

28 August 2019

## West Musgrave – Pre-feasibility Study progress update

- Pre-feasibility study assessing a 10 Mtpa scenario aligned to the Further Scoping Study<sup>1</sup> with an extended mine life
- Original Pre-feasibility Study timeline extended for detailed evaluation of a range of potential value-add opportunities
- Further update and maiden Ore Reserve planned for release early 2020

OZ Minerals and Cassini Resources today provide a progress update on the West Musgrave Project Pre-feasibility Study (PFS).

The West Musgrave project is a joint venture between OZ Minerals (70%) and Cassini Resources (30%) (ASX:CZI) to develop the Nebo and Babel copper and nickel deposits in Western Australia; some 800 km west of Uluru, near the intersection of the borders between Western Australia, South Australia and the Northern Territory. The current study work builds on the Further Scoping Study (FSS) completed by OZ Minerals and Cassini in November 2017.

The West Musgrave Province is relatively under-explored, and the potential upside is highlighted by a significant existing Inferred Resource at Succoth and prospectivity at One Tree Hill; both within 15 km of the Nebo Babel project.

OZ Minerals' CEO, Andrew Cole said "The Pre-feasibility Study is advancing on a base case assessment aligned with the Further Scoping Study conclusion of a 10 Mtpa copper-nickel open pit mine. The Further Scoping Study announcement commentary described an initial eight years of mine life with clear view on increasing this to beyond 15 years; an expectation of the PFS.

"We are using an innovative and inclusive process to develop West Musgrave as a modern mine that creates maximum value for key stakeholders. This process involves collaborating with the traditional owners, government agencies, and local and international industry and subject matter experts; which has required a significant investment in time and effort from the various parties.

"Through the collaborative process, we have identified several opportunities and some threats, warranting further investigation, including some significant innovations that will help improve the valuation of the project in one of the most remote areas of Australia. These include the use of a reduced site footprint via a Remote Operations Centre, the use of hybrid power solutions, potential to use innovative technology and a process flowsheet which pilot testing has shown could result in a significant reduction in power usage. We believe these

<sup>1</sup> The information initially appeared in the report entitled 'West Musgrave Project to progress to Pre-Feasibility Study' which was released to the market on 14 November 2017 and is available to view at [www.ozminerals.com/media/asx](http://www.ozminerals.com/media/asx). OZ Minerals confirms that all the material assumptions in the original market announcement continue to apply and have not materially changed.

opportunities have the potential to reduce our carbon footprint and power costs versus a traditional mine footprint while improving overall project economics.”

OZ Minerals’ Chief Commercial Officer, Mark Irwin said “Extending the timeline of activities also allows for a greater level of in-fill drilling than was contemplated in our original Pre-feasibility Study timeline, which will provide a clearer view of the project economics and key value drivers when the Pre-feasibility Study is completed early next year.

“We are taking a risk and value-based approach to project management underpinned by our Lean and Agile methodology. A similar approach was adopted in the design and construction phases of our Carrapateena construction project.

“We thank our partners, Cassini, and the various stakeholders who are participating in the collaborative process for their ongoing contribution.”

The value-based opportunities requiring further evaluation during the remainder of 2019 to form part of the Base Case of the PFS are discussed in further detail in the Opportunities section of this market release, and include:

- Undertaking further pilot testing of the Loesche Mill and additional flotation cell technologies, all of which have the potential to reduce capital and operating costs, while increasing metal recovery.
- Evaluating the merits of a Remote Operations Centre, focusing particularly on network infrastructure requirements and workforce planning.
- Deepening our knowledge of power options with a view to identifying future partners.
- Updating the Mineral Resource to include drilling completed since December 2018, and re-iterate the mine design, in order to release a maiden Ore Reserve.

Sufficient drilling has now been completed to support the completion of the PFS and drill rigs will be demobilized from site in mid-September.

The Bulk Flotation flowsheet, which is already in the Base Case, will be pilot tested over the coming months in order to fully de-risk it.

In addition to focusing on the opportunities, the community engagement and regulatory approvals processes will continue in-parallel with a view to securing all government approvals by Q2 2021.

To complete these works, the OZ Minerals Board has approved an additional \$10 million to complete the PFS.

The completed PFS is targeted for completion in early 2020, at which time an updated Mineral Resource and maiden Ore Reserve is also expected to be declared.

## **Study Update - Pre-feasibility Study work completed**

### **Resource Update**

A Mineral Resource update was released in April 2019 incorporating drilling up to December 2018. In that release Indicated Resources were increased from 40% to 60% of the total Mineral Resource compared to the previous release. Since December 2018 approximately 50,000m of infill drilling has been completed with a focus on increasing the proportion of Indicated Resources sufficiently to underpin an Ore Reserve once the PFS is completed. This drilling will be complete in mid-September, and work is underway to update the Mineral Resource.

### **Mine Optimisation**

A Mining ‘Hill of Value’ study has been completed to select the optimum processing rate and mining cut-off grade.

A detailed mine design, stockpiling strategy, operating cut-off grade and waste dump strategy have also been completed.

The Pre-Feasibility Study is working on improving on the Further Scoping Study's initial eight years of mine life with a clear view on increasing this to beyond 15 years.<sup>2</sup>

### Metallurgical Flowsheet Development

An alternate flotation flowsheet to the Sequential Separation flowsheet which was the basis for the Further Scoping Study has been tested to sufficient confidence to be included in the Base Case. This alternate Bulk Separation flotation flowsheet is used in the majority of copper-nickel projects worldwide that produce separate copper and nickel concentrates.

Bulk separation enables primary grind size to be increased from 75 microns to 165 microns which results in a capital cost and operating cost savings. While the Bulk Separation flowsheet has been tested with sufficient confidence to be included in the Base Case, further de-risking will be undertaken through locked cycle testing and a pilot plant later this year.

### Alternative Technologies

The study has identified three alternative processing technologies to that assumed in the Further Scoping Study that are not yet incorporated in the Base Case; the Loesche Mill, Woodgrove Flotation Cell and Hydro-float Cell. All of which are still to be fully tested and proved, but all of which have the potential to further reduce capital costs and operating costs and improve metal recoveries. Work on the Loesche Mill technology is the most advanced of these three. A Loesche Mill pilot plant test was completed in Germany on a two tonne sample of West Musgrave material with further testing underway.

### Power Solutions

A 55 MW hybrid diesel-solar-wind solution with 70–80% renewable penetration is the current Base Case. Baseline data collected over the last year has demonstrated a high quality, consistent solar and wind resource is available, with higher wind velocities at night offsetting the lack of solar power.

Power accounts for around 40% of the processing cost at West Musgrave and is a significant value lever on the project. Large-scale solar photovoltaic and wind solutions are currently economically viable and technically mature solutions to reduce the project's reliance on high cost fossil fuels for electricity generation.

A large number of proposals have been received from major utilities, independent power providers, infrastructure funders and equipment manufacturers. Evaluation of the proposals has resulted in confidence that there will be a reduction in the power cost assumption used in the Further Scoping Study.

### Groundwater Drilling

Ten groundwater drill holes have been completed across the site and a number of potential borefield areas identified within 20 km of the proposed mine and immediately surrounding the Nebo pit. Groundwater modelling has confirmed sufficient groundwater is present in these potential borefields to support the current base case scenario and water resources are therefore considered largely de-risked. The groundwater is present in shallow paleochannels 5–10 metres below the surface and is of excellent quality; significantly better than the hypersaline water present in the Western Australian goldfields.

### Remote Operations Centre

A preliminary assessment has been completed on the potential for a Remote Operations Centre for West Musgrave with the location and business case to be further developed.

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<sup>2</sup> See above at 1.

## Haulage Study

A preliminary haulage study has been completed, considering autonomous mine haulage as an option for comparison against a traditional contractor mining model. Further assessment is required.

## Logistics

A first principles logistics study has been completed which uses super quads for moving concentrates. Further assessment will look at backhauling opportunities.

## Improved Definition to Engineering and Cost Estimation

GR Engineering Services has supported the project with engineering and cost estimation for the process and non-process infrastructure. The various optimisation opportunities have meant that aspects of this work are being further reviewed, including revised comminution design parameters and the change to the bulk flotation circuit; which are still to be thoroughly incorporated into the estimate.

## Regulatory Approvals

The project secured Lead Agency status from the Government of Western Australia's Department of Mines, Industry Regulation and Safety (DMIRS). As the Lead Agency, DMIRS will act as the single point of contact between the project and the various government departments involved in the regulatory process. At this point, OZ Minerals intends to lodge its environmental approvals application during Q1 2020, with a view to securing all approvals by Q2 2021.

## Community

Community consultation has advanced. Discussion on a potential Mining Agreement has commenced and a Working Together Agreement, which sets out the values of each party and how we will work together, is under development.

A Western Australian Government Hub process was well supported with attendees from 10 different government departments. The intent of the Hub was to introduce OZ Minerals, Cassini and the project team to the government departments, and also to explore opportunities to work together to add value, particularly from a community perspective.

## Project Base Case

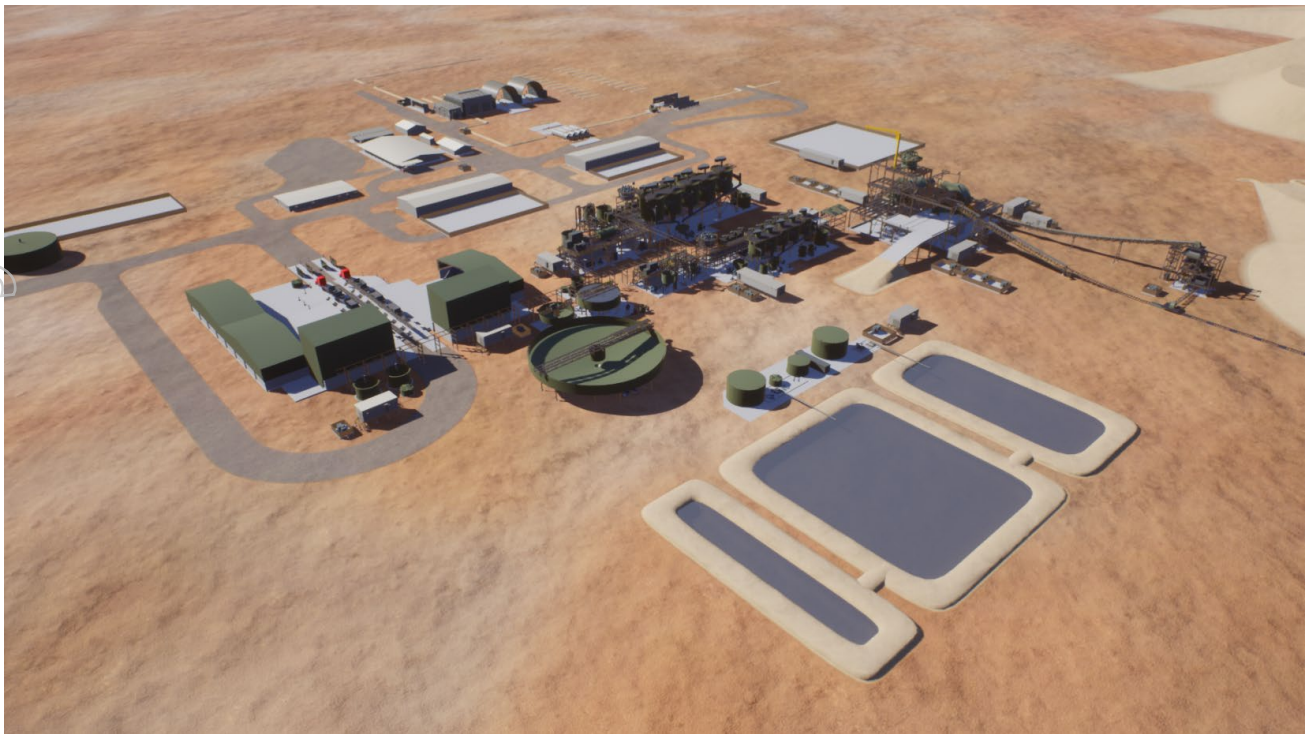
The current base case elements are provided in Table 1. A conceptual view of the site layout is shown in Figure 1 with a potential layout for the processing facility and site infrastructure shown in Figure 2.

**Table 1: Project description**

Area	Sub-Area	Description
Mining	Resource	As at 12 April 2019: 238 Mt at 0.35% Ni, 0.38% Cu <sup>i</sup> 59% Indicated and 41% Inferred
	Pits	Nebo pit and Babel pit
	Operations	Fully manned fleet, contractor mining
Processing	Flowsheet	SAG mill, ball mill and bulk flotation flowsheet
	Pyrite violarite	Treated in separate batches every 10 weeks
Infrastructure	Roads	Great Central Road (GCR) sealed by others 90 km from site to GCR possibly sealed by OZ Minerals
	TSF	Traditional, lined, single cell, with water recycled back to process
	Village and airstrip	400-person village and 1.9 km long airstrip located at site
	Water	7 GL/yr Borefields at Northern (11 bores) and Nebo (9 bores) areas
	Power	55 MW Power Purchase Agreement hybrid renewables (wind, solar, battery and diesel)
	Logistics	Containerised Super Quads to Leonora, rail to Esperance
	Customers	Nickel and copper smelters in Australia, Asia and Europe



**Figure 1: Potential Site Layout**



**Figure 2: Processing Facility and Infrastructure**

## **Study update - Opportunities being further assessed**

### Loesche Mill

Loesche Mills are a dry grinding technology commonly used in the cement industry but with limited uptake for base metals. There are currently more than 2,000 operational Loesche Mills worldwide. Pilot testing to date supports a 30% reduction in grinding power for a similar capital cost as a SAG / Ball Mill circuit, with further testing underway in the next few months. In the case of West Musgrave, the high cost of power drives a strong business case for this technology.

### Remote Operations

Site monitoring, operating (mine despatch, processing plant operations) and planning functions could potentially be located off-site in a Remote Operations Centre. Preliminary assessment suggests this will allow considerable savings in on-costs. The extent of off-site functionality will be dictated by communications constraints (fibre or satellite). A more detailed assessment will be completed on the potential value of remote monitoring and remote control.

### Power Cost

A further engagement with the energy market will focus on the key levers of wind and solar capacity factors, mine life implications and funding options, including government funding.

### Flotation Cell Technology

The Woodgrove Float Cell currently being operated and further installed at the Salobo copper and Chapada copper-gold mines in Brazil is being considered. It has a smaller footprint, and also uses less air, resulting in lower capital costs and operating costs. The HydroFloat Cell is designed to capture very coarse particles and has a potential application in scavenging coarse copper losses from the rougher circuit.



## Logistics Backhaul

Backloading opportunities for reagents and other consumables are being explored. Ongoing engagement with Main Roads WA and the local Shire will continue regarding sealing of Great Central Road and the potential associated opportunities and threats.

## Mining

There is an opportunity to dump later stage mine waste into earlier mined out stages at Babel. A review of overburden geotech suggests some of the pre-strip material at Nebo and Babel may be free dig; requiring no drill and blast.

Mining work will focus on a first principles work-up of mining cost and preparation of a Reserve, as well as examination of the opportunities described. The Reserve will be based on an updated Resource model, which will include drilling up to August 2019.

## Silver Credit

The Resource currently excludes silver, however payable silver has been measured in laboratory copper concentrates. Historic silver assays are now being retrieved from the lab to be included in project valuation.

## Value Engineering

Cost estimates for tailings, water, power, owner's costs and contingency are currently not at a PFS level of definition and further work will seek to identify cost savings while definition is improved. Engineering will be refined to capture changes identified through the ongoing test work program, namely changes to comminution design parameters and the introduction of the bulk flotation circuit.

## Autonomous Mining Fleet

Engagement with Original Equipment Manufacturers will continue so as to build a roadmap for reviewing the business case for autonomous haulage, developing an understanding of commercial differences between autonomous-off-the-shelf, autonomous-ready and manned trucks as well as implications of contractor versus owner operation.

## Nickel Sulphate or Mixed Hydroxide Product

Nickel sulphide concentrate can be further processed to produce nickel sulphate or mixed hydroxide product (MHP) as a precursor product into the battery market, materially increasing the payability of contained Nickel and reducing freight costs to market. A number of new technologies for converting nickel sulphide to sulphate or MHP are available and will be further examined.

## Succoth

The Succoth copper deposit is located only 13 km north-east from Nebo Babel.

Cassini has previously reported<sup>3</sup> an Inferred Resource at Succoth of 156 Mt at 0.6% copper with drilling including a highlight of 148 m at 0.94% copper from 30 m, including 42 m at 1.38% copper from 102 m (drill hole CZC0118).

A new structural interpretation of the mineralisation has been developed; demonstrating the potential for upside at Succoth. With Nebo Babel justifying the establishment of supporting infrastructure, Succoth can potentially add significant upside in mine life or production rate. Importantly, an extended mine life may underpin a further reduction in power costs for Nebo Babel by allowing capital costs to be amortized over a longer timeframe. At this stage, a detailed in-fill drilling program is being considered for 2020.

<sup>3</sup> Maiden Succoth Resource Estimate, Cassini ASX Release 7 December 2015.

[https://www.cassiniresources.com.au/images/files/151207\\_Succoth\\_Resource.pdf](https://www.cassiniresources.com.au/images/files/151207_Succoth_Resource.pdf)

## Study update - threats not fully mitigated in the Base Case

### Pyrite Violarite

The PV ore type oxidises rapidly resulting in a degradation of its nickel recovery over time. The Base Case assumption is that there is some minor degradation within three months of stockpiling, impacting recovery; however this has not been tested. PV ageing test work is underway to properly quantify this threat.

### Regulatory Approvals Delay

The project is currently targeting an 'Assessment on Referral' outcome with the Government Regulator based on the project having supportive stakeholders and well understood risks and controls. There is a risk that the Regulator may require a 'Public Environment Review' document to be submitted for assessment which would result in a 12 to 18-month delay to current timeline assumptions. The key environmental issue is the presence of subterranean fauna in groundwater.

### Nebo Dewatering and Backfill

The Nebo pit contributes 10% of total tonnes, albeit higher grade tonnes during the first five years of production. The western half of the pit is intersected by a saturated paleochannel that needs to be dewatered before mining. There is a risk that mining of the Nebo pit may need to be deferred to allow for dewatering. The groundwater drawdown is likely to affect some subterranean fauna and could therefore be a focus for the Regulator. As a potential mitigation strategy, the drawdown can be significantly reduced by backfilling the pit with waste rock or tailings. An optimisation study will be completed to address this threat.

### Performance Based Standard (PBS) Approval for Super Quads

Approval to run Super Quads on the Great Central Road may be delayed until the road is fully sealed. Consultation will continue with Main Roads WA, the local Shire, as well as potential logistics providers.

## PFS - next Steps

### PFS Completion - Finalise the Base Case

The scopes of work described above under each **Opportunity** will be completed and when each is considered de-risked to a PFS level of definition, it will be incorporated into an updated Base Case. The scopes related to Threats will either result in mitigation of those **Threats** or an update to the Base Case to allow for them.

### Community

Community engagement and consultation will continue with the Ngaanyatjarra People including the development of a Working Together Agreement and progression of a Mining Agreement. A Social Impact and Opportunity Assessment (SIOA) developed in collaboration with the Ngaanyatjarra Council and the University of Queensland will be commissioned in Q3 2019.

### Regulatory Approvals

The environmental baseline study program will be finalised, characterising the project's remaining outstanding environmental risks, including:

- Developing a robust groundwater model for the borefield and mine pits, suitable for predicting fine-scale impacts to groundwater dependent ecosystems (GDEs) including flora, subterranean fauna and potential third-party groundwater users
- Expanding the subterranean fauna study beyond the extent of groundwater impacts, including drilling a number of dedicated survey bores, and a geology-focused subterranean habitat survey.



Regulatory approvals documentation will be prepared, and associated stakeholder consultation conducted to support the primary approval under the *Environmental Protection Act 1986* (WA); known as a Section 38 Referral.

Continue long lead time studies required to support secondary approvals under the *Mining Act 1978* (WA) and *Environmental Protection Act 1986* (WA), Part V Works Approval.

## OZ Minerals' Strategy

OZ Minerals' strategy of working in a lean and agile way, with a commitment to value creation for our stakeholders, underpins the approach to this Pre-feasibility Study. We are exploring new ways to operate a remote mine, in a part of Australia with low levels of infrastructure and access. The Pre-feasibility Study is being prepared with the view to opening up opportunities across the Musgraves for OZ Minerals' stakeholders today, and for future generations of the traditional owners of the land.

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### Forward Looking Statements

Some statements in this document are forward-looking statements. Such statements include, but are not limited to, statements with regard to capacity, future production capacity and grades, projections for sales growth, estimated revenues and reserves, targets for cost savings, the construction cost of new projects, projected capital expenditures, the timing of new projects, future cash flow and debt levels, the outlook for minerals and metals prices, the outlook for economic recovery and trends in the trading environment and may be (but are not necessarily) identified by the use of phrases such as "will", "expect", "anticipate", "believe" and "envisage". By their nature, forward-looking statements involve risk and uncertainty because they relate to events and depend on circumstances that will occur in the future and may be outside OZ Minerals' control. Actual results and developments may differ materially from those expressed or implied in such statements because of a number of factors, including levels of demand and market prices, the ability to produce and transport products profitably, the impact of foreign currency exchange rates on market prices and operating costs, operational problems, political uncertainty and economic conditions in relevant areas of the world, the actions of competitors, activities by governmental authorities such as changes in taxation or regulation.

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<sup>i</sup> The information is extracted from the report entitled Nebo-Babel Mineral Resource Statement which was released to the market on 12 April 2019 and is available to view at [www.ozminerals.com/media/asx](http://www.ozminerals.com/media/asx). OZ Minerals confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and, in the case of estimates of Mineral Resources, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. OZ Minerals confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcement.