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Core Metallurgy
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The State of Queensland acting through the Department of State Development, Manufacturing, Infrastructure and Planning

Establishing the North-West Minerals Province (NWMP) as a major hub for mining innovation and testing project.

Abridged Report
Low Grade Minerals Processing

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This document is provided for the use of The State of Queensland acting through the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) for the "*Establishing the North-West Minerals Province as a major hub for mining innovation and testing project Low Grade Minerals Processing*" project.

All data and comments contained in this report are to the extent possible correct and true as of the date of the report "FINAL Rev 3" dated 8 June 2017, of which this is an abridged version.

Some inputs used in the preparation of this document have been sourced from third parties. Core Metallurgy Pty Ltd has, to the best of its abilities, reviewed this information, however accepts no responsibility for the accuracy of such information.

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1.1 Scope of project

Queensland Government DSDMIP has appointed Core Metallurgy ("Core") to undertake an audit of the low grade minerals in tailings dams, waste rock dumps and closed mines in the North-West Minerals Province ("NWMP") to determine the volumes and mix of minerals that may be extracted through new processing technology, excluding recovery from normal flotation processing.

As part of this exercise, all the reported significant resources in both operating and non-operating projects were compiled, to provide a complete database of potential future resources in the NWMP. The audit process has identified estimated project scopes and costs for several possible development scenarios.

The audit process has also obtained information from the resource companies on the challenges to processing low grade minerals including any Federal or State Government legislation that supports or is an impediment to the commercialisation of low grade minerals processing.

1.2 Methodology

This information was compiled from publicly-available sources such as company reports and reports from the Department of Natural Resources and Mines ("DNRM") and the Geological Survey of Queensland, supplemented by information provided by the project owners. Several constituents provided submissions. Face to face meetings or telephone interviews were conducted with most of the constituents. In addition, several constituents completed an on-line survey on barriers or impediments to the development of low grade resources in the NWMP. Core would like to thank all parties for their cooperation.

1.3 Exclusions and limitations

The following are not included within this project scope:

- Economic benefits analysis of low grade mineral projects;
- Recommendations on which companies could provide technological solutions;
- Completion of any government approvals process;
- Any determination of sources of capital for investment.

While Core has taken care to ensure the veracity, where possible, of all information and statements contained in this report, recipients should nonetheless undertake their own investigations and verification of such matters and should not rely upon this report for supporting investment decisions or any similar actions.

1.4 Confidentiality

In certain instances, companies provided non-public information to Core on the basis that such information was to be treated as commercial-in-confidence by DSD. This is a non-confidential abridged version of the original report.

2 Recommendations

Please note that while these recommendations are provided in good faith by Core in the interests of suggesting various actions which could be considered, the provision of recommendations was not part of the project scope of work. These recommendations have not been fully researched or analysed and should be regarded as preliminary in nature. The recommendations do not in any way reflect Queensland Government policy.

2.1 Consider changes to life of mine planning and end of mine life planning requirements, to encourage residual mineral recovery

Full life-cycle planning may ensure that mine closure is more fully considered and may encourage final residual mineral recovery. Mechanisms may also be considered to improve end of mine life planning. For example, as part of life of mine planning, formal end-of-mine life plans may include consideration of the following matters:

- Development of rehabilitation plans including a full costing to ensure that funding is adequate. It is noted that any such costing would need to be regularly revised and updated on a systematic basis to ensure its currency;
- Consideration of actions to enable any final recovery of economic minerals, including minerals recovered as part-funding of rehabilitation costs;
- Decommissioning of infrastructure and processing facilities may be “stayed” until rehabilitation plans (including final economic mineral recovery) have been fully considered;
- Establishment of a transparent process to enable third parties to evaluate final economic mineral recovery;
- Placement of constraints on disposal of the asset unless a fully funded closure plan is in place including any economic mineral recovery, and unless funding remains in place after disposal to fully fund closure costs and to enable any economic mineral recovery. (It is noted that under current arrangements, Financial Assurance must always remain in place until closure (i.e. resource is extracted, and rehab is completed) however Core understands that this does not currently extend to the extraction of any residual mineral recovery.

Such measures may be incorporated in currently proposed plans to require mining projects to submit life of mine plans with fully costed progressive rehabilitation activities and milestones. This may, Core understands, bring Queensland into line with many other jurisdictions. Core is generally supportive of the concept of requirements for life of mine plans including end of mine life plans, and requirements for progressive rehabilitation with agreed / mandated performance milestones. This may readily cover economic mineral recovery.

2.2 Provide for Increased transparency of resource data including secondary mineral resources

Various mineral stewardship mechanisms may be considered to support and encourage low grade mineral processing:

- Placement of all resource information from mining leases, including drilling and assay data on open file with free third-party access should be considered. Amongst other benefits this may encourage third parties to investigate opportunities for improved mineral processing.[1] This has the potential to uplift marginal ore into the economic category, with increased metal recoveries and less contained mineralisation being wasted.

- All low-grade mineralisation that is not to be further processed (for example intermediate stockpiles, tailings resource, coarse rejects) to be placed in engineered dumps or impoundments, with an eye to future reprocessing.

- That all low-grade mineralisation is properly accounted for and reported on open file. This may encourage third parties to investigate opportunities for re-processing and may enable simpler and more orderly eventual retreatment. In Queensland, Core understands that there are no current requirements for full reporting of and accounting for materials placed on low grade stockpiles or in tailings dams. If such information was available, there may be much greater awareness and transparency of where potentially economic mineralisation may exist in tailings resources, for example.

2.3 Facilitate permitting requirements for third party retreatment of low grade mineral resources on active mine sites

The best time to re-treat low grade mineral resources is usually while the primary operation is active, and all infrastructure and services are in place. Current impediments to third parties undertaking reprocessing of low grade mineral on active mine sites are the difficulties in identifying, apportioning and allocating environmental and other risks associated with parallel conduct of such activities alongside existing mining and processing operations. The primary mining operator is often discouraged from pursuing this option because of permitting and risk allocation obstacles. Development of permitting procedures to encourage such activity may be a useful enabler.

Therefore, where the tailings are on an operating site, some form of incentive may be offered to the operator to motivate the parallel retreatment of tailings and a reduction in tailings footprint or improve its environmental characteristics (reduction in acid forming sulphides or leachable metals), including by enabling third parties to take on the tailings retreatment task.

Consideration could be given to establishment of a specific form of mineral title to cover residual mineralisation such as tailings to better specify the rights and obligations of parties seeking to recover residual minerals; and to better apportion risks in this activity between the company and the State.

[1] Core is aware of a current case study in Western Australia (where Core understands that all resource drilling on mining leases is open file) where a third party has used this data to identify opportunities for resource beneficiation and value-uplift across multiple sites in the state using innovative beneficiation techniques.

2.4 Seek to put a value on reduction of environmental risk

There are significant resources contained in tailings in the NWMP. Impediments to development are that they are generally low grade and potential product sales revenues may be insufficient relative to the operating costs of retreating these resources. In some cases, they are held by parties with on-going primary mining activities, where tailings re-treatment is not a priority focus of activity, nor of capital allocation.

Often the economics of retreating these resources is best when existing plant and infrastructure can be used at the end of the primary mining activities, or if tailings can be treated simultaneously with primary mine feed, thus sharing established infrastructure. It needs to be recognised that tailings retreatment becomes more economically difficult if site facilities are decommissioned and removed from the site.

However, revenues earned through retreatment of these tailings may significantly fund or offset site rehabilitation costs, may reduce the disturbed site footprint, and may result in a more stable final landform, close to its pre-mining landform. A substantial benefit arises particularly if mined voids can be used to emplace reprocessed tailings. If a value is put to the resulting reduction in later rehabilitation costs, to the faster achievement of a reduced environmental risk and to a better final rehabilitation outcome, this may justify retreatment.

It is noted that a “value to rehabilitation” is currently implied by existing mechanisms to permit a reduction in the Financial Assurance as rehabilitation progresses, however the Financial Assurance framework does not encourage one type of rehab over another (i.e., residual mineral recovery vs general site rehabilitation. Potentially mechanisms encouraging residual mineral recovery could be incorporated into guidelines for developing the life of mine plan.

The same rationale may be true for certain abandoned mine sites where the stand-alone economics of treating residual mineralised material on site may be insufficient. However, revenues from mineral recovery may at least partially offset rehabilitation costs. If an allocation of risk and reward can be made between third parties and the State, there may be means to effect site rehabilitation while also generating economic activity and jobs.

2.5 Tackling input costs

Many of the known undeveloped resources in the NWMP have low contained mineral values per tonne of material, although the tonnage of mineralised material may be large. This is true both for some undeveloped primary resources, and for secondary materials such as tailings. Economic extraction therefore requires very low input costs. The input costs facing operators variously comprise power costs, transport costs, and reagent costs, particularly acid. Tackling input costs requires a collaborative effort between all stakeholders to not only reduce unit costs of inputs, but also to reduce consumption of inputs, particularly power.

2.5.1 Power costs and supply

Increasing power costs are a threat to mineral processing in the NWMP, and the primary factor is the cost of gas in the region at around A$12/GJ (and lack of grid connection to the National Electricity Market, which in turn leads to high electricity prices). The high gas prices are a result of the shortage of uncontracted gas in the Australian east coast gas market, and the impact of directing gas to export into higher priced North Asian markets.

The pending development of a gas connection to the Northern Territory may in the long-term lead to improved gas supply competition in the NWMP, but in the immediate future, high prices will continue due to the shortage of gas supply from any source. This situation poses a major threat to resource development in the NWMP.

It is worth considering if any tradability of take or pay energy contracts may be enabled. As many components of an energy supply agreements in the NWMP are purchased on a take or pay basis from limited suppliers (gas purchase, gas transport, power conversion, power transmission), it may introduce welcome flexibility and competitive pressure if some form of tradability for such contacts is permitted.

There may also still be a role for an HV DC power line serving the NWMP to introduce some energy diversity and competition. This proposed project (“CopperString”) was placed on hold in 2012 with the commitment of APA to build the Diamantina Power Station.

Irrespective of the costs of gas, there remains a critical shortage of uncontracted gas supply in Queensland, so any initiatives to encourage more supply are supported – for example by any actions by the State to facilitate and encourage more development of gas supply and reticulation in Queensland.

2.5.2 Transport costs

High transport costs are also cited by mining companies as an impediment to development. This affects outbound transport of mineral products, and inbound transport of fuels, reagents, chemicals and other supplies. Two key issues are identified:

- The poor condition of the Mount Isa to Townsville rail line and its high and inflexible access / cost structure. In particular Core understands that users are required to purchase transport allocations on a take or pay (TOP) basis, and currently with reduced mineral production in the region, significant charges are being levied for un-used take or pay allocations. One suggestion is that, as with the power market, where suppliers are sole-suppliers in the market, that TOP allocations should be tradeable, such that unused allocations can be transferred to other potential users, thus introducing a competitive factor and more flexibility into the market. Tradeable TOP arrangement are used elsewhere in similar circumstances.

- The future of the Century to Karumba concentrates pipeline and associated port – this is potentially an important strategic asset for the region, but it risks deterioration unless it is actively maintained, or at least put into well-managed “care and maintenance”.

As a secondary issue, companies are concerned about the condition of roads in the region, and the high road usage charges that are sought by shire councils for use by projects. Shire councils respond that they have limited budgets for road maintenance and heavy users should share the cost.

2.5.3 Acid costs and supply

Supply of acid at competitive prices is an important enabler in the region, as it is a vital input into leachable copper projects, and value-adding phosphate projects. Acid supply in the region is provided from Sun Metals in Townsville, from imported acid, and by Incitec Pivot from sulphur dioxide off-gas conversion from the Mount Isa copper smelter, supplemented by conversion of imported elemental sulphur.

While world acid prices are currently stable and relatively low compared to past spikes, once transport costs into the NWMP are considered, acid is a major input cost to consumers. There are also threats to acid supply security, such as eventual closure of the Mount Isa copper smelter as a cheap source of sulphur to make acid.

There are substantial pyrite resources in the region, both from primary production and from tailings, and these may provide an important source of sulphur for making acid. Some of these pyrite sources also contain cobalt, so there is the potential to not only recover valuable cobalt but also to provide an important new supply of acid in the region.

Removal and treatment of pyrite also reduces a potential acid generating material from the environment (from tailings or low grade/waste rock).

Potentially such a facility may be structured as a multi-user asset and might, for example, be eligible for infrastructure funding. A pyrite roaster may also be owned by an entity that in turn purchases the pyrite concentrate ex-mine gate from several different mining operations.

An alternate option may simply be to establish a sulphur burning acid production facility in the region, to underpin acid supply security and generate additional power for the NWQ grid.

2.6 Facilitating improved collaboration and adoption of innovative technology

One of the characteristics of the NWMP is the wide spread occurrence of sub-scale mineral projects that cannot by themselves support the costs of development, but when aggregated might be commercially viable. Collaborations might for example be parties cooperating to build a common mineral processing facility, parties offering competitive toll processing services for third parties, or parties producing products such as acid that in turn enable another third-party project development. Provision of a forum for exchange and collaboration, and incentives to assist collaboration, may be appropriate.

Various constituents have expressed support for collaborative initiatives and have expressed a willingness to play a role in “whole-of-region” approaches to encourage more mineral development. This may also be aided by such concepts as an “innovation hub” as described below.

There are also opportunities for new and emerging innovative technologies to assist in the development of low grade mineral resources (including tailings retreatment) in the region, and to seek innovative means to tackle increasing input costs. Collaborative support for adoption of such innovative technology might be effective.

For example, in WA there is collaborative (Government – Industry – Research) support for an “innovation hub” to be established in Kalgoorlie to support the implementation of novel “grade engineering” technologies to enable the beneficiation of low grade ores by screening and

sorting, with the potential to upgrade marginal ores to economic grade[2]. Such a model may also be very effective in Mount Isa. It could be mandated with a focus on developing best practice in tailings retreatments and mine site rehabilitation.

2.7 Seeding new industries

Some of the minerals present in the NWMP may form the basis for new industries. Some examples include further integrated development of the phosphate sector; development of the rare earths sector including refining of products, and the development of a cobalt refining sector.

For example, the retreatment of the Mary Kathleen tailings storage facility, in addition to the environmental benefits, presents a regional development opportunity for NWMP as the project may act as a catalyst for development of a rare-earth industry in Queensland and value adding industries.

Downstream processing of speciality metals, such as cobalt also offers an opportunity. Townsville may form an ideal location for further value adding industries as it has a history of refining copper, zinc, nickel and cobalt. These initiatives will likely require a multi-collaborator approach and so actions to bring together constituents to develop whole-of-sector strategies may be required to initiate such developments

2.8 Reducing workload and costs of compliance and imposts

Given the high-risk nature of developing low grade resources in a remote location, it is worth looking at how regulatory costs and burdens can be eased to ensure that Queensland remains an attractive and competitive resources investment destination. This is particularly the case in the NWMP as many pre-development resources are held by financially-stretched junior companies, often on legacy Mining Leases. Examples cited are high tenement holding costs, prohibitive costs for environmental authorities and financial assurances, and a generally high compliance burden and workload, compared to other jurisdictions.

Any streamlining, simplification and cost reduction of these processes may act as a powerful stimulant. It is recognised that aspects of the compliance requirements are being reviewed, for example the financial assurance framework, to make it more effective for all parties. Suggestions such as further reductions in royalties for value-adding mineral products, or where minerals are extracted from secondary sources where royalties have previously been levied, are worth consideration. The Queensland Government has recently demonstrated a willingness to consider royalty holidays or deferrals to encourage higher-risk project development in infrastructure-deficient frontier areas such as the Galilee Basin, and likewise frontier activities such as large-scale tailings re-treatment might be encouraged by some targeted royalty relief.

2.9 Streamlining and standardising native title processes

Again, reflecting the presence of many under-resourced junior companies in the region, there is a call for simplified and streamlined native title processes, for example standardised forms of agreement, rather than requiring all agreements to be fully negotiated and drafted from scratch. There does not seem to be significant concern about the willingness of parties to form agreements.

[2] The Cooperative Research Centre for Optimising Resources Extraction ("CRC ORE") and the Western Australia School of Mines has undertaken an initial study to assess the potential for creating an industry-led technology innovation hub in Kalgoorlie to deliver value to Australian producers and METS in the Western Australian mining industry.

3 Opportunities for low grade mineral processing in the NWMP

3.1 Tailings resources

There are a variety of tailings resources in the region with economic potential. These include significant resources of copper ("Cu"), lead ("Pb"), zinc ("Zn"), cobalt ("Co"), gold ("Au") and silver ("Ag") at Century, Mount Isa, Ernest Henry, Osborne and Cannington inter alia. Challenges include generally low grades and prohibitive costs of retreatment per recovered metal unit, in some cases these resources are metallurgical complex, and are often a lower priority for owners compared to their primary mining activities. The recent example of arrangements entered into by MMG for New Century Mining as a successor operator to re-treat tailings gives one model of an arrangement to recover metal values from tailings and to facilitate site rehabilitation.

3.2 Abandoned mine sites

Some abandoned mine sites may have economic potential, most notably Mary Kathleen with residual rare earths and uranium[3] resources in tailings and low-grade ore stockpiles. This project has been the subject of past commercialisation initiatives, most recently with a Queensland government tender process in 2014. The extraction of rare earths at the Mary Kathleen site also provides an opportunity to further rehabilitate the site via the recovery and reprocessing of the tailings and low-grade ore stockpiles.

3.3 Integrated metals and acid production

There is potential for an integrated mineral processing and acid production facility in the region, using cobalt-rich pyrite tailings as a feed to a roaster which may not only recover cobalt but may also supply significant quantities of acid into the region. Cobalt rich pyrite can be sourced from several locations such as Osborne Mine tailings or from Aeon Metals' Walford Creek project. This acid has the potential to enable other regional projects such as copper heap leaching, or beneficiation of phosphate resources. Incitec Pivot is one possible off-taker. Alternately there may be potential to develop a sulphur burning / acid facility to produce acid and to generate power.

3.4 Development of phosphates

There are extensive phosphate resources in the region but reflecting the high transport and logistics cost of direct shipping ore, development may rely on integrated production of value-added products, which in turn depends upon competitive gas, electricity and acid prices in the NWMP.

At Phosphate Hill, Incitec Pivot has identified several initiatives to recover additional phosphates from its gypsum tailings and rock fines tailings, thus taking advantage of its existing facilities and infrastructure

3.5 Project aggregations

There are regional opportunities to "aggregate" clusters of smaller scale projects, for example to feed a centralised copper concentrator, or a centralised copper solvent extraction and electrowinning ("SXEW") facility. Smaller projects can also supply ore into existing third-party regional processing facilities. This may overcome the lack of critical mass of individual projects. Many of the smaller projects are located on mining leases with legacy environmental issues and therefore high compliance burdens.

[3] For uranium mining, treatment or processing to be a feasible opportunity, changes to Queensland Government policy and regulation would be required. There is no indication that such a change is intended.

3.6 Use of new processing technologies to enable projects

There are several other low-grade pre-development projects in the NWMP across a range of commodities which will rely on significantly reduced input costs, or improved commodity prices, before they are likely to advance. There may be opportunities for the application of technologies to improve the economics of such projects. This includes techniques such as ore sorting, gravity separation or other beneficiation techniques to upgrade low grade ores. There may be an opportunity to establish an “innovation hub” in Mount Isa to support the introduction of innovative technology, like an initiative currently being considered for Kalgoorlie

3.7 Regional infrastructure issues and opportunities

Power prices are high, despite good power infrastructure, with delivered gas prices of around A$12/GJ in the NWMP, and therefore HV power supply costs of >A$0.18 / kWHr. This is a direct function of east coast gas market dynamics, which result in these high delivered gas prices to the MWMP, and therefore high power prices. Development of the Jemena Northern Gas Pipeline from the Northern Territory offers some diversification of gas supply and may result eventually in improved gas market competition. There is also a shortage of available uncontracted gas for any additional power supply.

The Mount Isa to Townsville rail line is deteriorating with slow transit times due to speed restrictions. There are limited competitive pressures on bulk transport, resulting in high prices. Rail transport allocations are sold on a take or pay basis, and currently some companies are paying take or pay payments for unused allocations. Industry constituents also expressed concern about the poor road conditions and high levies for road usage in the region.

The Century to Karumba concentrates pipeline and associated port and ship loading facilities are important regional infrastructure, but there are risks that these assets will deteriorate following the closure of primary mining activities at Century.

4 Overview of the NWMP

4.1 Mineral endowment

The NWMP contains world scale mineral endowment in copper, lead, zinc, gold, silver and phosphates, and important resources of uranium, cobalt, rare earth oxides and other minerals. It is also considered highly prospective for future mineral discovery. It has a long history of mining from very large scale to artisanal operations. It is relatively well endowed with support infrastructure and services, and with downstream mineral processing and refining operations. It is thus a vital part of the economy of Queensland.

Minerals produced have included copper, lead, zinc, gold, silver, phosphates and uranium[4]. There is an endowment of other minerals including rare earth minerals, molybdenum and rhenium that have not been the subject of past production but may form the basis of future operations.

Legacies of the extensive mining history in the NWMP are that there are numerous former mining operations in the region, and some of these host residual primary mineral resources which may be exploited in the future. There are also widespread accumulations of secondary resources such as tailings dams and low-grade stockpiles. Apart from a range of high grade mineral resources, there is a long tail of low grade mineral resources in the region:

The NWMP continues to be highly prospective for future mineral discovery, with widespread and extensive mineral occurrences. Despite this, no major discoveries have been made in the NWMP since the early 1990s. Factors to which this is attributed are the difficulties and associated cost of deep exploration, including exploration under transported cover, and the large land-holdings that are owned by under-resourced companies which cannot finance large scale exploration activities.

[4] For uranium mining, treatment or processing to be a feasible opportunity, changes to Queensland Government policy and regulation would be required. There is no indication that such a change is intended.

4.2 Infrastructure and services

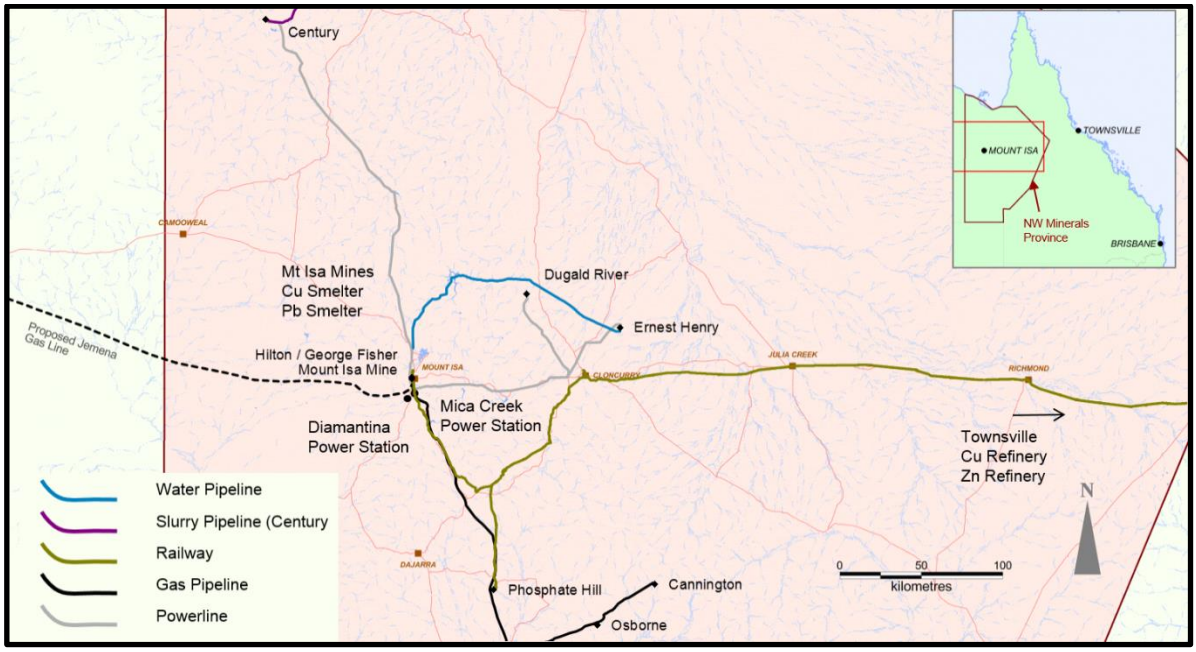


Figure 1 NWMP Regional Infrastructure Assets

Important infrastructure includes:

- Power: Natural gas supply, power generation and HV grid electricity reticulation.
- Water: Infrastructure including a bulk water pipeline from Lake Julius to Cloncurry.
- Transport: extensive regional road infrastructure, good air connections, rail line to the Port of Townsville where there is bulk mineral capacity, concentrates pipeline from Century Mine to Karumba, with barge transhipment facilities.
- Services: Good regional population and services centres in Mount Isa and Cloncurry.
- Mineral Processing: Copper and lead smelters in Mount Isa, and copper and zinc refineries in Townsville.

4.3 NWMP mineral production

The NWMP is one of the world's premier mineral producing regions with a very important contribution to the economy of Queensland.

Product	Main Producers	Unit of Qty	Quantity Produced	Value of Production
Copper cathode	Glencore	Tonnes	211,196.652	$2,019,881,299
Copper concentrate	Glencore, Chinova	Tonnes	137,663.800	$236,050,921
Copper direct-shipping ore	CuDeCo	Tonnes	27,918.000	$194,303,222
Gold in concentrates	Glencore	Kilograms	4,237.000	$206,406,642
Lead - silver bullion	Glencore	Tonnes	156,217.000	$421,155,237
Lead - silver concentrate	South32, Glencore	Tonnes	365,950.000	$1,096,676,171
Lead dross	Glencore	Tonnes	13,701.000	$35,324,930
Zinc concentrate	Glencore, South 32, MMG Century	Tonnes	1,296,845.000	$1,367,988,844
Phosphate Rock	Incitec Pivot	Tonnes	1,034,957.000	$534,569,222

Figure 2 Mineral production from the NWMP.

Source: DNRM (note there is double-counting due to further mineral processing in Queensland)

Several factors have however resulted in steeply reduced mineral output, particularly over the past two years. Copper output has declined by nearly 50% over 10 years due to the aging of the Mount Isa and Ernest Henry operations, and due to the closure of Osborne and Mt Gordon Mines, and this decline continues.

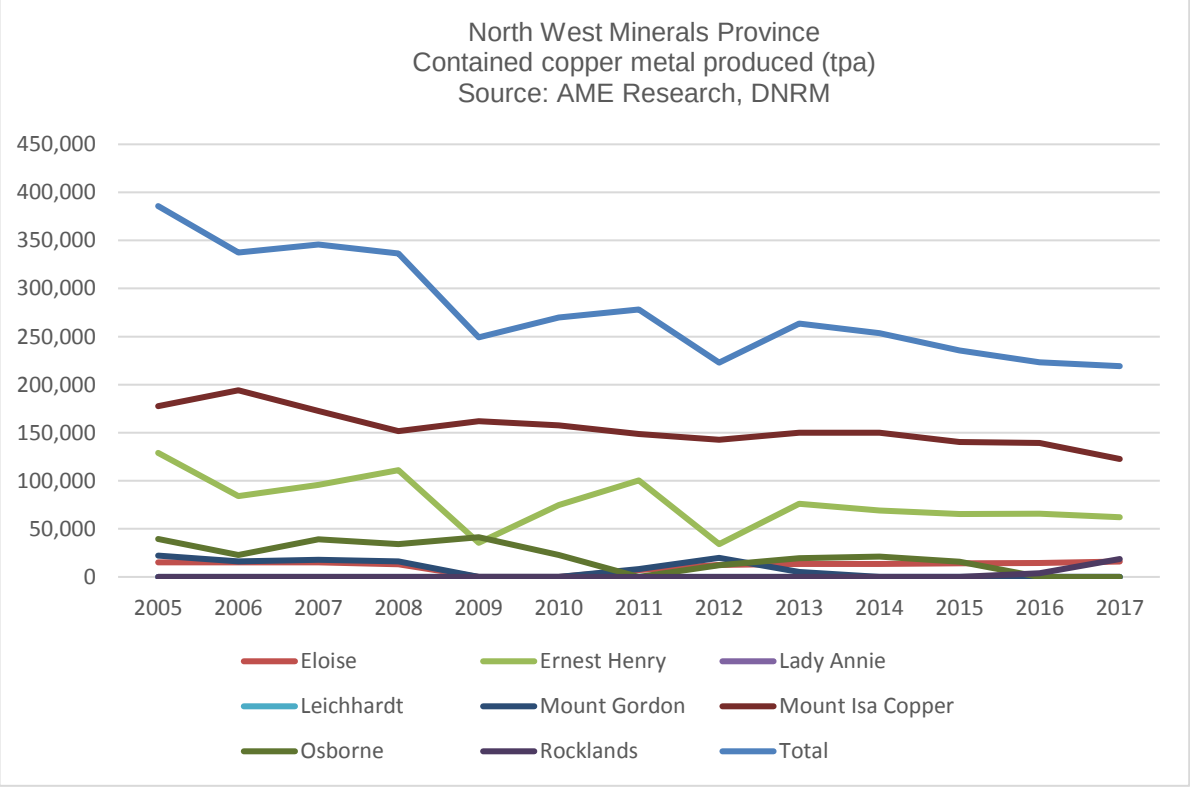


Figure 3 Copper production in the NWMP

Zinc output has declined over the last two years because of the closure of Century Mine, and managed output reductions from Mount Isa in the face of weak market conditions.

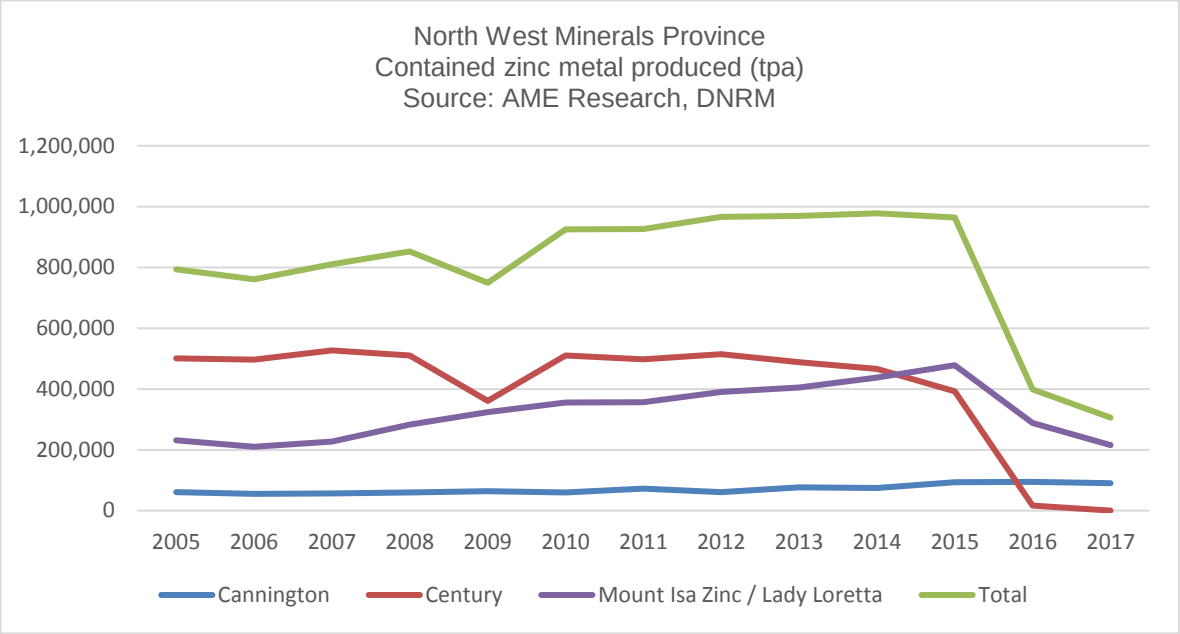


Figure 4 Zinc Production in the NWMP

Lead production has also fallen over the past two years, due to the closure of Century, managed production reductions at Mount Isa / Lady Loretta, and declining lead grades at Cannington.

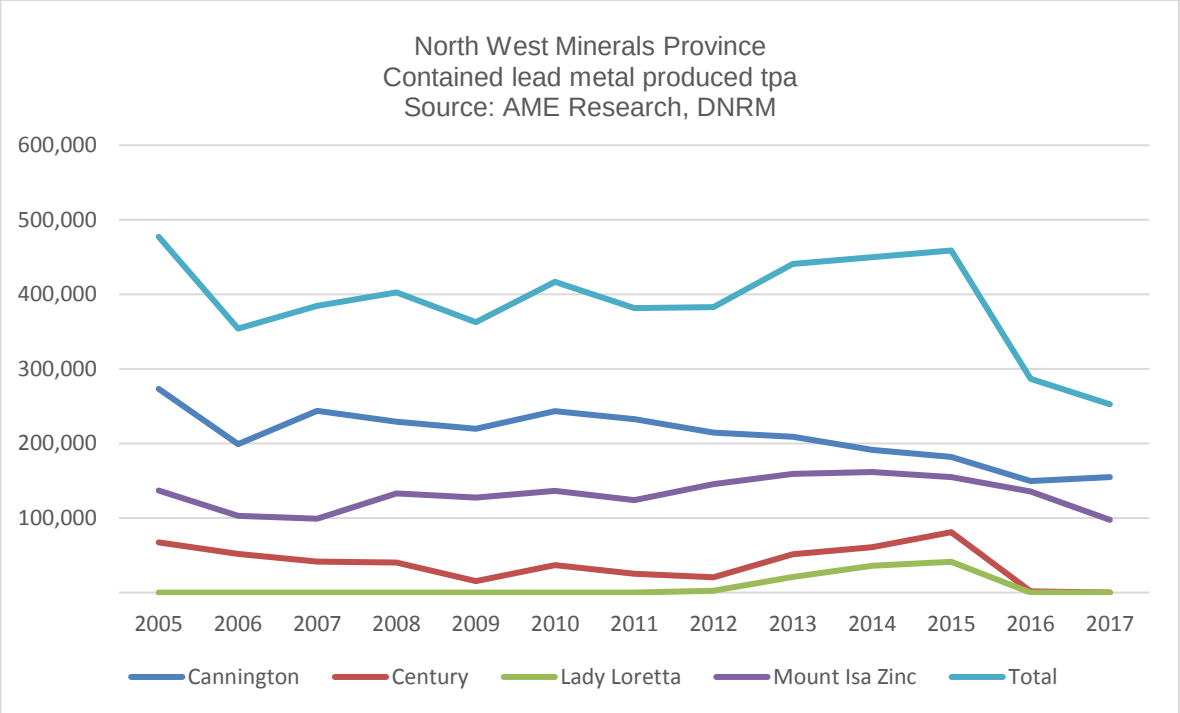


Figure 5 Lead Production in the NWMP

4.4 Challenges in the NWMP:

Substantial declines in production, particularly over the past two years, in all mineral commodities.

No major new mineral discoveries have been made in the NWMP in over 20 years, despite the prospective geology. This may reflect the cost and technical challenges of exploration at depth and under cover in the region, and the lack of stakeholder commitment (for assorted reasons) to undertake expensive and high risk exploration. Some brownfields additions have been made, such as E1 / Monakoff, leveraging off existing developments.

Some major regional projects have come to the end of their lives or are declining, with Century Mine closing in 2016 and Osborne in 2017. Other than Dugald River, there are no new large-scale future tier-1 projects to replace lost production. Copper production is declining as Mount Isa and Ernest Henry age, and zinc production has fallen markedly as Century closes and Glencore constrains production during times of price weakness.

The region is also characterised by widespread and numerous smaller projects with short lives and limited scale, and often held by owners with limited financial capacity. These are difficult to finance and develop and are vulnerable to commodity price fluctuations and other factors.

The cost of doing business in the region is high, despite the relatively good infrastructure and the presence of support services. Notable are the cost of bulk transport of products to port by road or rail (and inflexible take-or-pay rail transport contracts), and the very high cost of gas and electric power in the region, where the NWMP has become “captured” by the rapid Australian east coast gas price escalation and shortage of uncontracted gas. The high gas price (and lack of gas availability) is a particular threat to the health of the NWMP.

5 Audit of minerals projects

5.1 Large-scale base and precious metals

Regional mineral endowment is dominated by the Mount Isa lead – zinc – silver ores with an in-situ mineral value of >$120 billion. These ores are high grade and will underpin lead-zinc-silver ore production and downstream processing for many years to come.[5] Mount Isa is the world's third largest zinc producer and has the world's largest Pb-Zn resource endowment. Production can be supplemented by satellite ore feed from Lady Loretta Production is only constrained by the supply-demand balance in world Pb-Zn markets, although it should be noted that future ores will present an increasing level of metallurgical complexity due mineralogical variability, and increasingly process innovation will be important. Mount Isa has been a strong past innovator with the development of the IsaMill technology to improve lead-zinc recoveries and reduce tailings losses, along with ISASMELT and Jameson Cell technology.

The remaining copper resources in Mount Isa contain a substantial inventory, particularly when aggregated with supplementary feed from Ernest Henry.[6] [7] Future copper supply requires increasing levels of technology and innovation, with more complex copper ores arising from the Mount Isa Black Rock Open Cut (BROC) operation, and large-scale bulk underground mining at increasing depths at Ernest Henry.

The other 'tier one" projects in the region are the newly developing Dugald River project, and the Cannington project. None of these projects may be described as low grade and while they all require levels of innovation and use of technology, they are not the focus of this report.

[5] Comprises Black Star (O/C): 10 Mt @ 4.9% Zn, 4.3% Pb & 75 g/t Au; Mt Isa O/C: 236 Mt @ 3.7% Zn, 2.9% Pb & 62 g/t Ag; George Fisher P49: 50 Mt @ 8.2% Zn, 5.2% Pb & 109 g/t Au George Fisher L72: 153Mt @ 9.0% Zn, 3.6% Pb & 57 g/t Au; Handlebar Hill O/C (Primary): 5.2 Mt @ 6.6% Zn 2.2% Pb & 37 g/t Au; Handlebar Hill O/C (Oxides): 0.6 Mt @ 0.4% Zn 7.8% Pb & 85 g/t Au.

[6] Comprises Mt Isa Cu (X41, 500, 600, 1100 & 1900 orebodies): 40.2 Mt @ 1.86% Cu; Mt Isa Cu (3000 & 3500 orebodies): 34.7 Mt @ 2.55% Cu; Mt Isa O/C: 130 Mt @ 1.37% Cu.

[7] Comprises Ernest Henry U/G: 80.7 Mt @ 1.18% Cu & 0.61 g/t Au; E1 (O/C): 10.1 Mt @ 0.73% Cu & 0.22 g/t Au; Monakoff (O/C): 2.4 Mt @ 0.95% Cu & 0.30 g/t Au

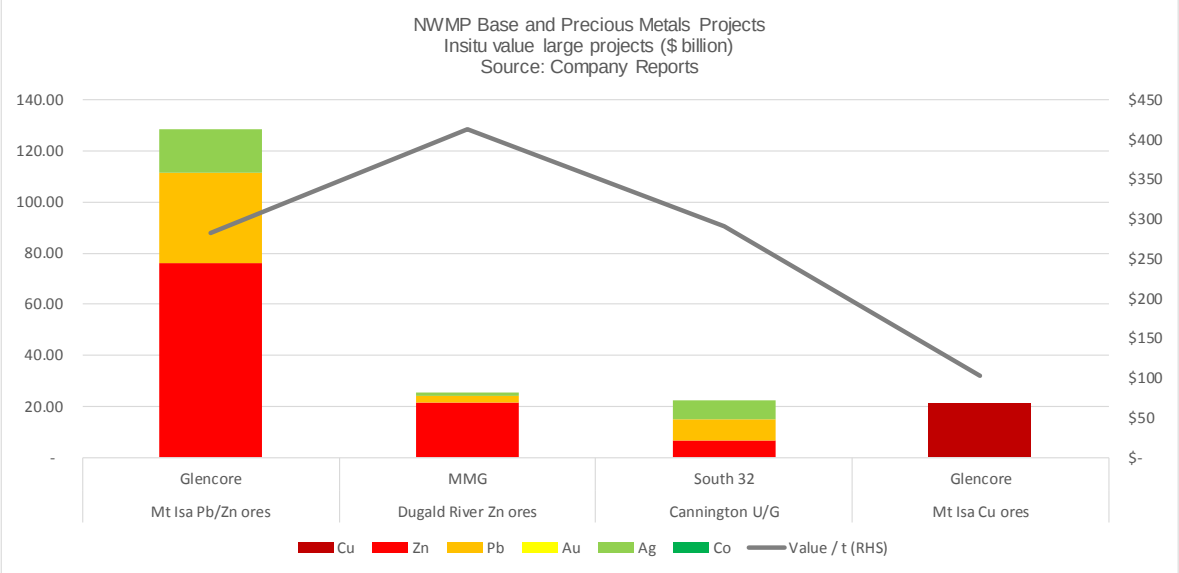


Figure 6 Large Scale Base and Precious Metals resources

5.2 Medium-scale base and precious metals

The projects classified as medium-scale (defined as containing in-situ mineral endowment of between US$1.0 billion and US$10.0 billion) are probably the group which have the greatest potential for meaningful economic development in the NWMP, and where technology and innovation can have an effect.

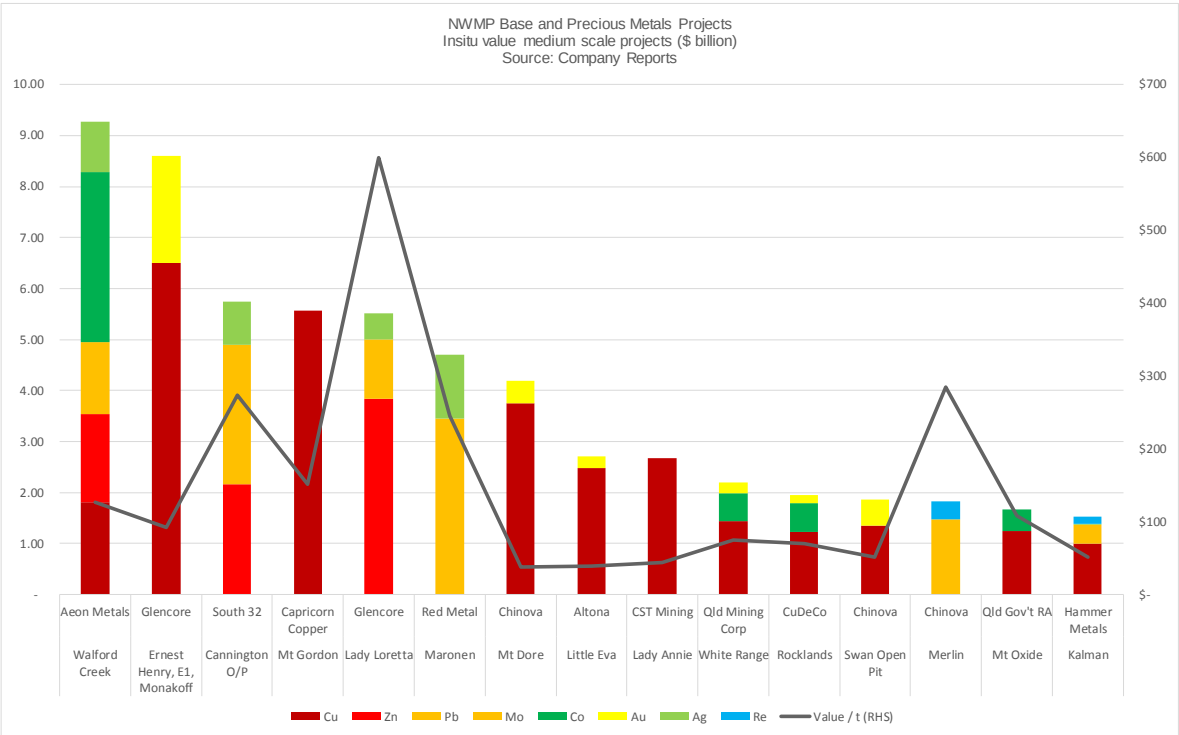


Figure 7 Medium Scale Base and Precious Metals resources

5.3 Small Scale Base and precious metals

These projects may be able to collaborate to form aggregations which have scale, or they may act as supplementary feed into existing ore processing facilities in order to achieve sufficient critical mass for development. An example is Ausmex with a resource base of 2.8 Mt contained in four separate resources[8]. CopperChem's Cloncurry Project and Malaco Mining's Leichardt Project similarly are aggregations of deposits. Vendetta Mining's Pegmont Project may be able to provide a supplementary feed into an existing Pb-Zn concentrator.

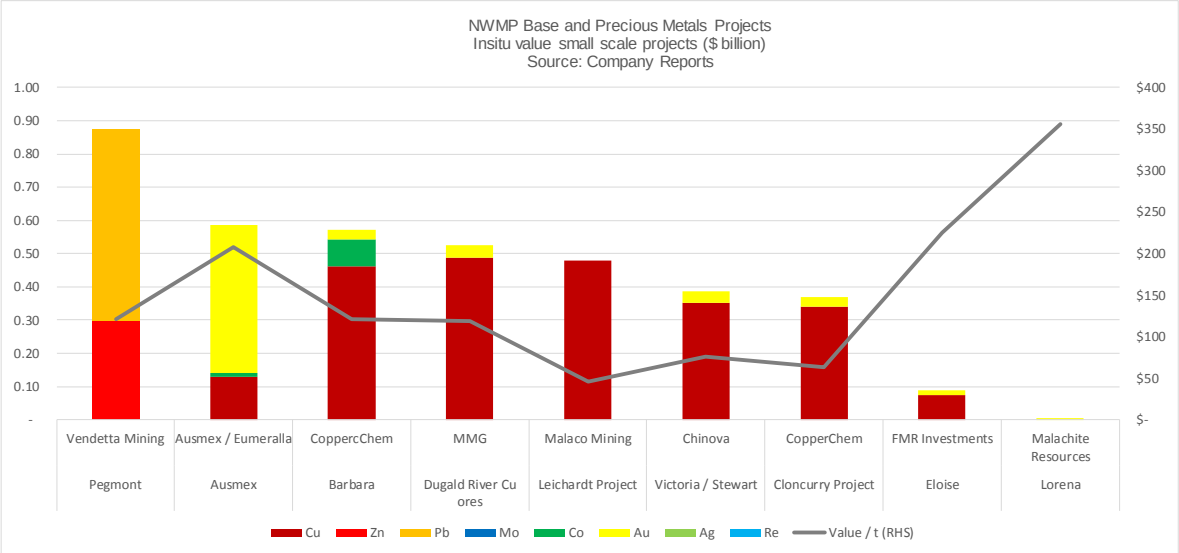


Figure 8 Small Scale Base and Precious Metals resources

[8] Comprises Flamingo: 117 kt @ 6% Cu, 1.8g/t Au; Gilded Rose:143.5 kt @ 4.6 g/t Au; Mt Freda 1.6 Mt @ 1.7 g/t Au; Horseshoe 960 kt @ 1.5 % Cu, 0.1 g/t Au, 0.02% Co

5.4 Tailings projects

A fruitful area for consideration is the opportunity to retreat tailings arisings in the region to recover valuable minerals and to assist in site rehabilitation. Several of these projects may be of economic significance and are worthy of consideration.

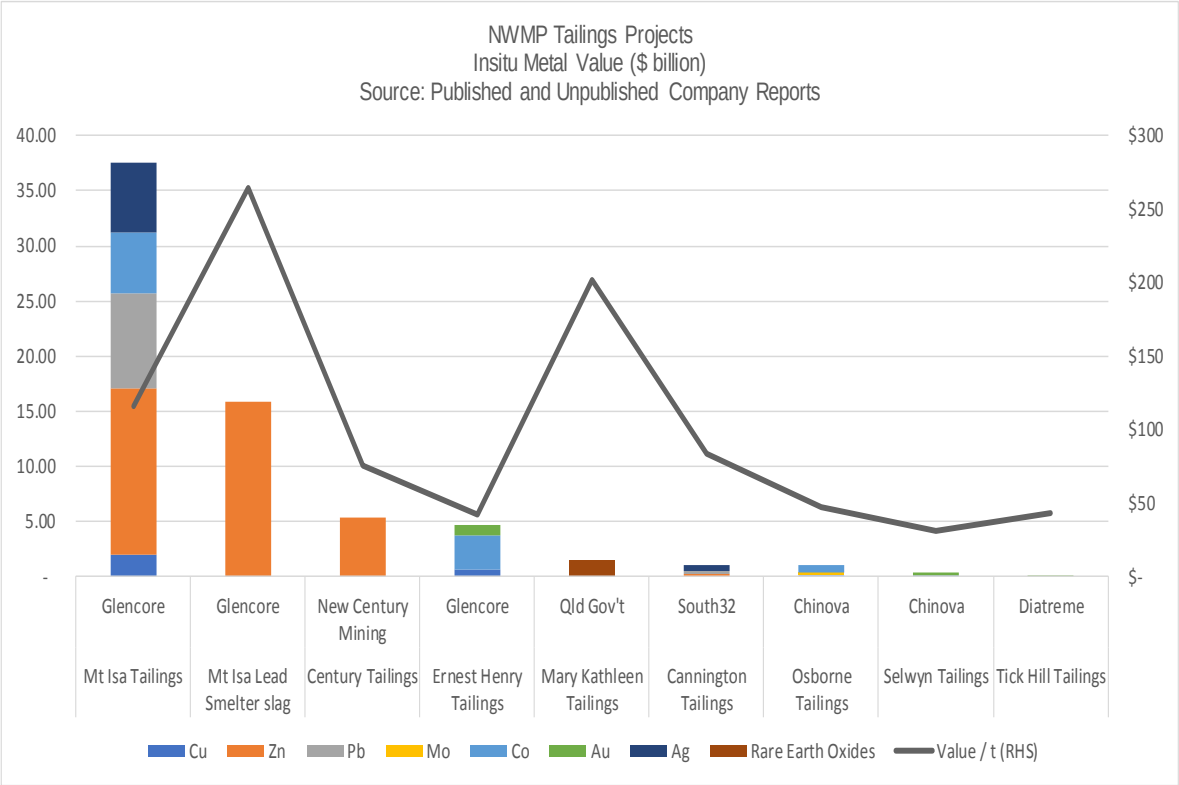


Figure 9 Tailings resources

5.5 Phosphates projects

There are extensive phosphate resources in the NWMP (and in the Northern Territory accessible to the NWMP). Except for Phosphate Hill, none have been developed. Any development would require the integrated development of a value-adding MAP / DAP fertilisers facility, as the export of rock phosphate as an un-beneficiated product from the NWMP is unlikely to be economically viable. In turn, manufacture of MAP / DAP requires competitive power, process gas, sulphuric acid, and bulk transport, so any commercial development will have to take these factors into account. Core considers that none of the current project incumbents have the capacity to undertake such a large scale integrated development without significant third-party assistance and support, and that the current high cost of inputs (gas, power, acid, transport) and lack of available gas supply renders such developments impossible.

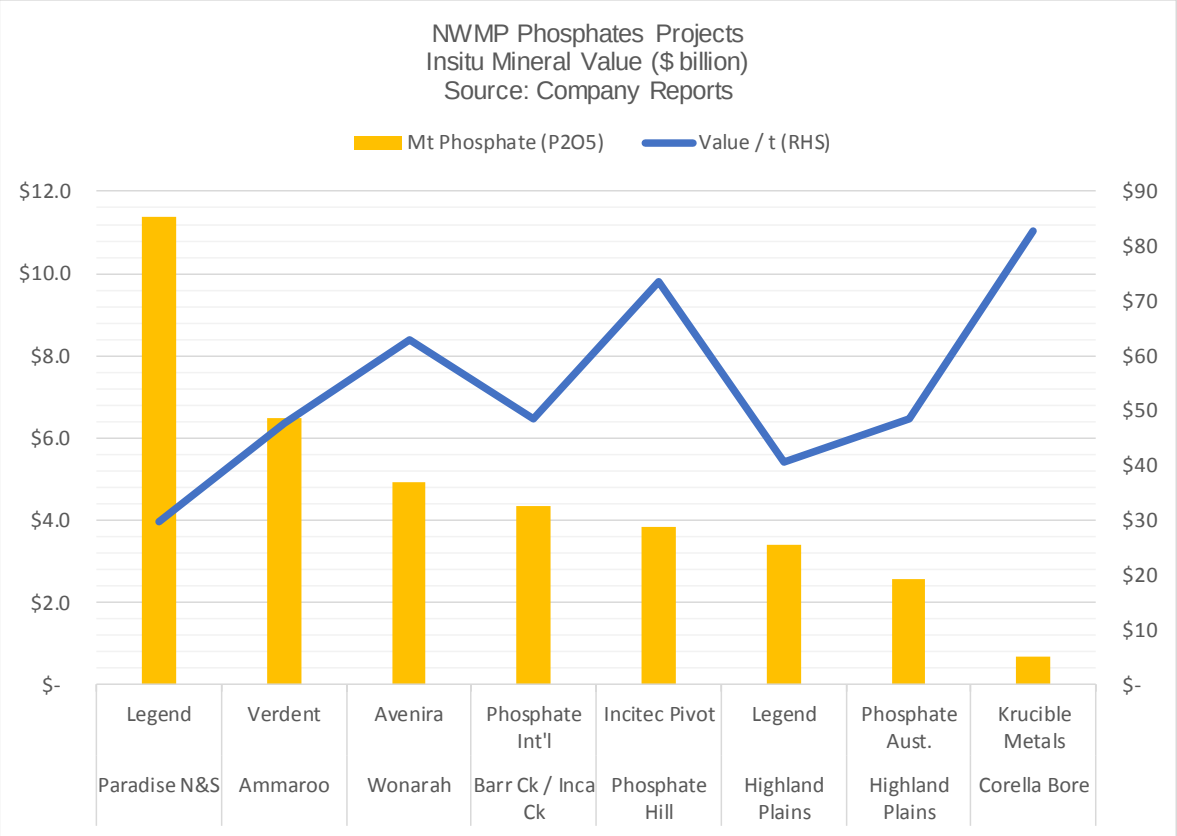


Figure 10 Phosphates Resources

At Phosphate Hill, Incitec Pivot has identified initiatives to further increase the recovery of valuable P_2O_5 (phosphorus compounds) from the gypsum tailings facility and from the rock fines tailings facility.

5.6 Uranium and rare earths projects

The NWMP hosts two identified and significant uranium resources. Given restrictions on the mining or processing of uranium in Queensland, Core has not considered these projects further.[9]

Uranium Projects	Project Owner	Resource Million Tonnes	Grade ppm U3O8	Contained Million kg U3O8	Insitu Value $bn
Westmoreland	Laramide	18.7	890	16.6	0.9
Valhalla, Skal etc	Paladin Energy / Summit	48.8	718	35.0	1.8

Figure 11 Uranium and Rare Earths Resources

[9] The Queensland Government's uranium policy is that it will not grant mining tenements for the purpose of mining uranium in Queensland, nor will it permit the treatment or processing of uranium within the State. (Queensland Government, Department of Natural Resources and Mines).
The States and Territories regulate the day to day operations of uranium mines in their jurisdictions and provide mining license approvals. Australian Government policy states that Australian uranium can only be sold to countries with which Australia has a nuclear cooperation agreement, to make sure that countries are committed to peaceful uses of nuclear energy. They must also have safeguards agreements with the International Atomic Energy Agency (IAEA), including an Additional Protocol. Consequently, the Australian Government's policy is that uranium exploration and mining will only be approved subject to stringent environmental and safety requirements in line with world's best practice. (Australian Government, Department of Industry, Innovation and Science).
For uranium mining, treatment or processing to be a feasible opportunity, changes to Queensland Government policy and regulation would be required. There is no indication that such a change is intended.

6 Regional infrastructure

See also Figure 1 NWMP Regional Infrastructure Assets for a map of regional infrastructure assets.

6.1 Diamantina/Leichardt power stations

The Diamantina Power Station (DPS) owned by APA Group (APA) is in Mount Isa and provides most of the generated power in the NWMP. The DPS comprises 242 megawatt (MW) of combined cycle gas turbines and is backed up by APA's 60 MW dual fuel, open cycle gas turbines at Leichhardt Power Station which also has a black start capacity. The DPS currently serves its foundation customers Glencore and Ergon.

6.2 Mica Creek power station

The Mica Creek Power Station (MCPS), is owned and operated by Stanwell Corporation Limited (Stanwell) and has a capacity of 218 MW (excluding its now redundant units). Three of MCPS's generating units have combined cycle-gas turbine technology. The MCPS has been in care and maintenance since February 2016 when its single remaining customer, MMG Century Mine ceased mining operations. The MCPS is currently recommissioning units at the MCPS to supply power to the Dugald River zinc mine being developed by MMG, 65 kilometres north west of Cloncurry. Stanwell will supply power to the Dugald River Mine until 2020. The MCPS is currently scheduled to close in 2020.

6.3 Clarke Energy

Clarke Energy owns and operates the 33 MW gas fired turbines at the X41 Power Station (XPS). Clarke Energy also owns 5 MW of temporary power at Mount Isa that provides back up during upgrades of the XPS.

6.4 Regional generation and power users (other than Glencore)

Mine	Description
Cannington	South32's Cannington Mine has a dual fuel (gas/diesel) 40 MW power station which is owned and operated by EDL.
Capricorn Copper (previously known as Mount Gordon)	Capricorn Copper is contracting with APA to supply power to its restarted operation. Production is anticipated for the third quarter of 2017. Mount Gordon was previously supplied by the now de-energised Mount Isa to Century line.
Century	The Century Mine previously owned by MMG and transferred to Attila Resources in 2017 is reviewing to provide the power for reprocessing of tailings dam operation.
Rocklands	CuDeCo has its own diesel generation.
Lady Annie	NetMind Financial Holdings Limited's mine is currently on care and maintenance. The operation was previously supplied power by MCPS.

Osborne	Chinova Resources has a 22.3 MW of duel fuel gas / diesel generation.
Phosphate Hill	Incitec Pivot's Phosphate Hill power station is natural gas powered with six Solar Taurus 60 gas turbines and one Siemens steam turbine that generate a combined capacity of approximately 30 MW of electricity. An emergency black start capacity is provided from 2 Caterpillar 3516 diesel generators.

6.5 Gas supply and pipelines

AGL Energy supplies the natural gas fuel source for the DPS under existing gas sales agreements which continue until 2023. The gas is delivered to the DPS by the Carpentaria Gas Pipeline (CGP), also known as the Ballera to Mount Isa Pipeline, which is a transmission pipeline that is owned and operated by APA. Stanwell's Mica Creek Power Station (MCPS) also sources gas from the south-west Queensland fields via the CGP.

The CGP includes the 840 km mainline, the 96 km Cannington lateral, the Mica Creek metering facility and the 6 km Mount Isa lateral. The pipeline transports gas from the South West Queensland Pipeline at Ballera in south west Queensland to these power stations and other customers (e.g. South32's underground Cannington mine and Incitec Pivot's Phosphate Hill) in Mount Isa and the surrounding Carpentaria mineral province.

A new gas pipeline, the Northern Gas Pipeline (NGP) is currently in the planning/development phase with construction scheduled to commence in 2017 and first gas by the end of 2018. The NGP is intended to carry excess from the offshore Blacktip field. Incitec Pivot is a foundation customer of the NGP.

Jemena Northern Gas Pipeline Pty Ltd, a joint venture between State Grid Corporation of China and Singapore Power, has been selected by the Northern Territory Government to construct and operate the NGP. The 622 km NGP will connect gas fields in the Northern Territory with customers in the Eastern Gas Market. The NGP will run between Tennant Creek in the Northern Territory and Mount Isa in western Queensland, and potentially extend to south-east Queensland. The NGP is still in the development phase, however recently achieved a key milestone, securing land access with all traditional owner groups across the pipeline route.

The NGP has the potential to be an enabler to future development in the NWMP by improved access to energy supply to projects along the pipeline corridor in the region both individually and through the ability to develop a multi-user lateral pipeline connecting to several projects; and improved competition for gas supply contracts to new projects in the NWMP along the NGP and CGP pipeline routes, potentially reducing energy costs.

6.6 HV Electric power reticulation

Ergon Energy's transmission network assets in the NWMP include the following:

220 kV line from Mount Isa to Century mine. This line however has been de-energised since the closure of the Century mine in 2016;

220 kV line from Mount Isa to Chumvale, near Cloncurry;

220 kV lines from Chumvale to Ernest Henry and Dugald River Mines.

Whilst the maximum capacity on Ergon's 66 kV Mount Isa to Cloncurry line is approximately 7 MW, Ergon indicated that if a greater capacity was required, augmenting the 66 kV line may result in a more cost-effective transmission charge than that for the alternative 220 kV line from Mount Isa to Cloncurry due to the higher asset value and operating costs for the 220 kV line

Ergon Energy do not own any 220 kV transmission network assets to the south of Cloncurry

To the north of the existing Mount Isa to Cloncurry lines there is also a new 63 km 220 kV line running from Chumvale, near Cloncurry to MMG's Dugald River mine and was recently energised, with an initial 2 MW supply

In response to mining projects with shorter mine lives, Ergon has the ability to provide 'skid substations' which have the ability for the substation to be re-located at the expiration of the contract.

6.7 Water

The NWMP's major water supply sources are Julius Dam and Moondarra Dam. Julius Dam is located at the junction of Paroo Creek and the Leichhardt River, approximately 70 kilometres north-east of Mount Isa. Julius Dam is owned by SunWater Limited (SunWater) and supplies several mining projects as well as the Cloncurry Shire Council. Currently SunWater has 10,850 ML of unallocated water from Julius Dam. Importantly for investment considerations, all the water allocations from Julius Dam are high priority.

Moondarra Dam is located on the Leichardt River 18 km north of Mount Isa and is operated by the Mount Isa Water Board (MIWB) which supplies water to the Mount Isa City Council (MICC), Mount Isa Mines (MIM) and Incitec Pivot's sulphuric acid plant. The current annual water allocations from Moondarra Dam are at 100% and allocated as follows, MICC 12,500 ML, MIM 12,500 ML, MIWB (Distribution) 1,250 ML and MIWB (Any) 50 ML. (Note: Water allocations without CWSA arrangements in place). There are not significant spare water allocations from Moondarra Dam for new customers and all allocations from this dam are only medium priority water allocations

Additional regional water supply sources include, the Cloncurry Weir which is owned by the Cloncurry Shire Council (CSS) and enables 700 ML/a to be water harvested from the Cloncurry River into China Creek Dam which contributes to a secure water supply for the town

Corella Dam is located 40 km west of Cloncurry and previously provided water supply for the Mary Kathleen mine and township. The CSS is currently in the final stages of acquiring the Corella Dam from the State Government which will provide an additional water allocation for the CSS to be able to supply to future mining or agricultural customers

East Leichardt Dam, 25 km east of Mount Isa, currently owned by the State Government, is currently not utilised.

The North-West Queensland Water Pipeline Pty Ltd (NWQWPC), a subsidiary of SunWater owns and operates the 113 km pipeline from Lake Julius to the Ernest Henry Mine (EHM) (NWQWP). The existing NWQWPC customers are MMG, EHM and the CSS and several rural customers. The NWQWP has a total capacity of 15,000 ML/a of which 10,500 ML/a is currently available.

The NWQWP also owns and operates the Cloncurry Pipeline, which is a 38 km extension from EHM to Cloncurry and transports water for both domestic and industrial supply. The Cloncurry Pipeline has a capacity of 950 ML/a, and it is understood that in 2016 the CSS used the full capacity of this pipeline. Therefore, if in future years the utilisation of the capacity of the Cloncurry Pipeline remains at full capacity, the pipeline may need to be augmented to have capacity to transport additional water to new customers

The MIWB owns and operates the pipeline from Julius Dam to Mount Isa. Moondarra Dam is the primary water supply source for the MIWB and its customers. The pipeline from Julius Dam to Mount Isa is only utilised by the MIWB when Moondarra Dam falls below 20% as the pumping costs from Julius Dam to Mount Isa are significantly higher than those from Moondarra Dam which is only 18 km from Mount Isa in contrast to Julius Dam which is over 70 km.

6.8 Transport infrastructure

Queensland Rail operates the Mount Isa to Townsville rail line which connects the NWMP to refining and port facilities in Townsville. This is a vital piece of transport infrastructure serving the NWMP. Bulk freight users have expressed concern in relation to perceived high transport costs and inflexible take or pay transport allocations on this line, including inflexibility under contractual arrangements to trade unused take or pay allocations, with the result that some users are paying large take or pay fees on unused allocations. Mining proponents have also commented on the poor condition of the rail line between Cloncurry to Mount Isa which contributes to longer transit times due to speed restrictions and frequent derailments.

A 304 kilometre underground concentrates pipeline extends from the now closed Century mine to Karumba. During the Century mine operations, the pipeline was used to transfer processed zinc and lead concentrates from the mine to the port at Karumba.

6.9 Infrastructure impediments and opportunities

For a regional area, the NWMP has a significant amount of established infrastructure for water, power, rail and road. Despite this, several serious infrastructure impediments are faced by mining projects, particularly small to medium scale projects, with a short mine life of 5-10 years:

6.9.1 Gas pricing and availability

Whilst there is sufficient power generating capacity, contracted gas, and gas pipeline capacity to meet current projected demand in the NWMP, future gas availability and current price is a critical constraining issue.

While Australian domestic wholesale gas prices have been reported in recent years to be internationally competitive at around US$4 to 6 / GJ, domestic prices are rising rapidly as LNG exports ramp up. The result of access to higher priced (gas-depleted) North Asian markets for this gas is that domestic wholesale prices are escalating rapidly.

Figure 12 Asia-Pacific Wholesale Gas Prices 2015

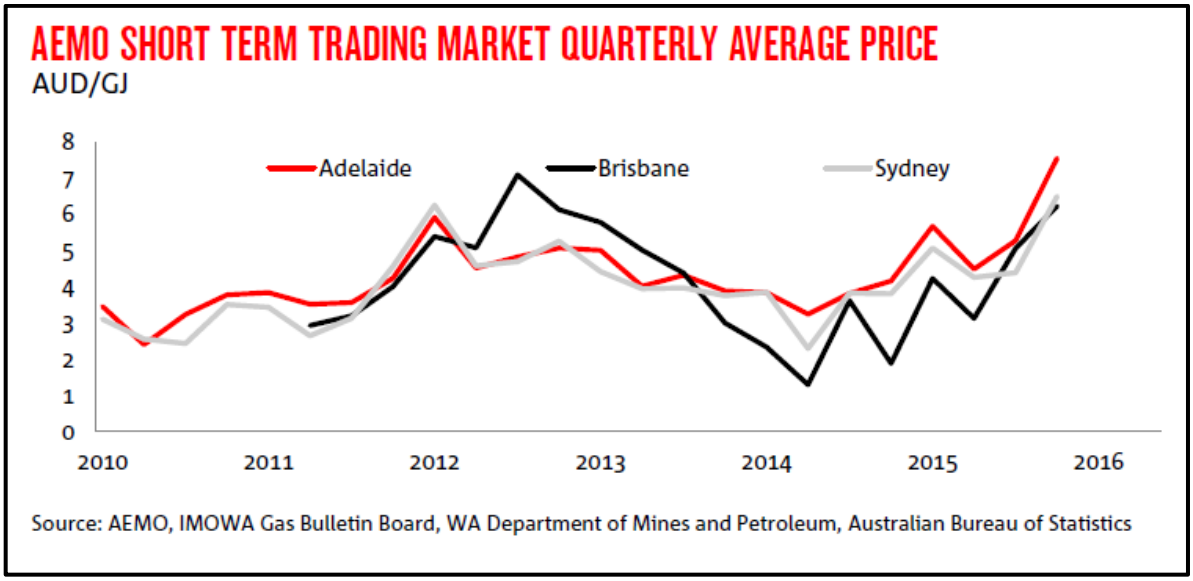


Figure 13 Australian Short Term Quarterly Average Gas Prices (A$/GJ)

It is understood that gas delivered at Mount Isa is approximately A$12/GJ and that bulk electricity supply regionally is priced at 18 to 20 c/kWh. Diesel power costs approximately 25 to 30 c/kWh. These prices are a function of the eastern Australia gas crisis and have the potential to impact on the competitiveness of the NWMP. Although the introduction on the Northern Gas Pipeline from the Northern Territory will bring diversity of gas supply, in the immediate future these is no available uncontracted gas and so there is no short-term prospect of any further competitive pressures being brought to reduce gas prices.

It is also worth considering if any tradability of take or pay energy contracts may be enabled. As many components of an energy supply agreements in the NWMP are purchased on a take or pay basis from limited suppliers (gas purchase, gas transport, power conversion, power transmission), it may introduce welcome flexibility and competitive pressure if some form of tradability for such contacts is permitted.

6.9.2 High capital charges for access to power infrastructure

Mining projects that require existing infrastructure such as transmission network assets or water pipeline (e.g. EHM to Cloncurry) to be augmented are required to bear the augmentation costs, often resulting in transmission or water transportation charges that cannot support investment decisions.

When renewal programs are undertaken on transmission network assets, the assets are renewed ‘like for like’ to comply with the regulatory framework and are not able to be renewed for future developments. It is noted that the marginal cost to augment to meet future needs is relatively low when the renewal is actually being undertaken. Mining projects that are not sufficiently proximate to existing infrastructure also face significant capital and operating costs to be able to connect into or utilise such infrastructure.

6.9.3 Expensive and inflexible rail transport take or pay contract

Core understands that allocations for rail transport on the Mount Isa to Townsville line are typically contracted on a take or pay basis. There appears to be very limited leverage to competitively negotiate contractual arrangements, given QR’s sole supplier status. One current user reports annual take or pay obligations being paid on un-used take or pay allocations, at a time that a new entrant has entered the market and is seeking an allocation. A proposal for consideration is that there should be some tradability rights on take or pay rail allocations so that unused entitlements can be sole to third parties. Apart from the ability to defray costs on un-used allocations, this may introduce some competition into this sole-supplier market.

6.9.4 Opportunities to establish new common user infrastructure

An opportunity exists to locate common user infrastructure, such as a pyrite roaster near EHM given the availability of a suitable volume of high priority water allocations from Sun Water (Julius Dam) and pipeline capacity in the NWQWP from Lake Julius to EHM; the proximity to and capacity of Ergon’s transmission network assets to take 20 MW of power generated from the pyrite roaster operation; and proximity to existing rail or road access

Such an operation may process sulphur concentrates to produce both acid that can be used in various mining projects in the NWMP as well as power.

Further if the CSS can provide sufficient water allocation from the newly acquired Corella Dam, or alternatively release capacity on the EHM to Cloncurry water pipeline by using the allocation from Corella Dam for existing requirements, Cloncurry may also be another location that may be considered for the location of a regional pyrite roaster

Appendix A On-line survey

Barriers or impediments to development of low grade mineral projects in the NWMP.

As part of the audit process, Core interviewed a range of regional stakeholders on their perceptions of barrier or challenges to the future processing of low grade mineral resource in the NWMP. Similar consultations were reported in "North West Minerals Province - Barriers and Challenges to Exploration, Development and Sustaining Operations" (de Kruiff / Thompson, May 2016). The stakeholders were questioned about their views on challenges to processing low grade minerals including any Federal or State Government legislation that supports or is an impediment to the commercialisation of low grade minerals processing,

Figure 14 Costs / Availability of inputs in the NWMP

To what extent this was a factor in constituents' business

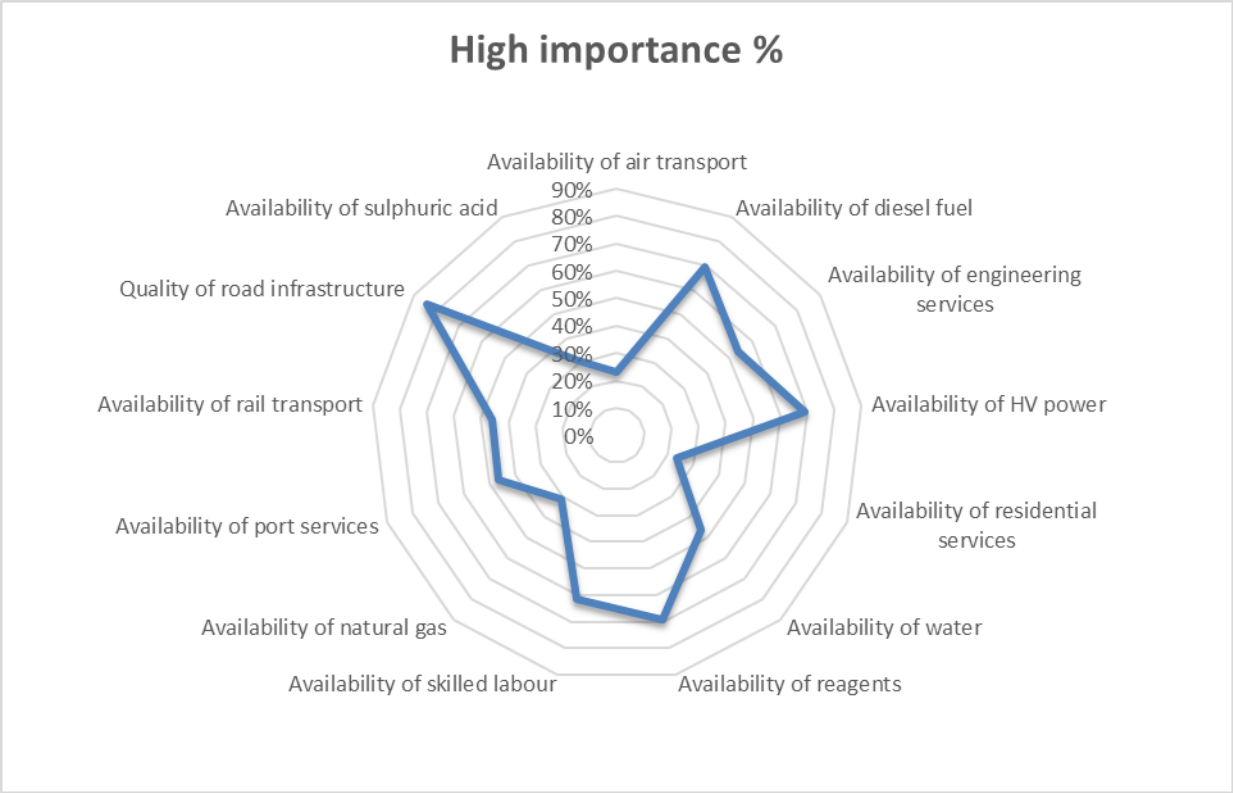


Figure 15 Regulatory / Permitting processes in the NWMP

To what extent this was a factor in constituents' business

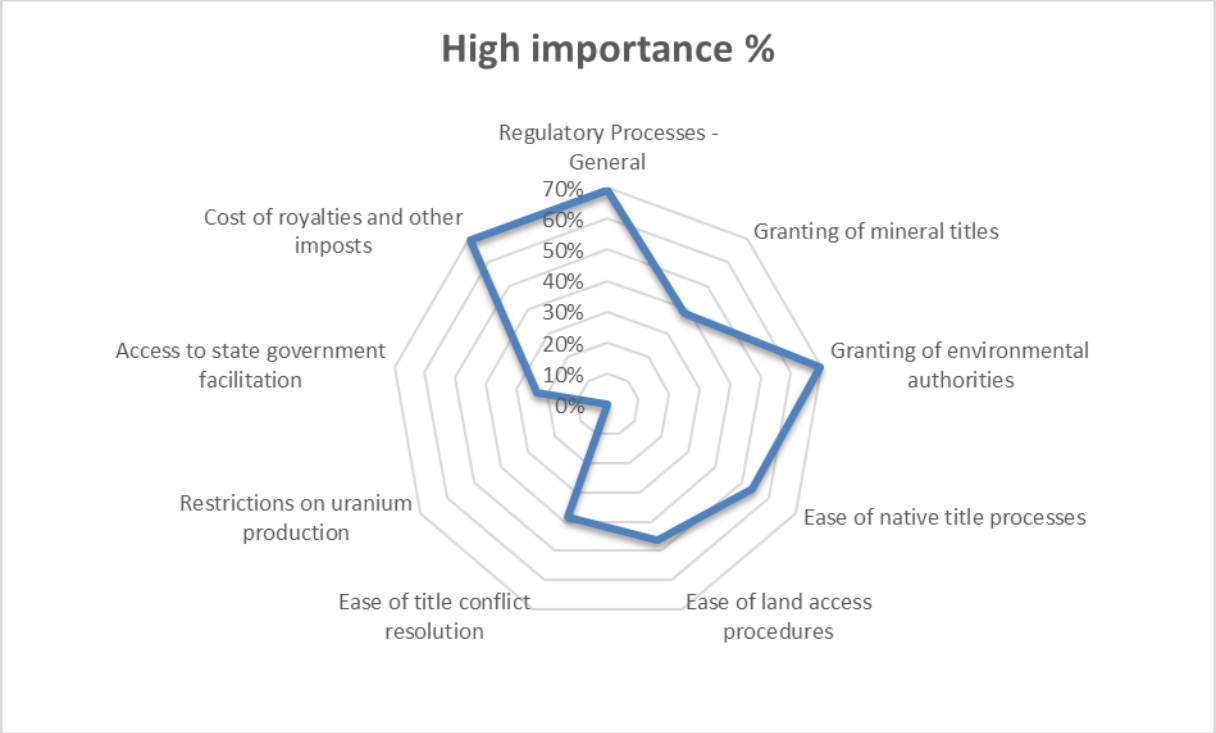
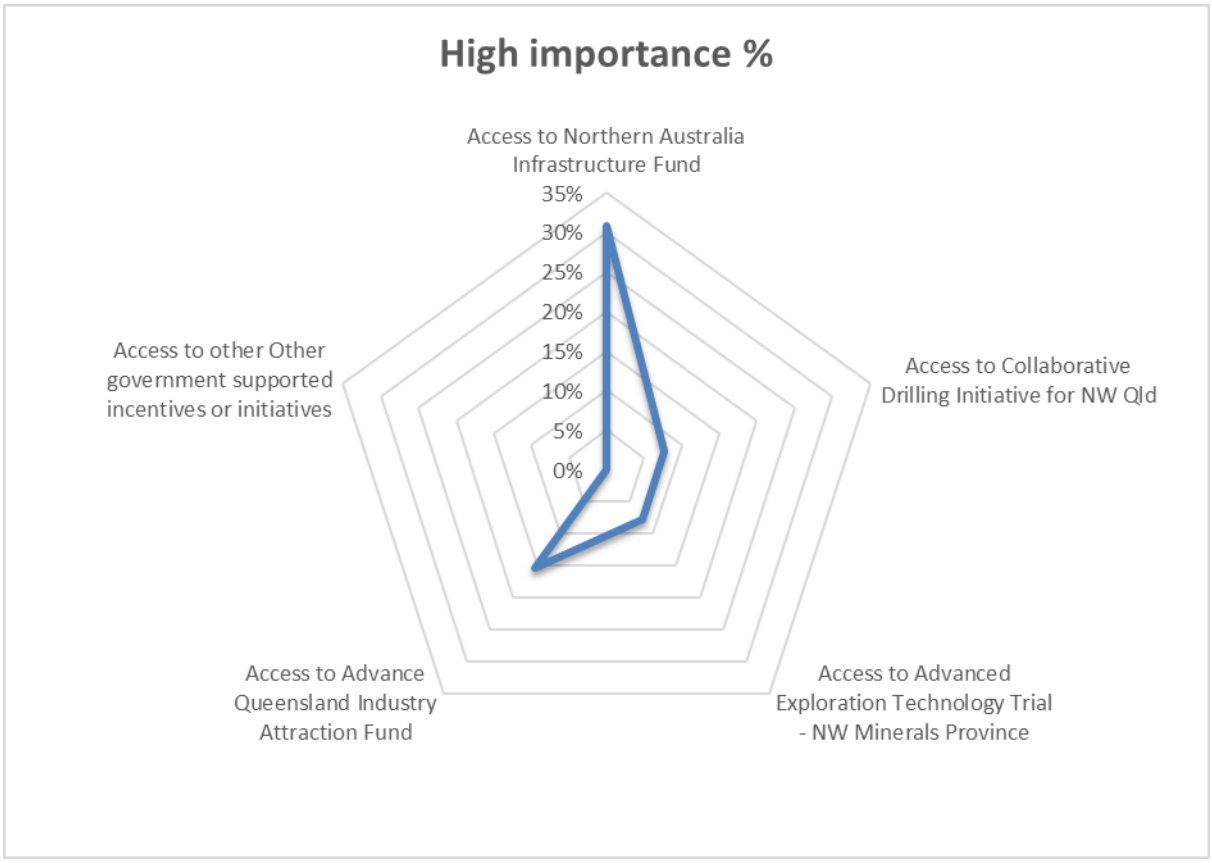


Figure 16 Government programs / assistance in the NWMP

To what extent this was a factor in constituents' business.



Appendix B Glossary of terms

Units of measurement used in this report conform to the SI system and chemical terms conform to IUPAC.

All currency in this report is Australian dollars (A$) unless otherwise noted.

µm micron

% percentage

°C degrees Celsius

°F degrees Fahrenheit

µg microgram

a annum

A ampere

AAL Acid Albion Leach

AAS Atomic Absorption Spectrometer

AI Abrasion Index (Bond)

AlkAL Alkaline Albion Leach

Albion Process™

Albion Process Technology owned and patented by Glencore

AP Albion Process

ARD aqua regia digest

ASLP Australian Standard Leach Procedure (AS4439.3-1997)

Ag Silver

As Arsenic

Au Gold

A$ Australian dollars

BLEG Bulk Leach Extractable Gold, a diagnostic cyanide leaching test

Btu British thermal units

BWi Ball Mill Work Index (Bond)

C$ Canadian dollars

cal calorie

capex Capital Cost Estimate

CIL carbon in leach

cm centimetre

cm^2 square centimetre

CN cyanide

con Concentrate (e.g. kg/t con)

Core Core Metallurgy Pty Ltd

CSTR Continuously stirred tank reactor

Cu copper

CWI Impact Crushing Work Index

d day

dia. diameter

dmt dry metric tonne

DWi drop weight index

dwt dead-weight ton

ES elemental sulphur

EIS environmental impact statement

EMEW® Proprietary electrowinning technology from Electrometals Technology

F_{80} 80% passing size of feed material

FA free acid

Fe Iron

ft foot

ft/s foot per second

ft^2 square foot

ft^3 cubic foot

g gram

G giga (billion)

G&A General & Administration

Gal Imperial gallon

g/L gram per litre

g/t gram per tonne

g/cm^3 gram per cubic centimetre

gpm Imperial gallons per minute

gr/ft^3 grain per cubic foot

gr/m^3 grain per cubic metre

GT Glencore Technology

h hour

h/yr hours per year

ha hectare

hp horsepower

hrltesting hrltesting Pty Ltd

Hz hertz

ICP Inductively Coupled Plasma method for chemical analysis of liquors

ID Inside Diameter

in	inch
in²	square inch
J	joule
k	kilo (thousand)
kt	kilo tonne (s)
kcal	kilocalorie
kg	kilogram
kg/t	kilogram per tonne
km	kilometre
km/h	kilometre per hour
km²	square kilometre
kPa	kilopascal
kVA	kilovolt-amperes
kW	kilowatt
kWh	kilowatt-hour
kWh/t	kilowatt-hour per tonne
L	litre
L/s	litres per second
LeachWELL™	Diagnostic cyanide leaching test containing accelerants to promote precious metal dissolution
m	metre
m/h	metres per hour
METSIM®	Process model software package used under license
mg	milligrams
mg/L	milligrams per litre
M	mega (million)
Mt	million metric tonnes
m²	square metre
m³	cubic metre
min	minute
MASL	metres above sea level
mm	millimetre
mph	miles per hour
mV	milli volt
Mtpa	million metric tonnes per year
MVA	megavolt-amperes
MW	megawatt
MWh	megawatt – hour
m³/h	cubic metres per hour
NAG	Net Acid Generation
NAL	Neutral Albion Leach
NaNAL	Sodium assisted Neutral Albion Leach
Neut	Neutralisation
NSG	Non-Sulphide Gangue
opt, oz/st	ounce per short ton
OD	Outside diameter
Opex	Operating Cost Estimate
ORP	oxidation reduction potential
oz	Troy ounce (31.1035g)
oz/a	ounce per year
oz/dmt	ounce per dry metric tonne
pa	per year
PBD	Process Block Diagram
PDC	Process Design Criteria
PFD	Process Flow Diagram
PLS	Pregnant Leach Solution
ppm	parts per million
PD	pulp density
POx	pressure oxidation
P_{80}	80% passing size
Pb	Lead
PSD	Particle Size Distribution
psia	pound per square inch absolute
psig	pound per square inch gauge
RC	reverse circulation (drilling)
RL	relative elevation
ROM	run-of-mine
S^0	Elemental Sulphur
S^{2-}	Sulphide Sulphur
S_T	Total Sulphur
s	second
SAD	strong acid dissociable (cyanide)
SART	Sulphidisation Acidification Recycle Thickening (cyanide recovery process)
scats	oversize from a SAG Mill
SG	specific gravity
SMC	S Morrell Comminution Test
sol	solution
SOx	sulphide sulphur oxidation
SO_2	sulphur dioxide
st	short ton
stpa	short ton per year
stpd	short ton per day
SX	Solvent extraction
SS	Sulphur species (assay S^{2-}, S^0, SO_4^{2-})
t	metric tonne

T.B.A. to be advised

T.B.D. to be determined

TCLP Toxicity Characterisation Leach Procedure

tph metric tonne per hour

tpa metric tonne per year

tpd metric tonne per day

Toowong Process

Toowong Process technology owned and patented by Core

UFG Ultrafine Grinding

UCS Unconfined Compressive Strength

US$ United States dollars

US$M United States million dollars

USEPA United States Environmental Protection Agency

USg United States gallon

USgpm US gallon per minute

V volt

W watt

WAD weak acid dissociable (cyanide)

wmt wet metric tonne

w.r.t. with respect to

w/v weight for volume (ratio)

w/w weight for weight (ratio)

XRD X-Ray Diffraction method for identifying and quantifying crystalline minerals

yd^3 cubic yard

yr. year

Zn Zinc