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Natilus Minerals Inc

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Gut Infrastruktur

Molim Moa Gorkoli na  
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Ngapeli La'ala, Ngapeli Bld, Ngapeli Bsa



# Conclusions

# Expert Recommendation

Pursuing a global economy that is more sustainable and provides greater services for the world's poorest requires more copper. Copper is necessary for wind, hydro, wave, geothermal, and tidal power production. If terrestrial mining could be reduced, Solwara 1 would still be preferred over new or existing terrestrial mines because it entails fewer social and natural capital impacts as shown by Analyses II-IV.

Four analyses were conducted in this report, as well as a high-level summary of deep seabed science in the Bismarck Sea and a discussion of copper smelting relevant to Nautilus' proposed activities.

Analysis I showed that recycling and substitutes cannot be sufficiently increased to displace copper mining. Recycling is likely limited to around 35% of the supply because copper has a long productive life, high prices, and efficient recycling markets. Substitutions for some copper applications are taking place. For example, the replacement of long-haul copper communication lines with fiber optic cables is market driven. At the same time, the demand for copper for new applications is also increasing. Expanding global renewable energy supplies (copper generator windings), clean water provisioning (copper plumbing) and communications technology requires millions of tons of copper. Pursuing a global economy that is more sustainable and provides greater services for the world's poorest requires more copper. Copper is necessary for wind, hydro, wave, geothermal, and tidal power production. If terrestrial mining could be reduced, Solwara 1 would still be preferred over new or existing terrestrial mines because it entails fewer social and natural capital impacts as shown by Analyses II-IV.

Analysis II identified goods and services that are impacted by terrestrial and deep seabed copper mining. The displacement of communities, food production, impact to water supplies and the risk of failing waste structures are all impacts that are present in terrestrial mining, but not present in deep seabed mining. By impacting fewer categories of natural capital, Solwara 1 is far superior to existing (and proposed) terrestrial mines that entail far greater environmental and social impact and risk.

Analysis III demonstrated that Solwara 1 will produce more copper with fewer natural capital inputs, fewer damaging outputs, and a smaller area of impact for every metric ton of copper produced. Quantifiable physical impacts were measured per ton of copper produced. Solwara 1 outperforms the other copper mines in terms of fresh water required, mineral waste, carbon dioxide emissions and energy use per ton of copper produced. This reflects the physical efficiency of copper production, and the likely lower natural capital impacts of Solwara 1.

Analysis IV estimated the dollar value of natural capital assets impacted to be far lower for Solwara 1 than for a comparable terrestrial mine. There are no ecosystem service valuation studies for the deep seabed. Some ecosystem services can be accurately

valued at zero because they do not exist at the deep seabed, such as fresh water filtration and supply. Other ecosystem services exist at the Solwara 1 site, but are scarce or low-functioning compared with terrestrial systems. A proxy for estimating deep seabed ecosystem services that exist is to use high terrestrial values, likely overestimates, for the values provided in the deep seabed, and this was applied. Solwara 1 has far lower natural systems impact values than terrestrial mines. For terrestrial mines, mines located in deserts appear to perform better than mines located in forests.

A discussion of the proposed shipping, concentrating, and smelting process for Solwara 1 shows that it is likely a far better process than those offered at other smelting facilities. The TNFM smelter is the world's most modern smelter (completed in 2014). However, there are concerns that are present for all sulphide copper ores, such as arsenic wastes and salt in the ore. Nautilus is not responsible for the mineralized material once sold to a smelter. However, the company has contracted with one of the world's newest smelters and requested an accounting from TNFM of the fate of all copper concentrating and smelting byproducts. This establishes a new best practice in the copper mining and production industry.

Solwara 1 can also set a high bar for deep seabed mining. This includes the establishment of conservation sites based on careful science to protect the biodiversity and promote post-mining larval recolonization. There are currently eight other deep seabed mining leases which have been approved globally. Setting a high standard in PNG provides a model for the International Seabed Authority and other countries when considering regulation of seabed mines.

**In a world of over 7.3 billion people, copper is needed. The current path is to expand terrestrial mining of copper ore with declining concentrations of copper, higher costs, increased long-term risks and greater social and environmental impacts. This environmental and social benchmarking study demonstrates the clear benefits of developing the first deep seabed copper mine.**

What sets Solwara 1, Nautilus, and the PNG Government apart is the implementation of deep seabed mining. Copper mining has been exclusively terrestrial for 7,000 years. Expanding metal mining to the deep seabed opens most of the earth's solid surface to mining for the first time. The technological transformation associated with the mining technology, machinery and production vessel is remarkable. History records few technological developments with such capacity for change, economic advancement, and transformation toward greater sustainability.

In a world of over 7.3 billion people, copper is needed. The current path is to expand terrestrial mining of copper ore with declining concentrations of copper, higher costs, increased long-term risks and greater social and environmental impacts. This environmental and social benchmarking study demonstrates the clear benefits of developing the first deep seabed copper mine. Solwara 1 provides

an opportunity to expand mining to 7% copper,<sup>135</sup> with fewer social and ecological impacts and long-term risks. It provides an opportunity to meet the copper demands for expanding sustainable energy production, rural electrification, better and more widespread telecommunications, safe drinking water and a plethora of modern products. Providing these goods and services that require copper is essential to improving the quality of life for over a billion people living in severe poverty. In a world of declining terrestrial copper concentrations, Solwara 1 provides a path toward producing copper with higher concentrations in the 21st century and beyond.

Overall, Earth Economics finds the Solwara 1 proposal to be a clear opportunity to dramatically reduce the social and environmental impacts of copper mining.

