Evaluation of the Environmental Impact Statement (EIS)
for the proposed Sepik Development Project

This report contains my opinions about the EIS for the proposed Sepik Development Project dated 07 November 2018, which includes he Frieda River Copper-Gold Project and the Frieda River Hydroelectric Project. Briefly, I believe that:

- The EIS fails to discuss how the project would increase the risk of malaria in locations where the disease is already hyperendemic;
- The EIS fails to include a Resettlement Plan for forcibly displaced villages;
- The EIS admits to the substantial loss of life that would occur if there is a partial or complete failure of the ISF embankment;
- The EIS fails to identify how risks of acid mine drainage and failure of the ISF embankment would be managed in perpetuity;
- The EIS inadequately characterizes the risk of species extinctions; and
- The EIS improperly dismisses alternative project designs that would eliminate or substantially reduce harm the project would cause.

Qualifications

I have a Ph.D. from Johns Hopkins University School of Public Health and a law degree from the University of Oregon School of Law (with an emphasis on environmental law). Since 1992, I have served as Staff Scientist for the Environmental Law Alliance Worldwide (ELAW) advising public interest environmental lawyers on a variety of scientific matters, including more than 100 cases involving issues of sustainable development. In June 2005,[1] and again in February 2011,[2] the European Court of Human Rights relied on my opinions to reach landmark decisions regarding the right to environmental justice. Recently, testimony I provided about how the impacts of proposed development projects were presented in Environmental Impact Assessments (EIAs) contributed to landmark judgments of the High Court of Kenya and the

[1] *Fadeyeva v. Russia* 55723/00 [2005] ECHR 376 (9 June 2005)

[2] *Dubetska v. Ukraine* 30499/03 [2011] ECHR (10 February 2011)

National Environment Tribunal.[3] I have evaluated numerous EIAs for proposed mining projects, and I am the author of a popular guidebook for evaluating EIS for mining projects that has been translated into three other languages.[4]

I reside at 877 W. 35th Place, Eugene, Oregon, U.S.A. I have read the Harmonised Expert Witness Code of Conduct, and agree to be bound by it, including a paramount duty to assist the Court impartially. I declare that I made all the inquiries I believe are desirable and appropriate to formulating the opinions below, and no matters of significance have been withheld.

1. The EIS fails to discuss how the project would increase the risk of malaria in locations where the disease is already hyperendemic

The Environment Act 2000 requires that an EIS must set out the "social environmental impacts which are likely to result from the carrying out of the activity." *Impacts to human health* are among the crucial social environmental impacts encompassed by this requirement.

The high incidence of malaria in the highlands of Papua New Guinea is well known.[5] The EIS for the proposed Sepik Development Project contains the following sobering information about the prevalence of malaria in the project area: Page 7-164 of the EIS states:

> "Table 7.36 shows the reported medical conditions recorded during the 2010 health baseline survey, indicating the significant morbidity due to malaria and intestinal parasites (Appendix 13).
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> "The 2015 community surveys reported that fevers due to malaria and upper respiratory tract infections and diarrhoea were the most prominent morbidity factors. The Telefomin district development program plan (Sandaun, 2014) indicated that skin disease was also an important source of morbidity."

Table 7.36 Reported medical conditions in the previous 12 months

Village area and number surveyed	Asthma (%)	Pneumonia (%)	Hypertension (%)	Intestinal parasites (%)	Malaria (%)	Dengue-like fever (%)
Mine and FRHEP area villages (480)	3.1	1.3	4.4	39.0	77.0	-

Source: CEH, 2018.

[3] Mohamed Ali Baadi and Others v. Attorney General, Petition No. 22/2012 (High Court of Kenya at Nairobi) (judgment dated 30 April 2018); Save Lamu v. NEMA, Appeal No. 196 of 2016 (National Environment Tribunal (Judgment dated 26 June 2019)

[4] Environmental Law Alliance Worldwide (2010) "Guidebook for Evaluating Mining Project EIAs" https://www.elaw.org/mining-eia-guidebook

[5] Park, J. W., Cheong, H. K., Honda, Y., Ha, M., Kim, H., Kolam, J., ... & Mueller, I. (2016). Time trend of malaria in relation to climate variability in Papua New Guinea. *Environmental health and toxicology*, *3*

The proposed Sepik Development Project includes the Frieda River Hydroelectric Project that would entail the creation of reservoir of stagnant water of massive dimensions, covering an area of more than 12000 hectares (12 square kilometers). It is well-established that when free-flowing rivers are converted into stagnant reservoirs, the risk of malaria increases because mosquitos breed in stagnant water. The increased risk of malaria extends a significant distance from the newly stagnant body of water. According to a recent peer-reviewed publication examining malaria incidence and dams in Africa:

> "Evidence on the effect of dams on malaria transmission in Africa is mounting. African dams have been shown to cause at least 1·1 million malaria cases each year. However, this estimate is conservative, because the study included only 956 large dams out of more than 2000 dams existing in the region. The population at risk of malaria around these dams is estimated to be 15 million. This is projected to increase to 25–26 million by the 2050s as a result of population growth and climate change, and the number of malaria cases associated with reservoirs is projected to rise to 2·1–2·9 million in the 2050s. With hundreds of large dams under construction or planned, it is time to look critically at various measures that need to be taken to alleviate malaria around African dams.
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> "*Numerous previous studies have shown that damming rivers slows down the water flow and creates large impoundments that provide ideal breeding habitats for malaria-causing mosquitoes*. Communities living close to reservoirs are thus at greater risk of contracting malaria than those living further away. For example, in communities living close to the Koka dam of Ethiopia, malaria incidence is nearly 20-times higher than in those living more than 6 km away. This indicates how reservoir communities are facing possible negative public health effects of river damming."

The proposed Sepik Development Project would create communities newly living close to a large reservoir. How much these communities would be at greater risk of contracting malaria is a crucial issue about which the EIS has failed to inform decision-makers and stakeholders contrary to the requirements of the Environment Act 2000.

2. The EIS fails to include a Resettlement Plan for forcibly displaced villages

The 2004 Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement requires that "sufficient information [in the Environmental Impact Statement] should be provided to enable DEC to anticipate possible environmental management, monitoring and reporting requirements for an Environment Permit. …. Information detailed in this section shall include but not limited to the following information on *socio-economic management* and monitoring strategy."

As admitted to by the EIS, the forcible ousting of villagers by the Sepik Development Project is among the most serious socio-economic impacts of the project. However, no detailed

Resettlement Plan, including basic information, such as where oustees would be resettled, is provided in the EIS. Page 5-9 of the EIS states:

> "Construction and eventual flooding of the ISF reservoir in a portion of the Frieda River catchment (including the Nena, Ok Binai, Niar and Anai rivers) for the FRHEP will displace the villages of Ok Isai and Wabia. ….
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> As a result, the residents of the Ok Isai, Wabia, Paupe, and Wameimin 2 villages will be resettled. Options for resettlement sites have been identified through consultation with residents of these villages; ***however, final locations are yet to be agreed***. Figure 5.1 shows the areas where physical constraints may restrict settlement, such as the tenement locations, very steep slopes, elevation and distance from a water supply. ***Options for resettlement locations are being investigated outside of these constraints areas***."

Page 4-15 of the EIS shows that potential oustees have not be consulted nor consented to any of the specifics of their potential resettlement, stating:

> "In the mine area villages, Project awareness discussions focussed on communicating changes to the Project description as they had been involved in Project awareness discussions previously. A key area of interest within the mine area villages was the issue of resettlement, and ***villages were informed that a resettlement team would engage with them at a later date***."

It is internationally-accepted best practice to include a detailed Resettlement Plan as part of or contemporaneously with the EIS so that the details of the plan can be subject to the same kind of rigorous scrutiny as other proposed mitigation measures.[6] The lack of a detailed

[6] World Bank Operational Procedure 4.12 - Involuntary Resettlement (Revised 2013). Item 19: "Resettlement planning includes early screening, scoping of key issues, the choice of resettlement instrument, and the information required to prepare the resettlement component or subcomponent. The scope and level of detail of the resettlement instruments vary with the magnitude and complexity of resettlement. In preparing the resettlement component, the borrower draws on appropriate social, technical, and legal expertise and on relevant community-based organizations and NGOs. The borrower informs potentially displaced persons at an early stage about the resettlement aspects of the project and takes their views into account in project design." Item 26: 25. A draft resettlement plan that conforms to this policy is a condition of appraisal (see Annex A, para. 2-21) for projects referred to in para. 17(a) above.25 However, where impacts on the entire displaced population are minor,26or fewer than 200 people are displaced, an abbreviated resettlement plan may be agreed with the borrower (see Annex A, para. 22). Inspection Panel. 2017. "Consultation, Participation and Disclosure of Information." "OP/BP 4.12 Involuntary Resettlement. Meaningful consultations under the Bank Policy on Involuntary Resettlement create the opportunity for active stakeholder participation that influences design and implementation of the resettlement process. The consultation process begins early in the development of a resettlement program to provide the basis for the census and socioeconomic survey that inform its design. The Panel's experience shows the importance of stakeholders' awareness of the purpose of the surveys and how the results will be used in the resettlement program. The process provides affected people with an opportunity to be informed about their rights pertaining to resettlement and to be consulted on resettlement options, including forms of compensation, alternative livelihood strategies and resettlement locations. Well-designed resettlement

Resettlement Plan in the EIS for the proposed Sepik Development Project is lack of information on socio-economic management that is required by the 2004 Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement

3. The EIS admits to the loss of life that would occur if there is a partial or complete failure of the ISF embankment, but inadequately characterizes such risk

There is a long history of tailings dam failures[7] including the sudden failure in January of 2019 of the tailings dam of the Córrego do Feijão iron ore mine near Brumadinho, Região Metropolitana de Belo Horizonte, Minas Gerais, Brazil, that generated a slurry wave killing at least 248 people.[8] With respect to a tailings dam failure, Section 11.3.1 of the EIS states:

> "As described in Section 5.6, *the partial or complete failure of the ISF embankment presents a catastrophic environmental and social risk to the Project*. The extent of downstream impacts will depend on the size of failure, the location of the failure or distance from the embankment and the depth of the failure. Potentially catastrophic impacts of embankment failure and dam break would potentially affect more than 30 villages located downstream along the river systems including the Frieda and Sepik rivers (and, potentially, future communities as a consequence of in-migration towards the mine area) and impacts to the environment. As such, an ISF embankment failure is classified as "extreme" under ANCOLD and ICOLD guidelines. *Section 5.6 provides details of the ISF design that address this consequence and the stewardship program FRL will implement through construction, operations and closure to prevent partial or complete failure of the ISF embankment*. …
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> "*With appropriate controls in place*, primarily relating to the application of conservative design standards and criteria and a specific ISF stewardship program incorporating a dam safety program, management oversight and an independent external review by the TRIP (see Chapter 5), *the probability of a failure is very unlikely*. However, the extreme consequences of complete failure leading to the uncontrolled release of large quantities of water and solids (from waste rock and tailings placement) would likely result in extreme downstream environmental and social impacts. These would include:
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> • Flooding of downstream environments with consequential environmental impacts.

programs consider this feedback from displaced persons and incorporate it into the design of project activities. The draft resettlement plans should be consulted on and clearly discuss the resettlement entitlements for each category of impact. Panel cases have shown that resettlement programs that are informed by the needs of affected peoples can minimize negative impacts during implementation and subsequently promote effective livelihood restoration practices."

[7] https://www.wise-uranium.org/mdaf.html

[8] https://www.wise-uranium.org/mdafbr.html

• *Loss of life in the vicinity of the ISF, and loss of livelihood in communities located downstream of the ISF on the Frieda, Sepik, Wario and Wogamush rivers, Kaugumi and lower Saniap creeks and Lake Warangai*.
• Long-term environmental contamination through the release and widespread distribution of waste rock and tailings and potentially acid-forming material, with subsequent downstream impacts on water quality, soils and biota.
• Physical damage to downstream aquatic and terrestrial environments, including loss of flora and fauna due to habitat inundation and destruction, extensive erosion and altered water quality.
• Exposure of potentially acid-forming material that is still retained within the ISF due to the reduced water levels, leading to the formation of AMD and subsequent impacts, primarily in terms of water chemistry, i.e., reduced pH and elevated metal concentrations in downstream waters.

There have been 11 major tailings dam failures in the last decade, and the rate of such failures is increasing.[9] The ISF for the Sepik Development project would be constructed in a location highly vulnerable to seismic events and would need to hold back several million tons of mining wastes in perpetuity (essentially forever). The claim in the EIS that the probability of a failure of the ISF is unlikely is weakened by the fact that the 'stewardship program' offered in Section 5.6 of the EIS refers to a future program that is not part of the EIS and contains no details of the kind of "monitoring, maintenance and oversight, which will be needed both during operations and after closure."

4. The EIS fails to identify how risks of acid mine drainage and failure of the ISF would be managed in perpetuity

The EIS contains numerous admissions about the high potential of mined waste to generate acid mine drainage. Section 5.5.3 of the EIS states:

> "Waste rock is defined as material with subeconomic mineral concentration that must be excavated to gain access to the ore. The primary factor that determines the requirements for management of waste rock is its potential to produce acid upon exposure to oxygen, and its consequent generation of drainage that is both acidic and contains elevated concentrations of dissolved metals. The composition and variability of the waste material from the HITEK deposits was therefore evaluated in terms of its geochemistry, with a focus on acid-forming potential. The results of this evaluation have guided the proposed management strategy for the short and longterm management of waste rock.
>
> "Waste Rock Characteristics

[9] World Mine Tailings Failures from 2015: https://worldminetailingsfailures.org/

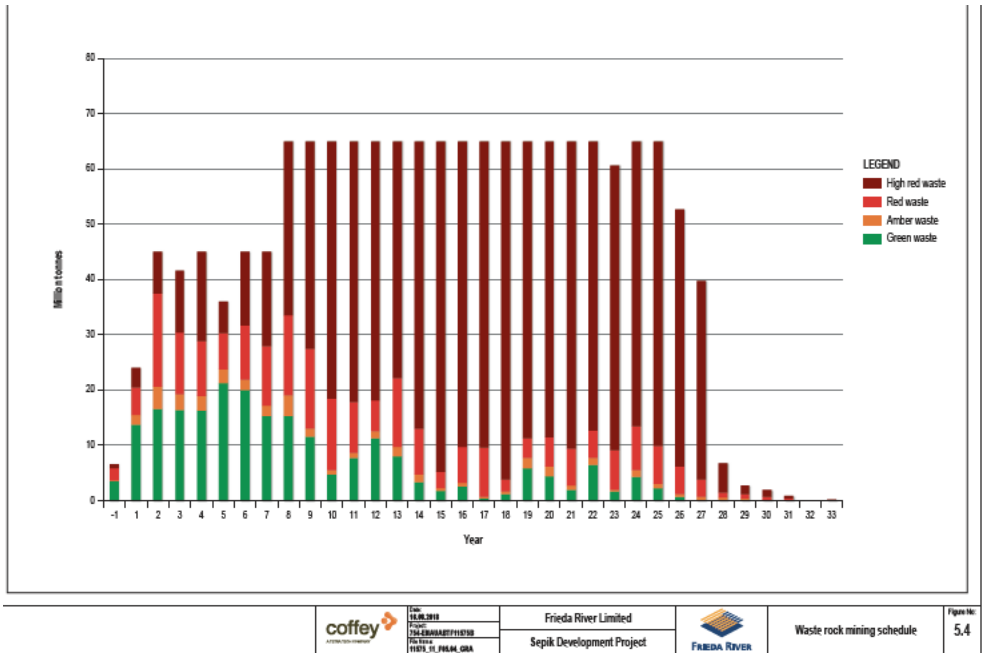
“Four geochemical characterisation programs have been undertaken on waste rock samples by the geochemistry specialist companies Environmental Geochemistry International (EGi) and SRK Consulting (SRK). The first geochemical characterisation program was completed in 1996 by EGi, and each subsequent geochemical characterisation program has refined and built on the body of knowledge regarding the geochemical characterisation of the waste rock and options for its management. The most recent geochemical characterisation program was completed in 2016 by Gi and the results of this and other geochemical characterisation programs are reported in Appendix 1.

“A total of 461 samples from the HIT deposit, 26 samples from the Ekwai deposit and 54 samples from the Koki deposit were assessed to determine their acid-forming potential. The geochemical characterisation programs indicated that waste rock contains little acid neutralising capacity (ANC), with acid generating capacity mainly a function of sulphur content and alteration. Management of the potential for AMD is a key focus for the Project. Classification of the waste rock lithologies expected to be encountered during mining in terms of their acid-forming potential is described in Appendix 1.

“Testwork reported in Appendix 1 established that the majority of waste rock exposed during mining will have high to very high sulphur (S) content (averaging 4% S) and low to zero ANC and has the potential to generate AMD. Given the limited ANC available, and in the absence of any mitigation, it is likely that strong acid conditions would develop within weeks to a few months of exposure after the material is blasted and excavated during the mining process. Waste rock that does have some ANC may take in the order of months to a year to acidify, but the evidence to date suggests that it is unlikely there will be significant tonnages of waste rock with a high ANC that would provide a prolonged lag period of many years during which circum-neutral drainage would be produced. About 22% of HIT samples tested were classified as NAF. A higher percentage of samples tested were classified as NAF for Ekwai (31%) and Koki (33%) When informed by a comprehensive geochemical characterisation program such as that completed for the Project, the percentage of total sulphur in waste rock can be used for mine planning, as well as during operations, to allow rapid identification of NAF and PAF material and therefore its appropriate handling and management. The following criteria was adopted for the modelling of pit shell exposures and for waste rock management planning purposes:

- Green (NAF): <0.5% S or totally oxidised.
- Amber (PAF): 0.5 to 1.0% S.
- Red (low sulphur) (PAF): 1.0 to 3.0% S.
- Red (high sulphur) (PAF): >3.0% S.

”The amount of waste as a proportion of the waste classification over the mine life is shown in Figure 5.4.



“Management of PAF Waste Rock

“The high acid-forming potential of the waste rock requires a robust management strategy to ensure PAF material is stored in a manner that limits exposure to atmospheric oxygen and subsequent formation of AMD.

“The International Network for Acid Prevention (INAP) is an organisation of international mining companies dedicated to reducing liabilities associated with sulphide mine materials and AMD. Founded in 1998, INAP has sponsored the preparation of the Global Acid Rock Drainage (GARD) Guide (INAP, 2009), which is intended as a state-of-the-art summary of the best practices and technology to assist mine operators and regulators to address issues related to AMD. According to the GARD Guide (INAP, 2009):

> "The fundamental principle of ARD [acid rock drainage] prevention is to apply a planning and design process to proactively prevent, inhibit, retard or stop the hydrological, chemical, physical, or microbiological processes that result in the impacts to water resources… Disposal of acid-forming materials below a water cover is one of the most effective methods for limiting AMD generation… because the transport of oxygen through water by advection and diffusion is in the order of 10,000 times slower relative to transport in air.”

"To limit the potential for generation of AMD from PAF waste rock, SRK designed the ISF to provide a permanent water cover for the waste rock and tailings material. This is termed ‘subaqueous deposition’ and will limit the risk of AMD that could occur if the PAF waste rock were exposed to air for more than a few months. Section 5.6, Frieda

River Hydroelectric Project and Appendix 2, Frieda River Hydroelectric Project Selection Phase Study provide further detail on the design, construction and operation of the ISF.

"During the early filling stages of the ISF (i.e., approximately the first 10 months) and prior to the surface of the lake reaching the minimum operating level of the barge loading facility (RL 199 m), PAF waste will be transported by truck and deposited on dry land at the headwaters of the reservoir so that the rising water level will inundate the waste rock. The ISF will ultimately store 1,450 Mt of waste rock subaqueously, of which around 86% is expected to be PAF."

The strongly acid nature of such waste would create the need for active measures to prevent acid mine drainage at least throughout the remainder of this century. For example, page 5-30 of the EIS states:

"Water discharged from the flooded open-pit lake will continue to be treated prior to release to Ubai Creek until downstream water quality criteria can be met without treatment. Modelling of sulphide depletion in the pit walls predicts this will take at least 50 years post closure (Appendix 6a). Regular post closure monitoring and maintenance will be undertaken as completion criteria are progressively achieved and sustained."

As discussed in point 3 above, the ISF of the Sepik Development project creates a significant risk of a failure that would cause catastrophic consequences. Page 5-7 of the EIS states:

"The FRHEP will include an engineered ISF for the storage of construction spoil, mine waste rock and tailings, and sediment control. The embankment will be located in the Frieda River Valley and has been designed as an engineered rock-fill:

• Operating life of greater than 100 years."

Preventing a failure of the ISF, such as vigilant monitoring of its structural integrity, would also require active measures for at least throughout the remainder of this century. However, the EIS does not identify the resources available for the treatment of water discharged from the flooded open-pit lake and monitoring the structural integrity of the ISF that would be required as part of active measures to prevent acid mine damage and catastrophic failure of the tailings storage facility.

5. The EIS inadequately characterizes the risk of species extinctions

Papua New Guinea is a party to the Convention on Biological Diversity (CBD), the objective of which is: "the conservation of biological diversity." In June of 2006, the Conference of Parties to the CBD issued Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment that are: "structured in accordance with the internationally accepted sequence of procedural steps characterizing good-practice environmental impact assessment [and aimed at] a better

integration of biodiversity-related considerations into the EIA process."[10] The Guidelines identify the following procedural steps characterizing good-practice environmental impact assessment:

> "29. Assessing impacts usually involves a detailed analysis of their nature, magnitude, extent and duration, and a judgement of their significance, i.e., whether the impacts are acceptable to stakeholders and society as a whole, require mitigation and/or compensation, or are unacceptable.
>
> "31. A number of practical lessons with respect to the study process have emerged including that the assessment should: …
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> "(i) If possible, quantify the changes in biodiversity composition, structure and key processes, as well as ecosystem services. Explain the expected consequences of the loss of biodiversity associated with the proposal, including the costs of replacing ecosystem services if they will be adversely affected by a proposal."

Permanent loss of biodiversity composition is a certain outcome of the Sepik Development Project considering its vast industrial footprint, including a reservoir that would inundate at least 12 square kilometers of pristine tropical forests. However, the EIS for the Sepik Development Project does not quantify changes in biodiversity composition, structure and key processes, as well as ecosystem services. For example, with respect to ***species new to science and endemic species***, the EIS puts forward the following assessment on pages 8-171 to 8-172:

> "Biodiversity surveys in such a remote and inaccessible part of the tropics that has not been biologically explored before, particularly one as comprehensive as that conducted for the Project, is likely to find species new to science. At least 85 species were discovered during field surveys for this Project, some of which have now been formally named. The majority of these species were from less well-known groups of plants, herpetofauna and invertebrates. Known distributions of these species may be a reflection of the limited scientific research focus on these taxa, rather than the actual distribution of these species.
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> "Nonetheless, with new species it is possible that some are restricted or have a significant part of their population within the terrestrial biodiversity study area. The residual impact on these species depends upon the extent to which they are restricted in range. A major impact would occur if their ranges were so small that they wholly or mostly overlapped with the Project footprint and thus would be subjected to severe range reduction. Where species new to science are found on isolated mountaintops, mountain ranges, islands or restricted habitats they may be expected to be restricted in distribution. The only species likely to be so restricted is the butterfly Mycalesis sp nov. 1 found only in the peat forest. All other species are in habitat that is continuous along

[10] COP 8 Decision VIII/28. https://www.cbd.int/decision/cop/default.shtml?id=11042

the north slope of the Central Cordillera or on the continuous Sepik River lowlands and thus are unlikely to have very narrow distributions.

"Of the species potentially new to science, five species (one plant, one mammal, one reptile, and two odonates), were found only at a survey site within the Project disturbance area; the rest occurred outside, or both inside and outside, the Project disturbance area. However, experience suggests that continued ecological investigation generally continues to increase the known range of species previously thought to be narrowly restricted. The large number of range extensions resulting from the Project surveys demonstrates this. It is extremely unlikely that any of the new species, including those only found so far in the Project footprint, are entirely restricted to the terrestrial biodiversity study area as all but Mycalesis sp. nov. 1 were in widespread habitats. With management measures limiting habitat loss and fire, reducing habitat degradation and limiting the introduction of noxious pests and weeds, the residual direct impact to species new to science is assessed as being negligible.

"In assessing indirect effects on species new to science, it is noted that none of the species would be of any interest to hunters or subsistence gatherers and so would not be targeted by in-migrants. Clearing of vegetation by in-migrants or the accidental introduction of exotic pests and pathogens are greater potential indirect impacts. The residual indirect impact to species new to science is predicted to increase to moderate significance.

"The endemic species recorded during the field surveys for the Project do not appear to be concentrated in particular ecological niches nor particular locations within the terrestrial biodiversity study area overall. The Project is therefore highly unlikely to alter the levels of endemism in the biota. The magnitude of residual direct and indirect impact to endemic species is thus predicted to be negligible."

By their very nature, species new to science are species for which little is known about their distribution, habitat, ecology and behavior. For this reason, the material presented on pages 8-171 to 8-172 inherently cannot be a quantification of "the changes in biodiversity composition, structure and key processes, as well as ecosystem services" as required to meet procedural steps characterizing good-practice environmental impact assessment outlined in the Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment that is part of the CBD. When the extinction of a species is possible outcome, assessments of impacts to biodiversity cannot be based on facts that *only appear to be so*, such as whether endemic species recorded during the field surveys are concentrated in particular ecological niches within the overall project area. Where a project involves so many species new to science and endemic species, then compliance with the requirements of the CBD must require years of study to gain a full understanding of distribution, habitat, ecology and behavior of such species, rather than an assessment based on guesswork.

The rich biodiversity unique to Papua New Guinea is an important part of its national heritage. This heritage is undermined by environmental assessments that fail to convey the full dimension of how development projects will impact such biodiversity.

6. The EIS improperly dismisses alternative project designs that would eliminate or substantially reduce substantial harm the project would cause

Chapter 6 of the EIS is titled "Assessment of Alternative Development Options." The assessment of project alternatives is often called the *Heart of the EIA Process* because it enables finding ways to attain the benefits of a project in a manner that minimzes its social and environmental costs.

For the Sepik Development Project, the comparison of design alternatives must be examined in the light of vast amounts of revenue that would be available to FRL, owned by the Government of China, to implement design alternatives. In 2017, FRL announced:

> "The Frieda River Project represents one of the largest undeveloped copper-gold deposits in the world. The HITEK global Mineral Resource (Appendix I) is now estimated to contain 2.64 billion tonnes of mineralization at an average grade of 0.44% copper and 0.23g/t gold representing 12 million tonnes (Mt) of copper and 19 million ounces (Moz) of gold.
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> "Average annual production of metal in concentrate is 175,000 tonnes copper and 240,000 ounces gold (Table 1). The initial mine life is estimated at 18 years with 714 Mt of mill feed that includes 686 Mt of Ore Reserve (Appendix II). The HITEK open-pit design is based exclusively on Measured and Indicated Mineral Resources and the mill feed represents approximately a quarter of the global Mineral Resource. The Project will have a competitive C1 cost of US$0.69/lb copper (average over the life of mine) that will place it within the first quartile of the global copper cost curve (Table 1).
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> "The Project configuration, as described in supporting documentation submitted with the application for a Special Mining Lease and in the Environmental Impact Statement, is largely unchanged. However the economic value and risk profile for the Project has been materially improved as a result of the updated Mineral Resource estimate, revised open-pit designs and optimised mine production schedule. The Project NPV has increased by 38% from US$820 million to US$1,130 million using Wood Mackenzie price forecasts of US$3.30/lb copper, US$1,455/oz gold and US$80/bbl Brent crude oil (Table 1). While the short to medium term outlook for the copper price is less certain, the long term fundamentals appear strong.
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> "The initial Project development yields a life of mine post-tax free cash flow of US$7.1 billion; post-tax net present value of US$1,130 million (discount rate 7.8% real); and, an internal rate of return of 11%. The preproduction capital cost is estimated at US$3.6 billion which equates to a pre-production capital intensity of US$17,000/t of copper

equivalent in concentrate production. The payback period (post commencement of production) is estimated at six years (Table 1)."[11]

All of the harms described in this report – increased incidence of malaria, forced resettlement of villages, catastrophic failure of a tailings storage facility, actively managing the risk of acid mine drainage and a dam failure for the rest of this century, vast extinctions of species – could be reduced or substantially eliminated by a design alternative in which waste rock and tailings are neutralized with alkaline materials and used to progressively backfill the open pits; and the use of wind turbines and solar installations for meeting the power demands of the project.

A June 2015 report of the Mine Environment Neutral Drainage (MEND) Program sponsored by the Mining Association of Canada (MAC) describes the feasibility of using the backfill method for disposal of acid-generating mine wastes.[12] The report states:

> "The options for disposal of mine waste that represent low long-term liabilities are limited at a large proportion of mine sites. Although not new, the disposal of mine wastes into mined-out pits has, in recent years, received increased acceptance particularly for acid generating, metal leaching, radioactive and perceptively hazardous tailings, waste rock and water treatment sludges.
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> "*The published results for a selection of in-pit disposal options have been, in general, very positive in demonstrating the long-term isolation demanded by companies, regulators and the public*. This document is an update of the 1995 MEND Report 2.36.1 and *provides a summary of 12 case studies of in-pit disposal of mine waste at locations around the world*. Case studies were selected to provide examples of in-pit disposal of mine wastes exhibiting a variety of environmental risks and located in various hydrogeological and climatic settings."

Improperly, Chapter 6 of the EIS dismisses the backfill option citing economic barriers. FRL makes the following claim in the EIS:

> 6.3.5 Management of Final Open-pit Void
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> "FRL considered two options for the management of the final open-pit void:
> 1. Backfilling with waste rock.
> 2. Allowing the void to naturally fill with water.

[11] Frieda River Copper-Gold Project feasibility study update, new Mineral Resource and Ore Reserve estimates. https://panaust.com.au/sites/default/files/20170504_Frieda%20River%20Copper-Gold%20Project%20feasibility%20study%20update_new%20Mineral%20Resource%20and%20Ore%20Reserves%20estimates_FINAL.pdf

[12] Mine Environment Neutral Drainage (June 2015) "In-Pit Disposal of Reactive Mine Wastes: Approaches, Update and Case Study Results." http://mend-nedem.org/wp-content/uploads/2.36.1b-In-Pit-Disposal.pdf

Backfilling the large open-pit void with waste rock after the cessation of mining is not practically possible because of the subaqueous waste rock deposition plan and would impose a significant cost impost on the FRCGP that would severely impact its economics to the point where it would not be economic to proceed. Mine planning does not allow for the sequential backfilling of the open-pit and given the topographic setting and high rainfall it is not possible to store the large volumes of waste rock for the life of the mine to allow backfilling as part of mine closure without the risk of creating AMD. It would also impose significant cost on any future development of the deposits, should economic circumstances permit."

However, FRL has stated to investors that the: "initial Project development yields a life of mine post-tax free cash flow of US$7.1 billion." Therefore, it is not enough to state that backfilling the open-pit voids are not practically possible because of the imposition of significant costs. Considering how many of the substantial impacts of the project are avoided by use of the backfill method, FRL needs to transparently estimate the cost of using the backfill method iand compare it to the post-tax free cash flow of the project. Also, it is important to note that the project involves three open pits – the HIT, Ekwai, and Koki open pits – that would facilitate the backfill method by allowing waste from one pit to be placed into another. FRL should clarify its claim that "*given the* topographic setting and *high rainfall it is not possible to store the large volumes of waste rock for the life of the mine to allow backfilling as part of mine closure*" in light of the fact that the Omai Gold Mine in Guyana, where annual rainfall exceeds two meters, backfilled its open pit with tailings after the collapse of its wet tailings impoundment.[13]

With respect to the design alternative of supplying the power for the project from renewable resources, FRL makes the following claim in the EIS:

"6.3.8 Power Supply

Renewable power sources considered included:
• Hydroelectric power generation using a large reservoir located in the Frieda River catchment, independent of mine waste storage.
• Hydroelectric power generation making use of the water stored in the ISF.
• Run-of-river hydroelectric power generation in the upper catchment of the Nena River.
• Solar, wind and geothermal energy.

Solar and wind power supply are not suitable for total power demand given local climatic conditions. No viable local geothermal source has been identified. Therefore, these options were not considered further."

[13] Mine Environment Neutral Drainage (MEND) Program (June 2015) "In-Pit Disposal of Reactive Mine Wastes: Approaches, Update and Case Study Results."

Page 5-32 of the EIS states: "The mine's power demand will be approximately 180 MW increasing up to 280 MW by Year 8." The provinces of West Sepik and East Sepik are known to have a high potential for renewable wind and solar energy generation.[14] The provision of 180 MW of power, increasing up to 280 MW by Year 8, should be easily met by either a handful of modern wind turbines in the capacity range of 10-15 MW each, a relatively small utility-scale solar photovoltaic park, along with battery storage to overcome intermittency barriers of wind and solar installations. Therefore, meeting the mine's power demand can be accomplished entirely without a 12 square kilometer reservoir that would generate substantial environmental and public health risks.

Date: 11 February 2020

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[14] Samanta, S., & Aiau, S. S. (2015). Spatial analysis of renewable energy in Papua New Guinea through remote sensing and GIS. *International Journal of Geosciences*, *6*(8), 853.