



1 February 2019

Corporate Details

Ordinary Shares:
795,237,123

Market Capitalisation:
~\$180 million

Cash, bullion and available financing facilities at 31 December 2018:
\$18.2 million

Debt at 31 December 2018:
\$5 million

ASX Code: MOY

Board of Directors

Greg Bittar
Non-Executive Chairman

Tim Kennedy
Non-Executive Director

Peter Lester
Non-Executive Director

Bruno Lorenzon
Non-Executive Director

Management

Peter Cash
Chief Executive Officer

Ray Parry
Chief Financial Officer and
Company Secretary

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Latest sulphide metallurgical results confirm potential to grow production, cash flow and mine life

Millennium on track to unlock value of extensive sulphide mineralisation at Nullagine – paving the way for increases in Ore Reserves

- **Latest metallurgical test work results confirm outstanding gold recoveries from sulphide ore:**
 - **+80% from pyrite-dominant ore**
 - **~70% from arsenopyrite-dominant ore**
- **Exceptional recoveries on arsenopyrite-dominant ore achieved using pressurised in-mill oxidation process. As a result, Millennium is now planning to undertake a two-stage expansion of the Nullagine processing plant, comprising:**
 - **Stage 1: In-mill oxidation to facilitate processing of pyrite/arsenopyrite-dominant ore. Capital cost of \$15M, commissioning April 2019.**
 - **Stage 2: Pressurised in-mill oxidation to facilitate processing of arsenopyrite-dominant ore. Capital cost of \$5M, commissioning early 2020.**
- **Total capital investment for two-stage sulphide plant expansion of just \$20M, with metallurgical results indicating potential for strong Return on Investment.**
- **Plant upgrade to provide processing optionality, enabling Millennium to apply a combination of fine grinding, in-mill oxidation and pressurised in-mill oxidation to optimise recoveries and cash flow from different ore types.**
- **Metallurgical results to underpin completion of maiden Ore Reserve estimate for Golden Gate Underground. Results will be included in the global Resource & Reserve update for the Nullagine Project as at 31 December 2018, which is on-track for delivery in early February.**
- **Sulphide Expansion Project, which is currently under construction and on track for commissioning in Q2 2019, will see a large number of new ore sources come on stream over the next 12 months.**



Millennium Minerals (ASX: MOY) is pleased to announce outstanding metallurgical test results which provide more strong evidence that its sulphide expansion strategy at the 100%-owned Nullagine Gold Project in WA's Pilbara will be a technical and economic success.

The latest tests were conducted on a range of pyrite and arsenopyrite ore samples with varying degrees of refractory behaviour from the Golden Eagle deposit, the largest deposit defined to date at Nullagine.

The test work was undertaken using two innovative processing techniques – in-mill oxidation (INOX) and pressurised in-mill oxidation (PINOX) – both of which have been patented by Millennium.

Millennium has previously announced that tests conducted on samples of mildly refractory pyrite-dominant ore and moderately refractory pyrite/arsenopyrite samples from Golden Eagle generated recoveries of over 80 per cent using its in-mill oxidation (INOX) process (see ASX Announcement 14 January 2019).

The latest results now confirm that gold recoveries of ~70 per cent can be generated from highly refractory arsenopyrite-dominant ore from Golden Eagle using the pressure oxidation (PINOX) process. Previous cyanidation test work on this highly refractory ore delivered gold recoveries averaging less than 30%, meaning this mineralisation has never previously been considered economic.

An overview of the Innox test work results across the various ore types is provided in Table 1.

Millennium Chief Executive Peter Cash said the latest metallurgical results confirm that the Company's sulphide expansion strategy has the potential to increase production, operating margins and mine life at Nullagine by opening up an extensive inventory of sulphide mineralisation across the project to economic exploitation.

"These are hugely exciting results that indicate we can deliver highly-profitable additional ounces at Nullagine by processing sulphide ore," he said.

"The expanded plant configuration will enable Millennium the processing flexibility to apply the required methods to optimise the plant performance for each ore type. Within the single circuit, we will have the ability to process oxide ore with no additional treatment, or choose to apply a combination of fine grinding, INOX or PINOX to optimise recoveries from all ore types."

"This set-up will provide the Company with an exceptional level of control and optionality to ensure we can deliver strong operating margins from each ore type, with a priority focus on maximising cash flow across our operations.

"Importantly, the plant expansion is being completed at very low capital cost. Phase one, which will see us processing pyrite-dominant ore from Golden Eagle by April, will cost around \$15 million. And phase two, which will enable us to process arsenopyrite-dominant ores by early next year, is expected to cost an additional \$5 million.

"These metallurgical results show the potential to generate outstanding returns on that investment. The current sulphide expansion project timeline will see us bring a large number of new ore sources on-stream over the next 12 months, potentially supporting an increase in our production profile beyond 100kozpa with a focus on strengthening operating margins and cash flow while at the same time increasing mine life. It will be a huge winner for Millennium on so many levels," he continued.

Construction of the expanded plant is underway, with the gravity concentration spirals on site and the mills expected to arrive in March.

Stockpiling of sulphide concentrates will start later this quarter with plant commissioning scheduled for early April.

The Golden Eagle deposit is expected to provide baseload feed at Nullagine for the next two years.



In light of these strong metallurgical results, test work has been initiated on samples from the Golden Gate deposit. This will enable Millennium to complete a maiden underground Reserve and Resource estimate for Golden Gate.

This estimate will form part of the Company's annual Reserve and Resource statement, which is expected to be released in early February, along with its production and cost guidance for the year to December 31, 2019.

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Table 1: Metallurgical results based on ore type – leach versus INOX

Sample Classification	Average leach recovery	Average INOX recovery
Highly refractory	34.8%	70.6%
Moderately refractory	63.8%	82.8%
Mildly refractory	86.2%	92.1%

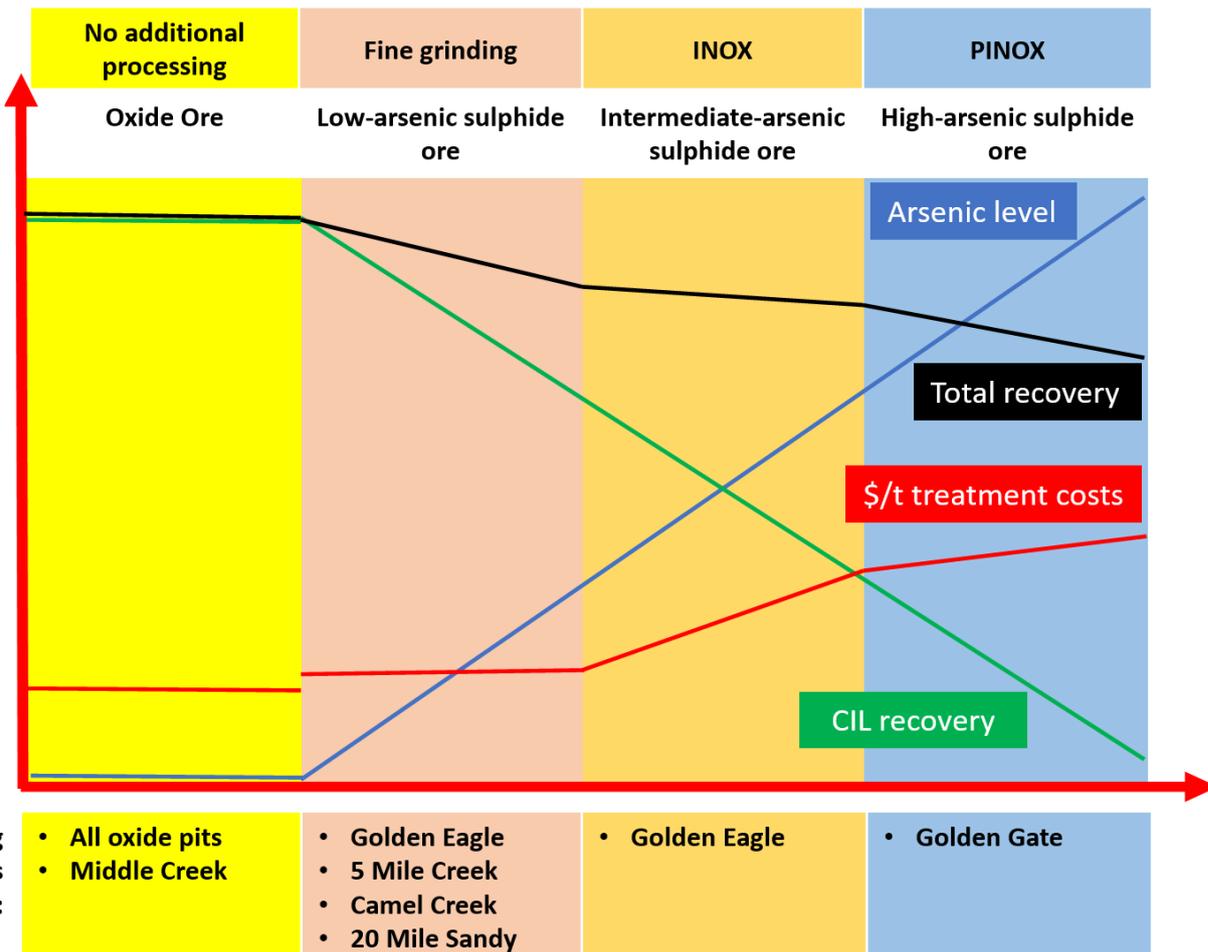


Figure 1: Comparison of processing options and outcomes

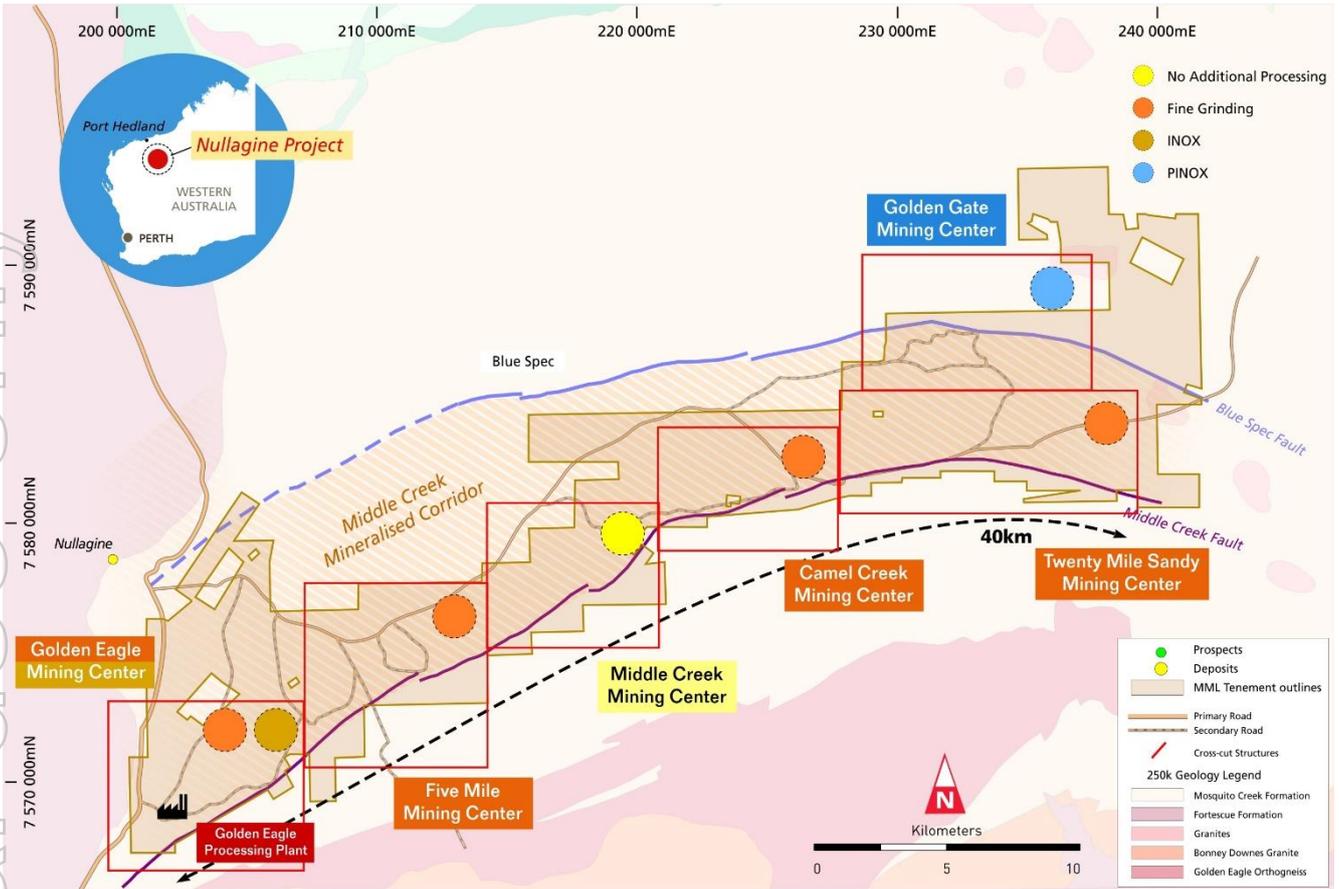


Figure 2: Plan view of Nullagine Gold Project showing mining centres and processing options



Pilot-scale PINOX equipment at ALS Laboratories



Spirals in transport frames on site



Spiral steel work pre-assembly



Mill urethane wear parts



Mill shell and base ceramic lined



Metallurgical test work – Explanatory Statement

Metallurgical factors and assumptions

- The metallurgical process proposed and the appropriateness of that process to the style of mineralisation.
- Whether the metallurgical process is well-tested technology or novel in nature.
- The nature, amount and representativeness of metallurgical test work undertaken, the nature of the metallurgical domaining applied and the corresponding metallurgical recovery factors applied.
- Any assumptions or allowances made for deleterious elements.
- The existence of any bulk sample or pilot scale test work and the degree to which such samples are considered representative of the orebody as a whole.
- For minerals that are defined by a specification, has the ore reserve estimation been based on the appropriate mineralogy to meet the specifications?
- The Nullagine processing plant is currently in operation and has been since 2012. It is an industry standard 1.5 Mt pa primary crusher, SAG mill, gravity circuit and carbon-in-leach tankage facility.
- This is conventional, well-tested technology, and is appropriate for oxide and free milling lode style of mineralisation in all the Project deposits, as demonstrated by successful plant operation since commercial production was declared in February 2013.
- Recovery factors of 70% to 95% (varies between deposits) have been assumed in the estimation of the Ore Reserves. The recovery factors are based on comprehensive test work on metallurgical core holes, mini BLEG and Leachwell analyses on RC and Diamond Core samples.
- The Ore Reserves are quoted 'delivered to mill' basis; this excludes metallurgical recovery factors.
- Pyrite and arsenic as arsenopyrite are present in the ore and are known to interfere with the metallurgical performance of the ore. The treatment of these minerals is seen as key to providing the enhancement or recovery in the treatment process.

Metallurgical test work completed in 2017 (Process Plants International report – PPI-003-PR-RWEP-02_Nullagine testwork) has indicated that with appropriate processing routes, CIL gold recoveries of between 63% and 80% on the Golden Eagle ore can be achieved. These figures were based on grinding the whole ore sample to the target size followed by a conventional laboratory cyanide leach.

The samples tested in this program were from Stages 1 & 2 of the Golden Eagle ore body and were made up of RC and blast hole samples.

With the overall potential leach recovery identified in this work, an option was assessed for a potential process route that could deliver the desired recoveries without the need to grind the entire ore to the target, fine grind size.

Research into existing processing routes in the Western Australian Goldfields region provided evidence of processing options that could be used (New Celebration Gold Mine¹ and Granny Smith Gold Mine² tailings retreatment circuits). This process option was based on:

- Processing the whole ore through the existing CIP circuit at the current process conditions
- treating the tailings stream (gravity circuit) to recover a concentrate containing the un-leached sulphide materials
- fine grinding of this concentrate to the desired liberation size (20 micron or less)
- intense cyanidation of the ground concentrate for final Au recovery

Preliminary test work was conducted on a single diamond core sample from Golden Eagle South. The core was crushed and blended to produce a whole of ore zone sample with subsamples being split for various test work. The test program followed is as per ALS laboratory flow sheet "Flow Sheet - Millennium - Golden Eagle Study - Scouting Sample - Rev 1"

- The test on a 1 kg sub sample indicated that:
 - CIL leaching produced a 52.6% Au recovery
 - Gravity concentration of the leach tail produced a concentrate with 73.4% of the gold from the tailings in 6.8% of the tailings mass
 - CIL leaching of the concentrate following grinding to a p80 of 10 um provided a 27.9% leach recovery
- The leaching of the concentrate was carried out at cyanide levels higher than the standard laboratory CIL (0.2% vs 0.1%) but below the levels expected for intense cyanidation treatment (5%+)

Following the outcome of this program, a larger (100Kg) sub-sample (ALS Flow Sheet-Millennium-Golden Eagle- Scouting Sample-BULK LEACH-Jan 2018) of the whole of hole composite was generated for leach, gravity concentration and concentrate leach optimisation work.

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The test work on this lead to the development of the InOx (IN mill oxidation) process and establishment of the base line test procedure for the more refractory samples.

Metallurgical drill sampling has been undertaken on the Golden Eagle ore source incorporating stages 1,2 and Golden Eagle South. From this material, metallurgical domains were identified based on Au, As, Fe grades and bottle roll leach recoveries of the individual core sample intervals and variability samples were generated for testing on the process established on the GEDDMET009 sample.

Ausenco Engineering were engaged to as SMP contractor to progress the process through to construction and commissioning based on the finalised designed flow sheet incorporating spiral concentrators, fine grinding mills, reagent supply and addition and waste water treatment facilities. The direct capital cost estimation for the plant expansion is circa \$16M.

Operational costs were updated from the original trade off study figures and developed from the final design criteria parameters as well as inputs from the existing Nullagine Gold Operations processing cost base, including consumables, maintenance and overhead costs. The final Operating cost estimation for the plant expansion is estimated to be circa \$5/tonne in addition to the existing processing costs.

¹ Martins, V.,R. Dunne and G. Delahey, "New Celebrations Tailings Treatment Plant – 18 Months Later", in XVIII International Mineral Processing Congress, Sydney, May 1993. 1215-1222.

² Recovery Of Gold Carriers at the Granny Smith Mine Using Kelsey Jigs J1800 G.Butcher and A.R. Laplante

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