

HAIB COPPER PROJECT HEALTH IMPACT ASSESSMENT (as part of the Environmental and Social Impact Assessment)

For Knight Piésold Consulting (Pty) Ltd (KP Namibia)

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Executive Summary

The Haib Copper Project Health Impact Assessment (HIA), conducted as part of the broader Environmental and Social Impact Assessment (ESIA), evaluates the potential health effects of the proposed open-pit porphyry copper-molybdenum mine, milling and flotation facility, and hydrometallurgical processing facility in the Karas Region of Namibia. There will be no onsite smelter. The assessment applies the International Finance Corporation's (IFC) 12 Environmental Health Areas (EHAs) framework, drawing on literature from comparable African and global copper mining contexts (Zambia, DRC, Chile), baseline data, air dispersion modelling, and project-specific design features. This HIA focusses on potentially affected communities (the external receptors), and the project workforce (internal receptors). Where possible these impacts are indicated separately, although they are to some extent inter-related. Workforce impacts will need to be dealt with at a later stage by way of occupational health risk assessments for the different phases of the project.

Potential negative health impacts arise from:

- Community anxiety from uncertainty (EHA 9,10)
- Population influx- Workforce and community influx effects, including communicable diseases, STIs/HIV (EHAs 1, 4)
- Population influx- Strain on local health services (EHA 12)
- Accommodation - Communicable diseases (TB) from community overcrowding (EHA 1).
- Exposure to contaminated water/soil (EHA 3)
- Legacy contamination causing long-term diseases (EHA 3, 6)
- Worker exposures to dust and respirable silica exposure leading to respiratory, communicable and non-communicable diseases, chemicals, injuries, and psychosocial stress (EHAs 2, 6, 7, 8, 9), particularly during construction and operations.

Positive health impacts arise primarily from:

- Direct and indirect employment (up to 3,500 during construction; 1,350 during operations) improving income, nutrition, education, and health-service access (EHAs 5, 11, 12).
- Potential corporate social responsibility (CSR) initiatives may enhance existing community health programs (HIV screening, clinic support).

Pre-mitigation significance ratings range from Low to High (highest for legacy contamination and chronic dust/chemical exposures during operations). The absence of a smelter significantly reduces air quality risks compared with operations which include smelting.

With effective implementation of proposed mitigations, such as dust suppression, lined heap leach pads, on-site occupational health clinic, STI/HIV programs, progressive rehabilitation of the site, local hiring quotas, and long-term monitoring, residual impacts may be reduced to Low or Medium across all four phases (preconstruction, construction, operations and decommissioning). Net health outcomes can be positive for the region, particularly through sustained socioeconomic benefits and proactive legacy management.

Many of the exposures will be significantly higher for workers than for community residents. An occupational health risk assessment by phases along with establishing an onsite clinic is thus recommended.

Relocating the workers' camp to Noordoewer is recommended so that it is not downwind of the mine, and a recipient of mine dust. All road surfaces should be sealed to minimize dust exposure.

As baseline data is still relatively sparse, continuous monitoring of air and water quality is required in order to have greater confidence in both current and future modelling over time of the distribution of dust and metals in air and (ground and surface) water.

To the extent possible, maximizing local participation, corporate social responsibility (CSR) health and other local investments to support secondary economic opportunities, and community involvement in closure planning would have beneficial effects.

Overall, the Haib Copper Project can achieve low residual health risks and meaningful positive contributions to regional well-being over its 23-year life-of-mine and beyond, provided mitigations are rigorously enforced through the Environmental and Social Management Plan (ESMP) and adaptive monitoring. Monitoring stations should be set up at the perimeter of the mine and at sensitive sites like Noordoewer, the Orange River and Aussenkehr.

The scientific literature reports very little in the way of preventive environmental and receptor population exposure monitoring, despite findings of serious environmental and occupational health impacts of copper mining and processing projects globally.

The HAIB project has the potential to be a world class example of health impact assessment.

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ABBREVIATIONS

AAQS	Ambient Air Quality Standards
ADM	Air Dispersion Modelling
AP	Acid Potential
APP	Atmospheric Pollution Prevention (Ordinance)
AQ	Air Quality
ARD	Acid Rock Drainage
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CEO	Chief Executive Officer
CMSA	Copper Mines of Southern Africa
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
CSR	Corporate Social Responsibility
Cu	Copper
EAP	Environmental Assessment Practitioner
EAPAN	Environmental Assessment Professionals of Namibia
EBRD	European Bank for Reconstruction and Development
ECC	Environmental Clearance Certificate
EHS	Environmental Health and Safety
EPL	Exclusive Prospecting License
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
GDP	Gross Domestic Product
GISTM	Global Industry Standard on Tailings Management
GLC	Ground Level Concentrations
GN	General Notice
HIV	Human Immunodeficiency Virus
HM	Haib Minerals
I&APs	Interested and Affected Parties
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
IEMA	Institute of Environmental Management and Assessment (UK)
IFC	International Finance Corporation
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
ILO	International Labour Organization

IPP	Independent Power Producer
ISEP	Institute of Sustainability and Environmental Professionals
KIRLUP	//Karas Integrated Regional Land Use Plan
KP	Knight Piésold Consulting (Pty) Ltd
LDV	Light Delivery Vehicle
LOM	Life of Mine
mamsl	Metres above mean sea level
mbgl	Metres below ground level
MFMR	Ministry of Fisheries and Marine Resources (Namibia)
MIME	Ministry of Industries, Mines and Energy Haib
ML	Mining License
MMIF	Mesoscale Model Interface Program
Mtpa	Megatonnes per annum / Million tonnes per annum
NamPort	Namibian Ports Authority
NamPower	Namibia Power Corporation
NamWater	Namibia Water Corporation
NCE	Namibia Chamber of Environment
NCJV	Namibian Copper Joint Venture
NCM	Namibian Copper Mines Inc.
NDP	National Development Plan
NHC	National Heritage Council of Namibia
NNP	Net Neutralising Potential
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NO _x	Oxides Of Nitrogen
OHTL	Overhead Transmission Line
ORASECOM	Orange-Senqu River Commission
PEA	Preliminary Economic Assessment
PM	Particulate Matter
PM ₁₀	Particulate matter with aerodynamic diameters less than 10 µm
PM _{2.5}	Particulate matter with aerodynamic diameters less than 2.5 µm
Project	Haib Copper Project
ROM	Run-of-Mine
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
SO ₂	Sulphur Dioxide
TCu	Total Copper
TSF	Tailings Storage Facility
TSP	Total Suspended Particles

UNAM	University of Namibia
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRD	Waste Rock Dump
XRD	X-Ray Diffusion

1.0 INTRODUCTION

1.1 Background and purpose

Haib is a porphyry copper exploration project located in the //Karas Region of southern Namibia, approximately six kilometres (km) north of the border with South Africa and between 12 km and 15 km east of the tarred B1 highway that connects Namibia with South Africa.

Towards advancing the copper mining activities at Haib, a comprehensive Environmental and Social Impact Assessment (ESIA) which includes a Health Impact Assessment (HIA) with an associated Environmental and Social Management Plan (ESMP) and public consultations are currently being undertaken and developed to meet both Namibian national requirements and International Finance Corporation (IFC) standards for the Project. The ESIA is being prepared to obtain an Environmental Clearance Certificate (ECC) for the Project from Namibian authorities and to support the standards of disclosure required by the Canadian Securities Administrator in a technical report (NI 43-101) providing environmental and social compliance components.

The proposed Project comprises an open pit mine, a 37 million tonnes per annum (Mtpa) crushing, milling and flotation concentrator, a hydrometallurgical plant consisting of an 3 Mtpa heap leach, copper solvent extraction, impurity removal and copper electrowinning plant, as well as infrastructure on and off site necessary to support these operations (waste rock dumps, stockpiles, tailings storage facilities, pipelines and abstraction works, power infrastructure, roads, offices etc.). The operation will achieve a combined throughput of 40 Mtpa. The mining schedule indicates a total material movement of approximately 87.5 Mtpa, providing approximately 23 years' supply of mineralised material. This equates to a total of 1.58 billion tonnes of material to be mined.

Knight Piésold Consulting (Pty) Ltd (KP Namibia) was appointed by Haib Minerals (Pty) Ltd to support in the development of the environmental scoping and impact studies, including a health impact assessment, and ongoing regulatory compliance.

1.2 Project description

If the Haib Copper Project moves forward, the Namibian economy can expect benefits from revenues during the construction phase, royalties and taxes during the Life of Mine (LoM), and positive contributions towards employment and infrastructure development. The broad mine plan indicates that a maximum of 3,500 staff during construction and maximum of 1,350 during operations will be required by the Project. This will provide direct benefits through income and thus livelihoods to these households as well as support the broader economy for a minimum of 23 years of production in addition to the construction period of about two years. The site layout has been designed around critical landform features such as topography, sensitive biodiversity areas, and heritage features. The optimisation has additionally considered the efficiencies required for the mining operation.

It must be noted that this site layout represents the results of preliminary studies, however, it is not final. The final layout will be informed by specialist impact studies and the broader environmental and social impact assessment, as well as ongoing design processes. This finalisation process will also integrate considerations received through the regulatory public consultation process.

A summary of the key proposed components is provided:

- Open Pit - The Haib deposit straddles the ephemeral Volstruis River and forms the basis for the open pit. The open pit consists of four target areas which will combine to form the larger pit.
- The Concentrator Processing Plant - The concentrator processing plant has been laid out to the east of the pit. The Volstruis river valley in which the pit is found flattens to the east as it joins the

Haib riverbed. This relatively flat area allows flexibility of the plant layout and an opportunity to minimise earthworks. The Run-of-Mine (ROM) tip pads are located close to the pit edge and are at a similar elevation to the pit rim. The typical processing plant supporting infrastructure comprises a change house, administration facility, workshop, stores, reagents stores, sewerage and water treatment facilities. The final copper and molybdenum concentrate will be dried in a filter press and exported by road. The Concentrator design is based on a 37 Mtpa facility, executed in a single phase and comprising crushing, milling and flotation circuit modules. The Concentrator will treat higher grade primary sulphide material containing at least 0.275% copper (Cu), for recovery of copper and molybdenum (Mo) minerals and will produce separate copper and molybdenum flotation concentrates (dependent on market conditions and feed grade), which will be trucked to and shipped to international customers.

- Hydrometallurgical Plant - The area in the north-west of the EPL footprint on the flatter plain, as well as the area directly north of the pit have been identified as alternatives currently being assessed for the heap leach and hydrometallurgical plant. Mineralised material will be crushed at the ROM pads and conveyed to the agglomeration plant before being stacked on the Heap Leach pad.
- The heap leach, solvent extraction and electrowinning plant is designed with a feed capacity of 3 Mtpa, to process low-grade primary sulphide mineralised material, as well as small quantities of oxide or secondary sulphide mineralised material over approximately 23 years. Copper cathode produced in this circuit will be exported to the market.
- Tailings Disposal – A raised ring feed Tailings Facility.
- The TSFs will have an underdrainage system and downstream seepage interception trenches/wells to maximise seepage water recovery. The TSF options are designed to Global Industry Standard on Tailings Management (GISTM) published in 2020.
- Waste Rock Dumps/Stockpiles - Waste Rock Dumps were designed as close to the pit exits as possible to optimise productivity and minimise waste mining costs or environmental impacts.
- Access and Haul Roads - The Project can be accessed from Windhoek or Noordoewer through the B1 National Highway and then via sets of farm roads and tracks developed during the various exploration programmes. Different access road options were investigated during the conceptual design stage, and the access (road) going along the Haib riverbank was rated most favourable in terms of geometrics, gradients, and cut and fill material balance. Based on the capital cost, maintenance costs, ease of construction, dust mitigation, and visual aesthetics, a sealed road option is recommended for the mine access road for use by commercial haulage trucks, buses, and general vehicles. A gravel wearing course and dump rock pavement layer with a dust suppressant is recommended for the haul road section between the open pit and processing stockpiles, as well as to the waste rock dumps to lower dust emission, wear, and damage to the road surface.
- Bulk Water Infrastructure - The proposed Project's water demand is 20 million cubic metres per year (Mm³/yr) of which supply is being investigated the Orange River which will be managed through partnership with Namibia Water Corporation (NamWater)
- Raw water supply from the Orange River assumes seasonal reliability of supply. Off-channel storage facilities will offset the impacts of limited to nil water abstraction during the dry season or drought periods. The proposed system comprises an abstraction intake structure, a low-lift pumping station and booster pumping stations, as well as a pipeline to a site reservoir. Two sites for abstraction are under investigation.
- Mine housing is planned to be situated within Noordoewer designed to accommodate 1 350 personnel as aligned to operational phase. Additional housing requirements for construction phase will be sourced from within Noordoewer with the assumption that housing accommodation facilities will be available.
- The concept for mine housing in Northern Noordoewer includes various types of worker accommodation, public open spaces, cafeteria and clubhouse and associated infrastructure

services to ensure functionality. An allocation for temporary construction housing on site is made to support early construction works.

- Bulk Power Supply - The power supply concept design includes a hybrid solution combining a solar PV plant (150 MWp (megawatt peak)) and a connection to the regional grid system from the local service provider, the Namibia Power Corporation (NamPower). The system is sized to meet the proposed project's peak demand that may be up to a maximum of 150 MVA (megavolt-amperes) and annual consumption of 1,123.3 GWh (gigawatt-hour). However, power optimisation studies are still ongoing and expected to provide improvements through introducing efficiencies. The grid supply is recommended to be via a double circuit overhead transmission line (OHTL) configuration for redundancy. The solar PV supply will include either 30% or 100% supply, subject to regulatory approval. Wind energy is a secondary option that was identified.

All infrastructure underwent alternative assessment, which considered designing the site around critical landform features such as topography, sensitive environmental habitats/areas, and heritage features. The process additionally considered the efficiencies required for the mining operation towards identifying an optimal layout. The presented site layout is a result of these considerations.

2.0 LITERATURE REVIEW

2.1 The state of managing health impacts in copper mining and processing operations.

Building a new copper mine in a remote area involves significant environmental and occupational health considerations, as evidenced by existing literature on copper mining operations worldwide. This review synthesizes findings from studies focusing on health risks to surrounding communities, including workers, drawing from experiences and relevant information, including the relatively few research studies on health aspects of copper mining and processing in countries like Chile, China, Namibia, the Philippines, and Zambia. Key themes include exposure to physical, chemical, biological, ergonomic, and injury hazards for community residents and mine workers, as well as broader environmental contamination that directly or indirectly impacts health. While some research highlights economic benefits that may indirectly improve health outcomes, the predominant focus is on adverse impacts, particularly in remote settings where access to healthcare and regulatory enforcement may be limited.¹²

³ The literature is sparse but frequently emphasizes the need for mitigation strategies to balance resource extraction with health protection. There have been an increasing number of research reviews and research results publications since 2010, and especially since 2020. It is notable that in the main, there is very little in the way of reported evidence based on ongoing monitoring of well-known hazardous exposures, or health monitoring of exposed communities and workers^{4 5 6}. This is the case even in instances where there has been widespread damage to the environment and population health.⁷ What evidence is available in the literature appears not to clearly show the efficacy of some preventive health interventions, primarily HIV interventions, in the better organised mining projects⁸. Follow up studies based on exposure and health monitoring are rare.

2.2 Potential Community Health Impacts of Copper mining and processing

Environmental health impacts from copper mining and processing primarily stem from pollution of air, water, soil, and ecosystems, with direct and indirect effects on individual and community health. Recent

¹ Li Chen 1, Mingxi Zhou 2, Jingzhe Wang 3, et al. (2022). A global meta-analysis of heavy metal(loid)s pollution in soils near copper mines: Evaluation of pollution level and probabilistic health risks. *Sci Total Environ* Aug 20:835:155441. doi: 10.1016/j.scitotenv.2022.155441.

2 Zhiqiang Wang 1, Chen Hong 2, Yi Xing 3 et al. (2018). Spatial distribution and sources of heavy metals in natural pasture soil around copper-molybdenum mine in Northeast China. *Ecotoxicol Environ Saf*, Jun 15:154:329-336. doi: 10.1016/j.ecoenv.2018.02.048.

3 Anura Widana (2019). Environmental Impacts of the Mining Industry : A literature review. Unpublished paper presented to the United Nations Development Program. Anura.widana@yahoo.com

4 John Kasongo a,b, Laurent Y. Alleman a,*, Jean-Marie Kanda et al. (2024). Metal-bearing airborne particles from mining activities: A review on their characteristics, impacts and research perspectives. *Science of the Total Environment* 951 175426.

5 Phenny Mwaanga a,b,*, Mathews Silondwa c, George Kasali et al. (2019). Preliminary review of mine air pollution in Zambia. *Heliyon*. e02485.

6 Benoit Nemerya,*, Célestin Banza Lubaba Nkulub, (2018). Assessing exposure to metals using biomonitoring: Achievements and challenges experienced through surveys in low- and middle-income countries. *Toxicology letters* 298:13-18. <https://doi.org/10.1016/j.toxlet.2018.06.004>

7 A. Muimba-Kankolongo ,1 C. Banza Lubaba Nkulu,2 J. Mwitwa et al. (2022). Impacts of Trace Metals Pollution of Water, Food Crops, and Ambient Air on Population Health in Zambia and the DR Congo. *Journal of Environmental and Public Health* Volume 2022, Article ID 4515115, 14 pages <https://doi.org/10.1155/2022/4515115>.

8 Astrid M. Knoblauch1,2*, Mark J. Divall3, Milka Owuor3 et al. (2017). Experience and lessons from health impact assessment guiding prevention and control of HIV/AIDS in a copper mine project, northwestern Zambia. *Infectious Diseases of Poverty* (2017) 6:114. DOI 10.1186/s40249-017-0320-4

research reviews indicate widespread contamination, including land, water, air, and noise pollution, as well as biodiversity disruption and loss of cultural artifacts.⁹ In copper mining hotspots like the Atacama Desert in Chile, tree-ring analyses show surges in metals and metalloids like copper and arsenic during peak production periods, linked to tailings deposits.¹⁰ These indicate increased environmental exposure risks for local indigenous communities and associated health effects.¹¹

Tailings management is a critical concern. In Chañaral, Chile, over 80 years of copper tailings accumulation has caused coastal geomorphological changes, metal contamination of seawater and sediments (e.g., Cu, As, Mo, Zn, Cd), and biodiversity loss, including impacts on algae, marine organisms, and birds.¹² Public health consequences include chronic exposure via wind-dispersed fine particulates measured as PM_{2.5} and elevated urinary metal levels (e.g., arsenic, nickel, mercury) which exceed health standards.¹³ Fine dust has been associated with respiratory problems in children, metabolic disorders in adults (hypercholesterolaemia, hyperglycaemia) in lower socio-economic groups, and heightened health risk perceptions in the nearby community, particularly among women.¹⁴

Heap leaching of low-grade oxide or sulfide copper ores, often followed by solvent extraction and electrowinning, introduces additional risks including acid rock drainage (ARD) from sulfuric acid irrigation, leading to prolonged acidification and mobilization of heavy metals (Cu, As, Cd) into groundwater and surface water even post-closure. Liner failures or runoff can cause widespread soil/water contamination, biodiversity loss, and chronic community exposure via acidic mists or leached toxins.

Soil pollution around copper mines in eastern China, show high levels of thallium and other heavy metals (Cu, Cd, Hg). Moderate or extreme contamination together with high bioavailability, posed carcinogenic and non-carcinogenic risks to both adults and children primarily via ingestion.¹⁵ In the Philippines, surface mining communities report perceived declines in air and water quality due to dust, smoke, sedimentation, and noise, leading to respiratory issues, diarrhoea, and sleep disturbances, with stronger effects in proximate remote villages.¹⁶ Metallurgical processes further contribute to dust pollution, adding to long-term environmental and health risks from mine wastes.¹⁷

9 Izydorczyk, G., Mikula, K., Skrzypczak, D., et al. (2021). Potential environmental pollution from copper metallurgy and methods of management. *Environmental Research*, 197, 111050. <https://doi.org/10.1016/j.envres.2021.111050>

10 Zanetta-Colombo, N.C., Scharnweber, T., Christie, D.A., et al. (2024). When another one bites the dust: Environmental impact of global copper demand on local communities in the Atacama mining hotspot as registered by tree rings. *Science of the Total Environment*, 920, 170954. <https://doi.org/10.1016/j.scitotenv.2024.170954>

11 Zanetta-Colombo, N.C., Fleming, Z.L., Gayo, E.M., et al. (2022). Impact of mining on the metal content of dust in indigenous villages of northern Chile. *Environment International*, 169, 107490. <https://doi.org/10.1016/j.envint.2022.107490>

12 Cortés, S., González, P., Leiva, C., Vargas, Y., Vega, A., & Pastén, P. (2025). Environmental and Public Health Impacts of Mining Tailings in Chañaral, Chile: A Narrative Case-Based Review. *Sustainability*, 17(17), 7732. <https://doi.org/10.3390/su17177732>

13 Cortés, S., Lagos, L., Burgos, S., Adaros, H., & Ferreccio, C. (2016). Urinary Metal Levels in a Chilean Community 31 Years After the Dumping of Mine Tailings. *Journal of Health & Pollution*, 6(10), 19–27. <https://doi.org/10.5696/2156-9614-6-10.19>

14 Yohannessen, K., Alvarado Orellana, S., Mesías Monsalve, S., et al. (2018). Trace element contents in fine particulate matter (PM_{2.5}) in urban school microenvironments near a contaminated beach with mine tailings, Chañaral, Chile. *Environmental Geochemistry and Health*, 40, 1077–1091. <https://doi.org/10.1007/s10653-017-0032-9>

15 Zhao, K., Hu, R., Wan, X., et al. (2023). Pollution characteristics and probabilistic human health risks of thallium and other heavy metals in soils from a typical copper mining city in the Yangtze River Delta, eastern China. *Environmental Pollutants and Bioavailability*, 35(1), 2250912. <https://doi.org/10.1080/26395940.2023.2250912>

16 Lazarte, J.M.T., Miranda, C.F., Apas, R.S., et al. (2025). Perceived Health Impacts of Surface Mining: Local Perspectives from the Mining Communities in Libjo, Dinagat Islands, Philippines. *International Journal of Environmental Research and Public Health*, 22(3), 365. <https://doi.org/10.3390/ijerph22030365>

17 GreenSpec. (n.d.). Copper production & environmental impact. GreenSpec website. Retrieved from <http://www.greenspec.co.uk/building-design/copper-production-environmental-impact/> (No specific authors or pages; online resource.)

In remote areas, these impacts are exacerbated by lack of regulation, limited monitoring, and socio-environmental inequalities, with persistent ecosystem (legacy) contamination often lasting decades post-operations.¹⁸ As populations grow in areas near mining operations, urban expansion takes place over contaminated sites from legacy exposures. Vulnerable populations, including poor rural communities and migrants, pregnant and lactating mothers, and their children may be disproportionately affected, leading to birth defects, DNA damage, and neurodevelopmental impairments from cross-placental toxic metal transfer.¹⁹

2.3 Occupational Health Aspects

Occupational exposures amongst mineworkers are typically orders of magnitude higher than community exposures. Health risks in copper mining are multifaceted, encompassing physical, chemical, biological, ergonomic, injury, and psychosocial hazards. A scoping review of Chilean copper mine workers (2008-2019) identifies primary physical hazards as high-altitude work, silica dust inhalation²⁰, and noise exposure, which contribute to conditions like altitude sickness, silicosis²¹, and hearing loss. Chemical exposures include heavy metals such as copper, arsenic, and lead, leading to respiratory and neurological issues. For instance, in energy transition metal mining (including copper), workers face elevated risks of lung diseases, chronic bronchitis, and neurotoxicity from heavy metals in copper mining and processing operations.²² Workers in heap leaching and solvent extraction/electrowinning face heightened risks from sulfuric acid handling (burns, respiratory irritation from mists), organic solvent exposure in solvent extraction (e.g., neurotoxicity, skin irritation), and electrowinning hazards (acid fumes, electrical risks, hydrogen gas explosions). These amplify existing chemical and ergonomic issues in remote operations. Traumatic injuries from falls, cave-ins, explosions, and machinery are common, with higher mortality rates in inadequately equipped sites.²³ Psychosocial factors, such as chronic stress, burnout, and shift work in isolated environments, exacerbate mental health issues, including elevated suicide rates and psychological distress.²⁴ In remote areas, these risks are amplified by poor sanitation, overcrowding, and infectious disease outbreaks (e.g., tuberculosis, HIV), as seen in underserved mining communities in Central and Southern African countries.^{25 26} Artisanal mining, which may parallel informal aspects of new remote mines,

18 Stewart, A.G. (2019). Mining is bad for health: a voyage of discovery. *Environmental Geochemistry and Health*, 42, Brown, C.W., Goldfine, C.E., Allan-Blitz, L.T., et al. (2024). Occupational, environmental, and toxicological health risks of mining metals for lithium-ion batteries: a narrative review. *Journal of Occupational Medicine and Toxicology*, 19, 35. <https://doi.org/10.1186/s12995-024-00433-6> <https://doi.org/10.1007/s10653-019-00367-7>

19 Brown, C.W., Goldfine, C.E., Allan-Blitz, L.T., et al. (2024). Occupational, environmental, and toxicological health risks of mining metals for lithium-ion batteries: a narrative review. *Journal of Occupational Medicine and Toxicology*, 19, 35. <https://doi.org/10.1186/s12995-024-00433-6>

20 Matamala Pizarro, J., & Aguayo Fuenzalida, F. (2021). Occupational Health in Chilean Copper Mine Workers: A Scoping Review of Literature (2008-2019). *Salud Uninorte*, 37(3), 803–827. <https://doi.org/10.14482/sun.37.3.616.52>

21 Dongming Wang, MD; Min Zhou, MD; Yuewei Liu, MD et al. (2020). Comparison of Risk of Silicosis in Metal Mines and Pottery Factories: A 44-Year Cohort Study. *Chest* 158(3):1050-1059

22 Brown as in 11

23 García-Gómez, M., et al. (2024). Occupational accidents in mining workers: scoping review. *BMJ Open*, 14(10), e080572. <https://doi.org/10.1136/bmjopen-2023-080572>

24 Matamala Pizarro, J., & Aguayo Fuenzalida, F. (2021). Mental health in mine workers: a literature review. *Industrial Health*, 59(6), 343–370. <https://doi.org/10.2486/indhealth.2020-0178>

25 Stuckler, D., Basu, S., McKee, M., & Lurie, M. (2011). Mining and Risk of Tuberculosis in Sub-Saharan Africa. *American Journal of Public Health*, 101(3), 524–530. <https://doi.org/10.2105/AJPH.2009.175646>;

26 Podewils, L.J., et al. (2022). Zambia Assessment of Tuberculosis (TB) and HIV in the Mines (ZATHIM). *BMC Public Health*, 22, 791. <https://doi.org/10.1186/s12889-022-13053-8>

highlights additional hazards like mercury exposure and poor hygiene, leading to varied adverse health outcomes depending on environmental factors.²⁷

The literature underscores substantial occupational risks from physical, ergonomic and chemical exposures in copper mining, alongside environmental health threats from pollution and tailings, particularly in remote areas where isolation compounds vulnerabilities. While some studies note indirect health benefits from economic development, the overall evidence points to unacceptable risks without robust mitigation, such as improved regulations, longitudinal monitoring to compare health status and potential impacts with exposures prior to mine construction and operation, and community involvement.²⁸ There is a limited number of research reports and publications that are specific to copper mining in remote contexts, and most studies are cross-sectional in nature and unable to capture information on longer-term effects.²⁹ Prioritising health impact assessments including longitudinal follow up studies can potentially address these concerns.

2.4 As applied to an African porphyry copper mine without a smelter

The above discussion pertains mainly to mining of porphyry copper molybdenum deposits. Environmental and occupational health impacts are milder than for sediment-hosted stratiform copper-cobalt deposits such as in the Central African Copperbelt or the Congo which have higher concentrations of toxic heavy metals. Of note is that many of the citations referenced above are from mining projects which include ore smelting.

Both community and worker health impacts would be markedly reduced in the absence of on-site or local smelters, due to elimination of smelter-related air pollution (SO₂ emissions, acid rain, fine particulates, smoke, and airborne heavy metals). The risk of widespread metal dispersion and respiratory issues in communities is decreased significantly. Tailings and water/soil contamination from mining and concentration processing persist, but without added smelter slag/effluents. The mitigation focus shifts accordingly and involves tailings management, dust control, and acid drainage prevention.

On the other hand, in the absence of an onsite smelter, occupational health risks remain largely unchanged in respect of physical (dust, noise, injuries), chemical (chemicals including metals in ore and concentrate), and psychosocial hazards.

Consequently, health impacts are expected to be most severe amongst those working on the mine and associated processing works rather than for the receptor communities beyond the boundaries of the mining operations. This is particularly so given the sparsity of nearby community receptors.

2.5 HIA precedents in specifically African Low- and Middle-Income Countries with large copper deposits in remote areas

Very few copper mining projects have conducted dedicated HIAs focussed on community health monitoring, baseline assessments, and long-term evaluations. The Trident Copper Mine Project (Northwestern Zambia) operated by First Quantum Minerals, underwent a formal HIA prior to development, which prompted ongoing monitoring of health determinants and outcomes in nearby

27 Landrigan, P., Bose-O'Reilly, S., et al. (2022). Reducing disease and death from Artisanal and Small-Scale Mining (ASM). *Environmental Health*, 21(1), 78. <https://doi.org/10.1186/s12940-022-00889-1>

28 Knoblauch, A.M., Farnham, A., Zabré, H.R., et al. (2020). Community Health Impacts of the Trident Copper Mine Project in Northwestern Zambia: Results from Repeated Cross-Sectional Surveys. *International Journal of Environmental Research and Public Health*, 17(10), 3633. <https://doi.org/10.3390/ijerph17103633>

29 Leuenberger, A., Winkler, M.S., Cambaco, O., et al. (2021). Health impacts of industrial mining on surrounding communities: Local perspectives from three sub-Saharan African countries. *PLoS ONE*, 16(6), e0252433. <https://doi.org/10.1371/journal.pone.0252433>

communities. This resulted in published reports focussing on the baseline (2011), follow-up assessments (2015), and surveys in 2019 triggered by the HIA. There were mixed outcomes³⁰ inclusive of:

- HIA-driven monitoring of socioeconomic and health changes taking place over time.³¹
- Women's health outcomes were linked to the HIA process³²; and
- Some success with HIV prevention.³³

Overall, the scientific literature shows very little in the way of preventive monitoring of receptor populations and the environment despite well-documented adverse effects of copper mining and processing.

2.6 Summary of Potential Health Impacts Copper Mining and Processing relevant to the Haib Copper Project

The following summary provides potential impacts introduced by a copper mining operation, assessed against the Haib Copper Mine. At this stage the focus of the HIA is mainly on the potentially affected communities (the external receptors), and to a lesser extent on the project workforce (the internal receptors) which will be dealt with at a later stage by way of occupational health risk assessments for the different phases of the project.

2.6.1 Respiratory Diseases and Dust Exposure

Dust levels can be considerable and are aggravated by a dry climate. Porphyry ores specifically have a high silica content and can contribute to chronic obstructive pulmonary disease (COPD) and pneumoconiosis or aggravate existing conditions such as asthma. Dust levels as measured by PM_{2.5}/PM₁₀ can frequently exceed regulatory limits.

Potential community impact: Impacted communities can experience respiratory irritation which may aggravate asthma and other chronic respiratory conditions although this is unlikely due to the distance of the community from the mine site.

Potential worker impact: Workers may develop reduced lung function and contract Tuberculosis co-infection as silica in the lungs impairs immunity and causes scarring all of which is aggravated by HIV infection, while TB can be transmitted to or from the community.

2.6.2 Heavy Metal Toxicity and other chemicals

Cu, Mo, As, Cd, Pb, Zn, Co, U, Mn are common in porphyry ores. Pollution from tailings can result in bioaccumulation in water, soil or food. Cancer risks (As, Pb, Cd) are present. DNT from explosives has been associated with bladder cancer. Leach pads, tailings storage facilities and waste rock dumps pose soil and water threats from Acid Rock Drainage (ARD) involving leaching of sulfuric acid and heavy metal mobilisation.

30 Knoblauch AM, Divall MJ, Owuor M, et al. Community Health Impacts of the Trident Copper Mine Project in Northwestern Zambia: Results from Repeated Cross-Sectional Surveys. *Int J Environ Res Public Health*. 2020;17(10):3650.

31 Knoblauch AM, Divall MJ, Owuor M, et al. Changes in socioeconomic determinants of health in a copper mine development area, northwestern Zambia. *Extr Ind Soc*. 2021;8(4):100935.

32 Knoblauch AM, Divall MJ, Owuor M, et al. Selected indicators and determinants of women's health in the vicinity of a copper mine development in northwestern Zambia. *BMC Womens Health*. 2018;18(1):62.

33 Knoblauch AM, Divall MJ, Owuor M, et al. Experience and lessons from health impact assessment guiding prevention and control of HIV/AIDS in a copper mine project, northwestern Zambia. *Infect Dis Poverty*. 2017;6(1):114

Potential community impact: Communities may experience elevated urinary (As, Ni, Hg). The proximity of the Orange River to the site makes this risk relevant to communities.

Potential worker impact: Workers may develop neurotoxicity from (As, Cd), kidney damage (Cd, U), gout-like symptoms (Mo), anaemia or chest infections (Cu, Mo).

2.6.3 Infectious Diseases

Infectious diseases such as tuberculosis (TB) and Human Immunodeficiency Virus (HIV) are relevant.

Potential community impact: HIV and other sexually transmitted diseases due to mineworker and indirect population influx can be transmitted from and to the worker population. The local community has a lower HIV prevalence than the country as a whole.

Potential worker impact: TB risks for workers are enhanced due to silica-containing dust exposure and HIV infection.

2.6.4 Other Risks

Potential community impact: Legacy environmental exposures post closure from leach pads, tailings storage facilities and waste rock dumps impacting downstream activities in the Orange River.

Potential worker impact: Injuries and fatality rates may increase during periods of low copper prices and cost cutting.

Elevated cancer risk for both community and workers is difficult to monitor or detect as the impact takes place over long periods of exposure and time and is dependent on the presence or absence of a cancer registry which Namibia does not have.

2.6.5 Positive Impacts

Significant job creation and economic stimulus to the local and national GDP. While local employment directly by the mine is likely low, however indirect and induced job creation and potential infrastructure upgrades/development would positively impact local populations. Improved income from job creation as well as better nutrition and access to health care would benefit both community members and workers.

3.0 PROJECT DESCRIPTION

The HAIB project, as per recent updates³⁴, is in the pre-construction phase with ongoing drilling³⁵ and an updated Preliminary Economic Assessment (PEA) from 2025³⁶ indicating a 40 Mtpa throughput, open-pit mining, bio-assisted heap leaching for low-grade ore, crushing/flotation for high-grade, waste rock dumps, and tailings facilities.³⁷ The project anticipates a 23-year life-of-mine (LOM)³⁸. The site is near Noordoewer in southern Namibia's ǀKaras Region³⁹, a remote, arid area with low population density (~0.7 persons/km²)⁴⁰, youthful demographics life expectancy ~64 years⁴¹. Vulnerable groups include migrant workers, children, and rural communities reliant on the Orange River⁴². The Mine Workforce population

The workforce currently envisioned by the project includes skilled, semi-skilled and unskilled workers, the majority of whom are skilled and semi-skilled. This means that only a low proportion of Nooroewer residents who are generally unskilled and who have worked in agriculture will be recruited, with the majority coming from outside the region. The maximum numbers (inclusive of administrative staff) will be around 3,500 during the construction phase and 1,350 during the operational phase. The town of Noordoewer has by comparison a smaller population of around 2,500–3,500 (low thousands).

3.1 Project Activities

The work process and details are described in the Haib Minerals (Pty) Ltd Environmental Support and EIA Draft Project Description Chapter⁴³

1. A single large open pit
2. A concentrator processing plant (crushing, milling and flotation circuit with a capacity of 37 Mtpa)
3. A heap leach, solvent extraction and electrowinning plant (capacity of 3 Mtpa)
4. A tailings storage facility (TSF)
5. Two Waste Rock Dumps (WRDs) (198Mt and 712 Mt)
6. A solar photovoltaic (PV) plant (150 MWp)
7. Storm water attenuation dams (SWADs) upstream of the open pit

34 Haib Copper Project: Environmental Support and ESIA Draft Environmental and Social Scoping Report 15 September 2025

35 Koryx Copper Inc. (2025, August 28). Koryx Copper Announces Further Drill Assay Results Extending Consistent Mineralization at Depth and Laterally at the Haib Copper Project, Southern Namibia [Press Release]. GlobeNewswire. Retrieved from <https://www.globenewswire.com/news-release/2025/08/28/3140679/0/en/Koryx-Copper-Announces-Further-Drill-Assay-Results-Extending-Consistent-Mineralization-at-Depth-and-Laterally-at-the-Haib-Copper-Project-Southern-Namibia.html> (Drilling ongoing in 2025; updated resource expected H1 2026; ESIA and ECC submission planned early 2026.)

36 Koryx Copper Inc. (2025, September 4). Koryx Announces Updated PEA Results for the Haib Copper Project, Southern Namibia [Press Release]. GlobeNewswire. Retrieved from <https://www.globenewswire.com/news-release/2025/09/04/3144341/0/en/Koryx-Announces-Updated-PEA-Results-for-the-Haib-Copper-Project-Southern-Namibia.html> (Additional filing: October 8, 2025.)

37 Koryx Copper Inc. (2025, September 4 & October 8). Press Releases: Updated PEA Results & Filing. GlobeNewswire.

38 Koryx Copper Inc. (2025, September 4). Updated PEA Results Press Release.

39 Koryx Copper Inc. (n.d.). Haib Copper Project Overview. koryxcopper.co

40 Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Main Report. Windhoek: NSA. Retrieved from <https://nsa.org.na/census/wp-content/uploads/2024/10/2023-Population-and-Housing-Census-Main-Report-28-Oct-2024.pdf> (ǀKaras Region population: 109,893; area ~161,325 km² → density ~0.68 persons/km².)

41 World Health Organization (WHO)/United Nations. (2023–2025 estimates). Life expectancy at birth – Namibia: ~64–67 years (MacroTrends/UN: ~67 in recent years; paragraph uses conservative ~64.)

42 Derived from regional context in NSA 2023 Census and project descriptions (e.g., agriculture/migration in Orange River valley).

43 Haib Minerals (Pty) Ltd Environmental Support and EIA Draft Project Description Chapter 15 September 2025

8. Off-channel water storage
9. Water abstraction works, pipeline and associated infrastructure
10. Ancillary infrastructure (access roads, transmission lines, labour accommodation camp, offices, etc.)

Figures 6, 7 & 8 provides an overview of the layout of the mine and processing facilities. Specific impacts on workers' health will require an occupational health risk assessment (See Appendix 2 for an approach).

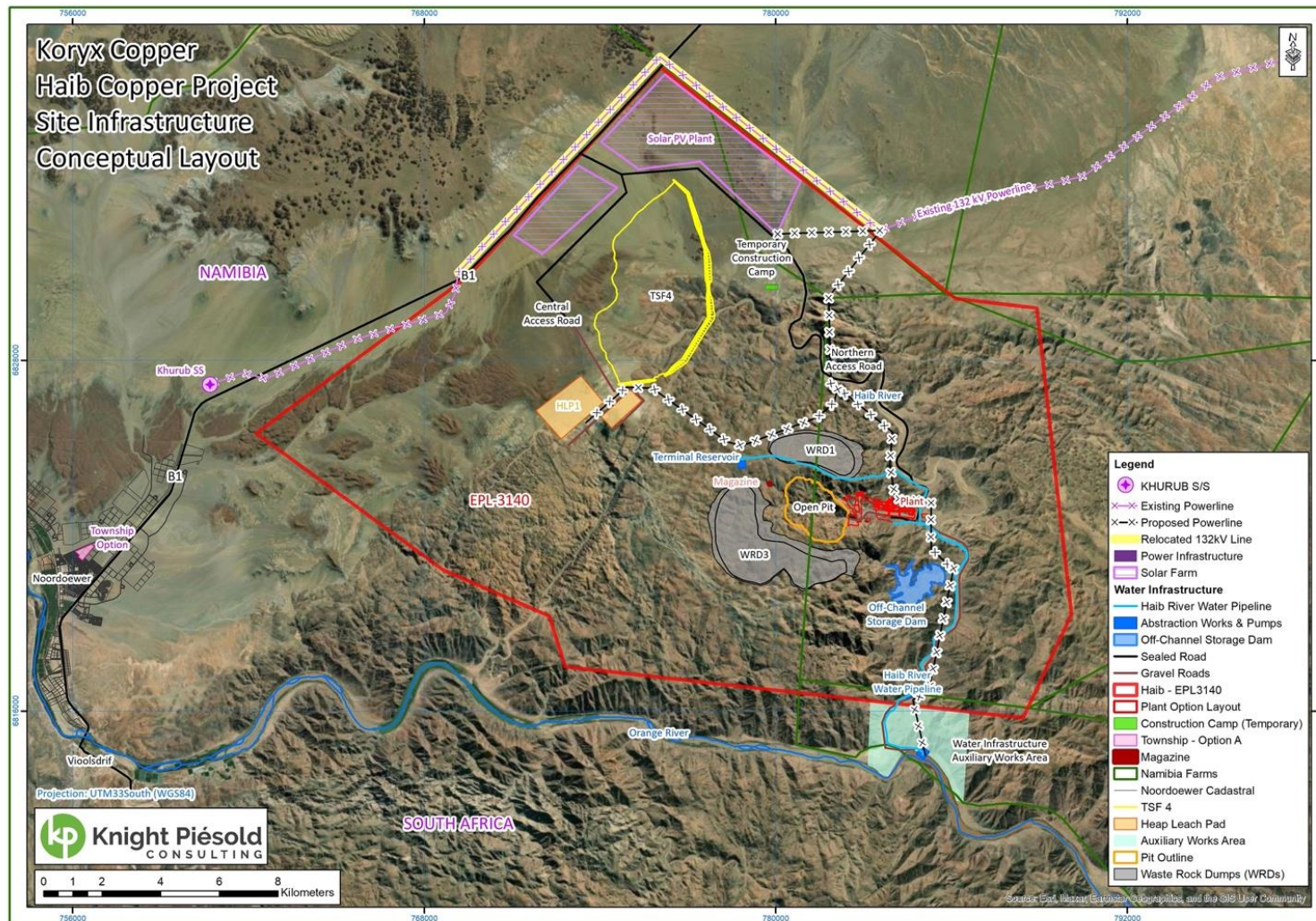


Figure 1: Mine site infrastructure

A simplified summary flowsheet is presented in Figure 4-7.

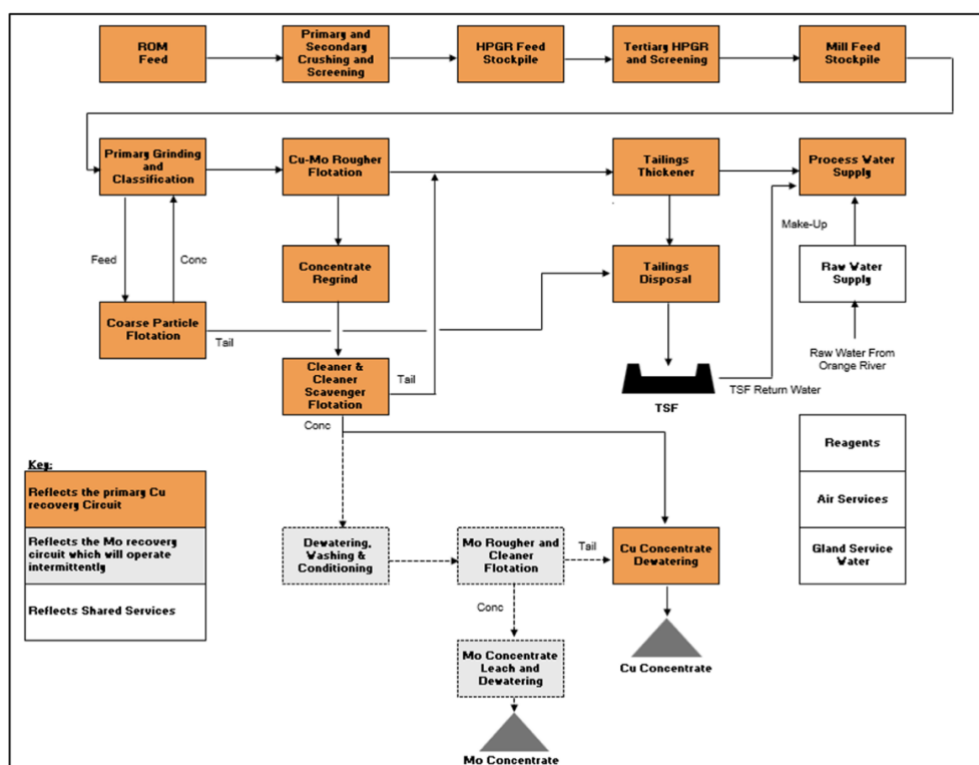


Figure 2: Milling and Flotation Process flow

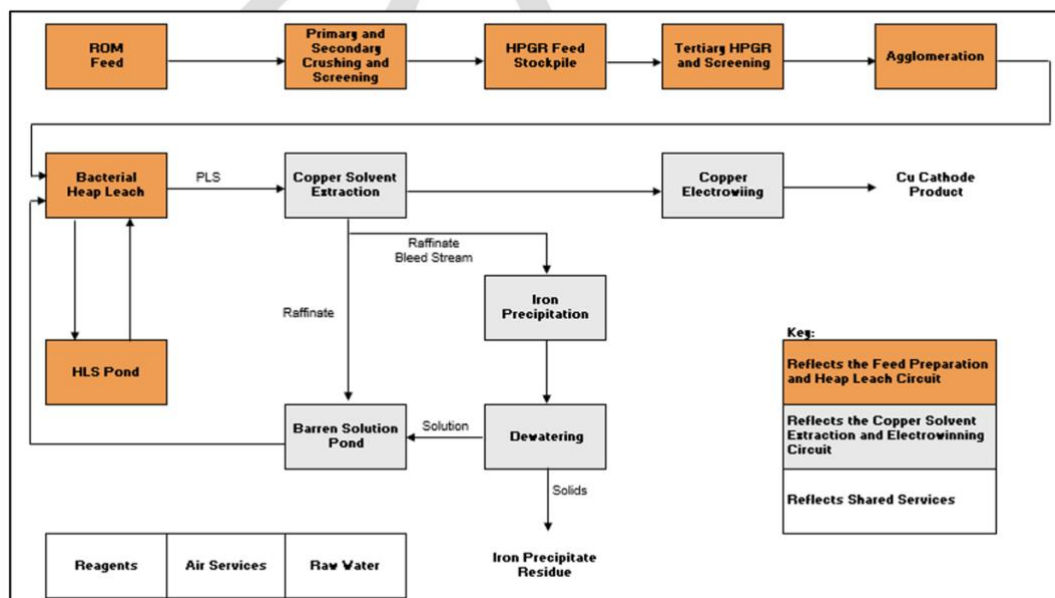


Figure 3: Hydrometallurgical process flow

4.0 BASELINE RECEIVING ENVIRONMENT

4.1 Potentially Affected Communities

This report is concerned with both direct and indirect health impacts on key sensitive receptors (Table 1). Sensitive receptors refer to environmental, social, or human elements that could be adversely affected by project activities (e.g., excavation, water use, dust, noise, and waste generation).

Table 1: Sensitive Receptors

Category	Key Receptors	Potential Impacts	Mitigation Considerations
Hydrological	Orange River, Volstruis River	Water pollution, abstraction	Monitoring, zero-discharge tailings, river setbacks
Ecological	Arid habitats, endemic wildlife	Habitat loss, species displacement	Biodiversity offsets, rehabilitation plans
Human	Noordoewer communities	Health risks from dust/water/noise	Community engagement, air quality, noise barriers

This section deals with human receptors whose health may be directly or indirectly impacted by impacts on other ecological or hydrological receptors.

The community and the workforce are inter-related, and the boundary between community and workforce when managing hazard pathways can become blurred. As this report focusses on community health impacts, an occupational health risk assessment will clearly also be required given the large size of the workforce (3 500 rotation based personnel) in relation to the size of nearby communities (~2000).

4.1.1 Human Population Receptors

The HAIB project area is remote and sparsely populated, with the primary human receptors being three small settlements along or near the Orange River (

Table 2). The most important of these due to proximity is Noordoewer with its local farming communities engaged in agriculture (e.g., vineyards, livestock) along the Orange River. Receptors include vulnerable groups such as children, elderly and asthmatics.

Population data is limited for small settlements; estimates rely on regional trends and recent sources. Putting this in context the //Karas Region grew from 77,421 (2011) to 109,893 (2023), an average annual growth rate of ~2.9%. The national growth rate post-2023 is projected at ~1.8–2.5% annually with Namibia's overall population expected to reach ~3.09–3.12 million by mid-2026.⁴⁴ The mine work force is estimated to be a maximum of 3 500 during operation and 1 350 during operational phase.

Table 2: Potentially affected communities

Aspect	Aussenkehr (Namibia)	Noordoewer (Namibia)	Vioolsdrif (South Africa)
Location & Distance from Haib	Northern bank of Orange River; ~50–60 km northwest	Northern bank of Orange River; ~25–35 km west	Southern bank of Orange River; opposite Noordoewer, ~25–35 km west

Aspect	Aussenkehr (Namibia)	Noordoewer (Namibia)	Vioolsdrif (South Africa)
Primary Industries	Intensive table grape farming/vineyards (irrigation-dependent); seasonal migrant labor	Border control, irrigated agriculture (grapes), tourism (river activities/stopover)	Border control/trade, tourism (rafting/campsites), small irrigated agriculture
Population Estimate (2023–2026)	12,000–18,000 (commonly ~16,000; highly seasonal)	2,500–3,500 (low thousands)	600–800
Demographics	Transient; mostly northern migrant workers (Oshiwambo speaking); some local Nama/Coloured; youthful, male-dominated labour	Primarily Coloured/Afrikaans-speaking; some White/Nama; youthful national profile	Primarily Coloured/Afrikaans-speaking; small White/Black African groups

Human settlements within a 40.Km radius of the project site are sparse, and the region has few formal settlements, mostly small villages or farming communities along the river valley. This includes transborder settlements in South Africa (Northern Cape, Richtersveld area).

Population sizes are estimates based on the latest available data as at 2025/6 (primarily 2023 Namibia Census preliminary results, older censuses, and reports). Specific figures are not yet available. Much of the population data is based on extrapolation from regional/national trends due to lack of small settlement-specific census details. Very small farms or temporary camps are excluded.

No other formal settlements (e.g., Sendelingsdrif at 70+ km, Kuboes at 80+ km, Lekkersing at more than 40 km) fall within 40 km. The area is dominated by remote farms, mining exploration camps (transient), and the Richtersveld/Ai-Ais Transfrontier Park with minimal permanent residents. Total population in the radius is roughly 15,000-30,000, heavily influenced by seasonal agricultural workers at Aussenkehr.

4.1.2 Aussenkehr socio-demographics

4.1.2.1 Location & Distance from Haib Mine

Aussenkehr is in Namibia's //Karas Region on the northern bank of the Orange River, between 50–60 km northwest of the Haib copper project site and Noordoewer. The name means "outer bend" in German, reflecting a river curve.

4.1.2.2 Overview

It is a major agricultural hub focused on export table grape production and irrigated vineyards, and has grown rapidly since the 1980s. It relies on Orange River water in an arid desert climate (summer >40°C, rainfall <50 mm/year). There is minimal tourism and basic amenities include shops, schools, a clinic with a doctor, and mostly informal housing.

4.1.2.3 Population

It is a non-self-governed settlement with limited available census data.

- 2011 census: 4,522⁴⁵

⁴⁵ City Population. (n.d.). Namibia: Administrative Division – Regions, Constituencies and Settlements. <https://www.citypopulation.de/en/namibia/> (2011 census baseline for Aussenkehr: 4,522.)

- Current estimates (2023–2026): 12,000–18,000 highly variable due to seasonal migrant workers peaking in November to February). The //Karas Region population is 109,893 (2023) with a density of 0.7 persons/km².⁴⁶

4.1.2.4 *Demographics*

The population of Aussenkehr is highly transient and diverse, shaped primarily by migrant farm labour from across Namibia. Most residents are northern Ovambo migrants, who make up around 50% of the national population, alongside smaller groups of local Nama/Khoekhoe and Coloured residents, as well as White farm owners. Regionally, the proportions of Coloured and White residents exceed the national averages of 2.1% and 1.8% respectively. The age structure reflects the youthful national profile, with 37% of the population below 15 years, 56.1% in the working-age group (15–59 years), and only 6.8% aged 60 and above, giving a median age of 21.3 years. The regional sex ratio stands at 103 males per 100 females. Oshiwambo and other northern dialects dominate among the migrant workforce, while Afrikaans and English are used in administration, with some Nama/Khoekhoe also spoken locally.

4.1.2.5 *Economy & Employment*

This is Centered on grape exports (about 33 million kg/year with N\$840M value recently). Thousands are employed regionally (about 10,000 permanent/15,000 seasonal). Wages are low with substantial inequality, and high multidimensional poverty (about 43% nationally).³⁸

4.1.2.6 *Education & Health*

There are basic schools and a clinic (with both doctor and nurses present). Regional literacy is at 95.6%. Health risks include waterborne diseases, poor sanitation, heat stress and HIV (with a 12% national prevalence). Life expectancy is 64 years nationally.

4.1.2.7 *Community Characteristics*

Many live in informal reed/zinc shelters without electricity, piped water, or sanitation (river water is used directly, raising contamination/drowning risks).⁴⁷ Fires are common and conditions can be considered hazardous.⁴⁸

Recent improvements include private housing projects with 76 new farmhouses in 2025⁴⁹ and government plans for serviced land, water treatment, schools, and clinics. The community is resilient but strained by seasonality and migration.

These data are primarily from 2023 Namibia Census regional profiles and industry reports due to lack of settlement-specific details.

4.1.3 *Noordoewer Socio Demographics*

4.1.3.1 *Location & Distance from Haib Mine*

46 Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Main Report. Windhoek: NSA. <https://nsa.org.na/census/wp-content/uploads/2024/10/2023-Population-and-Housing-Census-Main-Report-28-Oct-2024.pdf> (Primary source for national/regional demographics, population, age/gender, ethnicity.)

47 McChesney, R. (2021, January 12). Grape Crop Brings in Millions, but Farm Workers Live a Harsh Life. Circle of Blue. <https://www.circleofblue.org/2021/agriculture/grape-crop-brings-in-millions-but-farm-workers-live-a-harsh-life/> (Population ~16,000; living conditions; economic data.)

48 Informanté. (2025, November 11). Aussenkehr grape farm workers live in hazardous conditions, National Council warns. <https://informante.web.na/?p=385355> (Hazardous reed shelters; seasonal influx; infrastructure issues.)

49 Namibia Broadcasting Corporation (NBC). (2025, October 20). Namibia Grape Company to build 76 farmhouses for employees at Aussenkehr [Video]. <https://www.youtube.com/watch?v=9KJTzUGwngk> (Housing developments.)

Noordoewer is located in Namibia's //Karas Region on the northern bank of the Orange River, directly opposite Vioolsdrif in South Africa. It lies approximately 25–35 km west of the Haib copper project site and serves as a key border post on the B1 highway linking Namibia to South Africa's N7 via a road bridge.

4.1.3.2 Overview

It is a small rural settlement whose name means “North Bank” in Afrikaans. The economy is based on irrigated agriculture (mainly table grapes), border control and customs services, and limited tourism (canoeing, guest houses, and stopover facilities). The arid desert climate, with summer temperatures often exceeding 40°C and very low rainfall, shapes daily life and makes irrigation from the Orange River essential.

4.1.3.3 Population

As a non-self-governed settlement, Noordoewer has limited settlement-specific census data. Current estimates for 2023–2025 range between 2,500 and 3,500 residents, including seasonal farm workers.⁵⁰ The broader //Karas Region population stands at 109,893 (2023) with a density of approximately 0.7 persons/km².⁵¹

4.1.3.4 Demographics is influenced by border location and historical South African ties.

The population is influenced by its border location and historical ties to South Africa. It has a higher proportion of Coloured (2.1% nationally) and White (1.8% nationally) residents than the national average, along with smaller Nama/Khoekhoe and Basters groups and with fewer northern Ovambo groups (50% nationally).⁵² The age structure follows the national youthful profile, with a median age of 21.3 years. The regional sex ratio is approximately 95.5 males per 100 females. Afrikaans is the dominant language, with English used in administration and some Nama/Khoekhoe spoken locally.

4.1.3.5 Economy & Employment

The local economy depends on irrigated grape and fruit farming, cross-border trade, customs services, and basic tourism. Multidimensional poverty remains high (approximately 43% nationally), and many households rely on remittances and informal trade.⁵³

4.1.3.6 Education & Health

There are basic local schools with regional literacy at 92%. There is a clinic with 2 registered nurses (RN) and 4 ordinary nurses. The nearest doctor is at Aussenkehr some 50 km away. Minor ailments are treated, and emergency care is provided for injuries which are referred to Karasburg by vehicular transport/ambulance supplied from the Karas Health District. The clinic is open from 8am to 5pm with afterhours emergency. The busiest time is from September to December during the grape packing season migrant worker influx and the capacity is adequate. Health Risks are heat stress, waterborne diseases, HIV with a 12% national prevalence.⁵⁴ Life expectancy is 64 years nationally.⁵⁵

50 National population: 3,022,401 (2023) Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Preliminary Report. Windhoek: NSA. https://nsa.org.na/wp-content/uploads/2024/07/Preliminary-Report-2023-Population-and-Housing-Census_compressed.pdf

51 //Karas Region population/density (~0.68 persons/km²) Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Main Report. Windhoek: NSA. (Population: 109,893; area ~161,325 km².)

52 Ethnic composition (Whites 1.8%, Coloureds 2.1% nationally; higher in south) Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Main Report.

53 Multidimensional poverty ~43% NSA & OPHI. (2021). Namibia Multidimensional Poverty Index (MPI) Report 2021. Windhoek: NSA/UNICEF/UNDP. <https://www.unicef.org/esa/media/9041/file/UNICEF-Namibia-Multidimensional-Poverty-Index-2021.pdf> (Incidence: 43.3%.)

54 HIV prevalence ~12% MoHSS Namibia / UNAIDS. (2023–2024 estimates). Adult prevalence ~9.7–12.8%.

55 Life expectancy ~64 years WHO / United Nations. (2023–2025 estimates).

4.1.3.7 *Community Characteristics*

Noordoewer is a resilient, close-knit, multicultural community shaped by its isolation (approximately 100 km from Keetmanshoop) and cross-border activity. Residents are concerned about potential water and environmental impacts from the Haib project but also see opportunities for local employment. Many families depend on seasonal agriculture and informal trade.

4.1.3.8 *Population*

Population Projections (2026–2030) Conservative projections based on regional growth trends⁵⁶ (approximately 2.9% annual from 2011–2023) and national patterns estimate:

- 2026: 2,600–3,700
- 2030: 2,800–4,200

Growth will be influenced by possible mining and agriculture expansion, tempered by the arid climate and urban out-migration.⁵⁷

4.1.4 *Vioolsdrif socio demographics*

4.1.4.1 *Location & Distance from Haib Mine*

Vioolsdrif (also spelled Vioolsdrift) is a small border settlement in South Africa's Namakwa District Municipality (Northern Cape Province), located on the southern bank of the Orange River directly opposite Noordoewer in Namibia. It lies approximately 25–35 km west of the Haib copper project site and serves as a key border post on the N7 national road.

4.1.4.2 *Overview*

The name means “violin ford” in Afrikaans, referring to a historical shallow river crossing. It functions as a quiet rural transit point supporting limited irrigated agriculture (dates, grapes, and vegetables), border control and trade, and tourism (river rafting, canoeing, and campsites). The arid desert climate, with summer temperatures often exceeding 40°C and minimal rainfall, limits development outside irrigated areas.⁵⁸

4.1.4.3 *Population*

As an unincorporated settlement, detailed census data at the sub-place level is limited. The 2011 census⁵⁹ recorded approximately 599 residents. Current estimates (2023–2026) place the population at 600–800⁶⁰, reflecting minimal growth in this remote area. The broader Namakwa District had 148,935⁶¹ residents in 2022, while the Northern Cape Province totalled 1,355,629. National population is 62 million.⁶²

4.1.4.4 *Demographics*

56 Fertility rate ~3.0 Derived from intercensal data in Namibia Statistics Agency (NSA). (2024). 2023 Population and Housing Census Main Report Presentation

57 Population estimates/projections Extrapolated from NSA 2023 regional data and growth trends; no specific NSA/UN projections for Noordoewer.

58 Wikipedia. (2025). Vioolsdrif. <https://en.wikipedia.org/wiki/Vioolsdrif> (General description and historical context.)

59 Statistics South Africa (Stats SA). (2012). Census 2011 Municipal Fact Sheet / Nama Khoi Local Municipality. Pretoria: Stats SA. (Vioolsdrif sub-place ~599 in 2011.)

60 City Population. (n.d.). South Africa: Northern Cape Province – Urban Areas and Places. <https://www.citypopulation.de/en/southafrica/northerncape/> (Estimates based on 2011 census with minor growth.)

61 Adrian Frith. (n.d.). Census 2011 Interactive Maps and Data. <https://census2011.adrianfrith.com/> (Sub-place visualization; confirms small population.)

62 Statistics South Africa (Stats SA). (2024). Mid-Year Population Estimates 2024. Pretoria: Stats SA. (Northern Cape updates; low rural growth.)

The small population is influenced by the border location and consists mainly of Coloured (mixed-race) residents, with smaller White (farming/tourism) and Black African groups.⁶³ The age structure aligns with national patterns, with a slightly older rural profile in the Northern Cape. Afrikaans is the predominant language, with English used officially.

4.1.4.5 *Economy & Employment*

The economy is constrained by remoteness and aridity. Key sectors include border customs and transport, tourism (lodges and campsites), small-scale irrigated farming, and informal commerce. Rural unemployment is relatively high.

4.1.4.6 *Education & Health*

Educational and health facilities are basic, with major services located in Springbok. Provincial literacy exceeds 90%. Health risks include heat stress and limited access to specialised care. National life expectancy is approximately 64 years.

4.1.4.7 *Community Characteristics*

Violsdrif is a close-knit, quiet community shaped by overland travellers and border trade. Residents are concerned about Orange River water allocation and environmental issues but remain sparsely populated. Future mining or irrigation developments could bring change, though the settlement is expected to stay small.

4.2 *Specialist Studies*

A variety of specialist studies were completed as part of the EIA of which may be relevant for receptors of direct and indirect health impacts including:

1. Air Quality Impact Assessment
2. Aquatic health Impact Assessment
3. Terrestrial Biodiversity Impact Assessment
4. Noise Impact Assessment
5. Traffic Impact Assessment
6. Blast/Vibration Impact Assessment
7. Archaeological Impact Assessment
8. Social Impact Assessment
9. Water Resource and Water Demand Impact Study (Orange River)
10. Hydrogeological Impact Assessment (incl Geochemistry)

A summary of relevant findings are provided below.

4.2.1 *Surface and Groundwater Quality*

Two reports on surface water⁶⁴ and ground water⁶⁵ quality show that the quality of the water is not acceptable for human or presumably livestock consumption currently. The Orange river is polluted with chemicals and metals and representative samples indicated exceedances for the Aluminium (Al), copper (Cu), iron (Fe), strontium (Sr) and sulphates (SO_4^{2-}) for applicable regulatory standards at every point sampled. Some points showed exceedances for suspended solids, selenium (Se), manganese (Mn) and chlorides (Cl).

63 Statistics South Africa (Stats SA). (2023). Census 2022 Statistical Release. Pretoria: Stats SA. https://census.statssa.gov.za/assets/documents/2022/P03014_Census_2022_Statistical_Release.pdf (National/provincial population; Namakwa District ~148,935.)

64 July 2025 Monthly Water Quality Monitoring Report

65 July 2025 Monthly Groundwater Water Quality Monitoring report

These baseline levels can be used to monitor possible contributions from the mine and processing facilities over time which could add to the chemical and metal pollution further downstream.

4.2.2 Air quality and Air Distribution Modelling

4.2.2.1 Air Quality

A January 2026 air quality measurements report⁶⁶ showed no exceedances across all monitoring points during a survey for dust fallout and ambient air quality monitoring. As there is no active mining, dust generation from the detected concentrations is likely due to vehicular movements and exploration activities only. Measured values remain below international thresholds. The dominance of coarse particles (PM₁₀) over fine particles (PM_{2.5}) suggests that emissions are primarily from natural sources rather than combustion or industrial processes.

Overall, the monitoring results demonstrate that the baseline air quality within the survey area is good, with no evidence of significant pollution sources. The findings are consistent with expected background conditions for a dry, sparsely populated environment. These data provide a reliable reference point for the impact assessment, particularly in evaluating potential changes associated with new developments or seasonal dust variations.

Monthly ambient air quality monitoring was recommended to ensure that sufficient data are obtained prior to the development of the proposed mine to serve as a more detailed baseline.

4.2.2.2 Wind Direction

The Air Dispersion Modelling report uses the wind roses in Figure 5 below to obtain likely wind directions given the topography at the mine.

66 ACEN. Association of Consulting Engineers of Namibia 2025 Air Quality Monitoring Report

Table 6-4 – Project Site Wind Roses

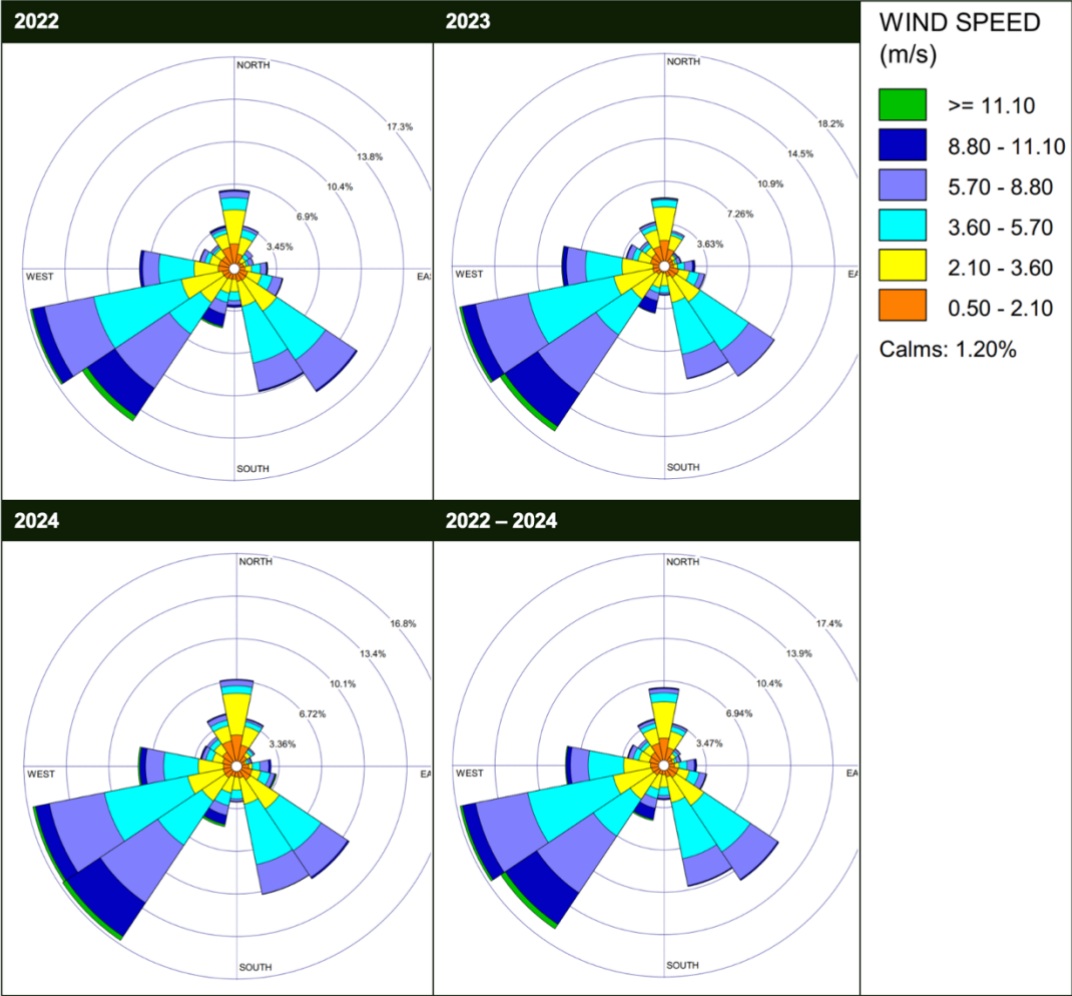


Figure 4: Wind roses 2022 – 2024

4.2.2.3 Air Dispersion Modelling

The ADM report ⁶⁷ found that measured levels were consistently low for both PM₁₀ and PM_{2.5} across all four monitoring sites around the Project site. These low concentrations are characteristic of remote arid regions such as the southern Namibian landscape, where natural dust emissions dominate PM levels and anthropogenic activities are limited. The terrain in the area is rocky and sparsely vegetated, and the survey period (July 2025) corresponds to the dry winter season, typically marked by low humidity and minimal rainfall. Under such conditions, dust generation can occur from exposed soils and unpaved surfaces. The absence of strong winds and limited human activity likely contributed to the relatively low readings observed.

The ADM models isopleths which cross the Orange river, impacting sensitive receptors there (surface water), livestock herding and grazing to some degree or another based on different modelled receptor locations. Isopleths are shown for annual average PM measurements (PM₁₀ and PM_{2.5}) in the two figures below. This is surprising given that the long-term average wind directions year in and year out are predominantly from the South. The topography could explain the small Northerly component visible in the wind roses above.

67 WKC Air Dispersion Modelling Report 9 January 2026

The ambient measurements on which all the modelling is based seem very few. The method used for PM measurements can only operate in the daylight, so they are not fully 24-hour measurements. Consequently, the modelling results seem rather top-heavy with respect to the sparse actual measured data, contributing some uncertainty.

When the annual average estimated values are used, the dust concentrations are relatively light over the Orange River. Looking at the topography on the map it seems that in the area where sensitive receptors (SRs) 6 to 10 are the most impacted by high PMs, are either at the top of the cliffs, or at ground level at the bank of the Orange River. There are most likely very few or zero human receptors in these areas (maybe only livestock). Possibly meat from grazing livestock could be impacted. The air pollution becomes water pollution and impacts should be considered for water users downstream.

Noordoewer and Vioolsdrif and immediate surrounds are not impacted by mine dust in the ADM. Downstream abstractions could be impacted by water pollution downstream from the mine. Aussenkehr although further away might also be impacted by dust given the prevailing South Easterly winds, and baseline and continuous air quality monitoring data should be collected at Aussenkehr.

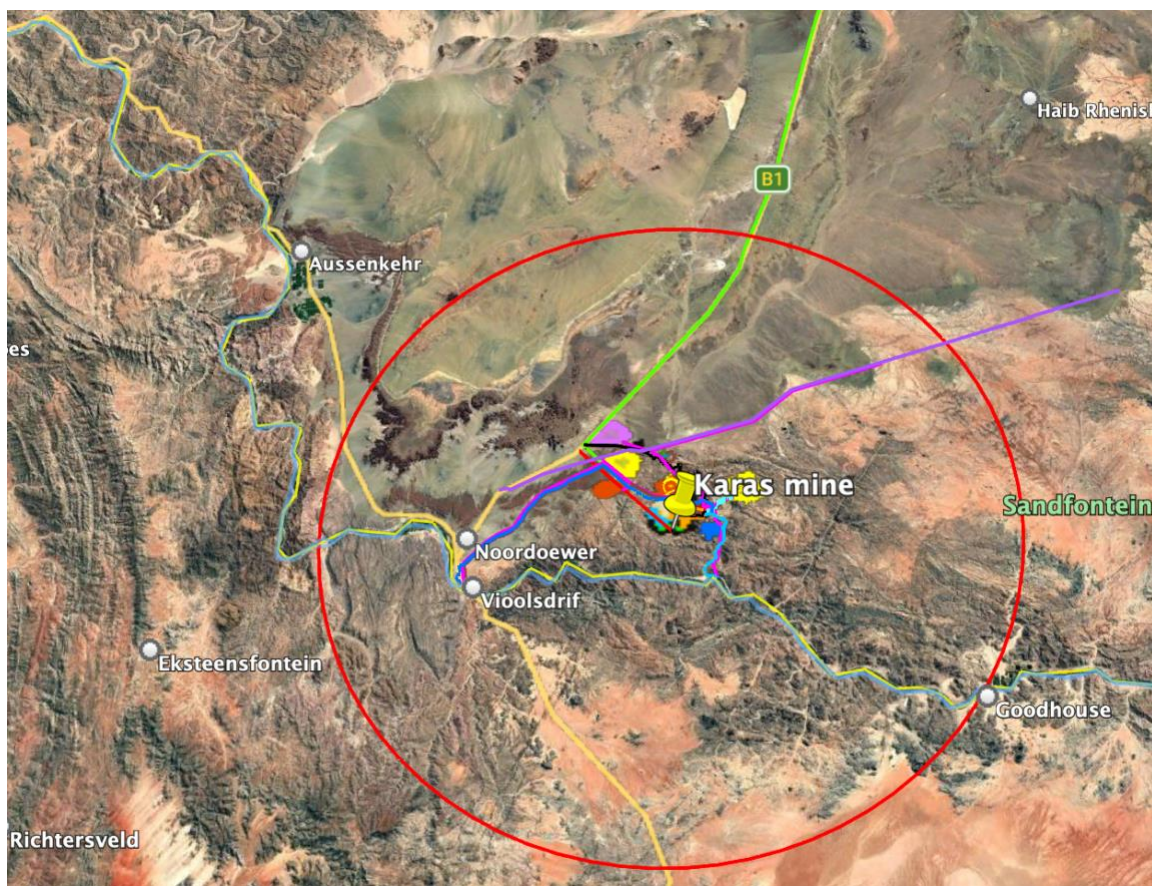
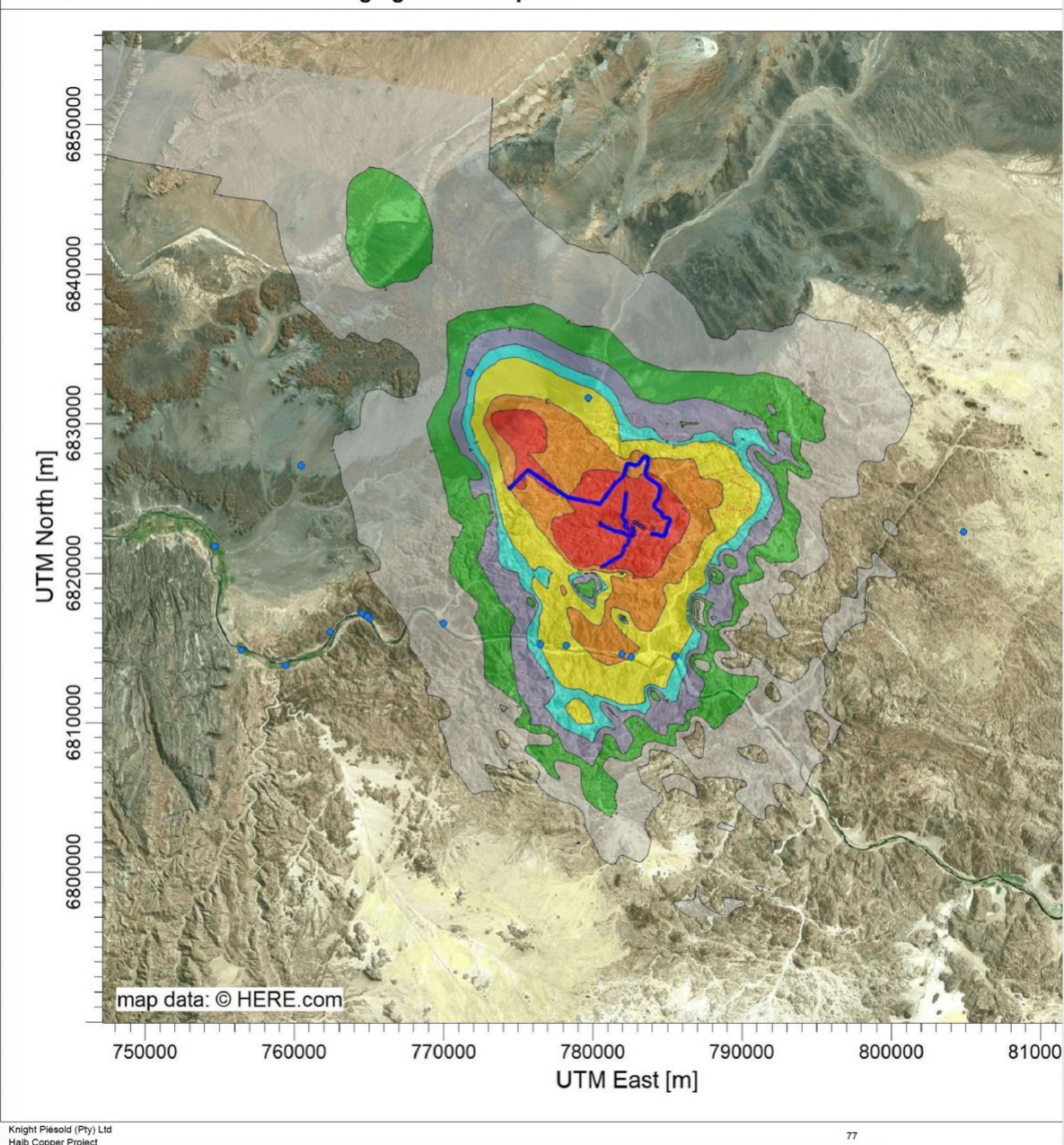


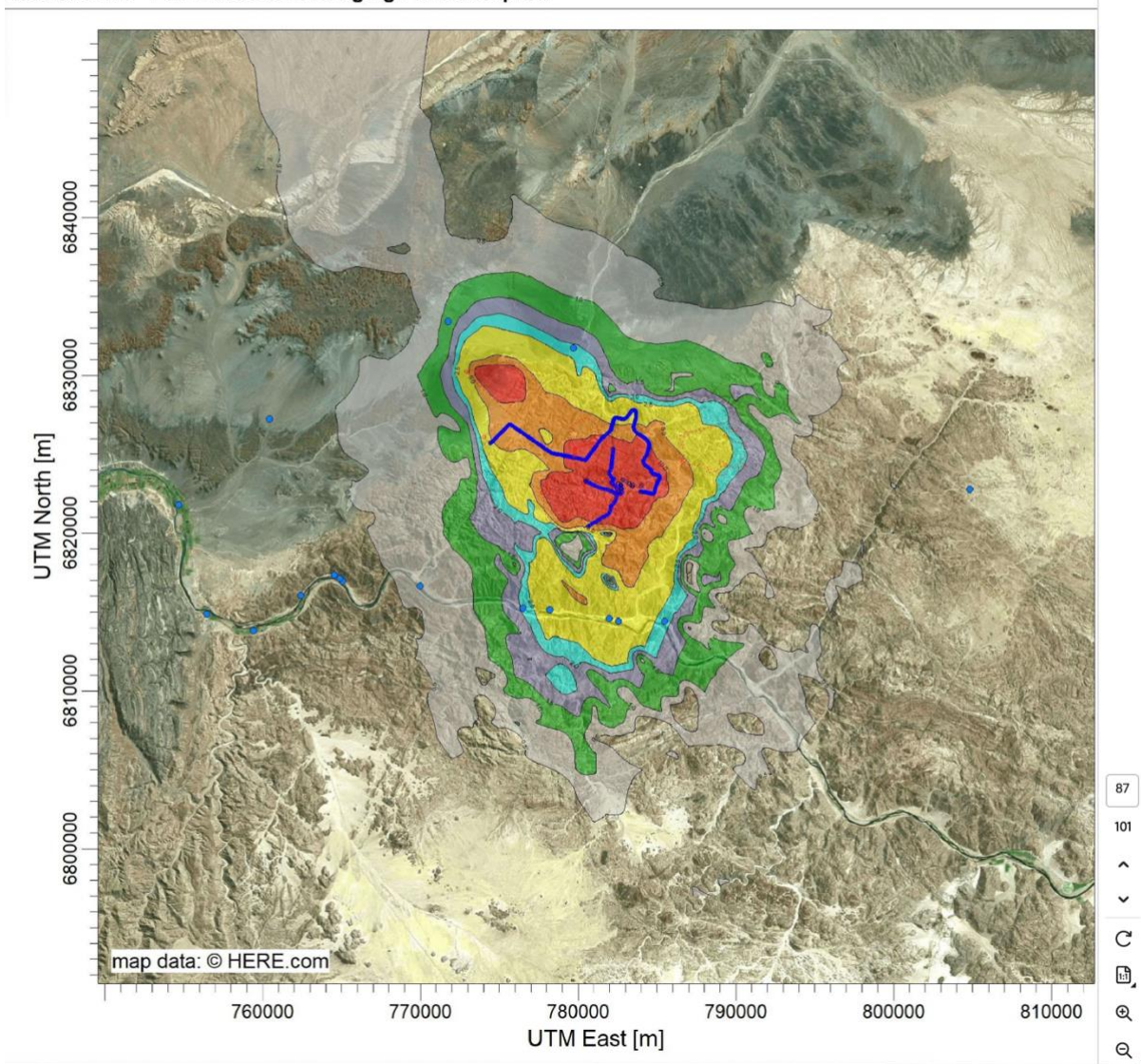
Figure 5: Aussenkehr downstream

Notably, the modelling estimates significantly high dust levels for workers in mine operations, and could be very usefully contribute to an occupational health risk assessment.

PROJECT TITLE:

J-SAF-50862 Haib Copper Project**Scenario 2A - PM₁₀ Annual Averaging Period Isopleth****Figure 6: PM₁₀ isopleths**

PROJECT TITLE:

J-SAF-50862 Haib Copper Project**Scenario 2A - PM_{2.5} Annual Averaging Period Isopleth****Figure 7: PM_{2.5} isopleths**

5.0 METHODS

5.1 Study type

This is a desktop baseline study of current secondary health-related data in and near the project area.

5.2 Health Impact Assessment methodology

5.2.1 Purpose

The purpose of impact assessment is to identify and evaluate the likely significance of the potential health-related impacts on identified receptors and resources according to defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise, reduce or offset for any potential adverse effects, to enhance positive impacts and to report the significance of the residual impacts that remain following mitigation.

5.2.2 Identification of potential health-related impacts

The Environmental Health Areas (EHAs) approach⁶⁸ will be used to capture all health-related impacts on the receptors, principally human receptors in the community and amongst the workforce. The HIA will evaluate potential impacts across all 12 EHAs, tailored to the mine's activities and context. Both positive and negative health impacts, which are both direct and indirect with cumulative effects on health will be considered.

5.2.3 Impact assessment methodology

This study will use the Knight Piésold impact assessment methodology and specialist guidelines KP to conduct this impact assessment.⁶⁹

5.2.3.1 *Defining the nature of the impact*

An impact is essentially any change to a resource or receptor brought about by the presence of the proposed project component or by the execution of a proposed project related activity. The terminology used to define the nature of an impact is detailed in Table 1 below.

⁶⁸ IFC performance standard 4

⁶⁹ KP Memorandum, August 2022.

Table 3: Impact Nature

Term	Definition
Positive (+)	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative (-)	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.
Direct impact (D)	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect impact (I)	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. in-migration for employment placing a demand on resources).
Cumulative impact (C)	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

5.2.3.2 *Assessing Significance*

The Knight Piésold impact significance rating system is based on the following equation:

Significance of Environmental / Social Impact = Consequence x Probability

The consequence of an impact can be derived from the following factors:

- **Severity / Magnitude** – the degree of change brought about in the environment
- **Reversibility** - the ability of the receptor to recover after an impact has occurred
- **Duration** - how long the impact may be prevalent
- **Spatial Extent** - the physical area which could be affected by an impact.

The **severity, reversibility, duration, and spatial extent** are ranked using the criteria indicated in Table 2 and then the overall consequence is determined by adding up the individual scores and multiplying it by the **overall probability** (the likelihood of such an impact occurring). Once a score has been determined, this is checked against the **significance** descriptions indicated in Table 3.

Table 4: Ranking Criteria

Severity / magnitude (M)	Reversibility (R)	Duration (D)	Spatial extent (S)	Probability (P)
5 – Very high – The impact causes the characteristics of the receiving environment/ social receptor to be altered by a factor of 80 – 100 %	5 – Irreversible – <u>Environmental</u> - where natural functions or ecological processes are altered to the extent that it will permanently cease. <u>Social</u> - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.	5 – Permanent - Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	5 – International - Impacts that affect internationally important resources such as areas protected by international conventions, international waters etc.	5 – Definite - The impact will occur.
4 – High – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 60 – 80 %		4 – Long term - impacts that will continue for the life of the Project, but ceases when the Project stops operating.	4 – National - Impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.	4 – High probability – 80% likelihood that the impact will occur
3 – Moderate – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 40 – 60 %	3 – Recoverable <u>Environmental</u> - where the affected environment is altered but natural functions and ecological processes may continue or recover with human input.	3 – Medium term - Impacts are predicted to be of medium duration (5 – 15 years)	3 – Regional - Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by	3 – Medium probability – 60% likelihood that the impact will occur u

Severity / magnitude (M)	Reversibility (R)	Duration (D)	Spatial extent (S)	Probability (P)
	<u>Social</u> - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support or intervention.		administrative boundaries, habitat type/ecosystem.	
2 – Low – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 20 – 40 %		2 – Short term - Impacts are predicted to be of short duration (0 – 5 years)	2 – Local - Impacts that affect an area in a radius of 2 km around the site.	2 – Low probability - 40% likelihood that the impact will occur
1 – Minor – The impact causes very little change to the characteristics of the receiving environment/ social receptor and the alteration is less than 20 %	1 – Reversible <u>Environmental</u> - The impact affects the environment in such a way that natural functions and ecological processes are able to regenerate naturally. <u>Social</u> - People/ communities are able to adapt with relative ease and maintain pre-impact livelihoods.	1 – Temporary - Impacts are predicted to intermittent/ occasional over a short period.	1 – Site only - Impacts that are limited to the site boundaries.	1 – Improbable - 20% likelihood that the impact will occur

Table 5: Significance Definitions

Score According to Impact Assessment Matrix	Significance Definitions	Colour Scale Ratings	
		Negative Ratings	Positive Ratings
Between 0 and 29 significance points indicate Low Significance	An impact of low significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.	Low	Low
Between 30 and 59 significance points indicate Moderate Significance	An impact of moderate significance is one within accepted limits and standards. The impact on the receptor will be noticeable and the normal functioning is altered, but the baseline condition prevail, albeit in a modified state. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is As Low As Reasonably Practicable (ALARP). This does not necessarily mean that “moderate” impacts have to be reduced to “low” impacts, but that moderate impacts are being managed effectively and efficiently to not exceed accepted standards.	Moderate	Moderate
60 to 100 significance points indicate High Significance	An impact of high significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An impact with high significance will completely modify the baseline conditions. A goal of the ESIA process is to get to a position where the Project does not have any high negative residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be high residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.	High	High

6.0 RESULTS OF THE IMPACT ASSESSMENT

6.1 Impact Identification - 12 Environmental Health Areas (EHAs)

The HIA follows IFC and ICMM guidelines, integrated with the Knight Piésold impact assessment methodology. The method identifies positive, negative, or neutral impacts across all 12 Environmental Health Areas (EHAs). See Appendix 1 for detailed citations.

Each EHA is tailored for relevance to the HAIB project, and additionally for relevance to the community receptors on the one hand, and the worker population on the other in Table 6.

Table 6: Relevance of the 12 EHAs to the Haib project, community and workers

EHA	Potential Impacts (HAIB-specific)	Relevance to Community	Relevance to Workers
EHA 1 Communicable diseases linked to housing and living conditions	Overcrowding, poor sanitation and inadequate hygiene in worker camps can spread respiratory infections (TB, influenza), gastrointestinal diseases and skin infections. Dust in arid environment may worsen respiratory spread.	Moderate – mainly indirect through worker influx	High – direct risk in construction and operation camps
EHA 2 Vector-related diseases	Standing water in heap leach pads, tailings ponds or construction sites may create mosquito breeding sites. Possible increase in African tick-bite fever from disturbed vegetation.	Low– possible increase near Orange River	Low – workers near ponds and disturbed areas
EHA 3 Soil-, water-, and waste-related diseases	Potential contamination of soil, groundwater and Orange River from metals or process reagents in waste rock dumps and tailings. Risk of gastrointestinal illness and chronic toxicity via drinking water or irrigated crops.	Moderate to High – downstream communities reliant on Orange River	Moderate – workers using on-site water sources

EHA	Potential Impacts (HAIB-specific)	Relevance to Community	Relevance to Workers
EHA 4 Sexually transmitted infections (STIs), including HIV/AIDS	Large male workforce influx and increased disposable income may raise STI/HIV transmission, especially with existing ~12% national prevalence.	Moderate – risk to local communities through interaction	Moderate– direct risk among workers and camp populations
EHA 5 Food- and nutrition-related issues	Positive: income from employment improves food security. Negative: possible metal bioaccumulation via dust/ground water in crops/fish;	Moderate – both positive (income) and negative (food chain)	Moderate positive and negative
EHA 6 Non-communicable diseases (NCDs)	Chronic dust (silica, copper/molybdenum) exposure may cause silicosis, COPD or cardiovascular disease. Long-term low-level heavy metal exposure risk.	Low - dust unlikely to affect community	Moderate – direct occupational exposure for plant and mining workers
EHA 7 Accidents and injuries	Traumatic injuries from blasting, machinery, rockfalls, vehicles and chemical hazards. Highest during construction.	Low – indirect (road traffic accidents)	Moderate – primary occupational risk for all on-site workers
EHA 8 Exposure to hazardous materials, noise, and odours	Exposure to sulfuric acid mists, solvents, dust, noise from crushing/blasting and haul trucks.	Low – at distance	Moderate – daily occupational exposure in plant and pit
EHA 9 Psychosocial impacts	Stress from shift work, isolation, family separation, community anxiety and perceived environmental changes.	Moderate – community stress and tensions due to influx	Moderate – isolation, long shifts and camp life
EHA 10 Cultural health practices	Disruption to Nama/Khoekhoe traditional practices, medicinal plant	Low – cultural and spiritual impacts on local groups	Low – mainly affects community

EHA	Potential Impacts (HAIB-specific)	Relevance to Community	Relevance to Workers
	gathering and cultural sites near the Orange River.		
EHA 11 Social determinants of health	Positive: employment, skills development and infrastructure. Negative: inequality, boom-bust cycles, gender imbalances.	Low– positive effects education, housing and equity Moderate – negative effects	High – income and skills, but also job-loss risk at closure
EHA 12 Health systems infrastructure and capacity	Increased demand on limited local clinics from worker influx and disease burden. Potential project-funded improvements	Moderate– strain on Noordoewer/Aussenkehr clinics given influx of workers and additional population	Positive Moderate – workers rely on onsite and possibly expanded local facilities

6.2 Impact Assessment including Mitigation Measures

6.2.1 Exploration, Planning and Surveys

During the pre-construction exploration, planning and permitting phase (drilling, surveys and stakeholder consultations), on-site activity is minimal and largely non-intrusive. The dominant health effects are psychosocial: community anxiety and uncertainty about the future mine, balanced by positive anticipation of economic benefits and improved health services. Because the mine site is 25 km from the nearest settlements (Noordoewer and Vioolsdrif) and the setting is remote and arid, there are no significant physical exposures at this stage.

Preconstruction

- Community anxiety from uncertainty (EHA 9,10). Moderate risk (pre-mitigation) reduces to Low post-mitigation.

The impact is Moderate because early rumours and uncertainty can cause stress, especially among local communities and river-dependent households near the Orange River. Regular stakeholder engagement sessions, transparent project updates, Q&A forums and access to psychological support resources build trust, reduce misinformation and quickly lower anxiety in this low-activity phase.

Decommissioning

- Community anxiety from uncertainty due to possible job loss or indirect economic decline (EHA 9,10). Moderate risk (pre-mitigation), reduced to Low post-mitigation.

Uncertainty on decommissioning and closure phase can cause stress, especially among communities that benefit from the proposed activity. This stress is introduced through possible loss of employment or and indirect/induced employment in the region. The impact significance is low. Regular stakeholder engagement sessions, transparent project updates, Q&A forums and access to psychological support resources build trust, reduce misinformation and quickly lower anxiety resulting in impact significance maintained at low impact.

6.2.1.1 Summary: Pre-Construction Impact Mitigation

Table 7: Pre-Construction Impact and Mitigation/Enhancement Measures

Project activity or issue	Potential impact	Mitigation/Enhancement Measures (Elaborated)
Planning and surveys	Community anxiety from uncertainty	Mitigation: Implement regular stakeholder engagement sessions with transparent project updates and Q&A and provide psychological support resources to vulnerable groups where anxiety escalates. This reduces stress by building trust and minimizing misinformation in the remote arid setting.
Planning and surveys	Positive economic anticipation and health awareness	Enhancement: • Announce local hiring opportunities and CSR health initiatives early, and partner with local leaders to deliver skills workshops that extend economic benefits and awareness to migrant workers and river-dependent communities.

6.2.2 Site preparation, infrastructure development and operation of machinery/equipment

During the approximately 2-year construction/site-preparation phase (peak workforce 3,500), the HAIB project involves extensive earthworks, infrastructure development and heavy machinery operation. The main potential health stressors are dust, including silica, from excavation and crushing, noise and vibration from machinery, and blasting. Positive effects include short-term job creation. Because the nearest communities (Noordoewer and Vioolsdrif) are 25 km away in an arid desert setting and there is no smelter on site, most community-level impacts remain inherently low once standard controls are applied which mitigate any anticipated community health effects. Most of these impacts are workforce specific.

Construction

- Dust including silica inhalation leading to respiratory issues (EHA 6, 8). Moderate risk (pre-mitigation) reduces to Low post-mitigation focussing on the workforce.

The results of the ADM show risks of dust including silica content (PM10 and PM2.5) on sensitive receptors to be low during construction phase and thus health risks as a result of this hazard are low. However, the impact significance is moderate to the workforce during peak construction because of large-scale earthworks and crushing in an arid environment where coarse and fine dust can disperse. Dust, especially silica, is negatively interactive with TB and HIV infections, and the close association between workers and the Noordoewer community may favour the spread of these infections. Mitigation may reduce the risk to workforce to a low impact significance.

- Noise and vibration affecting community (EHA 6, 8). Low risk (pre-mitigation), and Low post-mitigation. The results of noise and vibration studies show community health risks to be low during the construction phase. However, the noise and vibration studies did not include noise and vibration from increased mine-related traffic. Possible noise impacts from heavy vehicle traffic near Noordoewer may result in nuisance impact resulting in a low impact significance before and low after mitigation.

All other construction-phase risks (injuries, STIs, communicable diseases, health-service strain) are covered in the separate Workforce Mobilisation section.

6.2.2.1 Summary: Site Preparation, Infrastructure Development, and Operation of Machinery/Equipment Impact Mitigation

Table 8: Site Prep, Infrastructure Development, Operation of Machinery and Equipment Impacts and Mitigation/Enhancement Measures

Project activity or issue	Potential impact	Mitigation/Enhancement Measures (Elaborated)
Site prep and infrastructure	Dust and silica inhalation leading to respiratory issues	Mitigation: Minimise dust and silica exposure by installing water suppression on haul roads and earthworks, providing fit-tested respiratory PPE to workers as required, and where possible establish vegetated buffer zones to reduce wind-driven dust dispersion and long-term exposure over the life of mine.
Earthworks and machinery	Noise and vibration affecting community	Mitigation: Where required, install acoustic barriers around high-noise areas and implement vibration monitoring near nearby settlements (e.g., Noordoewer/Vioolsdrif) to minimise disturbance and prevent structural or sleep impacts.

6.2.3 Workforce and Allied Mobilization Impact

During the construction (peak 3,500 workers), 23-year operation (1,350 workers) and decommissioning phases of the HAIB copper mine, the main health issues related to workforce mobilisation stem from the large influx of workers into a remote, arid area with limited local services. It is also anticipated that about 2 additional people will be part of the general influx to Noordoewer. Key stressors communicable diseases and STIs and accommodation overcrowding especially for the population influx that is additional to labour and is likely to settle in informal housing with inadequate services at the outskirts of the town, bringing family members, strain on the local clinic in Noordoewer, and eventual job-loss effects at closure. Positive effects arise from direct and indirect employment, income gains and nutritional improvements for local households.

Construction

- Accidents and injuries to workers (EHA 7). Moderate impact (pre-mitigation) reduces to Low post-mitigation.

Some construction workers will be part of the community. The impact is moderate during construction due to heavy machinery, open-pit development and remote access roads. Mandatory safety training, barriers, signage and on-site emergency response (as detailed in the mitigation table) effectively lower it to low for the full 23-year life-of-mine.

- Job creation (Direct, indirect, induced) improving income and nutrition (EHA 5, 11). Moderate positive (pre-mitigation), improves further with enhancement.

This is a positive to the local community through direct, indirect and induced job creation. In the event that local hiring quotas and vocational training are implemented improved nutrition would benefit IKaras residents and reduce multidimensional poverty. CSR-funded programmes would amplify the effect for families in Noordoewer and Aussenkehr.

- Population influx- STIs from population influx (EHA 4). Moderate impact (pre-mitigation) reduces further but is still likely to be Moderate post-mitigation.

The impact remains moderate because of the large influx (up to 3,500 during construction) from areas with a likely higher baseline HIV prevalence (about 12 % nationally). There will also be influx indirectly related to the project. Voluntary testing, providing prophylactics, awareness campaigns and codes of conduct will limit new transmissions but cannot eliminate the issue entirely, especially in a border community.

- Population influx- Strain on local health services (EHA 12). Moderate impact (pre-mitigation), Low impact post-mitigation.

The strain is likely to be high at the single clinic in Noordoewer. The project will likely fund an on-site clinic for emergency care and occupational healthcare for workers. Mitigation would involve supporting preventative programmes and services support. The development of influx impact management plan inclusive of support to local services is recommended. This could prevent overload of the limited local facilities, which from current reports are not currently all that strained.

- Accommodation - Communicable diseases from overcrowding (EHA 1). Moderate impact (pre-mitigation) and could reduce with provision of services or implementation of appropriate action plans to moderate impact.

While the impact is initially low for the labour force, the expected non labour influx is expected to result in a moderate potential impact pre-mitigation. Together with general community support, provision of services and implementation of influx impact management plan, the impact is maintained at moderate. Support to communities may include hygiene education, TB/flu vaccinations and screenings to keep respiratory and other accommodation-related diseases under control

6.2.3.1 Summary: Workforce Mobilisation Impact Mitigation

Table 9: Workforce Mobilisation, Impact and Mitigation/Enhancement Measures

Project activity or issue	Potential impact	Mitigation/Enhancement Measures (Elaborated)
Workforce mobilization	Accidents and injuries to workers	Mitigation: Implement mandatory safety training for all personnel, install barriers and signage at construction sites, and establish an on-site emergency response system with ambulance support and drills tailored to remote access conditions to minimise injury severity.
Workforce mobilization	Positive jobs improving income and nutrition	Enhancement: Prioritise local hiring (e.g., quotas for //Karas residents), implement vocational training and certification programmes, and provide subsidised nutritious meals for workers while extending community nutrition initiatives to amplify income benefits and support regional poverty reduction.
Workforce mobilization	STIs from labour/ population influx	Mitigation: Implement voluntary HIV/STI testing and treatment programmes (including prophylaxis and antiretroviral support), collaborate with the Ministry of Health and Social Services and implement targeted awareness campaigns, and enforce codes of conduct to reduce exploitation and transmission in high-prevalence border communities.
Workforce mobilization	Strain on local health services due to influx	Mitigation: • Establish an on-site first-aid/occupational health nursing clinic to do routine medical surveillance, fit-testing for PPE, respiratory function, and audiometry screening with first aid capability run by an occupational health nurse.. The development of influx impact management plan inclusive of support to local

		services is recommended. This could prevent overload of the limited local facilities, which from current reports are not currently all that strained.
Workforce mobilization	Communicable diseases from overcrowding due to influx	Mitigation: Monitor influx-related impacts and support the implementation of an influx impact management plan together with local governance structures that includes hygiene education, vaccination drives (e.g., TB and influenza), and regular health screenings to prevent disease spread and reduce respiratory risks in arid conditions. The Mine is responsible for ensuring accommodation for workforce is available and up to standard to ensure risks of communicable disease due to overcrowding is sufficiently managed.
Site closure	Job loss leading to poverty and mental health issues	Mitigation: In preparation for decommissioning, look to provide retraining programmes in alternative sectors (e.g., agriculture and tourism), look to offering closure transition support, and provide mental health counselling for affected workers and families to mitigate boom–bust socio-economic impacts in the region.

6.2.4 Mining Operations, Processing and Decommissioning

During the 23-year operational phase and subsequent decommissioning of the HAIB copper mine, the main activities involve open-pit extraction, crushing and flotation of higher-grade ore, heap leaching, solvent extraction and electrowinning of lower-grade ore, together with ongoing waste rock and tailings management. Because there is no smelter on site, the primary potential health stressors are dust, process chemicals (sulfuric acid and flotation reagents), and possible seepage from tailings and waste facilities.

There some shared impacts with the construction phase but the dust, noise and vibration impacts are lower, while exposure to chemicals will be higher.

- Chemical exposure from leaching and flotation (EHA 8). Moderate Impact (pre-mitigation) reduces to Moderate to Low post-mitigation.

This principally affects workers and falls under occupational risk due to direct contact with sulfuric acid mists and flotation reagents in the plant and heap leaching and electrowinning areas. The daily handling of these chemicals still requires strong engineering controls. Processes will need to be enclosed and ventilated with exhaust in concentrator and solvent extraction and electrowinning areas to capture sulfuric acid mists and solvents. Workers will need to be provided with specialised PPE with regular fit testing and decontamination protocols. Real-time exposure monitoring and annual medical checks for workers would reduce long-term toxicity risks.

- Exposure to contaminated water/soil (EHA 3). Moderate Impact (pre-mitigation) reduces to Low post-mitigation.

The current kinetic geochemical testing results showing neutral pH, stable alkalinity, and extremely low heavy-metal release from all waste types (including tailings). With no smelter and lined heap-leach pads, significant groundwater or Orange River contamination is considered unlikely once the Tailings Storage Facility is properly engineered

The latest geohydrological specialist report includes that both the TSF and WRDs will be unlined. This design is supported by the 19-week kinetic testing (to be completed at week 24), which demonstrates that the flotation tailings and waste rock are non-acid-generating, with stable neutral pH, declining

sulphate trends, and negligible metal mobilisation. These hydrogeological assessment results indicate a low potential for acid rock drainage and heavy-metal leaching and the proposal for unlined facilities is based on the favourable geochemical characteristics of the material. As the TSF and WRDs are located in the catchment of the Orange River (a transboundary watercourse), the final design should remain subject to detailed regulatory review and approval by the Ministry of Environment, Forestry and Tourism (MEFT). Due to this risk the impact significance is rated as moderate. Additional seepage collection, monitoring wells, and contingency measures may still be required to ensure protection of groundwater and surface water resources reducing the impact significance to low.

- NCDs from chronic dust and emissions (EHA 6). Moderate Impact (pre-mitigation), reduces to Low post-mitigation.

This risk is greater than during construction and principally involves workers. With the deployment of advanced dust suppression (sprays, seal road surfaces, enclosures) and emission controls, as well as periodic NCD screenings (lung function tests, Xrays) for workers/locals; and setting up buffer zones with vegetation to limit arid wind dust dispersion, long-term exposure over the life of the mine should reduce the impact to low. The low impact is also contributed to by low concentrations of sulphide and toxic heavy metals in the ore. However the aridity would exacerbate the dust (silica) component and air monitoring will be important for specifically for workers.

- Vector-borne diseases from water pools (EHA 2). Low Impact (pre-mitigation), reduces to Low post-mitigation affecting mainly workers.

The arid Namibian environment already makes mosquito breeding unlikely. Proper drainage design and larvicide use around ponds and avoidance of large spills will keep this risk low. This is mainly a risk for workers.

- Shift work and isolation stress (EHA 9). Moderate Impact (pre-mitigation), reduces to Low post-mitigation.

This is a social/psychosocial issue which could be somewhat ameliorated should worker accommodation be in Noordoewer as opposed to workers accommodation on the mine. Family housing would help to reduce stress. Good shift rotation, counselling, and recreational facilities in the camp can effectively reduce it to low. There may also be some psychological stress in the current community given the large influx of workers as well as additional influx by others who could settle in informal settlements at Noordoewer.

- Prevalence of zoonotic diseases (EHA 2). This affects workers and is of Low Impact (pre- and post-mitigation).

The arid desert and limited wildlife displacement around the site keep zoonotic disease risk inherently low, although there are infections like plague which can be transmitted to humans by infected wildlife as well as infections like tick bite fever transmitted by tick vectors.

Decommissioning

- Legacy contamination causing long-term diseases (EHA 3 & 6). Moderate impact (pre-mitigation), reduces to Low post-mitigation.

The latest geohydrological specialist report demonstrates that the flotation tailings and waste rock are non-acid-generating, with stable neutral pH, declining sulphate trends, and negligible metal mobilisation. These results thusfar indicate a low potential for acid rock drainage and heavy-metal leaching, the proposal for unlined facilities is based on the favourable geochemical characteristics of the material. As the TSF and WRDs are located in the catchment of the Orange River (a transboundary watercourse), the final design should remain subject to detailed regulatory review and approval by the Ministry of Environment, Forestry and Tourism (MEFT). Due to potential risk the impact significance is

rated as moderate. Additional seepage collection, monitoring wells, and contingency measures may still be required to ensure protection of groundwater and surface water resources. Long-term monitoring and effective engineering interventions are recommended to manage any residual seepage after closure which reduces the significance to low.

6.2.4.1 Summary: Operation and Decommissioning Impact Mitigation

Table 10: Mining Operations and Resource Processing, Impact and Mitigation/Enhancement Measures

Project activity or issue	Potential impact	Mitigation/Enhancement Measures (Elaborated)
Processing and leaching	Chemical exposure from leaching and flotation	Mitigation: Install enclosed ventilation and exhaust systems in concentrator and solvent extraction/electrowinning areas to capture sulphuric acid mists and solvent emissions, provide specialised PPE with regular fit-testing and decontamination protocols, and conduct real-time exposure monitoring and annual medical surveillance to reduce long-term toxicity risks..
Employment and CSR	Positive economic and CSR health benefits	Enhancement: Enhance positive benefits through CSR-funded programmes focussing on aspects such as: community clinics, HIV programmes, and/or youth scholarships. Establish community health action plans with associated development funds for health and education to sustain long-term socio-economic benefits over the 23-year life of mine.
Waste and tailings management	Soil/water contamination	Mitigation: Implement seepage collection systems, groundwater monitoring wells, and contingency measures to protect groundwater and surface water resources, enable early detection of metals, and enforce progressive rehabilitation with vegetation cover to prevent downstream contamination affecting irrigation-dependent communities such as Vioolsdrift, Noordoewer and Aussenkehr.
Ongoing operations	NCDs from chronic dust and emissions	Mitigation: Minimise dust and silica exposure by installing water suppression on haul roads and earthworks, providing fit-tested respiratory PPE to workers as required, and where possible establish vegetated buffer zones to reduce wind-driven dust dispersion and long-term exposure over the life of mine. Conduct periodic non-communicable disease (NCD) screenings (including lung function tests and chest X-rays) for workers and nearby communities,
Shift work	Shift work and isolation stress	Mitigation: Provide mental health counselling, implement fair shift rotation systems and family accommodation/visitation policies, and develop recreational facilities (including internet access) in worker camps to reduce isolation and mitigate burnout among operational staff in the remote project area.
Wildlife displacement	Zoonotics	Mitigation: Establish wildlife corridors and appropriate fencing to minimise habitat fragmentation and displacement and implement wildlife and zoonotic disease monitoring (including tick-borne risks) with veterinary oversight and worker awareness programmes to manage ecological interactions in the Orange River arid ecosystem.

Project activity or issue	Potential impact	Mitigation/Enhancement Measures (Elaborated)
Legacy sites	Legacy contamination causing long-term diseases	Mitigation: Implement long-term site remediation measures, including capping of waste dumps and treatment of potential leachate, establish long-term groundwater monitoring wells and community health action plans where required, and partner with government authorities for ongoing post-closure environmental and health surveillance to minimise chronic risks beyond the 23-year life of mine.
Rehabilitation	Positive site rehabilitation reducing environmental hazards	Enhancement: Involve local communities in rehabilitation planning, including re-vegetation and eco-tourism development, and fund long-term sustainable land-use initiatives such as sustainable farming to extend environmental, health, and livelihood benefits beyond mine closure for river-dependent communities.

6.2.5 Integrated Risk Table showing both Community and Worker Health Impacts

Health impact ratings for both the surrounding community and the workforce are provided in the table below. Ratings for the workforce are shown as grey shaded cells in the table and these will be dealt with in greater detail at a future stage as part of an occupational health risk assessment. .

Table 11: Impact Significance Pre and Post Mitigation (Greyed out impacts are typically managed through occupational health and safety on site)

Project activity or issue	Potential impact	Phase	Nature of impact		Significance before mitigation							Significance after mitigation as per EMP						
			+ / -	D/I/C	M	R	D	S	P	TOTAL	SP	M	R	D	S	P	TOTAL	SP
Community Health																		
Exploration, Planning, Surveys	Community anxiety from uncertainty (EHA 9,10)	Pre-construction	-	I	4	1	1	2	4	32	M	2	1	1	1	3	15	L
		Decommissioning	-	I	3	1	2	2	4	32	M	2	1	2	2	3	21	L
Site prep, infrastructure development and operation of machinery/equipment	Dust and silica inhalation leading to respiratory issues (EHA 6, 8)	Construction	-	D	3	3	2	2	4	40	M	2	3	2	2	3	27	L
		Operation	-	D	2	1	4	2	3	27	L	2	1	4	2	2	18	L
		Decommissioning	-	D	2	1	2	2	3	21	L	2	1	2	2	2	14	L
	Noise and vibration affecting community (EHA 6, 8)	Construction	-	D	2	1	2	2	3	21	L	2	1	2	2	2	14	L
		Operation	-	D	2	1	4	2	2	18	L	1	1	4	2	1	8	L
		Decommissioning	-	D	1	1	2	2	2	12	L	1	1	2	2	1	6	L
Workforce Mobilisation	Accidents and injuries to workers (EHA 7)	Construction	-	D	3	3	2	2	4	40	M	2	3	2	2	3	27	L
		Operation	-	D	1	3	4	2	2	20	L	1	3	4	2	2	20	L
		Decommissioning	-	D	1	3	2	2	2	16	L	1	3	2	2	2	16	L
	Job creation improving income and nutrition (EHA 5, 11)	Construction	+	I	3	1	2	3	4	36	M	4	1	2	3	4	40	M
		Operation	+	I	3	1	2	3	4	36	M	4	1	2	3	4	40	M
	Population influx- STIs from population influx (EHA 4)	Construction	-	I	3	5	2	3	4	52	M	3	5	2	3	3	39	M
		Operation	-	I	2	5	4	3	4	56	M	2	5	4	3	3	42	M
	Population influx- Strain on local health services (EHA 12)	Construction	-	I	3	3	2	2	4	40	M	2	3	2	2	3	27	L
		Operation	-	I	2	3	4	2	2	22	L	1	3	4	2	2	20	L
	Accommodation - Communicable diseases from community overcrowding (EHA 1).	Construction	-	I	5	3	2	2	4	48	M	4	3	2	2	3	33	M
Operation		-	I	4	3	4	2	4	52	M	3	3	4	2	3	36	M	
Mining Construction, Operations and Decommissioning and Resource Processing	Chemical exposure from leaching and flotation (EHA 8)	Construction	-	D	1	3	2	2	2	16	L	1	3	2	2	2	16	L
		Operation	-	D	4	3	4	2	4	52	M	3	3	4	2	3	36	M
		Decommissioning	-	D	1	3	2	2	2	16	L	1	3	2	2	2	16	L
	NCDs from chronic dust and emissions (EHA 6)	Construction	-	D	1	3	2	2	2	16	L	1	3	2	2	2	16	L
		Operation	-	D	4	3	4	2	3	39	M	2	3	4	2	2	22	L

Project activity or issue	Potential impact	Phase	Nature of impact		Significance before mitigation						SP	Significance after mitigation as per EMP						SP
			+ / -	D/I/C	M	R	D	S	P	TOTAL		M	R	D	S	P	TOTAL	
		Decommissioning	-	D	1	3	2	2	2	16	L	1	3	2	2	2	16	L
	Shift work and isolation stress (EHA 9)	Construction	-	D	4	1	2	2	4	36	M	3	1	2	2	2	16	L
		Operation	-	D	4	1	4	2	3	33	M	3	1	4	2	2	20	L
		Decommissioning	-	D	2	1	2	2	2	14	L	2	1	2	2	2	14	L
	Prevalence of Zoonotic diseases (EHA 2)	Construction	-	D	2	1	2	2	2	14	L	2	1	2	2	1	7	L
		Operation	-	D	2	1	4	2	2	18	L	2	1	4	2	1	9	L
		Decommissioning	-	D	1	1	2	2	2	12	L	1	1	2	2	1	6	L
	Exposure to contaminated water/soil (EHA 3)	Operation	-	D	4	3	4	2	3	39	M	3	3	4	2	2	24	L
		Decommissioning	-	D	4	3	2	2	3	33	M	3	3	2	2	2	20	L
	Legacy contamination causing long-term diseases (EHA 3, 6)	Decommissioning	-	D	3	3	5	3	4	56	M	3	3	5	3	2	28	L

7.0 RECOMMENDATIONS

1. Air Quality and Noise Management

- Position mine camp as far west as feasible to place it upwind of the open pit, haul roads, and potential TSF/heap leach areas. Alternatively, locate the accommodation in Noordoewer.
- Preferably seal all internal roads including haul roads as far as possible.
- Expand baseline and ongoing monitoring of PM₁₀, PM_{2.5}, respirable silica, and TSP at the mine perimeter, workers' camp, Aussenkehr, Noordoewer, and Vioolsdrif, and at vehicle-loading/unloading stations.
- Dust should be managed at vehicle-loading/unloading sites both on site and in transit where possible (i.e. covers or dust suppression methods).
- Minimise dust and silica exposure by installing water suppression on haul roads and earthworks, providing fit-tested respiratory PPE to workers as required, and where possible establish vegetated buffer zones to reduce wind-driven dust dispersion and long-term exposure over the life of mine.
- Implement air quality monitoring at the mine boundary and nearby communities (Noordoewer and Aussenkehr) to detect PM₁₀, PM_{2.5}, and silica levels early.
- Where required, install acoustic barriers around high-noise areas and implement vibration monitoring near nearby settlements (e.g., Noordoewer/Vioolsdrif) to minimise disturbance and prevent structural or sleep impacts.
- Conduct periodic non-communicable disease (NCD) screenings (including lung function tests and chest X-rays) for workers and nearby communities (eg to estimate a baseline for conditions such as asthma).

2. Water & Contamination Prevention

- Conduct comprehensive baseline groundwater monitoring (including new well drilling) around the site, tailings facility, waste rock dumps, and downstream near the Orange River influence zone.
- Establish perpetual post-closure monitoring wells and ensure appropriate community health action plans are in place to manage any unforeseen residual impacts.
- Implement seepage collection systems, groundwater monitoring wells, and contingency measures to protect groundwater and surface water resources, enable early detection of metals, and enforce progressive rehabilitation with vegetation cover to prevent downstream contamination affecting irrigation-dependent communities such as Vioolsdrif, Noordoewer and Aussenkehr.

3. Occupational Health

Formal Occupational Health Risk Assessments by Construction, Operation and Decommissioning Phases focusing on workers' higher exposure to physical injury, dust, silica, chemicals (sulfuric acid, metals, solvents), noise, and shift-work stress should be conducted.

- Establish an on-site first-aid/occupational health nursing clinic to do routine medical surveillance, fit-testing for PPE, respiratory function, and audiometry screening with first aid capability run by an occupational health nurse. The development of influx impact management plan inclusive of support to local services is recommended. This could prevent overload of the limited local facilities, which from current reports are not currently all that strained.
- Provide mental health counselling, implement fair shift rotation systems and family accommodation/visitation policies, and develop recreational facilities (including internet

access) in worker camps to reduce isolation and mitigate burnout among operational staff in the remote project area.

- Implement mandatory safety training for all personnel, install barriers and signage at construction sites, and establish an on-site emergency response system with ambulance support and drills tailored to remote access conditions to minimise injury severity.
- Install enclosed ventilation and exhaust systems in concentrator and solvent extraction/electrowinning areas to capture sulphuric acid mists and solvent emissions, provide specialised PPE with regular fit-testing and decontamination protocols, and conduct real-time exposure monitoring and annual medical surveillance to reduce long-term toxicity risks.

4. Community & Influx Management

- Establish a project-funded on-site clinic with emergency capabilities to reduce pressure on local health facilities, support preventative programmes and services, and implement an influx impact management plan that includes support to local services to avoid overburdening existing capacity.
- Implement voluntary HIV/STI testing and treatment programmes (including prophylaxis and antiretroviral support), collaborate with the Ministry of Health and Social Services and implement targeted awareness campaigns, and enforce codes of conduct to reduce exploitation and transmission in high-prevalence border communities.
- Provide access to high-speed internet in worker accommodation for recreation and family contact.
- Implement regular stakeholder engagement sessions with transparent project updates and Q&A and provide psychological support resources to vulnerable groups where anxiety escalates.
- Monitor influx-related impacts and support the implementation of an influx impact management plan together with local governance structures that includes hygiene education, vaccination drives (e.g., TB and influenza), and regular health screenings to prevent disease spread and reduce respiratory risks in arid conditions. The Mine is responsible for ensuring accommodation for workforce is available and up to standard to ensure risks of communicable disease due to overcrowding is sufficiently managed.
- Announce local hiring opportunities and CSR health initiatives early, and partner with local leaders to deliver skills workshops that extend economic benefits and awareness to migrant workers and river-dependent communities.
- Prioritise local hiring (e.g., quotas for Karas residents), implement vocational training and certification programmes, and provide subsidised nutritious meals for workers while extending community nutrition initiatives to amplify income benefits and support regional poverty reduction.
- In preparation for decommissioning, look to provide retraining programmes in alternative sectors (e.g., agriculture and tourism), look to offering closure transition support, and provide mental health counselling for affected workers and families to mitigate boom–bust socio-economic impacts in the region.
- Enhance positive benefits through CSR-funded programmes focussing on aspects such as: community clinics, HIV programmes, and/or youth scholarships. Establish community health action plans with associated development funds for health and education to sustain long-term socio-economic benefits over the 23-year life of mine.

5. Legacy & Long-Term Planning

- Develop and fund a detailed closure/rehabilitation plan with community involvement (e.g., re-vegetation, potential eco-tourism/agriculture transition).
- Establish independent, periodic reviews of all monitoring data (air, water, health) with transparent public reporting.

- Explore mechanisms to support a secondary local economy (e.g., small-scale agriculture, tourism linkages) to buffer against boom-bust effects.
- Establish wildlife corridors and appropriate fencing to minimise habitat fragmentation and displacement and implement wildlife and zoonotic disease monitoring (including tick-borne risks) with veterinary oversight and worker awareness programmes to manage ecological interactions in the Orange River arid ecosystem.
- Implement long-term site remediation measures, including capping of waste dumps and treatment of potential leachate, establish long-term groundwater monitoring wells and community health action plans where required, and partner with government authorities for ongoing post-closure environmental and health surveillance to minimise chronic risks beyond the 23-year life of mine.
- Involve local communities in rehabilitation planning, including re-vegetation and eco-tourism development, and fund long-term sustainable land-use initiatives such as sustainable farming to extend environmental, health, and livelihood benefits beyond mine closure for river-dependent communities.

6. Monitoring & Adaptive Management

- Complete a full baseline health, air, water, and socioeconomic data collection before construction.
- Integrate annual reviews of monitoring results into the EMP with adaptive triggers for additional mitigation if thresholds are approached.
- Provide feedback sessions based on these annual reviews, or more frequently as necessary, with community stakeholders
- Strengthen stakeholder engagement with local communities with active inclusion of vulnerable groups and river users to address cultural health practices and psychosocial concerns.

Implementation of these recommendations, combined with strong regulatory oversight and community partnerships, positions the Haib Copper Project to achieve low residual health risks and meaningful positive contributions to regional well-being over its anticipated 23-year operational life and beyond.

8.0 CONCLUSION

The Haib Copper Project Health Impact Assessment concludes that the proposed open-pit porphyry copper-molybdenum mine, milling and flotation works, heap leaching and hydrometallurgical processing in the absence of a smelter presents a manageable set of health risks when appropriate mitigation is applied effectively and consistently across all project phases.

Negative health impacts for workers are primarily associated with the respiratory effects of dust, particularly silica exposures; potential chemical exposures (heavy metals, sulphuric acid and solvents) during heap leaching and physical injuries. Community impacts are a consequence of workforce and additional influx-related communicable diseases (STIs);. Psychosocial stress from shift work, isolation, rapid change of the nature of the population and boom-bust dynamics affect both workers and the community. Long-term legacy contamination risks from tailings and waste rock affecting soil and water quality near and in the Orange River could negatively impact the community.

Positive health benefits stem mainly from employment-driven improvements in income, nutrition, education, skills acquisition, and health-service access, as well as targeted CSR initiatives.

Overall, pre-mitigation significance ratings range from Low to Moderate (highest in legacy contamination for the community and chronic dust/chemical exposure for workers), although most ratings moderate to low in nature. Effective implementation of proposed controls reduces nearly all impacts to low, or in isolated instances to moderate residual levels. Without a smelter, air quality risks are substantially lower than in conventional copper mining and processing operations.

The project can deliver net positive socioeconomic and health outcomes for the !Karas Region if legacy risks are proactively addressed through long-term monitoring, community engagement, and progressive rehabilitation.

9.0 APPENDICES

9.1 Appendix 1: Citation details for the 12 Environmental Health Areas

Overview

The articles and reviews from 2004–2025 cited below, highlight health risks from copper mining, particularly porphyry copper-molybdenum deposits. For HAIB (no onsite smelter), risks stem from dust (crushing/milling), chemicals (sulfuric acid/solvents in heap leach/SX/EW), tailings/waste dumps (ARD/metals leaching), and water abstraction (Orange River). Legacy risks are prominent due to persistent contamination. Positive impacts include economic benefits improving nutrition/health access, but are limited. Brief summaries below are organized by the IFC's 12 EHAs, with evidence from porphyry Cu-Mo contexts (e.g., Zambia, DRC, Chile, China). Monitoring and prevention strategies are integrated where relevant.

EHA 1: Communicable Diseases Linked to Housing/Living Conditions

Overcrowding/poor sanitation in worker camps increase respiratory (TB, influenza) and gastrointestinal infections, exacerbated by dust in arid areas. In Zambia Cu mines, high silica dust correlates with TB (OR=6.4 for cumulative exposure)¹; DRC Cu-Co sites show similar risks from migrant influx². Legacy: Persistent dust from old dumps aids spread³. Monitoring: Camp hygiene audits, TB screenings⁴. Prevention: IFC-compliant housing (ventilation/sanitation); vaccination drives⁵.

EHA 2: Vector-Related Diseases

Standing water in leach pads/ponds breeds mosquitoes (malaria/Rift Valley fever), though low risk in arid Namibia. Zambia/DRC reviews note increased vectors from mining ponds⁶. Legacy: Abandoned ponds persist as breeding sites⁷. Monitoring: Vector traps, incidence tracking⁸. Prevention: Drainage/larvicides; nets for workers/communities⁹.

EHA 3: Soil-, Water-, and Waste-Related Diseases

ARD/metals (Cu, Mo, As, Cd, Pb) leach from dumps/TSF, contaminating Orange River/soil, causing gastrointestinal/skin issues, chronic toxicity. Zambia/DRC: High Cu/Co/As/U in water/crops exceed WHO limits, linked to diarrhea/kidney damage¹⁰; Chile tailings: As/Cu in dust/soil cause metabolic disorders¹¹. Legacy: Persistent soil pollution (decades), bioaccumulation in food (e.g., crops/fish)¹². Monitoring: Wells/soil sampling (monthly); biomonitoring (urine for metals)¹³. Prevention: Lined TSF/neutralization; water recycling (70–90% feasible)¹⁴.

EHA 4: Sexually Transmitted Infections (STIs), Including HIV/AIDS

Influx (3,500 construction/1,350 operations) boosts STIs/HIV via informal economies; Zambia: 3–5% positivity, 29.9% child risk¹⁵. Silica/TB co-infection worsens HIV¹⁶. Legacy: Sustained transmission post-closure¹⁷. Monitoring: Annual testing¹⁸. Prevention: HTC programs, condom distribution; family camps¹⁹.

EHA 5: Food- and Nutrition-Related Issues

Positive: Jobs improve nutrition/security²⁰. Negative: Metal bioaccumulation in crops/fish (e.g., As/Cd in soils exceed thresholds)²¹. Legacy: Chronic food chain pollution²². Monitoring: Crop/soil testing²³. Prevention: Buffer zones, safe procurement; CSR gardens²⁴.

EHA 6: Non-Communicable Diseases

Dust/silica cause COPD/silicosis (Zambia: 59% exceed PEL²⁵; China: HR=1.41 high silica²⁶); metals (As/Cd) raise cancer/cardiovascular risks (global meta: Carcinogenic>threshold)²⁷. No Mo-pneumoconiosis; mixed dust dominant²⁸. Legacy: Chronic exposure from tailings dust²⁹. Monitoring: Lung screenings³⁰. Prevention: Dust suppression, PPE³¹.

EHA 7: Accidents and Injuries

Open-pit/processing risks: Falls, equipment/vehicle accidents; low prices increase fatalities (11% multi-fatality <AUD55/tonne)³². Legacy: Abandoned sites hazards³³. Monitoring: Incident logs³⁴. Prevention: Training, barriers; vigilance during downturns³⁵.

EHA 8: Exposure to Hazardous Materials, Noise, and Odors

Chemicals (acids/solvents) cause burns/neurotoxicity; dust/noise lead to hearing loss (Zambia/DRC: High metals in air³⁶); TI in effluents risks toxicity³⁷. Legacy: Persistent odors/dusts from dumps³⁸. Monitoring: Air quality stations³⁹. Prevention: Ventilation, PPE; enclosed systems⁴⁰.

EHA 9: Psychosocial Impacts

Stress from noise/dust/visual changes, influx tensions (Zambia: Boom-bust cycles cause anxiety⁴¹). Legacy: Post-closure unemployment stress⁴². Monitoring: Surveys⁴³. Prevention: Engagement forums, EAPs⁴⁴.

EHA 10: Cultural Health Practices

Disruption to vulnerable communities rituals/medicinal gathering near Orange River (Chile/Atacama: Cultural loss from mining⁴⁵). Legacy: Permanent access loss⁴⁶. Monitoring: Cultural assessments⁴⁷. Prevention: Sensitivity training⁴⁸.

EHA 11: Social Determinants of Health

Positive: Employment (1,350 jobs) boosts education/health access (Zambia: Open-pit reduces some risks vs underground⁴⁹). Negative: Inequality, gender imbalances, boom-bust cycles (UNDP: Socioeconomic disparities⁵⁰). Legacy: Economic decline post-closure⁵¹. Monitoring: Socioeconomic surveys⁵². Prevention: Local hiring, funds⁵³.

EHA 12: Health Systems Infrastructure and Capacity

Influx strains clinics (Zambia Trident: CSR enhances via contributions⁵⁴). Legacy: Reduced capacity post-closure⁵⁵. Monitoring: Utilization audits⁵⁶. Prevention: On-site clinics, partnerships⁵⁷.

Legacy Risks

Post-closure ARD/metal leaching (Chile: 80-year tailings impact⁵⁸); bioaccumulation persists (Atacama: As/Cu in rings 20+ years⁵⁹). Fatalities in downturns⁶⁰. Duration: Decades-centuries⁶¹.

Monitoring Programs

Biomonitoring (urine for metals⁶²). PM stations (size-fractioned⁶³). Water/soil sampling (HI for soils⁶⁴). Tree rings historical⁶⁵. Registries (TB/cancer⁶⁶). HAIB: Baseline urine; river stations⁶⁷.

Impact Prevention Strategies

Dust suppression/vegetation (recycle 70–90% water⁶⁸); lined TSF/neutralization⁶⁹. PPE/ventilation⁷⁰. CSR HTC⁷¹. Progressive rehab/funds⁷². Low-price vigilance⁷³. HAIB: River minimization; no-smelter air advantage⁷⁴.

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9.2 Appendix 2: Proposed outline of an Occupational Health Risk Assessment (OHRA) for the Phases

An Occupational Health Risk Assessment (OHRA) for Haib Copper Project mine workers should be conducted as a follow-up to the Health Impact Assessment (HIA), focusing specifically on occupational exposures that are more intense for the workforce than for nearby communities. This assessment aligns with international best practices, including ICMM Good Practice Guidance on Occupational Health Risk Assessment (2nd edition), ISO 45001:2018 requirements for hazard identification and risk assessment, and relevant mining-specific frameworks (e.g., ILO Code of Practice on Safety and Health in Open-pit Mines). The OHRA should be undertaken after HIA completion (e.g., during detailed design or pre-construction), led by a qualified occupational hygienist and physician team in collaboration with mine management, workers' representatives, and external specialists. It will inform the site's Occupational Health and Safety Management System (OHSMS) and integrate with the ESMP.

Proposed Outline for a Formal OHRA

Scope and Objectives

Define the assessment boundaries: all workers (direct employees, contractors) across project phases (construction, operation, decommissioning), job roles (drillers, haul truck operators, process plant operators, maintenance), and locations (open pit, concentrator, heap leach/solvent extraction/electrowinning, tailings facility, waste rock dumps, camp).

Objectives:

- Systematically identify occupational health hazards beyond community-level EHAs.
- Quantify exposures and risks to prioritize controls.
- Identify unwanted health events (injuries, silicosis cases, chemical poisoning).
- Recommend critical controls and monitoring to achieve zero serious occupational illness, injuries or fatalities.

Team Composition and Governance

Multidisciplinary team: occupational hygienist (lead), occupational physician, safety engineer, process engineer, worker representatives, HR/CSR, external consultant (if needed). Establish governance: terms of reference, reporting to site OHS committee, alignment with ISO 45001 leadership commitment.

Hazard Identification

Comprehensive methods:

- Job/task-based walkthrough surveys and observations.
- Review of process flow diagrams, Safety Data Sheets, and equipment specifications.
- Worker interviews, focus groups, and incident and ill-health data.
- Baseline exposure monitoring and sampling data. Key anticipated hazards tailored to Haib's operations.
- Dust and particulates: Respirable crystalline silica, copper/molybdenum dust, mixed dust from blasting/crushing/milling (risk of silicosis, COPD, pneumoconiosis).
- Chemical exposures: Sulfuric acid mists, solvents/extractants, flotation reagents, heavy metals (from potential effluents).
- Physical agents: Noise (machinery, blasting), whole-body/hand-arm vibration, heat stress (arid climate), ergonomic strains (lifting, awkward postures).

- Biological: Limited but potential zoonotics from wildlife and vegetation displacement or camp vectors.
- Psychosocial/organizational: Shift work, isolation, fatigue from long rotations, remote location stress.

Exposure Assessment

Quantitative where possible:

- Personal breathing-zone sampling (e.g., for silica, metals, acid mists), noise dosimetry, vibration measurements, thermal stress indices (WBGT).
- Qualitative for others: task-based exposure profiling.
- Compare against occupational exposure limits (OELs): Namibian regulations, WHO/ICMM/ACGIH guidelines (silica <0.025 mg/m³ respirable).
- Identify exposed groups, exposure duration/frequency, and cumulative risks over shifts and the LOM.

Risk Analysis and Evaluation

- Use a semi-quantitative matrix (ICMM): likelihood × consequence (severity of health outcome, reversibility).
- Prioritize risks: high for chronic exposures (silica/chemicals) leading to irreversible disease; medium for acute (chemical burns, noise-induced hearing loss).
- Identify critical controls for unwanted health effects (ventilation + PPE + medical surveillance for silica).
- Tools: Bowtie analysis for major hazards, WRAC (Workplace Risk Assessment and Control), or AHP (Analytic Hierarchy Process) for ranking occupational groups/tasks.

Control Hierarchy and Recommendations

Apply elimination > substitution > engineering > administrative > PPE.
Examples:

- Enclosed cabs, water suppression, ventilation for dust.
- Enclosed systems, local exhaust for chemicals.
- Hearing conservation program, vibration-damped tools.
- Heat management (hydration, shade, work-rest cycles).
- Ergonomic redesign, rotation schedules.

Monitoring, Surveillance, and Review

Recommend ongoing program: periodic personal/environmental monitoring, biological monitoring (e.g., urine for metals), health surveillance (spirometry, audiometry, blood tests). On-site clinic role: pre-placement, periodic, exit medicals; record-keeping for trends. Integrate into OHSMS: annual reviews, incident investigation linkage, worker feedback loops.

Reporting and Documentation

Produce a formal report: executive summary, detailed findings, prioritized action plan with timelines/responsibilities, appendices (sampling data, risk matrices). Include communication plan for workers and integration into training/induction programs.

Timeline and Resources

Duration: 3–6 months (phased: planning → fieldwork → analysis → reporting).
Resources: budget for sampling equipment, lab analysis, consultant fees; involve site team for ownership.

This OHRA will provide a robust, worker-focused complement to the HIA, ensuring higher-risk occupational exposures are addressed proactively to support a strong safety culture and compliance with IFC Performance Standard 2, Namibian OHS legislation, and ICMM/ISO 45001 expectations. If needed, it can be scoped further based on detailed engineering designs

12 May 2026

Re: INDEPENDENCE DECLARATION

I, the undersigned, declare the following in respect to the above-mentioned client:

- I acted as the independent specialist for this assessment
- I have expertise in conducting specialist health impact assessments and reporting relevant to this report, including relevant legislation and any guidelines that have relevance to the proposed activity
- I performed the work relating to the assessment in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I do not hold any financial interest, business and personal relationships or provision of other services, which would impair my independence and objectivity (e.g. shares held by a trust where I am trustee and a beneficiary etc.)
- The fees relating to the specialist work performed is of a fixed nature and are not contingent on the results of your report.
- I acted independently from the above mentioned client during my performance of the specialist services and can confirm that the following threats did not impair my objectivity in performance of the service:
 - Self-interest
 - Advocacy
 - Familiarity
 - Self-review
 - Intimidation

Yours sincerely



Emeritus Professor J E Myers

