Orion Minerals

ASX/JSE RELEASE: 31 October 2019

Positive progress achieved from optimisation work on Prieska Copper-Zinc Project Bankable Feasibility Study

- **Positive results from water treatment trials for the shaft water to be purified for off-site discharge, thereby allowing increased pumping rates which will accelerate planned project development timelines.**
- **Semi-autogenous milling test work indicates reduced processing plant capital and operating costs.**
- **Mine-to-market optimisation studies on track to deliver results by year-end.**

Orion's Managing Director and CEO Errol Smart, commented:

"We continue to progress a number of significant optimisation opportunities identified during the preparation of the Foundation Phase Bankable Feasibility Study for the Prieska Project. Our aim is to complete these studies before the end of the year and have an improved and simple-to-execute project plan with both CAPEX and OPEX benefits ready for execution next year.

Dewatering the mine is a significant workstream and is the critical path activity where the greatest impact may be achieved on development timelines and capital costs. Positive results from water treatment trials mean that we now have more options for dewatering and can improve on what we see as an already very robust plan.

In addition, having SAG milling as a real alternative to ball milling, is yet another opportunity to make material improvements on capital and operating costs."

Orion Minerals Limited (**ASX/JSE**: **ORN**) (**Orion** or the **Company**) is pleased to provide a progress update on the encouraging results emerging from the ongoing value engineering and optimisation work that has been under way since the Bankable Feasibility Study (**BFS**) for the development of the Prieska Copper-Zinc Project (**Prieska Project**) was completed in June 2019 (refer ASX release 26 June 2019).

Key studies currently in progress include:

- Water treatment trials investigating supplementary means of dealing with the water to be pumped out from the underground workings so that the dewatering timeline and costs can be reduced;
- Value engineering of the ore processing plant designs and layouts to improve operational factors and reduce both capital and operating costs; and
- Mine-to-market enterprise optimisation of the Foundation Phase mining plan, in order to holistically assess the key value drivers of the project and ensure that the best business scenario is selected for project execution.

Pilot-Scale Dewatering Field Trials

The historic Prieska mine is currently flooded to within 320m of the surface (Figure 1). The BFS plan assumed the dewatering of approximately 8.7 million m^3 of accumulated mine water, into a lined surface dam, before any mining can take place.

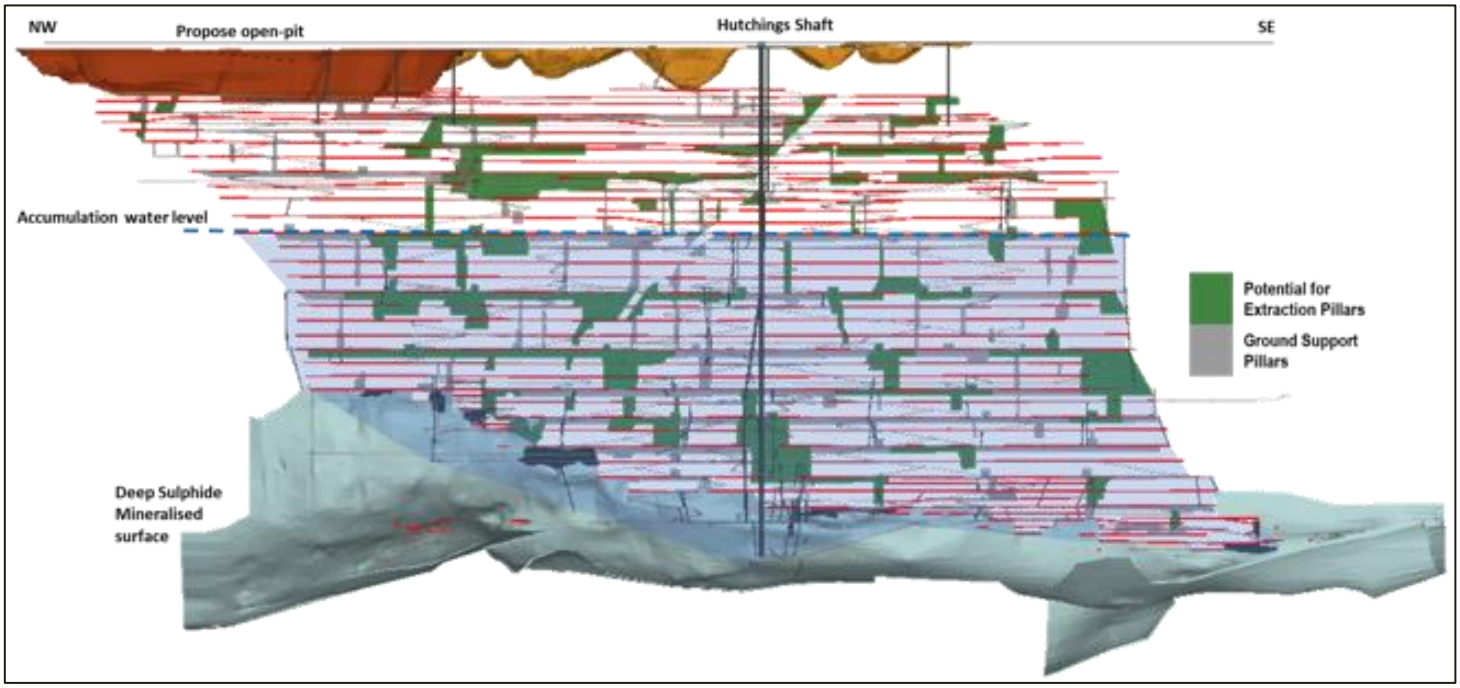


Figure 1: Long-section view of the Prieska Project underground workings showing the accumulated water level.

The current BFS plan assumes an 18-month timeline to set up and empty the mine of the accumulated water, which would be pumped into a surface dam with a designed maximum capacity of 1 million m^3 (Figure 2). A bank of evaporators will supplement natural evaporation to ensure that evaporation matches the 1,200m^3 per hour average dewatering rate that is planned. Due to the high capital costs for a lined dam, the rate at which the stored water can be evaporated is the limiting factor as to how quickly mine dewatering can take place.

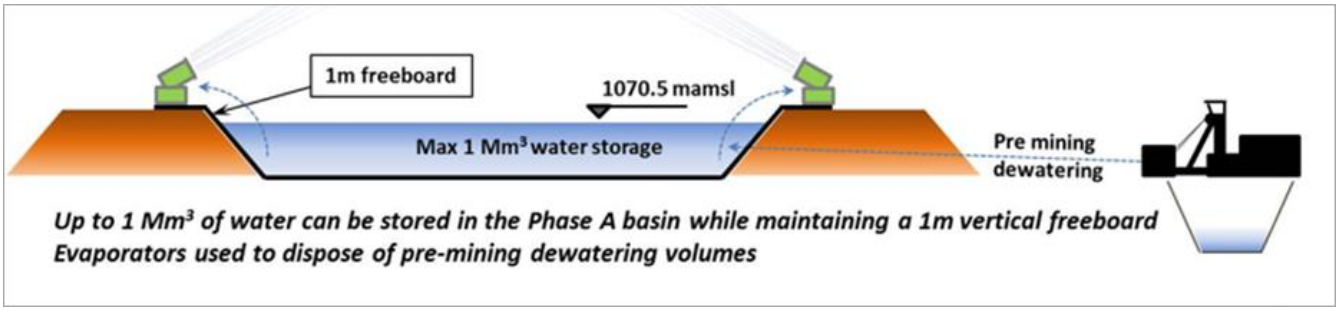


Figure 2: Section view through the evaporation dam planned for the Prieska Project to handle the pumped-out water during evaporation.

If current water treatment trials confirm that water can be discharged offsite after treatment, the Prieska Project economics could significantly improve by increasing the pumping rates to dewater the mine, thereby reducing the project development timelines and costs.

Although the mine water has been shown to have a neutral pH and low levels of chemical contaminants, including no micro-biological contaminants at all, laboratory analyses indicate that some metal concentrations are above the South African National Standards (**SANS**) Operational Limits for potable water (SANS 241:2015) (**SANS Drinking Water Standards**) and will therefore require the water to be treated to achieve chemical concentrations prescribed by environmental regulations, before off-site discharge options are permitted.

Pilot-scale water treatment trials commenced in July 2019 and were designed to provide the engineering data required to allow detailed design and costings of water treatment and discharge options (refer ASX release 30 July 2019). The trials are being undertaken at a feed rate of 5m^3 per hour, compared with the full-scale operating throughput which will average >1,200m^3 per hour.

The pilot tests are being undertaken in three phases and are due for completion before year-end. A water treatment plant, designed specifically for the intended water treatment trials, has been constructed and established on-site (Figure 3). The three phases are outlined below.

Figure 3: Pilot scale containerised water treatment plant and processing tanks at the Prieska Project site.

- **Phase 1** aims to confirm the technical feasibility of treating the shaft water through a combination of chemical treatment, precipitation, filtration and reverse osmosis to generate water permitted for agricultural use;
- **Phase 2** aims to determine the range of water qualities that can viably be produced; and
- **Phase 3** involves completing the trade-off studies on the various available options, taking into account comparative project economics, environmental impact and regulations (Figure 4).

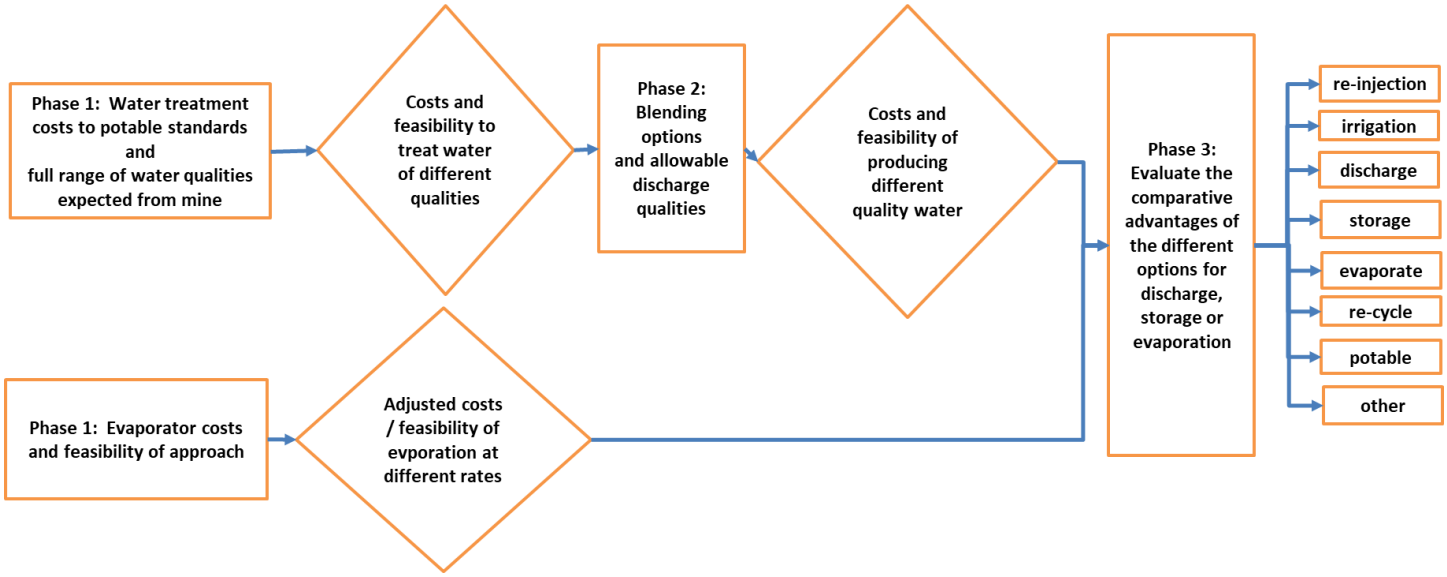


Figure 4: Approach to evaluating water treatment as an alternative or supplement to evaporation.

Phase 1 preliminary results. The design intent of Phase 1 was to treat Prieska Project shaft water to a purity meeting SANS Drinking Water Standards without being blended with any other water, using the combination of selected treatment processes (Figure 5).

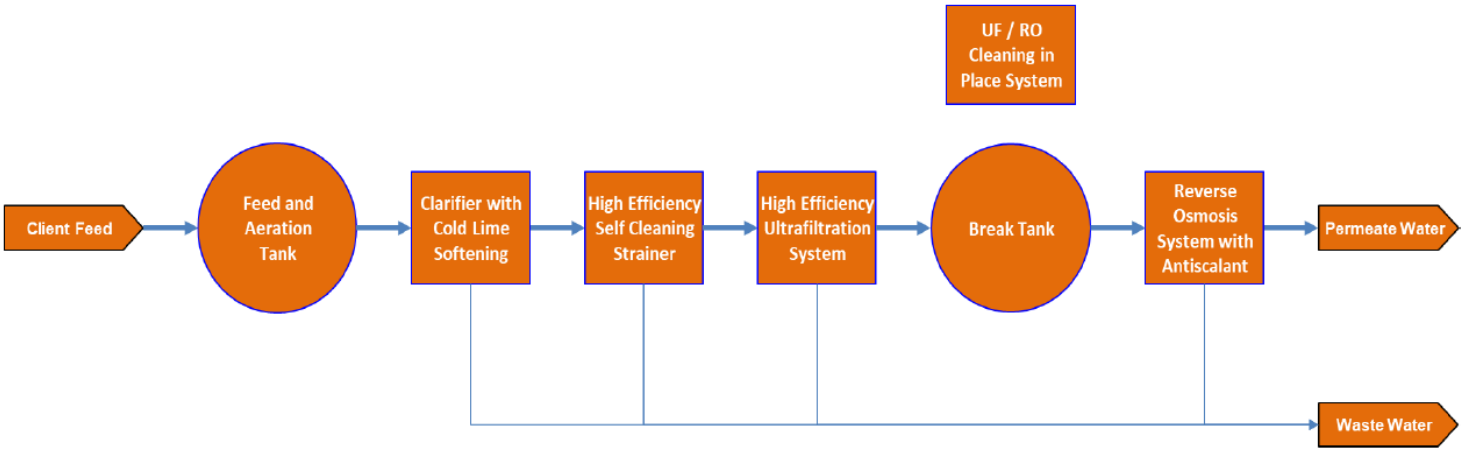


Figure 5: Water treatment plant process stages.

Water samples used for the testing to date have been obtained by continuous pumping from the main shaft at depths of 380m and 680m below surface with future tests planned for pumping from 780m and 880m, in order to assess the operation of the plant for different pumping depth profiles. The performance of each pilot scale process was monitored to assess effectiveness, reagent consumption rates and scalability.

Preliminary results indicate that water treatment to SANS Drinking Water Standards can be effectively achieved using the designed water treatment flowsheet. All process stages achieved their design intent, with purified water recoveries of up to 78%. Reagent and power consumption rates were also determined as tabled below (Table 1).

The test work procedure, implementation and results, have been independently peer reviewed by Nexus Vitae, South African engineering specialists in water treatment plant designs and operation.

Parameter	Reagent consumption	
Lime	600.0	g/m^3
Caustic	57.9	g/m^3
Hydrochloric acid	103.7	g/m^3
Power	4.5	kW/m^3

Table 1: Reagent and power consumption measured for the water treatment as a unit of feed water throughput over the two-week preliminary trial period.

Preliminary Cost Comparison – Based on the work undertaken to date, a preliminary cost comparison of a technically realistic water treatment scenario to the BFS evaporation plan, indicates that water treatment has potential merit, given that there is scope to increase the rate of pumping with an offsite discharge option and so reduce the time to dewater the mine, as well as reduce the size of surface water storage dams. To undertake the comparison, it was assumed that Prieska shaft water would be treated to agricultural standards such that the water could be used for irrigation at a location near the project site.

This scenario assumes that 75% of the underground water would be treated to produce a clean permeate (purified water) at SANS Drinking Water Standards. The balance of the water would be rejected as a brine to be stored in a brine dam until evaporated. The purified water would then be blended with some shaft water, partially treated (clarified) to reduce metal concentration, so that the diluted product would be suitable for irrigation purposes.

Water from the bottom of the mine (12.5% of the water) was assumed to be unsuitable for cost-effective treatment, and so would be pumped to settle in the tailings storage facility (**TSF**). This flowsheet would result in 68.5% of the shaft water being made suitable for irrigation, 19% to be concentrated to a brine for evaporation and 12.5% as water unsuitable for efficient treatment for placement into the TSF.

Using this scenario, total unit costs for water treatment and discharge are estimated (currently +-35% accuracy) to amount to AUD2.74 per m^3 of water treated compared to AUD2.84 per m^3 in the BFS case which assumes using mechanical evaporation, as shown in Table 2.

Parameter	Units	Water Treatment	Evaporation
Total Cost	**AUDM**	**23.83**	**24.14**
Capex	AUDM	15.00	21.45
Opex	AUDM	8.83	2.69
Unit Cost	**AUD/m^3**	**2.74**	**2.84**

Table 2: Comparative costs for water treatment of the Prieska Shaft water to SANS Drinking Water Standards compared to evaporation.

The results indicate that the costs for the two water handling options are of similar orders of magnitude, before taking into consideration the other potential benefits of water treatment over evaporation, such as the option for offsite discharge, reduced storage dam footprint and faster pumping rates which would improve the project development timelines.

These considerations will be assessed as part of the ongoing phases of the treatment trials and trade-off studies.

Ore Processing Value Engineering

SAG milling potential benefits

Since the completion of the BFS in June 2019, value engineering of the ore processing design has been in progress, (refer ASX release 30 July 2019). The value engineering exercise is:

- Assessing semi-autogenous grinding (**SAG**) in the milling section as an alternative to ball milling;
- Investigating improved plant layouts;
- Rationalising the sizes, placement and uses of various plant buildings; and
- Re-estimating efficient surge capacity allowances in line with the proposed refinements.

The use of SAG milling, rather than conventional ball milling as presently incorporated into the BFS, could simplify plant operability and significantly reduce upfront capital expenditure. The use of SAG milling removes the need for multi-stage crushing and screening of the rock ahead of milling (refer Figure 6).

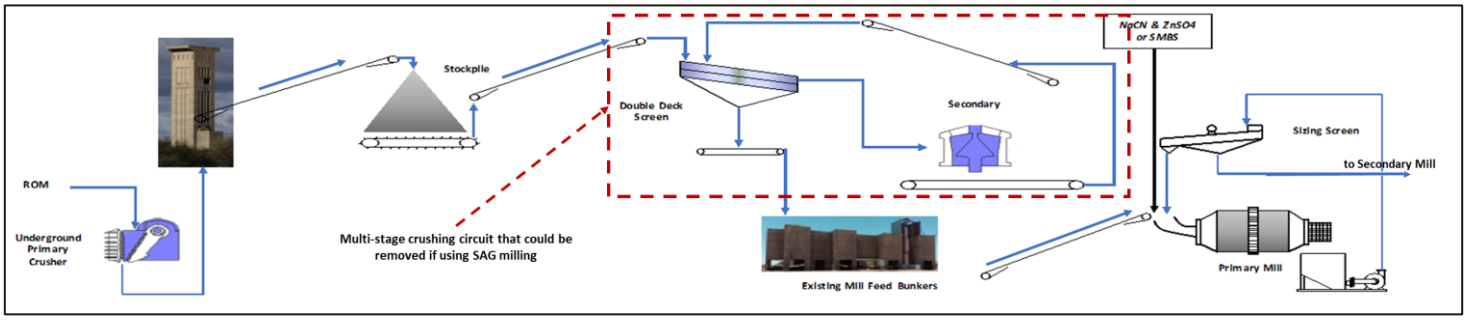


Figure 6: Current feasibility study ore processing design showing multi-stage crushing and screening section, removable if using SAG milling.

The plant and equipment comprising the current multi-stage crushing section of the plant contributes approximately AUD11 million to the total plant capital cost of AUD109 million (refer ASX release 26 June 2019). This represents a significant target for reducing capital expenditure without compromising overall plant recovery performance, while the streamlined layout increases the plant's mechanical availability and reduces maintenance effort.

The conventional two-stage ball milling setup was selected as a conservative design option in the BFS on the grounds that insufficient SAG milling-specific test work had been completed to conclusively assess the viability and comparative benefits of SAG milling. A preliminary value engineering assessment using the BFS test work results indicated that a SAG milling circuit, with a pebble crusher, no screening and a reduced length conveyor layout could be viable. This motivated further SAG milling test work and analyses to confirm amenability of the ore to SAG milling.

Sample collection

Samples for the SAG milling test work were collected from underground stockpiles on the 178m and 259m Levels. The samples were selected being mindful that, for SAG milling test work, it is essential to have competent test samples that have particle sizes greater than 75 mm. The samples were collected to also ensure that they were representative of the massive and disseminated fresh sulphide mineralisation targeted for mining for the duration of the Foundation Phase.

For both the massive sulphide and disseminated types of mineralisation, two samples were collected from two different locations, each sample group weighing in excess of 100kg, for a total of 400kg of samples (Table 3).

Description	Ore type	Quantity	Source
Sample 1A	Massive	100 kg	178m and 259m Levels
Sample 1B	Massive	100 kg	178m and 259m Levels
Sample 2A	Disseminated	100 kg	178m and 259m Levels
Sample 2B	Disseminated	100 kg	178m and 259m Levels

Table 3: Summary of samples collected.

Evaluation of results

The JKTech analysis indicated that the Prieska Project ore can be classified as soft and is amenable to milling via SAG milling. Due to the soft nature of the ore, high steel charge SAG milling will likely be the optimal design to ensure efficient and reliable operation.

Detailed design, costing and trade-off

A SAG milling layout is being refined and advanced to final design with the development of associated capital and operating costs. This information will allow a comprehensive comparison to be made between SAG milling

and the conventional ball milling option that is currently the basis of the BFS. This workstream is expected to be completed during Q4 2019.

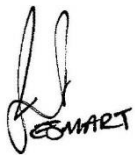
Whittle Enterprise Optimisation

Whittle Consulting (Pty) Limited (**Whittle**) was engaged to undertake mine-to-market optimisation of the business plan that was formulated as part of the BFS, (refer ASX release 30 July 2019). Whittle use their proprietary enterprise optimisation process (**WEO**) which involves the detailed and accurate mapping and linking of the whole value chain, from the Mineral Resource inventory to the marketed product. Thereafter, critical value drivers along the value chain are simultaneously varied, using specialised computer algorithms, until optimal permutations are identified.

Fundamental parameters such as cut-off grades, mining sequence, mining rates, targeted metal recoveries, mill throughput rates, targeted grind sizes, feed blends, product specifications, product logistics routes and variances in metal prices are all considered as one integrated system to derive a series of optimal business scenarios.

Whittle has a demonstrated track record of having dramatically improved base case plans, with previous projects having achieved in the order of 10% - 30% improvement in Net Present Value (NPV) from their base cases.

Work is in progress and on track to prepare the base evaluation model that links the key value drivers and establishes a baseline scenario using the current BFS assumptions. Thereafter, numerous permutations will be run and the practicality of implementing recommended changes concurrently assessed. This process of assessing WEO business scenarios is expected to be completed by end of November 2019, culminating in the selection of optimisations to be incorporated into an updated operating plan.



Errol Smart
Managing Director and CEO

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Investors	**Media**		**JSE Sponsor**
Errol Smart – Managing Director & CEO	Nicholas Read	Barnaby Hayward	Rick Irving
Denis Waddell – Chairman	Read Corporate, Australia	Tavistock, UK	Merchantec Capital
T: +61 (0) 3 8080 7170	T: +61 (0) 419 929 046	T: +44 (0) 787 955 1355	T: +27 (0) 11 325 6363
E: info@orionminerals.com.au	E: nicholas@readcorporate.com.au	E: orion@tavistock.co.uk	E: rick@merchantec.co.za
Suite 617, 530 Little Collins Street Melbourne, VIC, 3000			

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