

Ok Birim Tailings Storage Facility Project

Environmental and Social Impact Assessment

Chapter 13

Natural hazards, climate change and unplanned events



13. NATURAL HAZARDS, CLIMATE CHANGE AND UNPLANNED EVENTS

The proposed Ok Birim Tailings Storage Facility (TSF) Project (the project) has the potential to result in unplanned events outside normal operating conditions. According to the International Finance Corporation (IFC) *General Environmental, Health and Safety (EHS) Guidelines* (2007a), an emergency is an unplanned event in which a project operation loses or may lose control of a situation that could result in risks to human health, property or the environment, either within the facility or surrounding area.

Such events are typically unforeseen and triggered by natural causes (such as earthquake or extreme weather) or by incidental factors (for example, human error, equipment failure or accidents). While their likelihood is generally low, the potential consequences can be severe, resulting in significant environmental, social and operational impacts including land or water contamination, habitat loss, harm to human health and safety, livelihood and resource use disruption, culturally heritage damage and major environmental non-compliances.

Papua New Guinea (PNG) is among the world's most disaster-prone countries and is exposed to many geological, hydrological and meteorological hazards such as earthquakes, landslides, flooding, tropical cyclones and storms, and droughts (CFE-DM 2025a).

Climate change may also influence the frequency and severity of certain natural hazards during the life of the project and post-closure, with possible changes in rainfall patterns, flooding regimes and extreme weather events that may affect infrastructure, local communities and the surrounding environment.

This chapter outlines the relevant legislation, guidelines and Ok Tedi Mining Limited's (OTML) policies and standards for the management of natural hazards, climate change and unplanned events. It considers potential unplanned events with the greatest potential to cause significant impacts on project infrastructure, local communities and the surrounding environment, and outlines the proposed design controls, mitigation measures and emergency preparedness and response actions to address these. Where relevant, the measures build on OTML's existing operational risk management systems and emergency procedures.

13.1 REGULATORY AND CORPORATE FRAMEWORKS

This section outlines the relevant PNG legislation, OTML policies and standards, and international guidelines applicable to the management of natural hazards, climate change and unplanned events for the project.

13.1.1 Applicable PNG legislation

PNG legislation does not prescribe specific requirements for natural hazard identification or risk assessment for mining developments. However, several provisions are relevant to managing natural hazards and unplanned events:

- *Ok Tedi Environment Management Act 2019*. Section 8 requires that 'the permit holder shall not carry out an activity, in relation to the Ok Tedi Mine, that causes or is likely to cause environmental harm unless the permit holder takes all reasonable and practicable measures to prevent or minimise the harm'.
- *Mining Act 1992*. Section 43(1) requires proposals for mining leases (and special mining leases) to include adequate provisions for environmental protection.
- *Environmental Code of Practice for the Mining Industry* (OEC 2000). Requires contingency plans to manage risks from unplanned events, including natural disasters and equipment failures.
- *Natural Disaster Risk Reduction Framework 2017-2030*. Provides policy and operational frameworks for disaster risk prevention and reduction, including climate-induced risks (CFE-DM 2025a).

For climate-related matters, PNG ratified the Paris Climate Agreement in 2016 and submitted its Nationally Determined Contribution the same year, followed by its Enhanced Nationally Determined Contribution in 2020, which sets out national targets on greenhouse gas emission reductions and adaptation (WBG 2021). PNG also published its first National Adaptation Plan in 2023, which sets out the strategic framework to mainstream climate adaptation across sectors with a roadmap for implementation over 2022 to 2030 (PNG CCDA 2023).

The Climate Change (Management) Act 2015 is PNG's primary legislation for addressing climate change. It establishes a national framework for climate change mitigation and adaptation, including climate-related commitments. The Climate Change and Development Authority is responsible for overseeing the implementation of the National Climate Compatible Development Management Policy as well as coordinating and reporting PNG's climate-related commitments. Amendments to this act in 2021 and 2022 further strengthened the framework by introducing carbon markets, funding mechanisms for climate adaptation and cross-sectoral disaster risk management and planning, including for the mining sector.

PNG's broader policy frameworks including the National Strategy on Responsible Sustainable Development, PNG Vision 2050, and Medium-Term Development Plan IV 2023-2027 further promote sustainable development and climate resilience across all sectors (WBG 2021; CFE-DM 2025a).

The project is consistent with these national, provincial and sectoral policies as a large-scale environmental improvement initiative over the medium to long term.

13.1.2 Relevant OTML policies and standards

OTML has established integrated management system (IMS) and risk management frameworks that set out policies and standards supporting the company's commitment to a safe, environmentally and socially responsible operations. These frameworks aim to provide a consistent, multidisciplinary approach to managing hazards and risks by implementing risk reduction strategies for unacceptable risks, maintaining effective controls and promoting risk-informed decision-making (OTML 2003).

Under these frameworks, environment and social hazards and risks associated with OTML's operations are routinely identified and evaluated through structured risk assessments. This is supported by procedures for personnel to identify and report environmental and social hazards, incidents or unsafe situations for appropriate action. Risks are evaluated based on their likelihood and potential consequences, with those assessed as high or greater prioritised for treatment until residual risk levels are reduced to an acceptable level through targeted actions, systems and arrangements. Control measures follow the hierarchy of controls (eliminate, reduce, isolate, protect) to maintain residual risks as low as reasonably practicable (OTML 2003; 2020b).

Environmental and social risks identified through this process are recorded on a risk register with actions tracked and reviewed regularly to assess control effectiveness and incorporate lessons learned. The risk register also informs operational objectives and targets set through OTML's annual planning and budgeting cycle (OTML 2020b).

OTML's emergency preparedness and response framework is described below, while Chapter 14 outlines the IMS framework applicable to environmental and social management for the project.

13.1.2.1 OTML's existing contingency and emergency response framework

Under its IMS, OTML implements an emergency preparedness and response framework to prevent, mitigate and respond to unplanned events and major incidents. The following documents set out how OTML addresses contingency and emergency response planning across its operations and are applicable to the project:

- IMS-STD-1.16 Emergency Preparedness and Response Standard/Incident Management Standard – defines requirements for emergency preparedness and response procedures to be taken for any incident.

- IMS-1.11-P01 Major Incident Management Plan/Incident Management Plan – details the actions, responsibilities, escalation processes and protocols for incidents depending on their type and location.
- PRO-OPS-0622-168 Pipeline Integrity Management Plan Pyrite & Copper Concentrate Pipeline – sets out procedures for safe operation and maintenance of pipelines.
- IMS-STD-1.02 Risk & Opportunity Management Standard – outlines systematic identification and management of environmental and social risks and opportunities on a planned schedule, and control measures for significant risks to reduce the overall risk profile of the company.
- IMS-STD-3.08 Tailings Management and associated Tailings Management Plan – sets minimum requirements and approach for managing tailings and dredged material to comply with legal obligations.
- IMS-STD-3.01 Hydrocarbon Management – defines requirements for the management of hydrocarbons to control spills, releases, leaks and uncontrolled flows to avoid or minimise environmental impacts.
- IMS-STD-3.03 Chemical Management – sets requirements for the management of chemicals including purchasing, spill prevention, spill response and disposal of chemicals to minimise environmental impacts.
- IMS-STD-1.19 Incident Reporting and Investigation Standard – provides procedures for non-conformities, including significant and environmental incidents requiring reporting, investigation, corrective and preventative actions in line with IMS-STD-1.20 Corrective & Preventive Action.

These standards and plans provide specific protocols, procedures and processes to address both inherent hazards (such as accidental spills, vehicle or equipment incidents) and external risks (such as natural disasters) so that they are effectively managed and mitigated. Detailed procedures to identify potential emergency situations and define specific response actions are periodically reviewed and updated to incorporate lessons learnt from previous incidents.

13.1.2.2 Major incident management and site-specific plans

The risk-based Major Incident Management Plan/Incident Management Plan and Major Incident Management Team (MIMT) Plan provide a structured, company-wide framework for effective, coordinated response to major incidents and emergency situations that may affect workers (staff and contractors), local communities, the environment and business continuity. The MIMT Plan defines:

- Chain of command, roles and responsibilities.
- Notification, activation and escalation processes and flowcharts.
- Incident-specific protocols and checklists, including for personnel kidnap/extortion, arrest/detention, fatality, medivac, epidemic/infection disease outbreak, dry weather/prolonged drought, and operational shutdowns.
- Incident-specific duty cards, forms and templates.
- External and internal communications plans, contact lists and notification details.

The plan also includes detailed oil spill response tools and reference material.

The plans are supported by site-specific plans for Bige, Kiunga, Tabubil, Ok Tedi mining and processing operations. In the event of a major incident, OTML will implement its Major Incident Management Plan/Incident Management Plan and site-specific subplans, where appropriate.

The nature of a major incident will determine which authorities are to be notified. Under Environment Permit EP-L3(636) and associated operational environmental management and monitoring plan, OTML is required to notify the Director of Conservation and Environment Protection Authority within 24 hours of any significant environmental incident. An incident is classified as significant if it is assessed as an actual level 3 consequence for environmental, reputational or compliance impact in accordance with the OTML IMS Consequence Table outlined in the *Risk and Opportunity Management Guideline* (OTML-IMS-STD-1.03).

13.1.3 Applicable guidelines

The IFC General EHS Guidelines (2007a) and mining sector EHS Guidelines (2007b) provide the main international benchmarks for managing natural hazards, accidents and unplanned events. Section 3.7 of the IFC General EHS Guidelines requires the development of project-specific emergency preparedness and response plans that cover natural disasters, fires, spills and hazardous materials incidents. The mining sector EHS Guidelines (IFC 2007b) (sections 1.1 and 1.2) provide additional guidance on management of mining-related hazards and risks, including those associated with tailings management, pipelines, hazardous materials and structural failure of containment facilities.

The Equator Principles IV (Equator Principles Association 2020a) further require the assessment of climate change risks for Category A and relevant Category B projects, including mining developments. This includes evaluating physical climate risks, quantifying greenhouse gas emissions (scopes 1 and 2) and identifying measures to reduce and manage these throughout the project lifecycle.

In addition, international guidelines used as guidance to address the inherent risks associated with the design, construction and operation of TSFs include:

- *Global Industry Standard for Tailings Management (GISTM)* (ICMM et al. 2020)
- *Australian National Committee on Large Dams (ANCOLD) Guidelines*, including for:
 - *Design of Dams and Appurtenant Structures for Earthquake* (ANCOLD 2019b).
 - *Guidelines on Tailings Dams - Planning, Design, Construction, Operation and Closure* (Revision 1, ANCOLD 2019a).
 - *Guidelines on Risk Assessment* (ANCOLD 2022).
- Canadian Dam Association (CDA) guidelines, including:
 - *Dam Safety Guidelines* (CDA 2013) and supplementary technical bulletins for dam safety.
 - *Application of Dam Safety Guidelines to Mining Dams* (CDA 2019).
- International Commission on Large Dams (ICOLD) guidelines, including:
 - *Bulletin 139: Improving Tailings Dam Safety – Critical Aspects of Management, Design, Operations and Closure* (ICOLD 2011).
 - *Bulletin 153: Sustainable Design and Post-Closure Performance of Tailings Dams* (ICOLD 2013).
 - *Bulletin 181: Tailings Dam Design – Technology Update* (ICOLD 2021).
 - *Bulletin 194: Tailings Dam Safety* (ICOLD 2022).
- International Council on Mining and Metals (ICMM):
 - *Integrated Mine Closure: Good Practice Guide (2nd Edition)* (ICMM 2019).
 - *Tailings Management: A Good Practice Guide* (ICMM 2021).

These standards underpin the design basis and philosophy described in Chapter 6 so that the TSF and associated infrastructure are designed, constructed and operated consistent with globally recognised industry practices for TSF safety, risk management and climate resilience.

13.2 CLIMATE CHANGE RISKS

Tetra Tech completed a Climate Change Risk Assessment (CCRA) for the project and this is provided in Appendix J. The aim of the CCRA was to identify and evaluate potential climate-related physical risks that may influence the construction, operation, and closure of the project. In accordance with the Equator Principles, only the physical risks were assessed as the project's estimated annual Scope 1 and Scope 2 greenhouse gas emissions are significantly below the Equator Principles threshold of 100,000 tonnes of CO₂e

per year that would trigger consideration of climate transition risks (as defined by the Task Force on Climate-Related Financial Disclosures) and preparation of a greenhouse gas alternatives analysis.

The CCRA supports the integration of climate considerations into project planning to enable and enhance the climate resilience of the project over its life cycle.

This CCRA is focused on the assessment of physical climate risks and the associated resilience and adaptive capacity of the project. The assessment considered how climate variability and change may affect key aspects of the project, including hydrology, water management, infrastructure, and operation. The subsequent identification of appropriate adaptation and risk management measures is intended to support the long-term integrity of the project and reduce potential risks to the project and affected communities.

The assessment generally aligns with the requirements of international frameworks and standards, including:

- *Equator Principles* (EP) (2020a). As required under Principle 2 of the fourth version of the EPs (EP4), the assessment of climate-related risks and the preparation of a CCRA supports the early identification and management of climate-related impacts and risks within project designs.
- *International Finance Corporation (IFC) Performance Standards* (IFC 2012). The IFC Performance Standards require consideration of risks associated with a changing climate, as well as the identification of adaptation opportunities.
- *Global Industry Standard on Tailings Management* (GISTM) (ICMM et al. 2020). GISTM requires operators to incorporate climate change and associated physical risks into the TSF lifecycle by developing a knowledge base that captures climate-related uncertainties, integrating climate change considerations into site characterisation, impact assessment, and design (including water management systems), and applying adaptive management to regularly evaluate and update risk mitigation measures in response to evolving climate conditions and extreme weather hazards.

The CCRA has also considered PNG's Nationally Determined Contribution (NDC) under the Paris Agreement for the project's compatibility with host country climate commitments. PNG's NDC identifies the country as highly vulnerable to climate change and places strong emphasis on assessing climate impacts and risks. It highlights the importance of strengthening infrastructure resilience and integrating climate considerations into planning and decision-making. Consistent with such objectives, the CCRA evaluates how project design responds to various climate hazards and identifies how the project can contribute to climate-resilient development.

13.2.1 Assessment approach

The CCRA involved risk screening and scoping, followed by a risk assessment to evaluate potential physical climate risks to the project. Key steps of the assessment included:

- Characterising the baseline and projected climate conditions relevant to the project area, including:
 - Review of historical climate and hydrology, evaluation of climate conditions and assumptions used in the project design basis, and the analysis of climate data and future climate projections for the project location.
 - Assessment of climate trends and variability using available local monitoring data, supplemented by regional datasets and outputs from global climate models.
 - Identification of key climate hazards that may represent material risks to the project, considering the location and design of the project.
- Physical risk assessment to build on the identified hazards to evaluate their potential implications for the project, including:
 - Analysis of historical records and projected future climate conditions to derive relevant climate parameters used in engineering designs of the project and as an indication of long-term chronic risks.

- Consideration of how these parameters may influence hydrological conditions, water management, geotechnical performance, and overall operational stability of the TSF and supporting infrastructure.
- Evaluation of the project's exposure and sensitivity to climate-related hazards, and the extent to which the current design and operational assumptions provide resilience to these conditions.
- Identifying and describing measures to manage the physical climate risks, supporting integration of climate risk considerations into the project in a manner consistent with international industry practice, applicable standards and guidelines.

Future climate conditions are considered using a range of representative climate scenarios to reflect uncertainty in global emissions pathways and associated climate change outcomes. Current global policy trajectories indicate a likely warming outcome in the order of approximately 2.7°C to 2.8°C by the end of the century (UNEP 2025), broadly consistent with the Shared Socioeconomic Pathway (SSP) 2-4.5 adopted in the CCRA. Higher-end scenarios, such as the SSP5-8.5 adopted in the CCRA, represent more extreme (and less likely) warming outcomes considered to provide an upper bound for sensitivity testing.

This scenario-based approach supports a risk-informed assessment by considering both likely (SSP 2-4.5) and upper bound (SSP5-8.5) climate conditions. The outcomes of the analysis:

- Facilitate understanding of how the project may perform under a range of climate outcomes, including extreme weather conditions
- Consider whether the design and management framework is sufficiently robust to accommodate these conditions
- Inform the integration of climate considerations into site characterisation, impact and risk assessment
- Support an adaptive management approach to periodically review and adopt necessary measures in response to evolving climate conditions over the project lifecycle.

A key limitation of the assessment is the uncertainty associated with hydrological characterisation in the project area. This reinforces the need for flexible adaptive management, ongoing monitoring, and periodic review of design assumptions as additional information becomes available.

13.2.2 Historical climate change

Global climate change has accelerated over the past century, with the International Panel on Climate Change (IPCC) reporting that global average surface temperature increased by approximately 1.1°C in 2011–2020 relative to pre-industrial conditions. This is associated with widespread physical changes, such as rising ocean temperatures and sea level rise. Additionally, climate and weather extremes, including heatwaves, heavy precipitation events, drought and compound events, have become more frequent and severe (WBG 2021). Global average temperature is projected to increase in the near term (2021–2040), with warming levels of approximately 1.5°C likely to be reached or exceeded within this period (IPCC 2023; UNEP 2025). Long-term warming is projected to increase by the end of the century, with projections ranging from about 1.4°C to approximately 4.4°C. These increases are expected to further intensify climate hazards (IPCC 2023).

PNG is reported as one of the most at-risk countries from climate change, projected to have an average temperature increase slightly lower or similar to a global average, while flooding and landslides are likely to intensify and pose increasing risks (WBG 2021). Based on the INFORM 2025 Risk Index (European Commission 2025) as cited in Appendix J), PNG is high-risk and ranked 20th out of 191 countries, with greater-than-average exposure to physical climate hazards and risks from tropical cyclones and flooding. PNG regularly experiences riverine and coastal flooding, which are driven by intense rainfall, seasonal variability, and sea level rise, as well as frequent landslides in mountainous regions where heavy precipitation and seismic activity destabilise slopes (CFE-DM 2025a).

As discussed in Chapter 8, historical rainfall records indicate a very high rainfall environment, with average annual rainfall in the order of ~5,500 mm at Bige and up to ~9,800 mm at higher elevation stations. Monthly

rainfall is consistently high throughout the year, with no pronounced dry season, although relatively higher rainfall generally occurs between May and October. The region also experiences high short-duration rainfall intensities associated with convective storm activity.

Long-term weather and climate data from six active hydrometeorology monitoring stations were reviewed to assess historical climate trends in the project region. The available data indicate substantial spatial variability in both annual rainfall totals and rainfall extremes, reflecting differences in elevation, terrain and exposure to prevailing weather systems. Higher elevation inland areas, such as Tabubil, generally record greater annual rainfall totals, while some lower elevation areas, such as Konkonda and PMP59, experience higher short-duration rainfall extremes associated with localised convective storm processes.

Analysis of historical climate records indicates that changes in rainfall extremes are more pronounced than changes in annual average rainfall. Overall, the available data suggest that climate variability and climate change in the project area are more strongly expressed through increasing rainfall intensity and precipitation extremes than through changes in mean annual rainfall.

13.2.3 Future climate projections

Future climate projections for the project area were assessed using Climate Change Knowledge Portal (CCKP) datasets (WBG 2025 as cited in Appendix J) under SSP2-4.5 and SSP5-8.5 climate scenarios. The assessment considered projected changes in average temperature, extreme temperature, average precipitation, extreme rainfall and drought-related climate indicators, with results shown in Figure 13.1.

The climate projections indicate a notable increase in both average temperature and temperature extremes over the project life. Average annual precipitation is projected to increase modestly, while precipitation extremes are projected to increase more substantially. Overall, the projections suggest that future climate conditions in the project area are likely to become warmer and wetter, with more intense rainfall events.

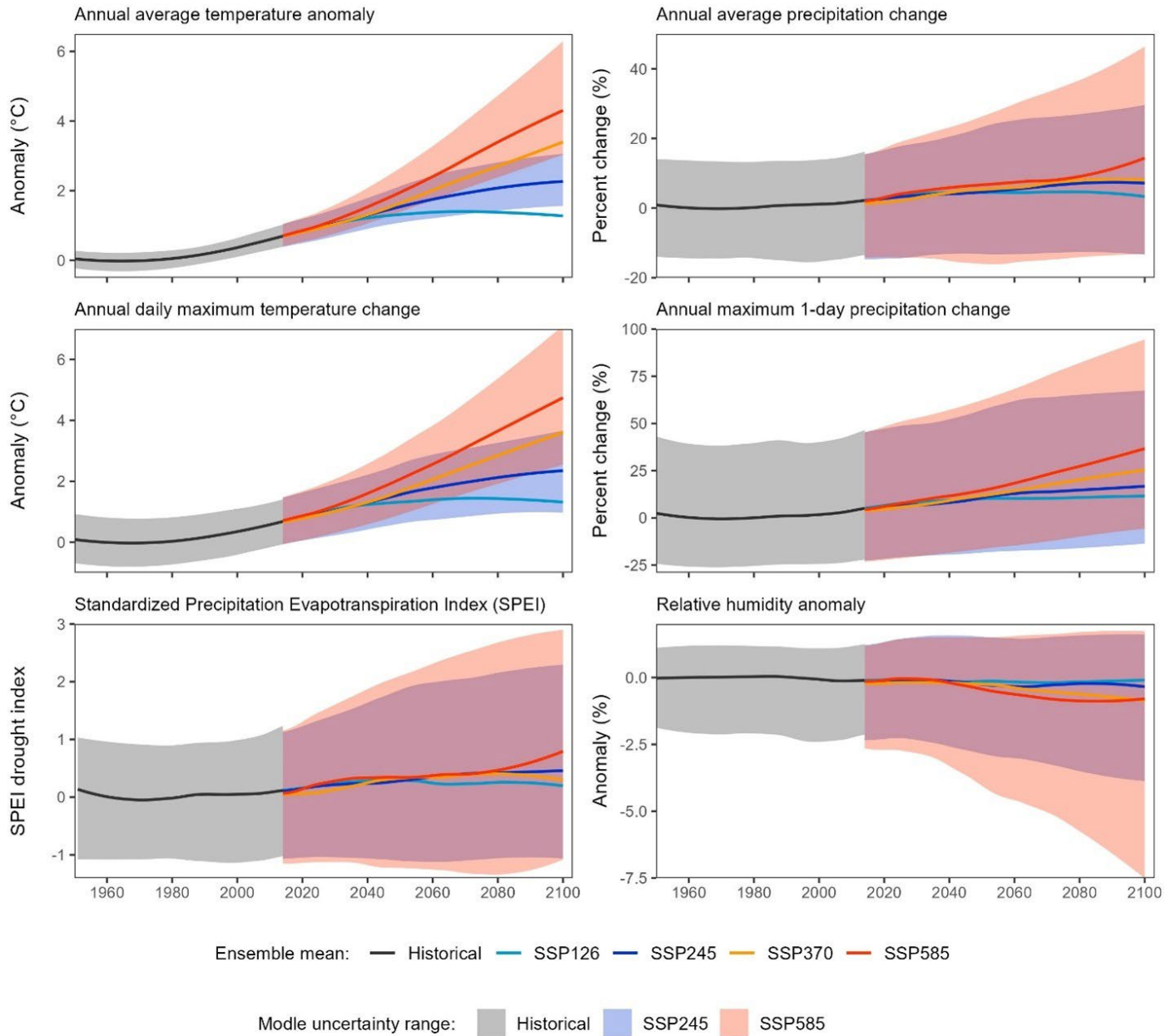
Drought-related projections are less certain. Some climate indicators suggest generally wetter average conditions, while others indicate the potential for increased frequency or severity of dry periods under some scenarios. This suggests that although average conditions may become wetter overall, climate variability may increase and periods of drought may still occur.

13.2.4 Assessment of selected climate hazards

In accordance with a risk-informed approach, hazards were selected for further assessment based on:

- The magnitude and direction of projected climate changes
- The exposure of the project given its geographic and environmental setting
- The potential for these hazards to affect the performance, integrity, or operation of the TSF and associated infrastructure.
- Climate projections suggest that the most pronounced changes are associated with increasing temperature (including more frequent extreme heat conditions) and greater intensity of precipitation extremes. These risks are discussed further in the following subsections. Wildfire and tropical cyclone risk were also assessed; however, are not discussed in detail within this section due to their low risk.

Modelled 80% confidence intervals are presented for
historical, SSP2-4.5, and SSP5-8.5 simulations



SOURCE
World Bank Group, 2025



OK TEDI MINING LIMITED
OK BIRIM TAILINGS STORAGE FACILITY PROJECT

FIGURE 13.1
**Climate projections for the Fly River
catchment**



DATE: 21.06.26 PROJECT: 754-MELEN374244 FILE: 374244C_R08_F13.01_GRA

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The project is in a densely vegetated tropical environment which introduces exposure to wildfire risk, particularly under conditions of elevated temperature and potential drying. Although projections of wildfire trends remain uncertain and rainfall is typically very high in the region, the presence of extensive surrounding vegetation and historical occurrence of fires in the broader region warrant inclusion of wildfire as a relevant operational hazard. At the regional scale, Western Province has experienced some notable fire-related impacts historically, particularly in areas toward the southeast of the province near the coastline. In contrast to these broader regional patterns, the historical fire losses in proximity to the TSF development area appear limited, with much of forest losses attributable to non-fire-related causes such as logging and vegetation dieback. While wildfire is a recognized hazard at the regional scale and the extensive forest landscape in the project area creates a fire hazard environment, the observed occurrences of wildfires in the project area are limited. The greatest risk of wildfire is expected during early revegetation, when fire prone *Acacia* spp. are likely to dominate disturbed areas. Appropriate fire breaks and active management of fire-prone vegetation near infrastructure are expected to reduce this risk. Overall, wildfire risk is low to moderate.

Tropical cyclones are also considered despite the inland location of the project. Direct exposure to cyclone landfall is low and the site is not influenced by coastal processes such as storm surge or sea level rise. Despite this, cyclonic systems in the region can generate intense rainfall and, in some cases, strong wind fields that extend inland. Extreme wind events may influence freeboard requirements and wave run-up.

Other potential hazards such as sea level rise and coastal flooding are screened out for the same reason.

13.2.4.1 TSF development area

The TSF development area represents the highest-consequence component of the project and is engineered using a risk-informed hierarchy of design criteria ranging from relatively more frequent operational events (e.g., 1:100 annual exceedance probability (AEP)) to extreme events defined by probable maximum precipitation (PMP)/ probable maximum flood (PMF) conditions. The CCRA indicates that the TSF storage and spillway systems are expected to remain robust under future climate change. A number of sub-components and elements are more sensitive to projected changes in precipitation extremes and temperature and these are described in this section.

Extreme heat and prolonged hot days

Historical and future projected temperature (both averages and extremes) show 2 to 4°C increases from 1950 to the end of century in the project region. Increasing temperatures and prolonged hot conditions represent a chronic climate hazard for the project, particularly for workforce health, safety and operational performance.

Elevated temperatures reduce labour productivity, particularly in hot and humid environments, through heat stress, fatigue, and increased risk of heat-related illness. The projected increase in temperature and prolonged hot days may therefore result in reduced effective working hours, increased need for work-rest cycles, and potential impacts on construction and operational scheduling of the project.

Higher temperatures may also affect operational systems and infrastructure, including pumps, pipelines and power systems.

While increasing ambient temperature could, hypothetically, lead to acceleration of the processes associated with acid and metalliferous drainage (AMD) in the TSF as a result of increased rates of sulfide oxidation reactions and associated geochemical pathways, this is not expected to fundamentally change the non-acid forming (NAF) characterisation of the tailings. This is because the average oxidation rates are already likely to be relatively low with the leachate chemistry for all samples under both free draining and saturated conditions dominated by calcium and sulfate, consistent with ongoing sulfide oxidation and concomitant calcite dissolution and acid neutralisation. Ongoing removal of pyrite by the Tailings Processing Plant and limestone addition to the mill to increase acid neutralising capacity will help manage this risk. The project proposes a comprehensive water monitoring program to detect changes to the geochemical behaviour of tailings, and this

is anticipated to detect any climate-related change in leachate. Further, the closure plan design for the TSF nominally involves capping the facility with NAF material, further limiting the potential for ongoing oxidation of the NAF tailings.

Projected increases in temperature are not expected to create acute TSF failure risks; however, they may contribute to increased operational and maintenance requirements over the project life cycle.

Rainfall extremes and flooding

Rainfall extremes and associated pluvial and riverine flooding events represent a critical climate hazard for the project, given the dominant role of intense precipitation in controlling hydrological response, water management performance, and TSF stability. The design of many project components is based on rainfall- and flood-related design criteria expressed in terms of AEP, ranging from more frequent operational events (e.g., 1:10 to 1:100 AEP) to extreme conditions defined by PMP/PMF.

Historical and climate-change-adjusted precipitation estimates provide a quantitative basis for comparison with the design values used in the project designs, enabling an evaluation of the resilience of different infrastructure components to future changes in rainfall intensity and associated flooding.

As the assessment estimates a range of 10 to 35% increases in annual maximum 1-day precipitation, depending on climate scenario, this range was used to project the future range of precipitation extremes. Table 13.1 presents the results of projected future precipitation intensities and the precipitation intensity values used for the TSF design basis. These estimates are slightly lower than the projected future values for more frequent precipitation events.

Table 13.1 Estimated historical and future precipitation intensities (mm/hr) near the project area and a comparison with the values reported by KCB (2024)

Duration and AEP	Historical, derived near TSF)	Future, lower bound (10% increase)	Future, upper bound (35% increase)	KCB 2024 estimates used for basis of design
24-hour, 1:2	7.6	8.4	10.3	7.6
24-hour, 1:5	9.0	9.9	12.2	9.0
24-hour, 1:10	9.8	10.8	13.3	9.8
24-hour, 1:20	10.5	11.6	14.2	10.7
24-hour, 1:50	11.3	12.4	15.3	11.8
24-hour, 1:100	11.8	13.0	16.0	12.7
72-hour, PMP	11.9	13.1	16.1	19.6

The PMP-based designs for the TSF are robust, whereas other design components based on more frequent precipitation events (such as those associated with sedimentation ponds) are sufficient under current and near-future climate conditions, reasonable for the 20-year duration of the project, but are subject to a larger climate risk in the longer-term. Longer-term climate risk is less of a concern because several operational components are not expected to be active beyond 2052, including sedimentation ponds and temporary access tracks. Some elements may continue to be in use, including certain roads and bridges. Continued consideration of climate change effects and adaptive management may be appropriate for these elements.

Projections of riverine flooding from World Resources Institute's Aqueduct Floods (WRI 2020 as cited in Appendix J) are used to provide a preliminary assessment of potential changes in fluvial conditions. These flood inundation estimates rely on global-scale models that do not account for the complex, site-specific conditions of the Ok Tedi and Fly River systems. Results inform relative changes in flood extent and frequency rather than absolute flood magnitudes, given the substantial uncertainty associated with limited hydrological data and the significant influence of historical mining-related sediment transport on river

morphology and hydraulics (as discussed in Chapter 8). If riverbed conditions stabilise to historical pre-mine conditions then the regional scale projections suggest that climate change may cause greater flooding. This projection is complicated by the changing river and floodplain sediment and hydrology dynamics in the basin, including due to the reduction of sediment loads due to the TSF.

If the projected increases in riverine flooding were to occur and be measurable given the complex sediment and hydrology dynamics of the basin, they suggest the potential for heightened exposure of certain project design components/elements, particularly those designed for more frequent events. Supporting water management systems such as diversions, which are designed for 1:100 AEP flood event, and ancillary or linear infrastructure (e.g., sedimentation ponds, roads, drainage systems, minor bridges and culverts) designed for more frequent events (e.g., 1:10 to 1:50 AEP), may be more susceptible to increased frequency of exceedance or reduced performance under future conditions. In contrast, the TSF storage and spillway system, which is based on conservative PMP/PMF-based design criteria, is expected to retain a high degree of robustness.

13.2.4.2 Infrastructure corridor

The infrastructure corridor comprises linear and distributed assets including the tailings pipeline, access roads, bridges and crossings, associated drainage systems, and ancillary facilities. Compared to the TSF development area, these components are generally designed to lower return-period events (1:10 to 1:100 AEP depending on criticality), reflecting their lower consequence of failure and the feasibility of repair or replacement.

Due to their distributed nature and direct interaction with riverine and hillslope processes, infrastructure corridor components have higher exposure to climate hazards, particularly extreme rainfall, flooding, and landslides. Unlike the TSF area, infrastructure corridor elements are more sensitive to increases in the frequency and intensity of precipitation events and associated hydrological responses. These components represent a key area where climate change may lead to increased operational disruptions, maintenance requirements, and localised failures over the project life cycle.

Extreme heat and prolonged hot days

Projected increases in temperature and prolonged hot days introduce chronic risks to the infrastructure corridor components. These include thermal stress on pipeline materials, potential changes in soil strength and moisture conditions affecting slope stability, and impacts on mechanical and electrical systems supporting corridor operations.

Rainfall extremes and flooding

Projected increases in precipitation intensity (in the order of 10 to 35%) are expected to directly affect surface runoff, drainage capacity, and flow conditions along the corridor. Road drainage systems (e.g., table drains and cross-drains), typically designed for more frequent events (e.g., 1:10 AEP), are particularly susceptible to exceedance under future conditions. This may result in overtopping of drainage structures, erosion of road surfaces, slope instability, and localised washouts. Similarly, access roads designed for 1:20 to 1:100 AEP events may experience more frequent inundation or damage, particularly in low-lying or floodplain areas. Minor bridges and watercourse crossings, which are designed for lower return periods (1:10 AEP), are also exposed to increasing risks from higher peak flows, increased debris loading, and enhanced scour potential. The exception is major permanent bridge crossings, which are designed to accommodate 1:2,000-year rainfall events due to their greater operational importance and consequence of failure.

Increased sediment transport associated with extreme rainfall may exacerbate channel instability and foundation exposure, increasing the likelihood of structural damage or reduced serviceability over time. In addition to fluvial processes, the corridor traverses steep and highly weathered terrain, where intense rainfall

can trigger landslides and slope failures. Projected increases in rainfall intensity and antecedent moisture conditions may elevate the frequency of such events, posing risks to road stability, pipeline integrity, and access continuity. These risks are particularly relevant during prolonged wet periods or compound events.

Similar to the TSF area, the uncertainty associated with limited long-term observational data and sediment dynamics makes it difficult to assess the baseline conditions and future projected risks. This uncertainty is greater for the infrastructure corridor due to the spatial variability of catchments and localised conditions.

13.2.5 Risk management and assessment summary

The TSF design, including storage and spillway components, was assessed to have high resilience due to the adoption of conservative criteria for PMP and PMF events. As a result, the likelihood of catastrophic failure associated with extreme hydrological events remains low under both current and future climate conditions. Supporting infrastructure and operational systems designed for more frequent events, such as surface water management structures and linear infrastructure, are more sensitive to increases in rainfall intensity and may experience more frequent exceedance of design conditions over time. This could increase the risk of localised flooding, erosion, sediment transport, and operational disruption.

With the implementation of the monitoring, management, and adaptive measures, the project can be developed and operated to address climate risk under both current and future climate conditions. Table 13.2 presents a summary of the project physical climate risk profiles and adaptation and management measures.

Table 13.2 Summary of project physical climate risk profiles and adaptation and management measures

Project component	Infrastructure element	Climate hazard	Risk level	Key adaptation and management measures
TSF development area	TSF embankment, storage system, spillways	Extreme rainfall, flooding, and prolonged wet conditions	Low	Freeboard management; spillway capacity checks; maintaining contingency storage; continuous monitoring; adaptive management and periodic design review
	Water management system (sedimentation ponds, diversion channels, erosion protection)	Extreme rainfall and flooding	Low to Moderate	Triggered action response plan implementation; ongoing water balance monitoring; periodic reassessment of design storms; staged upgrades and capacity improvements; erosion control
	TSF geochemistry and water quality	Increasing temperature and prolonged heat	Low	Water quality monitoring; AMD management; integration into environmental management plans
	TSF operations and workforce	Extreme and prolonged heat	Moderate	Workforce heat management (work-rest cycles, hydration); equipment maintenance; operational adjustments
	TSF (general)	Wildfire	Low	Vegetation management; integration into operational risk management
Infrastructure development corridor	Roads (major and minor), access tracks	Extreme rainfall and flooding	Moderate to High	Routine inspection and maintenance; drainage upgrades; erosion control; rapid repair planning
	Drainage systems (table drains, culverts, cross-drains)	Extreme rainfall and flooding	Moderate to High	Regular checks and maintenance; capacity reassessment; upsizing or retrofitting; additional drainage installation

Project component	Infrastructure element	Climate hazard	Risk level	Key adaptation and management measures
	Bridges and crossings	Flooding, debris loading, scour	Low to Moderate	Scour protection; structural inspection; targeted upgrades based on monitoring; design review
	Slopes and embankments along corridor	Landslides and slope instability	Moderate	Slope stabilisation; drainage control; erosion protection; identification of high-risk areas
	Pipeline and associated infrastructure	Flooding, ground instability, temperature effects	Low	Continuous automated monitoring of pipeline integrity; regular maintenance and checks; localised stabilisation measures as required
	Corridor construction and workforce	Extreme and prolonged heat	Moderate	Workforce heat management (work-rest cycles, hydration); equipment maintenance; operational adjustments
	Corridor (general)	Wildfire	Low to Moderate	Vegetation management; inspection and maintenance

Resilience of the project can be further achieved through a combination of adaptive management, monitoring, and risk-based operational controls. To improve the overall climate resilience and reduce physical climate risks, the project will adopt adaptive management practices, including:

- Use of initial conservative design assumptions.
- Continuous verification of design performance through monitoring.
- Iterative estimation and updates of related climate parameters (e.g., rainfall intensity, inflow assumptions) as new data and climate model results become available.
- Implementation of additional mitigation measures when required.

13.3 MAJOR ACCIDENTS AND UNPLANNED EVENTS

This section considers the major unplanned events that may occur over the life of the project due to natural disasters, technical failure or human error. Detailed design and assessment of the project will follow the Feasibility Study. Where relevant and where assessments for the current project design are not yet available, the assessment incorporates findings from the TSF risk assessment conducted by Klobn Crippen Berger (KCB) for the 2024 Pre-Feasibility Study (PFS) Design Update (KCB 2024a). This information is expected to be generally representative of the current project design and suitable for this assessment.

While not all major unplanned events can be anticipated or fully prevented, OTML's contingency and emergency response framework (see Section 13.1.2), supported by ongoing operational risk assessments, help identify potential unplanned events and accidents with the greatest potential to cause significant environmental, social or health impacts.

The following credible major incidents have been identified for the project during construction and operation based on OTML's operational experience, the environmental context, and hazards that are typically associated with large TSFs and supporting infrastructure:

- Natural disasters (e.g., flood, earthquake, landslide, El Niño-induced drought).
- Overtopping of the TSF.
- Structural failure or breach (e.g., TSF or major river crossing/bridge).
- Tailings pipeline failure.
- Hazardous materials spill or leakage (e.g., hydrocarbons).

- Fire or explosion.
- Traffic accident (road, air or water).
- Plant or mobile machinery accident.
- Epidemic or infectious disease outbreak.
- Civil unrest, protest or riot.

The following sections describe potential causes and triggers, likely impacts and consequences, and key design and management controls proposed to prevent or reduce significant environmental, social and health risks associated with these events.

13.3.1 Natural disasters

The international disaster database (EM-DAT) maintained by the Centre for Research on the Epidemiology of Disasters defines major natural disasters as events resulting in at least 10 fatalities, 100 affected people, a declared state of emergency, or a call for international assistance. In PNG, floods, landslides and earthquakes are the most frequent natural hazards associated with major natural disasters, and exposure to these events is expected to increase as more people live in flood and landslide prone areas (CFE-DM 2025a; CFE-DM 2025b).

The project is in a region that is periodically affected by natural hazards such as earthquakes, landslides, extreme rainfall during storms, seasonal floods, drought and bushfires. Although infrequent, these events have the potential to cause significant disruption, damage to project infrastructure and serious social and environmental impacts. The severity of impacts will depend on the scale of the event, local conditions and the effectiveness of implemented control measures.

With consideration of climate change risks, natural hazards most likely to severely affect the project include:

- Earthquakes and landslides, potentially damaging infrastructure or causing slope instability or structural failure.
- Severe storms, potentially causing extreme rainfall, flooding and significant erosion.
- Flood events, potentially damaging infrastructure or disrupting project access and operations.
- Prolonged droughts, leading to reduced river navigability and supply constraints from shipping.
- Bushfires, which can arise during extended dry periods.

Potential consequences of these events may include:

- Serious injury or loss of life for workers or nearby community members.
- Damage to infrastructure and property (project and non-project owned).
- Ground or structural instability affecting critical project infrastructure such as the TSF, tailings pipeline or major river crossing/bridge.
- Disruption of accessibility, supply and/or TSF operations.
- Uncontrolled release of contaminated water or hazardous materials to the environment, resulting in increased sedimentation and potential harm to human and ecological health, and reduced availability of livelihood resources (e.g., food and water).
- Degradation of terrestrial or aquatic habitats.
- Loss of land, livelihoods and assets with flow-on impacts to the community.
- Damage to or destruction of cultural heritage sites.

13.3.1.1 Specific design controls and management measures

Natural hazards are well understood for the region. OTML has experience managing and/or responding to these through 40 years of operation, and they have been considered during the design phase of the project. In the event of a natural disaster, OTML will follow established management and response strategies. Specific design controls to avoid or minimise potential impacts from natural disasters described in Chapter 6 include:

- Integrate risk-informed approach, incorporating credible TSF failure modes, into the design, operation and closure strategy for the TSF.
- Adopt geotechnical, structural and containment design criteria with appropriate factors of safety for susceptible and high consequence critical infrastructure including the TSF, hydro-cyclone house, tailings pipeline, on-site hazardous material storage facilities and diesel gensets.
- Design, construct and operate project infrastructure (including the TSF, access roads, water crossings and bridges, tailings pipeline) to accommodate for local geotechnical and climatic conditions, credible natural hazards and projected climate changes, consistent with international standards, including:
 - Design the project in accordance with the seismic assessment, noting the assessment recommends that additional geotechnical investigations, site response analyses and refinement of seismic hazard inputs be undertaken during detailed design as further site-specific information becomes available.
 - Locate the TSF and key facilities considering historical flood levels to mitigate flood interaction and entirely confined within the mine-affected Ok Tedi catchment to prevent impacts on adjacent catchments (such as the Ok Birim catchment).
 - Design TSF to meet applicable design standards including GISTM, ANCOLD and ICOLD guidelines.
 - Design TSF to withstand credible extreme rainfall and seismic events, including:
 - Structural resilience to withstand seismic events with a 1:10,000 annual exceedance probability (AEP) based on site-specific probabilistic seismic hazard assessment, as per GISTM and ICOLD guidelines.
 - During operations, design the TSF and spillways to accommodate the probable maximum flood of 1:100,000 AEP storm event with minimum 3 m operational freeboard.
 - TSF design to safely pass designated flood events and operate as a flow-through system (i.e., a full reservoir with little capacity for storage of flood events above the spillway invert level) with minimal decant water stored in TSF at any time.
 - Design flood storage and freeboard contingency for emergency scenarios as follows:
 - Pond storage critical duration storm allowance of 1:100 AEP (72-hr event) in accordance with ANCOLD (2019) and 1:10,000 in accordance with GISTM (ICMM et al. 2020).
 - Minimum operational freeboard of 3 m to provide adequate contingency for potential extreme seismic deformations, which could reach up to 5 m. This freeboard is intended to prevent risk of overtopping of the TSF or damage from large shear movements, as per ANCOLD and ICOLD.
 - Dry freeboard for overall flood storage requirements, which incorporates the hydrologic freeboard determined by the design flow depth in the spillway channel for the 1:1,000 AEP event, inclusive of the 1:10 AEP wind-wave run-up with an additional 0.5 m freeboard allowance.
 - Install surface water structures to reduce flood risk levels including stormwater controls and diversion drains to intercept and divert clean water off site, convey site runoff and surface water flows into the TSF or sedimentation ponds, and reuse water stored on-site to the extent practical.
 - Design engineered slopes and foundations with appropriate safety factors to maintain stability.
- Integrate automated alarm and early warning systems that notify of normal, abnormal, and shutdown/start-up (including out-of-service, critical system shutdown or activation of emergency procedures) states for the TSF, hydro-cyclone house and tailings pipeline. Early warning systems to consider natural disasters as triggers for activation of emergency procedures.

13.3.2 TSF failure or breach

As outlined in Section 6.2.1.4, a dam breach analysis (KCB 2026c) has been prepared to inform the consequence classification assessment and design of the TSF and confirm that appropriate factors of safety have been applied in accordance with GISTM (ICMM et al. 2020), ANCOLD (2019a) and ICOLD (2022). The analysis modelled critical credible failure scenarios under operational and post-closure conditions to identify potential downstream inundation zones and communities at risk. The failure scenarios that were adopted are:

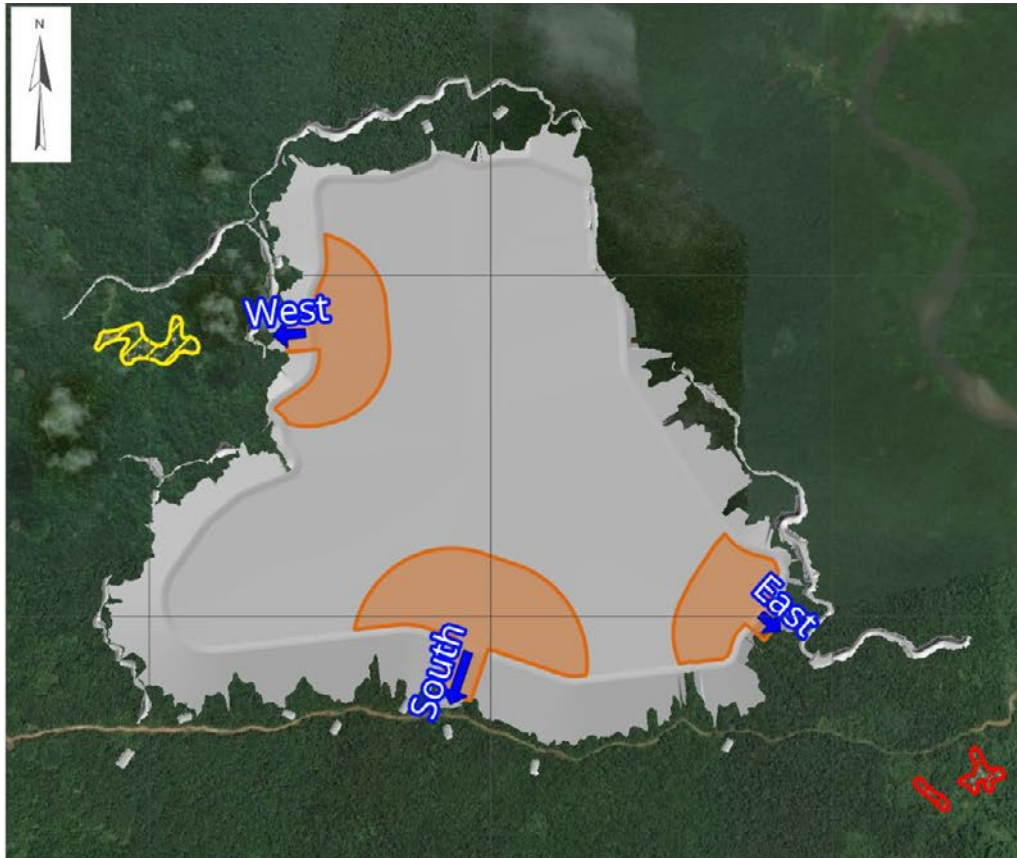
- Sunny day failure (SDF): a failure that occurs during normal hydrologic conditions within the TSF and immediate surrounding catchments.
- Rainy day failure (RDF): a failure that coincides with a flood event. When assessing the consequences of a RDF, only incremental consequences resulting from the dam failure beyond those attributable to a natural flood are considered. The 1:1,000 AEP event was adopted within this assessment to determine this incremental impact.

The extent of downstream impacts will depend on the size of failure, location of the failure or distance from the embankment as well as the depth of the failure. With the implementation of appropriate controls, including conservative design standards and criteria, a dedicated TSF stewardship program incorporating a dam safety program (see Section 6.2.1.1), and management oversight, the probability of failure is considered very unlikely. However, the consequences of complete failure leading to the uncontrolled release of large quantities of water and solids (from tailings placement) would likely result in major downstream environmental and social impacts. These could include:

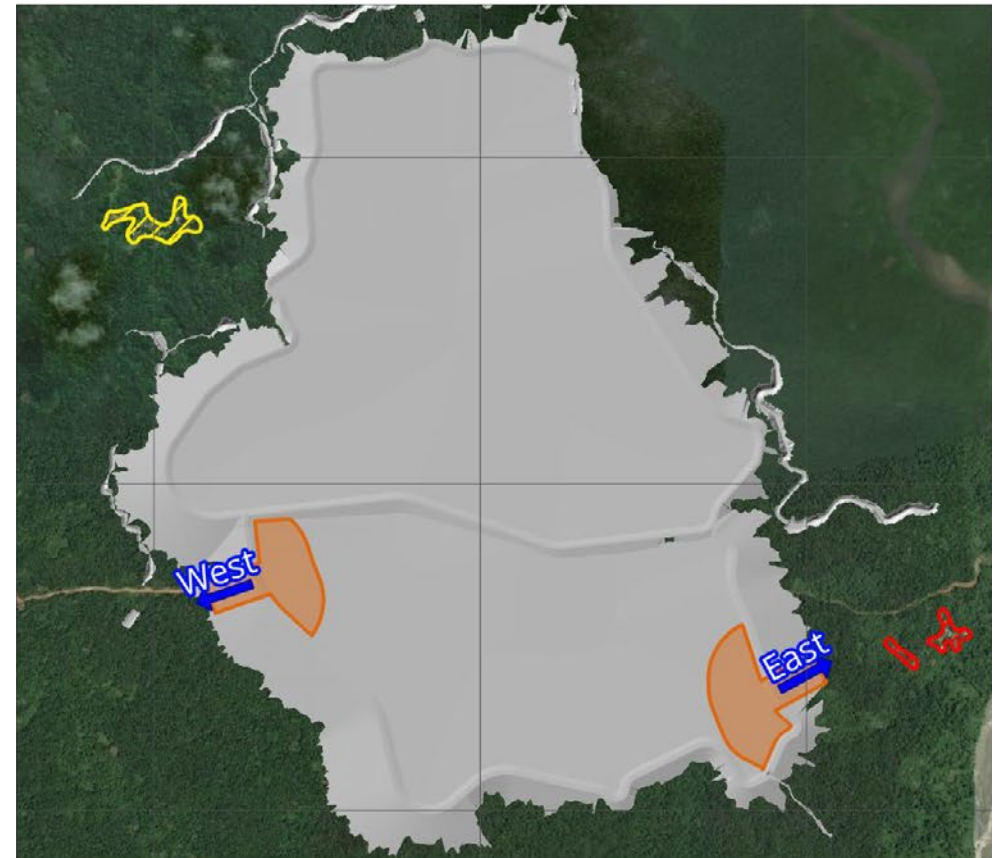
- Flooding of downstream environments with consequential environmental impacts.
- Potential for public health of 100 to 1,000 people to be affected via tailings inundating gardens and other locations not directly attached to dwellings.
- The majority of tailings runout is likely to be contained in proximity to the failure location. However, there is potential for suspended solids and contaminants to be transported by surface water flows to downstream (Ok Tedi or Ok Yep) receptors.
- Physical damage to downstream aquatic and terrestrial environments, including loss of flora and fauna due to habitat inundation and destruction, erosion and altered water quality.
- Potential for tailings to inundate surface water features (Ok Yep and local tributaries).

13.3.2.1 Dam break assessment

Five breach locations were selected to represent credible failure scenarios (Figure 13.2). These locations target the potential impacts to the villages of Kungembit and Birimkamba, as well as other locations that may result in population at risk.



Cell 1 failure locations



Cell 2 failure locations

SOURCE
KCB, 2026

LEGEND
Village



Birimkamba



Kungembit

Tailings breach



Tailings mobilisation extent



Failure planes



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FIGURE 13.2

Dam breach scenario locations



DATE: 21.06.26 PROJECT: 754-MELEN374244 FILE: 374244C_R08_F13.02_GRA

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The results of the dam break assessment can be summarised as:

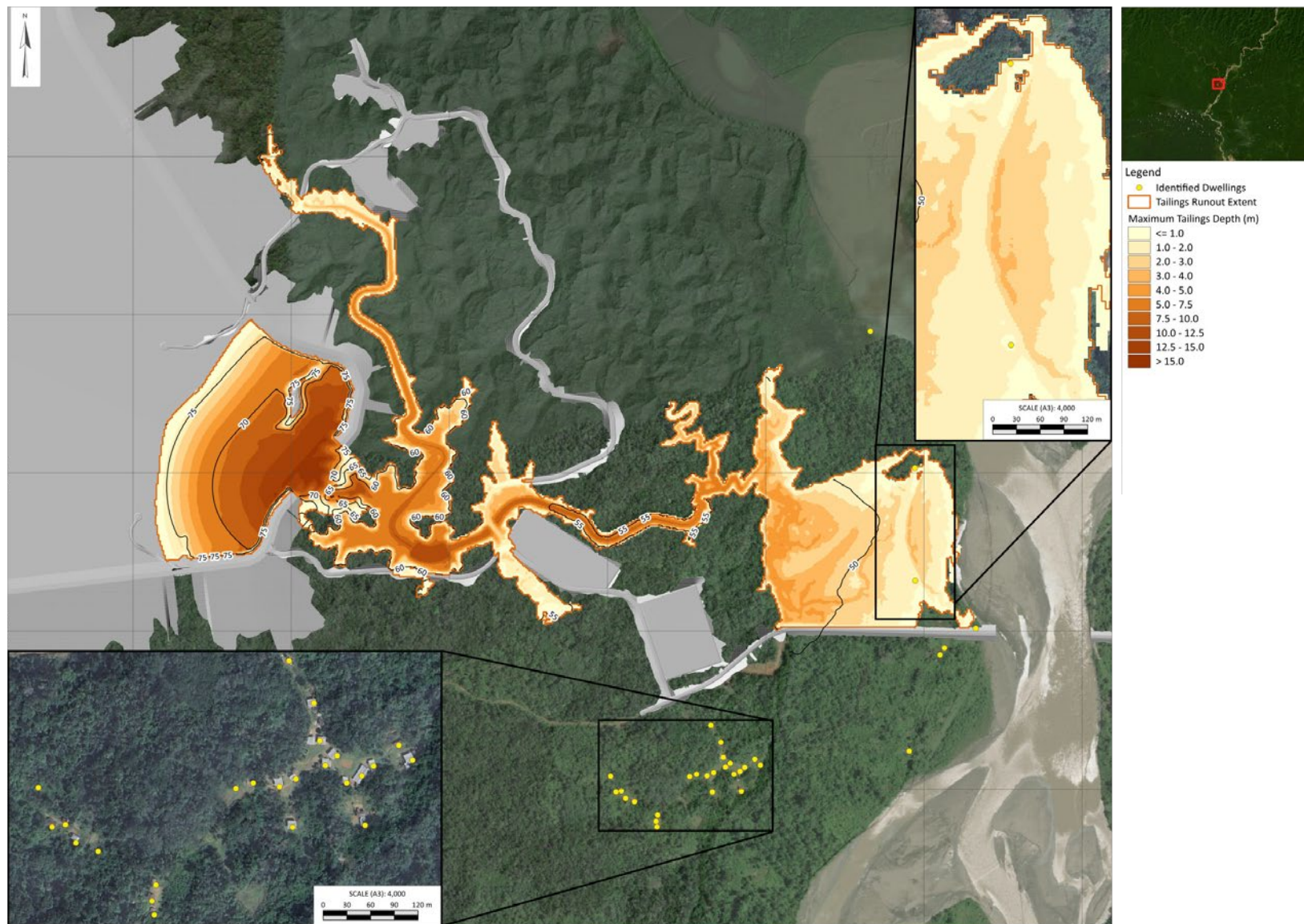
- Cell 1 Eastern break scenario: in a maximum depth scenario tailings runout extends west close to Kungembit; however, does not interact with any dwellings. It also runs north from the break location, before flowing for more than 5 km southwest along a valley north and west of Kungembit.
- Cell 1 Southern break scenario: in a maximum depth scenario tailings runout extends southwest avoiding Kungembit and Birimkamba; however, it would immediately flow across more than 1.5 km of the infrastructure tax credit scheme (ITCS) road significantly impacting it before moving in a southwest direction for more than 2 km.
- Cell 1 Eastern break scenario: in a maximum depth scenario the tailings runout extends north along a gully for more than 1 km. It also extends along an eastern gully for more than 2 km where it interacts with the site office infrastructure and hydro-cyclone access road. The tailings runout also travels east and expands into the Ok Tedi floodplain, impacting two dwellings and potentially impacting the bridge and ITCS Road as it reaches the Ok Tedi. The minimum time of arrival to reach the dwellings in this scenario is 1 to 2 hours. Figure 13.3 and Figure 13.4 show the maximum depth and minimum time of arrival for the cell 1 eastern break scenario.
- Cell 2 Western break scenario: in a maximum depth scenario tailings runout extends across the ITCS Road for approximately 500 m and then travels south down a gully for more than 2 km. The tailings runout also interacts and abuts the western edge of the TSF.
- Cell 2 Eastern break scenario: in a maximum depth scenario tailings runout extends in an arc along the gullies to the north and northeast for more than 1 km, coming close to dwellings but not interacting with them. It also extends in a southwest direction for more than 2 km, impacting two dwellings near the Ok Tedi. Tailings runout also flows across the ITCS Road at two locations south of the site office and laydown area, impacting approximately 1 km of the ITCS Road. The minimum time of arrival for the runout to reach the dwellings is between 30 minutes to 2 hours. Figure 13.5 and Figure 13.6 show the maximum depth and minimum time of arrival for this scenario.

Key conclusions that can be drawn from the dam break assessment are:

- The townships of Kungembit and Birimkamba are not inundated by the SDF runout because of the topographic separation from the TSF, and there is no incremental population at risk identified in the RDF scenario at the townships.
- Two dwellings identified through aerial imagery north of the planned Alice Bridge and ITCS Road are affected by the SDF runout, with incremental RDF flood depth increases of approximately 900 mm and 750 mm respectively.
- The ITCS Road is subject to significant impact, particularly in the cell 1 southern breach scenario. This road will be realigned prior to the completion of cell 2 construction.

The ANCOLD severity of damage and loss associated with dam break assessment was determined to be 'Major'. Consequences of complete failure leading to the uncontrolled release of large quantities of water and solids would likely result in extreme downstream environmental and social impacts. These would include:

- Potential for significant loss or degradation of critical habitat or rare and endangered species and contamination of fauna water supply. Low potential for acid and metalliferous drainage. Potential area of impact less than 20 km² with restoration being possible but difficult.
- Closure or temporary suspension of production at the mine has the potential to lead to both direct and indirect losses of employment. Potential for short-term human health effects.
- Potential for high economic losses affecting infrastructure, particularly blockage of the ITCS Road. Closure or temporary suspension of production at the mine has the potential to lead to both direct and indirect losses of employment. Relocation or compensation costs to communities are expected to be less than US\$100 million.



SOURCE
KCB, 2026

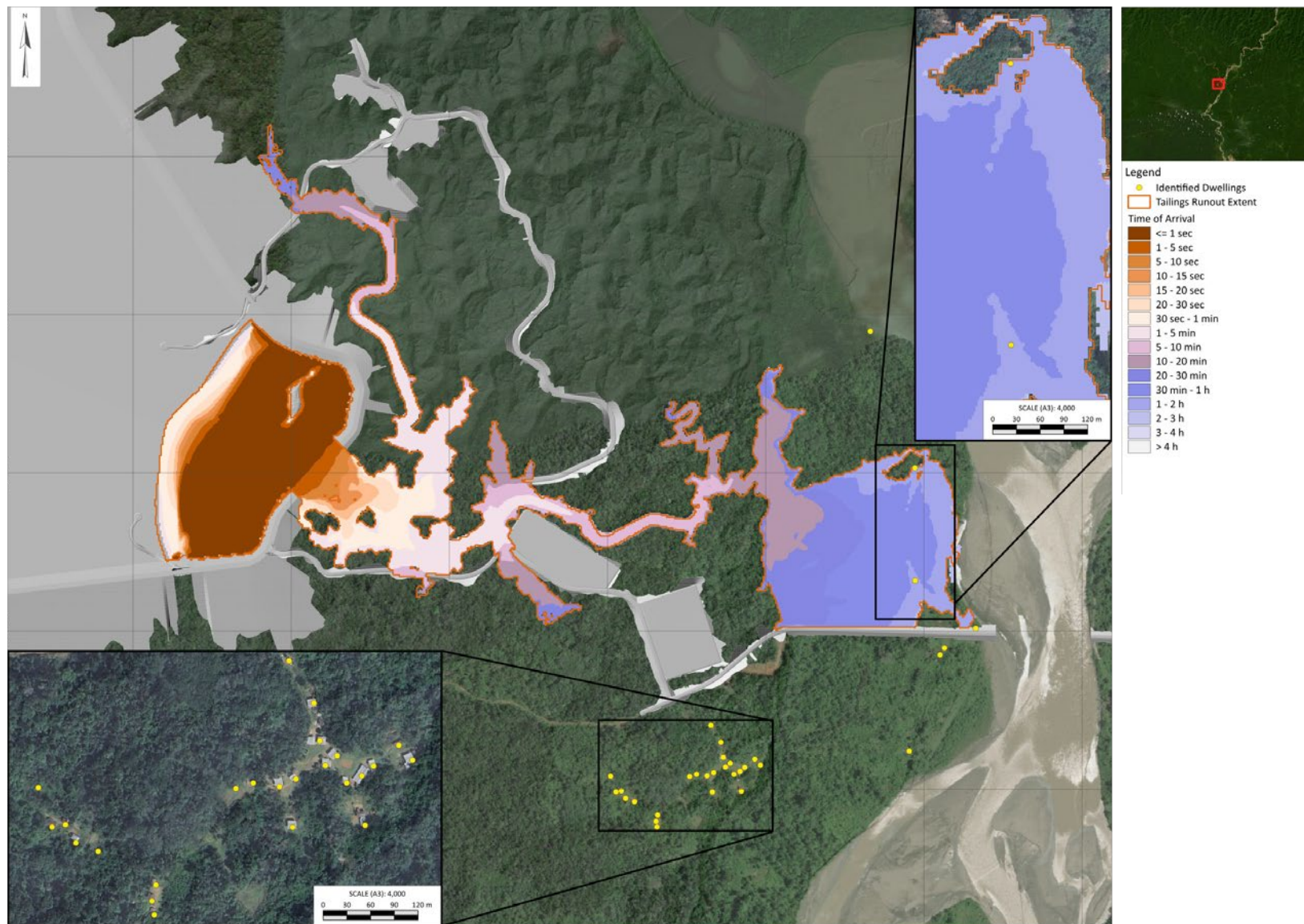


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FIGURE 13.3
Cell 1 eastern break maximum depth



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SOURCE
KCB, 2026

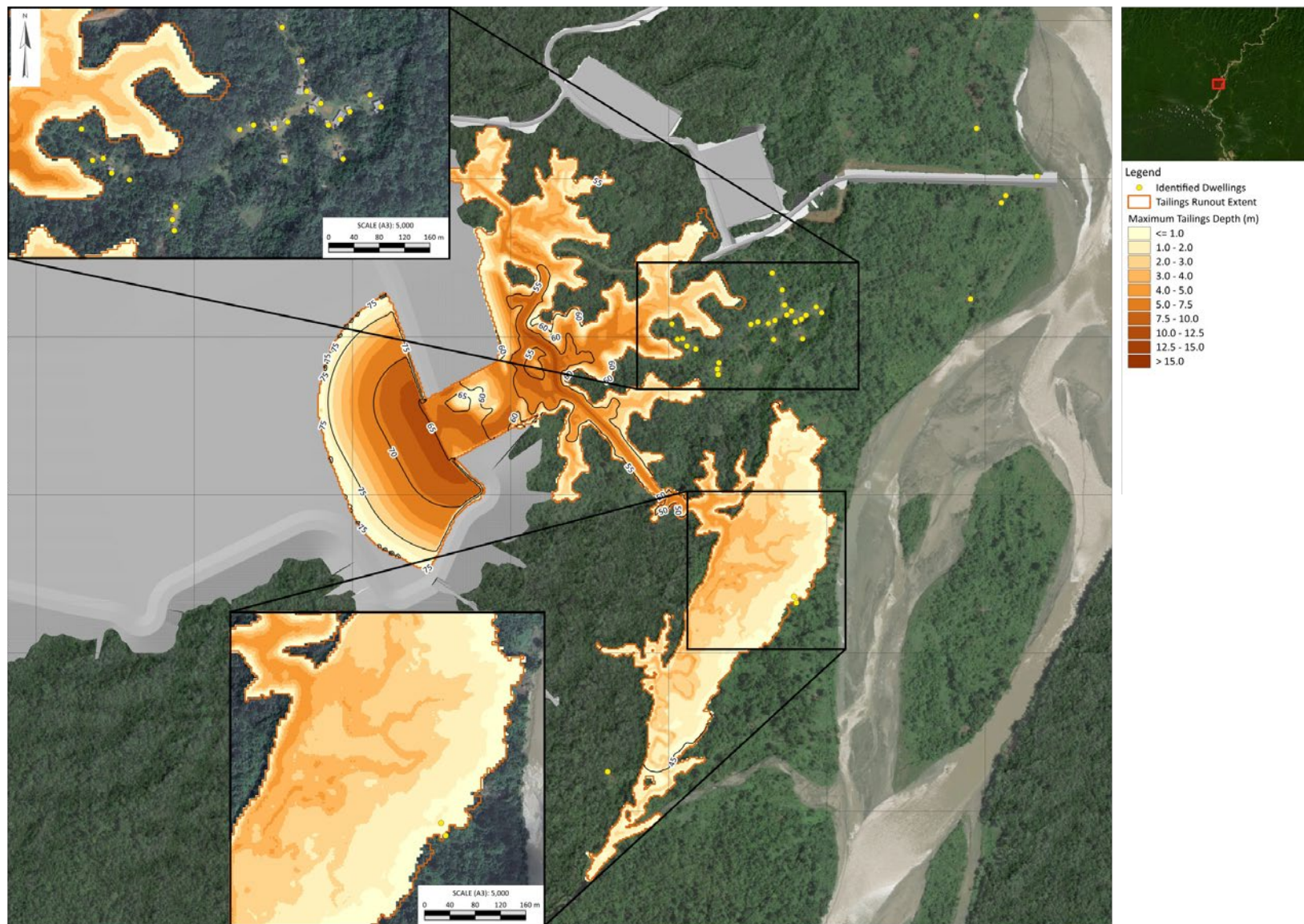


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FIGURE 13.4
Cell 1 eastern break minimum time of arrival



DATE: 21.06.26 PROJECT: 754-MELEN374244 FILE: 374244C_R08_F13.04_GRA



SOURCE
KCB, 2026

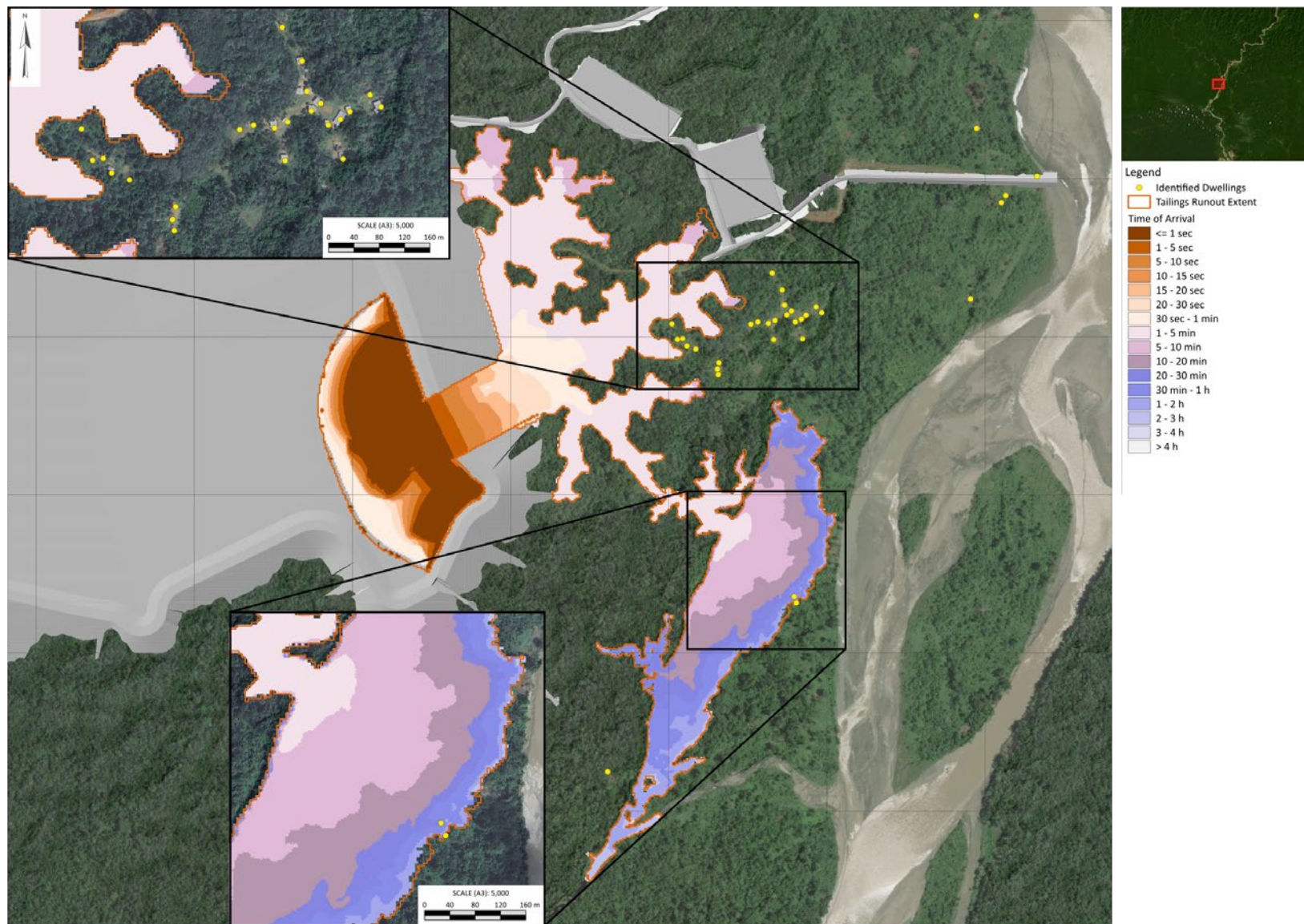


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FIGURE 13.5
Cell 2 eastern break maximum depth



DATE: 21.06.26 PROJECT: 754-MELEN374244 FILE: 374244C_R08_F13.05_GRA



SOURCE
KCB, 2026



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FIGURE 13.6
Cell 2 eastern break minimum time of arrival

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13.3.2.2 Potential loss of life

The potential loss of life has been estimated using population at risk values (PAR) and estimated fatality rates. The procedures published within the reclamation consequence estimating methodology (RCEM) guidance (US BoR 2014) have been adopted for flooding that can be primarily associated with water. The RCEM method adopts a fatality rate defined quantitatively in terms of a depth-velocity product and assumes there is little to no warning prior to failure.

For tailings inundation, the method of estimation described in Quantitative Vulnerability Estimation for Scenario-Based Landslide Hazards (Li et al. 2010) has been adopted. The approach considers the average velocity for the approaching material, the physical ability of a given person (approximated by age) and the preparedness for the event. The estimation method (dynamic for individuals) is described for persons in open space. The approach results in a significantly higher hazard to persons due to debris flow (interpreted as muds, sediment laden flows and landslides).

The PAR is defined as people who are exposed to a flood assuming they take no action to evacuate. In the rainy-day failure scenarios, the PAR is based on the incremental population over a natural flood that is affected by the dam break and is limited to a difference in depths greater than a 300 mm increment. Population estimates for adjacent settlements were derived through desktop assessment of available aerial imagery to identify dwelling locations. An assumed value of 6.1 persons per dwelling was applied based on regional demographic statistics for the Northern Fly District, Papua New Guinea (NSO 2011b).

Table 13.3 presents the incremental population at risk and the potential loss of life estimates based on an event with little or no warning time prior to failure.

Table 13.3 Incremental population at risk and potential loss of life estimates

Failure transect	Scenario	Incremental population at risk	Incremental potential loss of life	ANCOLD potential loss of life consequence category	GISTM consequence category
Cell 1 East	SDF	12.2	12.2	High A	Very High
	RDF	12.2	12.2	High A	Very High
Cell 1 South	SDF	0	0	Low	High
	RDF	0	0	Low	High
Cell 1 West	SDF	0	0	Low	High
	RDF	0	0	Low	High
Cell 2 East	SDF	6.1	6.1	High A	High
	RDF	12.2	6.1	High A	High
Cell 2 West	SDF	0	0	Low	High
	RDF	0	0	Low	High

13.3.2.3 Specific design controls and management measures

The likelihood of partial or complete failure of the TSF will be limited by:

- Incorporating geotechnical earthquake and slope stability studies and analysis, including drilling and the seismic hazard assessment, into the TSF design.
- Acquiring geotechnical information to inform and categorise the embankment foundations of the TSF.
- Adopting conservative criteria under ANCOLD and GISTM to address potential uncertainties associated with hydro-cyclone performance, foundation conditions and final tailings characteristics.
- Engaging and involving potentially affected parties downstream of the TSF to identify community risks and develop appropriate management strategies.

To address key limitations outlined in the dam break assessment (KCB 2026c) and verify requirements for emergency response planning measures the following measures are proposed:

- Undertake additional LiDAR surveys to address survey gaps from the lower Ok Yep catchment as well as bathymetric surveys.
- Develop updated population databases using a combination of available public data, remote sensing data, and ground truthing.
- Re-evaluate and perform testing after the cyclone is in operation (or when further pilot plant or processes are available).
- Validate village extents and usage of surrounding areas to support consequence category descriptions.
- Further develop and evaluate the failure mechanisms to support subsequent consequence category assessment and inform emergency and response planning.

13.3.2.4 Early warning surveillance monitoring of TSF embankment

In the event of a dam breach, significant environmental impacts could occur within the flood inundation zone and more widely from the release of tailings and decant water in the TSF. This has the potential to adversely impact on several nearby communities, including a number of dwellings and cultivated land and gardens associated with Birimkamba and Kungembit as well as surrounding roads/tracks used by the local community, including the ITCS Road.

Based on OTML's operational experience at Bige for constructing and managing similar large landforms in a high rainfall climate, recovery from a hypothetical breach is considered technically feasible through early warning systems and use of cofferdams, dewatering pumps and reinstatement of containment using hydraulic deposition of tailings.

Key components of the emergency preparedness and response planning for the project will include:

- Real-time surveillance monitoring of the TSF embankment stability and integrity using piezometers and other appropriate instrumentation.
- Early warning systems and communication protocols for downstream communities potentially at risk.
- Evacuation procedures for site personnel and downstream communities potentially at risk.
- Emergency support planning for essential services in downstream affected communities.

The Mineral Resources Authority of PNG (MRA) has regulatory responsibility for dam safety aspects of the project. Detailed emergency preparedness measures and procedures will be developed in consultation with MRA, PNG Conservation and Environment Protection Authority (CEPA), local authorities and downstream communities prior to TSF operation commencing.

Table 13.4 outlines the surveillance monitoring by trained personnel in accordance with ANCOLD (2019a) guidelines.

Table 13.4 Dam safety inspection levels and frequency for ‘high A’ dam failure consequence category

Type of inspection	Personnel	Purpose	Frequency of Inspection
Comprehensive	Dams Engineer and Specialist (where relevant)	The identification of deficiencies by a thorough on-site inspection, by evaluating data, and by applying current criteria and prevailing knowledge. Equipment should be test operated to identify deficiencies.	After first year of operation then once every two years.
Intermediate	Dams Engineer	The identification of deficiencies by visual examination of the dam and review of surveillance data against prevailing knowledge. Equipment is not necessarily operated.	Annual.
Routine	Operations personnel/inspector	The identification and reporting of deficiencies by field and operating personnel as part of their duties at the dam.	Daily to three times per week.
Special	Dams Engineer and Specialist	The examination of a particular feature of a dam for some special reason (e.g., after earthquakes, heavy floods, rapid draw-down).	As required.

13.3.2.5 Pipeline failure

The 87-km-long tailings pipeline will transport final tailings slurry from the existing Tailings Processing Plant at the Ok Tedi Mine to the TSF. A failure along the pipeline could result in the release of significant volumes of tailings material to the surrounding environment, potentially affecting land, water and nearby communities. The maximum volume of tailings discharged into the receiving environment in the event of a full rupture may reach 3,600 m³/hr until the system is shut down, based on the nominal volumetric flow rate of between 2,000 and 3,600 m³/hour.

Potential causes of failure include external factors such as vehicle collision, third-party interference (e.g., vandalism), extreme natural events (landslide, seismic activity) or significant erosional event (from flood at water crossings); as well as internal factors such as poor design, construction or maintenance (leading to corrosion); human error or equipment fault (i.e., overpressure or system malfunction).

A major leak or failure of the tailings pipeline or associated infrastructure could result in:

- Discharge of final tailings slurry onto land or into watercourses, leading to smothering of vegetation and habitat, increased downstream sedimentation and deterioration of water quality.
- Loss or decline of terrestrial and aquatic biodiversity and ecosystem function.
- Soil or water contamination affecting local environmental values and resource use.
- Adverse community impacts including health risks and disruption of livelihood or resource access.
- Operational disruption to the TSF or major breach of environmental compliance.

Although the final tailings slurry is expected to be non-acid forming, trace metals may still be present that could impact local water quality in the event of an uncontrolled release. The level of impact would depend on the location, discharge volume, dispersal pathway (i.e., in a watercourse or on cultivated land or settlement area) and duration of exposure. If tailings enter nearby streams, local surface water quality will be affected by sedimentation and elevated levels of metals, with the potential for localised adverse impacts on water quality, aquatic habitats and community water resource use. However, suspended sediment loads and contaminants transported along watercourses to the Ok Tedi are expected to be diluted rapidly upon entering the Ok Tedi, thereby limiting the potential for additional long-term downstream impacts on river water quality in the already degraded system.

13.3.2.6 Specific design controls and management measures

There have been failures of the pyrite concentrate and copper concentrate pipelines at Ok Tedi in the past and OTML has incorporated the lessons learned from these events in the design of the tailings pipeline. The design for the tailings pipeline and associated infrastructure therefore incorporates multiple safeguards to prevent failure and minimise the consequences of accidental release. Key design and engineering controls include:

- Select an optimised route that avoids permanent waterbodies (e.g., swamps, lakes) and minimises crossing unstable or karst terrain (as identified through geotechnical and seismic investigations) as far as practicable, while minimising river crossings, the number of catchments affected and potential transboundary risks.
- Subject the pipeline design to third party independent review by a suitably qualified engineer.
- Engineer all pipeline and bridge/water crossings in accordance with AS 5100 Bridge Design, incorporating protective measures to resist erosion, scour and failure due to flooding.
- Install pump station and choke stations at strategic locations to control pressure, prevent overloading and enable isolation of sections during maintenance or emergency shutdowns to minimise tailings loss in the event of a pipeline rupture.
- Equip the pipeline with automated monitoring systems, including flow meters and pressure sensors, to detect anomalies and trigger alarms for operator response in real time.
- Use high-pressure carbon steel pipeline with external protective coating on welded joints. Cathodic protection and pigging systems will be installed to allow for corrosion control, cleaning and maintenance, and internal inspection.

Additional design considerations to be confirmed through ongoing studies will aim to avoid and minimise the risk of tailings spillage entering high-value watercourses in the event of a pipeline rupture. Key considerations include:

- Locating the pipeline entirely within the Ok Tedi catchment.
- Installing rupture discs/pressure relief valves and bypass lines within the choke stations to prevent over-pressurisation and potential spillage to the environment.
- Incorporating control logic to minimise the magnitude of pressure transients during operational interruptions.
- Constructing containment troughs, diversion structures or catch ponds at sensitive locations along the pipeline, to control and contain any accidental or emergency discharge from the pipeline.
- Installing a fibre-optic communication backbone, connecting flow and pressure instrumentation along the system with acoustic/vibration detection capabilities. This communication method will enable the necessary data feed and delivery for a robust system that provides accurate and rapid leak and pig tracking capabilities.

Additional management and mitigation measures include:

- Bury pipeline to the extent possible (approximately 80% of the route) in accordance with good international industry practice to reduce exposure to accidental damage or third-party interference.
- Conduct hydrostatic and pressure testing prior to commissioning to check pipeline integrity.
- Inspect and maintain the pipeline routinely with targeted integrity checks following flood or ground instability events (washouts, landslips or seismic activity), including at bridge and water crossings for potential erosion and scouring.

- Schedule routine in-line inspections using intelligent pigging tools to measure metal loss and estimate erosion rates. Inspection intervals will be based on the risk presented by each pipeline segment, and results will be compared with previous inspections to monitor change over time.
- Install clear safety warning signage as needed along the pipeline.
- Implement conservative operating procedures consistent with IMS-STD-3.08 Tailings Management and supporting Tailings Management Plan.
- Remove or treat tailings spillage as required in accordance with OTML standard practices.

During operation, OTML will conduct regular inspection and maintenance of the tailings pipeline for leaks, ruptures or defects, and in the event of such failures, implement emergency shutdown procedures. Pump pressure and flow monitoring will assist with detecting leaks or blockages within the tailings pipeline and associated piping infrastructure. Visual inspections of the pipeline will also be undertaken regularly as per OTML's Pipeline Integrity Management Plan.

In the unlikely event of a tailings pipeline leak or rupture, control room personnel will immediately shut down the pipeline pumps to halt flow and activate spill response and clean-up procedures including dispatch of a maintenance crew to the affected section. Where feasible, slurry released into high-risk areas may be directed into purpose-designed containment structures (such as lined trough or catch pond) for recovery and returned to the TSF for safe disposal. The feasibility of this approach will be determined through detailed design.

Slurry tailings may also be temporarily diverted through the existing 1.5 km tailings processing plant pipeline for controlled discharge into tributaries of the upper Ok Tedi, consistent with OTML's current tailings management practices. If needed, post-incident downstream monitoring may be conducted of impacted areas to confirm if further actions for removal or remediation are required.

These procedures will be integrated within the project's Emergency Preparedness and Response Plan and other relevant documents to facilitate coordinated and timely emergency response followed by clean-up and environmental remediation in line with established OTML spill-response protocols.

13.3.3 Hazardous materials spill or leakage

The project will involve the handling, transport, storage and use of hazardous materials required for site operations, primarily hydrocarbons (diesel, lubricants) and hazardous wastes such as raw sewage and waste oil. Accidental large-scale spills or leaks of hazardous materials may lead to serious environmental and safety consequences.

Loss of containment may occur during transport, transfer or storage due to factors such as tank rupture, equipment failure, operator error, or external damage from collision, fire, explosion or earthquake. Transport of bulk fuel from Port Moresby to Kiunga by boat, and subsequently along the Kiunga–Tabubil Highway and ITCS Road by truck, also presents potential spill risks during transit due to vehicle/vessel collisions, operator error or equipment malfunction.

The severity of consequences will depend on the type and quantity of hazardous material released, location (land or water) and the sensitivity of the receiving environment. Large-scale releases could result in:

- Contamination of surface water or groundwater, with potential impacts on water quality.
- Degradation or sterilisation of land and soil, with consequential impacts on productivity and resource use.
- Loss or decline of terrestrial or aquatic biota (fauna, flora and habitat).
- Increased fire or explosion risk if flammable or combustible materials are involved.
- Community health risks and grievances from diminished livelihoods and loss of resource use access.
- Temporary interruption of project activities or major breach of environmental compliance.

Although the risk of major spills is low, the consequences warrant a robust design and operational procedures supported by comprehensive emergency preparedness and response.

Potential environmental impacts of hazardous material spills and leaks are further examined in Chapter 10.

13.3.3.1 Specific design controls and management measures

Hazardous materials will be managed under OTML's existing Hydrocarbon Management (IMS-STD-3.01) and Chemical Management (IMS-STD-3.03) standards, which establish controls for the safe handling, storage, transfer, and disposal of hazardous substances. The following design controls will apply to the project design:

- Design secure transfer and storage facilities for bulk fuel and liquid hazardous materials with primary and secondary containment (i.e., bunding) in accordance with PNG and Australian standards and guidelines, such as AS1940:2017 for the storage and handling of flammable and combustible goods.
- Install warning signage, security fencing and restricted access around fuel and hazardous materials storage areas and refuelling facilities to prevent unauthorised entry.
- Fit automated monitoring and response systems that will alert for irregular flows, pressures, etc. that could indicate leaks or containment failure.
- Procure fit-for-purpose vehicles, plant and machinery and regularly inspect and maintain in accordance with manufacturer specifications.

Management measures for hazardous materials transport, storage and handling are described in Chapter 10. Additional relevant measures include:

- Implement a hazardous materials management plan specifying requirements for the handling, transport, storage, spill response kit and disposal of hazardous materials consistent with OTML Hydrocarbon and Chemical Management Standards (IMS-STD-3.01 and 3.03).
- Provide appropriate personal protective equipment, training and spill clean-up equipment for handling hazardous substances.
- Require approved drivers and operators (including contractors) to be trained in safe handling of hydrocarbons, hazardous materials and environmental emergency response procedures with spill response equipment kept and maintained on trucks.
- Refuel vehicles, vessels and aircrafts at designated locations with measures provided to intercept and capture spills or contaminated water for adequate treatment.
- Regularly inspect and replenish spill response kits and safety equipment so they are always available.
- Monitor pipe, hose pressure and attachment during fuel transfers to enable early detection of spills or leaks.
- Undertake regular integrity testing and maintenance of hazardous materials transfer hosing and couplings.
- Implement grievance mechanism for community-related concerns or complaints relating to hazardous material spill or leak.

In the event of hazardous material spills or leaks, OTML will activate its established emergency response procedures in accordance with IMS-STD-1.16 Emergency Preparedness and Response Standard/Incident Management Standard, IMS-1.11-P01 Major Incident Management Plan/Incident Management Plan and MIMT Plan. These define a tiered response system compliant with IPIECA 2000 guidelines:

- Tier I – local site response managed with on-site resources.
- Tier II – national response led by PNG National Maritime Safety Authority with activation of the OTML Spill Response Committee.
- Tier III – international assistance if large-scale support is required.

OTML will ensure that all relevant personnel are trained and equipped to respond promptly to spills, recover spillage where possible, and remediate affected areas. Post-incident monitoring may be conducted as needed to verify the effectiveness of clean-up.

13.3.4 Fire or explosion

Uncontrolled fires or explosions may occur during construction or operations because of natural events or human activity, whether project-related or external. Project activities involving construction, materials handling, bulk fuel storage, transport and on-site power generation require the use of flammable and combustible materials such as fuels, and if blasting is required for construction, explosives. These present a risk of accidental fires or explosions.

Potential ignition sources include equipment or electrical failure, hazardous material leaks or spills, improper storage or handling of flammable and explosive materials, nearby bushfires or controlled burns (e.g., shifting cultivation by local villagers) and natural causes such as lightning.

Such incidents may result in significant injury, property damage and environmental harm, including:

- Fatalities or serious injuries to workers or community members within the impact zone.
- Damage to project, public or private assets and infrastructure.
- Air pollution from smoke and toxic fumes as well as contaminated runoff from firefighting water or spills.
- Contamination of land or water resources leading to environmental degradation.
- Loss of vegetation, fauna and habitat.
- Adverse community impacts, including health risks, loss of property, livelihoods and resource use.
- Unplanned disruption or suspension of project activities.

The severity of potential impacts from uncontrolled fires can be influenced by weather such as hot dry conditions or prolonged droughts, which can increase the risk and spread of bushfires.

13.3.4.1 Specific design controls and management measures

The project will integrate the following key design controls to avoid or minimise potential impacts of fire or explosion:

- Install fire detection and suppression systems as required at key project facilities, including the hydro-cyclone house, bulk fuel storage areas and diesel generators (where applicable).
- Incorporate specific fire prevention, detection, control and personnel safety criteria into the design of project infrastructure.
- Design fire alarm and suppression systems to meet current applicable PNG standards or, where lacking, Australian Standards such as AS1851:2012 Routine Service of Fire Protection Systems and Equipment.
- Provide appropriate bunding and engineer bulk fuel and hazardous material storage facilities in accordance with AS1940:2017 standards for flammable and combustible liquids.

Additional management measures for unplanned fires or explosions include:

- Develop and implement a fire management plan containing measures to prevent and respond to fire or explosion emergencies on-site, including fire prevention and firefighting training to the site emergency response team, staff and contractors.
- Implement a hazardous materials management plan, detailing specific requirements for the handling, transport, storage, appropriate personal protective equipment (PPE) and spill response and disposal of hazardous materials; adapted from OTML's existing standards, where appropriate.

- Follow safe handling, storage and transportation practices for hazardous, explosive and flammable materials (including waste) in compliance with relevant statutory standards and AS 1940:2017 for the storage and handling of flammable and combustible goods. Key requirements include secure segregation and siting at least 500 m from manned areas such as control rooms and accommodation facilities.
- If applicable during construction, store explosives and blasting accessories in secured magazine compound at least 500 m from other infrastructure and in compliance with relevant statutory requirements.
- Maintain trained emergency response teams and identify firefighting equipment suitable for each risk area, including regular testing and servicing.
- Prohibit all 'hot-works' (work involving heat, spark or flame) near flammable or combustible materials.
- Establish and maintain firebreaks around critical infrastructure including the TSF, cyclone house, fuel and hazardous storage areas, and diesel generators.
- If fire hazard is high (e.g., during prolonged drought), stockpile cleared vegetation in an open area (i.e., surrounded by a firebreak) and do not burn cleared vegetation.
- Engage a suitably licensed testing and certification authority to inspect, approve, certify and commission all fire safety and suppression systems and equipment.

In the event of a fire or explosion, OTML will activate its EPRP for the project to coordinate fire control, evacuation and response actions. Emergency teams will suppress fires using on-site firefighting systems.

13.3.5 Traffic accident (road, air or water)

During construction and operations, the project will require the transport of workers (including contractors), heavy machinery and equipment, fuel, materials, and supplies primarily between Port Moresby, Kiunga Port and the TSF site. Bulk fuel, materials and equipment will be shipped via boat from Port Moresby to OTML's Kiunga Port on the Upper Fly River, then trucked by road via the existing Kiunga-Tabubil Highway and ITCS Road to the site. Workers will be transported primarily by bus, while helicopters and charter aircraft will be used for limited movements of key personnel and equipment/supplies using helipads established around worksites and the existing Tabubil airstrip.

Traffic incidents such as collisions, crashes, vessel groundings or sinkings may occur due to equipment or structural failure, poor maintenance or road conditions, operator error, driver fatigue, adverse weather (e.g., poor visibility), natural hazards (e.g., landslides, seismic activity, flooding, tree debris). Shared use of key transport routes, particularly the Kiunga-Tabubil Highway, ITCS Road and Fly River main channel, also increases the risk of accidents involving other road and river users.

Potential significant consequences from project-related traffic accidents include:

- Fatalities or serious injuries to workers or community members.
- Damage to vehicles, vessels, aircraft or property (project and non-project owned).
- Disruption of logistics or key transport routes affecting TSF operations.
- Fuel spills or release of other hazardous materials causing contamination or fire hazards (as discussed in sections 13.3.4 and 13.3.5).
- Community impacts or grievances, particularly if other local users or villages are impacted.

13.3.5.1 Specific design controls and management measures

The project will adopt robust design, operational and safety controls to minimise traffic risks across all modes of transport. These measures will align with OTML's existing operational transport safety practices, procedures and comply with PNG regulations.

Key design and engineering controls include:

- Design and construct project roads, bridge and water crossings to OTML specifications and PNG Department of Works standards and applicable Australian national codes and standards, incorporating flood, scour and erosion protection.
- Design main access roads to accommodate a 1-in-100-year flood event and 1-in-20 for construction and minor access roads/tracks.
- Consider local topography, flood prone areas and visibility constraints (e.g., low-lying fog zones, vegetation maintenance requirements) in the positioning and safe design of access roads and helipads.
- Upgrade access roads to the site in accordance with the project description (Chapter 6) to accommodate for construction activities and associated vehicle fleet.
- Design and maintain safe access roads with good visibility and sightlines, with no sharp turns or blind drop-offs.
- Locate laydown areas and construction facilities away from villages and major settlements where practicable.
- Provide dedicated pedestrian footpaths on single or two-lane bridges.

Major traffic-related incidents will be minimised by implementing the following management measures:

- Implement site management and safety measures, including exclusion zones near construction works and using traffic controllers near work areas, at entries/ exits to construction sites, etc.
- Apply OTML's zero-tolerance policy for alcohol and drugs, including random testing of drivers and operators.
- Integrate OTML's existing operational traffic management programs and procedures, including for journey management, fatigue management, driver training and competency, and vehicle maintenance.
- Implement a traffic and transport management plan prior to construction to manage traffic safety risks associated with the project, particularly along shared routes. The traffic and transport management plan will include traffic safety measures, such as:
 - Speed limits for OTML drivers.
 - Safe distance between other vehicles/vessels/aircraft, pedestrians and obstacles, where required.
 - Procedure to limit or stop operations in extreme weather or unsafe conditions.
 - Project trucks to be in convoy with escort vehicles.
- Conduct regular inspection and maintenance of vehicles, vessels, aircraft and transport infrastructure (e.g., integrity checks of road surface and water crossing/bridge particularly after flood) in accordance with OTML safety standards.
- Require all drivers and operators (including contractors) to hold valid licences and complete mandatory safety and defensive driving/operating training.
- Restrict project traffic to approved routes based on vehicle route risk assessments factoring in type of vehicle, cargo and crossings; and travel in convoy if needed for high-risk transport (e.g., dangerous or hazardous materials).
- Install speed limits, clear signage and road markings on project routes to promote safe driving behaviour.
- Provide road signage near villages and major settlements.
- Coordinate regularly with local authorities and communities to manage shared access, maintain safety and minimise disruptions.
- Conduct regular community engagement and awareness campaigns to inform local residents of project traffic patterns, transport safety awareness, and safety precautions.

- Plan logistics to avoid high-risk travel during peak hours of schools, at night-time or during poor visibility where practicable; and carefully manage shipping during low water levels on the Fly River to reduce risk of boat traffic incidents.
- Equip all vehicles, vessels and aircraft with appropriate fire extinguishers, safety equipment, spill kits and emergency response tools and train operators/drivers on how to use them.
- Apply dust suppression as required on key access roads if visibility is poor due to dust generation.
- Maintain an incident reporting system and grievance mechanism for project-related traffic incidents.

13.3.6 Plant or mobile machinery accident

Heavy plant and mobile machinery will be required during project construction and operations for land clearing, TSF embankment construction, tailings pipeline installation, road construction works, and materials extraction and hauling from local borrow pits and quarries. The frequent use of heavy plant and machinery poses inherent safety and operational risks such as crushes, collisions or rollovers.

Accidents may occur due to mechanical failure, operator error and fatigue, unsafe ground conditions, poor weather visibility, or natural hazards (landslide, seismic activity). Potential consequences of heavy plant or mobile machinery accidents may include:

- Serious injury or loss of life to operators or nearby workers.
- Damage to machinery, plant equipment, site infrastructure and property (project and non-project owned).
- Environmental harm from fuel spills and fire hazards (as discussed in sections 13.3.4 and 13.3.5).
- Temporary disruption to construction or operational activities.

13.3.6.1 Specific design controls and management measures

The project will apply OTML's established occupational health and safety systems, supported by training, inspection and maintenance programs, to minimise risks associated with the use of heavy plant and machinery. Major accidents involving plant or mobile machinery will be minimised through implementing the following measures:

- Apply OTML's zero-tolerance policy for alcohol and drugs, including random testing of operators.
- Develop and implement an occupational health and safety plan detailing requirements for mandatory safety training and refreshers, pre-start inspections and toolbox meetings, incident reporting and investigation in relation to plant and mobile machinery hazards, etc.
- Install warning signage and restricted access to high-risk areas where active mobile machinery occurs.
- Equip all machinery with standard safety features, including shutdown systems, audible and visual reversing alarms, warning beacons, headlights, and communication devices such as radios and walkie-talkies.
- Enhance the visibility of light vehicles by equipping them with high visibility markings, hazard flags and flashing beacons.
- Enforce safe operating procedures, designated routes and site speed limits consistent with the traffic and transport management plan.
- Conduct regular inspection and maintenance of heavy plant and mobile machinery in accordance with manufacturer specifications and OTML safety standards.
- Require all operators to undergo mandatory training, hold valid licenses and necessary qualifications specific to the equipment they operate.

- Undertake site-specific safety inductions and training programs to all project workforce to promote awareness of safe work practices, particularly around heavy plant and mobile machinery.
- Monitor operator performance periodically to evaluate ongoing compliance and competency and conduct refresher training if needed.

In the event of a major accident involving plant or mobile equipment, OTML will initiate its MIMT Plan to coordinate emergency response actions. This will include securing the area, providing immediate first aid and medical assistance, notifying relevant authorities, and conducting an incident investigation to identify root causes and corrective measures. Lessons learned will be incorporated into future training and operational procedures to prevent recurrence.

13.3.7 Epidemic or infectious disease outbreak

Epidemics and infectious disease outbreaks (such as COVID-19, HIV/AIDS, tuberculosis) and vector-borne diseases (such as malaria) have the potential to be introduced and/or spread throughout the project duration due to:

- Transmission of vector-borne diseases (transfer by insects or other animals) and pathogens from the influx and movement of non-local persons into the project area (project workforce, migrant work seekers and service providers) particularly during construction, and interactions with the local communities.
- Poor hygiene practices and awareness about infectious disease transmission control.
- Improper waste management and/or limited access to sanitation, medicine and health facilities.
- Creation of standing water pools and mosquito breeding habitat during construction or from improper site drainage.

Such outbreaks may lead to significant negative impacts to the health and wellbeing of affected workers and local communities, including:

- Severe illness or loss of life among workers and community members.
- Disruption of project operations due to reduced workforce.
- Loss of income and livelihoods due to inability to work or access essentials such as food and water.
- Community tensions and unrest due to fear or misinformation.

Such impacts can be particularly severe in remote areas where access to health services is limited.

Chapter 11 provides further details on community health risks.

13.3.7.1 Specific design controls and management measures

The potential for outbreaks of epidemics and infectious disease outbreaks will be minimised by implementing the following measures:

- Follow health protocols established by local and national authorities for infectious disease control in compliance with the *National Pandemic Act 2020* requirements, as well as internal policies and mandatory health testing and quarantine protocols.
- Integrate existing OTML policies, strategies and plans for the project to control the spread of infectious diseases. This includes the MIMT Plan, which includes a dedicated infectious disease outbreak checklist requiring activation of the MIMT, implementation of personal hygiene protocols, social distancing measures, and business continuity plans to operate safely.
- Prepare and implement a Project-induced In-Migration Management Plan in consultation with landowners, Ningerum local-level government and provincial government.
- Include TSF villages within existing water, sanitation and hygiene education and awareness activities conducted by Ok Tedi Development Foundation.

- Engage with provincial government and Monfort Catholic Mission to monitor the capacity of health services in Kungim, Ningerum, Matkomnai, and Rumginae and investigate any reductions in service capacity.
- Require pre-employment medical screenings and regular health check-ups for workers (including contractors) to test for infectious diseases such as tuberculosis and sexually transmissible infections, as well as proper counselling and treatment to those affected while respecting confidentiality.
- Deliver regular health awareness and education programs for workers, contractors and the local community focussed on the symptoms and prevention methods of prevalent infectious diseases such as for HIV/AIDS infection, tuberculosis and malaria such as promoting safe sex and good hygiene practices.
- Coordinate with local health services to support community health education and awareness campaigns, including for regular immunisations, tuberculosis screening, maternal and HIV/AIDS education, nutrition and medicine support.
- Implement vector-borne disease prevention measures such as:
 - Design and maintain drainage systems to minimise standing water and reduce mosquito breeding sites, particularly around camps and active construction areas.
 - Support improved access to clean water, sanitation infrastructure and impregnated mosquito nets in communities affected by the project through OTML's community development initiatives.
- Equip major camp and worksite facilities with appropriate medical facilities and resources to encourage good hygiene practices and prevention of sexually transmissible infections (e.g., free access to masks and condoms for workers).
- Manage sanitation of the workforce and accommodation camps, including handwashing and sanitation facilities; site sewage and waste management and disposal as per OTML's current practices; pest and vermin control plan and personal protective equipment as required.
- Require contractors to adhere to relevant measures for disease prevention and management.
- Engage with and support local health services to monitor health of local communities and address emerging or significant trends in disease outbreaks.

13.3.8 Civil unrest, protest or riot

Civil unrest, protests or riots may occur during project construction or operation due to social, economic or political tensions within local communities or the wider region. Causes may include real or perceived inequities in employment and benefit sharing, land ownership disputes, growing population and in-migration pressures, or community dissatisfaction and grievances related to OTML or project activities. External factors such as socio-political instability, external organised agitation, regional conflict or rise in criminal activity can also exacerbate these risks.

Potential consequences and impacts of unrest or protest may include:

- Threats to workers and community safety, including incidents of violence or intimidation.
- Arrest, illegal detention, kidnapping, ransom or extortion of personnel.
- Property damage, vandalism or theft of assets (project and non-project owned).
- Disruption or temporary suspension of project activities.
- Escalation of community grievances resulting in reputational damage or regulatory consequences for OTML.

13.3.8.1 Specific design controls and management measures

OTML has undertaken extensive stakeholder engagement with local communities over the last four decades for its current operations. Through this, the company has established formal communication channels and committees at various levels, and tailored consultation programs and a grievance mechanism designed to identify and address potential sources of tension. These practices now align with international good practice for stakeholder engagement, security and human rights.

Major incidents involving civil unrest, demonstrations and riots will be minimised via the following measures:

- Continue transparent and inclusive stakeholder engagement to maintain open dialogue with communities, leaders and local authorities throughout all project phases. Engagement activities will include awareness programs on local job and business development opportunities, compensation and benefits-sharing, and the grievance redress mechanism.
- Provide fair compensation, livelihood restoration and support for losses of, or loss of access to, community land and resources, assets, and livelihoods arising from project activities. Specific attention will be given to the support of people most directly impacted by loss of land due to the TSF footprint.
- Promote OTML's policy on local employment, recruitment and labour conditions as well as localisation and in-migration plans to discourage opportunistic in-migration.
- Implement a supply and procurement policy for the project that gives priority to establishing contracts with local service providers and vendors.
- Establish buffer zones, perimeter fencing, patrols and security infrastructure including gatehouse with entry checkpoints to prevent unauthorised access to high-risk facilities (e.g., hydro-cyclone house, hazardous materials storage areas).
- Require that all security personnel are provided with appropriate training and code of conduct about respecting human rights, prohibiting the use of force and conflict de-escalation strategies.
- Develop and implement a security plan for the project incorporating routine security risk assessments.
- Implement grievance mechanism to international standards for project-related complaints.
- Work closely with local governments and traditional authorities to manage influx of persons and support law and order, including for police presence in the area if needed.

In the event of unrest or civil disturbance, OTML will activate the MIMT Plan and site-specific security protocols. Immediate actions will focus on personnel safety, securing facilities, and maintaining communication with affected stakeholders. OTML will work closely with law enforcement and community leaders to restore calm, resolve grievances (if applicable), and facilitate the safe resumption of operations.

13.4 PROJECT EMERGENCY PREPAREDNESS AND RESPONSE

OTML's existing IMS-1.11-P01 Major Incident Management Plan (MIMP) will be used in accordance with IMS-STD-1.16 Emergency Preparedness and Response Standard/Incident.

The MIMP defines clear responsibilities, communication systems and coordination arrangements for effective emergency management. It will include, but not be limited to:

- Protocols for early notification of potential and actual emergency situations.
- Triggers for escalation of emergency response procedures based on defined levels of threat for the workforce and potentially affected communities.
- Regular drills to test timely and effective response to a natural disaster, emergency or spill.
- Periodic inspection and maintenance of critical systems and facilities, including the TSF, tailings pipeline, diesel generators and hazardous materials storage and handling facilities.

- Regular inspection, testing and maintenance of fire suppression, firefighting and emergency spill response equipment.
- Measures to reduce risks to as low as reasonably practicable.
- Training and induction programs for all personnel and contractors.
- Procedures for medical evacuation and coordination with nearby health facilities.
- Community notification and evacuation protocols in the event of a TSF-related emergency or major spill.
- Defined coordination arrangements with PNG government agencies, local authorities and community leaders.
- Regular awareness programs for potentially affected communities about emergency preparedness and response to understand the alert and communications systems used in the very unlikely event of a TSF-related emergency.
- Details of OTML's emergency support arrangements to assist affected communities following an incident.

The MIMP will be updated as required to address TSF-related major incidents.

OTML's existing emergency response procedures will cover most major incidents and potential emergency situations. These will be integrated within the MIMP specific to TSF-related major incidents and include relevant protocols for coordination, response, communication and notifying potentially affected parties for the project.

OTML will also establish a comprehensive TSF stewardship and governance framework, including the development and implementation of a TSF Operations, Maintenance and Surveillance (OMS) Manual consistent with the principles and requirements of GISTM, ANCOLD and ICOLD guidelines. The framework will define clear accountability for design verification, independent technical review, change management, performance monitoring, and emergency preparedness. Regular audits and lessons-learned evaluations will drive continuous improvement in risk control effectiveness.

Key provisions from the TSF OMS Manual will be incorporated into the MIMP, including performance thresholds that trigger predefined contingency actions and emergency response protocols. Together, these arrangements will maintain a proactive, well-coordinated and transparent approach to emergency preparedness and response throughout the project lifecycle.

13.5 CONCLUSION

Emergency preparedness and response underpin OTML's commitment to safe and responsible operations. The project design incorporates prevention, control and mitigation measures consistent with good international industry practice so that significant risks and credible major incidents are anticipated, mitigated and effectively managed.

An important component of the TSF design has been the development of design, engineering and operational controls to prevent or withstand most extreme credible natural hazards and unplanned events, including those related to climate change. Recognised international guidelines, technical standards and design criteria have been applied to avoid or minimise risks to people, the environment and operations. Key examples include:

- Designing the TSF to meet an extreme hazard/consequence category under ANCOLD guidelines, providing a conservative contingency appropriate for a high consequence facility.
- Adopting conservative geotechnical and hydrological design criteria that accommodate extreme flood and seismic events.
- Integrating structural redundancy and conservative factors of safety for critical systems and facilities (including the TSF, bridge/water crossings, tailings pipeline, hazardous materials storage areas).
- Incorporating conservative design allowances for rainfall variability and water balance management under projected future climate scenarios.

In addition to these design safeguards, OTML will implement its MIMP for the commencement of construction and update this for TSF-specific major incidents prior to commissioning the TSF. The plan will define clear emergency management responsibilities, communication protocols and response procedures for specific major incidents, including natural disasters, major spills, fires, TSF or pipeline failure and other unplanned events. It will align with OTML's operational risk management system and the associated plans, standards and procedures that form part of its established emergency preparedness and response framework.

Although the probability of major incidents is low, the project has been suitably designed with robust and climate-resilient safeguards in place to minimise significant risks to people, the environment and operations. During detailed design, significant risks and credible major incident scenarios will be re-evaluated using updated site-specific information and risk workshops to confirm that residual risks are as low as reasonably practicable.