

# Ok Birim Tailings Storage Facility Project

Environmental and Social Impact Assessment

## Appendix I

Noise assessment technical report



# Ok Birim Tailings Storage Facility

Noise and Vibration Impact Assessment

S8629C5

June 2026

sonus.

**Sonus Pty Ltd**  
17 Ruthven Ave  
Adelaide SA 5000  
Phone: +61 (8) 8231 2100  
Email: [info@sonus.com.au](mailto:info@sonus.com.au)  
[www.sonus.com.au](http://www.sonus.com.au)

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Noise and Vibration Impact Assessment

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**Author** : Byron Holmes, MAAS

**Reviewer** : Chris Turnbull, MAAS

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## EXECUTIVE SUMMARY

Sonus has been engaged by Tetra Tech Coffey (**TTC**) on behalf of Ok Tedi Mining Ltd (**OTML**) to conduct an environmental noise assessment for the Ok Birim Tailings Storage Facility (**TSF**) project (the **project**) within Papua New Guinea's (**PNGs**) Western (Fly) province.

The assessment has established baseline noise levels at noise sensitive receptor locations, and environmental noise criteria which apply to the construction and operational phases of the project. Noise levels from each aspect of construction and operation of the project have been predicted and compared against the established noise criteria.

Based on the assessment, operational noise impacts are predicted to achieve the nominated criteria at all noise sensitive receptor locations during both the "daytime" (7:00 am to 10:00 pm) and "nighttime" (10:00 pm to 7:00 am) periods, except at one sensitive receptor location (Kungembit) when an exceedance is predicted during the nighttime period only.

As the operational noise impacts at Kungembit are dominated by mobile plant conducting tailings placement and embankment uplift activities, the exceedance will be limited to periods when these activities occur within 1,500 m of Kungembit during the night period. Outside of this distance compliance with the nominated criteria is predicted at all noise sensitive receptor locations at any time of the day or night. Operational noise impacts from the project will therefore be localised to a single noise sensitive receptor and relatively short-lived in duration, and in this context are considered to be relatively minor.

Recommended noise mitigation measures are provided which should be reviewed as the construction methodology is refined and included in an Operational Noise Management Plan (**ONMP**) to ensure that operational noise impacts are minimised as far as is practicable.

Noise from construction of the TSF and associated infrastructure will achieve the nominated criteria at all noise sensitive receptor locations. Notwithstanding, it is recommended that a Construction Noise and Vibration Management Plan (**CNVMP**) be prepared for infrastructure corridor works in the vicinity of populated areas to ensure that construction noise and vibration impacts are minimised as far as is practicable.

Road traffic noise associated with gravel haulage between the Ok Tedi and the TSF has been predicted, and will comfortably achieve the nominated noise criteria. Lower traffic volumes occur for other aspects of the project, and are expected to result in negligible impacts in the context of the ambient noise environment and existing road traffic on the relevant routes. Noise from additional road traffic along the pipeline access road beyond that directly associated with the project (i.e. 'induced demand') has also been predicted and will also achieve the relevant noise criteria.

## GLOSSARY

|                                          |                                                                                                                                                                                                                                                         |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A-weighting                              | Frequency adjustment representing the response of the human ear                                                                                                                                                                                         |
| ANZECC                                   | Australian and New Zealand Environment Conservation Council                                                                                                                                                                                             |
| The ANZECC Guidelines                    | <i>Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration</i>                                                                                                                                           |
| CONCAWE                                  | The oil companies' international study group for conservation of clean air and water in Europe.                                                                                                                                                         |
| Background Noise                         | Noise in the absence of the project determined by monitoring conducted for previous similarly located projects within PNG                                                                                                                               |
| C weighting                              | Frequency adjustment which places emphasis on the low frequency range                                                                                                                                                                                   |
| CMCA                                     | Community Mine Continuation Agreement                                                                                                                                                                                                                   |
| CNVMP                                    | Construction Noise and Vibration Management Plan                                                                                                                                                                                                        |
| dB(A)                                    | A weighted noise level measured in decibels.                                                                                                                                                                                                            |
| dB(C)                                    | C weighted noise level measured in decibels.                                                                                                                                                                                                            |
| DIN 4150-3                               | <i>DIN 4150-3 Structural vibration - Effects of vibration on structures (1999) for dwellings and buildings of similar design and/or occupancy</i>                                                                                                       |
| EHS                                      | Environment, Health and Safety.                                                                                                                                                                                                                         |
| ESIA                                     | The Environmental and Social Impact Statement for the project                                                                                                                                                                                           |
| IFC                                      | International Finance Corporation                                                                                                                                                                                                                       |
| IFC Guidelines                           | International Finance Corporation <i>General Environmental, Health, and Safety (EHS) Guidelines: Environmental Noise Management (April 2007)</i>                                                                                                        |
| Infrastructure corridor communities      | Refers to communities located in proximity to the infrastructure corridor, including those along the proposed tailings pipeline and access road                                                                                                         |
| Infrastructure corridor development area | Encompasses the construction footprint required for the proposed access road, bridge and water crossings, tailings pipeline and supporting facilities outside the TSF development area.                                                                 |
| ITCS                                     | Infrastructure Tax Credit Scheme                                                                                                                                                                                                                        |
| ITCS Road                                | Alice Pit–Border Post Road to be constructed under the ITCS. The assessment, approval and construction of ITCS Road is separate to the project and its ESIA                                                                                             |
| Kiunga-Tabubil Highway                   | The primary mine access road transporting materials between the mine and Kiunga Port. The highway also connects the mine to Bige and regional centres Tabubil, Ningerum and Kiunga. Currently maintained and progressively upgraded and sealed by OTML. |
| LA90                                     | The A weighted sound pressure level that is exceeded for 90 percent of the time over which a given sound is measured.                                                                                                                                   |

|                              |                                                                                                                                                                                                                                                                                                                        |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L <sub>Aeq</sub>             | The A weighted equivalent continuous noise level – the energy-average of noise levels occurring over a measurement period.                                                                                                                                                                                             |
| dB <sub>Lin, Peak</sub>      | The linear (unweighted) peak instantaneous noise level in decibels.                                                                                                                                                                                                                                                    |
| OTML                         | Ok Tedi Mining Ltd (project proponent)                                                                                                                                                                                                                                                                                 |
| PNG                          | Papua New Guinea                                                                                                                                                                                                                                                                                                       |
| PPV                          | Peak Particle Velocity which is the maximum velocity of a particle of the solid surface.                                                                                                                                                                                                                               |
| The project                  | Ok Birim Tailings Storage Facility project                                                                                                                                                                                                                                                                             |
| Project affected communities | Refers to communities potentially directly and indirectly impacted by the project                                                                                                                                                                                                                                      |
| Project area                 | The geographic area occupied by the project's infrastructure and directly associated activities, including the permanent and temporary facilities required for construction, operations, and closure. This includes the TSF, access road, bridge and water crossings, tailings pipeline and supporting infrastructure. |
| Project footprint            | Refers to all areas directly impacted by the project during construction.                                                                                                                                                                                                                                              |
| Regional centres             | Refers to the towns that service the region                                                                                                                                                                                                                                                                            |
| Sensitive receptor           | A location in the vicinity of the project as known to have some level of sensitivity to the project.                                                                                                                                                                                                                   |
| Sound power level            | A measure of the sound energy emitted from a source of noise.                                                                                                                                                                                                                                                          |
| TSF                          | Tailings Storage Facility                                                                                                                                                                                                                                                                                              |
| TSF communities              | Refers to communities located within and near the TSF development area                                                                                                                                                                                                                                                 |
| TSF development area         | Encompasses the construction footprint of the proposed TSF impoundment, hydro-cyclone house, laydown area and associated ancillary infrastructure.                                                                                                                                                                     |
| TTC                          | Tetra Tech Coffey                                                                                                                                                                                                                                                                                                      |
| WBG                          | World Bank Group                                                                                                                                                                                                                                                                                                       |
| WHO                          | World Health Organisation                                                                                                                                                                                                                                                                                              |
| WHO Guidelines               | Berglund B, Lindvall T & Schwela DH 1999, <i>Guidelines for Community Noise</i> , World Health Organisation (WHO).                                                                                                                                                                                                     |

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## 1 INTRODUCTION

Sonus has been engaged by Tetra Tech Coffey (**TTC**) on behalf of Ok Tedi Mining Ltd (**OTML**) to conduct an environmental noise assessment for the Ok Birim Tailings Storage Facility (**TSF**) project (the **project**) within Papua New Guinea's (**PNGs**) Western (Fly) province.

The assessment predicts noise impacts on noise sensitive receptor locations arising from the construction and operational phase of the project.

The objectives of the assessment are to:

- Establish baseline noise levels at sensitive receptor locations in the vicinity of the project
- Establish environmental noise criteria applicable to the construction and operational phases of the project
- Evaluate predicted noise impacts on sensitive receptors arising from the construction and operational phases of the project against the established noise criteria.

This report details the prediction and evaluation of noise and blasting vibration and air-blast overpressure impacts on sensitive receptor locations in the vicinity of the project area against appropriate criteria established in accordance with contemporary standards and guidelines.

The assessment is based on the following:

- *Ok Birim Tailings Storage Facility Project – Short Project Description for Technical Studies*, reference 754-POMEN374244C\_R12, dated 2 April 2026.
- Traffic data for the project provided by TTC 27 April 2026.
- Spatial data (including terrain elevation) for the project accessed via TTC's Geographical Information System (**GIS**) portal.
- Environmental noise criteria based on the World Bank Group (**WBG**) International Finance Corporation (**IFC**) *General Environmental, Health, and Safety (EHS) Guidelines: Environmental Noise Management* (April 2007) (the **IFC Guidelines**).
- Noise and vibration criteria for blasting activity based on the Australian and New Zealand Environment Conservation Council's (**ANZECC**) guidelines titled, *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*.
- New South Wales (**NSW**) Department of Environment, Climate Change and Water (**DECCW**) *NSW Road Noise Policy* (2011).

## 2 PROJECT DESCRIPTION

### 2.1 Project Context

The project is in the northwestern corner of Western Province, south of the Central Cordillera Mountain range which runs east-west along the length of PNG. The proposed TSF is approximately 1 km west of the confluence of the Ok Birim and Ok Tedi, and about 55 km south of the existing Ok Tedi Mine (90 km by road via the Kiunga-Tabubil Highway). The mine lies approximately 5 km west of the Ok Tedi, a major tributary of the larger Fly River.

The Ok Tedi Mine at Mt Fubilan is an open-cut copper, gold and silver mine owned and operated by OTML since 1984. Ore is mined and processed at an on-site processing plant, with copper concentrate transported via a 156-km-long pipeline to port facilities at Kiunga, where it is dried then shipped along the Fly River to Port Moresby for export.

Pyrite concentrate produced at the tailings processing plant (**TPP**) near the mine is transported via a 125-km-long pipeline to subaqueous storage pits on the west bank at Bige, where it is kept permanently submerged to prevent oxidation and acid generation. Residue sand tailings from the TPP are discharged via a 1.5-km-long tailings river disposal pipeline to Ok Kumiup, which flows into the Ok Tedi via Harvey Creek. Waste rock is also disposed to the creek system at the mine.

OTML is currently progressing several planned developments aimed at improving long-term environmental performance and supporting potential mine life extension as part of its Growth 2050 strategy. Projected mine production to 2050 will generate additional tailings and waste rock, placing additional pressure on the downstream river system. OTML has therefore committed to largely eliminate the currently approved practice of riverine tailings disposal.

The project involves storing tailings on land in an engineered TSF from 2030 to limit further additions of mine-derived sediment to the Ok Tedi and Fly River system, reduce downstream environmental and social impacts and support continued mine operations to 2050.

An environmental and social impact assessment (**ESIA**) has been prepared for the project to meet the requirements of *Ok Tedi Environment Management Act 2019* as well as align with the Department of Environment and Conservation Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (DEC 2004); and follows good international industry practice including the International Finance Corporation (**IFC**) Performance Standards (2012) and Equator Principles 4.

As a separate but related development, OTML is also designing and supervising construction of the 14.5 km Alice Pit–Border Post Road under the *Infrastructure Tax Credit Scheme (ITCS)*. This road includes a planned bridge over the Ok Tedi to connect to the existing Kiunga-Tabubil Highway near Alice Pit and improve regional accessibility and cross-border connectivity at the Yetetkun PNG–Indonesia border post. The assessment, approval and construction of ITCS Road is separate to the project and its ESIA.

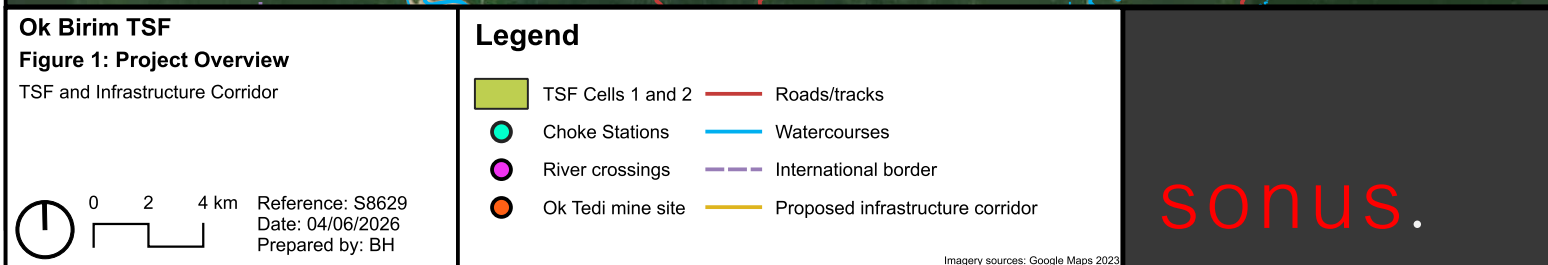
The ITCS Road will provide initial access to the TSF, and its final alignment is expected to be modified as required over the project life to accommodate the staged development of the TSF.

## 2.2 Project Area

Based on the proposed layout, the total disturbance footprint is estimated at approximately 1,900 ha. Project activities will primarily occur in the following two areas:

- TSF development area (approximately 1,500 Ha) – This includes the TSF footprint, hydro-cyclone house and ancillary infrastructure, surface water management facilities and internal roads and tracks. The area is within a lowland setting with regional topography gently sloping to the south. The TSF site is in a sub-catchment of the Ok Yep, to the west and south of Ok Birim and Ok Tedi confluence. The northern part of the TSF site is approximately 1 km west of this confluence. The TSF site is generally flat with undulated shallow valleys ranging in elevation from approximately 40 m to 80 m above mean sea level (**AMSL**).
- Infrastructure corridor development area (approximately 400 Ha) – This includes the proposed pipeline access road, bridges and water/ravine crossings, tailings pipeline and supporting facilities outside the TSF development area. The corridor area varies from the rugged, steep-sided valleys near the mine to the more gently undulating terrain and floodplains towards the TSF site.

An overview of the region showing the location of the TSF, the infrastructure corridor route and identified noise sensitive receptor locations is provided in Figure 1 below.



## 2.3 Project Components

Key components of the project are:

- A hydro-cyclone house for separating coarse and fine tailings, with coarse underflow used for embankment construction and fine overflow directed to the TSF impoundment.
- A ring-dyke TSF comprising internal storage cells developed progressively, with embankments primarily constructed using cyclone underflow sand.
- An 87-km-long tailings delivery pipeline from the existing TPP at Ok Tedi Mine to the proposed TSF site, including associated pumping and piping distribution systems (i.e., one pump station at the mine site and two intermediate choke/valve stations).
- A pipeline access road corridor including three bridges and several minor water/ravine crossings.
- Ancillary infrastructure including site offices, laydown areas, workshops, maintenance stations, waste and sewage management facilities, fuel storage, borrow and gravel pits and accommodation camps (as required).
- Power supply primarily from on-site diesel generators, with an installed capacity of up to 11 MW during the operational phase.
- Water supply sourced primarily from existing mine site supply, TSF decant water during operational phase, supplemented by rainfall and potential abstraction from nearby watercourses or groundwater for construction and potable water (if required).

### 2.3.1 TSF and Associated Infrastructure

The TSF is designed to store approximately 368 Mt of tailings material generated by the Ok Tedi Mine over a 20-year operational period, at a nominal annual rate of 20 Mtpa of tailings produced by the TPP. The maximum storage capacity allowance designed for the TSF is 263 Mm<sup>3</sup>.

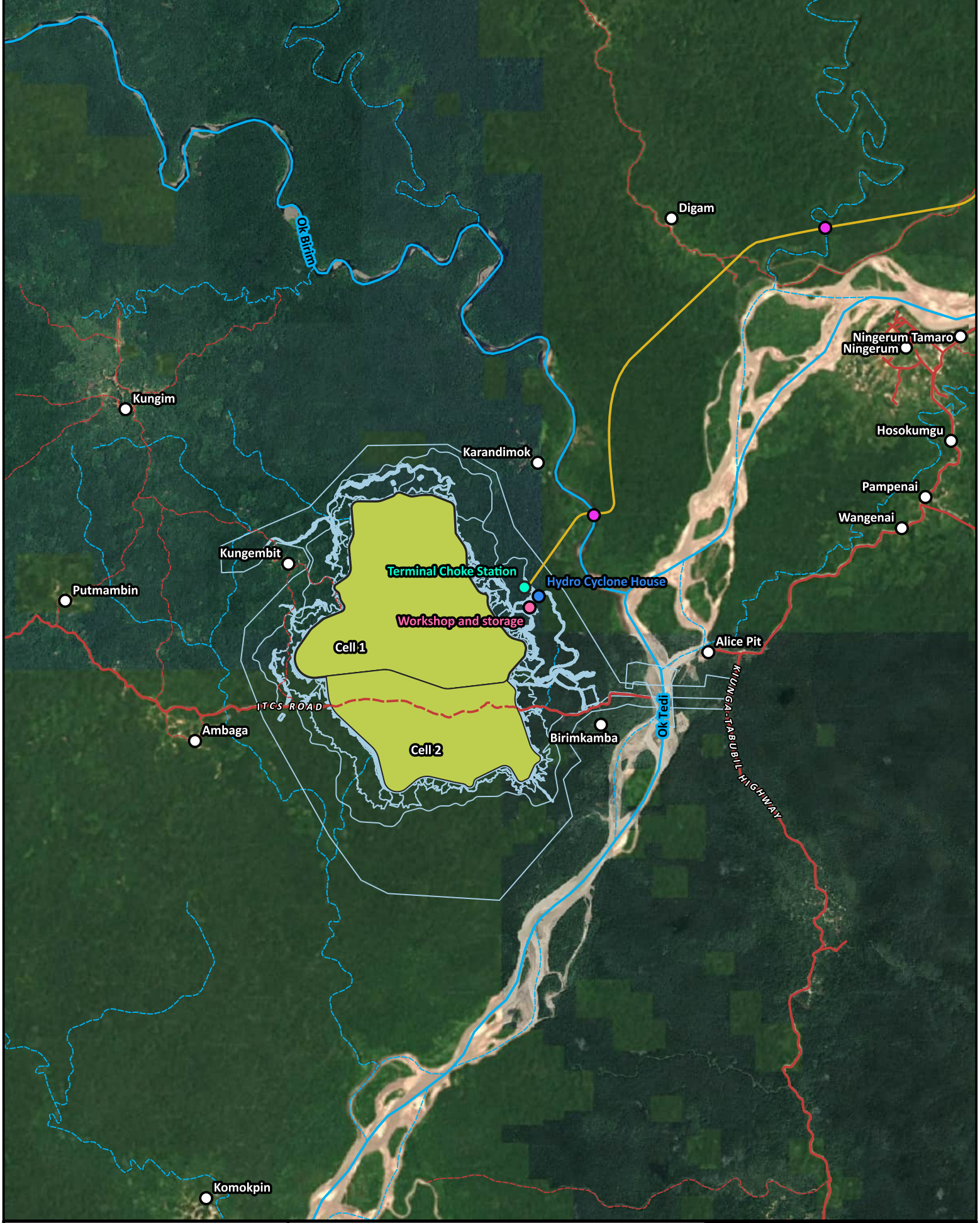
An on-site hydro-cyclone house will be constructed to separate piped tailings into fines (overflow) and coarse (underflow) sands prior to TSF disposal, with coarse sands used for embankment construction. Piped tailings will be processed through a single-stage cyclone system. There will be a dedicated piping and pumping network to transport slurry materials and decant water between the hydro-cyclone house and TSF. Decant water will be continuously reclaimed for reuse in the cyclone process, contributing to water efficiency and reducing the need for process make-up water.

The proposed TSF design involves the staged construction of a cyclone-sand ring-dyke (paddock) facility comprising two cells: a northern cell (Cell 1) and an adjoining southern cell (Cell 2). Both cells will be fully enclosed by ring-dyke embankments and separated by the new ITCS Road alignment. Staging details for the TSF are summarised in Table 1 below.

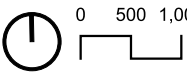
An overview of the TSF showing the proposed staging, the locations of access roads and fixed infrastructure and identified noise sensitive receptor locations is provided in Figure 2 below.

*Table 1: Staging details for proposed TSF design*

| TSF Cell                        | Brief description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Tailings to be impounded (m <sup>3</sup> ) |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Starter embankment<br>2030-2031 | <ul style="list-style-type: none"> <li>A starter dam will be built to a crest elevation of 65 m RL using suitable local borrow fill.</li> <li>The crest elevation of the starter embankment was specifically selected to minimise the volume of borrow fill required and increase the storage capacity.</li> <li>Cell 1 shares a centerline with the starter embankment. The centerline of the starter embankment was set back from the ITCS Road to prevent the Cell 1 raise from interfering with the current alignment of the ITCS Road.</li> <li>Located entirely to the north of the ITCS Road to allow time for the potential re-alignment of this road as the TSF expands.</li> </ul> | 17,545,246                                 |
| Cell 1<br>2032-2041             | <ul style="list-style-type: none"> <li>The dam will be raised to 80 m RL using underflow material from cyclone sand.</li> <li>Cell 1 will be raised to the ultimate crest elevation of the TSF along the same centerline of the starter embankment.</li> <li>Cell 1 will be specifically aligned to allow the current ITCS Road alignment to remain in operational use for longer.</li> <li>The footprint of Cell 1 is adjusted to allow room for infrastructure associated with the TSF, minimise surface water diversion works and increase the buffer distance between the toe of the TSF and the Ok Tedi as well as surrounding communities such as Kungembit.</li> </ul>                | 85,255,454                                 |
| Cell 2<br>2042-2049             | <ul style="list-style-type: none"> <li>Cell 2 will be constructed following completion of Cell 1 and built entirely with underflow material, reaching a final elevation of 80 m RL.</li> <li>Cell 2 occupies the remainder of the overall TSF footprint and is adjusted to minimise surface water diversion works and increase the buffer distance between the toe of the TSF and the Ok Tedi.</li> <li>Cell 2 overlies the ITCS Road and therefore requires re-alignment of the road prior to Cell 2 being constructed.</li> </ul>                                                                                                                                                          | 70,316,339                                 |



**Ok Birim TSF**  
**Figure 2: Project Overview**  
TSF Enlargement



Reference: S8629  
Date: 03/06/2026  
Prepared by: BH

**Legend**

- |                                                                                                         |                                                                                                                      |
|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|  TSF Cells 1 and 2   |  Workshop and storage             |
|  Choke Stations      |  Roads/tracks                     |
|  River crossings     |  Watercourses                     |
|  Hydro Cyclone House |  Proposed infrastructure corridor |

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### **2.3.2 Infrastructure Corridor**

The project includes access roads, bridges and water crossings as well as a tailings delivery pipeline and associated pipeline access road connecting the Ok Tedi Mine to the proposed TSF site, as described below:

#### Pipeline

The 87-km-long pipeline will be constructed to transport tailings slurry from the existing TPP at the Ok Tedi Mine to the proposed TSF. The tailings pipeline will generally follow the Kiunga-Tabubil Highway for approximately 22 km from the mine site, crossing the highway between the TPP and Tabubil. After passing through Tabubil and crossing the Ok Tedi, the tailings pipeline will turn south near the village of Kumkit and generally follow the proposed pipeline access road alignment to the TSF site. Where feasible, the pipeline will be constructed within already disturbed areas within or adjacent to roads and access tracks. Subject to further detailed design, approximately 80% of the pipeline will be buried and 20% will be aboveground (i.e., at creek and ravine crossings).

#### Pipeline Access Road

Construction and upgrade of 87-km-long two-way pipeline access road from the Ok Tedi Mine to the proposed TSF comprising approximately 65 km of new road; three permanent bridges constructed over the Ok Tedi (immediately south of Tabubil), Ok Taub (approximately 10 km northeast from TSF) and the Ok Birim (approximately 1.2 km east of the TSF); and several minor crossings over creeks and ravines using culverts and/or standard crossing structures. From kilometre point (KP) 22 to the TSF site, the pipeline and access road will be located within an infrastructure corridor covering approximately 330 ha; assuming a construction footprint of 50 m in width plus contingency to account for limited design information available at this stage. Following construction, the operational footprint for the tailings pipeline and access road is expected to be reduced to approximately 130 ha (including  $\pm 25\%$  contingency); assuming progressive rehabilitation of disturbed areas no longer required.

#### Hydro-cyclone Access Road

A new two-way access road approximately 3 km in length will be constructed from the ITCS Road to the hydro-cyclone house. This road will provide initial access to the TSF site for construction works with a temporary laydown area proposed at the junction of ITCS Road and Kiunga-Tabubil Highway east of the planned Alice Bridge for storage of construction materials, equipment and supplies before transfer to the TSF site. The access road will include crossing a diversion drain and several streams, with culverts assumed to be sufficient for most crossings, while a pre-fabricated timber bridge may be required at the diversion drain crossing. The road will be built with two lanes approximately 3.25 m wide with 1 m shoulder for up to approximately 150 vehicles/day including 50% heavy vehicles.

#### Perimeter Access Road

A perimeter road will be constructed progressively in line with the TSF cell development stages to provide access to operational facilities around the TSF footprint, using a similar construction approach to the pipeline access road. This road is planned to be shared for community use and enhance accessibility for surrounding communities such as Birimkamba, Karandimok, Kungembit and Ambaga.

#### Temporary Minor Access Roads and Tracks

Temporary minor access roads and tracks will be required for site access and supply during the construction phase. These will be located around the TSF and along sections of the tailings delivery pipeline and intermediate choke/valve stations that do not follow existing roads or tracks. These roads/tracks are planned to be cut to final design width but initially constructed as temporary facilities, with sections upgraded as required for the ITCS Road re-location. Final locations will be confirmed through further studies and will be located within already disturbed areas to the extent possible.

#### ITCS Road Realignment

During operations, the TSF footprint will intersect the new ITCS Road. To maintain continued use of this road during construction and operation of TSF Cell 1 (northern cell), the ITCS Road will initially remain in its current alignment. In 2041 (Operational Year 12), the ITCS Road will be re-aligned over the crest of the southern embankment of Cell 1 to enable construction of TSF Cell 2.

### 3 EXISTING ENVIRONMENT

#### 3.1 Noise and Vibration Sensitive Receptors

The TSF and infrastructure corridor are located within a relatively sparsely populated area, with noise and vibration sensitive receptors (i.e. project affected communities) primarily comprising CMCA and non-CMCA villages and other minor settlements surrounding the TSF (TSF communities) and along the infrastructure corridor route (infrastructure corridor communities and regional centres).

The nearest sensitive receptors to the TSF comprise the villages of Kungembit, Karandimok, Birimkamba and Ambaga, located between 900 and 1,800 m from the TSF cells. These sensitive receptors have the potential to be exposed to noise and vibration impacts during both the construction and ongoing operational phase of the project.

The nearest noise sensitive receptors to the infrastructure corridor comprise villages and settlements located along the infrastructure corridor alignment beyond KP 22 (i.e. after the corridor crosses the Ok Tedi), including Ankit, Kumkit, Nioksikwi/Ok Ma, Kolebon and Wogam. Additional sensitive receptors are located along the highway between the TPP and the Ok Tedi crossing, including Kawentikin, Finalbin, Bultem, and Tabubil. These sensitive receptors are expected to be exposed to noise and vibration during the construction phase, and noise due to additional traffic movements along the highway associated with the project.

Overviews of the region showing the location of noise sensitive receptor locations are provided in Figure 1 and Figure 2 above. The coordinates of each sensitive receptor location are provided in Appendix A.

#### 3.2 Existing Noise Levels

The proposed TSF will be located in an area which is generally distant from major industrial sources of noise and vibration. However, some villages and communities in the vicinity of the TSF are expected to be exposed to existing road traffic noise associated with the ITCS Road (Birimkamba and Ambaga), and noise associated with temporary riverine gravel extraction activities from the Ok Tedi near Alice Pit (Birimkamba and Alice Pit)..

Similarly, the infrastructure corridor will largely pass through areas which are distant from major sources of industrial and transportation noise and vibration. However, villages and communities along the Kiunga-Tabubil Highway upstream of where the infrastructure corridor crosses the Ok Tedi (such as Tabubil, Kawentikin and Finalbin) are expected to be exposed to existing road traffic noise associated with the highway. It is noted that

the nearest settlement to the Ok Tedi mine site is more than 5 km from the processing plant, and as such existing noise impacts are expected to be minimal.

For villages and communities not already exposed to industrial or road traffic noise, the existing acoustic environment is expected to be largely consistent with that of other similarly located projects within PNG. Previous noise measurements have been conducted by Sonus and other professional acoustic engineering consultants for a number of similarly sited projects within PNG, including the Woodlark Gold Project and the PNG LNG Plant (among others).

The measurement data collected for previous projects has indicated that at locations distant from transportation and industrial sources of noise and vibration, the ambient noise environment is dominated by natural sounds and sources of vibration, including birds, fauna, insects and wind-induced vegetation noise and vibration. Background ( $L_{A90}$ ) noise levels (which represent the continuous noise in the absence of intermittent noise), are typically in the range of 30 dB(A) to 50 dB(A). Average ( $L_{Aeq}$ ) levels of noise (which include all sources of noise) are typically between 40 dB(A) and 60 dB(A). For both descriptors, the higher levels occur at night as a result of insects.

These levels are expected to be typical of the existing noise at villages and settlements in the vicinity of the project which are not already exposed to industrial or road traffic noise. At such locations, insect noise is likely to be the dominant noise source leading to generally higher ambient and background noise levels during the night-time period (between 10:00 pm and 7:00 am) than occur during the day-time period (between 7:00 am and 10:00 pm).

For receptors in the vicinity of major transport routes (such as the Kiunga-Tabubil Highway and the ITCS Road), it is expected that average noise levels are higher during the day (reflecting the influence of intermittent traffic and other local noise sources), but similar at night when traffic is likely to be reduced and insects are likely to be dominant. As existing traffic represents an intermittent noise source, background noise levels at villages and settlements in the vicinity of transport routes would not be increased.

## 4 ASSESSMENT CRITERIA

There is currently no legislation in Papua New Guinea which provides objective criteria for environmental noise and vibration.

In the absence of any domestic governing policies or guidelines, reference has been made to the World Bank Group (**WBG**) International Finance Corporation *General Environmental, Health, and Safety (EHS) Guidelines: Environmental Noise Management* (**the WBG EHS Guidelines**) to determine appropriate environmental noise criteria. This is consistent with the Equator Principles, which require evaluation of project performance against the WBG EHS Guidelines for projects in *non-designated countries* (such as PNG).

For noise and vibration from blasting, objective criteria have been determined based on the Australian and New Zealand Environment Conservation Council's (**ANZECC**) guidelines titled *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (**the ANZECC Guidelines**).

Further discussion describing the assessment criteria applicable to specific sources of noise and vibration associated with the project is provided in the following sections.

### 4.1 Construction Noise

Construction activities typically occur over a limited duration, and the ability to attenuate construction noise is often more limited than during the operational phase of a project. As such, in recognition of these factors construction noise is typically assessed differently to operational noise.

For the purposes of this assessment, construction activity is considered to include construction of the TSF Cells 1 and 2 starter bunds, associated TSF infrastructure (such as access roads and fixed infrastructure including the hydro-cyclone house), and construction of the pipeline, access road and other associated infrastructure (such as bridges and culverts).

A typical approach for construction noise is for all reasonable and practicable measures to be taken to reduce noise impacts, and for activities which cannot be sufficiently attenuated to be conducted during the daytime only. Where construction activities must occur within close proximity to noise sensitive receptors, an additional requirement to achieve occupational noise exposure limits may also be appropriate.

This approach ensures that necessary construction activities can proceed even where located near noise sensitive receptors, while ensuring that nearby residents are protected against sleep disturbance and hearing loss (where relevant).

It is understood that a typical 10-hour construction workday is proposed within the daytime hours of the WBG EHS Guidelines (i.e. between 7:00 am and 10:00 pm). As such, for the majority of construction activities no specific noise criterion is proposed. For activities which occur in close proximity to noise sensitive receptors, noise limits of 85 dB(A) ( $L_{Aeq, 8 \text{ hour}}$ ) and 140 dB(C) ( $L_{Cpeak}$ ) are appropriate to protect against loss of hearing.

For any construction activities that must occur during the night (i.e. between the hours of 10:00 pm and 7:00 am), the general approach proposed is for a night-time criterion of 45 dB(A) ( $L_{Aeq, 1 \text{ hour}}$ ) to be achieved (consistent with the WBG EHS Guidelines and the recommendations of the *World Health Organisation (WHO) Guidelines for Community Noise* (the **WHO Guidelines**)).

#### 4.1.1 TSF and Associated Infrastructure

Construction activity related to the TSF and associated infrastructure will include the following:

- Construction of the TSF Cell 1 starter bund
- Construction of access roads
- Construction of fixed infrastructure (such as the hydro-cyclone house).

Construction of the TSF Cell 1 and 2 starter bunds is anticipated to take between 1-2 years each to complete. Given the extended duration of this activity, it is considered appropriate for noise from this construction aspect be designed to comply with the WBG EHS Guidelines criteria during the proposed construction hours. Specifically, the following criteria apply to construction of the TSF Cell 1 starter bund during the daytime period:

Table 2: WBG EHS Guidelines noise levels

| Receptor                                | $L_{Aeq, 1 \text{ hour}}$ [dB(A)] |
|-----------------------------------------|-----------------------------------|
|                                         | Day-time<br>(7:00 am – 10:00 pm)  |
| Residential, institutional, educational | 55                                |
| Industrial, commercial                  | 70                                |

As other construction aspects associated with the TSF will occur over a more limited duration at any particular location, no specific objective criteria are proposed.

#### 4.1.2 Infrastructure Corridor

Construction activity associated with the infrastructure corridor includes the following:

- Construction of the pipeline and access track
- Construction of bridges, culverts and other riverine crossings

In some areas, the infrastructure corridor alignment passes near to or through villages and communities. In such circumstance, the potential exists for construction activity to occur in close proximity to noise sensitive receptors. As such, where the infrastructure corridor passes through villages or communities, noise limits of 85 dB(A) ( $L_{Aeq, 8 \text{ hour}}$ ) and 140 dB(C) ( $L_{Cpeak}$ ) have been adopted to protect hearing loss.

As works are proposed to occur during the daytime only, no criteria apply under the WBG EHS Guidelines.

#### 4.2 Operational Noise

For the purposes of this assessment, the operational phase is considered to comprise ongoing tailings placement within TSF Cells 1 and 2, including embankment raises using cyclone underflow material and operation of the hydro-cyclone house and other fixed infrastructure (such as power generation). As 24-hour operation is proposed for the operational phase, the following noise criteria are applicable under the WBG EHS Guidelines:

Table 3: WBG EHS Guidelines noise levels

| Receptor                                | Noise Level Guidelines [ $L_{Aeq, 1 \text{ hour}}$ dB(A)] |                                    |
|-----------------------------------------|-----------------------------------------------------------|------------------------------------|
|                                         | Day-time<br>(7:00 am – 10:00 pm)                          | Night-time<br>(7:00 am – 10:00 pm) |
| Residential, institutional, educational | 55                                                        | 45                                 |
| Industrial, commercial                  | 70                                                        | 70                                 |

It is noted that the WBG EHS Guidelines recommend that either the noise levels in the table are not exceeded, or there is a maximum increase in background levels of 3 dB at the nearest receptor location off-site. For this project, it is proposed to use the criteria in Table 3.

#### 4.3 Traffic Noise

The noise impacts arising from off-site transport associated with the project (including light vehicles) are anticipated to be relatively minor in the context of the existing acoustic environment and the more significant construction elements of the project. On this basis, a subjective assessment comprising a comparison of the existing impacts of these transport modes against the projected impacts during the project lifetime has been conducted and is expected to be sufficient for evaluation of the impacts associated with most transport aspects of the project.

However, where more significant impacts are expected to occur, reference has been made to the New South Wales Department of Environment, Climate Change and Water *NSW Road Noise Policy* (2011). The NSW Road Noise Policy provides the following relevant assessment criteria for road traffic noise when assessed at residential land uses. It is noted that the following criteria are generally consistent with the criteria used in other Australian jurisdictions (including South Australia):

Table 4: Road Traffic Noise Criteria

| Road Category                                | Type of project / land use                                                                            | Assessment criteria [dB(A)]                      |                                                 |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------------|
|                                              |                                                                                                       | Day<br>(7:00 am to 10:00 pm)                     | Night<br>(10:00 pm to 7:00 am)                  |
| Freeway/<br>arterial/ sub-<br>arterial roads | 1. Existing residences affected by<br>noise from new freeway/arterial/sub-<br>arterial road corridors | $L_{Aeq, 15 \text{ hour}} \leq 55$<br>(external) | $L_{Aeq, 9 \text{ hour}} \leq 50$<br>(external) |

#### 4.4 Blasting

The most significant source of air-blast overpressure and ground vibration expected to be associated with the project during the construction phase is blasting. No significant sources of air-blast overpressure and ground vibration are expected to be associated with the operational phase of the project.

Blasting can generate impulsive noise with high instantaneous sound levels. Objective criteria concerning air-blast overpressure and ground vibration from blasting are based on the Australian and New Zealand Environment Conservation Council's (ANZECC) guidelines titled *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (the **ANZECC Guidelines**). The ANZECC Guidelines are endorsed by the Environment Protection Authorities (EPA's) of Australian states, and therefore in the absence of specific legislation or criteria within PNG are considered an appropriate basis for assessment.

#### **4.4.1 Air-Blast Overpressure**

To minimise the annoyance and discomfort from air-blast overpressure to persons at sensitive receptors, the ANZECC Guidelines state:

- the recommended maximum level for air-blast overpressure is 115 dB (Lin, Peak);
- the level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB (Lin, Peak) at any time.

It is noted that the above values are more stringent than the maximum impulse levels of 140dB (Lin, peak) and 120dB (Lin, peak) recommended by the WHO Guidelines for adults and children respectively.

#### **4.4.2 Ground Vibration**

To minimise the annoyance and discomfort from ground vibration to persons at sensitive receptors, the ANZECC Guidelines state:

- the recommended maximum level for ground vibration is 5mm/s (peak particle velocity (**PPV**))
- the PPV level of 5mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10mm/s at any time.

The ANZECC Guidelines also recommend restricting blasting to the hours of 9am to 5pm on Monday to Saturday, with no blasting activity on Sunday or public holidays.

#### 4.5 Assessment Criteria Summary

The adopted assessment criteria for each aspect of the project are summarised below:

*Table 5: Assessment criteria summary*

| Project aspect:                                | Criteria:                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction - TSF Cell Starter Bunds          | <ul style="list-style-type: none"> <li>55 dB(A) (<math>L_{Aeq, 1 \text{ hour}}</math>) at nearby noise sensitive receptor locations during the daytime (i.e. 7:00 am to 10:00 pm)</li> </ul>                                                                                                                                                        |
| Construction – Other Aspects                   | <ul style="list-style-type: none"> <li>85 dB(A) (<math>L_{Aeq, 8 \text{ hour}}</math>) and 140 dB(C) (<math>L_{Cpeak}</math>) when occurring in close proximity to noise sensitive receptors during the day-time, otherwise no criteria</li> <li>45 dB(A) (<math>L_{Aeq, 1 \text{ hour}}</math>) when occurring at night</li> </ul>                 |
| Construction – Blasting                        | <ul style="list-style-type: none"> <li>Airblast overpressure: 115 dB (Lin, Peak)</li> <li>Ground vibration: 5 mm/s (peak particle velocity)</li> </ul>                                                                                                                                                                                              |
| TSF Operations and intermediate choke stations | <ul style="list-style-type: none"> <li>55 dB(A) (<math>L_{Aeq, 1 \text{ hour}}</math>) at nearby noise sensitive receptor locations during the daytime (i.e. 7:00 am to 10:00 pm)</li> <li>45 dB(A) (<math>L_{Aeq, 1 \text{ hour}}</math>) at nearby noise sensitive receptor locations during the nighttime (i.e. 10:00 am to 7:00 pm)</li> </ul>  |
| Road traffic                                   | <ul style="list-style-type: none"> <li>55 dB(A) (<math>L_{Aeq, 15 \text{ hour}}</math>) at nearby noise sensitive receptor locations during the daytime (i.e. 7:00 am to 10:00 pm)</li> <li>50 dB(A) (<math>L_{Aeq, 9 \text{ hour}}</math>) at nearby noise sensitive receptor locations during the nighttime (i.e. 10:00 am to 7:00 pm)</li> </ul> |

## 5 NOISE ASSESSMENT

### 5.1 Methodology

The noise from each aspect of the project has been predicted using the SoundPLAN three-dimensional computer noise modelling software package, and the CONCAWE<sup>1</sup> noise propagation model. Both the SoundPLAN noise modelling software and the CONCAWE propagation model have been widely accepted as appropriate for calculation of noise propagation outdoors. The noise prediction methodology considers the following factors:

- The sound power level and location of noise sources
- The distance between the noise sources and noise sensitive receptor locations
- Ground and air absorption
- Reflections and shielding by the ground and structures
- Meteorological conditions (discussed below).

The CONCAWE noise propagation model utilises a weather category system to characterise the influence of meteorological conditions on noise propagation over long distances. The weather categories range from 1 to 6, with Category 1 representing weather conditions which provide the highest attenuation of noise (and therefore the lowest noise levels), and Category 6 representing conditions which provide the least attenuation of noise (and therefore the highest noise levels).

Category 6 conditions therefore represent the “worst case” in terms of predicted noise levels, and correspond to a light breeze blowing from the noise source towards noise sensitive receptors under stable atmospheric conditions or a temperature inversion.

In the interests of a conservative assessment, the noise predictions have been generated using conditions corresponding to CONCAWE Category 6 (comprising a wind speed of 1.5 m/s blowing from source to receptor, and Pasquill atmospheric stability category F). These conditions are representative of a temperature inversion.

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<sup>1</sup> Manning CJ 1981, “Report no. 4/81: The propagation of noise from petrochemical complexes to neighbouring communities”, the oil companies’ international study group for conservation of clean air and water in Europe (CONCAWE), Den Haag.

The inputs to the noise prediction model are summarised in Table 6 below.

Table 6: Summary of noise model inputs

| Model Input:                 | Assumption:                                                                                |
|------------------------------|--------------------------------------------------------------------------------------------|
| Ground type:                 | Soft ground (except for propagation over water)                                            |
| Temperature:                 | 10°C                                                                                       |
| Relative humidity:           | 70%                                                                                        |
| Air pressure:                | 1013 mbar                                                                                  |
| Wind speed:                  | 1.5 m/s from source to receptor                                                            |
| Pasquill Stability category: | Category F                                                                                 |
| Resulting CONCAWE category:  | CONCAWE Category 6 (least noise attenuation)                                               |
| Receptor height:             | 1.5 m above ground level (AGL)                                                             |
| Topography:                  | Undisturbed landform based on provided 1 m LiDAR contour data<br>Per scenario; refer below |
| Noise sources:               | Per scenario; refer below                                                                  |
| Source height:               | 2 m above ground level, unless stated otherwise                                            |
| Operating hours:             | Per scenario; refer below                                                                  |

### 5.1.1 Ground Topography

Ground topography for all scenarios has been based on the provided 1m resolution *Digital Elevation Model (DEM)*. The provided DEM covers the project area in its entirety, with the exception of a small portion of the infrastructure corridor alignment.

For the TSF, the DEM was modified to represent the height of the TSF Cells as relevant to each stage of construction/tailings placement in the following sequence:

Table 7: DEM modifications

| Year:             | Phase:                                                                              | Elevation data:                                                                                    |
|-------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Year 0<br>(2030)  | Commencement of starter bund construction                                           | Undisturbed landform                                                                               |
| Year 2<br>(2032)  | Conclusion of starter bund construction<br>Commencement of operations within Cell 1 | Cell 1 raised to ultimate height of starter bund (65 m RL)<br>Cell 2 at undisturbed landform level |
| Year 11<br>(2041) | Closure of operations within Cell 1<br>Commencement of operations within Cell 2     | Cell 1 raised to ultimate cell height (80 m RL)<br>Cell 2 at undisturbed landform level            |
| Year 19<br>(2042) | Closure of tailings placement within Cell 2                                         | Cell 1 raised to ultimate cell height (80 m RL)<br>Cell 2 raised to ultimate cell height (80 m RL) |

### **5.1.2 Noise Sources – Construction Phase**

Noise-generating construction phase activities will include the following:

- Initial construction of the starter bund for the Cell 1 of the TSF, including extraction of borrow fill from the west bank of the Ok Tedi within 5 km of the TSF, transport of the borrow fill to the TSF and placement at the TSF.
- Construction of access roads and permanent infrastructure (including the hydro-cyclone house) in the vicinity of the TSF.
- Construction of the tailings pipeline, including riverine crossings
- Construction of the pipeline access road, including bridge crossings
- Construction of the hydro-cyclone house, choke station, power generation and other temporary facilities.

Additional construction works will occur during the operational phase for development of Cell 2 of the TSF during years 2040-2042, and to relocate the ITCs Road. Despite occurring once operations have commenced, these works will produce noise which is temporary and similar in character to other similar construction phase activities and as such these works are considered as part of the construction phase for the purposes of the noise assessment.

The proposed construction methodologies have been reviewed, and the approximate sound power levels for each construction task have been estimated based on a typical 'worst case' combination of plant and equipment to be associated with each task (i.e. expected to result in the highest predicted noise levels). The construction scenarios should be reviewed at the appropriate stage, once full details of construction methodologies and staging are known, and updated if required.

Sound data for each activity or item of plant and equipment are provided in Appendix B.

Table 8: Construction phase activities and noise sources

| Construction Task:                                                                        | Equipment:                                                                                                                                                                                                                                                                                                                                                                                                               | Sound Power Level [dB(A)] |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Access road construction<br>(pipeline and TSF access roads)                               | <ul style="list-style-type: none"> <li>• 1x Dozer (D8)</li> <li>• 1x Mulcher/shredder</li> <li>• 1x Grader (140M)</li> <li>• 1x Wheel loader/Integrated tool loader (IT38)</li> <li>• 1x Vibratory roller</li> <li>• 1x Water truck</li> <li>• 2x Diesel generators</li> <li>• Dump trucks</li> </ul>                                                                                                                    | 120                       |
| Pipeline construction                                                                     | <ul style="list-style-type: none"> <li>• 1x Excavator (30t)</li> <li>• 1x Mulcher/shredder</li> <li>• 3x Pipe loaders</li> <li>• 1x Wheel loader/Integrated tool loader (IT38)</li> <li>• 1x 50t Hydraulic mobile crane (Franna)</li> <li>• 3x Diesel generators</li> <li>• Dump trucks</li> </ul>                                                                                                                       | 119                       |
| Fixed infrastructure construction<br>(incl. bridges, hydro-cyclone house, choke stations) | <ul style="list-style-type: none"> <li>• 1x Excavator (30t)</li> <li>• 1x Dozer (D8)</li> <li>• 2x Wheel loaders/Integrated tool loaders (IT38)</li> <li>• 1x Vibratory roller</li> <li>• 1x Water truck</li> <li>• 2x 50t Hydraulic mobile cranes (Franna)</li> <li>• 1x Concrete agitator truck and pump</li> <li>• 4x Diesel generators</li> <li>• Hand tools (e.g. angle grinders)</li> <li>• Dump trucks</li> </ul> | 120                       |
| Aggregate extraction                                                                      | <ul style="list-style-type: none"> <li>• 2x Excavator (30t)</li> <li>• 1x Wheel loader/Integrated tool loader (IT38)</li> <li>• 2x Mobile crushing plant</li> <li>• 2x Diesel generators</li> <li>• Haul trucks and dump trucks</li> </ul>                                                                                                                                                                               | 121                       |
| TSF starter bund construction                                                             | <ul style="list-style-type: none"> <li>• 4x Excavators (30t)</li> <li>• 4x Dozers (D8)</li> <li>• 4x Wheel loaders/Integrated tool loaders (IT38)</li> <li>• 1x Grader (140M)</li> <li>• 1x Vibratory roller</li> <li>• 1x Water truck</li> <li>• 2x Diesel generators</li> <li>• Haul trucks</li> </ul>                                                                                                                 | 122                       |
| Rock breaking<br>(where required)                                                         | <ul style="list-style-type: none"> <li>• Hydraulic rock-breaking tool fitted to excavator</li> </ul>                                                                                                                                                                                                                                                                                                                     | 121                       |

### 5.1.3 Noise Sources – Operational Phase

Noise-generating activities associated with ongoing tailings placement include the following:

- Hydro-cyclone house to separate tailings into underflow and overflow fractions
- Choke/valve stations (including two intermediate choke/valve stations located along the pipeline route and a terminal choke/valve station near the hydro-cyclone house)
- Dedicated on-site pumping infrastructure for the TSF operations
- Tailings placement and compaction (dozers and excavators)
- Power generation

The noise predictions consider the following scenarios:

*Table 9: TSF Operational Scenarios*

| Year:          | Scenario:                     | Description:                                                                                  |
|----------------|-------------------------------|-----------------------------------------------------------------------------------------------|
| Year 2 (2032)  | TSF Cell 1 – Initial Landform | Tailings placement within Cell 1 at opening (following completion of the starter bund)        |
| Year 11 (2041) | TSF Cell 1 – Final Landform   | Tailings placement within Cell 1 at closure (based on the ultimate embankment height of 80 m) |
|                | TSF Cell 2 – Initial Landform | Tailings placement within Cell 2 at opening                                                   |
| Year 19 (2042) | TSF Cell 2 – Final Landform   | Tailings placement within Cell 2 at closure (based on the ultimate embankment height of 80 m) |

The predictions consider the following noise sources:

- Fixed infrastructure comprising the following (at the locations identified in Figure 2):
  - Hydro-cyclones and associated pumps enclosed within a hydro-cyclone house. The hydro-cyclone house will be constructed on concrete foundations with a steel superstructure and profiled sheet steel cladding (resulting in a total sound power level of 109 dB(A)).
  - A terminal choke/valve station located outdoors near the hydro-cyclone house, and an additional two intermediate choke/valve stations located along the pipeline alignment at KPs 15 and 37 (each with an assumed sound power level of 110 dB(A)).
  - Diesel power generation comprising ten 1,250 kVA generator sets (2 on standby) enclosed within or near the hydro-cyclone house (with a total sound power level of 118 dB(A)).

- Mobile equipment and infrastructure at the point within the TSF Cell 1 or 2 closest to each noise sensitive receptor location (corresponding to the location with the highest potential for noise impacts at each receptor location):
  - 4x Excavators (45t)
  - 4x Dozers (D8)
  - 3x Diesel generators
  - 6x Lighting plant (as required)
  - Dedicated mobile pumping infrastructure for the TSF operations (including the decant syphon discharge system). The pumping infrastructure will be moved in line with Cell 1 and 2 development.

Sound data for each of the above noise sources are provided in Appendix B.

## **5.2 Construction Noise Impacts**

Noise from each construction phase has been predicted in accordance with the methodology described in Section 5.1 above. For each construction phase, the predictions consider the combination of activities expected to produce the highest noise emissions and meteorological conditions conducive to noise propagation, resulting in a conservative assessment.

For construction which does not occur at a fixed location (such as pipeline and access road construction, and construction of the starter bunds), the predictions consider the location which results in the highest predicted noise levels at each noise sensitive receptor location (generally the closest point to each noise sensitive location).

Accordingly, lower noise levels are predicted as construction works progress further from each noise sensitive receptor, for combinations of activities which produce lower noise emissions and for meteorological conditions less conducive to noise propagation.

### 5.2.1 TSF Starter Bund

Noise levels at each noise sensitive receptor location in the vicinity of the TSF due to construction of the starter bunds have been predicted based on the initial and final landforms. The highest predicted noise level at each location is presented in Table 10 below.

Table 10: Predicted Noise Levels – TSF Starter Bund Construction

| Locality:  | Highest Predicted Noise Levels [ $L_{Aeq, 1 \text{ hour dB(A)}}$ ] |                            |        | Criteria<br>[ $L_{Aeq, 1 \text{ hour dB(A)}}$ ] | Complies? |
|------------|--------------------------------------------------------------------|----------------------------|--------|-------------------------------------------------|-----------|
|            | Cell 1 - Initial<br>Landform                                       | Cell 1 - Final<br>Landform | Cell 2 |                                                 |           |
| Alice Pit  | 46                                                                 | 46                         | 46     | 55                                              | Yes       |
| Ambaga     | 36                                                                 | 36                         | 36     | 55                                              | Yes       |
| Birimkamba | 51                                                                 | 51                         | 51     | 55                                              | Yes       |
| Karandimok | 42                                                                 | 41                         | 34     | 55                                              | Yes       |
| Kungembit  | 47 (53) <sup>2</sup>                                               | 47 (53) <sup>2</sup>       | 43     | 55                                              | Yes       |
| Kungim     | 27                                                                 | 27                         | 23     | 55                                              | Yes       |
| Putmambin  | 28                                                                 | 28                         | 27     | 55                                              | Yes       |

Based on the above, noise from construction of the TSF Cell 1 and 2 starter bunds is predicted to comfortably achieve the relevant noise criteria at all identified noise sensitive receptor locations in the vicinity of the TSF.

### 5.2.2 TSF Access Roads and Fixed Infrastructure

Noise levels have been predicted for each noise sensitive receptor location in the vicinity of the TSF from construction of access roads and fixed infrastructure at the TSF site (including the perimeter access roads). The highest predicted noise levels from construction of access roads and fixed infrastructure are presented in Table 11 below.

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<sup>2</sup> The nearest structure in Kungembit is significantly closer (300 metres) to TSF Cell 1 than the coordinates representing this settlement. As such, predicted noise levels are also presented for the nearest structure (within brackets). For all other sensitive receptor locations, a significant difference in noise levels is not predicted.

Table 11: Predicted Noise Levels – TSF access roads and fixed infrastructure

| Locality:  | Highest Predicted Noise Levels [L <sub>Aeq</sub> dB(A)] |                                   | Criteria [L <sub>Aeq</sub> dB(A)] | Complies? |
|------------|---------------------------------------------------------|-----------------------------------|-----------------------------------|-----------|
|            | Road Construction                                       | Fixed Infrastructure Construction |                                   |           |
| Alice Pit  | 33                                                      | 31                                | -                                 | N/A       |
| Ambaga     | 39                                                      | 18                                | -                                 | N/A       |
| Birimkamba | 56 (62) <sup>3</sup>                                    | 35                                | -                                 | N/A       |
| Karandimok | 48                                                      | 36                                | -                                 | N/A       |
| Kungembit  | 56 (71) <sup>3</sup>                                    | 30                                | -                                 | N/A       |
| Kungim     | 27                                                      | 16                                | -                                 | N/A       |
| Putmambin  | 29                                                      | 15                                | -                                 | N/A       |

The highest predicted noise levels from TSF access road construction occur at Birimkamba and Kungembit when construction works are occurring at the closest point to these sensitive receptor locations.

While no criteria are applicable to construction works during the daytime, it is noted that noise levels at these sensitive receptor locations would exceed the relevant daytime noise level guideline of 55 dB(A) applicable under the WBH EHS Guidelines (were it to apply) when construction occurs within approximately 500 m of these locations. Noise levels at all other sensitive receptor locations achieve the 55 dB(A) criterion for all construction locations.

It is noted that noise impacts associated with access road construction are inherently limited in duration (likely confined to several weeks in duration in close proximity to any one noise sensitive receptor). In the context of noise levels at the majority of sensitive receptor locations, which are comparable to those that would be permissible for permanent noise sources, the impacts are considered to be relatively minor.

Notwithstanding, given the proximity of the works to noise sensitive receptors, it is recommended that a construction noise and vibration management plan (**CNVMP**) be prepared for works which provides details of how construction noise impacts will be managed. Examples of noise mitigation measures which may be considered by the CNVMP are described in Section 5.2.4 below.

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<sup>3</sup> The nearest structures in Kungembit and Birimkamba are significantly closer (300 metres) to the TSF access roads than the coordinates representing this settlement. As such, predicted noise levels are also presented for the nearest structure (within brackets). For all other sensitive receptor locations a significant difference in noise levels is not predicted.

It is noted that predicted noise levels associated with construction of the fixed infrastructure (i.e. the hydro-cyclone house and the choke station) are lower than the expected existing background noise levels and as such no adverse impacts are expected to occur.

### 5.2.3 Infrastructure Corridor

Noise levels have been predicted at each noise sensitive receptor location in the vicinity of the infrastructure corridor from construction of the pipeline and access road. The highest predicted noise levels (generally occurring at the closest point to each noise sensitive receptor location or where the infrastructure corridor passes near villages) are presented in Table 12 below.

Table 12: Predicted Noise Levels - Infrastructure Corridor Construction

| Locality:        | Highest Predicted Noise Levels [L <sub>Aeq</sub> dB(A)] |                       |                                |           |           |
|------------------|---------------------------------------------------------|-----------------------|--------------------------------|-----------|-----------|
|                  | Access Road Construction                                | Pipeline Construction | Rock Breaking (where required) | Criteria: | Complies? |
| Finalbin         | 72                                                      | 71                    | 74                             | 85        | Yes       |
| Kawentikin       | 69                                                      | 68                    | 71                             | 85        | Yes       |
| Kolebon          | 63                                                      | 62                    | 65                             | 85        | Yes       |
| Kumkit/ Amkit    | 72                                                      | 71                    | 73                             | 85        | Yes       |
| Nioksikwi/ Ok Ma | 73                                                      | 72                    | 75                             | 85        | Yes       |
| Ok Teditau       | 71                                                      | 70                    | 73                             | 85        | Yes       |
| Tabubil          | 80                                                      | 79                    | 80                             | 85        | Yes       |
| Wogam            | 74                                                      | 73                    | 75                             | 85        | Yes       |

Based on the above, the highest predicted noise level is 80 dB(A) at the nearest noise sensitive receptors within the regional centre of Tabubil (during pipeline construction). A similar level is also predicted at this location in circumstances where rock breaking is required.

It should be noted that Tabubil is a larger regional centre and as such existing noise levels are influenced by road traffic on the Kiunga-Tabubil Highway and industrial activities servicing the Ok Tedi mine (such as power stations, workshops and steel fabrication). The highest predicted noise level at a more remote village along the infrastructure corridor (where existing noise levels are likely to be lower) is 74 dB(A) (at Wogam).

As such, noise from all aspects of construction is predicted to achieve the nominated 85 dB(A) criterion at all locations along the infrastructure corridor.

It is noted that bridge and choke station construction are expected to comprise activities which will generate a similar sound power level to the worst-case construction scenarios considered above; as such predicted noise levels associated with these construction activities will be no higher than those presented above.

Notwithstanding, it is recommended that similar to TSF access road construction, a CNVMP be prepared for works in the vicinity of populated areas which provides details of how construction noise impacts will be managed. Examples of noise mitigation measures which may be considered by the CNVMP are described in Section 5.2.4 below.

#### **5.2.4 Mitigation**

For construction works which will occur in close proximity to noise sensitive receptor locations (defined as within 500 metres) it is recommended that CNVMP be prepared for the works. At a minimum, the CNVMP should consider the following:

- Liaising with the local community to provide advance notification of nearby construction works
- Scheduling the works to occur during the least sensitive parts of the day
- Limiting the number of consecutive days where receptors are impacted
- Substituting noisy plant or processes for quieter, lower impact alternatives
- Fitting broadband reversing alarms in lieu of traditional tonal reversing alarms, and ensuring the alarms are adjusted to be no louder than is required to safely alert bystanders of moving machinery.
- Ensuring all plant is properly maintained e.g. silencers and enclosures are intact, rotating plants are balanced, loose bolts are tightened, frictional noise is reduced through lubrication; and cutting noise reduced through keeping cutting equipment sharp
- Operating plant so as to minimise noise impacts, e.g. use minimum power required to complete the task
- Taking care to site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas
- Installing local noise mitigation barriers around noisy equipment and processes.

### 5.3 Operational Noise

Noise from each stage of the operational phase has been predicted in accordance with the methodology described in Section 5.1 above. For each stage, the predictions consider the following:

- The combination of activities expected to produce the highest noise emissions,
- embankment lifts and tailings placement occurring at the closest point in each TSF cell to each noise sensitive receptor location, and;
- meteorological conditions conducive to noise propagation, resulting in a conservative assessment.

Accordingly, lower noise levels are predicted for embankment lifts and tailings placement occurring further from each noise sensitive receptor, for combinations of activities which produce lower noise emissions and for meteorological conditions less conducive to noise propagation.

#### 5.3.1 TSF Operations

The highest predicted noise level at each noise sensitive receptor location in the vicinity of the TSF due to ongoing tailings placement within each TSF cell (Cell 1 and Cell 2) has been predicted based on the initial and final landforms. The highest predicted noise levels at each location are presented in Table 13 below.

Table 13: Predicted Noise Levels – Ongoing Tailings Placement

| Locality:  | Highest Predicted Noise Levels [L <sub>Aeq</sub> dB(A)] |                      |                      |                      | Criteria<br>[L <sub>Aeq</sub> dB(A)]: | Complies? |
|------------|---------------------------------------------------------|----------------------|----------------------|----------------------|---------------------------------------|-----------|
|            | TSF Cell 1                                              |                      | TSF Cell 2           |                      |                                       |           |
|            | Initial Landform                                        | Final Landform       | Initial Landform     | Final Landform       |                                       |           |
| Alice Pit  | 30                                                      | 31                   | 30                   | 30                   | 45                                    | Yes       |
| Ambaga     | 36                                                      | 37                   | 36                   | 36                   | 45                                    | Yes       |
| Birimkamba | 41                                                      | 43                   | 43                   | 44                   | 45                                    | Yes       |
| Karandimok | 42                                                      | 42                   | 35                   | 35                   | 45                                    | Yes       |
| Kungembit  | 47 (53) <sup>4</sup>                                    | 48 (54) <sup>4</sup> | 40 (43) <sup>1</sup> | 40 (43) <sup>1</sup> | 45                                    | No        |
| Kungim     | 27                                                      | 27                   | 23                   | 23                   | 45                                    | Yes       |
| Putmambin  | 28                                                      | 28                   | 27                   | 27                   | 45                                    | Yes       |

<sup>4</sup> The nearest structures in Kungembit and Birimkamba are significantly closer (300 metres) to the TSF access roads than the coordinates representing this settlement. As such, predicted noise levels are also presented for the nearest structure (within brackets). For all other sensitive receptor locations a significant difference in noise levels is not predicted.

Based on the above, the highest predicted noise level at a noise sensitive receptor location is 54 dB(A) at the nearest structure within Kungembit, which exceeds the 45 dB(A) WBG EHS Guidelines criterion applicable during the “nighttime” period (i.e. between 10:00 pm and 7:00 am).

It is noted that compliance with the 55 dB(A) WBG EHS Guidelines criterion is achieved at all noise sensitive receptor locations during the “daytime” period (i.e. between 7:00 am and 10:00 pm), and with the WBG EHS Guidelines “nighttime” criterion at all noise sensitive receptor locations except Kungembit.

As the predicted noise levels at Kungembit (and other noise sensitive receptor locations) are dominated by mobile plant and equipment operating at the closest point within the relevant TSF cell, lower noise levels will occur where tailing placement and embankment uplift activities occur further from noise sensitive receptor locations. Specifically, the WBG EHS Guidelines criteria are predicted to be achieved at all times of the day and under all weather conditions at distances beyond approximately 1,500 m from Kungembit.

For weather conditions less conducive to noise propagation (for example neutral or upwind conditions), this distance is reduced to approximately 850 m.

Based on the above, operational noise impacts which exceed the nominated criteria will be limited to a single noise sensitive receptor location (Kungembit) during the nighttime period only, and will be relatively short-lived in the context of the overall project timeline. In this context, the operational noise impacts of the project are considered to be relatively minor.

Notwithstanding the above, it is recommended that noise mitigation be considered where tailings placement and embankment uplifts will occur within approximately 1,500 m of the nearest noise sensitive receptor. While the exact noise mitigation methodology will depend on the specific construction methodology employed, examples of noise mitigation measures which may be considered include the following:

- Selecting plant and equipment which produces lower sound power levels compared with other comparable items in the marketplace.
- Ordering ‘low noise’ versions of plant and equipment (where available), or fitting manufacturer-supplied “hush kits” (where available).
- Considering smaller/lower capacity items of plant and equipment where capable of achieving the required task.
- Downscaling mobile plant operations closest to the nearest noise sensitive receptor where potential exceedances may occur (for example, reducing number of dozers and excavators required).

- Considering electric-powered alternatives to internal combustion engined plant and equipment (where practical).
- Enclosing fixed (or skid-mounted) items of plant and equipment, and fitting exhaust mufflers and intake attenuators where relevant.
- Weighting operations towards the “daytime” period such that the quantity of mobile plant and equipment required during the “nighttime” period can be reduced (for example, stockpiling material during the “daytime” period for use in the “nighttime” period).
- Operating within different parts of the TSF during the “nighttime” period (where practical).
- Limiting the loudest activities to the “daytime” period only when downwind conditions from the TSF to the nearest noise sensitive receptor are predicted to occur (where practical).

The above should be reviewed as the construction methodology is refined with specific noise mitigation measures included in an Operational Noise Management Plan (**ONMP**) to ensure that operational noise levels are minimized as far as is practicable.

### **5.3.2 Intermediate Choke Stations**

The two intermediate choke stations are proposed to be located at KPs 15.5 and 37, which will place them approximately 600 m and 2 km from the nearest villages or settlements (Tabubil and Nioksikwi/Ok Ma respectively).

Based on the assumed sound power level of 110 dB(A) for the intermediate choke stations, a noise level in the order of 43 dB(A) is predicted at the nearest noise sensitive receptor location 600 metres from the first choke station at the 15.5 KP. Lower noise levels are predicted for other noise sensitive receptor locations further from the choke stations (including the closest settlement to the second intermediate choke station).

On this basis, it is predicted that noise from the choke stations will achieve the WBS EHS Guidelines criteria throughout the operational phase, at all times of the day or night.

As the above is based on estimates of the operational parameters of the pipeline (including flow rate, tailings density and operating pressures) and approximate siting of the choke station, predicted noise levels should be reviewed during the detailed design stage once specific sites have been identified to confirm that compliance is achieved.

It is noted that noise mitigation measures may need to be considered should a higher sound power level be associated with the choke stations or should they be located closer to sensitive receptors, and would likely comprise enclosing the valve and associated above ground pipework, and potentially lagging the pipework.

## 6 TRAFFIC NOISE ASSESSMENT

Increases in traffic are expected to occur on the existing road network due to construction and operation of the project, in addition to traffic on new access roads and tracks to be constructed as part of the project.

The following additional vehicle movements are expected to be associated with the project:

Table 14: Construction phase vehicle movements

| Route:                                                             | Description:                      | Vehicle Type(s):              | Daily Vehicles (one way):               |
|--------------------------------------------------------------------|-----------------------------------|-------------------------------|-----------------------------------------|
| <b>Construction Phase (2027 to 2030):</b>                          |                                   |                               |                                         |
| Kiunga to Tabubil<br>(via Kiunga-Tabubil Highway)                  | Materials, supplies and equipment | Long haul semi-trailer trucks | 2x daily convoys<br>(8 vehicles each)   |
| Ningerum to TSF site<br>(via ITCS Road)                            | Construction workforce            | 57-seater crew bus            | 3x vehicles daily                       |
| Tabubil to pipeline worksite                                       | Construction workforce            | 25-seater bus                 | 6x vehicles daily                       |
| Alice Pit to pipeline worksite                                     | Construction workforce            | 25-seater bus                 | 6x vehicles daily                       |
| Ok Tedi to TSF site (via ITCS Road)                                | Gravel haulage                    | 45-tonne haul trucks          | 207x vehicles daily                     |
| <b>Operational Phase (2030 to 2049):</b>                           |                                   |                               |                                         |
| Kiunga to Tabubil<br>(via Kiunga-Tabubil Highway)                  | Materials, supplies and equipment | Long haul semi-trailer trucks | 1.6x daily convoys<br>(8 vehicles each) |
| Kiunga-Ningerum<br>(via Kiunga-Tabubil Highway)                    | Materials, supplies and equipment | Long haul semi-trailer trucks | 0.4x daily convoys<br>(8 vehicles each) |
| Ok Tedi to TSF site<br>(via ITCS Road)                             | Gravel haulage                    | 45-tonne haul trucks          | 67x vehicles daily                      |
| Ningerum to TSF site<br>(via Kiunga-Tabubil Highway and ITCS Road) | Operational workforce             | 57-seater crew bus            | 6x vehicles daily                       |
| Pipeline access road                                               | Maintenance and inspections       | Light vehicles                | 1.5x vehicles <u>weekly</u>             |
| TSF access roads                                                   | Maintenance and inspections       | Light vehicles                | 10x vehicles daily                      |

It is noted that workers will be transported to the pipeline worksite by bus for the first 18 months of construction, with workers accommodated in temporary camps along the pipeline route thereafter.

Based on the above, in most circumstances, traffic noise levels are expected to be negligible in the context of the background noise environment and existing traffic on the existing road network.

The exception to the above is haulage between Ok Tedi and the TSF site, where up to 207 haul truck movements per day are expected to occur during the construction phase (reducing to 67 haul truck movements during the operational phase).

Noise levels have therefore been predicted at the nearest noise sensitive receptor location to the haul route (Birimkamba) using the same noise prediction model described in Section 5.1 above, and considering the following assumptions:

- 45 tonne articulated dump trucks (“moxys”) with a sound power level of 110 dB(A)
- 207 one-way vehicle movements per day over a 10-hour period in each direction (i.e. 207 return trips per day).

Based on the above, a road traffic noise level of 52 dB(A) ( $L_{Aeq, 15 \text{ hour}}$ ) is predicted at the nearest structure within Birimkamba, which achieves the noise criterion of 55 dB(A) ( $L_{Aeq, 15 \text{ hour}}$ ) applicable to arterial/sub-arterial roads (i.e. ‘major’ roads) under the NSW Road Noise Policy. It is noted that if traffic noise levels were to be averaged over a 1-hour period during the proposed 10-hour workday a noise level of 54 dB(A) would be predicted, which would also achieve the NSW Road Noise Policy of 55 dB(A) ( $L_{Aeq, 1 \text{ hour}}$ ) applicable to minor/local roads.

Lower traffic volumes occur for other aspects of the project, and are expected to result in negligible impacts in the context of the ambient noise environment and existing road traffic on the relevant routes.

### **6.1 Induced Demand – Pipeline Access Road**

Vehicle movements along the pipeline access road associated with the project during the operational phase are expected to be relatively minor, comprising in the order of 1-2 vehicles weekly for maintenance and inspection purposes.

However, construction of the pipeline access road will provide an alternative access option for communities along or near the access road alignment. It is anticipated that this will result in additional traffic along the new access road beyond that directly associated with the project (i.e. ‘induced demand’). This additional traffic may potentially result in additional noise impacts on noise sensitive receptors in close proximity to the access road alignment.

Noise from induced traffic demand on the pipeline access road has therefore been predicted based on a conservative methodology which assumes traffic volumes equivalent to those currently carried on the Kiunga-Tabubil Highway, being a total of 176 vehicles per day with 32% heavy vehicles. For the purposes of the predictions, a 90%/10% (day/night) split has been assumed for both heavy and light vehicles, and an average speed of 50 km/h.

Based on the above, noise from road traffic on the pipeline access road is predicted to be less than 50 dB(A) during both the day (7:00 am to 10:00 pm) and night (10:00 pm to 7:00 am) periods at the nearest identified existing noise sensitive along the pipeline access road alignment.

Therefore, noise from additional traffic along the pipeline access road (i.e. not directly associated with the project) is predicted to achieve the nominated criteria of 55 dB(A) ( $L_{Aeq, 15 \text{ hour}}$ ) and 50 dB(A) ( $L_{Aeq, 9 \text{ hour}}$ ) at all noise sensitive receptor locations which are not currently exposed to traffic noise.

## 7 BLASTING ASSESSMENT

The relationships between the air-blast overpressure and ground vibration from blasting at a particular site are dependent on a number of variables specific to that site. While the magnitude of the air-blast overpressure and ground vibration are expected to decrease with increasing distance from the blast and increase with increasing charge weight per delay, other variables such as particular source-receptor geometries, rock type and formation, the blasting methodology and the local geology of the site have an equal or greater influence on the result of blasting. It is therefore common practice for the blasting specialist to design each blast to achieve the project criterion.

To provide an indication of the likelihood of ground and vibration impacts occurring at sensitive receptor locations due to blasting (where it is required), setback distances to achieve the nominated blast overpressure and ground vibration criteria for a given effective charge (within a confined blasthole) have been determined based on the procedures described in Appendix J of Australian Standard AS 2187.2-2006 Explosives – *Storage and Use, Part 2: Use of Explosives (the Australian Standard)* using ‘average’ site conditions as noted by the *Standard* and are presented in Figure 3 and Figure 4 below. The below setback distances are based on the assumption of a confined blasthole charge, and site conditions consistent with following typical values provided by Appendix J of AS 2187.2-2006 (it is noted that greater setback distances are required to achieve the same blast overpressure for an unconfined surface charge):

Table 15: Assumed airblast overpressure and ground vibration prediction parameters

| Aspect:                | Site Constant:                                | Site Exponent: |
|------------------------|-----------------------------------------------|----------------|
| Ground vibration:      | $K_g = 1140$                                  | $B = 1.6$      |
| Airblast overpressure: | $K_a = 30$ (typical values range from 10-100) | $a = -1.45$    |

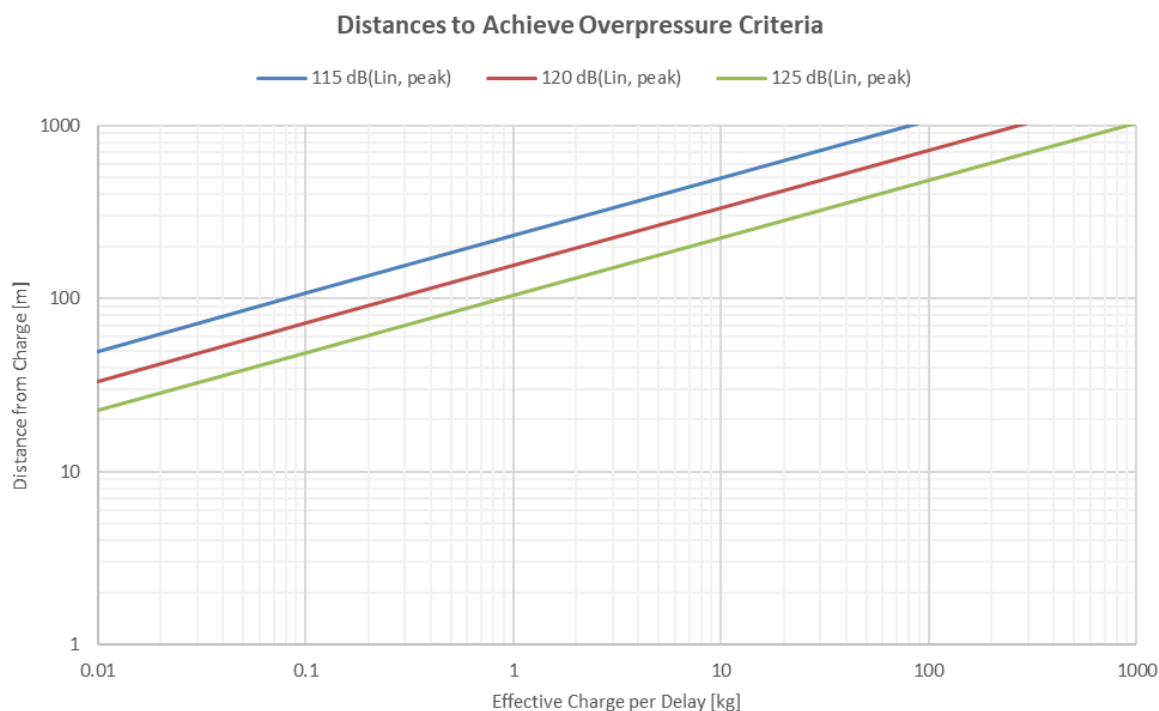


Figure 3: Distances to achieve blast overpressure criteria for a given charge weight (confined blasthole)

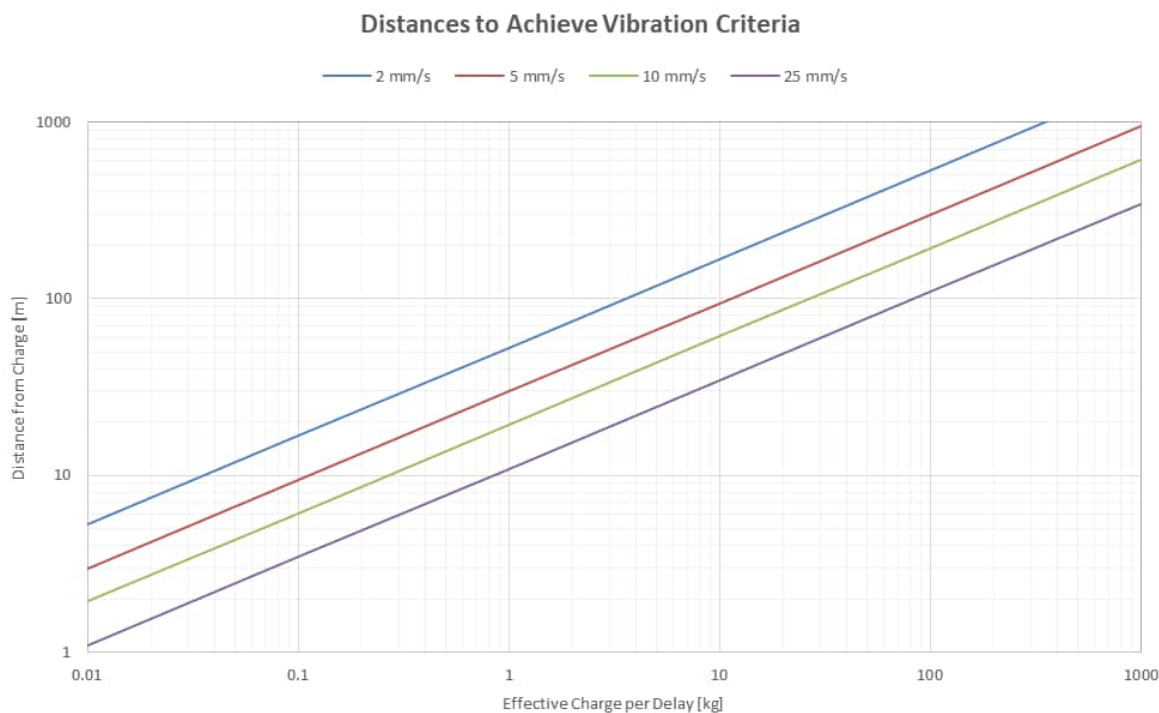


Figure 4: Distances to achieve ground vibration criteria for a given charge weight

With reference to the above, to achieve a blast overpressure of 115 dB(lin) and vibration criterion of 5 mm/s for a confined blasthole charge of 1 kg per delay, distances of approximately 200 m and 30 m respectively would be required to achieve the relevant criteria.

The above methodology provides a guide for estimating when consideration of blast overpressure and vibration impacts are likely to be required, and is considered appropriate at the environmental impact assessment stage of the project when complete details regarding charge weights, specific blasting locations and the proposed blasting methodology are not yet known and will provide an estimate of the number of sensitive receptor locations and structures likely to be impacted by blasting activities associated with the project.

The final blasting methodology will typically be designed by the blasting specialist to confirm the project criteria are achieved, and will consider the following factors:

- the type of rock and stratigraphy/faulting;
- the distance between the blast site and the sensitive receptors;
- the type, size and number of charges used;
- the depth and manner in which the charge is installed, and;
- meteorological conditions.

## 8 CONCLUSION

Sonus has been engaged by Tetra Tech Coffey (**TTC**) on behalf of Ok Tedi Mining Ltd (**OTML**) to conduct an environmental noise assessment for the Ok Birim Tailings Storage Facility (**TSF**) project (the **project**) within Papua New Guinea's (**PNGs**) Western (Fly) province.

The assessment has established baseline noise levels at noise sensitive receptor locations, and environmental noise criteria which apply to the construction and operational phases of the project. Noise levels from each aspect of construction and operation of the project have been predicted and compared against the established noise criteria.

Based on the assessment, operational noise impacts are predicted to achieve the nominated criteria at all noise sensitive receptor locations during both the "daytime" (7:00 am to 10:00 pm) and "nighttime" (10:00 pm to 7:00 am) periods, except at one sensitive receptor location (Kungembit) when an exceedance is predicted during the nighttime period only.

As the operational noise impacts at Kungembit are dominated by mobile plant conducting tailings placement and embankment uplift activities, the exceedance will be limited to periods when these activities occur within 1,500 m of Kungembit during the night period. Outside of this distance compliance with the nominated criteria is predicted at all noise sensitive receptor locations at any time of the day or night. Operational noise impacts from the project will therefore be localised to a single noise sensitive receptor and relatively short-lived in duration, and in this context are considered to be relatively minor.

Recommended noise mitigation measures are provided which should be reviewed as the construction methodology is refined and included in an Operational Noise Management Plan (**ONMP**) to ensure that operational noise impacts are minimised as far as is practicable.

Noise from construction of the TSF and associated infrastructure will achieve the nominated criteria at all noise sensitive receptor locations. Notwithstanding, it is recommended that a Construction Noise and Vibration Management Plan (**CNVMP**) be prepared for infrastructure corridor works in the vicinity of populated areas to ensure that construction noise and vibration impacts are minimised as far as is practicable.

Road traffic noise associated with gravel haulage between the Ok Tedi and the TSF has been predicted, and will comfortably achieve the nominated noise criteria. Lower traffic volumes occur for other aspects of the project, and are expected to result in negligible impacts in the context of the ambient noise environment and existing road traffic on the relevant routes. Noise from additional road traffic along the pipeline access road beyond that directly associated with the project (i.e. 'induced demand') has also been predicted and will also achieve the relevant noise criteria.

## APPENDIX A: NOISE SENSITIVE LOCATIONS

### Appendix A.1: Regional Centres

| Locality: | Coordinates [PNG94 / PNGMG94 zone 54] |           |
|-----------|---------------------------------------|-----------|
|           | Easting:                              | Northing: |
| Ningerum  | 515720                                | 9373004   |
| Tabubil   | 525282                                | 9417557   |

### Appendix A.2: TSF Communities

| Locality:  | Coordinates [PNG94 / PNGMG94 zone 54] |           |
|------------|---------------------------------------|-----------|
|            | Easting:                              | Northing: |
| Ambaga     | 504497                                | 9366795   |
| Birimkamba | 510906                                | 9367052   |
| Karandimok | 509909                                | 9371187   |
| Komokpin   | 504673                                | 9359579   |
| Kungembit  | 505971                                | 9369593   |
| Kungim     | 503400                                | 9372032   |
| Putmambin  | 502447                                | 9369009   |

### Appendix A.3: Infrastructure Corridor Communities

| Locality:   | Coordinates [PNG94 / PNGMG94 zone 54] |           |
|-------------|---------------------------------------|-----------|
|             | Easting:                              | Northing: |
| Alice Pit   | 512601                                | 9368197   |
| Awin Tamaro | 517115                                | 9373340   |
| Bolewogam   | 527679                                | 9391564   |
| Boungkim    | 522157                                | 9406332   |
| Bultem      | 523622                                | 9424748   |
| Bumbin      | 526673                                | 9383566   |
| Digam       | 512020                                | 9375045   |
| Finalbin    | 522293                                | 9423500   |
| Haidawogam  | 533322                                | 9392984   |
| Hiorinkia   | 517356                                | 9373366   |
| Hosokumgu   | 516433                                | 9371533   |

| Locality:        | Coordinates [PNG94 / PNGMG94 zone 54] |           |
|------------------|---------------------------------------|-----------|
|                  | Easting:                              | Northing: |
| Hosonae          | 522381                                | 9378444   |
| Kolebon          | 517985                                | 9386742   |
| Kumkit/ Amkit    | 523383                                | 9413674   |
| Kwiloknai        | 530509                                | 9387894   |
| Ningerum Tamaro  | 516582                                | 9373182   |
| Nioksikwi/ Ok Ma | 518178                                | 9408587   |
| Ok Teditau       | 522460                                | 9406927   |
| Pampenai         | 516029                                | 9370646   |
| Seven Kona       | 524465                                | 9414596   |
| Sisimakam        | 534103                                | 9394462   |
| Tapko            | 523881                                | 9378285   |
| Walawam          | 523613                                | 9392671   |
| Wangbin          | 525668                                | 9416501   |
| Wangenai         | 515656                                | 9370154   |
| Wogam            | 516114                                | 9381431   |
| Wurimkanatgo     | 526184                                | 9382894   |

## APPENDIX B: SOUND DATA

### Appendix B.1: Construction Phase

| Description / Comment                      | Total Sound Power Level |                         | Octave Band Sound Power Level [L <sub>WA</sub> dB(A)]<br>Centre Frequency [Hz] |     |     |     |     |     |     |     |
|--------------------------------------------|-------------------------|-------------------------|--------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|
|                                            | L <sub>w</sub> [dB]     | L <sub>WA</sub> [dB(A)] | 63                                                                             | 125 | 250 | 500 | 1k  | 2k  | 4k  | 8k  |
| Excavator (30t)                            | 114                     | <b>107</b>              | 85                                                                             | 91  | 97  | 101 | 102 | 100 | 94  | 87  |
| Dozer (D8)                                 | 116                     | <b>111</b>              | 85                                                                             | 93  | 95  | 102 | 110 | 99  | 94  | 85  |
| Grader (140M)                              | 120                     | <b>115</b>              | 90                                                                             | 99  | 102 | 104 | 112 | 107 | 103 | 92  |
| Wheel loader/Integrated tool loader (IT38) | 117                     | <b>107</b>              | 89                                                                             | 94  | 96  | 103 | 101 | 99  | 93  | 84  |
| Franna (50t)                               | 117                     | <b>105</b>              | 89                                                                             | 94  | 97  | 99  | 99  | 96  | 89  | 79  |
| Mobile crushing plant                      | 119                     | <b>111</b>              | 88                                                                             | 96  | 103 | 106 | 106 | 104 | 100 | 93  |
| Lighting tower                             | 107                     | <b>93</b>               | 79                                                                             | 84  | 83  | 85  | 87  | 86  | 83  | 69  |
| Diesel generator (7 kVA)                   | 107                     | <b>93</b>               | 79                                                                             | 84  | 83  | 85  | 87  | 86  | 83  | 69  |
| Diesel generator (50 kVA)                  | 109                     | <b>93</b>               | 81                                                                             | 86  | 86  | 89  | 83  | 80  | 74  | 69  |
| Water truck (20t)                          | 114                     | <b>109</b>              | 82                                                                             | 93  | 94  | 104 | 101 | 103 | 99  | 92  |
| Dump truck (20t)                           | 119                     | <b>113</b>              | 88                                                                             | 96  | 105 | 108 | 107 | 105 | 101 | 94  |
| Haul truck (45t)                           | 119                     | <b>113</b>              | 88                                                                             | 96  | 105 | 108 | 107 | 105 | 101 | 94  |
| Mulcher/shredder                           | 124                     | <b>114</b>              | 96                                                                             | 99  | 102 | 108 | 108 | 107 | 105 | 98  |
| Skid steer                                 | 112                     | <b>101</b>              | 81                                                                             | 93  | 87  | 94  | 94  | 94  | 90  | 79  |
| Rock breaker (where required)              | 121                     | <b>121</b>              | 81                                                                             | 94  | 100 | 107 | 114 | 115 | 115 | 112 |
| Vibratory roller                           | 120                     | <b>108</b>              | 92                                                                             | 96  | 96  | 106 | 101 | 97  | 94  | 88  |
| Grinder                                    | 108                     | <b>109</b>              | 59                                                                             | 63  | 71  | 85  | 98  | 106 | 102 | 100 |
| Crane or sideboom pipe layer               | 112                     | <b>107</b>              | 77                                                                             | 91  | 96  | 102 | 102 | 100 | 94  | 84  |

## Appendix B.2: Operational Phase

| Description / Comment       | Total Sound Power Level |                            | Octave Band Sound Power Level [L <sub>WA</sub> dB(A)]<br>Centre Frequency [Hz] |     |     |     |     |     |     |     |
|-----------------------------|-------------------------|----------------------------|--------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|
|                             | L <sub>w</sub><br>[dB]  | L <sub>WA</sub><br>[dB(A)] | 63                                                                             | 125 | 250 | 500 | 1k  | 2k  | 4k  | 8k  |
| <b>Fixed Infrastructure</b> |                         |                            |                                                                                |     |     |     |     |     |     |     |
| Hydro-cyclone house         | 110                     | <b>109</b>                 | 64                                                                             | 77  | 90  | 101 | 104 | 104 | 101 | 93  |
| Choke station               | 112                     | <b>109</b>                 | 81                                                                             | 87  | 92  | 101 | 105 | 102 | 100 | 90  |
| Diesel generator (1250 kVA) | 116                     | <b>108</b>                 | 88                                                                             | 94  | 95  | 97  | 98  | 101 | 105 | 105 |
| <b>Mobile Equipment</b>     |                         |                            |                                                                                |     |     |     |     |     |     |     |
| Excavator (45t)             | 115                     | <b>107</b>                 | 87                                                                             | 90  | 96  | 102 | 101 | 100 | 97  | 90  |
| Dozer (D8)                  | 116                     | <b>111</b>                 | 85                                                                             | 93  | 95  | 102 | 110 | 99  | 94  | 85  |
| Pumps                       | 104                     | <b>103</b>                 | 56                                                                             | 68  | 81  | 98  | 97  | 99  | 93  | 89  |
| Portable diesel pump        | 118                     | <b>105</b>                 | 91                                                                             | 91  | 92  | 99  | 98  | 100 | 97  | 95  |
| Lighting plant              | 113                     | <b>93</b>                  | 87                                                                             | 86  | 83  | 86  | 84  | 83  | 83  | 82  |
| Diesel Generator (50 kVA)   | 109                     | <b>93</b>                  | 81                                                                             | 86  | 86  | 89  | 83  | 80  | 74  | 69  |

## APPENDIX C: AIR-BLAST OVERPRESSURE AND GROUND VIBRATION MITIGATION MEASURES

Potential measures to reduce ground vibration:

- Reducing bench height
- Reducing blast hole depths
- Reducing blast hole diameter
- 'Deck loading' of blast holes (i.e. placing two separate charges in the same blast hole separated by a column of inert material and firing with a separate delay)
- Increasing stemming height
- Maximising the blast distance from vibration sensitive locations.

Potential measures to reduce air-blast overpressure:

- Increasing confinement (i.e. increasing standard front row burden and stemming height)
- Reducing the charge mass per delay
- Directing blasts away from sensitive sites where possible/practicable
- Conducting blasting in locations where topography eliminates 'line of sight' to noise sensitive locations
- Conducting blasting near sensitive areas during weather periods unfavourable to noise propagation
- Maximising the blast distance from noise sensitive locations.