10%.

The CBA modelling for the Project at the discount rate of 7% is economically desirable, with the following results:

- A Net Present Value (NPV) of $3,006.1 million over the assessment period with total present value (PV) benefits of approximately $11,140.9 million compared to an aggregated PV costs of approximately $8,134.8 million.
- A BCR of 1.37, highlighting that the Project is estimated to return $1.37 for every dollar cost.

The CBA identifies that, at a 7% discount rate, the Project is economically desirable with the benefits outweighing the costs. The Project returns a desirable result across each of the discount rates examined, with the BCR ranging between 1.26 (10% discount rate) and 1.48 (4% discount rate). The CBA is insensitive to the discount rate used with minimal change in BCR across discount rates examined. The Project has an Internal Rate of Return (IRR) of 18.4%.

Table 5.5. Summary CBA Results of Project Impacts to Queensland

Impact	Undiscounted ($M)	Present Value ($M)		
		4% Discount Rate	7% Discount Rate	10% Discount Rate
Costs				
Initial Construction	$2,109.9	$1,962.4	$1,862.7	$1,771.2
Sustaining Capital	$962.2	$493.4	$324.0	$225.4
Operations	$16,688.3	$8,739.5	$5,844.6	$4,143.3
Traffic Generation	$263.7	$146.3	$103.4	$78.1
Total Costs	***$20,024.1***	***$11,341.6***	***$8,134.8***	***$6,218.0***
Benefits				
Revenue	$31,233.9	$16,233.8	$10,785.4	$7,593.8
Reduction in GHG Emissions	$1,021.7	$533.3	$355.5	$251.1
Total Benefits	***$32,255.6***	***$16,767.1***	***$11,140.9***	***$7,845.0***
Summary				
Net Present Value (NPV)	**$12,231.4**	**$5,425.5**	**$3,006.1**	**$1,626.9**
Benefit Cost Ratio (BCR)	**1.61**	**1.48**	**1.37**	**1.26**

Source: AEC

5.3.2 Sensitivity Analysis

The sensitivity analysis has been undertaken using a Monte Carlo analysis (refer to **Appendix B**) across the key assumptions used in the CBA modelling (the base assumptions used are outlined in section 5.2).

Each of the assumptions has been tested in isolation with all other inputs held constant, with the results reported in Table 5.6 in terms of the modelled change in NPV resulting from the variance in the base assumptions at a discount rate of 7%. The final row of the table examines each assumption simultaneously to provide a "combined" or overall sensitivity of the model findings to the assumptions used. The table also outlines the distribution used allowing for a 10% confidence interval, with the "5%" and "95%" representing a 90% probability that the distribution and NPV will be within the range outlined in the table.

The table shows that, at a discount rate of 7%, there is a 90% probability the Project will provide an NPV between $962.6 million and $5,032.1 million. Sensitivity testing returned a positive NPV across 99.2% of the 5,000 iterations run in Monte Carlo analysis, with the analysis most sensitive to Project revenue.

Table 5.6. Sensitivity Analysis Summary, Discount Rate 7%

Variable	NPV ($M)	
	5%	95%
Costs		
Initial Construction	$2,665.8	$3,318.9
Sustaining Capital	$2,803.1	$3,049.2
Operations	$1,988.3	$4,010.2
Traffic Generation	$2,893.8	$3,041.1
Benefits		
Revenue	$1,084.2	$4,849.1
Reduction in GHG Emissions	$2,903.6	$3,011.0
Combined	**$962.6**	**$5,032.1**

Note: The percent distributions used for each variable are provided below:

- **Initial Construction:** Maximum 30% higher, minimum 20% lower.
- **Sustaining Capital:** Maximum 30% higher, minimum 20% lower.
- **Operations:** Normally distributed with standard deviation of 0.1.
- **Traffic Generation:** Normally distributed with standard deviation of 0.2.
- **Revenue:** Normally distributed with standard deviation of 0.1.
- **Reduction in GHG Emissions:** Normally distributed with standard deviation of 0.1.

Source: AEC.

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APPENDIX A: CGE METHODOLOGY

MODEL OVERVIEW

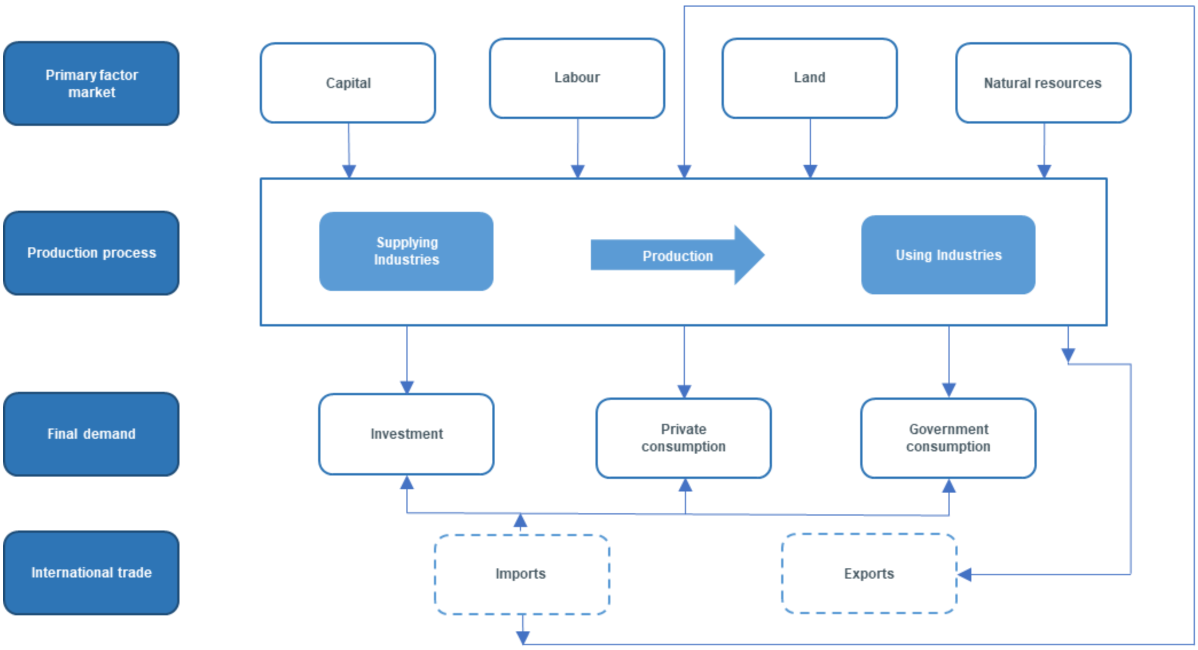
Computable General Equilibrium (CGE) economic models represent the workings of the economy through a system of interdependent behavioural and accounting equations linked to an input-output database.

Beginning with the production processes of individual industries, supported by inputs from other industries and the use of the primary factors of production, then adding in investment demand, private and government consumption, imports and exports, CGE modelling represents a fully integrated model of the world economy. In the model used for this assessment, production technology, individual markets, investment, trade and consumption are represented by equations with strong microeconomic foundations. The simultaneous solution of these equations in response to external changes (or 'shocks') generates the model solutions. When an economic shock, such as a new project, is applied to the model, each of the markets adjusts to a new equilibrium according to the economic theory and behavioural parameters that underpin the model.

In addition to recognising the linkages between industries in an economy, CGE models also recognise the constraints that apply in an economy (e.g. increased demand for labour will push the costs of labour up if there is full employment).

The CGE model used for this assessment is a dynamic model, which means it solves year-by-year, allowing a stream of annual results to be reported. Results are presented as deviations from a base (or reference) case, where the base case represents an anticipated growth path of the economy without the project.

Figure A.1. Representation of a Single Region in the CGE Model



MODELLING ASSUMPTIONS

The economic impacts of Stage 1 of the TECH Project on the Local Catchment, Northern Queensland Catchment, Queensland and national economies has been assessed by Prime Research utilising the Tasman Global Computable General Equilibrium (CGE) modelling framework.

Dynamic simulations using CGE modelling require two separate model runs. The first model run, known as the 'base case', simulates one view of the economic future. In this view of the future, the Project does not proceed.

In the second model run, known as the 'with project case', an alternative view of the economic future is simulated. In this view of the future, the Project development proceeds and includes activities associated with manufacturing activity for export markets.

Economic growth rates used in the modelling are based on near-term projections from Australian Government and State Treasuries, and medium to long term projections are a function of assumptions regarding changes in population (particularly changes in the working age population), workforce participation rates and changes in labour productivity.

Regional population growth used in the modelling has been projected using an in-house demographic model. This model projects how populations change in each region and subsequently estimates changes in the working age population which flows through to regional labour supply and participation rates.

Population growth for the eight Australian States and Territories incorporates detailed ABS data on population levels, births, deaths and migration. Population growth in the regional catchment is based on information referenced from the Queensland Government.

Labour productivity growth is influenced by many factors, including capital intensity, training and education and composition of the workforce. Over the last 30 years, Australia's labour productivity growth has averaged around 1.4% per annum. In the 'base case', Australian labour productivity growth is to be at a slightly lower rate of 1.3% per annum.

Table A.1. Base Case Economic Growth Assumptions

Region	Average Annual Growth (%)
Queensland	2.0%
Australia	2.9%

Source: Prime Research (unpublished).

A constrained labour mobility assumption has been utilised between States, with labour mobility assumed to be motivated by real wage differentials. Labour mobility assumptions include both inter-industry labour movement within regions as well as inter-regional and interstate labour movement. Labour is assumed to not be sufficiently mobile to remove these real wage differentials completely (i.e., in order to attract labour, real wages will increase).

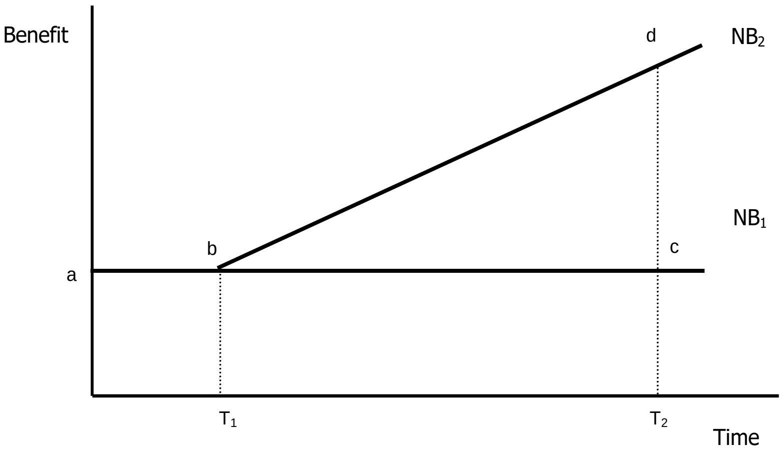
APPENDIX B: CBA METHODOLOGY

STEP 1: DEFINE THE SCOPE AND BOUNDARY

To enable a robust determination of the net benefits of undertaking a given project, it is necessary to specify base case and alternative case scenarios. The base case scenario represents the 'without project' scenario and the alternative or 'with project' scenario examines the impact with the project in place.

The base case (without) scenario is represented by line NB_1 (bc) over time T_1 to T_2 in Figure C.1. The investment in the project at time T_1 is likely to generate a benefit, which is represented by line NB_2 (bd). Therefore, the net benefit flowing from investment in the project is identified by calculating the area (bcd) between NB_1 and NB_2.

Figure B.1. With and Without Scenarios



Source: AEC.

STEP 2: IDENTIFY COSTS AND BENEFITS

A comprehensive quantitative specification of the benefits and costs included in the evaluation and their various timings is required and includes a clear outline of all major underlying assumptions. These impacts, both positive and negative, are then tabulated and where possible valued in dollar terms.

Some impacts may not be quantifiable. Where this occurs the impacts and their respective magnitudes will be examined qualitatively for consideration in the overall analysis.

Financing costs are not included in a CBA. As a method of project appraisal, CBA examines a project's profitability independently of the terms on which debt finance is arranged. This does not mean, however, that the cost of capital is not considered in CBA, as the capital expenses are included in the year in which the transaction occurs, and the discount rate (discussed below in Step 5) should be selected to provide a good indication of the opportunity cost of funds, as determined by the capital market.

STEP 3: QUANTIFY AND VALUE COSTS AND BENEFITS

CBA attempts to measure the value of all costs and benefits that are expected to result from the activity in economic terms. It includes estimating costs and benefits that are 'unpriced' and not the subject of normal market transactions but which nevertheless entail the use of real resources. These attributes are referred to as 'non-market' goods or impacts. In each of these cases, quantification of the effects in money terms is an important part of the evaluation.

However, projects frequently have non-market impacts that are difficult to quantify. Where the impact does not have a readily identifiable dollar value, proxies and other measures should be developed as these issues represent real costs and benefits.

One commonly used method of approximating values for non-market impacts is 'benefit transfer'. Benefit transfer (BT) means taking already calculated values from previously conducted studies and applying them to different study sites and situations. In light of the significant costs and technical skills needed in using the methodologies outlined in the table above, for many policy makers utilising BT techniques can provide an adequate solution.

Context is extremely important when deciding which values to transfer and from where. Factors such as population, number of households, and regional characteristics should be considered when undertaking benefit transfer. For example, as population density increases over time, individual households may value nearby open space and parks more highly. Other factors to be considered include, depending on the location of the original study, utilising foreign exchange rates, demographic data, and respective inflation rates.

Benefit transfer should only be regarded as an approximation. Transferring values from similar regions with similar markets is important, and results can be misleading if values are transferred between countries that have starkly different economies (for example a benefit transfer from the Solomon Islands to Vancouver would likely have only limited applicability). However, sometimes only an indicative value for environmental assets is all that is required.

STEP 4: TABULATE ANNUAL COSTS AND BENEFITS

All identified and quantified benefits and costs are tabulated to identify where and how often they occur. Tabulation provides an easy method for checking that all the issues and outcomes identified have been addressed and provides a picture of the flow of costs, benefits and their sources.

STEP 5: CALCULATE THE NET BENEFIT IN DOLLAR TERMS

As costs and benefits are specified over time it is necessary to reduce the stream of benefits and costs to present values. The present value concept is based on the time value of money – the idea that a dollar received today is worth more than a dollar to be received in the future. The present value of a cash flow is the equivalent value of the future cashflow should the entire cashflow be received today. The time value of money is determined by the given discount rate to enable the comparison of options by a common measure.

The selection of appropriate discount rates is of particular importance because they apply to much of the decision criteria and consequently the interpretation of results. The higher the discount rate, the less weight or importance is placed on future cash flows.

The choice of discount rates should reflect the weighted average cost of capital (WACC). For this analysis, a base discount rate of seven percent has been used to represent the minimum rate of return, which is in line with NSW and Australian Government guidelines. As all values used in the CBA are in real terms, the discount rate does not incorporate inflation (i.e., it is a real discount rate, as opposed to a nominal discount rate).

To assess the sensitivity of the project to the discount rate used, discount rates either side of the base discount rate (seven percent) have also been examined (four percent and ten percent).

The formula for determining the present value is:

$$PV = \frac{FV_n}{(1+r)^n}$$

Where:

PV = present value today

FV = future value n periods from now

r = discount rate per period

n = number of periods

Extending this to a series of cash flows the present value is calculated as:

$$PV = \frac{FV_1}{(1+r)^1} + \frac{FV_2}{(1+r)^2} + \cdots + \frac{FV_n}{(1+r)^n}$$

Once the stream of costs and benefits have been reduced to their present values the Net Present Value (NPV) can be calculated as the difference between the present value of benefits and present value of costs. If the present value of benefits is greater than the present value of costs, then the option or project would have a net economic benefit.

In addition to the NPV, the internal rate of return (IRR) and benefit-cost ratio (BCR) can provide useful information regarding the attractiveness of a project. The IRR provides an estimate of the discount rate at which the NPV of the project equals zero, i.e., it represents the maximum WACC at which the project would be deemed desirable. However, in terms of whether a project is considered desirable or not, the IRR and BCR will always return the same result as the NPV decision criterion.

STEP 6: SENSITIVITY ANALYSIS

Sensitivity analysis allows for the testing of the key assumptions and the identification of the critical variables within the analysis to gain greater insight into the drivers to the case being examined.

A series of Monte Carlo analyses has been conducted to test the sensitivity of the model outputs to changes in key variables. Monte Carlo simulation is a computerised technique that provides decision-makers with a range of possible outcomes and the probabilities they will occur for any choice of action. Monte Carlo simulation works by building models of possible results by substituting a range of values – the probability distribution – for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions. The outputs from Monte Carlo simulation are distributions of possible outcome values.

During a Monte Carlo simulation, values are sampled at random from the input probability distributions. Each set of samples is called an iteration, and the resulting outcome from that sample is recorded. Monte Carlo simulation does these hundreds or thousands of times, and the result is a probability distribution of possible outcomes. In this way, Monte Carlo simulation provides a comprehensive view of what may happen. It describes what could happen and how likely it is to happen.

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