

Ok Birim Tailings Storage Facility Project

Environmental and Social Impact Assessment

Appendix G

Terrestrial biodiversity impact assessment report



TERRESTRIAL BIODIVERSITY ASSESSMENT FOR THE OK BIRIM TAILINGS STORAGE FACILITY PROJECT

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A report prepared for Tetra Tech Coffey
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DISCLAIMER

For brevity this assessment assumes the reader has a basic, but not in-depth, understanding of Melanesian geography, vegetation and biodiversity and of basic ecological concepts like edge and barrier effect. Maps are not provided for all place names mentioned in the text and the reader can refer to GoogleEarth or Microsoft Bing as necessary. I, and the authors of the field surveys commissioned for this project, have had recourse to use experience and data collected in survey work elsewhere in Melanesia by ourselves and colleagues over the last 35 years for a variety of resource projects and NGOs. Of particular relevance to this assessment has been work in the Fly, Sepik, Ramu, Kikori and Purari drainages, the Müller Range, the Star Mountains, the Hindenburg Wall, the Central Range and localities in Indonesian Papua. Much of this is unpublished or awaiting publication, only available as internal company documents or only temporarily available on web sites. It has formed an important background for understanding species ranges and sensitivities but in-confidence agreements prevent some of it being specifically referred to here, e.g. locations. This is regrettable but unavoidable.

All efforts have been made to keep the sequence of taxa in tables and appendices consistent - fauna in systematic order and plants in alphabetic order. However in some tables and appendices they are arranged in conservation status or groupings relevant to text.

Finally, apart from spellcheckers in Microsoft products, no AI has been used in preparation of this assessment.

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1 EXECUTIVE SUMMARY

This is an analysis of the potential impacts on terrestrial biodiversity of construction and operation of the Ok Birim Tailings Storage Facility (TSF) which is intended to replace the current system of riverine tailings disposal by piping tailings produced at the Ok Tedi mine to a TSF in the lowlands. The development area consists of the TSF itself and an infrastructure corridor with pipeline and road from mine site to the TSF. As well as reducing river impacts, the TSF has the potential to alleviate dieback caused by bed aggradation and overbank flooding which resulted from mine waste disposal into the Ok Tedi. This had impacted 214,635 ha of the floodplains of the Ok Tedi and Fly River by 2024. Modelling suggests that the TSF can reduce silt input by 20% and this, combined with possible future levee and tie channel engineering to assist drainage, could optimistically alleviate stress on between 7,500 - 9,000 ha of forest and pessimistically 3,700 - 4,500 ha.

The project is entirely within intact Low Altitude Forest On Uplands and on Agricultural Land, mostly shifting cultivation with small plantations. The project is anticipated to impact approximately 2,042 ha consisting of 1,563 of Intact Forest, 318 ha of Agricultural Land, and 132 ha of roads and tracks. Biodiversity surveys commissioned by the project recorded 638 species of flora, 54 native species of mammals, 139 birds, 40 frogs, 30 reptiles and 52 odonates that occur or could occur. All but 20 fauna species are lowland species. Eight species of plants, two frogs and six damselflies are likely new to science and these and another 81 species recorded are of conservation relevance and a further 29 conservation relevant species could occur.

The mitigation hierarchy was followed in impact analysis. There were limited opportunities for avoidance of clearing at the design stage but forest loss beyond design could be avoided further by careful management of the area of retained forest between the TSF footprint and its perimeter road. The infrastructure corridor route avoids intersecting the Lukwi caves area. Forty-eight mitigations are recommended to reduce impacts.

The significance of residual impacts was determined by examining the magnitude of the impact and the sensitivity of the receptor being impacted. The projected recovery of stressed vegetation in dieback areas resulted in an overall positive impact for Low Altitude Forest On Uplands and for most species. Impacts on hunted species are higher on the basis of indirect impacts potentially increasing hunting and forest degradation by improved access.

The project is in IFC Critical Habitat on the basis of the occurrence of several restricted range species triggering or tentatively triggering Criterion 2; plus two Endangered tree species tentatively triggering Criterion 1b.

A habitat gain/loss analysis using habitat hectares indicates a significant net-gain is possible even with a 3% time discount. The final figure of how much stressed vegetation recovers and delivers net-gain and whether the expansion of stressed areas has been halted or slowed can only be determined by monitoring.

CONVENTIONS

Vegetation—vegetation classification follows the system used for the PNG Forest Resource Inventory Management System (PNG-FRIMS) (see Appendix 2 and PNG Forest Authority 2022).

Mammals—nomenclature follows Wilson and Mittermeier 2015, 2019, Wilson et al. (2017) and IUCN (2026).

Birds—nomenclature follows the International Ornithological Congress (IOC) World Bird List version 15.1 (Gill et al. 2025).

Herpetofauna—nomenclature follows IUCN (2026), or the latest relevant literature, including recent species descriptions, where not evaluated by the IUCN.

IFC PS6 habitat types – When specifically referring to IFC PS6 habitat types the words Natural, Modified and Critical are capitalised. When used as normal English they are not.

Elevation above mean sea level is expressed as “m”

Sample Sites - when referring specifically to one or more of the five sample sites used by the biodiversity surveys commissioned for this assessment (see section 4.1) they will be capitalised “Site”.

ACRONYMS

AoA – Area of Analysis

BAP – Biodiversity Action Plan

CI – Conservation International

EMMP – Environmental Management and Monitoring Plan

EOO – Extent of Occurrence

EP – Environment Permit

EWRD – Engineered Waste Rock Dump

FIMS – Forest Inventory Management System

GN – Guidance Note

IFC – International Finance Corporation

ITCS – Infrastructure Tax Credit Scheme

IUCN – International Union for the Conservation of Nature

LAFU – Low Altitude Forest on Uplands

Mt – Millions of tonnes

OTML - Ok Tedi Mining Ltd.

PIIM – Project-induced in-migration

PNG – Papua New Guinea

PNG-FRIMS – Papua New Guinea Forest Resource Information System

PNGFA – Papua New Guinea Forest Authority

PS – Performance Standard

TSF – Tailings Storage Facility

PART 1 INTRODUCTION AND THE PROJECT

2 INTRODUCTION

This is an analysis of the potential impacts on terrestrial biodiversity of construction and operation of the Ok Birim Tailings Storage Facility Project (“the project”) proposed by Ok Tedi Mining Ltd (OTML). The project, in Western Province of Papua New Guinea (PNG), is one of several potential developments aimed at improving long term environmental performance and supporting mine life extension of the Ok Tedi copper, gold and silver mine run by OTML at Mt Fubilan.

The project aims to replace the current system of riverine tailings disposal by piping tailings to a Tailings Storage Facility (TSF) in the lowlands. This analysis assesses the potential impact of the project on terrestrial habitats, flora, mammals, birds, reptiles, amphibians and odonates (damselflies and dragonflies). It does not assess impacts on aquatic habitats nor species.

The project description supplied by Tetra Tech Coffey as document “754-POMEN374244C_R12” and a series of figures as document “374244C_R08_Figures_CH06-RevB” forms the basis for this impact assessment. The project has two development areas:

1. **TSF development area** encompassing the construction footprint of the proposed TSF impoundment, hydro-cyclone house, laydown area and associated ancillary infrastructure.
2. **Infrastructure corridor development area** (henceforth the “Infrastructure corridor”) encompassing the construction footprint required for the proposed access road, bridge and water crossings, tailings pipeline and supporting facilities outside the TSF development area.

Sagata and Richards (2026) provide a background to the geography of the area.

From a terrestrial biodiversity perspective dieback of forests in the Ok Tedi and Fly River system has been, and is, the most significant of the mine’s impacts. Bed aggradation in these rivers, caused by riverine waste rock and tailings disposal, has caused overbank flooding and consequent dieback of forests, woodlands and swamplands over approximately 214,000 ha of the floodplains of these rivers and their tributaries in the last two decades. A dedicated TSF that reduces tailings input into the river system by 90% or more could be an important element in ameliorating the long standing problem of dieback. This impact analysis, therefore, takes account of the positive effects the project may produce as well as the negative.

This impact assessment is designed to meet the requirements of the *Ok Tedi Environmental Management Act 2019*, the *Mining (Ok Tedi Agreement) Act 1976* and its supplements up to *The Mining (Ok Tedi Mine Continuation (Ninth Supplemental) Agreement) (Amendment) Act 2018*, the Department of Environment and Conservation 2004 *Guideline for Conduct of Environmental Impact Assessment and Preparation of Environment Impact Statement*, Equator Principles 4, and International Finance Corporation Performance Standard 6 (IFC PS6) and its accompanying 2021 Guidance Notes (GNs).

3 DIEBACK AND THE POTENTIAL BENEFITS OF A TSF

3.1 BACKGROUND

Mine inputs into the rivers are waste rock and tailings. The former comes from two existing dumps designed to continuously erode to the Ok Tedi via Sulphide, Harvey and Warrama Creeks “over a few months period” (OTML 2023). This input is to be reduced by construction of two Engineered Waste Rock Dumps (EWRDs) that are designed to be geotechnically stable and so significantly slow the overall waste rock delivery to the Ok Tedi (OTML 2023). The first EWRD is under construction and the second is planned for later this decade.

At present, tailings from the copper concentrator circuit are transferred to a Tailings Processing Plant where pyrite is removed. This concentrate is piped 128 km to Bige and buried subaqueously in dredged storage pits. This will continue as will the dredging operations at Bige which remove mine waste (sand) from the river. The remaining depyritised tailings from the Tailings Processing Plant consists of sand and silt which is thickened and eventually discharged into the Ok Kumiup, a tributary of the Ok Mani then the Ok Tedi (OTML 2020, 2024). This will be discontinued and, instead, these tailings will be piped to the proposed TSF for permanent storage above the Ok Tedi’s floodplain.

This reduction of inputs into the river systems is an attempt to both reduce aquatic impacts in the rivers and to reduce the spread of impacts on the floodplain. It could act to both mitigate existing impacts and avoid their future expansion. To realise the full potential of these works additional local engineering on the floodplain, as suggested by Pickup and Ridd (2024), is also planned (J. Pile OTML *in litt* to D. Moriarty Tetra Tech Coffey 16/3/26).

The EWRDs and TSF will obviously act together to reduce input into the river system but this terrestrial biodiversity impact assessment concerns the TSF only. However, synergies with the EWRDs and local floodplain engineering will be addressed where appropriate.

3.2 DIEBACK

Forest dieback refers to decline in vigour or death of numerous trees in a forest, caused by changing hydrology, drought, disease, insect attack, etc and occurs naturally in forests and swamplands but in the Ok Tedi context it is due to changed hydrology on a massive scale. The history and mechanism of the Ok Tedi dieback phenomenon, first noticed in 1991, is detailed in Marshall and Rau (1999). They recorded that dieback was due to changes to depth, frequency and duration of flooding or waterlogging patterns, physical damage by flowing water, and sediment deposition suffocating roots and seedlings, but they subsequently focussed on hydrological changes as being the dominant force responsible, with duration of flooding being the most significant of those.

The extent of dieback has been monitored since 1992 using a variety of remote sensing methods and ground truthing (Appendix 1). Although there has been an elaboration on occasion, the basic categories of dieback and their relationships in the dieback monitoring reports are shown in Figure 1. Basically trees are stressed and leaves brown off and die. If flooding persists trees will die but, if flooding recedes or is alleviated, dieback areas may subsequently slowly regenerate to the original habitat (recover) or convert to a more aquatic habitat or to a novel one (Rogers and Kelimbua 2019). Recovered and converted habitat may also subsequently suffer stress.

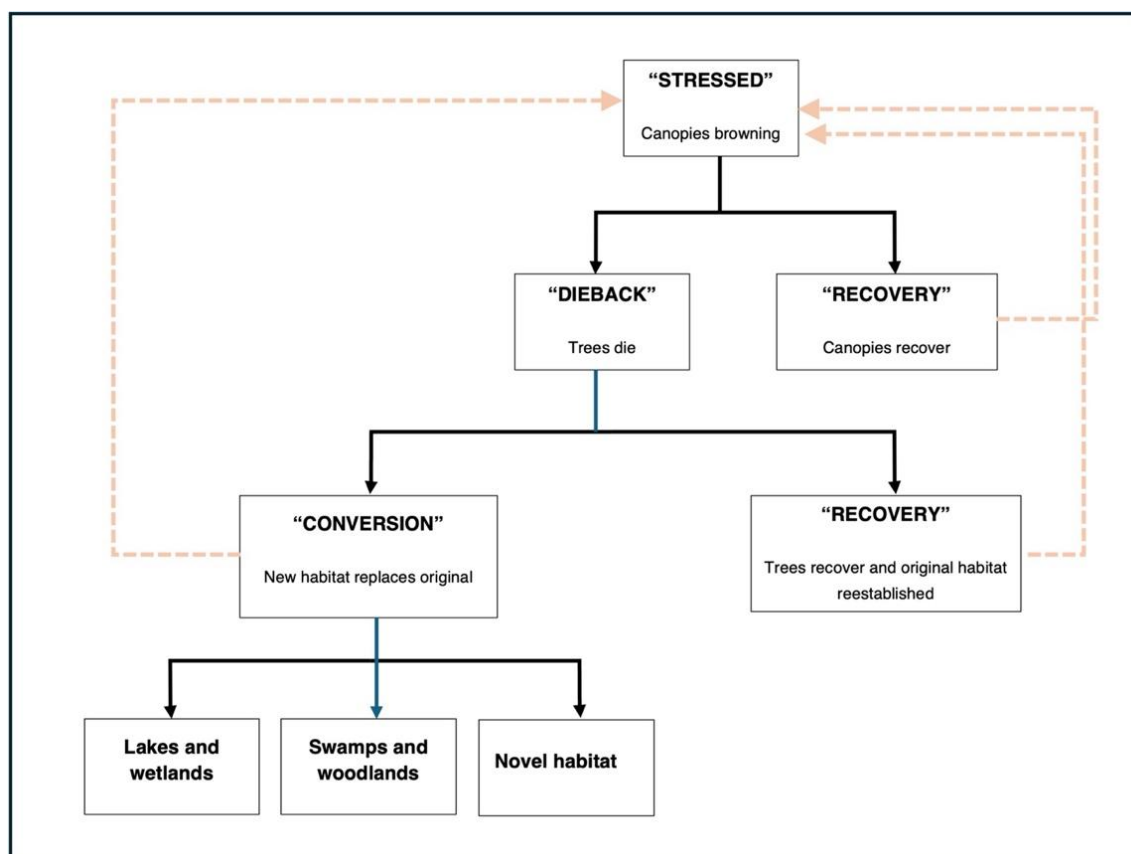


Figure 1 Schematic of relationship between dieback categories

Marshall (2003) developed a model that produced three predictions of future dieback extent: a “pessimistic” one of 411,200 ha, a more “likely” one of 284,200 ha, reducing to 239,500 ha if dredging is continued at Bige. The latter has

been the working hypothesis for the final extent of dieback. This model was a significant development in such an ecologically and hydrologically complex system and with the coarse terrain models available at the time. Figure 2 shows the recent dieback mapping.

Mine impacts are imposed on an already hard to predict natural dynamic. Plant species can respond to very minor changes in depth, duration and periodicity of inundation produced by variations in river flows and local rainfall affecting both overbank and within floodplain water movements, which in turn can be affected by small scale variations of terrain.

So far, the total estimated impacted area has fallen short of the predicted maximum (Table 1) but the predicted geographic limits have been exceeded in places. Stress and dieback in areas where it was not predicted to occur is mostly on the margins and higher elevation peripheral areas and Marshall (2016) notes that this is mostly occurring in the Upper Fly and its headwaters. High resolution aerial photography, drone missions and ground truthing has enabled detection of quite narrow, 10 to 30 m, fringes of stress that are not readily found with 30 m imagery.

Table 1 Progression of dieback in the Ok Tedi and Fly River floodplains

YEAR	AREA IMPACTED (HA)	RECOVERY (HA)	STRESS (HA)	CATEGORIES INCLUDED*	SOURCE
1992	1,750	n/a	1,750	S + H	Table 3.9 in Marshall and Rau 1999
1994	5,270	n/a	5,270	S + H	Table 3.8 in Marshall and Rau 1999
1995	10,590	n/a	10,590	S + H	Table 3.7 in Marshall and Rau 1999
1996	17,640	n/a	17,640	S + H	Table 3.6 in Marshall and Rau 1999
1997	47,800	1,550	46,250	E + S + H	Table 3.5 in Marshall and Rau 1999
2000	134,090	2,360	63,900	S + F + E	Table 1 in Marshall 2001.
2002	146,130	16,710	60,030	S + F	Table in Marshall 2002
2006	160,200	40,980	47,800	S + F	Table 2 in Marshall 2006.
2007	163,290	45,910	no data	no data	Marshall 2007.
2010	170,270	36,460	no data	no data	Marshall 2010.
2011	179,450	29,780	no data	no data	Marshall 2011.
2012	181,965	29,793	62,860	S + F	Table 1 in Marshall 2012.
2013	187,536	28,817	61,500	S + F	Table 1 in Marshall 2013.
2016	195,410	17,730	56,140	S + F	Table 1 in Marshall 2017.
2018	203,368	14,774	45,089	S	Table 2 in Marshall 2018.
2019	203,405	15,942	41,360	S + F	Table 3 in Marshall 2020.
2023	209,926	16,065	40,343	S	Table 3 in Marshall 2024.
2024	214,635	13,870	42,857	S	Table 3 in Marshall 2025.

* Categories from dieback reports. S- stressed, E – estimated stress, F – fringe stress, H – highly stressed

In addition to stress moving into new peripheral areas, recovery of the floodplain is declining. The following quote from Marshall (2025) encapsulates the problem.

*“Initially the pattern of vegetation recovery tracked that of overall impact, indicating that a proportion of the impacted vegetation in any given year recovered if inundation conditions became more favourable. This continued through to 2005 when the rate of increase in recovery extent changed, with a plateauing occurring through to approximately 2009. **Since that time recovery extent has steadily decreased such that it is now 57% less than the 2005 peak.**”*

Marshall (2025), Pickup (2025) and Pickup and Ridd (2024) do not consider this to be due to raised water levels in the river *per se* but to the floodplain not draining adequately during lowered river levels. This has been brought about by the heavy silt loads in the rivers depositing on the levees, increasing overall levee height, repairing natural breaches in the levees and promoting closure of tie-channels¹. Open tie-channels and breaches in levee banks are important elements that permit drainage but are no longer functioning adequately. The floodplain has become more isolated and water is being retained longer on the floodplain thus increasing the inundation time of vegetation, increasing stress at the floodplain periphery and reducing recovery. Marshall (2025) says

¹ Tie-channels are connectors between the main river and off river water bodies.

“Should the frequency of extreme flooding events continue into the future it is likely that the severity of vegetation impact within the Lower Ok Tedi and Fly River floodplains will continue, and the extent of vegetation recovery continue to decrease.”

Silt loads have been particularly important in reducing floodplain drainage. Pickup and Marshall (2019) p. 37 say.

“... larger areas of floodplain are inundated at higher frequencies than thought previously ... areas of the floodplain are becoming isolated from the main river floodplain and drain more slowly, if at all, except during major droughts. This behaviour is largely related to silt deposition on levees plus sand and silt deposition in tie-channels and meander cutoff entry points.”

The proposed TSF could ameliorate this problem by reducing sediment flows, particularly silt.

Pickup and Ridd (2024) and Pickup (2025) have modelled the effects of a TSF and EWRDs on sediment transport. According to Pickup and Ridd (2024) the natural sand load prior to the mine was about 2 Mt/year but “Since 2010, about 20 Mt/year of sand has reached Bige”. Two thirds of these dredged sands are from tailings, the rest from waste rock (Pickup 2025 p. 44) but dredging at Bige captures most of the sand so only small amounts extend further downstream. Pickup’s (2025) modelling shows (p. 99) that, with the proposed TSF, sand output to the lower river system and the Bige dredge will fall from around 17 Mt/year to an average of 6 to 7 Mt/year i.e. a 60% reduction.

Silt, however, is not affected by the dredging at Bige (Pickup and Ridd 2024). Pickup *et al.* (2018 referenced in Pickup and Marshall 2019) estimated that 20 to 30 Mt per year of silt passes Bige, and Pickup’s (2025) modelling (p. 102) suggests the proposed TSF will reduce this by 6.2 Mt per year in addition to the 6.2 Mt per year reduction predicted to be effected by the EWRDs. Using the figure of 30 Mt per year of silt passing Bige, the proposed TSF could reduce silt loads by 20% and in conjunction with the EWRDs by 40%.

Pickup’s (2025) overall conclusion about the effectiveness of the proposed TSF is that:

“Diversion of tailings to a TSF will further reduce bed level rise in the lower and central Middle Fly and eliminate it in the lower Ok Tedi and upper Middle Fly” (p. 5)

and that without a TSF:

“there will be continued sedimentation, water level rise, and further floodplain impacts” (p. 6).

Specifically with a TSF (p. 6) he concludes.

- *“There will be significant reductions in sand and silt delivered to Lower Ok Tedi and Middle Fly.*
- *Increased riverbed erosion on the lower Ok Tedi and at the upper end of the Middle Fly but little change further downstream, and possible continued deposition on the lower Middle Fly but at a very slow rate.*
- *Reductions in water levels on the lower Ok Tedi but at a decreasing rate further downstream with minimal change beyond Mabaduam and into the central and lower Middle Fly.*
- *Possible reduction in floodplain inundation frequency and delivery of mine derived sediment to floodplain surfaces and Off River Waterbodies.”*

Pickup (2025) predicts that the effect of the proposed TSF would be greatest at the upper end of the system with decreases in water level of up to 1.5 m and (p. 106) it will *“enhance the improvements resulting from dredging and in combination produce a small but useful improvement downstream as far as Wygerin.”* He predicts that further downstream, any changes would be small.

To what extent will this improvement reduce dieback and accelerate recovery of terrestrial habitats? The modelling and predictions about the dynamics of sediments and dieback are fraught with uncertainty. The dieback monitoring reports suggest a 10% error in mapping and Pickup (2025) discusses uncertainty and errors. For instance, it is not possible to model the effects of silt reduction on the dynamics of levees and tie-channels. From their experience, Pickup and Ridd (2024) and Pickup (2025) consider that levee rise will reach a limit at some stage but blocking of levee breaches and tie-channels will continue. This appears to be where local engineering would be effective. Opening levee breaches and clearing tie-channels to allow drainage, as suggested by Pickup and Ridd (2024), would act synergistically with the TSF. Reduced silt loads should slow levee growth, slow infill of breaches and tie-channels and prolong the life of the engineering works.

With improved drainage of the floodplain and reduced inundation brought about by reduced silt loads, it would be expected that the areas of stress, particularly in fringing and peripheral areas, would recover rapidly and not continue extending into adjoining unimpacted forest. Areas that have died back will recover much more slowly. From 2018 to 2024 the area of stressed vegetation has remained steady at about 41,000 ha (Table 1). The dieback mapping has a misclassification error of about 10% (Marshall 2002, 2006) so, under the present trajectory, between 37,400 and 45,700 ha of vegetation would be classified as stressed each year². Should the present stressed areas expand by only 10 m on their edges, an additional approximately 2,000 – 2,500 ha would become stressed³.

On the simple assumption that recovery is proportional to silt reduction, then the 20% per annum silt reduction produced by the proposed TSF may optimistically reduce the area of stressed vegetation by 7,500 - 9,000 ha. A pessimistic 10% reduction, as suggested in Pickup and Ridd's (2024) earlier modelling, could mean 3,700 - 4,500 ha. In combination with the ERWDs an optimistic scenario would be 15,000 - 18,000 ha or pessimistically 7,500 - 9,000 ha.

In summary, and parsimoniously, it is possible that the proposed TSF could reduce stressed areas by 3,000 to 9,000 ha. These must be considered only approximate figures and the final figure of how much stressed vegetation recovers and whether the expansion of stressed areas has been halted or slowed can only be determined by monitoring.

² This would consist of both newly stressed areas and existing stress.

³ This was estimated by applying a 10 m buffer around the mapped polygons of stressed low altitude forest below 1000 m in the shape file "Dieback Status 2018.shp" provided by Tetra Tech Coffey and reprojected to PNG94/PNGM94 zone 54.

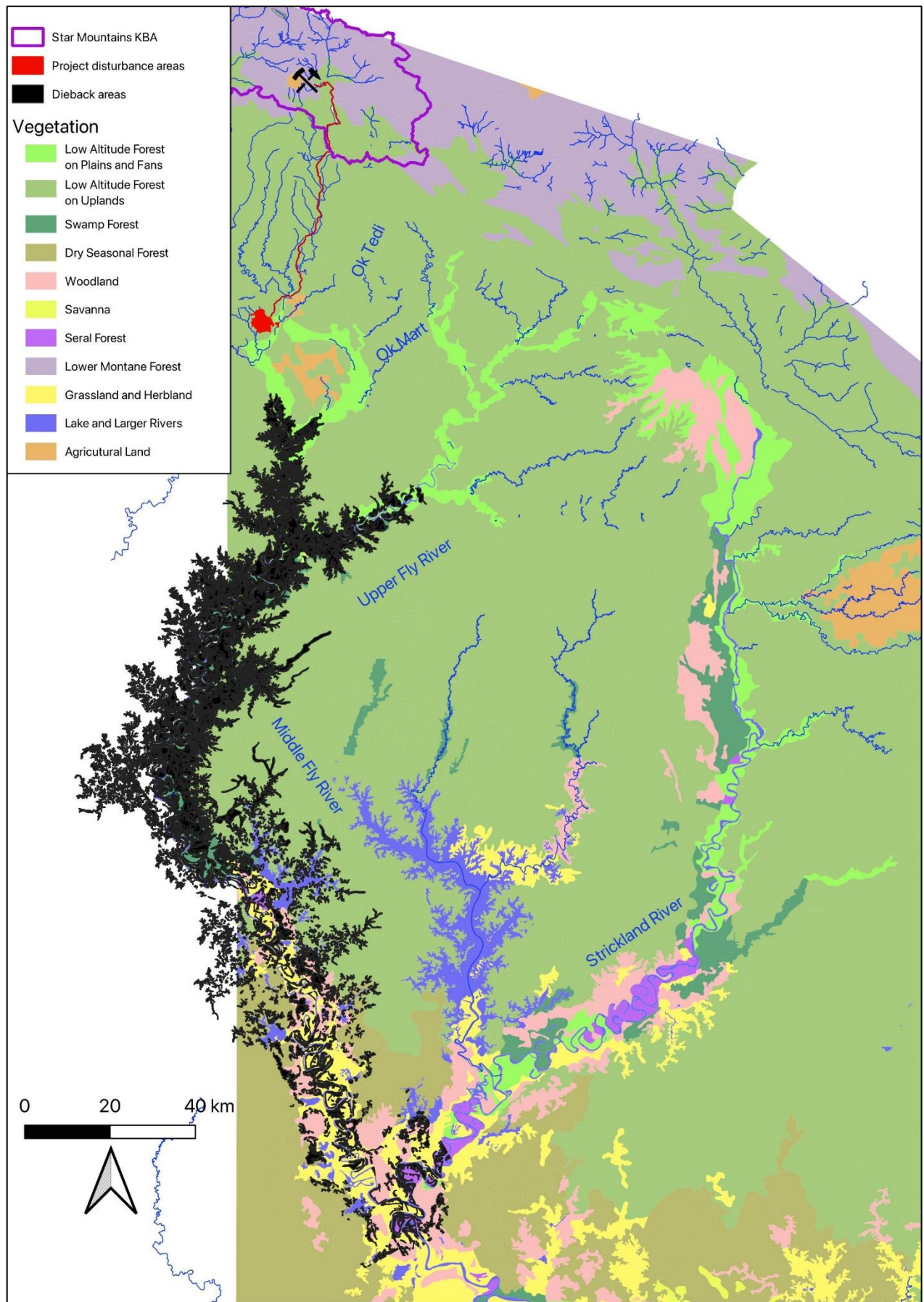


Figure 2 Northwest of Western Province showing project location in relation to vegetation and dieback.

PART 2 HABITATS AND BIODIVERSITY

4 INTRODUCTION

4.1 DATA SOURCES

Data on flora and fauna was gathered by specially commissioned biodiversity surveys of the TSF and the Infrastructure corridor development areas (Sagata and Richards 2026). A nine person field team of specialists surveyed three sites (Sites 1, 2 and 3) in and around the TSF site in 2025 and two (Sites 4 and 5) along the Infrastructure corridor in 2026. The locations of these sites are shown in Figure 3. Sites 1 to 3 were between 63 and 83 m elevation, Site 4 at 130 m, and Site 5 at 465 m. Site 3 was a site where only camera traps were deployed and so it provided data only on mammals and birds.

Additional data was available from a preliminary survey of the TSF project area (BMT WBM 2015), and a survey of the Bige tailings storage area, 25 km to the south (BMT WBM 2016). Bige's elevation and proximity to the TSF development area means that species at the former would also occur at the latter so the data was combined.

Background information for Sagata and Richards (2026) and this impact assessment was sourced as follows.

- Vegetation of the Ok Tedi–Fly River System (Rau and Reagan 2008).
- Biodiversity surveys of the Hindenburg Wall (Richards and Whitmore 2015)
- Cornell Birds of the World <https://birdsoftheworld.org/bow/home>
- American Society of Mammalogists Mammal Diversity Database <https://www.mammaldiversity.org/index.html>
- Plants of the World Kew Online <https://powo.science.kew.org/>
- PNG Plant Database <https://www.pngplants.org/>
- IUCN Red List of Threatened Species (IUCN 2026)
- Amphibian Species of the World <https://amphibiansoftheworld.amnh.org>
- Amphibia Web <https://amphibiaweb.org/search/>
- The following general references: New Guinea Vegetation (Paijmans, 1976), Mammals (Flannery 1995, Bonaccorso, 1998, Wilson and Mittermeier 2015, 2019, Wilson et al. 2017), Birds (Pratt and Beehler 2015).

4.2 ESTIMATING THE SIZE OF SPECIES' RANGES

The range measure used here is the IUCN Extent of Occurrence (EOO) concept. IUCN (2012) defines EOO as “... *the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy . . . This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat) . . . Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees, and which contains all the sites of occurrence)*”.

Estimates of the size of ranges in this assessment are mostly based on the maps in IUCN (2026). These can only be considered approximate as the knowledge of the distribution of perhaps the majority of species in New Guinea is more informative of collectors' activities than underlying distributional patterns. This is particularly problematic with plants, herpetofauna and odonates where ranges in IUCN (2026) for many taxa are shown as a set of location dots without generation of a minimum convex polygon and EOOs are either absent or obviously unreliable. Where necessary in these situations, personal experience and Sagata and Richards (2026) have been used to estimate EOO.

For some mammals and birds the 100 m resolution range maps of Lumbierres *et al.* (2022) were polygonised and ranges estimated.

4.3 CONSERVATION RELEVANCE

Species that have already been scientifically named were classed as conservation relevant if they are.

1. Listed as Critically Endangered, Endangered, Vulnerable, Near Threatened, or Data Deficient on the IUCN Red List (IUCN 2026).
2. Protected species under the PNG Fauna (Protection and Control) Act 1966. Section 154 of the Act was repealed by the Protected Area Act 2024 and the legal situation in regard to protected species remains obscure. The categorisation is fundamentally related to hunting rather than to conservation status and is outdated. Species status under the 1966 act continues to be used here.

3. Restricted range species. These are species with small ranges. Following IFC PS6 restricted range species are those with EOOs of less than 50,000 km².

4.4 UNNAMED SPECIES AND SPECIES NEW TO SCIENCE

The Ok Birim surveys found species that:

- a) are identified to genus only or are designated “cf.” e.g. the frog *Amniphylla* cf. *arfakiana* means that it looks like *A. arfakiana* but may be different,
- b) were undescribed, i.e. previously known from elsewhere but not scientifically named yet, or
- c) were newly discovered during these surveys and, therefore, new to science.

This is expected in biodiversity surveys in New Guinea where new species are being regularly discovered. For example surveys for the Frieda River EIS at sites approximately 100 km northeast of the Ok Tedi Mine, discovered 23 new plants, 2 new mammals, 25 new frogs, 5 new reptiles, 15 new odonates and 9 new butterflies (<https://www.friedariver.com/eis/volumes/?type=Investor>).

Detailed taxonomic investigations are required to determine whether new discoveries are indeed that or simply already described species. Even if confirmed as a new species, there is still no information as to conservation status. A new species could be an extremely narrow endemic or distributed throughout New Guinea. These species were treated as follows.

- a. Species that could not be identified – not conservation relevant species.
- b. Undescribed – treated as a conservation relevant restricted range species. The only exception was the damselfly *Idiocnemis* sp. 1 where the description in Sagata and Richards (2026) is not definitive that the species is already known so it was conservatively classed as a new species in this impact analysis.
- c. New species – generally treated as a conservation relevant restricted range species possibly endemic to the region in and around the project development area. This applies to species whether definitely or only tentatively considered a new species and recorded as “NTS” or “UN/NTS” by Sagata and Richards (2026).

4.5 ELEVATION

Species may occur at the northern end of the infrastructure corridor that do not come down to the elevation of the TSF and, therefore, would not be advantaged by any reduction in dieback that the TSF may produce. Generally, these are species with their distributions mostly above 500 m even though they may on occasion extend further down in certain places or at certain times. These species are termed “upland species” and, where possible, have been distinguished in order to take that into account during the impact analysis.

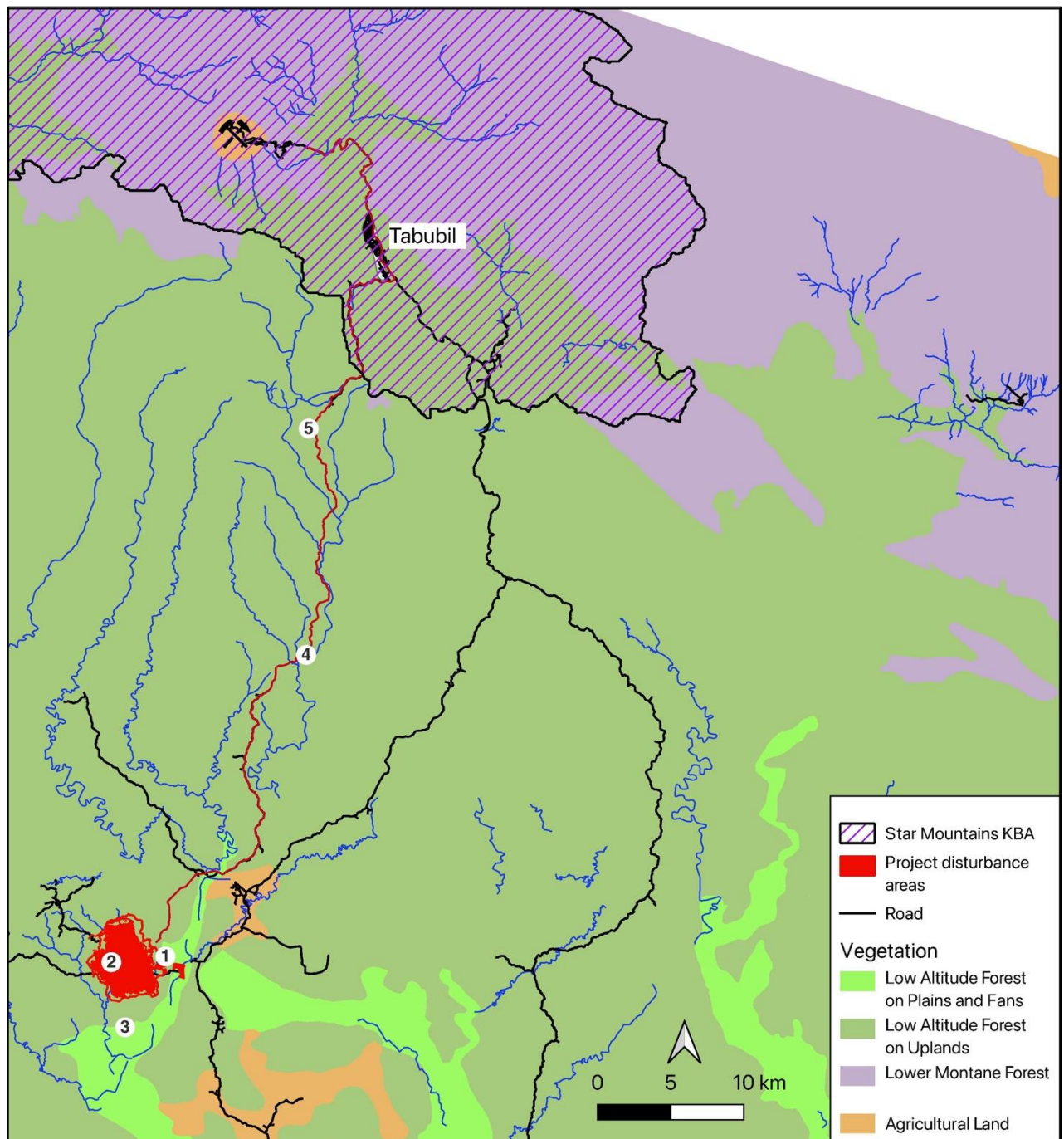


Figure 3 Biodiversity sample site locations 1 to 5.

5 PROTECTED AREAS

5.1 NATIONAL PROTECTED AREAS

There are no PNG nor Indonesian protected areas near the project.

5.2 KEY BIODIVERSITY AREAS AND ALLIANCE FOR ZERO EXTINCTION

Part of the project is within the Star Mountains Key Biodiversity Area (KBA). This is a 120,000 ha area originally designated as an Alliance for Zero Extinction (AZE) site because of the presence of six species of mammals and twenty species of amphibians. These are now considered legacy species and would not now qualify the site as a KBA under new rules (Key Biodiversity Areas Partnership 2026). However, it qualifies as a KBA because it "... holds the only known populations of the Critically Endangered plant species, *Cryptocarya dipterocarpifolia*, *Cyrtostachys bakeri*, and *Eurya ryoana*" each of which triggers the A1e criteria of an Alliance for Zero Extinction (AZE) site. i.e. it contains effectively the entire population of an IUCN Critically Endangered or Endangered species (IUCN 2016).

None of these were recorded by Sagata and Richards (2026) (see section 7) but, nonetheless, they will be treated as potentially present in the impact analysis in section 15.3.1.

The boundary of this KBA was drawn to include the Ok Tedi mine.

6 HABITATS

Habitat is described in terms of its identity and condition i.e. to what extent it is degraded from pristine. It is also classified according to the IFC PS6's definitions of Natural, Modified, and Critical.

Natural Habitats "...are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition". (PS6 paragraph 13).

Modified Habitats "...are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified Habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands." (PS6 paragraph 11).

Critical Habitats are "areas of high biodiversity value" and are defined by possessing one or more of several specified values (see section 16). Both Natural and Modified Habitats may classify as Critical Habitats.

Natural Habitat requires project activities result in no-net-loss and Critical Habitats require that they result in net-gain.

Distinguishing Natural and Modified Habitats can be difficult in the PNG context. In a developed broad-acre agriculture/urban/industrial landscape patches of Natural Habitat can usually readily be picked out and delineated. In the case of PNG the landscape is mostly large expanses of Natural Habitat and it becomes a matter of picking out patches of Modified Habitat within it. Such areas rarely have distinct boundaries. The only likely Modified Habitat in the landscape that the project is embedded in are road surfaces, the mine area, Tabubil and the modified lands in-between.

6.1 VEGETATION

Vegetation is categorised by the higher level categories in the PNG Forest Inventory Management System (FIMS) system (Hammermaster and Saunders 1995). These categories are more-or-less interchangeable with the vegetation types of the PNG Forest Resource Information System (PNG-FRIMS) which is now the mapping system used for forest management in PNG so the nomenclature of the latter was used (see Appendix 2 and Table 2).

Figure 2 shows the project in relation to vegetation in northwestern Western Province. The TSF and the Infrastructure corridor development areas are within Low Altitude Forest on Uplands (LAFU). This is the commonest vegetation type in PNG comprising 31% of the country's forest vegetation. As noted in Table 2 patches of sago occur in low lying areas and this was noted at the TSF site by Sagata and Richards (2026).

Three categories were used for impact analysis – Intact Forest, Agricultural Land and “Roads and tracks”. They were mapped within the TSF and Infrastructure corridor development areas by visual examination of publicly available imagery.

Table 2 Vegetation types used in the impact analysis

CATEGORY*	DESCRIPTION
Formations below 1,000 m	
Low Altitude Forest on Plains and Fans	Tall forest with emergents to 50 m with an Irregular open canopy. Common genera include <i>Pouteria</i> , <i>Otto</i> , <i>Ficus</i> , <i>Alstonia</i> , <i>Terminalia</i> , <i>Planchonella</i> , <i>Canarium</i> , <i>Vitex</i> , <i>Hopea</i> and <i>Vatica</i> . It tends to be flood tolerant to a certain extent. On poorer soils the canopy tends to be denser, lower and more even. Swampy vegetation develops in more low lying areas and cospes of sago can occur commonly.
Low Altitude Forest on Uplands	This forest type is tall but usually less than 40 m high, with medium to large, generally densely spaced trees with crowns 4 – 15 m in diameter and no ground layer visible. Tress get smaller with increasing altitude. Common canopy tree genera are <i>Pometia</i> , <i>Canarium</i> , <i>Anisoptera</i> , <i>Cryptocarya</i> , <i>Terminalia</i> , <i>Syzygium</i> , <i>Ficus</i> , <i>Celtis</i> , <i>Dysoxylum</i> and <i>Buchanania</i> . With increasing altitude, and particularly above 500 m, species of <i>Flindersia</i> , <i>Castanopsis</i> , <i>Lithocarpus</i> , <i>Litsea</i> , <i>Cinnamomum</i> , <i>Elaeocarpus</i> , <i>Planchonella</i> , <i>Sterculia</i> and <i>Garcinia</i> become more common. It is not as flood tolerant as low altitude forest on plains and fans but like it swampy vegetation develops in lower lying areas and cospes of sago can occur at even high altitudes.
Other Treed Formations	
Swamp Forest	Forest with an irregular open canopy and a dense understory of sago growing in low lying areas with a fluctuating water table.
Dry Seasonal Forest	Open forest to 25 m high with emergents to 40 m and the flora characterised by Australian genera e.g. <i>Acacia</i> , <i>Ristantia</i> , <i>Xanthostemon</i> , <i>Flindersia</i> , <i>Grevillea</i> , <i>Rhodamnia</i> etc.
Woodland	An impoverished form of low altitude forest on uplands with a low open tree layer and a dense ground layer of shrubs herbs and/or grasses.
Littoral Forest	Forests along beaches.
Seral Forest	Successional forests lining rivers and common on meander scrolls.
Savanna	Very open formations with sparse trees usually less than 6 m high and a grassy ground layer.
Mangrove Forest	Mangroves
Forest above 1,000 m	
Lower Montane Forest	This is dense forest generally less than 30 m high with only occasional emergents. Confers become common at higher altitudes and common genera are <i>Lithocarpus</i> , <i>Castanopsis</i> , <i>Astronia</i> , <i>Caldcluvia</i> , <i>Dryadodaphne</i> , <i>Galbulimima</i> <i>Cryptocarya</i> , <i>Litsea</i> , and <i>Cinnamomum</i> .
Montane Forest	Low moss forest 5- 15 m high above 3,000m. Common genera include <i>Dacrycarpus</i> , <i>Podocarpus</i> , <i>Phyllocladus</i> , <i>Libocedrus</i> and <i>Drimys</i> .
Other Formations	
Scrub	
Grassland and Herbland	
Sub-Alpine Grassland	
Alpine Grassland	
Bare areas	
Lakes and Larger Rivers	
Other Non-vegetation and Areas Dominated by Land Use	
Larger Urban Centre	
Non-Forest Plantation	
Agriculture Land	Gardens in various stages of fallow, small plantations of copra, betel and other tree crops, abandoned lands given over to grass, and cleared areas.
Forest Plantation	

* No description means it is not mapped as present or not relevant to this impact assessment.

Intact Forest is LAFU with no obvious signs of human activity. This does not mean that it is pristine as the area may still be used for hunting, and artisanal gathering of timber and other resources. Intact Forest is a conservation relevant habitat because it provides the full range of resources that maintains biodiversity. It has the highest diversity of plant species, and therefore resources to fauna, and is the only habitat where the full range of ground and litter conditions, important to herpetofauna, are retained. It maintains stream quality and provides the propagules for forest successions to progress within the shifting cultivation estate.

Intact Forest classifies as Natural Habitat according to IFC PS6 paragraphs 13 to 15 and the requirement is that development results in "... no-net-loss if feasible".

Agricultural Land includes both subsistence and commercial activities. In the project area it consists of small settlements, shifting cultivation, i.e. gardens in various stages of fallow, small plantations of copra, betel and other tree crops, abandoned lands given over to grass, and cleared areas. Forest included in this mosaic is likely subject to hunting and collection of timber and non-timber forest products. The importance of Agricultural Land to biodiversity depends upon the stage of succession of fallow gardens. Grasslands and early stages are of limited value but the later stages of fallow will have faunas approaching that of forest and even the more specialised forest frogs can be found in these parts of the cultivated landscape, although not necessarily in abundance. The combination of Intact Forest and Agricultural Land produces higher biodiversity than either individually because the latter supports open habitat species that do not occur in Intact Forest.

Agricultural Land, as defined here, is therefore considered to be of medium biodiversity value. It would still classify as Natural Habitat under IFC PS6 because it "has not essentially modified an area's primary ecological functions and species composition" (paragraph 13). The shifting cultivation system still retains ecological function and mimics natural forest processes to some extent. Individual huts, and small hamlets could classify as Modified Habitat but they are too small to distinguish in terms of the size of the areas of habitat the project impacts.

Roads and tracks are areas devoid of vegetation and edge effects penetrate into the adjoining forest. Resources such as insects that are harvested along road corridors by e.g. bats and swifts derive from surrounding forest. Roads and tracks have minimal to no conservation relevance and classify as Modified Habitat under IFC PS6.

6.1.1 Projected vegetation losses in the project development areas

Figure 4 and 5 and Table 3 shows the projected vegetation loss in the TSF and Infrastructure corridor development areas. The TSF development will result in the loss of approximately 1,556 ha, of which 3% is the perimeter road, assuming a width of 20 m. This represents about 18 to 19% of the Ok Yep catchment within which the TSF development is located. 86% of this loss will be Intact Forest but since there are no obvious boundaries between Intact Forest and Agricultural Lands and assuming a 20% misclassification error, the loss of Intact Forest would be between 1,300 and 1,400 ha. Since Agricultural Land in this context must be considered IFC PS6 Natural Habitat, overall the project will result in an estimated loss of 1,838 ha of Natural Habitat and 118 ha of Modified Habitat i.e. roads and tracks. Between the TSF footprint and the perimeter road is an area of 520 ha, of which 430 ha is Intact Forest and in which no infrastructure is planned as yet (Figure 6.)

Table 3 Approximate vegetation losses in the project development areas (ha)

		INTACT FOREST	AGRICULTURAL LAND	ROADS & TRACKS	GRAND TOTAL
TSF DEVELOPMENT AREA					
	TSF	1,307	198	8	1,513
	TSF perimeter road	32	10	1	43
	Subtotal	1,339	208	9	1,556
SECTION	INFRASTRUCTURE CORRIDOR DEVELOPMENT AREA				
1	Mine site to Ok Tedi River at Tabubil			114	114
2	Ok Tedi River at Tabubil to Ok Teditau	10	17	2	29
3	Ok Teditau to Nioksikwi/Ok Ma		30	3	34
4	Nioksikwi/Ok Ma to the Ok Ma	33	10	1	44
5	Ok Ma to the Ok Iluk	16			16
6	The Ok Iluk to Kolebon	64	2		66
7	Kolebon to Wogam		30	3	34
8	Wogam to the Ok Taub	39	6	8	53
9	Ok Taub to the TSF site	33			33
	Subtotal	195	96	109	423
	+15% for fly roads and road/pipe offset	29	14		63
	Subtotal	224	110	109	486
	Grand Total	1,563	318	132	2,042

The Infrastructure corridor is conservatively assumed to be 50 m wide which allows for a 30 m working space for pipelaying and road construction and 10 m either side to account for damage to the edging forest. It is 85⁴ km long of which 53 km is along existing roads and tracks. The route is divided into 9 sections for the following discussion (Figure 4).

Section 1 Mine site to Ok Tedi River at Tabubil The route follows the existing main road between the mine, Tabubil and the river for about 1 km east of the mine where the route follows an existing narrower service track for about 1.5 km. Elevation drops from about 1,000 m at the mine to about 380 m at the river. This section is 22.8 km long and is entirely in Modified Habitat.

Section 2 Ok Tedi River at Tabubil to Ok Teditau From the Ok Tedi at about 380 m the route follows the Ok Hwie valley then climbs to about 780 m at the village of Ok Teditau following the track between Ok Teditau and Nioksikwi/Ok Ma. 60% of this 5.8 km stretch is Agricultural Land but in several areas the road is narrow and the forest edging the road appears to be in good condition.

Section 3 Ok Teditau to Nioksikwi/Ok Ma This 6.7 km part of the route continues along the track through rugged elevated terrain descending to the village of Nioksikwi/Ok Ma at about 550 m. This section is entirely Agricultural Land.

Section 4 Nioksikwi/Ok Ma to the Ok Ma The route continues 8.7 km descending a long spur into lower elevations to the Ok Ma at about 170 m. The road becomes indiscernible about 1.3 km past Nioksikwi/Ok Ma. The route is 75% Intact Forest in this section and it passes within 1.3 km of the Lukwi cave complex to the west in the karst on the Ok Ma.

Section 5 Ok Ma to the Ok Iluk The route climbs out of the valley of the Ok Ma and traverses gentler but still hilly terrain at about 300 to 400 m before crossing the Ok Iluk at about 125 m. This short 3.3 km section is entirely through Intact Forest.

Section 6 Ok Iluk to Kolebon From Ok Iluk the route follows the valley of the Ok Ma then tracks the watershed between it and the Ok Dine at about 250 to 300 m before descending to cross the Ok Dine and Ok Nong at about 125 m. It then climbs to the hamlet of Kolebon at about 270 m. This section is 13.2 km long and is 97% Intact Forest.

Section 7 Kolebon to Wogam At Kolebon the route picks up the road between Kolebon and Digam and follows it to Wogam at about 230 m along a series of narrow ridges. This 6.8 km section is entirely through Agricultural Land.

Section 8 Wogam to the Ok Taub From Wogam the route continues 10.6 km to the Ok Taub at about 60 m, near its junction with the Ok Tedi. About 1.4 km past Wogam the road narrows considerably and the forest edging the road appears to be in good condition so 74% is classified as Intact Forest.

Section 8 Ok Taub to the TSF site The last 6.7 km of the route is entirely through Intact Forest. It traverses lower elevation terrain less than 100 m.

6.2 CAVES

Caves are key roosting and breeding habitat for bats and swiftlets. A range of karst features and caves occur at Lukwi 37 km north of the TSF area and 1.3 km west of the infrastructure corridor (Figure 4). These have high conservation relevance and classify as Natural Habitat under IFC PS6.

6.3 STREAMS AND RIPARIAN VEGETATION

Small, clear-flowing streams and adjacent riparian forest provide habitat for a distinct assemblage of stream-breeding odonates. Almost all of these are damselflies and within this assemblage are all the IUCN listed, restricted range and potentially new-to-science species that were documented during the surveys. Forest along riverbanks also provides specialised habitats for a range of vertebrates and certain species are particularly abundant in these habitats, including kingfishers and Shining Flycatcher. Although no species are restricted to this habitat, many birds will move into them in the drier parts of the year and at hot times of the day. At such times the riverine forests act as refuges. These have high conservation relevance and classify as Natural Habitat under IFC PS6.

⁴ Based on the shape file provided by Tetra Tech Coffey

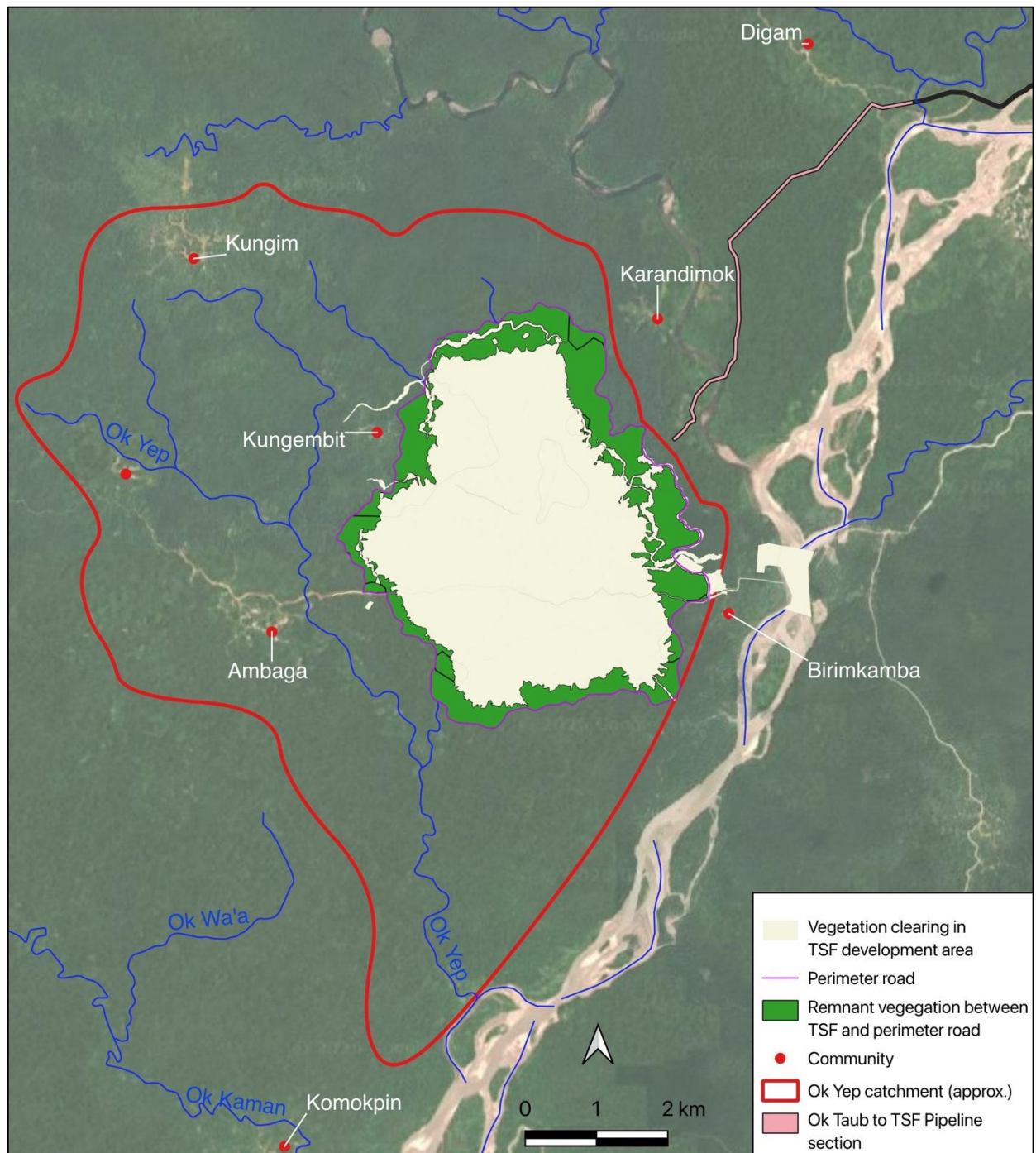


Figure 4 Likely future remnant vegetation at the TSF development area.

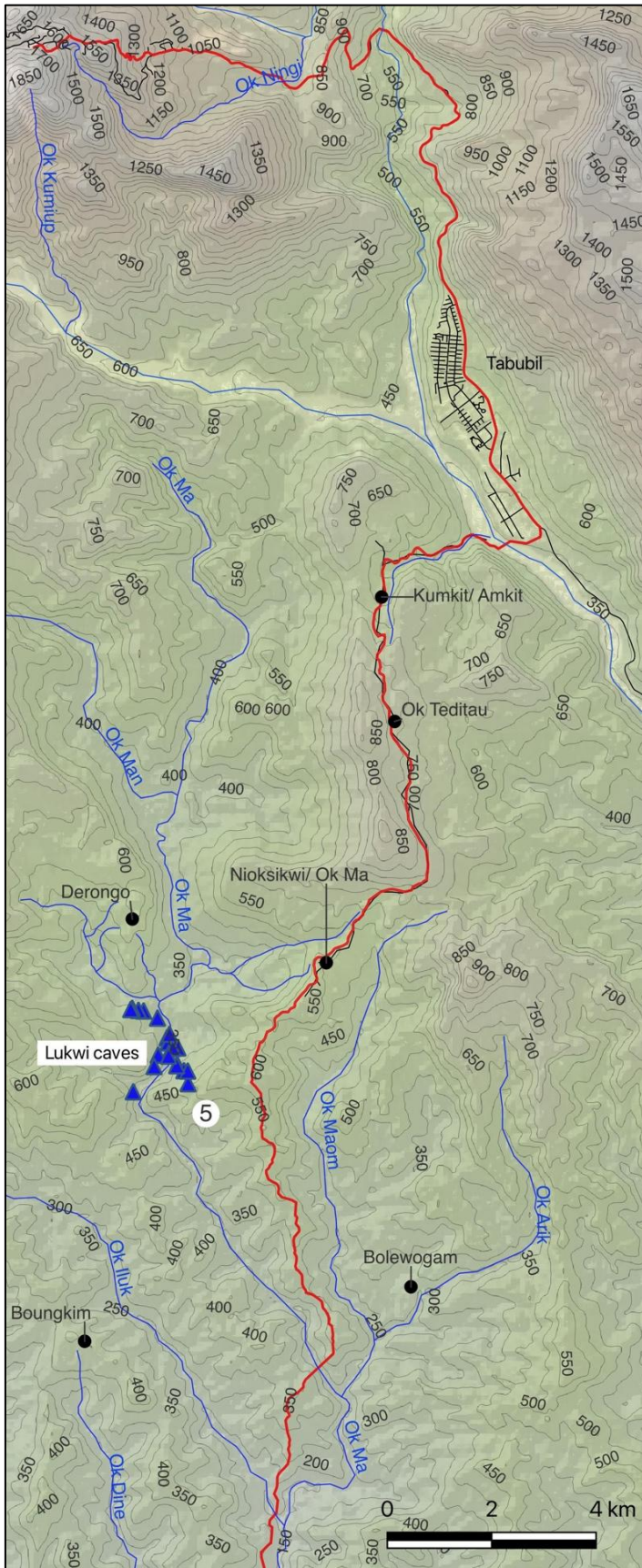
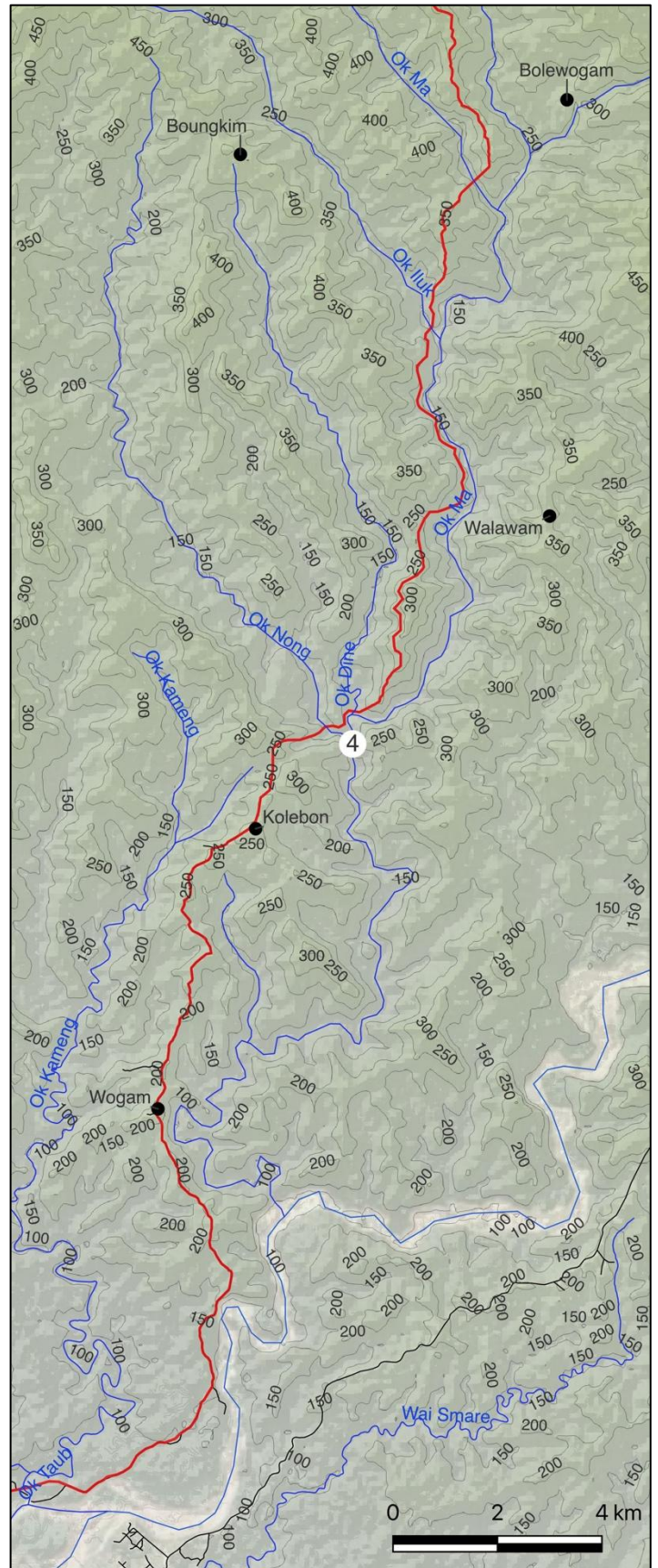


Figure 5 Infrastructure corridor. LEFT: mine site to Ok Ilik; RIGHT Ok Ilik to Ok Taub. Blue triangles are Lukwi caves. Numbers are biodiversity sample sites.

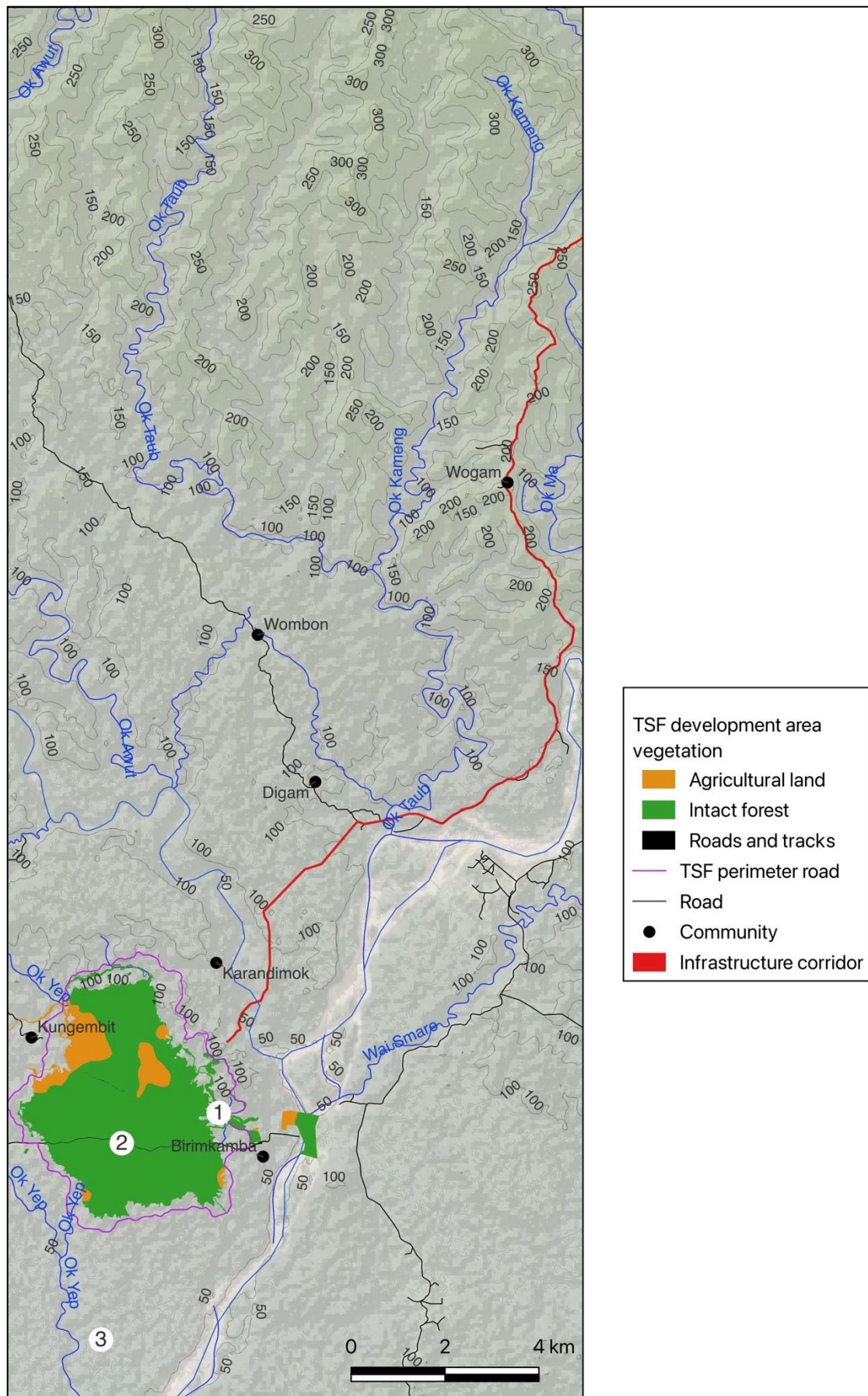


Figure 6 Infrastructure corridor. Ok Taub to the TSF.

7 FLORA

638 species were recorded by Sagata and Richards (2025). Nearly half, 299 species, have not been evaluated by IUCN and the ranges and altitudinal limits of most are poorly known, complicating the estimation of range and conservation status. The records for several species were large range extensions which is to be expected in remote area surveys. For example, the palm *Licuala bakeri*, recorded from the TSF development area, was a restricted range species only known from Indonesian Papua; the nearest known collection site 500 km west of Tabubil. This is a significant extension of range but would also make the species no longer a restricted range species and probably not classified as IUCN near threatened. The catalogue of plants can be found in Sagata and Richards (2026) as Appendix 1 and is not reproduced here.

Overall the flora shows little evidence of lower montane species occurring along the infrastructure corridor. There is only one species of Fagacea recorded and no typically montane genera such as *Galbulimima* nor *Dryadodaphne*. With the limited knowledge available there do not appear to be any plant species that are restricted to the higher elevations of the corridor.

8 FAUNA

Sagata and Richards (2026) recorded 50 native species of mammals (26 non volant mammals and 24 bats), 116 species of birds, 32 frogs, 25 reptiles and 52 odonates at the five survey sites in the project development area. Five exotic species were also recorded. A further four mammals⁵, 23 birds, eight amphibians and five reptiles had been recorded at the earlier surveys at the TSF development area and/or at Bige (BMT WBM 2015 and 2016) (Table 4). Sagata and Richards (2026) include data from these surveys but did not consolidate the records. Bige is only 20 km to the south in the same forest type and all species recorded there would be expected to occur in the TSF development area so a unified catalogue is included as Annex 1 for the purposes of this impact analysis. Sagata and Richards (2026) also considered 25 additional species should be included as possibly occurring. These are also included in Annex 1 but not in Table 4.

Table 4 Native fauna recorded in the project area

GROUP	IUCN STATUS*					GRAND TOTAL
	VU	NT	DD	LC	NE	
Mammals	2	2	2	46	2	54
Birds	2	3		134		139
Amphibians			2	24	14	40
Reptiles	1			21	8	30
Damselflies			4	9	12	25
Dragonflies				24	3	27
Grand Total	5	5	8	258	39	315

*VU – Vulnerable, NT Near Threatened, DD – Data Deficient, LC – Least Concern, NE – Not Evaluated.

Four mammals, five birds, three frogs and six odonates can be considered upland species (Table 5). Other upland species that could occur are Seri's Tree Kangaroo *Dendrolagus stellarum* and six IUCN Data Deficient and restricted range damselflies, *Pseudagrion parafarinicollae*, *Teinobasis cuneata*, *Teinobasis flavolineata*, *Idiocnemis schorri*, *Nososticta oculata* and *Papuargia brevistigma*.

The mammal and bird faunas of the TSF development area are typical of PNG faunas of the southern watershed and a further 20 to 30 widespread species of landbirds and several small mammals would be expected to occur. A large number of records were from local informants and while this is a very effective way to gather information on difficult to find species it has its pitfalls because it is usually hard to decipher precisely where a particular species was encountered by the informant and when. This is particularly an issue for the heavily hunted echidnas and tree kangaroos.

⁵ Their record of *Paramelomys naso* is excluded as the species is only recorded in West Papua.

Table 5 Upland species recorded

FAMILY	SCIENTIFIC NAME	COMMON NAME	IUCN STATUS ¹	RESTRICTED RANGE
Tachyglossidae	<i>Zaglossus bartoni</i>	Eastern Long-beaked Echidna	VU	
Dasyuridae	<i>Dasyurus albopunctatus</i>	New Guinea Quoll	NT	
Rhinolophidae	<i>Rhinolophus philippinensis</i>	Large-eared Horseshoe Bat	LC	
Rhinolophidae	<i>Rhinolophus robertsi</i>	Greater Large-eared Horseshoe Bat	NE	
Casuariidae	<i>Casuaris bennetti</i>	Dwarf Cassowary	LC	
Megapodiidae	<i>Aepyodius arfakianus</i>	Wattled Brushturkey	LC	
Columbidae	<i>Otidiphaps nobilis</i>	Pheasant Pigeon	LC	
Melanocharitidae	<i>Melanocharis arfakiana</i>	Obscure Berrypecker	LC	
Cinclosomatidae	<i>Ptilorhoa castanonota</i>	Chestnut-backed Jewel-babbler	LC	
Microhylidae	<i>Austrochaperina</i> sp. 1 (fast call)		NE	
Microhylidae	<i>Choerophryne</i> cf. <i>tuberculus</i>		NE	
Pelodyadidae	<i>Kallistobatrachus majikthise</i>		LC	X
Coenagrionidae	<i>Papuagrion</i> sp. (short legs)*		NE	
Coenagrionidae	<i>Teinobasis</i> sp. 2 (yellow)*		NE	X
Platycnemididae	<i>Palaiargia</i> sp. 1		NE	X
Platycnemididae	<i>Papuargia</i> sp. 1		NE	X
Platycnemididae	<i>Drepanosticta</i> sp.*		NE	
Libellulidae	<i>Lyriothemis Hirundo</i> *		LC	
Libellulidae	<i>Nannophlebia</i> sp. 1*		NE	
Macromiidae	<i>Macromia melpomene</i>		LC	

¹VU – Vulnerable, NT Near Threatened, DD – Data Deficient, LC – Least Concern, NE – Not Evaluated.

*Species new to science, likely upland.

9 SPECIES POTENTIALLY NEW TO SCIENCE

Eight species of plants, two frogs and six damselflies are likely new to science (Table 6). Ten of these were first recorded at the TSF Sites 1 and/or 2 but subsequently found at the higher elevation Sites 4 and/or 5 which are 24 to 38 km north-north-east and two to three catchments away from Sites 1 and 2. This exemplifies the importance of sample density in determining range. Had the surveys not extended into the infrastructure corridor they would have tentatively been classed as endemics to the TSF area.

Table 6 Species potentially new to science recorded by Sagata and Richards (2026)

SPECIES	FIRST RECORD TSF	SUBSEQUENTLY RECORDED AT SITE 4 OR 5	FIRST RECORD SITE 4 OR 5
FROGS			
<i>Choerophryne</i> sp. 1 cf. <i>gracilirostris</i>	X		
<i>Hylophorbus</i> sp. 1 (fast call)	X	X	
DAMSELFLIES			
<i>Teinobasis</i> sp. 1 (long, slender)	X	X	
<i>Teinobasis</i> sp. 2 (yellow)			X
<i>Nososticta</i> sp. 1	X		
<i>Palaiargia</i> sp. 1			X
<i>Papuargia</i> sp. 1			X
<i>Idiocnemis</i> sp. 1	X	X	
PLANTS			
<i>Begonia</i> sp. 1	X	X	
<i>Begonia</i> sp. 2	X		
<i>Calophyllum</i> sp. 1	X	X	
<i>Garcinia</i> sp. 1			X
<i>Dillenia</i> sp. 1	X		
<i>Aglaia</i> sp. 1			X
<i>Dysoxylum</i> sp. 1			X
<i>Glochidion</i> sp. 1	X		

10 CONSERVATION RELEVANT SPECIES

Conservation relevant species were extracted from Annex 1 to this assessment and from Appendix 1 in Sagata and Richards (2026). Ninety seven species of conservation relevance were recorded and a further 29⁶ could possibly occur (Table 7 and Appendix 3).

Table 7 Numbers of conservation relevant species recorded or likely to be present

	IUCN STATUS*							TOTAL
	CR	EN	VU	NT	DD	LC BUT RESTRICTED RANGE OR P	NE BUT RESTRICTED RANGE	
Mammals	1		4	2	3		1	11
Birds			3	3		7	1	14
Amphibians					2	5	5	13
Reptiles		1	1	2	1			5
Damselflies					12		6	18
Dragonflies					3			3
Plants		8	15	24	8		8	63
Grand Total	1	9	23	31	29	12	21	126

*CR – Critically Endangered, E – Endangered, VU – Vulnerable, NT Near Threatened, DD – Data Deficient, LC – Least Concern, NE – Not Evaluated
P – Protected in PNG.

Critically Endangered or Endangered Species While the Critically Endangered Bulmer's Fruit Bat possibly occurs, neither it nor any other Critically Endangered species was found on the surveys despite specifically targeting them. The Endangered Pig-nosed Turtle *Carettochelys insculpta* may occur, seven Endangered trees were found and another possibly occurs. Descriptions can be found in Appendix 5.

Vulnerable Species Eighteen Vulnerable species were recorded and a further five could possibly occur, including the heavily hunted tree kangaroos which local informants knew, but which species was involved, the upland Seri's Tree Kangaroo *Dendrolagus stellarum* or the Lowlands Tree Kangaroo *D. spadix*, or where they might be, was not clear (see notes in Appendix 5).

Near Threatened Species Eighty percent of the Near Threatened species detected by the surveys or that potentially occur were plants, the remaining were mostly hunted mammals, birds and turtles (see notes in Appendix 5).

Data Deficient Species This IUCN category is for species with limited data and that cannot be assigned to the preceding ones. Sixteen species were found on the surveys and another fifteen possibly occur. Refer to Appendix 5 for information on these species.

Restricted Range species This category is a trigger for IFC PS6 Critical Habitat. Twenty six species were considered to have restricted ranges of which 16 species are likely new to science and therefore of restricted range until shown otherwise. Another 14 could possibly occur (Table 17 and Table 18). Refer to Appendix 5 for information on these species.

⁶ The common and widespread threatened timber trees *Pterocarpus indicus* and *Intsia bijuga* were excluded as the description in Sagata and Richards (2026) suggest they are not present in the project development area.

PART 3 IMPACT ANALYSIS

11 APPROACH TO IMPACT ANALYSIS

The impact analysis follows the mitigation hierarchy of avoid, mitigate and rehabilitate and, if necessary, offset project impacts. Despite the fact that the project is expected to parsimoniously reduce the area of stressed forest by 3,000 to 9,000 ha (see section 3.2) i.e. significantly more than the area of forest lost to the project, the mitigation hierarchy actions suggested here are designed to reduce impacts even further. They only apply to the project development area not the dieback areas.

The analysis separates upland species from the rest as the former are unlikely to receive any benefit from improvements to dieback dynamics at lower elevations.

Actions are divided into:

- “mitigations” to be included in EMMPs for use by OTML and/or contractors during construction, and
- elements in a Biodiversity Action Plan (BAP). These are activities to be carried out by OTML prior to construction to provide missing information necessary to determine if other mitigations need to be developed or modified.

Direct impacts are those resulting from direct interaction between the Project and the environment, and there is an immediate cause-and-effect relationship. Potential direct impacts include.

- Clearing and forest loss.
- Edge and barrier effects.
- Damage and disturbance to caves.
- Damage to riverine habitats.
- Erosion, movement of spoil and changes to hydrology.
- Contamination of waterways and riverine forest from project waste streams and materials handling.
- Impacts of the TSF storage not related to clearing.
- Human disturbance of fauna and hunting.
- Loss of fauna in the pipe trench.

Indirect impacts are at least one step removed from Project activities in terms of cause-and-effect links. Potential indirect impacts include.

- Hunting and collection of fauna and flora.
- Accidental introduction of weeds, pests and diseases.
- Accidental wildfires.
- Impacts from increased access to the area and in-migration.
- Reduction in wetlands in the floodplain.
- Changes to hydrology in the Ok Tedi and Fly River reducing dieback

12 AVOIDANCE OF IMPACTS

Avoidance here refers to strategic efforts to reduce impacts through the design process. Tactical avoidance at a small scale, e.g. individual trees is included under mitigations. There were limited opportunities for avoidance at the design stage. The present route for the infrastructure corridor resulted in a 10 ha reduction in loss of Intact Forest compared to an earlier design but this is probably less than the error involved in making the predictions of losses. The route does, however, deliberately run more than 1 km east of the Lukwi caves complex known to support bat colonies.

Forest loss beyond design can be avoided further by careful management of the area between the TSF footprint and the perimeter road (see section 6.1.1). It is suggested, therefore, that a management plan for this area be developed with the aim of retaining the extent and quality of the 430 ha of Intact Forest there. This would be an element of the BAP.

13 MITIGATION OF IMPACTS

Mitigations are measures to reduce the duration, intensity, significance and/or extent of impacts that cannot be completely avoided, as far as is feasible. The mitigations suggested here are listed in Appendix 4.

13.1 DIRECT IMPACTS

13.1.1 Clearing and forest loss

Clearing reduces populations of plants and resident fauna and reduces foraging areas of wider ranging species such as bats and frugivorous birds. There is limited likelihood of resident forest fauna that vacate a cleared area surviving in the surrounding habitat because they are likely to encounter existing conspecific territory holders and be unable to compete and survive. Table 3 shows the estimated losses from the project.

The losses at the TSF cannot be mitigated but those along the pipeline corridor can and six mitigations are suggested in Appendix 4. Mitigation 3 concerns protection of very large trees and large fig trees which are important resources for specialist fauna (e.g. Mack and Dumbacher 2007, O'Brien *et al.* 1998, Shanahan *et al.* 2001).

There is little loss of higher elevation forests i.e. those north of the Ok Ma (Table 8).

Table 8 Forest losses (ha) at higher elevations

AREA	INTACT FOREST	AGRICULTURAL LAND	ROADS AND TRACKS	GRAND TOTAL
Higher elevation forest (Mine site to the Ok Ma)	49	66	138	253
Lower elevation forest (Ok Ma to the TSF)	1,514	252	23	1,789
Total	1,563	318	161	2,042

13.1.2 Edge and barrier effects

Edge effects come about by exposure of the forest edge producing windier, dryer, hotter and lighter conditions in the forest next to the clearing which can produce continued degradation of forest adjacent to the edge and possibly receding of the forest. Edge effects are complex, not necessarily readily predictable, and depend upon the particular landscape (e.g. Laurance *et al.* 2007, Tabarelli *et al.* 2008, Zhou and Peng 2008). Edge habitats can also be a focus for establishment of invasive species of plants and animals and may provide corridors for penetration of pests allowing them to expand their ranges. Edge environments are more susceptible to desiccation and burning, and trees located in edge habitats are at a higher risk of mortality from wind throw. Under natural conditions at the elevation of the project, i.e. below 1,000 m, regrowth and sealing of the forest edge is rapid, so edge effects will be short lived. Edge effects are most likely along the infrastructure corridor and in the area of forest between the TSF and the perimeter road.

Barrier effects occur where a strip of open habitat provides a barrier of hostile habitat that prevents fauna moving across the gap, thus splitting or fragmenting populations (e.g. Goosem 1997, 2001). The infrastructure corridor will provide a barrier but 48 km (60%) is along existing roads or tracks which are already providing some sort of barrier. If the full 50 m of the corridor is cleared that will be a much large impediment to fauna. This may effect mostly forest interior and canopy species e.g. Lowland Ringtail *Pseudochirulus canescens* and frogs. However, many species of insectivorous bats and birds may benefit through creation of linear clearings, which will increase habitat diversity.

The measures to reduce habitat loss (section 13.1) will be effective to reduce edge and barrier effects but three additional mitigations are suggested in Appendix 4.

13.1.3 Damage and disturbance to caves

Caves represent a special situation in that roosting and/or breeding bats and swiftlets can be impacted or eliminated from caves by disturbance brought about by physical damage to a cave, blasting nearby and/or hunting. Frequent disturbance can cause mortality, especially during the breeding season when young bats are unable to fly and fall to the ground when their mothers are panicked. The Lukwi caves lie 1.3 km west of the infrastructure corridor and contain bat colonies including those of flying foxes. The infrastructure corridor deliberately avoids and does not intersect them but limestone for road construction may be required and the Lukwi region may be considered a source. Ideally, limestone would not be sourced from the Lukwi cave area and, if this is feasible, this would be considered a strategic avoidance action. Six mitigations for caves are included in Appendix 4. This area could be considered a location to develop a cave protection and conservation plan with the local peoples and this is included as an element in the BAP.

13.1.4 Damage to riverine habitats

Large and small waterways will be crossed and the larger ones involve a complex set of potential impacts including the removal of riparian vegetation, soil disturbance and potential impacts from sediment downstream. This may impact a range of species especially the specialist frogs and odonates discussed by Sagata and Richards (2026). Specific effects may be unpredictable because of species-specific responses to vegetation removal. Ten mitigations are suggested in Appendix 4.

13.1.5 Erosion, movement of spoil and changes to hydrology

Erosion, side casting and dumping of spoil during construction of the infrastructure corridor has the potential to impact biodiversity through direct loss of habitat by smothering vegetation in steep terrain beyond the 50 m corridor clearing width, contaminating streams and altering local hydrology. Silt can smother stream microhabitats such as interstitial spaces among rocks, fill deep holes, and alter streamside vegetation by silt deposition and changes to flooding regimes. For example, there is a link between fine sediments and declines in amphibian communities (Corn *et al.* 2003, Ashton *et al.* 2006). However, New Guinea streams and rivers are extremely dynamic and undergo periodic spates and floods with high levels of suspended solids, which normally clear rapidly, and the amphibious fauna has adapted to this.

The Project will manage these potential impacts under a range of EMMPs or subplans thereof, potentially including an Erosion and Sediment Control Plan, Groundwater Management Plan, and a Water Management Plan comprising measures common for similar developments in PNG and no further mitigations are included in Appendix 4.

13.1.6 Contamination of waterways and riverine forest from waste streams and materials handling

The Project will use and/or generate a range of potential contaminants including industrial and domestic wastes, domestic, process and agricultural chemicals, fuels and hydrocarbons, industrial chemicals, sewerage, and biocides. These may impact biodiversity through direct mortality, reductions in reproductive output and reduced survivability. Amphibians and odonates are particularly sensitive to contaminants (e.g. Ultsch *et al.* 1999, Sparling *et al.* 2010). All fauna are at risk from directly consuming contaminants but these substances would be controlled under the appropriate EMMPs, or subplans thereof, for hazardous materials and spills, emergency preparedness, air quality, noise and vibration, and waste management. While there may be instances of fauna being poisoned, this is likely to be extremely local and not to have consequences on population survivability.

13.1.7 Impacts of the TSF storage not related to clearing

Fauna can die at TSFs by being accidentally poisoned or becoming bogged should they venture into the facility. The potential fauna involved would be forest mammals and birds, and waterbirds attracted to the open water of the facility. The tailings are depyritised so toxicity levels will be expected to be low and deaths from poisoning unlikely – for example, cyanide is not used in ore processing at the Ok Tedi Mine and so there is no residual cyanide in tailings – and fauna becoming bogged and dying will likely be the major cause of deaths, if any, at the TSF. It is suggested that a monitoring system for fauna losses at the TSF be designed and this is included as an element of the BAP.

13.1.8 Other human disturbance of fauna

Disturbance, harassment and potentially death of fauna can be brought about by direct human interference, including traffic, collisions with powerlines, noise, lights, dust and fumes. Any disturbance to fauna causing them to retreat from the edges of construction sites is likely to be temporary and fauna is likely to return if not hunted or harassed. Direct human harassment of fauna can be a problem if not prohibited and measures are included Appendix 4 to achieve that.

Traffic deaths can be reduced by controlling speed limits and driver behaviour and would be managed under a traffic management plan or subplan to an EMMP. Noise is a particular issue for birds and bats and there is growing evidence that many bird species are less abundant in noisy areas (e.g. Parris and Schneider 2008, Slabbekoorn and Ripmeester 2008). This probably cannot be mitigated beyond the noise standards for human health imposed by the Project in any air quality, noise, and vibration management plan or subplan of the EMMPs. Dust from traffic is a minor nuisance to most fauna and roads will be watered as necessary in prolonged dry periods to reduce hazards. Mitigations are included in Appendix 4.

13.1.9 Loss of fauna in the pipe trench

During pipeline construction there will be times when the trench will be open over a distance and fauna can fall in, be unable to escape and perish. It is assumed that a fauna rescue procedure will be developed and implemented following the guidelines in O'Brien and Davey (undated), on the basis that entering the trench to rescue fauna will be generally prohibited. It is recommended this system be developed as an element of the BAP.

13.2 INDIRECT IMPACTS

13.2.1 Hunting and collecting of fauna and flora

Hunting is a traditional pursuit and the major prey in the project's area of influence would be pigs, cuscus, larger fruit bats, pigeons, megapodes, monitors and turtles. Hunting is a major contributor to rarity and decline of larger mammals and birds in New Guinea (Kocher Schmid 1993) and an impact the project may have is to increase hunting rates. This could come about through hunting by the workforce, improved access to new forest areas for local hunters and hunting by in-migrants. The effect of the present hunting intensity on fauna populations is unknown but impacts of hunting need not be related to the numbers of people hunting. Hunters vary in their skill, interest and dedication and for species that congregate like flying foxes, a few hunters can have large effects and potentially exterminate flying foxes at their roosts. Sagata and Richards (2026) noted the prevalence of airguns in the TSF area:

"Local informants from the vicinity of the TSF footprint were observed using air guns to hunt local wildlife. They reported that use of air guns is widespread in the area, and that their use has increased the success rate of hunting to about 99%."

The project can do nothing about local hunting but it can control its own workforce and that of its contractors so as not to increase present hunting pressure. Four mitigations are included in Appendix 4.

13.2.2 Accidental introduction of exotic weeds, pests and diseases

Biological invasions have played a major role in the irreversible loss of biodiversity worldwide (ISSG 2026), and while many forms of environmental damage may be mitigated or reversed through reinstatement programs, once established, the removal of invasive species is often impossible. The Global Invasive Species Database (ISSG 2026) lists 101 species that have invaded various habitats in PNG. Sagata and Richards (2026) recorded only one P1-listed weed *Piper aduncum* suggesting the project area is still in very good condition and while the project has no plans to introduce exotic species, its logistics operations may inadvertently introduce other pests, weeds or diseases that can impact terrestrial biodiversity. Perhaps the most severe potential invasives are cats, ants, the Rosy Wolfsnail *Euglandina rosea* and rodents but in terms of their impacts on animal diversity, cats, whether feral or free ranging domestic, are considered the worst exotic pest in the world (Nogales et al 2013, Donlan and Wilcox 2008).

Eight invasive ant species are already established in PNG according to ISSG (2026) including the Yellow Crazy Ant *Anoplolepis gracilipes*, the Little Fire Ant *Wasmannia auropunctata*, the Longhorn Crazy Ant *Paratrechina longicornis* and the Fire Ant *Solenopsis geminata*. It is unknown if any of these ants already occur in the project area of influence. The Yellow Crazy Ant is of particular concern as it forms supercolonies and kills and interferes with a wide range of arthropods, reptiles, birds and mammals and has invaded and degraded native ecosystems on numerous islands across the Pacific and Indian Oceans (Haines *et al.* 1994, Gerlach 2004, Green *et al.* 2004, Lester and Tavite 2004, Director of National Parks 2016).

Avoiding the invasion and spread of new exotics is likely to be challenging. The TSF development area is already accessible from Indonesia via the Alice Pit to Border Post Road, and the Tax Credit Scheme (ITCS) public road being constructed along that route will allow access from Tabubil and Kiunga. These provide or will provide a conduit for exotics to invade the OK Yep catchment. The project has no control over this.

The construction of the road in the project infrastructure corridor will provide additional opportunities for exotics to penetrate into the uninhabited Intact Forest the road traverses in the catchments of the Ok Ma and Ok Taub. This road is destined to be a public road so the project will have no control when that happens. Nonetheless, it is suggested that a quarantine program be developed to ensure that exotics from overseas that are not yet in PNG, are not inadvertently brought into the project area, and that a Weed and Pest Management EMMP is developed to reduce the spread of exotics along the infrastructure corridor. Some elements of such plans are included in Appendix 4.

13.2.3 Accidental wildfires

Forest fires may be brought about by people deliberately setting fires or by small domestic or industrial fires such as incinerating rubbish, burning felled vegetation, or bush cooking fires getting away. Fire is a significant factor in closed forest dynamics and during droughts even very wet forests can burn. While fire in wet tropical areas is considered uncommon, it has had a marked impact on environments throughout New Guinea where repeated burning has converted much forested land to grasslands such as in the Lae-Wau-Bulolo Valley, the Markham Valley and the Western Highlands Province.

It is suggested that a set of procedures to reduce the likelihood of small accidental fires causing forest fires be included in any emergency preparedness and response plan of the EMMP.

13.2.4 Impacts from increased access to the area

Increased population produced by either in-migration from elsewhere in New Guinea or from local movements of people can accelerate forest loss and the overexploitation of forest resources. The TSF development area is not isolated and the project will not alter this scenario but it will provide a possibly faster route between Tabubil and the TSF development area and allow access to as yet unimpacted forest areas that the infrastructure corridor traverses. Increasing population pressures is potentially most significant for biodiversity in the middle section of the Infrastructure corridor between the Nioksikwi/Ok Ma settlement and Kolebon village where there is a long stretch of Intact Forest free of roads. Tetra Tech Coffey (2026) concluded that Project-induced in-migration (PIIM) in the former area would be high and moderate at the latter. A good road would make access to uninhabited forest areas and places like the Lukwi caves easier. Controlling in-migration is largely out of the project's control so impacts from PIIM are expected to occur. The BAP provides some suggestions as to how protection of the Lukwi cave area could help ameliorate impacts on these forest areas.

13.2.5 Reduction in wetlands in the floodplain

Paradoxically, it could be suggested that reduction of stress in the floodplain brought about by less overbank flooding and better drainage would result in a loss of wetland habitats and waterbirds. However, since large areas of dieback have converted to aquatic and swamp vegetation according to the monitoring reports, this would only be restoring the original situation.

13.2.6 Changes to hydrology in the Ok Tedi and Fly River reducing dieback

The TSF will reduce silt input into the rivers and this is expected to reduce stress of floodplain vegetation (see section 3). It may slow or halt the spread of dieback and accelerate recovery of dieback areas. This would be a positive indirect impact of construction of the TSF.

14 REVEGETATION

Revegetation is used here to cover three, often confused, terms: regeneration, rehabilitation, and restoration which, here, mean the following.

1. **Regeneration** is the process of natural succession with no added management.
2. **Rehabilitation** is where the vegetation on a site has been degraded and is to be managed to return it to its previous state by assisting natural regeneration using simple mechanical, basic horticultural or other means. Facilitation continues until site capture – i.e. the site is regenerating naturally and requires no further management. The central activity is maintaining the long-term stability of soils and hydrology needed to sustain the natural vegetation.
3. **Restoration** is where intensive management is needed on sites completely cleared of habitat to return them to forest approaching at least late secondary condition or some other desired endpoint. It would involve a comprehensive program of site remediation and preparation, planting and tending etc. Again, management continues until site capture – i.e. the site is regenerating naturally and requires no further management.

As well as reestablishing habitat, revegetation can be a vehicle for reducing impacts on IUCN Endangered plants and those new to science with unknown EOOs (Table 9) by specifically including them in rehabilitation and restoration.

The contribution of revegetation to impact reduction, however, depends upon whether the desired end point is close to the original habitat or some other land use, and this will depend upon consultation with landowners and what lands remain under project control. At the end of project life the entire TSF area will be available for restoration but the substrates of the TSF itself will be low nutrient sands and silt and present the same difficulties for restoration as at Bige. However, the experience at Bige would be expected to provide an appropriate approach to restoration by then (GeoSystems Analysis 2019, 2024).

Natural regeneration will be the major pathway for revegetation of the edges of the infrastructure corridor but rehabilitation is likely to be required in specific areas such as large lay down sites, steep terrain, and difficult soils.

Options for revegetation need to be considered carefully. Appendix 4 provides some guidelines which would form a basis for developing a comprehensive Rehabilitation and Restoration Plan, either stand alone or as part of another EMMP. The incorporation of the plant species suggested in Table 9 into revegetation would require prior investigation of their horticultural requirements and this would best form part of the BAP.

A proven system which can be implemented for revegetation where natural regeneration is proving to be too slow is the Framework Species Method (FSM) (Goosem and Tucker 2013, Elliott *et al.* 2022) which involves planting a mix of primary, secondary, and pioneer species to produce rapid canopy development and closure with minimum inputs. A focus is on planting species that attract seed dispersers to maximise seed rain and hence speed up natural regeneration on a site. The rapid canopy evolution eliminates weeds and creates suitable microclimates for seedling establishment and development of a litter layer. There has been 35 years of experience with this method in Australia and elsewhere and Elliott *et al.* (2022) provide an excellent global assessment of the system.

Table 9 Endangered plants and those new to science suggested to be used in revegetation

IUCN ENDANGERED SPECIES	NEW TO SCIENCE
<i>Cryptocarya albifrons</i>	<i>Begonia sp. 1</i>
<i>Cryptocarya brevipes</i>	<i>Begonia sp. 2</i>
<i>Cryptocarya fluminensis</i>	<i>Calophyllum sp. 1</i>
<i>Cryptocarya sulcata</i>	<i>Garcinia sp. 1</i>
<i>Endiandra engleriana</i>	<i>Dillenia sp. 1</i>
<i>Timonius argenteus</i>	<i>Aglaia sp. 1</i>
<i>Palaquium morobense</i>	<i>Dysoxylum sp. 1</i>
<i>Calophyllum collinum (possible)</i>	<i>Glochidion sp. 1</i>
<i>Aglaia sp. 1</i>	<i>Cryptocarya dipterocarpifolia*</i>
<i>Dysoxylum sp. 1</i>	<i>Cyrtostachys bakeri*</i>
<i>Glochidion sp. 1</i>	

* Endangered plants from the Star mountains KBA (see section 15.3.1.1)

15 RESIDUAL IMPACT ASSESSMENT

15.1 DETERMINING IMPACT SIGNIFICANCE

In making assessments direct and indirect impacts are separated on the basis that management of the latter are not entirely within the Project's control. An assessment of the significance of direct impacts is first made then that is modified to a final assessment after consideration of indirect impacts. The analysis is based on experience with similar operations elsewhere in PNG and Asia.

15.1.1 Biodiversity values and their sensitivity

Sensitivity is assessed in terms of the conservation value of the species or site and the extent to which it can adapt or recover from change, its replacement potential, as well as its societal value, intactness and/or uniqueness (Table 10). Professional judgement was used to assess vulnerability based on published data and personal experience.

Table 10 Criteria for sensitivity of receptor

SENSITIVITY	CONTRIBUTING FACTOR	DEFINITION
Very high	Formal status, value or importance to society and community	An IUCN Critically Endangered or Endangered Species. A critical asset, internationally and nationally recognised site or value. Iconic or symbolic importance to national cultural value systems.
	Vulnerability	Known local endemic or very rare with distribution restricted to the project area. EOO if known <500 km ² . Habitat specialist and/or highly vulnerable to hunting or ecology unknown
High	Formal status, value or importance to society and community	An IUCN Vulnerable Species. A species new to science. A nationally recognised site. Iconic or symbolic importance to the broader area's cultural value systems (e.g., Ok Tedi and Fly River systems).
	Vulnerability	Abundance and distribution of site or value limited to the broader area (e.g., Ok Tedi and Fly River systems). EOO if known <10,000 km ² . Limited capacity to adapt to change.
Medium	Formal status, value or importance to society and community	An IUCN Near threatened species and/or classified as Protected under the PNG Fauna Act. A species with an EOO <50,000 km ² . A regionally or provincially recognised site or value.
	Vulnerability	A species with an EOO <50,000 km ² . Abundance and distribution of site or value limited to region or province. Some capacity to change.
Low	Formal status, value or importance to society and community	An IUCN Data Deficient species. Some local value or recognition.
	Vulnerability	Widespread site or value with some representative examples found. Some resilience to change.
Not sensitive	Formal status, value or importance to society and community	Limited to no local value or recognition.
	Vulnerability	Abundant, widespread, numerous representative examples present. Easily adaptable to change.

15.1.2 Magnitude of impact

The magnitude of an impact is defined as the amount and type of change, including the severity or intensity of the change, its potential geographic extent and the likely duration of the impact (Table 11).

Table 11 Criteria for magnitude of impact

MAGNITUDE	CONTRIBUTING FACTOR	DEFINITION
Very high	Severity	Effects are likely to be very large (severe) with little or no recovery. Changes irreversible.
	Geographic extent	Effects are widespread and extend beyond the project area, potentially reaching national or transnational extents.
	Temporal extent	Effects are long-term or permanent, extending beyond the life of the project.
High	Severity	Effects are readily detectable but not severe with some recovery expected.
	Geographic extent	Effects are widespread across the project area, including downstream.
	Temporal extent	Effects are medium to long-term extending up to 10 years.
Moderate	Severity	Effects are readily detectable with recovery towards pre-impact conditions expected.
	Geographic extent	Effects extend beyond the area of disturbance but generally limited to the local surrounds (e.g., within 1 to 2 km of project activities).
	Temporal extent	Effects are medium term extending up to five years.
Low	Severity	Effects are likely to have limited effect on existing conditions with recovery expected.
	Geographic extent	Localised effect restricted to the proposed development area of the project.
	Temporal extent	Effects are short term extending up to one year.
Very low	Severity	Effects are unlikely to affect existing conditions with full recovery expected.
	Geographic extent	Localised effect restricted to the disturbance area.
	Temporal extent	Once-off effect or occurs for less than one month.
Positive	The medium to long term effects would be to reduce stresses and enhance the value's survivability.	

15.1.3 Impact significance

The assessment of the significance of residual impacts, assuming the effective implementation of avoidance, mitigation and rehabilitation, was done by examining both the magnitude of the impact and the sensitivity of the receptor being impacted. This interaction between magnitude and sensitivity was expressed in a matrix, the entries being measures of significance of the impact (Table 12). All assessments assume that there is no failure of the TSF, that the mitigations are in place, that any in-migration plan is operational, that Weed, Pest and Quarantine Management Sub-plans to EMMPs are in place and that wildfires are not caused by the Project.

Table 12 Matrix of significance

MAGNITUDE OF IMPACT	SENSITIVITY OF VALUE				
	Not sensitive	Low	Medium	High	Very high
Very high	Moderate	High	Major	Major	Major
High	Low	Moderate	High	Major	Major
Moderate	Low	Low	Moderate	High	High
Low	Low	Low	Low	Moderate	Moderate
Very low	Very low	Low	Low	Low	Moderate
Positive	Positive	Positive	Positive	Positive	Positive

15.2 RESIDUAL IMPACT ON HABITAT

15.2.1 Low Altitude Forest On Uplands

These forests have high conservation value but are widespread and regenerate well so their sensitivity is classed here as Medium. The total area of forest that may be lost to the project is estimated at 1,563 ha (Table 3), of which between 1,300 and 1,400 ha will be lost in the TSF development area, depending upon the degree of misclassification between Intact Forest and Agricultural Land in that area. Section 3.2 indicated that by diverting tailings from the river the area of stressed vegetation in the OK Tedi and Fly drainages could be reduced, optimistically, by 7,500 - 9,000 ha or, pessimistically, to 3,700 - 4,500 ha. In combination with the ERWDs an optimistic scenario would be 15,000 - 18,000 ha. Moreover, the TSF itself will be restored so the long term gain will be even greater.

Logically, this recovery will be at the higher elevation areas of the floodplain i.e. in LAFU but other forest types, low altitude forest on plains and fans and swamp forest, will also benefit. This would amount to “trading up” as the latter are much less common types (PNG Forest Authority 2022 and see section 17). Indirect impacts that may increase losses in the project area are unlikely to alter this scenario. Thus the project is predicted to have a positive impact on these forests (Table 13) but only monitoring will confirm how much that will be.

Table 13 Residual impacts on habitat

HABITAT	SENSITIVITY	DIRECT		INDIRECT	
		MAGNITUDE	SIGNIFICANCE	MAGNITUDE	SIGNIFICANCE
LAFU	Medium	Positive	Positive	Positive	Positive
Caves	High	Very Low	Low	Low	Moderate
Streams	Medium	Moderate	Moderate	Moderate	Moderate

15.2.2 Caves

Reduction of stress in forest in the floodplain will be of no benefit to caves. The project approaches but does not traverse caves and there are none in the TSF development area. The suggested mitigations for caves and cave fauna would act to keep damage to a minimum should quarrying occur in the Lukwi area and there should be no direct impacts outside the project development area. The sensitivity of caves is rated as high so residual direct impacts are predicted to be low. This is not an area of mass tourism and the cave systems are prone to flooding (James *et al* 1989) therefore it is hard to see how indirect impacts would physically damage caves. Any indirect impacts on cave fauna would be through hunting. The Lukwi area is already accessible from Tabubil and only 2 km from the villages of Derongo and Nioksikwi/Ok Ma and flying foxes are traditionally hunted there (James *et al*. 1989). James *et al* (1989) also noted in 1985 that “*Ok Bedda cave is a tourist attraction at present for the more adventurous Tabubil residents.*”

The Ok Mi cave system if it were in a more accessible part of the world and less prone to regular flooding could be developed into a first class tourist cave. Its riverways, decorated passages and huge chambers are superb."

Easier access from Tabubil would not generate any new impacts but may allow heavier recreational hunting of flying fox colonies in the caves there. The potential impact could be low rather than very low, so the significance, therefore, moderate. This is assuming there are no colonies of Bulmer's Fruit Bat there (see section 15.3.2).

15.2.3 Streams and riparian vegetation

These small streams are dynamic and able to recover from some change so the sensitivity is classed as medium. All such streams in the TSF development area will be eliminated and those traversed by the infrastructure corridor will be disturbed and silt is likely to impact streams downstream of construction areas. The mitigations in the EMMPs or subplans thereof, potentially including an Erosion and Sediment Control Plan, Groundwater Management Plan, and a Water Management Plan, would be designed to prevent spread of impacts downstream from construction areas. Overall the impact magnitude is predicted to be low and the significance moderate. Indirect impacts are unlikely to increase this residual impact beyond moderate.

15.3 RESIDUAL IMPACT ON SPECIES

Impact analysis was carried out for species located on the surveys and also those possibly present. Brief notes relevant to impact analysis on all the conservation relevant species, derived from Sagata and Richards (2006), can be found in Appendix 5. Species were considered in seven groups.

- IUCN Endangered tree species
- Flagship mammal species
- Species where hunting is an additional and important source of impact
- Upland species
- Species new to science
- Turtles
- Other species

Table 14 presents the results for species in all groups except "Other species".

15.3.1 IUCN Endangered tree species

Eight species of trees are Endangered because of their suspected small distributions and the potential impacts of logging but, as the notes in Appendix 5 indicate, they all have all been recorded from widely separated localities on the mainland, Bougainville, New Britain and/or the Solomons. The records of Sagata and Richards (2026) are significant range extensions for all but *Calophyllum collinum*. One, *Cryptocarya sulcata*, was thought to be a montane species but the records from Sites 1 and 2 indicate it has a wide elevational range. Again, our knowledge of these species is a product of collector activities and it is likely the records from Sagata and Richards (2026) may serve to alter their IUCN conservation status. Either way, while habitat loss and logging are known threats to all these species, in the medium term the project will increase available habitat for them and this, combined with the project's propagation and use of them in revegetation, should result in a positive impact significance which is unlikely to be altered by indirect impacts.

15.3.1.1 KBA Endangered plants

According to IUCN each of the three KBA species is only known from a single locality. The site for *Cryptocarya dipterocarpifolia* is 3 km northwest of Tabubil. However, the palm *Cyrtostachys bakeri*, whose type locality is the junction of Harvey Creek and Ok Mani (Heatbun et al. 2009), appears to be more widely distributed around Tabubil and has been brought into cultivation. Plants are available online in the USA. The extent of the distributions of these two species are unknown but likely to extend beyond the Tabubil area. They are not included in Table 14 because they are insufficiently known. Both will be propagated and used in revegetation (Table 9) which would aim to compensate for any accidental losses during construction and may increase their populations.

The IUCN account of *Eurya ryozaana* being from a single locality appears to be mistaken and may be a product of nomenclatural confusion. While this will need to be verified by a systematist, the situation appears to be as follows. *E. ryozaana* is a synonym for *E. kanaheiri* which occurs from Geelvink Bay to Morobe Province. The name *E. kanaheiri*

was originally given to a plant from Boemi River region near Geelvink Bay (Kobuski in Bot. Mag. Tok. 55: 507 (1941)), but this name had already been given to a plant from Okinawa, so Hatsuhima (1951) renamed the New Guinea species as *E. ryazoana*. However, there appear to be no specimens with the name *E. ryazoana* in Lae or Brisbane herbaria and Plants of the World Online's specimen shown for *E. ryazoana* is a plant from the Eastern Highlands labelled *E. kanaheiri*. The record of IUCN appears to be a specimen in the Brisbane herbarium from Hong Kong Hill, Ok Tedi Headwaters labelled *E. kanaheiri* (BRI donor number AQ0085218). It seems that the specimens of *E. kanaheiri* have not been relabelled *E. ryazoana* in the databases. This species is therefore not considered at risk and not considered any further.

15.3.2 Flagship mammals

This impact analysis is applying this term to four species of mammals - Eastern Long-beaked Echidna *Zaglossus bartoni*, Lowlands and Seri's Tree-kangaroos *Dendrolagus spadix* and *D. stellarum* and Bulmer's Fruit Bat *Aproteles bulmerae*. While all are moderately tolerant of habitat disturbance, particularly echidnas, they have all suffered heavily from human predation, particularly Bulmer's Fruit Bat which was nearly exterminated not long after its discovery. These species are extremely difficult to definitively locate during field surveys and information is usually only available from local informants, which is often vague in terms of place and time.

Sagata and Richards' (2026) field surveys returned information from local informants that the Eastern Long-beaked Echidna *Zaglossus bartoni* occurred at the TSF development area and tree kangaroos occurred "higher up". The field teams did not locate any themselves nor retrieve any hunter's trophies. Eastern Long-beaked Echidna could easily occur at higher elevations on the infrastructure corridor but Sagata and Richards (2026) analysis suggests it would be highly unlikely that they occur at the TSF development area and so would not be advantaged by reduction in dieback stress in the floodplain. There is likely to be only a small (50 ha) loss of higher elevation forest (Table 8) and prohibitions on hunting by project workers would mean a very low direct impact and low significance but indirect impacts via increased hunting from improving access along the infrastructure corridor could increase indirect impacts to moderate and the significance to high.

There is insufficient information on tree kangaroo occurrence in the project area of influence. It is highly unlikely Seri's Tree Kangaroo comes down to the elevations of the northern parts of the infrastructure corridor as the lower elevation limit for the species is 2,600 m. Lowlands Tree Kangaroo is 150 km to the east (Figure 7). It is recommended that this be investigated further and is included as an element in the BAP. Pending the outcome of those investigations it is considered by this impact analysis that it is unlikely either would occur and so the direct impact magnitude is considered to be very low and the indirect magnitude also very low resulting in a low significance.

The northern end of the infrastructure corridor lies approximately 25 km southwest of Luplupwintem cave near Bultem village, one of only two known roosting caves of the IUCN Critically Endangered Bulmer's Fruit Bat which has been hunted by humans to near extinction. Originally known only from fossils, a living colony was discovered at Luplupwintem (see Flannery and Seri 1993 for a first-hand account). This colony has since been decimated but may still persist in small numbers. The species' range has been extended to a few other sites in PNG including the upper Fly and Purari drainages (see e.g. the IUCN account). Being a large fruit bat, it is capable of commuting tens of kilometres from its roost to forage in the large tracts of montane and lower montane forest that appears to be its stronghold. Sagata and Richards (2026) did not locate it, but weren't specifically searching for it and suggested that, although it wouldn't occur at the TSF site, it might forage at higher elevations.

This species does not suffer from shortage of habitat but from human hunting at its roost caves. The loss of higher elevation Intact Forest to the project is very low so the loss of putative Bulmer's Fruit Bat foraging habitat is miniscule. The more significant issue would be if a colony roosts at Lukwi caves but this area has been accessible from Tabubil for over 40 years and there have been no records of Bulmer's Fruit Bat from there. Whether it occurs or not, the infrastructure corridor deliberately avoids this cave area and the mitigations to prevent damage to caves and hunting by project workers would mean very low or no direct impact magnitude and so only moderate significance were the species to occur. Indirect impacts, via improving access to Lukwi from Tabubil or elsewhere increasing the potential for hunting, would be an issue were the species to roost there. Bulmer's Fruit Bat is generally thought to be a montane species with a lower elevation limit of 500 m so considering the Lukwi caves are at this lower elevation limit and so it is unlikely the species roosts there so the indirect impact magnitude is still classed as very low and the significance

moderate. However, it is suggested that the Lukwi area be investigated further and this is included as an element in the BAP.

15.3.3 Hunted species

Two mammal and six bird species were recorded that are commonly hunted. The record of Grey Dorcopsis *Dorcopsis luctuosa* from local informants is a long way north of their known distribution (Figure 7), and the note in Sagata and Richards (2026) that “the species occurs at higher elevations and not within the proposed TSF footprint” does not match with its main distribution further south. It is retained here for conservatism, nonetheless. They are tolerant of habitat disturbance, widespread, and likely to be advantaged by the reduction of dieback stress in the floodplain. A further two mammals and a bird-of-paradise species could occur. Mitigations will prohibit hunting by project workers so, considering potential habitat gains, direct impacts will be positive and the significance positive. Indirect impacts via immigration and increased hunting could counteract this to some extent and this would depend upon the value of the prey, with the larger bodied fauna and birds-of-paradise being favoured. This would mostly impact the infrastructure corridor and the indirect magnitude is classed as low or moderate rather than positive, depending upon the species, and the significance low, moderate, or, in the case of the Gray Forest Wallaby, potentially high.

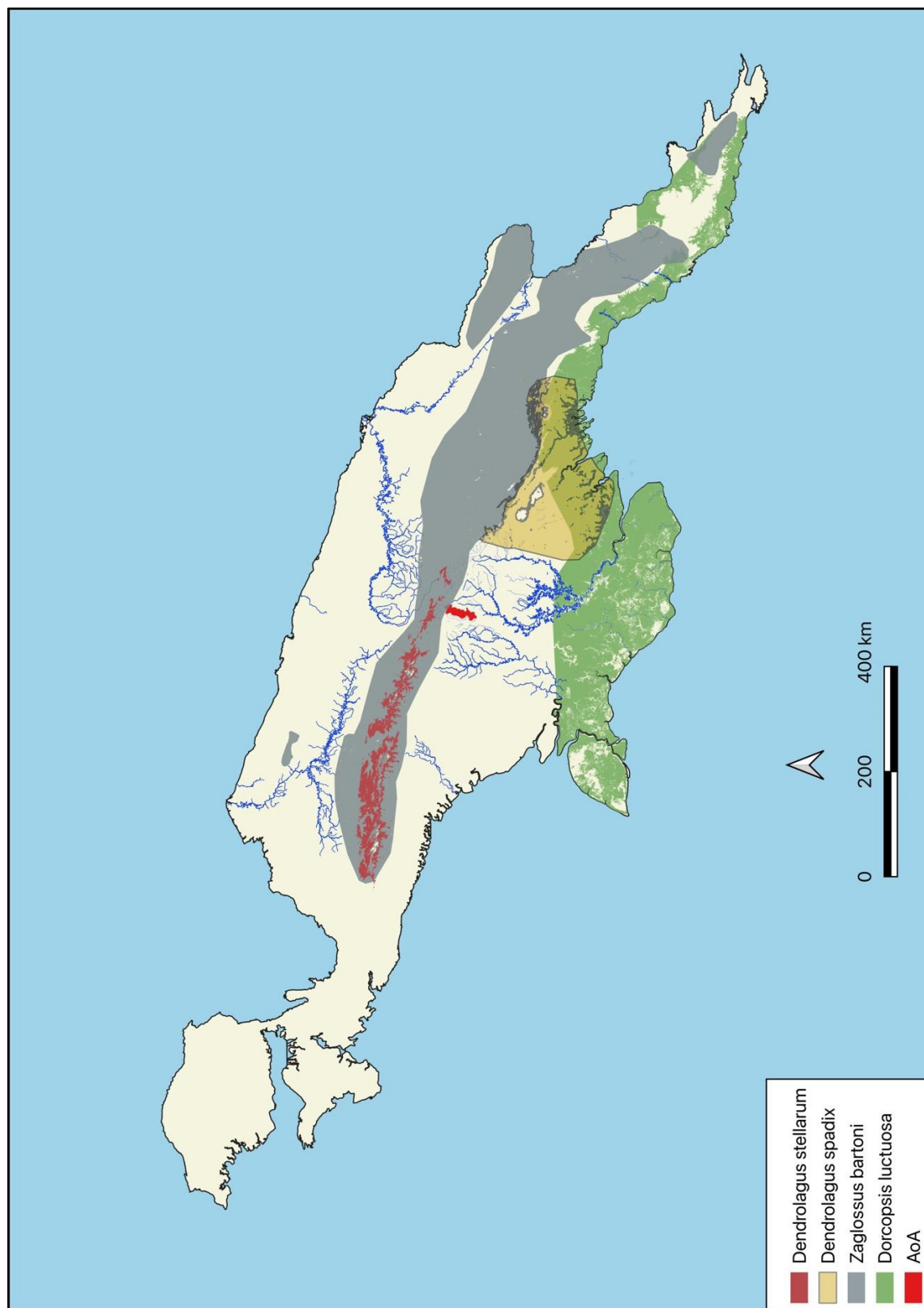


Figure 7 Distribution of Flagship mammals. AoA = Area of Analysis (see section 16).

15.3.4 Upland species

The New Guinea Quoll *Dasyurus albopunctatus* and the frog *Kallistobatrachus majikthise* were recorded at Site 5 and Sagata and Richards (2006) suggest four damselflies, *Teinobasis cuneata*, *T. flavolineata*, *Idiocnemis schorri* and *Nososticta oculata*, could occur at higher elevations where there will be no advantages from reduced dieback stress in the floodplain. The loss of Intact Forest to the infrastructure corridor is very small and mitigations to reduce impacts on streams during ROW construction would reduce magnitude of direct impacts to low and the significance to low. Indirect impacts would be unlikely to increase the significance further.

15.3.5 Species new to science

It is highly unlikely any of the species new to science are restricted to the project development area or even the Ok Birim catchment. They may be restricted endemics to the Ok Tedi drainage or widespread in New Guinea. The extent to which reducing dieback stress in the floodplain would advantage these species depends upon whether they range south from the Ok Birim catchment. There are no terrain barriers in these lowland areas so it is likely they do. If so then the magnitude of impact would be positive. If not, then it is likely to be a low negative one.

As suggested in section 14, the plant species potentially new to science should be propagated and be used in revegetation for the project. Whether these plants also occur elsewhere in the floodplain or not, their use in revegetation would mean that their local populations in the project development area are sustained. This, combined with the reasonable potential for them to be advantaged by reduced dieback stress, would make the magnitude of impact to be more likely positive and the significance positive.

Two, possibly three, of the damselflies are upland species so the loss of Intact Forest will be small and mitigations for streams (sections 13.1.4, 13.1.5 and 13.1.6) should reduce the magnitude of impact to very low and the significance to low.

Both frogs are forest floor dwellers and would be affected by forest loss and the three remaining damselflies by loss and damage to streams. There is no reason why they would not range further south and the magnitude of impact therefore would range from positive to low and the significance from positive to moderate. Indirect impacts would not change this assessment. It is recommended that the status of these new species be determined and this is included as an element in the BAP.

15.3.6 Turtles

Four conservation relevant turtles are, or could, be present in the project development area. Sagata and Richards' (2026) local informants reported the Southern New Guinea Giant Softshell Turtle *Pelochelys bibroni* in the Ok Ma, and that it, and the Pig-nosed Turtle *Carettochelys insculpta*, "occur in the Ok Birim and Ok Tedi but are not known from the proposed TSF footprint". Both of these are widely distributed species but have suffered heavily from overharvesting to the point where the Pig-nosed Turtle is IUCN Endangered. They both nest on sandy banks, preferably on larger water bodies. It is unknown how dieback in the floodplain has affected these species and it is possible that the expansion of wetlands and the growth of sandy levees has favoured them, but there are no studies to confirm this or otherwise. Two other smaller species might occur *Chelodina parkeri* and *C. reimanni*.

The project will be prohibiting hunting so damage to nesting sites on the Ok Ma and potentially Ok Birim is likely the major avenue for direct impact. Mitigations to reduce impacts on streams (section 13.1.4) and the use of horizontal directional drilling for pipeline installation across larger watercourses should produce a low magnitude of impact and a moderate significance. Indirect impacts could be higher because of increased harvesting with increasing human population and the magnitude of impact is estimated as moderate and so a potentially high significance.

Sagata and Richards (2026) recommended a survey of riparian zones of larger stream channels to locate potential nesting sites to avoid during construction and this is included in the BAP.

15.3.7 Other species

The remaining 78 species in Appendices 3 and 5, are expected to be advantaged by the reduction in dieback stress and they are not included in Table 14. Of these, 63 are known to be present and 15 likely occur. The major impact for all these species is habitat loss and while there will be initial loss during construction of the TSF, the improvement to

dieback dynamics in the floodplain will produce more habitat in the medium term. Indirect impacts are unlikely to alter this situation.

15.4 RESIDUAL IMPACT ON THE STAR MOUNTAINS KBA

158 ha of the northern end of the infrastructure corridor from about Nioksikwi/Ok Ma to the mine site are in the Star Mountains KBA. 9.6 ha of this is Intact Forest, 30 ha Agricultural Land and 118 ha is road. This will have no impact on the KBA, noting the Ok Tedi Mine sits entirely within it.

Table 14 Impact analysis for species

Scientific Name	Common Name	IUCN	Nationally Protected	Sensitivity	Direct Impacts		Direct + Indirect	
					Magnitude	Significance	Magnitude	Significance
Endangered Trees								
<i>Calophyllum collinum</i> *	Collin's Calophyllum	EN		Very high	Positive	Positive	Positive	Positive
<i>Cryptocarya albifrons</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Cryptocarya brevipes</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Cryptocarya fluminensis</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Cryptocarya sulcata</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Endiandra engleriana</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Timonius argenteus</i>		EN		Very high	Positive	Positive	Positive	Positive
<i>Palaquium morobense</i>		EN		Very high	Positive	Positive	Positive	Positive
Flagship Mammals								
<i>Zaglossus bartoni</i>	Eastern Long-beaked Echidna	VU	P	High	Very Low	Low	Moderate	High
<i>Dendrolagus spadix</i> *	Lowlands Tree-kangaroo	VU	P	High	Very Low	Low	Very Low	Low
<i>Dendrolagus stellarum</i> *	Seri's Tree Kangaroo	VU	P	High	Very Low	Low	Very Low	Low
<i>Aproteles bulmerae</i> *	Bulmer's Fruit Bat	CR	P	Very high	Very Low	Moderate	Very Low	Moderate
Hunted Species								
<i>Echymipera orio</i> *	Oriomo Echymipera	NE		Medium	Positive	Positive	Moderate	Moderate
<i>Echymipera echinista</i> *	Menzies' Echymipera	DD		Low	Positive	Positive	Moderate	Low
<i>Dorcopsis luctuosa</i>	Gray Forest Wallaby	VU		High	Positive	Positive	Moderate	High
<i>Dorcopsulus vanheurni</i>	Small Dorcopsis	NT		Medium	Positive	Positive	Moderate	Moderate
<i>Goura sclaterii</i>	Sclater's Crowned Pigeon	NT		Medium	Positive	Positive	Moderate	Moderate
<i>Harpyopsis novaeguineae</i>	Papuan Eagle	VU	P	High	Positive	Positive	Low	Moderate
<i>Probosciger aterrimus</i>	Palm Cockatoo	NT	P	Medium	Positive	Positive	Moderate	Moderate
<i>Psitttrichas fulgidus</i>	Pesquet's Parrot	VU	P	High	Positive	Positive	Low	Moderate
<i>Cicinnurus regius</i>	King Bird-of-paradise	LC	P	Medium	Positive	Positive	Moderate	Moderate
<i>Paradisaea raggiana</i>	Raggiana Bird-of-paradise	LC	P	Medium	Positive	Positive	Moderate	Moderate
<i>Paradisaea apoda</i> *	Greater Bird-of-paradise	LC	P	Medium	Positive	Positive	Moderate	Moderate
Upland Species								
<i>Dasyurus albopunctatus</i>	New Guinea Quoll	NT		Medium	Low	Low	Low	Low
<i>Kallistobatrachus majikthise</i>		LC		Medium	Low	Low	Low	Low
<i>Teinobasis cuneata</i> *		DD		Medium	Low	Low	Low	Low
<i>Teinobasis flavolineata</i> *		DD		Medium	Low	Low	Low	Low
<i>Idiocnemis schorri</i> *		DD		Medium	Low	Low	Low	Low

SCIENTIFIC NAME	COMMON NAME	IUCN	NATIONALLY PROTECTED	SENSITIVITY	DIRECT IMPACTS		DIRECT + INDIRECT	
					Magnitude	Significance	Magnitude	Significance
<i>Nososticta oculata</i> *		DD		Medium	Low	Low	Low	Low
SPECIES NEW TO SCIENCE								
<i>Choerophryne</i> sp. 1 cf. <i>gracilirostris</i>		NE		High	Positive to Low	Positive to Moderate	Positive to Low	Positive to Moderate
<i>Hylophorbus</i> sp. 1 (fast call)		NE		High	Positive to Low	Positive to Moderate	Positive to Low	Positive to Moderate
<i>Teinobasis</i> sp. 1 (long, slender)		NE		High	Positive to Low	Positive to Moderate	Positive to Low	Positive to Moderate
<i>Teinobasis</i> sp. 2 (yellow)		NE		High	Very Low	Low	Very Low	Low
<i>Idiocnemis</i> sp. 1		NE		High	Positive to Low	Positive to Moderate	Positive to Low	Positive to Moderate
<i>Nososticta</i> sp. 1		NE		High	Positive to Low	Positive to Moderate	Positive to Low	Positive to Moderate
<i>Palaiargia</i> sp. 1		NE		High	Very Low	Low	Very Low	Low
<i>Papuargia</i> sp. 1		NE		High	Very Low	Low	Very Low	Low
<i>Begonia</i> sp. 1		NE		High	Positive	Positive	Positive	Positive
<i>Begonia</i> sp. 2		NE		High	Positive	Positive	Positive	Positive
<i>Calophyllum</i> sp. 1	Kalo	NE		High	Positive	Positive	Positive	Positive
<i>Garcinia</i> sp. 1	Kandis	NE		High	Positive	Positive	Positive	Positive
<i>Dillenia</i> sp. 1		NE		High	Positive	Positive	Positive	Positive
<i>Aglaiia</i> sp. 1		NE		High	Positive	Positive	Positive	Positive
<i>Dysoxylum</i> sp. 1		NE		High	Positive	Positive	Positive	Positive
<i>Glochidion</i> sp. 1		NE		High	Positive	Positive	Positive	Positive
TURTLES								
<i>Pelochelys bibroni</i>	Southern New Guinea Giant Softshell Turtle	VU		High	Low	Moderate	Moderate	High
<i>Carettochelys insculpta</i> *	Pig-nosed Turtle	EN		High	Low	Moderate	Moderate	High
<i>Chelodina parkeri</i> *		NT		Medium	Low	Low	Moderate	Moderate
<i>Chelodina reimanni</i> *		NT		Medium	Low	Low	Moderate	Moderate

* possible

PART 3 CRITICAL HABITAT ANALYSIS

16 IFC PS6 AND CRITICAL HABITAT

In the following, the Guidance Notes (GN) to PS6 are treated as just that – guidance not requirements.

IFC PS6's definitions of Natural, Modified and Critical Habitat are introduced in section 6 above. The five criteria that define Critical Habitat in PS6 paragraph 16 are.

1. Habitat of significant importance to Critically Endangered and/or Endangered species.
2. Habitat of significant importance to endemic and/or restricted-range species.
3. Habitat supporting globally significant concentrations of migratory species and/or congregatory species.
4. Highly threatened and/or unique ecosystems.
5. Areas associated with key evolutionary processes.

These five criteria usually form the foundations of a critical habitat analyses but they are not the totality of what is meant by Critical Habitat in PS6 paragraph 16. The standard is concerned with “*areas of high biodiversity value*” and Critical Habitat only “includes” these criteria. GN 53 states specifically that Critical Habitat could include “*other recognized high biodiversity values*”. The project is without doubt in an “*area of high biodiversity value*” with large continuous swathes of intact, unfragmented, lowland rainforest extending into Indonesia, sparsely or unpopulated, with unimpacted ecosystems and very high species biodiversity of largely New Guinea endemics.

The definition of Critical Habitat is not related to levels of human disturbance but to biodiversity value and both Natural and Modified Habitat can be Critical Habitat. An area may qualify under several criteria but only a single criterion and/or “*other recognized high biodiversity value*” is needed to trigger classification as Critical Habitat.

The first four of the five criteria require quantitative assessment (GNs 70 to 80) and the thresholds for them are shown in Table 15.

Table 15 Quantitative thresholds for Critical Habitat criteria 1 to 4

CRITERION	THRESHOLD
1. Critically Endangered (CR)/ Endangered (EN) Species	<p>1(a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species ($\geq 0.5\%$ of the global population¹ AND ≥ 5 reproductive units of a CR or EN species).</p> <p>1(b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN 72(a).</p> <p>1(c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.</p>
2. Endemic/ Restricted Range Species	Areas that regularly hold $\geq 10\%$ of the global population size AND ≥ 10 reproductive units of a species ² .
3. Migratory/ Congregatory Species	<p>3(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle³.</p> <p>3(b) Areas that predictably support ≥ 10 percent of the global population of a species during periods of environmental stress.</p>
4. Highly Threatened and/or Unique Ecosystems	<p>4a) Areas representing $\geq 5\%$ of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN.</p> <p>4b) Other areas not yet assessed by IUCN but determined to be of high priority for conservation by regional or national systematic conservation planning.</p>

1 EOO (GN 65) is used as surrogate for population size.

2 For terrestrial vertebrates and plants it is any species with an EOO of 50,000 km².

3 Examples include the following (GN 77): Species that form colonies; Species that form colonies for breeding purposes and/or where large numbers of individuals of a species gather at the same time for non-breeding purposes (for example, foraging and roosting); species that utilize a bottleneck site where significant numbers of individuals of a species occur in a concentrated period of time (for example, for migration); species with large but clumped distributions where a large number of individuals may be concentrated in a single or a few sites while the rest of the species is largely dispersed (for example, wildebeest distributions); and source populations where certain sites hold populations of species that make an inordinate contribution to recruitment of the species elsewhere (especially important for marine species).

A Critical Habitat analysis needs to consider an area larger than the Project footprint (PS6 paragraph 6 and GN 58) as the question is not whether there is Critical Habitat within a project area but whether a project, or part thereof, is within a broader area of Critical Habitat. This does not mean, however, that a project is responsible for the entire area. An “Ecologically Appropriate Area of Analysis” (AoA), using the terminology in GN 59, was therefore designated as the aggregated catchments of all streams the project traverses which includes the Wai Smare, Ok Birim, Ok Ma, Ok Taub,

Ok Kameng, Ok Nong, Ok Dine, Ok Iluk, Ok Maon, Ok Arik and Ok Hwie. It excludes the catchments of the streams feeding the upper Ok Tedi as this is the mine area in lower montane habitats which the project does not impact. A second AoA was considered, however, for the montane species of flagship mammals but was abandoned because their occurrence in the project area is questionable (see section 15.3.2) and extending an AoA into these montane regions would have forced an assessment of high elevation species irrelevant to this impact analysis. The AoA is 870 km² in area and is shown in Figure 8.

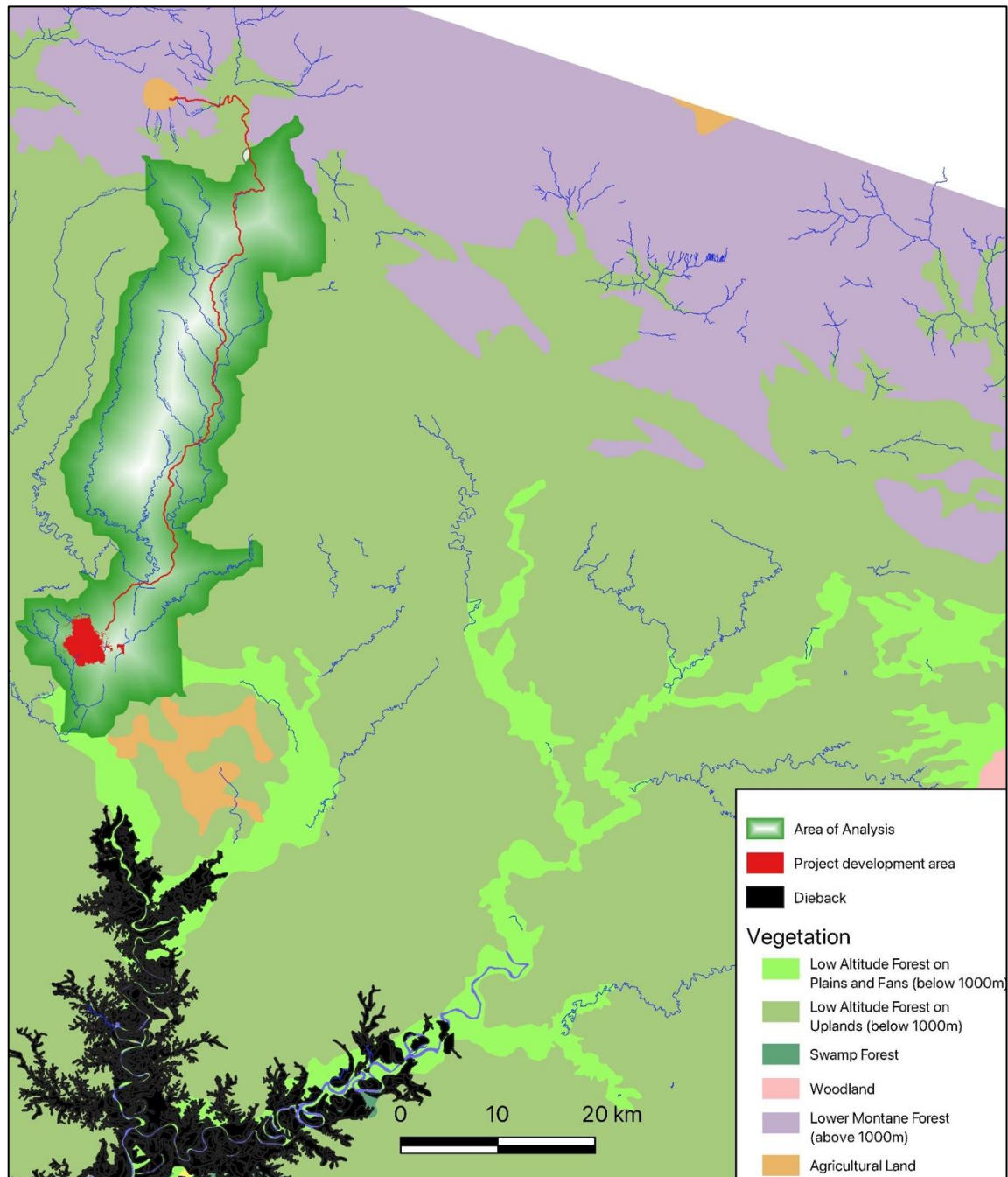


Figure 8 Area of analysis for critical habitat assessment.

16.1 CRITERION 1 CRITICALLY ENDANGERED AND/OR ENDANGERED SPECIES

16.1.1 1(a) concentrations of an IUCN Red-listed EN or CR species

A mammal, a turtle and eight species of plants occur listed as Critically Endangered or Endangered occur or could occur in the AoA. Distributions of the plants are difficult to determine with any confidence as the IUCN accounts are mostly outdated and the discoveries during the surveys of Sagata and Richards (2026) extended the ranges of several. As a rule of thumb, species with distributions outside mainland PNG, including Indonesia, the Admiralties and the Solomons, and those where Sagata and Richards (2026) demonstrated a significant extension of range have not been considered as triggers for criterion 1(a). All others have been considered tentative triggers.

Aproteles bulmerae

See section 15.3.2. The full range of this enigmatic bat is unknown but it is highly unlikely it occurs at the lower elevations of the AoA. If it occurs at all, it is most likely due to foraging animals and, logically, if they forage at these low elevations then its range needs to be seriously reconsidered. It does not trigger Critical Habitat.

Carettochelys insculpta

This is a riverine species and there is no IUCN EOO for it. It does not meet the requirement for being classed as a restricted range riverine species because its global range is greater than 500 km linear geographic span. It is widespread across southern New Guinea and occurs in northern Australia; its stronghold is in the southern watershed and the basins of the big south flowing rivers from the Mimika to the Purari incorporating the drainages of the Mappi, Bian, Bensbach, Fly, Purari and Kikori Rivers. The lower reaches of the Ok Birim and Ok Ma, where the species would occur are far less than 0.5% of this area. It does not trigger Critical Habitat.

Cryptocarya albifrons

When assessed by IUCN this tree's EOO was recorded as 8 km² based on two collections near Bulolo. It is now known to be widespread, with new locations confirmed in Central, Eastern Highlands and Morobe Provinces. With the record from Site 4 its range is now extended far westwards. A small EOO is no longer tenable and it is highly unlikely the AoA overlaps more than 0.5% of its range. It is not considered to trigger Critical Habitat.

Cryptocarya brevipes

IUCN records this species' EOO as 7,299 km² based on records from two disjunct sites, one on the Huon Peninsula and the other near Kiunga. This species has recently been recorded from another location in Eastern Highlands Province. It is difficult to see how the EEO was generated from this data and it cannot be determined how much of its range the AoA overlaps. It is tentatively considered to trigger Critical Habitat.

Cryptocarya fluminensis

The IUCN EOO of 2,097 km² appears to be based on it only being known from near Port Moresby but it has been documented from Bougainville and Western Province. This is a very large alteration to its known range and it must be assumed to be widely distributed so it is unlikely that the AoA represents more than 0.5% of this range. It is not considered to trigger Critical Habitat.

Cryptocarya sulcata

The IUCN EOO is 251-500 km² based on a tiny distribution in Morobe Province. Its discovery at Sites 1 and 2 represents a major range extension and substantially extends the species' known altitudinal range. A reassessment of its IUCN status may be warranted; it unlikely that the AoA represents more than 0.5% of this range and it is not considered to trigger Critical Habitat.

Endiandra engleriana

The IUCN EOO is 57,394 km² based on five localities scattered across northern New Guinea from near Jayapura to east of Lae, at elevations about 1,000 m. The record from Site 1 in the TSF development area is the first from Western Province and the first south of the central cordillera. This southern extension of its range means it has a much larger EOO and since its distribution is largely to the north it is unlikely that the AoA represents more than 0.5% of this range and it is not considered to trigger Critical Habitat.

Timonius argenteus

The IUCN EOO is 37,675 km² and prior to the studies for the project was only known from West Sepik, East Sepik, and Madang Provinces. The record from Site 5 is the first for Western Province and the first south of the central cordillera. As for *Endiandra engleriana*, this southern extension of range means it has a larger EOO and, since its distribution is largely to the north, the AoA overlaps with only a small southern extension of it. As such this is considered unlikely to be more than 0.5% of this range and so *Timonius argenteus* is not considered to trigger Critical Habitat.

Palaquium morobense

With an IUCN EOO of 123,704 km², this tree is widely distributed from Madang to West New Britain and the Solomons. It was recorded at Sites 4 and 5 which is a major extension of range and, as such, it is unlikely that the AoA represents more than 0.5% of this range. It is not considered to trigger critical habitat.

Calophyllum collinum

The IUCN EOO is 174.685 km² which appears to be a typographic error. The species is known from Western and Morobe Provinces as well as the Snow Mountains in Indonesian New Guinea, a large area which suggests the EOO may actually be 174,685 km². The records from Ningerum and Kiunga suggest that the AoA overlaps fully with its range. If this is the case then, within a margin of error, the AoA represents 0.5% of this range. It is tentatively considered to trigger Critical Habitat.

KBA species

It is likely that the AoA includes >0.5% of the ranges of *Cryptocarya dipterocarpifolia* and *Cyrtostachys bakeri* (see section 15.3.1.1).

Conclusion Three tree species, *Cryptocarya brevipes*, *Cryptocarya dipterocarpifolia* and *Calophyllum collinum*, and one palm *Cyrtostachys bakeri* trigger or tentatively trigger Criterion 1a.

16.1.2 1(b) Globally important concentrations of an IUCN Red-listed Vulnerable (VU) species ...

Table 16 presents the IUCN Vulnerable species occurring or potentially occurring in the AoA. For the three macropods it is moot as to whether they occur in the AoA at all, although the Gray Forest Wallaby supposedly occurs according to informants to Sagata and Richards (2026). The Fly River Grassbird's range is far to the south. Only three species of tree, *Elaeocarpus murukakai*, *Syzygium leptoneurum* and *Psychotria ramuensis*, have potentially greater than 0.5% of their ranges in the AoA as suggested by GN 72(a) but all are predicted to be impacted positively by the project.

16.1.3 1(c) nationally or regionally listed EN or CR species.

There are no other nationally or regionally listed species comparable to the IUCN categories.

Table 16 Vulnerable species in or potentially in the AoA

CLASS	SCIENTIFIC NAME*	COMMON NAME	SIGNIFICANCE OF IMPACTS		EOO (KM ²)	% OF EOO in AOA
			DIRECT	INDIRECT		
Mammals	<i>Zaglossus bartoni</i> (P)	Eastern Long-beaked Echidna	Low	High	433,199	0.20%
Mammals	<i>Dorcopsis luctuosa</i>	Gray Forest Wallaby	Positive	High	127,982 ¹	No overlap
Mammals	<i>Dendrolagus spadix</i> (P)	Lowlands Tree Kangaroo	Low	Low	63,710	No overlap
Mammals	<i>Dendrolagus stellarum</i> (P)	Seri's Tree Kangaroo	Low	Low	12,238 ¹	No overlap
Birds	<i>Harpyopsis novaeguineae</i> (P)	Papuan Eagle	Positive	Moderate	1,200,000	0.07%
Birds	<i>Psittichas fulgidus</i> (P)	Pesquet's Parrot	Positive	Moderate	689,000	0.13%
Birds	<i>Poodytes albolimbatus</i>	Fly River Grassbird	Positive	Positive	10,000	No overlap
Reptiles	<i>Pelochelys bibroni</i>	Southern New Guinea Giant Softshell Turtle	Moderate	High	424,000	0.20%
Plants	<i>Calophyllum suberosum</i>	Kalo	Positive	Positive	358,022	0.24%
Plants	<i>Anisoptera thurifera</i>	PNG Mersawa	Positive	Positive	3,260,823	0.03%
Plants	<i>Elaeocarpus murukakai</i>	Quandong	Positive	Positive	11,761	7.37%

CLASS	SCIENTIFIC NAME*	COMMON NAME	SIGNIFICANCE OF IMPACTS		EOO (KM ²)	% OF EOO in AOA
			DIRECT	INDIRECT		
Plants	<i>Lithocarpus vinkii</i>		Positive	Positive	563,596	0.15%
Plants	<i>Gmelina sessilis</i>		Positive	Positive	274,961	0.32%
Plants	<i>Cryptocarya caloneura</i>		Positive	Positive	388,162	0.22%
Plants	<i>Litsea collina</i>		Positive	Positive	694,999	0.12%
Plants	<i>Litsea globosa</i>		Positive	Positive	810,221	0.11%
Plants	<i>Pterocymbium beccarii</i>	Amberoi	Positive	Positive	967,926	0.09%
Plants	<i>Syzygium leptoneurum</i>		Positive	Positive	37,066	2.34%
Plants	<i>Cleistanthus insignis</i>		Positive	Positive	270,805	0.32%
Plants	<i>Psychotria ramuensis</i>		Positive	Positive	93,436	0.93%
Plants	<i>Palaquium supfianum</i>		Positive	Positive	73,053	0.19%
Plants	<i>Endospermum medullosum</i>	New Guinea basswood	Positive	Positive	large [†]	<0.5%
Plants	<i>Syzygium pergamaceum</i>		Positive	Positive	249,867	0.35%

*(P) = Protected under national legislation

1 range from Lumbierres *et al.* (2022)

† see Appendix 5

16.2 CRITERION 2 ENDEMIC/ RESTRICTED RANGE SPECIES

Forty restricted range species occur or possibly occur in the AoA. Two amphibians, six damselflies, and eight plants are likely to be species new to science (Table 6) and, although considered unlikely to be restricted to the project development area, could have a large proportion of their distributions centred on the drainages of the Ok Tedi. The AoA might not encompass their entire distributions but, until proved otherwise, it is possible the AoA contains more than 10% and therefore these 16 species would tentatively classify as triggers for Criterion 2.

Ten other restricted range species occur in the AoA (Table 17) but only the frog *Copiula lennarti* may tentatively trigger this Criterion. The remaining 14 species that could overlap with the AoA are presented in Table 18. Three damselflies, *Teinobasis cuneata*, *Teinobasis flavolineata*, and *Nososticta oculata* trigger Critical Habitat and Campbell's Fairywren and the *Pandanus irwin* tentatively do. The Oriomo Echymipera and gecko *Cyrtodactylus derongo* are too poorly known to make an assessment.

Table 17 Other restricted range species known to occur in the AoA

SCIENTIFIC NAME	IUCN	SIGNIFICANCE OF IMPACTS		NOTES	QUALIFIES
		DIRECT	INDIRECT		
FROGS					
<i>Copiula lennarti</i>	LC	Positive	Positive	The species was previously only known from the Muller range and so has an IUCN EOO of 3,275 km², it was subsequently encountered in the upper Ok Tedi area (Richards & Johnston unpublished data) and its discovery at Sites 1, 2, 4 and 5 extended its range westward and into the lowlands. It is possible that greater than 10% of Its range is within the AoA.	Tentative
<i>Oreophryne pseudunicolor</i>	LC	Positive	Positive	The IUCN range map is outdated as is the EOO of 3,896 km². Richards (2025) records this species from the upper Kikori westwards into the upper Strickland and now Sagata and Richards (2026) have extended it to the AoA. It has a much broader distribution than thought and it is unlikely the AoA contains more than 10% of it.	No
<i>Oreophryne sp. 1</i>	NE	Positive	Positive	Insufficiently known	?
<i>Kallistobatrachus majikthise</i>	LC	Low	Low	There is no IUCN EOO for this species and the map is outdated. Richards (2025) shows it has a broad distribution from Tabubil to the upper Kikori Basin i.e. over 200 km and occurs above 500 m and it is unlikely the AoA contains more than 10% of it.	No

SCIENTIFIC NAME	IUCN	SIGNIFICANCE OF IMPACTS		NOTES	QUALIFIES
		DIRECT	INDIRECT		
<i>Mahonabatrachus timidus</i>	LC	Positive	Positive	The range and EOO of 1,823 km ² in IUCN suggests it is more or less restricted to the AoA and surrounds. However, Richards (2025) records a very broad distribution from the foothills of the Snow mountains in Indonesia to Milne Bay. It is highly unlikely the AoA contains more than 10% of this range.	No
<i>Sandyrana pallidofemora</i>	LC	Positive	Positive	The IUCN map and EOO of 46,499 km ² matches well the information in Richards (2025). The AoA does not represent more than 10% of its range.	No
<i>Hylophorbus sp. 2 (slow call)</i>	NE	Positive	Positive	Insufficiently known	?
<i>Spicicalyx sp. 1 cf. genimaculata</i>	NE	Positive	Positive	Insufficiently known	?
DAMSELFLIES					
<i>Nososticta ovimacula</i>	DD	Positive	Positive	This species was previously known in the Upper Fly, Strickland and Kikori River basin. The findings at Sites 1 and 2 extend its range 88 km westward. It is highly unlikely the AoA contains more than 10% of this range.	No
<i>Nososticta rangifera</i>	DD	Positive	Positive	Previously known only from southeastern Indonesian New Guinea. The records at Sites 1 and 2 extend its distribution 30 km to the northeast and appears to be the first from PNG. It is highly unlikely the AoA contains more than 10% of this range.	No

* As recorded by IUCN

Table 18 Other restricted range species likely or known to occur in the AoA but not recorded in the project development area

SCIENTIFIC NAME	IUCN	SIGNIFICANCE OF IMPACTS		NOTES	QUALIFIES
		DIRECT	INDIRECT		
MAMMALS					
<i>Echymipera oriono</i>	NE	Positive	Moderate	See Appendix 5. This is a species complex in E. kalubu and known from the Ok Birim southwards. It is very difficult to identify and may or may not occur in the AoA.	?
BIRDS					
<i>Lonchura stygia</i>	LC	Positive	Positive	See Appendix 5. A species of grassland further south that may extend into the AoA.	No
<i>Chenorhamphus campbelli</i>	NE	Positive	Positive	See Appendix 5. Its distribution is mostly east of the AoA from Mt Bosavi to Kiunga. It is unlikely the AoA contains greater than 10% of its range if it occurs there at all.	Tentative
<i>Poodytes albolimbatus</i>	VU	Positive	Positive	Known from a few localities in the Trans-Fly including Wasur National Park, small areas along the Bensbach River and a handful of sites on the middle Fly River. The IUCN EOO of 10,000 km2 suggests that the AoA does not contains more than 10% of its range.	No
REPTILES					
<i>Cyrtodactylus derongo</i>	DD	Positive	Positive	See Appendix 5. Insufficiently known.	?
DAMSELFLIES					
<i>Teinobasis cuneata</i>	DD	Low	Low	See Appendix 5. Known from a single location near Tabubil so if it has a restricted range in this region, the AoA could easily have more than 10% of its range.	Yes
<i>Teinobasis flavolineata</i>	DD	Low	Low	See Appendix 5. Known from a single location near Tabubil at 282 m, the IUCN map shows half its range in the AoA.	Yes

SCIENTIFIC NAME	IUCN	SIGNIFICANCE OF IMPACTS		NOTES	QUALIFIES
		DIRECT	INDIRECT		
<i>Idiocnemis schorri</i>	DD	Low	Low	See Appendix 5. This damselfly ranges from Tabubil to the Kikori River between 360 and 520 m. It is unlikely the AoA contains more than 10% of this range.	No
<i>Nososticta oculata</i>	DD	Low	Low	See Appendix 5. Known from a single location at 433 m south of Tabubil in the north of the AoA which contains all if not most of its known distribution.	Yes
<i>Pseudagrion parafarinicolle</i>	DD	Positive	Positive	See Appendix 5. Known from the type locality at Lake Kutubu and a few sites in Gulf Province lowlands. It may occur in the AoA but unlikely to contain >10% of its range considering its distribution.	No
<i>Nososticta paraconifera</i>	DD	Positive	Positive	See Appendix 5. Known from two locations- the Upper Fly River east of the AoA and the Purari River. May occur in the AoA but is unlikely to contain >10% of its range considering its distribution.	No
<i>Nososticta marina</i>	DD	Positive	Positive	See Appendix 5. Occurs in the Aru Islands and Western and Gulf Provinces. The AoA is unlikely to contain >10% of its range considering its distribution.	No
<i>Papuargia brevistigma</i>	DD	Positive	Positive	See Appendix 5. Known from the upper Strickland and the Purari River basin (S. J. Richards, unpublished data) and it is unlikely the AoA contains >10% of its range if it occurs there at all.	No
PLANTS					
<i>Pandanus iwen</i>	DD	Positive	Positive	See Appendix 5. This pandanus has only been recorded from Kiunga. The AoA could contain >10% of its range.	Tentative

16.3 CRITERION 3 HABITAT SUPPORTING GLOBALLY SIGNIFICANT CONCENTRATIONS OF MIGRATORY SPECIES AND/OR CONGREGATORY SPECIES.

Migratory species

The species that are likely candidates are migratory waders from the northern hemisphere and migratory birds from Australia. Neither the AoA nor the project development area has any habitat suitable for waders and only occasional individuals may occur from time to time on the shores and sandbanks of the larger rivers. Major waterbird habitat is further south in the Fly River floodplain and waterbird surveys done by OTML shows the Fly system is, or was, important for waterbirds (Halse *et al.* 1969). Migrant birds from Australia are not congregatory species and are mostly partial migrants.

No migratory species occur that would trigger Criterion 3.

Congregatory species

Many species of birds such as pigeons and parrots flock and the breeding systems of many species of birds-of-paradise involves males gathering to display in leks, either terrestrially or in favourite trees. These are congregations but only small congregations and only a local phenomenon. They do not involve large proportions of the species population.

Congregating species under this criterion in PNG would be cavernicolous bats and swiftlets. 16 species of bats recorded by Sagata and Richards (2026) are cave roosters and some can form large roosts of several thousand e.g. *Hipposideros diadema*. Some, if not all, undoubtedly roost in the Lukwi cave region but whether any roosts would be large enough to form >1% of the global population is unknown but unlikely. James *et al.* (1969) explored these caves in detail and being speleologists did not report bats *per se*, other than that the local people caught flying foxes. However, they would have noted very large concentrations of bats if they were there.

No congregatory species would trigger this Criterion but further work at Lukwi may alter that.

16.4 CRITERION 4: HIGHLY THREATENED AND/OR UNIQUE ECOSYSTEMS

The Standard does not define what is meant by highly threatened and/or unique ecosystems. Guidance Note GN 79 simply states:

The IUCN is developing a Red List of Ecosystems, following an approach similar to the Red List for Threatened Species. The client should use the Red List of Ecosystems where formal IUCN assessments have been performed. Where formal IUCN assessments have not been performed, the client may use assessments using systematic methods at the national/regional level, carried out by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally recognized NGOs).

The thresholds for this Criterion are given in Table 15.

The IUCN Red list of ecosystems (<https://www.iucnrl.org>) lists no threatened terrestrial ecosystems for PNG. The AoA is entirely LAFU of which there are 11,121,353 ha in PNG with 77% still intact, 16% under shifting cultivation and 7% cleared (PNG Forest Authority 2022). Considering there is likely a similar amount in Indonesian New Guinea and considering how sparsely populated New Guinea is, the AoA would not meet any of the criteria for being a Critically Endangered or Endangered ecosystem.

16.5 CRITERION 5 AREAS ASSOCIATED WITH KEY EVOLUTIONARY PROCESSES

The area has no particular geological or geomorphological characteristics that would trigger this Criterion.

16.6 CONCLUSION

The AoA is Critical Habitat on the basis of the occurrence of three restricted range species that trigger Criterion 2 and three others plus 16 species new to science that tentatively do. Additionally, four Endangered plant species trigger or tentatively trigger Criterion 1a.

IFC Paragraph 17 states “In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

1. No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
2. The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
3. The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
4. A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client’s management program.

The project meets the requirements of item 1 as the TSF site selection process described in the ESIA has been ongoing for more than 10 years and any other site nearby would most likely also trigger Critical Habitat. Since the significance of the residual impact on the species triggering critical habitat are positive or low the requirements of items 2 and 3 are met. A monitoring program will be established to satisfy item 4.

17 HABITAT LOSS AND GAINS

Construction of the TSF is expected to produce a positive biodiversity impact by reducing the extent and severity of stress and dieback in the floodplain compared to the status quo of riverine tailings disposal for the remaining ~20 years of the mine’s life. The project disturbance area is estimated at 2,042 ha of which 132 ha is roads and tracks. The area of dieback in 2024 was 214,635 ha and under the “likely” with dredging scenario of Marshall (2003) this will expand to 239,500, a figure which is now under review (Marshall 2025). For a no-net-loss outcome, therefore, the 20% reduction of silt into the river will be expected to produce a 0.9% improvement in the floodplain.

IFC PS6 includes three ways to reduce residual losses - a) averted losses, b) improvement in condition and (c) improvement in protection. Reducing stress on vegetation is averting loss because it is preventing death of the forest, as would be reducing the final area of dieback. Promoting recovery of dieback areas, on the other hand, would be basically restarting regeneration and, therefore, improving condition.

The following loss-gain calculations use the habitat-quality approach by calculating “habitat hectares” (HH) which is a product of area, the condition of the habitat cleared, and the conservation value of the habitat lost. The total HH lost or gained is the sum of the areas of unique patch/condition/value combinations as follows:

$$\sum a_i c_i v_i \quad \text{Equation 1}$$

Where a_i = area, c_i = condition and v_i = value of patch.

Measuring condition Condition is often based upon vegetation structure expressed as a percentage of old growth condition, but, since this is not available for any habitat in PNG, a simple condition score was generated as follows.

- Intact Forest scores 1.0
- Forest converted to Agricultural Land (shifting cultivation) scores 0.5
- Roads score 0.0

Measuring value Conservation value was scored according to the forest type's rarity in PNG using the figures in PNG Forest Authority (2022). LAFU, the commonest forest type, was given a base score of 1 and other habitats scored proportionally to how smaller their areas were compared with LAFU (Table 19). In this case Agricultural Lands were not considered a habitat but a degraded state of the original LAFU as these lands in the AoA are shifting cultivation not plantation development and are valuable to biodiversity. Since roads have condition score of zero assigning them a conservation value is meaningless.

Table 19 Conservation value scores of forest types

FOREST TYPE	AREA OF PRIMARY FOREST	CONSERVATION VALUE SCORE
LAFU	8,524,631	1.0
Low altitude forest on plains and fans	5,482,352	1.6
Swamp Forest	2,181,730	3.9

Losses and gains The habitat hectare losses that may be produced by the project are presented in Table 20.

Table 20 Habitat hectare losses

HABITAT	AREA (HA)	CONDITION	VALUE	HH
LAFU	1,563	1	1	1,563
Agricultural Land (degraded LAFU)	318	0.5	1	159
Roads	132	0	0	0
TOTAL				1,722

It is not possible to predict which particular forest types will be benefited the most by reduction of stress so two scenarios were examined – one based on the gains being entirely LAFU, and the second on gains being equal across all forest types according to their proportion in the total stressed area.

Scenario 1 Entirely LAFU

The result for this scenario is shown in Table 21.

Scenario 2 All forest type apportioned

The results for this scenario are shown in Table 22.

Table 21 HH Gains for scenario 1

	PESSIMISTIC		OPTIMISTIC	
	LOWER	UPPER	UPPER	LOWER
Area (ha)	3,700	4,500	7,500	9,000
Condition	1	1	1	1
Value	1	1	1	1
HH	3,700	4,500	7,500	9,000
HH losses	1,722	1,722	1,722	1,722

GAIN	1,978	2,778	5,778	7,278
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Table 22 HH Gains for scenario 2

FOREST TYPES	PROPORTION OF STRESSED AREA*	VALUE SCORE	HH GAIN PESSIMISTIC		HH GAIN OPTIMISTIC	
			LOWER	UPPER	UPPER	LOWER
LAFU	0.432	1	1,598	1,944	3,240	3,888
Low altitude forest on plains and fans	0.197	1.6	1,166	1,418	2,364	2,837
Swamp Forest	0.243	3.9	3,506	4,265	7,108	8,529
Other	0.128	0	474	576	960	1,152
Total HH score			6,745	8,203	13,672	16,406
Losses			1,722	1,722	1,722	1,722
GAIN			5,023	6,481	11,950	14,684

* The proportions of habitat in stressed areas was taken from the 2018 dieback mapping in the file "Dieback Status 2018.shp" provided by Tera Tech.

Both scenarios show significant potential net gain. These figures, however, only concerned averting the demise of stressed vegetation. Other gains would be realised should the spread of dieback be slowed or halted and/or dieback areas start to recover and regenerate back to forest. Thus, ignoring the fact that the TSF will be restored on mine closure, the total gain by having the TFS would be the sum of these:

$$A + S + f(D,p,r,t) \quad \text{Equation 2}$$

Where A = area of stress recovered and death averted.

S = area of dieback spread averted.

f is a function of area of dieback (D), the proportion of dieback area regenerating (p), the recovery rate per year (r), and time (t).

Time discounting and uncertainty

There may be a requirement to include time discounting in these kinds of calculations to compensate for the temporary deficit of biodiversity that has occurred between loss of biodiversity and its regain by floodplain improvements. To do this, a discount rate must be chosen. The UK DEFRA Biodiversity Metric 3.1 uses 3.5% (Panks 2022) and United States regulation uses 3% for natural resource damage assessment (Horsch *et al.* 2023). A rate of 3% is used here. Time discounting can either be used to increase the figure for loss or decrease the figure that may be gained; here the figure for loss is discounted.

Using a discount rate of 3% and a notional five year time frame, by which time improvements in the floodplain should be readily evident, increases the HH needs for no-net-loss to 1,996 HH, still far below projected gains. At this discount rate it would take 23 years for HH losses to exceed the potential gain.

Time discounting also works the other way. The TSF will not be cleared all at once, and tailings will start to be deposited in it before all the basins have been cleared. Moreover, in 25 years the project will have ended and the TSF will start to be restored and biodiversity start to build there. Time discounting should take account of these factors as well but there is little point in taking such analyses any further and the wise words of West *et al.* (2024) come to mind. When they were describing attempts to determine baseline deforestation rates for REDD+ schemes they said these attempts were "... more akin to storytelling and arbitrary modelling choices than to genuinely accounting for the threats of deforestation".

18 CONCLUSION AND DISCUSSION

Overall the project is predicted to be a net-gain for biodiversity due to the cessation of riverine tailings disposal and its associated downriver impacts but the amount of that gain and its progression can only be assessed by monitoring as required under PS6. The major potential impactor of the project is predicted to be the construction of the road to the TSF which will open up the presently uninhabited Intact LAFU in the catchments of the Ok Ma and Ok Taub. The project has no direct way of influencing this but if a cave protection and conservation plan with the local peoples is pursued as suggested in section 13.1.3, it may be possible to develop it into a more regional conservation plan extending down to the Ok Taub catchment.

Monitoring floodplain improvement, as required, could be set up as an experiment. It is beyond the scope of this assessment to suggest a definitive design but, for example, locate three backwater areas with fringe stress that would drain quicker with levee and tie-channel engineering. One would act as a control and the other two be subject to engineering aimed at improving drainage. These areas would be monitored before and after the start of TSF operations. The hypothesis would be that stress would slow at all sites after startup of the TSF but that engineered sites would recover quicker. The following may be measured: water levels, silt loads in the main stream, levee aggradation and vegetation condition either along drone transects or mapping of the whole experimental areas and their edges, using very high resolution imagery (0.2 or 0.5 m).

Such floodplain monitoring would form the main, but not the sole arm, of a biodiversity monitoring plan, and it is recommended that two other components are included. The first is to track the status of the Lukwi caves area and the second to provide a more balanced assessment of what is happening to biodiversity more broadly on the floodplains (see e.g. Marshall 2011).

It is only recently that Rogers and Kelimbua (2019) have clarified what may be happening botanically to floodplain habitats and we now know in better detail what have been lost, what is likely to remain, and what may be developing. However, there has never been an assessment of terrestrial biodiversity. The floodplain has changed and the emphasis for the last two decades has been on the damage done. Nonetheless, present habitats have value. Alluvial forest may have converted to lagoons and swamps but likely that will support large flocks of waterbirds, crocodiles, turtles etc. Previously rare formations may have an opportunity to expand and species of birds or mammals previously rare in the Fly drainage may colonise the new vegetation formations. A system of monitoring fauna should be undertaken but it would have to be based on aerial assessment because the floodplain is too difficult to traverse by foot or boat and return reasonable data. It is suggested the following be designed and implemented.

1. Fixed wing, rotary or UAV waterbird/turtle/crocodile surveys be reintroduced following on from the original work of Halse *et al.* (1969) and using updated methods (e.g. Kingsford *et al.* (2020).
2. UAV surveys of arboreal mammals be undertaken in stressed areas as they recover, Thermal drone imaging has been successfully used by the Tenkile Conservation Alliance in their work on tree kangaroos (<https://tenkile.com/contribute/>).

19 REFERENCES

- Ashton, D. T., Marks, S. B. and Welsh, H. H. (2006). Evidence of continued effects from timber harvesting on lotic amphibians in redwood forests of northwestern California. *Forest Ecology and Management* 221:183-193.
- Baker, A. M. (2015). Family Dasyuridae (carnivorous marsupials). Pp. 232–349 in Wilson, D. E. and Mittermeier, R. A. (eds) *Handbook of the Mammals of the World. Vol. 5. Monotremes and Marsupials*. Lynx Edicions, Barcelona.
- BMT WBM (2015). Ok Birim Tailings Storage Facility: Terrestrial Ecology Pre-feasibility Assessment. Report to Ok Tedi Mining Ltd.
- BMT WBM (2016). Bige Tailings Storage Facilities: Terrestrial Ecology Pre-Feasibility Assessment. Report to Ok Tedi Mining Ltd.
- Bonaccorso, F. J. (1998). *Bats of Papua New Guinea*: Washington, D. C., Conservation International.

- Coates, B. J. (1985). *The Birds of Papua New Guinea, Including the Bismarck Archipelago and Bougainville. Volume I, Non-Passerines*. Dove Publications, Alderley, Queensland.
- Conn, B.J. (ed.) 1995. *Handbooks of the Flora of Papua New Guinea*. Melbourne University Press.
- Corn, P. S., Bury, R. B., Hyde, E. J. (2003). Conservation of North American stream amphibians. Pp. 24- 36 in: Semlitsch, R. D. (ed.), *Amphibian Conservation*. Smithsonian Institution Press, Washington, D.C.
- Director of National Parks (2016). *Christmas Island Yellow Crazy Ant Control Program. Moving from Chemical Control to a Biological Control Future*. <https://environment.gov.au/system/files/resources/898583db-b929-491a-8448-73fb652bca66/files/brochure-detail-crazy-ant-control-options.pdf>.
- Donlan, C. J. and Wilcox, C. (2008). Diversity, invasive species and extinctions in insular ecosystems. *Journal of Applied Ecology* 45:1114–1123 doi: 10.1111/j.1365-2664.2008.01482.x
- Eldridge, M. D. B. and Coulson, G. M. (2015). Family Macropodidae (kangaroos and wallabies). Pp. 630–735 in Wilson, D. E. and Mittermeier, R. A. (eds) *Handbook of the Mammals of the World. Vol. 5. Monotremes and Marsupials*. Lynx Edicions, Barcelona.
- Elliott, S., Tucker, N. I. J., Shannon, D. P. and Tiansawat, P. (2022). The framework species method—harnessing natural regeneration to restore tropical forest ecosystems. *Phil Trans B Theme* 20210073. <https://doi.org/10.1098/rstb.2021.0073>
- Filer C., Keenan R. J., Allen B. J. and McAlpine J. R. (2009). Deforestation and forest degradation in Papua New Guinea. *Annals of forest Science* 66: 813. (Published Online: 25 November 2009.)
- Flannery, T. F. 1995. *Mammals of New Guinea*. Chatswood, New South Wales: Reed Books.
- Flannery, T. F. and Seri, L. (1993). The Fall and Rise of Bulmer's Fruit-Bat. *Australian Natural History* 24:38-45.
- Gassmann, D., Richards, S.J. and Polhemus, D.A. (2016). *Idiocnemis schorri* sp. nov., a new damselfly species from southern Papua New Guinea (Odonata: Platycnemididae). *Zootaxa* 4173: 491–504.
- GeoSystems Analysis (2019). *Ecosystem Function Analysis: A Long-Term Monitoring Program for Evaluating Dredged Sand-Stockpile Rehabilitation Success in Bige, Western Province, Papua New Guinea*. Program Development & Field Guide Version 1.1. Prepared by GeoSystems. Analysis, Inc. Albuquerque, New Mexico, USA. Amended September 2019. Contract No. OTML 2222176.
- GeoSystems Analysis (2024). (2023). *Ecosystem Function Analysis Monitoring Results Summary*. Prepared for Ok Tedi Mining Limited. Prepared by GeoSystems Analysis, Inc. Albuquerque, New Mexico, USA. Contract No. OTML CW2284800, July 2024.
- Gerlach, J. (2004). Impact of the invasive crazy ant *Anoplolepis gracilipes* on Bird Island, Seychelles. *Journal of Insect Conservation* 8:15-25.
- Gibbs, D., Barnes, E. and Cox, J. (2001). *Pigeons and doves: A Guide to Pigeons of the World*. Yale University Press, New Haven.
- Gill F., Donsker, D. and Rasmussen P. (Eds). (2025). IOC World Bird List (v15.1).
- Goosem, M. (1997). Internal fragmentation: The effects of roads, highways and powerline clearings on movements and mortality of rainforest vertebrates. Pp. 241 – 255 in Laurence, W. F., and Bierregaard, R. O. Jr. (eds.). *Tropical Forest Remnants. Ecology, Management, and Conservation of Fragmented Communities*. University of Chicago Press, Chicago.
- Goosem, M. (2001). Effects of tropical rainforest roads on small mammals: inhibition of crossing movements. *Wildlife Research* 28:351-364.
- Goosem, S and Tucker, N. I. J. (2013) *Repairing the Rainforest*. Second ed. Cairns, Australia: Wet Tropics Management Authority and Biotropica Australia Pty. Ltd.
- Green, P., Comport, S. and Slip, D. (2004). *The management and control of the invasive alien crazy ant (Anoplolepis gracilipes) on Christmas Island, Indian Ocean: the aerial baiting campaign, September 2002*. Unpublished report to the

Department of Environment and Heritage and the Crazy Ant Steering Committee. 60 pp.

Gregory, P. (1995). *The birds of the Ok Tedi area*. Port Moresby, PNG: Ok Tedi Mining, Ltd.

Haines, I. H., Haines, J. B. and Cherrett, J. M. (1994). The impact and control of the Crazy ant, *Anoplolepis longipes* (Jerd.), in the Seychelles. pp. 206-218 in Williams, D. F. (ed.) *Exotic ants. Biology, impact, and control of introduced species*. Boulder, CO: Westview.

Halse, S. A., Pearson, G. B., Jaensch, R. P., Kulmoc, P., Gregory, P., Kay, W. R. and Storey, W. (1996). Waterbird Surveys of the Middle Fly River Floodplain, Papua New Guinea. *Wildlife Research* **23**:557-69.

Hammermaster, E. T. and Saunders, J. C. (1995). Forest Resources and Vegetation Mapping of Papua New Guinea. PNGRIS Publ. 4. CSIRO and AIDAB, Canberra.

Hatusima Sumihiko (1951). New and noteworthy plants from southern Japan and the adjacent districts. *Journal of Japanese Botany* **26**: 371.

Heatubun, C. D., Baker, W. J., Moge, J. P., Harley, M. M., Tjitrosoedirdjo, S. S. & Dransfield, J. (2009). A monograph of *Cyrtostachys* (Arecaceae). *Kew Bulletin*, **64**: 67–94.

Horsch, E., Phaneuf, D., Giguere, C., Murray, J., Duff, C. and Kroninger, C. (2022). Discounting in Natural Resource Damage Assessment. *Journal of Benefit-Cost Analysis* (2022), 1–21 doi:10.1017/bca.2022.24

Hyndman, D. C. and Menzies, J. I. (1990). Rain forests of the Ok Tedi headwaters, New Guinea: an ecological analysis. *Journal of Biogeography* **17**: 241–273.

Igag, P., Mack, A. L., Legge, S. and Heinsohn, R. (2019). Breeding biology of three large, sympatric rainforest parrots in New Guinea: Palm Cockatoo, Pesquet's Parrot and Eclectus Parrot. *Emu* **119**:1-9. DOI: 10.1080/01584197.2019.1616211

ISSG Global Invasive Species Database. 2026. <https://www.iucngisd.org/gisd/>

IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

IUCN (2016). A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0 . First edition. Gland, Switzerland: IUCN.

IUCN (2026). IUCN Red List of Threatened Species. Version 2025.2. Available at: www.iucnredlist.org

James, J. M., Bonwick, M., Nieuwendyk, P., Martin, D. J., Pawih, B., Slade, M. B. and Smith, G. B. (1989). Caves of Lukwi - Western Province, Papua New Guinea. *Helictite* **27**:13-50.

Kaize, J. and Kalkman, V. J.(2011). Records of dragonflies (Odonata) from Kabupaten Asmat and Kabupaten Mappi (Papua, Indonesia). *Suara Serangga Papua* **5**: 99–107.

Key Biodiversity Areas Partnership (2026) *Key Biodiversity Areas factsheet: Star Mountains*. Extracted from the World Database of Key Biodiversity Areas. <https://keybiodiversityareas.org/> Apr 13, 2026.

King, C. E. and Nijboer, J. (1994). Conservation considerations for crowned pigeons, genus *Goura*. *Oryx* **28**: 22–30.

Kingsford, R. T., Porter, J. L., Brandis, K. J. *et al.* (2020). Aerial surveys of waterbirds in Australia. *Sci Data* **7**, 172 (2020). <https://doi.org/10.1038/s41597-020-0512-9>.

Kocher Schmid, C. (1993). Birds of Nokopo. *Muruk* **6**: 1–61.

Kraus, F. (2016) Ten new species of Oreophryne (Anura: Micro-hylidae) from Papua New Guinea. *Zootaxa*, **4195**, 1–68. <https://doi.org/10.11646/zootaxa.4195.1.1>

Laurance, W. F., Nascimento, H. E. M., Laurance, S. G., Andrade, A., Ewers, R. M., Harms, K.E., et al. (2007). Habitat Fragmentation, variable edge effects, and the landscape-divergence hypothesis. *PLoS ONE* **2**(10): e1017. <https://doi.org/10.1371/journal.pone.0001017>.

- Leary, T., Seri, L., Flannery, T., Wright, D., Hamilton, S., Helgen, K., Singadan, R., Menzies, J., Allison, A., James, R., Aplin, K., Salas, L. and Dickman, C. (2016)a. *Zaglossus bartoni*. The IUCN Red List of Threatened Species 2016: e.T136552A21964496.
- Leary, T., Singadan, R., Menzies, J., Helgen, K., Allison, A., James, R., Flannery, T., Aplin, K., Dickman, C. and Salas, L. (2016b). *Dorcopsulus vanheurni*. The IUCN Red List of Threatened Species 2016: e.T6802A21952770.
- Lester, P. J. and Tavite, A. (2004). Long-legged ants, *Anoplolepis gracilipes* (Hymenoptera: Formicidae), have invaded Tokelau, changing composition and dynamics of ant and invertebrate communities. *Pacific Science* 58:391-401.
- Lieftinck, M. A. (1952). On the Papuan representatives of the genus *Macromia* Rambur, with descriptions of five new species and some larval forms (Odonata). *Treubia* 21: 437-468.
- Lieftinck, M. A. (1949). The dragonflies (Odonata) of New Guinea and neighbouring islands. Part VII. Results of the Third Archbold expedition 1938-1939 and of the Le Roux Expedition 1939 to Netherlands New Guinea (II. Zygoptera). *Nova Guinea* 5: 1-271.
- Lieftinck, M. A. (1971). Studies in Oriental Corduliidae (Odonata) I. *Tijdschrift voor Entomologie* 114: 1-63.
- Lumbierres, M., Dahal, P. R., Soria, C. D., Di Marco, M., Butchart, S. H. M., Donald, P. F. and Rondini, C. (2022) Area of Habitat maps for the world's terrestrial birds and mammals. *Scientific Data* 9, 749. doi.org/10.1038/s41597-022-01838-w (2022).
- Mack, A. L. and Dumbacher, J. (2007). Birds of Papua. Pp. 654–688 in Marshall, A. J. and Beehler, B. M. (eds.) *The ecology of Papua* (Part One). Hong Kong: Periplus Editions.
- Marshall, A. R. (2001). Lower Ok Tedi and Middle Fly Vegetation Impact – September 2000. Report to Ok Tedi Mining Ltd.
- Marshall, A. R. (2002). Lower Ok Tedi and Middle Fly vegetation dieback monitoring 2001-2002. OTML Environment Department.
- Marshall, A. R. (2003). Future vegetation dieback extent in the lower Ok Tedi and Fly River floodplains. OTML Environment Department.
- Marshall, A. R. (2006). Lower Ok Tedi and Middle Fly vegetation dieback monitoring 2005-2006. OTML Environment Department.
- Marshall, A. R. (2007). Lower Ok Tedi and Middle Fly vegetation dieback monitoring. Summary report 2006-2007. OTML Environment Department.
- Marshall, A. R. (2010). Lower Ok Tedi and Middle Fly vegetation dieback monitoring. Summary report 2009-2010. OTML Environment Department.
- Marshall, A. R. (2011). Lower Ok Tedi and Middle Fly vegetation dieback monitoring. Summary report. 2010-2011. OTML Environment Department.
- Marshall, A. R. (2012). Lower Ok Tedi and Middle Fly vegetation dieback monitoring. 2011-2012. OTML Environment Department.
- Marshall, A. R. (2013). Lower Ok Tedi and Middle Fly vegetation dieback monitoring. 2013. Report to Ok Tedi Mining Ltd.
- Marshall, A. R. (2017). Lower Ok Tedi and Middle Fly vegetation dieback mapping 2016. OTML Environment Department.
- Marshall, A. R. (2019). Lower Ok Tedi and Middle Fly vegetation dieback mapping 2018. OTML Environment Department.
- Marshall, A. R. (2020). Lower Ok Tedi and Middle Fly vegetation dieback mapping 2019. OTML Environment Department.
- Marshall, A. R. (2024). Lower Ok Tedi and Middle Fly vegetation dieback mapping 2023. OTML Environment Department.

- Marshall, A. R. (2025). The Spatial Extent of Vegetation Dieback within the Lower Ok Tedi and Middle Fly 2024. OTML Environment Department.
- Marshall, A. R. and Rau, M. T. (1999). Lower Ok Tedi and Middle Fly - Estimate of Current Vegetation Dieback and Classification of Floodplain Vegetation. Part 1 of *Ok Tedi Mining Limited Environment Department. 1999. Vegetation dieback. Extent, classification and prediction. Lower Ok Tedi and middle Fly, Western Province, Papua New Guinea*. OTML Environment Department.
- Nicol, S. C. 2015. Family Tachyglossidae (echidnas). Pp. 34–57 in Wilson, D. E. and Mittermeier, R. A. (eds) *Handbook of the Mammals of the World. Vol. 5. Monotremes and Marsupials*. Lynx Edicions, Barcelona.
- Nogales, M. Vidal, E., Medina, F. M., Bonnaud, E., Tershy, B. R. Campbell, K. J. and. Zavaleta, E. S. (2013). Feral Cats and Biodiversity Conservation: The Urgent Prioritization of Island Management. *Bioscience* 63:804-810.
- O'Brien, D. and Davey S. (undated). *Fauna Management in Gas Pipeline Construction*.
<https://mbsenvironmental.com.au/wp-content/uploads/2023/09/MBS-GEMG2010-Pipeline-Fauna-Paper.pdf>
- O'Brien, T. G., Kinnaird, M. F., Dierenfeld, E. S., Conklin-Brittain, N. L., Wrangham, R. W. and Silver, S. C. (1998). What's so special about figs? *Nature* 392:668.
- Orr, A. and Richards, S. J. (2017). Two new Papuargia Lieftinck, 1938 from Papua New Guinea (Odonata: Platycnemididae). *Odonatologica* 46: 137–152.
- OTML (2020). OTML-IMS-PLAN-3.04 Tailings Management Plan - Final Version (510318707.1).
- OTML (2023). Engineered Waste Rock Dump Management Plan. Final 03May2023.
- OTML (2024). OTML-IMS-PLAN-3.05 Dredge Spoil Management Plan - Final Version (510317219.1).
- Pajmans, K. 1976. (ed.) *New Guinea Vegetation*. CSIRO, Canberra.
- Panks S., White, N., Newsome, A., Nash, M., Potter, J., Heydon, M. Mayhew, E., Alvarez, M., Russell, T., Cashion, C., Goddard, F., Scot, S. J., Heaver, M., Scott, S. H., Treweek, J., Butcher, B., and Stone, D. (2022). Biodiversity metric 3.1: Auditing and accounting for biodiversity – User Guide. Natural England Joint Publication JP039.
- Parris, K. M. and Schneider, A. (2008). Impacts of traffic noise and traffic volume on birds of roadside habitats. *Ecology and Society* 14: 29.
- Patrick, L. and Ruedas, L. (2017). *Rhinolophus mcintyre*. The IUCN Red List of Threatened Species 2017: e.T84372245A84372277. <https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T84372245A84372277.en>. Accessed on 26 March 2026.
- Pickup, G and Marshall, A. (2019), *Mapping floodplain inundation from Sentinel and Palsar synthetic aperture radar*. Report to OTML.
- Pickup, G. (2025). *Technical report on the impact of a tailings storage facility at the lower Ok Tedi (Ok Birim) site. Geomorphology, sediment transport and riverine geochemistry*. Report to Tetra Tech Coffey.
- Pickup, G. and Ridd, M. (2024). *2024 SBP Environmental Modelling Summary Report*. Report to Ok Tedi Mining Ltd.
- Pickup, G. Cui, Y and Ridd, M.J. (2018). *Sediment and Geochemistry Modelling for the 2018 Strategic Plan*. Report to Ok Tedi Mining Ltd.
- PNG Forest Authority (2019). *Forest and Land Use Change in Papua New Guinea 2000 - 2015*. PNG Forest Authority. Port Moresby.
- PNG Forest Authority (2022). *Papua New Guinea Forest and Land Use Change 2000-2019*. PNG Forest Authority. Port Moresby.
- Pratt, T. K. and Beehler, B. M. (2015). *Birds of New Guinea*: Princeton University Press.
- Rau, M. T. and Reagan, D. P. (2008). Vegetation of the Ok Tedi–Fly River System. *Developments in Earth and Environmental Sciences*, 9: 515-547.

- Richards, S. J. and Theischinger, G. (2015). Chapter 5: Odonata (dragonflies and damselflies). Pp 75-83 in Richards, S. J. and Whitmore, N. (editors). *A rapid biodiversity assessment of Papua New Guinea's Hindenburg Wall region*. Wildlife Conservation Society Papua New Guinea Program. Goroka, PNG.
- Richards, S. J. (2025). *Field guide to the frogs of the Kikori River basin*, Papua New Guinea. ExxonMobil PNG.
- Richards, S. J. and Whitmore, N. (2015). *A rapid biodiversity assessment of Papua New Guinea's Hindenburg Wall Region*. Wildlife Conservation Society Papua New Guinea Program. Goroka, PNG.
- Rogers, H. and Nixon, R. (2023). Natural Resource Survey for Villages of the Middle Fly River. Report to Ok Tedi Mining Ltd.
- Rogers, H. and Kelimbua, B. (2019). Dieback vegetation change monitoring - baseline for Environment Department Ok Tedi Mining Ltd.
- Sagata, K. and Richards, S. (2026). *Terrestrial biodiversity characterisation of the Ok Birim Tailings Storage Facility area*. Report to Tetra Tech Coffey.
- Sam, K. and Koane, B. 2014. New avian records along the elevational gradient of Mt. Wilhelm, Papua New Guinea. *Bull. B. O. C* 134: 116-133.
- Saunders, J. C. 1993. *Forest Resources of Papua New Guinea. Explanatory Notes to Map*. PNGRIS Publication 2. CSIRO and AIDAB, Canberra.
- Shanahan, M., So, S., Compton, S. G. and Corlett, R. (2001). Fig-eating by vertebrate frugivores: A global review. *Biological Reviews* 76:529–572.
- Slabbekoorn, H. and Ripmeester, E. A. (2008). Birdsong and anthropogenic noise: implications and applications for conservation. *Molecular Ecology* 17: 72–83.
- Sparling, D. W., Linder, G., Bishop, C. A. and Krest, S. K. (2010). *Ecotoxicology of Amphibians and Reptiles* (second edition). CRC Press, Boca Raton.
- Tabarelli, M., Lopes, A. V. and Peres, C. A. (2008). Edge-effects drive tropical forest fragments towards an early-successional system. *Biotropica* 40:657-661. doi 10.1111/j.1744-7429.2008.00454x.
- Tetra Tech Coffey (2026). *Project-induced in-migration (PIIM) assessment associated with the Ok Birim TSF project*.
- Theischinger, G. and Richards, S. J. (2015). New species of damselflies from the Hindenburg Wall region of western Papua New Guinea (Odonata: Coenagrionidae, Platycnemididae). *Odonatologica* 44: 431–446.
- Tillyard, R. J. (1926). On a collection of Papuan dragonflies (Odonata) made by the late Mr. Allan R. McCulloch in 1922-3, with descriptions of new species. *Records of the Australian Museum* 15(2): 157-166.
- Turia R., Kaidong, E., Malan P., Antiko, J., Rome, G., Kadowaki, D., Koyama, T., Haraguchi, M. and Ochi, A. (2019a). *Papua New Guinea Forest Base-Map and Atlas*. Papua New Guinea Forest Authority (PNGFA) and Japan International Cooperation Agency (JICA).
- Turia, R. Malan, P., Laa, P., Antiko, J., Tongo, M., Kaidong, E., Kadowaki, D., Koyama, T., Haraguchi, M., Ochi, A., Okada, Y. Koide, T., Takahashi, H., Salim, S., Matambuai, B., Turia, J. and Paul, E. (2019b). Papua New Guinea Forest Resource Information Management System (PNG-FRIMS). Papua New Guinea Forest Authority (PNGFA) and Japan International Cooperation Agency (JICA).
- Ultsch, G. R., Bradford, D. F. and Freda, J. (1999). Physiology: Coping with the environment. Pp 189-214 in McDiarmid, R. and Altig, R. (eds) *Tadpoles: The biology of anuran larvae*. University of Chicago Press, Chicago.
- West, T. A. P., Bomfin, B. and Haya, B. K. 2024. Methodological issues with deforestation baselines compromise the integrity of carbon offsets from REDD+. *Global Environmental Change* 87: 102863. <https://doi.org/10.1016/j.gloenvcha.2024.102863>.
- Wilson, D. E. and Mittermeir, R. A. eds. (2015). *Handbook of the Mammals of the World. Vol. 5. Monotremes and Marsupials*. Barcelona: Lynx Edicions.

Wilson, D. E., Lacher, T. R. Jr. and Mittermeir, R. A. eds. (2017). *Handbook of the Mammals of the World. Vol. 7. Rodents*. Barcelona: Lynx Edicions.

Wilson, D. E. and Mittermeir, R. A. eds. (2019). *Handbook of the Mammals of the World. Vol. 9. Bats*. Barcelona: Lynx Edicions

Woolley, P., Leary, T., Seri, L., Flannery, T., Wright, D., Hamilton, S., Helgen, K., Singadan, R., Menzies, J., Allison, A. and James, R. (2016). *Dasyurus albopunctatus*. The IUCN Red List of Threatened Species 2016: e.T6299A21946965.

Zhou, T., Peng, S. L. T. (2008). Spatial scale types and measurement of edge effects in ecology. *Acta Ecologica Sinica*. 28: 3322-3333.

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20 APPENDIX 1 METHODS REPORTED IN OTML DIEBACK MONITORING REPORTS

YEAR	SATELLITES	RESOLUTION	DATES	ANCILLARY DATA	SOURCE
1992-1997	Landsat TM	30m		colour air photos (1992 - 1996) spot checks of vegetation condition from helicopter at 102 sites distributed along 3 transects in Oct 1998.	Marshall & Rau 1999
2000	NASA AirSAR (radar)	10m	15/9/2000	Ground truthed but reference not seen by me. Aerial photography or hi-res imagery.	Marshall 2001
2002	Landsat ETM7 SPOT 4	30m + 15m panchromatic panchromatic 10multispectral 20m	25/10/2001 to 29/6/2002	No ground truthing. Truthing done by back correlating Landsat imagery form 22/10/2000 against the AirSAR data and air photos from 16/9/2000.	Marshall 2002
2006	Landsat 5 TM	30m	1/2/2006 to 6/4/2006	"The extensive ground truthing data set captured in June 2006 was used to assist in classification."	Marshall 2006
2007	Landsat 5 TM	30m	19/1/2007	"An extensive aerial photography program was undertaken in January 2007, covering the Ok Tedi floodplain from Ningerum to D'Albertis Junction and the Fly River floodplain from Kiunga to Manda, and this imagery was used to assist with the dieback classification process."	Marshall 2007
2010	Landsat ETM7 Landsat 5 TM	30m + 15m panchromatic 30m	28/8/2009 to 09/4/2010	None?	Marshall 2010
2011	Landsat ETM7	30m + 15m panchromatic	11/3/2011	Extensive dieback ground truthing program in July 2011 was undertaken comprising the acquisition of high-resolution imagery. 1000+ digital images at 0.2m and real-time GPS positioning.	Marshall 2011
2012	Landsat TM5 Landsat ETM7 SPOT 4	30 m 30m + 15m panchromatic panchromatic 10multispectral 20m	10/08/2011 to 26/2/2012	"Aerial photographic imagery and the very high resolution satellite sensors such as Ikonos and GeoEye".	Marshall 2012
2013	Landsat ETM7	30m + 15m panchromatic	7/10/2012 to 17/4/2013	"Extensive aerial ground truthing"	Marshall 2013
2016	Landsat 8 OLI	30m + 15m panchromatic	1/4/2016 to 13/12/2016	UAV	Marshall 2017
2018	Sentinel-2 MS1 Landsat 8 OLI Landsat 5TM	20m 30m + 15m panchromatic 30m	28/1/2019- 7/2/2019 22& 28/3/2018 27/10/1987	P4 UAV imagery September 2018.	Marshall 2018
2019	Landsat-7 ETM Sentinel-2 MSI Landsat-8 OLI	30m + 15m panchromatic 10m 30m + 15m panchromatic	19/10/2019 to 28/11/2019	High resolution UAV 3 band visible spectrum imagery with resolution of 0.25m acquired July 2019 as part of the Sago mapping project.	Marshall 2020
2023	Landsat-8 OLI Landsat-9 OLI-2	15m pan-sharpened 15m pan-sharpened	15/11/23 to 07/04/24	"extensive ground truthing program was undertaken in late 2023 and early 2024"	Marshall 2024
2024	Landsat-8 OLI	Multispectral and 15m pan-sharpened	1/11/2024	"... image analysis has been limited to remotely sensed methodologies without the aid of ground truthing validation."	Marshall 2025

21 APPENDIX 2 CHOICE OF VEGETATION NOMENCLATURE SYSTEM

In the biodiversity field surveys carried out for the ESIA, botanists Kenneth Molem and Penniel Lamei used the PNG Forest Inventory Management System (FIMS) to describe the forest at the TSF site and the Infrastructure corridor (Sagata and Richards 2026). FIMS was also used by Rogers and Kelimbua (2019) and Rogers and Nixon (2023) for their vegetation and natural resource surveys of the Middle Fly but, in both cases, they variously aggregated FIMS vegetation types into higher categories. The use of FIMS by Molem and Lamei was appropriate considering the scale and the importance of species in distinguishing FIMS types. However, it was not considered appropriate to use FIMS for this impact analysis because of the need for broader scale mapping to put the project impacts in the regional context of the Ok Tedi and Fly River drainage. Specifically

- **The age of the FIMS imagery** FIMS provides vegetation mapping for PNG at 1:100,000. It maps 62 “types” – 35 of forest, 13 of other treed formations (woodland to scrub), ten of grassland and herbland, and four non-vegetated. These are grouped into higher level categories. Vegetation types in FIMS are mapped as Forest Mapping Units (FMUs) of pure types or complexes and the degree of disturbance within a polygon represented by a number. But the mapping is now 30 years old. It was based on 1973-74 aerial photography updated in 1996 using Landsat imagery and a series of 1:50,000 aerial photographs which had informed CSIRO’s 20 years of field work in PNG between 1953 and 1972 (Saunders 1993, Hammermaster and Saunders 1995a, Filer et al. 2009).
- **The development of the PNG Forest Resource Information System (FRIMS)** This is the system that the PNG forest authority now uses to manage forest in PNG and it has replaced FIMS. It was developed from a series of mapping exercises starting with the Forest Base Map of 2012, the most recent being a revised *Papua New Guinea Forest and Land Use Change 2000-2019* (Turia et al. 2019 a and b, PNG Forest Authority 2019, 2022). PNG-FRIMS uses 21 higher level categories of vegetation compared with 62 types in FIMS and does not use species to characterise types. However, at present PNG-FRIMS mapping is not available publicly.
- **The lack of high resolution aerial imagery of the project components available at the time of writing.** FIMS mapping needs high resolution imagery to adequately distinguish types and ideally some ground truthing. Turia et al. (2019a) used a smaller number of categories than FIMS to develop PNG-FRIMS as not all FIMS types could be distinguished by satellite imagery.
- **The complexity of vegetation in and around the Ok Tedi and Fly River.** The FIMS mapping of the vegetation of the Western Province has 65% of the area mapped as “complexes” sometimes with up to three vegetation types in a polygon, which basically means that fine scale mapping of the floodplain vegetation is probably impossible. Additionally, the mine impacts have dissolved FIMS boundaries and produced vegetation “types” not included in the original FIMS system. Rogers and Kelimbua (2019) report that lowland forests have been converted to “*open canopy short stature swamp woodland dominated by the tree Barringtonia acutangula and the climber Salacia ledermanii*,” “*a less diverse, more uniform and denser Pandanus dominated Mixed swamp forest, in association with the tree Nauclea coadunata*” and “*a transition forest dominated by flood tolerant species ... Terminalia, Nauclea, Blumeodendron, Elaeocarpus and Cleistanthus*.”

It was decided, therefore, that rather than use the 62 types in FIMS to use the higher level categories in the FIMS system (Hammermaster and Saunders 1995). These are more-or-less interchangeable with the vegetation types of PNG-FRIMS. To generate them FIMS FMUs were agglomerated into these higher level categories; complexes being agglomerated according to the dominant FIMS type in the complex. The boundaries generated by this process do not necessarily match those on PNG-FRIMS in two important areas: lowland forest and swamplands.

Lowland forest

Lowland forests in FIMS are distinguished according to whether they are developed on lower lying plains and fans (Low Altitude Forest on Plains and Fans below 1,000m) or on elevated areas (Low Altitude Forest on Uplands below 1,000 m), the former being more flood tolerant in general, with bigger trees and larger forest gaps. Marshall and Rau (1999) term the former as “Floodplain Forests” and the latter as “Rainforests”, while Rogers and Kelimbua (2019) and Rogers and Nixon (2023) call the former “Alluvial Forests” and the latter “Hill Forests”.

In developing PNG-FRIMS Turia et al (2019a) p. 10 note “As plains are dominant and topography is relatively gentle in Western Province; it was recognized that the distribution of ‘P’ and ‘H’ are significantly different between the Forest

Base Map 2012 ... and FIMS. This difference occurred mainly because the FIMS development process took into account the composition of tree species as well.“

Agglomerating FIMS types therefore means that the boundaries between 'P' and 'H' more closely follow the original FIMS ones than the PNG-FRIMS ones.

Swamplands

Mapping swamp areas is hard as swamp features vary with small changes in terrain and trying to map them in detail is too complex. Turia *et al.* (2019a) p. 10 note “... the *definition of land cover in FIMS includes not only swamp in forest but also swamp in woodland and in grass land. The Forest Base Map does not have these classes.*”

The proposed TSF site provides a good example: in the FIMS system the forest is a complex of “Medium Crowned Forest” and “Small Crowned Forest” but it also supports small sago swamps in low lying areas (Sagata and Richards 2025), a typical feature of lowland forests here and noted in the dieback monitoring reports (Marshall 2020).

Agglomerating FIMS types therefore means that swamp features, in particularly woodlands, are lost to mapping.

22 APPENDIX 3 CONSERVATION RELEVANT SPECIES

CLASS	SCIENTIFIC NAME ¹	COMMON NAME	CONSERVATION SIGNIFICANCE ²				
			I	P	U	R	N
Plants	<i>Calophyllum collinum</i> *	Collin's Calophyllum	EN				
Plants	<i>Cryptocarya albifrons</i>		EN				
Plants	<i>Cryptocarya brevipes</i>		EN				
Plants	<i>Cryptocarya fluminensis</i>		EN				
Plants	<i>Cryptocarya sulcata</i>		EN				
Plants	<i>Endiandra engleriana</i>		EN				
Plants	<i>Timonius argenteus</i>		EN				
Plants	<i>Palaquium morobense</i>		EN				
Mammals	<i>Zaglossus bartoni</i>	Eastern Long-beaked Echidna	VU	P	X		
Mammals	<i>Dendrolagus stellarum</i> *	Seri's Tree Kangaroo	VU	P	X		
Mammals	<i>Dendrolagus spadix</i> *	Lowlands Tree-kangaroo	VU	P			
Mammals	<i>Aproteles bulmerae</i> *†	Bulmer's Fruit Bat	CR	P			
Mammals	<i>Echymipera oriomom</i> *	Oriomo Echymipera	NE			X	
Mammals	<i>Echymipera echinista</i> *	Menzies' Echymipera	DD				
Mammals	<i>Dorcopsis luctuosa</i>	Gray Forest Wallaby	VU				
Mammals	<i>Dorcopsulus vanheurni</i>	Small Dorcopsis	NT				
Birds	<i>Goura sclaterii</i>	Sclater's Crowned Pigeon	NT				
Birds	<i>Harpyopsis novaeguineae</i>	Papuan Eagle	VU	P			
Birds	<i>Probosciger aterrimus</i>	Palm Cockatoo	NT	P			
Birds	<i>Psitttrichas fulgidus</i>	Pesquet's Parrot	VU	P			
Birds	<i>Cicinnurus regius</i>	King Bird-of-paradise	LC	P			
Birds	<i>Paradisaea raggiana</i>	Raggiana Bird-of-paradise	LC	P			
Birds	<i>Paradisaea apoda</i> *	Greater Bird-of-paradise	LC	P			
Mammals	<i>Dasyurus albopunctatus</i>	New Guinea Quoll	NT		X		
Amphibians	<i>Kallistobatrachus majikthise</i>		LC		X	X	
Zygoptera	<i>Teinobasis cuneata</i> *		DD		X	X	
Zygoptera	<i>Teinobasis flavolineata</i> *		DD		X	X	
Zygoptera	<i>Idiocnemis schorri</i> *		DD		X	X	
Zygoptera	<i>Nososticta oculata</i> *		DD		X	X	
Amphibians	<i>Choerophryne</i> sp. 1 cf. <i>gracilirostris</i>		NE			X	X
Amphibians	<i>Hylophorbus</i> sp. 1 (fast call)		NE			X	X
Zygoptera	<i>Teinobasis</i> sp. 1 (long, slender)		NE			X	X
Zygoptera	<i>Teinobasis</i> sp. 2 (yellow)		NE		?	X	X
Zygoptera	<i>Idiocnemis</i> sp. 1		NE			X	X
Zygoptera	<i>Nososticta</i> sp. 1		NE			X	X
Zygoptera	<i>Palaiargia</i> sp. 1		NE		X	X	X
Zygoptera	<i>Papuargia</i> sp. 1		NE		X	X	X
Plants	<i>Begonia</i> sp. 1		NE			X	X
Plants	<i>Begonia</i> sp. 2		NE			X	X
Plants	<i>Calophyllum</i> sp. 1	Kalo	NE			X	X
Plants	<i>Garcinia</i> sp. 1	Kandis	NE			X	X
Plants	<i>Dillenia</i> sp. 1		NE			X	X
Plants	<i>Aglaia</i> sp. 1		NE			X	X
Plants	<i>Dysoxylum</i> sp. 1		NE			X	X
Plants	<i>Glochidion</i> sp. 1		NE			X	X
Reptiles	<i>Pelochelys bibroni</i>	Southern New Guinea Giant Softshell Turtle	VU				

CLASS	SCIENTIFIC NAME ¹	COMMON NAME	CONSERVATION SIGNIFICANCE ²				
			I	P	U	R	N
Reptiles	<i>Carettochelys insculpta</i> *	Pig-nosed Turtle	EN				
Reptiles	<i>Chelodina parkeri</i> *		NT				
Reptiles	<i>Chelodina reimanni</i> *		NT				
Mammals	<i>Nyctimene draconilla</i>	Lesser Tube-nosed Bat	DD				
Mammals	<i>Rhinolophus mcintyreii</i> [†]	McIntyre's Horseshoe Bat	DD				
Birds	<i>Zonerodius heliosylus</i>	Forest Bittern	NT				
Birds	<i>Ardea plumifera</i>	Plumed Egret	LC	P			
Birds	<i>Chenorhamphus campbelli</i> *	Campbell's Fairywren	NE			X	
Birds	<i>Manucodia ater</i>	Glossy-mantled Manucode	LC	P			
Birds	<i>Ptiloris magnificus</i>	Magnificent Riflebird	LC	P			
Birds	<i>Poodytes albolimbatus</i> *	Fly River Grassbird	VU			X	
Birds	<i>Lonchura stygia</i> *	Black Manakin	LC			X	
Amphibians	<i>Callulops marmoratus</i>		DD				
Amphibians	<i>Copiula lennarti</i>		LC			X	
Amphibians	<i>Hylophorbus sp. 2 (slow call)</i>		NE			X	
Amphibians	<i>Oreophryne pseudunicolor</i>		LC			X	
Amphibians	<i>Oreophryne sp. 1</i>		NE			X	
Amphibians	<i>Amnihyala longicrus</i>		DD				
Amphibians	<i>Mahonabatrachus timidus</i>		LC			X	
Amphibians	<i>Sandyrana pallidofemora</i>		LC			X	
Amphibians	<i>Spicicalyx sp. 1 cf. genimaculata</i>		NE			X	
Reptiles	<i>Cyrtodactylus derongo</i> *		DD			X	
Zygoptera	<i>Argiolestes muller</i>		DD				
Zygoptera	<i>Podopteryx roseonotata</i>		DD				
Zygoptera	<i>Pseudagrion parafarinicolle</i> *		DD			X	
Zygoptera	<i>Nososticta marina</i> *		DD			X	
Zygoptera	<i>Nososticta ovimacula</i>		DD			X	
Zygoptera	<i>Nososticta paraconifera</i> *		DD			X	
Zygoptera	<i>Nososticta rangifera</i>		DD			X	
Zygoptera	<i>Papuargia brevistigma</i> *		DD			X	
Anisoptera	<i>Diplacina cyrene</i> *		DD				
Anisoptera	<i>Rhyothemis hurleyi</i> *		DD				
Anisoptera	<i>Macromia eurynome</i> *		DD				
Plants	<i>Goniothalamus aruensis</i>		NT				
Plants	<i>Goniothalamus imbricatus</i>		DD				
Plants	<i>Polyalthia longirostris</i> *		NT				
Plants	<i>Licuala bakeri</i>		NT				
Plants	<i>Licuala bellatula</i>		NT				
Plants	<i>Licuala brevicalyx</i>		NT				
Plants	<i>Calophyllum laticostatum</i>	Kalo	NT				
Plants	<i>Calophyllum suberosum</i>	Kalo	VU				
Plants	<i>Garcinia mangostifera</i>	Mangosteen	DD				
Plants	<i>Mammea novoguineensis</i>		NT				
Plants	<i>Terminalia impediens</i>	Okari	NT				
Plants	<i>Alsophila vandeusenii</i>	Tree Fern	NT				
Plants	<i>Anisoptera thurifera</i>	PNG Mersawa	VU				
Plants	<i>Aceratium parvifolium</i>		NT				
Plants	<i>Elaeocarpus multisectus</i>		NT				
Plants	<i>Elaeocarpus murukkai</i>	Quandong	VU				

CLASS	SCIENTIFIC NAME ¹	COMMON NAME	CONSERVATION SIGNIFICANCE ²				
			I	P	U	R	N
Plants	<i>Endospermum medullosum</i> *	New Guinea basswood	VU				
Plants	<i>Archidendron megaphyllum</i>		DD				
Plants	<i>Archidendron ptenopum</i>		NT				
Plants	<i>Lithocarpus vinkii</i>		VU				
Plants	<i>Gmelina sessilis</i>		VU				
Plants	<i>Cryptocarya caloneura</i>		VU				
Plants	<i>Cryptocarya massoy</i>	Massoy	NT				
Plants	<i>Litsea collina</i>		VU				
Plants	<i>Litsea globosa</i>		VU				
Plants	<i>Magnolia tsiampacca</i>	Wau Beech	DD				
Plants	<i>Pterocymbium beccarii</i>	Amberoi	VU				
Plants	<i>Aglaia cucullata</i>	Amoora	DD				
Plants	<i>Aglaia lepiorrhachis</i>		NT				
Plants	<i>Ficus aurantiacifolia</i>		DD				
Plants	<i>Myristica hooglandii</i>	Nutmag	NT				
Plants	<i>Syzygium coalitum</i>	Laulau	NT				
Plants	<i>Syzygium fibrosum</i>		DD				
Plants	<i>Syzygium leptoneurum</i>		VU				
Plants	<i>Syzygium pergamaceum</i> *		VU				
Plants	<i>Pandanus iwen</i> *	Woromo	DD			X	
Plants	<i>Aporosa ledermanniana</i>		NT				
Plants	<i>Bridelia macrocarpa</i>		NT				
Plants	<i>Cleistanthus insignis</i>		VU				
Plants	<i>Discocalyx latepetiolata</i>		NT				
Plants	<i>Helicia latifolia</i>		NT				
Plants	<i>Acronychia pullei</i>		NT				
Plants	<i>Psychotria ramuensis</i>		VU				
Plants	<i>Madhuca leucodermis</i>		NT				
Plants	<i>Palaquium supfianum</i>		VU				
Plants	<i>Palaquium warburgianum</i>	Pencil Cedar	NT				
Plants	<i>Planchonella thyrsoides</i>		NT				

¹ Species with an asterisk are possibilities only

† cave dweller

I - IUCN status, P – protected nationally, U – upland species, R restricted range, N New to science

23 APPENDIX 4 SUGGESTED MITIGATIONS

#	Suggested Mitigation	construction	operations	closure
	Forest loss in the infrastructure corridor			
1	Mark the extent of vegetation to be cleared on all technical drawings and identify extent within the site. Do not clear beyond design limits.	X	X	
3	As far as practicable locate permanent and temporary infrastructure, including vehicle parks, lay down areas, storage sites, fuel storage, non-mining waste dumps in cleared areas, secondary and/or degraded areas.	X	X	
4	Where practicable and safe to do so, leave very large trees (>130 cm dbh) and fig trees (>100cm dbh) and other roosting sites for fauna at sites for temporary facilities such as vehicle parks, lay down areas, storage sites, bulk fuel storage.	X	X	
5	If a fire hazard exists, cleared vegetation should be left to rot rather than be burnt.	X	X	X
6	As far as practicable, quarries should be located in cleared areas, secondary and/or degraded forest, and the need for quarries reduced by using whatever competent rock is excavated at construction sites.	X	X	
	Reducing edge and barrier effects			
7	Allow forest edges to naturally regenerate or create conditions to facilitate natural regeneration.			
8	If safe and practicable, fell trees into planned footprints or into natural spaces in the surrounding habitat.			
9	Prevent machinery from injuring or scarring trees on the work site edges.	X	X	
10	Where feasible in the infrastructure corridor keep clearing to less than the designed 50m.	X		
	Disturbance to caves	X	X	X
11	If feasible prohibit limestone quarrying in the Lukwi cave area.	X	X	X
12	Conduct a pre-clearance survey of infrastructure, including quarries, to determine presence of caves with bat colonies and where colonies are located within 100 m of infrastructure, establish procedures to reduce disturbance, where practicable.	X	X	X
13	Establish protocols for worker and contractor inductions, to prohibit unnecessary disturbance of bat colonies by Project workers.	X	X	X
14	Prohibit entry of worker and contractors into caves.			
15	Limit or control where practicable, blasting within 150 m of known colonies of cave bats.	X	X	X
16	Potential quarry sites should not be located within 150 m of caves with bat species.			
	Reducing degradation of streams and riparian vegetation	X	X	X
17	Conduct fine-scale routing of access ways to place crossings in disturbed riparian vegetation as far as practicable and keep road alignment approaches to watercourses as close to right angles as practicable to limit disturbances to the banks of watercourses.	X	X	X
18	Place suitable erosion control devices between tracks, haul roads and streams.	X	X	X
19	Where practicable, locate valley-bottom access way alignments so as to provide a buffer strip of natural vegetation between the access ways and watercourses.	X	X	X
20	Implement good industry-practice management of in-stream activities to limit the downstream extent of turbid water created by fords, trenching or bridge building as far as practicable.	X	X	
21	Maintain buffer zones between permanent surface water and Project infrastructure to protect waters and riparian vegetation, except to carry out works associated with the construction of watercourse crossing or where facilities need to be located within that buffer.			
22	Stabilize spoil stockpiles and areas of ground disturbance as soon as practicable after initial disturbance	X		
23	Prohibit the washing, servicing or refuelling of equipment, vehicles or machinery near or within watercourses.	X	X	
24	Limit the extent of riparian vegetation cleared, and trim, rather than remove riparian trees where practicable.	X	X	X
25	Do not fell vegetation into waterways.	X	X	X
26	Stabilize cleared banks of streams with local materials, such as vegetation and rocks, to provide a suitable habitat for recolonisation.	X		
27	Where watercourse crossings are to be revegetated use local species wherever practicable.	X	X	X
28	Reduce sediment loading by reducing side casting above watercourses.	X	X	X
29	Prohibit disposal of domestic and industrial waste into forest streams or sinkholes.	X	X	
	Reduction of hunting and disturbance to fauna	X	X	X
30	Hunting of wildlife and/or transport of wildlife or wildlife products by project workers, contractors or visitors shall be prohibited at all times; for employees who are also landowners prohibitions should apply while working or staying on site in a work-related capacity.	X	X	X
31	Implement appropriate site inductions and training to educate staff with hunting and collecting regulations.	X	X	X
32	Prohibit project staff and contractors from possessing firearms and/or bows and arrows while engaged in project activities.	X	X	X
33	Bush meat must not be procured or consumed at any project site.			
34	Prohibit keeping or temporary housing of pets or wild fauna at project facilities other than trained guard dogs under the control of a handler.	X	X	X
35	Strictly prohibit keeping of cats at project facilities.	X	X	X
36	Prohibit mine personnel and those of its contractors bringing any plants or animals into the project development area.	X	X	X

#	Suggested Mitigation	construction	operations	closure
37	Control speed limits via posted speed limit signs on project roads and tracks.	X	X	X
38	Where practicable, direct lights at project facilities to minimise shine into surrounding forest.	X	X	X
	Loss of fauna in pipe trench			
39	Fauna rescue system to be developed in a Biodiversity Action Plan.	X		
	Weeds, pests and diseases management and quarantine EMMPs	X	X	X
40	<p>Determine the current status of all potentially serious invasive species especially around existing infrastructure and develop and implement a Weeds, Pests and Diseases Management Plan and possibly a Quarantine Plan as EMMPs or a sub-plans. Depending upon the results of the exotic species investigations such a plan could include.</p> <ul style="list-style-type: none"> • Production of a priority weeds list, • Pest and weed quarantine procedures including for inbound foreign freight, and imported bulk materials. • A weeds management procedure to limit the introduction of invasive weed species. • Periodic habitat monitoring to detect new alien incursions. • Protocols for reporting sightings of serious infestations. • Prohibition of transportation of live plants or seeds to the project sites unless part of an approved rehabilitation and restoration plan. • Checks that soil and weed seeds are cleaned from plant and machinery before bringing to site. • Procedures to prohibit project workers/contractors from establishing any gardens, or introducing or transporting any plants, seeds or animals, including fish species, within the project area. • Pre-construction surveys of work sites for weeds and exotic fauna. • Eradication of infestations of high priority weeds at worksites prior to commencement of construction. • Where appropriate, establishing permanent chemical wash down point(s) to prevent weeds and pathogens being transported to work sites. • Prohibiting use of exotic plants or seeds in the project sites. • Inspection and treatment as necessary of imported equipment and materials. • Requirement that that all earthmoving and heavy machinery newly arrived on site have been adequately washed down and cleaned. • Development of disposal/destruction mechanisms for potentially contaminated material such as confiscated items. 	X	X	X
	Avoidance of wildfires			
41	Avoid burning cleared vegetation, wherever practicable.	X	X	X
	Project workers/contractors engaged in project activities, will be prohibited from lighting and using fire except for specific work requirements controlled under a 'Hot Works' permit procedure and in designated smoking areas.	X	X	X
42	Revegetation			
43	As far as practicable avoid using grasses for revegetation/rehabilitation as they can carry fire into the surrounding forest.	X	X	X
44	For active revegetation the Endangered and new to science species will be priority species to plant.	X	X	X
45	Revegetate with local species.	X	X	X
46	Avoid the use of exotics species for revegetation.	X	X	X
47	Grasses should not be used as they carry fire which can erode the forest edge.	X	X	X
48	Use species of plants in revegetation that provide nectar and fruit for fauna. They attract dispersers, which generate a seed rain that speeds up regeneration and reduces costs.	X	X	X

24 APPENDIX 5 NOTES ON CONSERVATION RELEVANT SPECIES

SCIENTIFIC NAME	NOTES
<i>Calophyllum collinum</i> *	This tree species is endemic to New Guinea and is known from the Snow Mountains of Indonesian New Guinea and Western and Morobe Provinces of PNG ranging from 25 to 500 m. Known locations in Western Province are Kiunga and Ningerum (Conn, 1995). Despite the proposed TSF development area being within <i>C. collinum</i> elevational range and close proximity to known localities, it was not documented by Sagata and Richards (2026).
<i>Cryptocarya albifrons</i>	This tree was assessed as Endangered when it was known from only two collections with an extremely small area of occupancy and extent of occurrence (8 km ²). It is now known to occur more widely, with new locations confirmed in Central, Eastern Highlands and Morobe Provinces. The record from Site 4 is a major range extension and the first record for Western Province.
<i>Cryptocarya brevipes</i>	This large tree was known from three localities between 100 and 1,830 m in PNG, between the Huon Peninsula and near Kiunga but has recently been recorded from another location in Eastern Highlands Province. Deforestation and agricultural expansion are the main threats.
<i>Cryptocarya fluminensis</i>	A small tree that previously known from four localities in PNG's lowlands (70–200 m) including several locations near Port Moresby, It has subsequently been documented from Tonolei and Buin on Bougainville, and from one location in Western Province.
<i>Cryptocarya sulcata</i>	This montane forest tree was previously known from three localities in Morobe Province between 750–1,550 m. It was found at Sites 1 and 2 which represents a major range extension and substantially extend the species' known altitudinal range.
<i>Endiandra engleriana</i>	This tree is known from five localities scattered across northern mainland New Guinea, where it grows at an altitude of about 1,000 m. The record from Site 1) is the first record from Western Province and the first from south of the central cordillera.
<i>Timonius argenteus</i>	This tree species is endemic to PNG where it has previously been reported from four locations in the lowland forests of West Sepik, East Sepik, and Madang Provinces. Logging and mining projects are serious threats to its habitat while locals used it for house construction. The record from Site 5 is the first from Western Province and the first from south of the central cordillera.
<i>Palaquium morobense</i>	This tree is known from Madang, Morobe and West New Britain Province and the Solomons and has an EOO of 123,704 km ² . Although the AOO may be larger with greater collection effort it is unlikely to exceed the boundaries of a threatened category. Logging activities and continuous gardening activities by local indigenous people are threats to the species. Its occurrence at Sites 4 and 5 are a significant extension of range.
<i>Zaglossus bartoni</i>	<p>A large echidna weighing up to 10 kg, endemic to New Guinea and recorded up to the highest mountains in a variety of habitats including hill forest, montane forest and sub-alpine grassland and scrub. Reports from near sea level (e.g., Leary et al. 2016a), appear to refer to records of the Western Long-beaked Echidna (<i>Z. bruijnii</i>) from the Vogelkop, which was previously treated as conspecific with Eastern Long-beaked Echidna (Flannery 1995; Nicol 2015). They tolerate of some habitat disturbance but are particularly susceptible to overhunting and are now rare or locally extinct in many areas. It was recognised by local informants interviewed at Sites 1, 2 and 5. However, this species is likely to be absent or very scarce within the project area because:</p> <ul style="list-style-type: none"> • There are no prior records from hill forest below 1,000 m reported for the Ok Tedi area (Hyndman and Menzies 1990). • There are no confirmed records below 600 m anywhere across the species' range. • During the present surveys, local informants mis-identified several mammal species from photographic materials. <p>If present in it is probably locally scarce, with the main body of the local population centred on forest at higher elevations.</p>
<i>Dendrolagus stellarum</i> *	This is a montane species of tree kangaroo extending broadly along the central cordillera to the Victor Emmanuel Range between 2,600 to 4,000 m. The main threat to the species is hunting.
<i>Dendrolagus spadix</i> *	The Lowlands Tree Kangaroo is the only species with a fundamentally lowland distribution. Like all tree kangaroos it is hunted where the opportunity presents itself and although it lives in a remote and mostly uninhabited part of New Guinea, large areas of its range are covered by logging concessions. IUCN considers this to be the major threatening process. However, the ecology of the species is very poorly known.
<i>Aproteles bulmerae</i> *2	Bulmer's Fruit Bat (<i>A. bulmerae</i>) roosts in caves at higher elevation in the Hindenburg Wall, Simbu and Eastern Highlands Provinces (Flannery & Seri 1993). It is unlikely to be found in lower elevation like Ok Birim or the lower Ok Tedi area. If <i>A. bulmerae</i> is found at low elevation, it is most likely due to foraging rather than roosting.

SCIENTIFIC NAME	NOTES
<i>Echymipera orio</i> [*]	The bandicoot <i>Echymipera orio</i> is not evaluated by IUCN because it is a species complex in <i>E. kalubu</i> (verbal comm., Daniel S. Okena). It is currently known from only a few localities spread between Ok Birim and the trans-Fly region south of Kiunga (BMT WBM 2016). However, <i>E. orio</i> could not be easily identified based on field morphological characters by any of the field team or the locals because as there are no clear morphological discernible characters. In this survey, the locals likely clumped <i>E. kalubu</i> with <i>E. orio</i> as a single species. There is also the possibility that <i>E. orio</i> can be misidentified from camera trap images. Like all bandicoots it is hunted with dogs and by trapping.
<i>Echymipera echinista</i> [*]	Menzies' Echymipera is very rare and only known from two locations: Fly River and Strickland River drainages from 40-80 m (Flannery 1995). There are also unconfirmed records from Mt Menawi in Papua, Indonesia, which would extend its range to 1,000 m (IUCN website).
<i>Dorcopsis luctuosa</i>	The Gray Forest Wallaby is known from sea level to 400 m in southern Trans-Fly to south-eastern parts of PNG; Gulf, Central and Milne Bay provinces. It occurs in primary forest and disturbed habitats like abandoned gardens (IUCN website). Local informants indicated its presence (BMT WBM 2016); however but at higher elevations.
<i>Dorcopsulus vanheurni</i>	A small forest wallaby weighing up to kg, endemic to New Guinea and found throughout the central cordilleras, usually above 800 m (Eldridge and Coulson 2015). It is mainly threatened by hunting and to some degree by habitat modification, with declines and localised extinctions recorded in some lower montane areas where human population densities are highest (Leary et al. 2016b; Eldridge and Coulson 2015). However, it is widespread and secure in suitable habitat across much of its range. Hyndman and Menzies (1990) reported it to be common above 500 m in the Ok Tedi area, and during this study it was recognised by local residents interviewed at Site 5.
<i>Goura sclaterii</i>	A large, terrestrial pigeon endemic to the lowlands (below c. 500 m) of New Guinea, occurring in groups of up to 30 birds and preferring gentle terrain including seasonally flooded habitats (Coates 1985; Gibbs et al. 2001). It occurs from the Mimika River to at least as far as the lower Kikori River. All <i>Goura</i> species are susceptible to hunting, being easily captured and highly prized for their meat and plumes (Coates 1985; King and Nijboer 1994; BirdLife International 2026). Gregory (1995) indicated that it had been extirpated from forest at lower elevations around Ningerum, indicating its susceptibility to local hunting. Other threats include habitat fragmentation, dogs and collisions with traffic in areas with roads. It was heard at Sites 1, 2 and 5.
<i>Harpyopsis novaeguineae</i>	This endemic is New Guinea's largest bird of prey, widespread in forested habitats from sea level to over 3,000 m (Coates 1985; Beehler and Pratt 2016). It occurs at low population densities with breeding pairs occupying extensive territories. While most records are from undisturbed forest, it also persists in logged forest (I. Woxvold, unpublished data). It hunts mammals and birds on the ground, in trees or from tree hollows by flying through or low over the canopy (Coates 1985; Watson and Asoyama 2001). Habitat loss and hunting present the major threats as the feathers are targeted by hunters.
<i>Probosciger aterrimus</i>	The Palm Cockatoo is widespread throughout New Guinea in the lowlands and hills, occasionally to 1,350 m, in primary and secondary forest and savanna (Beehler and Pratt 2016). It occurs more widely from the West Papuan Islands east to Cape York Peninsula, Australia. However, it is nowhere common and typically occurs at lower densities than other sympatric cockatoos and large parrot species (Igag et al. 2019). Habitat loss and hunting are major threats. Palm Cockatoos are also susceptible to the loss of trees with suitable nest hollows (Igag et al. 2019). They were recorded at Site 1 based on local informants. Gregory (1995) noted that it is generally uncommon in the region.
<i>Psittrichas fulgidus</i>	A large parrot endemic to New Guinea and heavily hunted for its feathers, which are used for ceremonial and trade purposes. As with a number of larger parrots and cockatoos, large trees with nest hollows are cut down to access nestlings, restricting the availability of nesting habitat in settled areas. Hunting has seriously impacted Pesquet's Parrot, which has been historically and recently extirpated from large areas, particularly in PNG. In the absence of hunting, this species appears at least somewhat tolerant of moderate habitat disturbance. Habitat loss, fragmentation and degradation also present threats to Pesquet's Parrot, in particular through the loss of food trees (<i>Ficus</i> spp.) and nest trees. Logging appears not to present a major threat as this species has been observed in 10-year regrowth in heavily logged areas (I. Woxvold, unpublished data). Pesquet's Parrot was recorded at Sites 1, 4 and 5 based on local informants. Suitable forest habitat is locally and regionally widespread and it may occur in small numbers anywhere. In the 1990s it was locally "still not uncommon away from habitation but becoming rare as hunting persists" Gregory (1995, p.17).
<i>Cicinnurus regius</i>	A small common bird-of-paradise widespread in the New Guinea lowlands. The lek is a terrestrial "exploded lek" where males gather loosely to display on perches 100 m or more apart. It is a resident of forests, including Swamp Forest formations and gallery forest up to ca. 300 m, less commonly higher (Frith and Beehler 1998).
<i>Paradisaea raggiana</i>	A widespread, common bird-of-paradise hunted for plumes.

SCIENTIFIC NAME	NOTES
<i>Paradisaea apoda</i> *	A widespread, common-bird-of-paradise hunted for plumes.
<i>Dasyurus albopunctatus</i>	A medium sized carnivore, endemic to New Guinea occurring from sea level to above 3,500 m, but less common in the lowlands and foothills (Flannery 1995; Baker 2015). It can be found in a variety of habitats including primary and secondary forest and nearby gardens and subalpine heath. It is uncommon and susceptible to forest loss and habitat degradation (Woolley et al. 2016) and poisoning by cane toads. It is too small and uncommon to be a specific hunting target, though it is taken opportunistically with snares and the use of dogs. It was photographed at Site 5. It is locally widespread where it may be fairly common above about 400 m.
<i>Kallistobatrachus majikthise</i>	A small treefrog that glues its eggs to leaves hanging over forest pools, seepages or small streams, where they develop into tadpoles that drop into the water below to complete their development. This species is known only from a small area around the headwaters of the Ok Tedi River.
<i>Teinobasis cuneata</i> *	A damselfly known from a single location, on a stream draining the southern slopes of the Hindenburg Range in Western Province, Papua New Guinea at an altitude of 365 m. (Theischinger & Richards 2015); a species of lowland rainforest that may occur at Ok Birim.
<i>Teinobasis flavolineata</i> *	A damselfly known from a single location, a stream draining the southern slopes of the Hindenburg Range near Tabubil town in Western Province, Papua New Guinea at an altitude of 282 m (Theischinger & Richards 2015).
<i>Idiocnemis schorri</i> *	Known from altitudes between 360 and 520 m along the southern fringe of Papua New Guinea's central cordillera between Tabubil in the west and the Kikori River basin in the east (Gassmann et al. 2016). Ok Birim is a bit lower altitude and the species requires clear-flowing streams so presence will depend on availability of suitable habitat.
<i>Nososticta oculata</i> *	A damselfly known from a single location at an altitude of 433 m on the southern slopes of the Hindenburg Range in Western Province, Papua New Guinea, south of Tabubil (Theischinger & Richards 2015). Altitude of Ok Birim TSF may be too low and requires rocky clear-flowing streams so will be habitat dependent.
<i>Choerophryne</i> sp. 1 cf. <i>gracilirostris</i>	A series of recordings from Site 1 cannot be associated with any known frog species but most closely resemble the calls of <i>Choerophryne gracilirostris</i> , a small, long-snouted species known from the Müller Range and Southern Highlands Province (Richards 2025). Voucher specimens are required to confirm the identity of this species, but it is likely to be new to science and likely has a small range.
<i>Hylophorbus</i> sp. 1 (fast call)	A terrestrial frog likely to be new to science and is possibly a local endemic. This is assumed to be the same species as <i>Hylophorbus</i> sp. B (fast) at Bige.
<i>Teinobasis</i> sp. 1 (long, slender)	Thus long, slender damselfly is new to science. It was encountered on low vegetation in primary forest at Sites 1, 4 and 5.
<i>Teinobasis</i> sp. 2 (yellow)	A small, slender, yellow-faced damselfly new to science. It is known from a single specimen collected on a hillslope far from water in primary forest at Site 4.
<i>Idiocnemis</i> sp. 1	A small, slender, stream-dwelling damselfly common along small streams at Sites 1, 2 and 5 and in nearby forest. It is a member of the <i>Idiocnemis bidentata</i> group, and two species of this group are known from the upper Fly River catchment: <i>Idiocnemis mertonii</i> and <i>I. schorri</i> . However, the thorax pattern of the specimens from Ok Birim differs consistently from both of these species (Gassmann 2000; Gassmann et al. 2016). It is possible it is the undescribed " <i>Idiocnemis</i> near <i>mertonii</i> " reported from approximately 230 km to the southwest in Indonesian New Guinea by Kaize & Kalkman (2011).
<i>Nososticta</i> sp. 1	A small, black damselfly with yellow markings on the thorax was collected from a small stream at Site 2. Its colour pattern and terminalia are unique in the genus and it is new to science.
<i>Palaiargia</i> sp. 1	A single male of a small but moderately robust damselfly belonging to the genus <i>Palaiargia</i> appears to be new to science. Two unidentified females may also belong to this species. All were collected near clear-flowing forest streams at Site 5.
<i>Papuargia</i> sp. 1	A robust, black-and-green damselfly is sufficiently different from the sole representative of this species in southern PNG that it is likely new to science. It was found along clear-flowing rocky streams in forest at Site 5.
<i>Begonia</i> sp. 1	This newly identified <i>Begonia</i> species was first recorded approximately 300 m east of Site 1 at 85 m. along Mohed Creek. Taxonomic comparison confirms that <i>Begonia</i> sp. 1 does not correspond to any specimens currently held in the Lae National Herbarium reference collections.

SCIENTIFIC NAME	NOTES
<i>Begonia sp. 2</i>	This species new to science was recorded at Site 2. It occurs predominantly along creeks and main streams within riverine forest zones, where it favours consistently moist conditions. The species was subsequently observed and recorded at three additional locations in the proposed TSF development area, with most sightings concentrated in humid riverine habitats.
<i>Calophyllum sp. 1</i>	No notes in Sagata and Richards (2026)
<i>Garcinia sp. 1</i>	No notes in Sagata and Richards (2026)
<i>Dillenia sp. 1</i>	This suspected new species of Dillenia shows no morphological resemblance to any specimens currently held in the Lae National Herbarium. The species is notably common within the proposed TSF development area and was recorded at both Site 1 and Site 2, particularly along valley drainage lines and in sago swamp areas.
<i>Aglaia sp. 1</i>	No notes in Sagata and Richards (2026)
<i>Dysoxylum sp. 1</i>	No notes in Sagata and Richards (2026)
<i>Glochidion sp. 1</i>	This suspected new to science species is a shrub reaching 1 m in height. It was first observed along ridge slopes and subsequently recorded on the ridge in the vicinity of the Site 1.
<i>Pelochelys bibroni</i>	A large turtle widespread in southern New Guinea in the major rivers and larger waterbodies. Informants reported it in the Ok Ma but whether it occurs in smaller waterways in the TSF development area is unknown but local informants did not report them as present. Populations declining through overharvesting.
<i>Carettochelys insculpta</i> *	A large turtle that has suffered severely from overharvesting. Widespread across southern New Guinea and it also occurs in northern Australia. This turtle occupies rivers, swamps, lagoons, mangroves and estuaries but usually larger waterbodies and nests preferentially on sandy banks above the low water line. Whether it occurs in smaller waterways within the TSF development area is unknown - local informants did not report them as present.
<i>Chelodina parkeri</i> *	Known from the floodplains and swamps of the Merauke River drainage in southeastern Indonesian Papua and the inland swamps of the Bensbach, Morehead, Fly, and Aramia-Bamu River drainages of the Western Province of southwestern Papua New Guinea. This medium sized turtle inhabits inland swamps and grassy wetlands.
<i>Chelodina reimanni</i> *	A turtle known from the Merauke area in adjacent Papua Province of Indonesia - not yet confirmed from PNG but could occur in waterways of the TSF development area. Little is known of this species ecology.
<i>Nyctimene draconilla</i>	This bat occurs mostly in the southern region between Mt. Bosavi and Asmat regency in Indonesia. Bonaccorso (1998) recorded the species from the central highlands in PNG. It has been recorded from sea level up to 100 m and is likely to occur in the TSF development area.
<i>Rhinolophus mcintyreii</i> 2	This is a poorly known bat species originally described as a subspecies of <i>Rhinolophus arcuatus</i> . It is relatively common south of the Central cordillera at 270 - 1,600 m. (K.N. Armstrong unpublished data) and roosts in caves. Although specific threats are not well documented, habitat loss and cave disturbance are likely risks (Patrick & Ruedas 2017).
<i>Zonerodius heliosylus</i>	A New Guinea endemic widely, though sparsely, distributed predominantly in the lowlands (but up to 1,650 m (Sam and Koane 2014, Beehler and Pratt 2016). It is a reclusive and rarely seen inhabitant of forest swamps, streams and pools (Coates 1985). Habitat loss, degradation and contamination of watercourses, riparian and wetland habitats present the major threats. It is not specifically targeted by hunters. It was recorded at Site 1 based on local informants but no records of this species was included in Gregory's (1995) summary of birds from the Ok Tedi region.
<i>Ardea plumifera</i>	A common waterbird.
<i>Chenorhamphus campbelli</i> *	Campbell's Fairywren is known from Mt Bosavi on the east to Lake Murray and Kiunga on the west (Rowley et al 2021, Pratt and Beehler 2015). However, the species is rarely observed and its ecology and biology are almost unknown.
<i>Manucodia ater</i>	A widespread, common bird of paradise not heavily hunted for plumes.
<i>Ptiloris magnificus</i>	A widespread, common bird of paradise not heavily hunted for plumes.
<i>Poodytes albolimbatus</i> *	This bird, is known from a few localities in the Trans-Fly region of New Guinea, including Wasur National Park, small areas along the Bensbach River and a handful of sites on the middle Fly River.

SCIENTIFIC NAME	NOTES
<i>Lonchura stygia</i> *	This is a grassland and riverine species (Beehler et al. 1986, Coates 1990, Gregory 1995) known from a restricted area of the southern Trans-Fly region. It may have extended its range northwards, with wetland and grassland development in the upper and middle Fly, brought about by hydrological changes due to mining activities but the habitat at the TSF development area itself may not be suitable for this species.
<i>Callulops marmoratus</i>	A poorly known frog that appears to be widespread between the Purari River and the upper Fly River area but may qualify as Restricted Range. Documented at Bige during the 2015 TSF development area survey (BMT WBM 2016).
<i>Copiula lennarti</i>	A small terrestrial frog that was described from the Müller Range but is known to occur more widely in south-western PNG. This species was previously encountered in the upper Ok Tedi area by S. J. Richards & G. Johnston (unpublished data).
<i>Hylophorbus</i> sp. 2 (slow call)	Identification of this frog is based on the call only, which closely resembles that of an undescribed <i>Hylophorbus</i> species known to occur widely in southern PNG to the east of Ok Birim. This species could also be “true” <i>H. rufescens</i> . This is assumed to be the same species as <i>Hylophorbus</i> sp. A (slow) at Bige.
<i>Oreophryne pseudunicolor</i>	This frog is known from the Gulf and Southern Highlands Provinces at elevations from 25-400 m. It is expected to occur more widely given the large amount of suitable habitat in the area (S. Clulow pers. comm. July 2019).
<i>Oreophryne</i> sp. 1	A small arboreal frog, undescribed but previously known from the outskirts of Tabubil town (Richards, unpublished data). It qualifies as Restricted Range and may have a small local range.
<i>Amnihyla longicrus</i>	A small treefrog with a broad distribution across the southern lowlands and foothills of mainland New Guinea between the Vogelkop and the Purari River (Richards 2025). It is found along small, clear-flowing rocky streams in forest and a single animal was encountered at Site 5.
<i>Mahonabatrachus timidus</i>	A small frog with a small range in the Ok Tedi and upper Fly drainage.
<i>Sandyrana pallidofemora</i>	The species occurs on the southern versant of the central cordillera of PNG in Gulf, Central, and Western provinces between 80-300 m (Kraus 2018).
<i>Spicocalyx</i> sp. 1 cf. <i>genimaculata</i>	This stream-dwelling frog is widespread in the New Guinea lowlands.
<i>Cyrtodactylus derongo</i> *	This gecko is known only from the type locality in PNG. Surveys in lowland areas around Tabubil have failed to collect this species (P. Oliver. pers. comm. 2014) but there is nothing obviously unusual about its known habitat and it may occur more widely in this region.
<i>Argiolestes muller</i>	A moderately robust “flatwing” damselfly previously known from two localities at elevations of 328–515 m in and near the Müller Range (Kalkman et al. 2010). It was encountered along clear-flowing streams at Sites 1, 2 and 5. The species’ range is poorly documented and its habitat requirements and population status are poorly understood (Richards 2019a).
<i>Podopteryx roseonotata</i>	A large, robust “flatwing” damselfly s known from scattered localities across mainland New Guinea and the Aru Islands from southwestern Papua Province to the Huon Peninsula. The records from Sites 2 and 5, fill a large gap in the known distribution of the species. It is probably a tree hole breeder.
<i>Pseudagrion parafarinicolle</i> *	A damselfly known from the type locality at Lake Kutubu in Southern Highlands Province and from a small number of sites in Gulf Province lowlands. It may occur south of Tabubil (as <i>P. farinicolle</i> ; Richards & Theischinger 2015). A species of small, low-gradient, clear-flowing streams that may occur in the project development area.
<i>Nososticta marina</i> *	Distribution poorly known but occurs in Aru Islands and Western and Gulf Provinces in PNG - likely to be forest-dependent and probably requires running water. Habitat at the TSF development area appears to be suitable.
<i>Nososticta ovimacula</i>	A small, stream-dwelling damselfly previously known from two locations tone in the upper Fly and Strickland River basins and the other in the Kikori River basin (Theischinger & Richards 2016). This species was moderately common at Sites 1 and these records extend this species’ range approximately 88 km to the west.
<i>Nososticta paraconifera</i> *	Known from two locations, the upper Fly River basin of Western Province (Theischinger & Richards 2016) and another in the Purari River Basin of Gulf Province (S. J. Richards, unpublished data). Occurs patchily along small, clear streams flowing over rocky and sandy substrates in lowland rainforest.
<i>Nososticta rangifera</i>	A small, stream-dwelling damselfly previously known only from southeastern Indonesian New Guinea (Kaize & Kalkman 2011). The record from Sites 1 and 2 extends the known distribution approximately 230 km to the northeast and appears to be the first from PNG.

SCIENTIFIC NAME	NOTES
<i>Papuargia brevistigma</i> *	A damselfly known from a single location in the upper Strickland River Basin (Orr & Richards 2017), and from one other site in the Purari River basin (S. J. Richards, unpublished data). In clear rocky streams and small waterfalls, so habitat at the TSF development area may not be suitable.
<i>Diplacina cyrene</i> *	This dragonfly appears to have a broad distribution in southern and western New Guinea but requires clear-flowing streams (sometimes rocky; Richards, unpublished data) so occurrence at the TSF development area is dependent on availability of suitable habitat.
<i>Rhyothemis hurleyi</i> *	Known from six locations in Indonesian New Guinea (Lieftinck 1949) and two in the southwest of PNG (Tillyard 1926). This dragonfly is found presumably near ponds and rivers; there is suitable habitat at Ok Birim so it may occur.
<i>Macromia eurynome</i> *	This dragonfly is known from two locations in the south of New Guinea, one on the Lorentz River in Indonesian New Guinea (Lieftinck 1952, 1971) and one in PNG (Richards et al. 1998). The known locations are separated by approximately 940 km. Occurs at streams and is almost certainly forest dependent so suitable habitat occurs at the TSF development area.
<i>Goniiothalamus aruensis</i>	A small, wide-ranging tree species from New Guinea to the Solomons in lower montane and montane forests.
<i>Goniiothalamus imbricatus</i>	According to IUCN, this species is only known from the type locality on the Ramu River, however, there are numerous specimens on the PNG plant site indicating a broad distribution in New Guinea.
<i>Polyalthia longirostris</i> *	This species is known from less than 10 locations from PNG and the Solomons from sea level to 100 m. There is only one record from Western Province below Kiunga around 23 m (IUCN website). Not much is known about its distribution and ecology. However, given that the TSF development area lies within its known elevational range, it is likely to occur there.
<i>Licuala bakeri</i>	This palm was previously known only from a few sites in Indonesian New Guinea. The records from the TSF development area are a significant extension of range.
<i>Licuala bellatula</i>	This small understorey palm is known from localities from the Fly River to the Vogelkop.
<i>Licuala brevicalyx</i>	A large lowland palm with scattered records over 1,000 km from Timika to Kerrema. Supposedly of restricted range but its wide distribution over rarely sampled areas suggests otherwise.
<i>Calophyllum laticostatum</i>	A tall tree >40 m high found on the mainland of New Guinea and New Britain in well-drained lowland forest.
<i>Calophyllum suberosum</i>	A large tree usually in swamp forest in New Guinea and Sulawesi. It was recorded from Site 1.
<i>Garcinia mangostifera</i>	A little known tree from PNG. No information available.
<i>Mammea novoguineensis</i>	A widely distributed tree from Geelvink Bay to Milne Bay in forest between 60 and 420 m but known from very few collections.
<i>Terminalia impediens</i>	A large lowland tree to 40 m high widely distributed across New Guinea.
<i>Alsophila vandeusenii</i>	This tree fern is only known from Mount Wilhelm and Mount Piora in Chimbu province. The record by Sagata and Richards (2026) at Site 1 may be an error.
<i>Anisoptera thurifera</i>	A large tree ranging from PNG through eastern Indonesia to the Philippines. It is heavily logged but appears to be a pioneer tree and may be advantaged by logging. This species was detected at Sites 1 and 2.
<i>Aceratium parvifolium</i>	A small sub canopy tree widespread In New Guinea in pristine and degraded forest from 200-1700 m.
<i>Elaeocarpus multisectus</i>	A medium sized tree distributed from the Vogelkop to New Britain declining as result of logging and agriculture. Generally in the lowlands to 500m.
<i>Elaeocarpus murukkai</i>	A canopy tree endemic to PNG, found in montane forests between 1,800 and 2,350 m. It was thought to have a restricted distribution on the Papuan Peninsula in eastern PNG and its population is declining through logging, mining and habitat loss. The record from Site 2 is the first for Western Province and represents a major range extension and a substantially lower known altitudinal occurrence. It can no longer be considered restricted range.
<i>Endospermum medullosum</i> *	A large mostly pioneer tree widely distributed in New Guinea, the Solomon and Vanuatu. The species has been recorded from near Kiunga. It is threatened by overharvesting for timber.

SCIENTIFIC NAME	NOTES
<i>Archidendron megaphyllum</i>	There appears to be discrepancy between the IUCN account and the record of specimens in PNG Plant Database where there are seven records from four provinces which the IUCN account appears to discount.
<i>Archidendron ptenopum</i>	This species is known only from the Madang/Morobe area and the record at Site 4 is a significant extension of range.
<i>Lithocarpus vinkii</i>	A large timber tree found the length of New Guinea, in lowland and montane forests from sea level to 1,800 m. It is threatened by logging and agricultural expansion. It was found at Site 1.
<i>Gmelina sessilis</i>	A lowland tree to 30 m high widespread in eastern mainland PNG and on New Britain. Based on Lae National Herbarium and IUCN records (IUCN 2026), there is also a record from the Snow Mountains in Indonesian New Guinea. It was known from nine locations and major threats include deforestation and conversion of forests to agriculture and plantations. The record from Sites 1 and 4 represents a major range extension and the first record for Western Province.
<i>Cryptocarya caloneura</i>	This lowland tree was previously known from nine localities spread across southern and northern mainland PNG, one of them in the upper Fly River catchment (de Kok, R. 2020). Based on Lae National Herbarium records this species also occurs from Mupi in Indonesian New Guinea. The species was recorded from Site 1.
<i>Cryptocarya massoy</i>	A tree up to 30 m high commonly harvested for its bark and widely distributed throughout the island of New Guinea and West New Britain. Populations have declined through over harvesting for bark export.
<i>Litsea collina</i>	A widespread tree in eastern and northern PNG, Manus Island and the Solomons. Deforestation and conversion to agriculture are the main threats. Based on Lae National Herbarium records, this species was collected near Ingembit and along the Bingge River, Western Province.
<i>Litsea globosa</i>	This tree has a very wide distribution from Sabah to New Guinea in montane forests up to 2,200 m. Deforestation and agricultural expansion are the major threats. It was encountered at Site 1.
<i>Magnolia tsiampacca</i>	A tree up to 60 m tall in primary and secondary forest. IUCN gives its lower elevation limit as 457 m but it was found at Site 2 at 69 m.
<i>Pterocymbium beccarii</i>	A large emergent widely distributed across mainland New Guinea in the lowlands, sometimes to 1,000 m and harvested for timber. This species was encountered at Site 5 and based on the Lae National Herbarium records; this is the second record for Western Province.
<i>Aglaia cucullata</i>	This tree species is found from India to PNG and generally near the coast.
<i>Aglaia lepiorrhachis</i>	A small widespread tree endemic to New Guinea and known from collections in East Sepik, Manus, Madang, Morobe and Milne Bay province.
<i>Ficus aurantiacifolia</i>	A PNG endemic, Sagata and Richards (2026) provide no notes on this species.
<i>Myristica hooglandii</i>	A lowland species widely distributed in eastern PNG with collections from Manus, Morobe, Milne Bay, Northern and Central Provinces. It grows up to an elevation of 450 m. The collections at Site 5 are a significant extension of its range westward.
<i>Syzygium coalitum</i>	A tree endemic to PNG so far only known from eastern PNG in Central, Gulf, Milne Bay and Morobe provinces. It was found at Site 1 a large extension of range. On this basis it is not considered restricted range.
<i>Syzygium fibrosum</i>	A small understorey tree from well-developed, drier rainforests in northern and eastern Australia, PNG and the Aru Islands. This tree has a very wide distribution, large population, is not currently experiencing any major threats, the only significant potential threat is from Myrtle Rust.
<i>Syzygium leptoneurum</i>	This small tree is endemic to PNG between 30–500 m. Based on Lae National Herbarium collections, it occurs in Morobe, Central, West Sepik, Madang and Gulf Provinces. It was documented at Site 1 which represents a substantial range extension and the first record for Western Province. Logging concessions and plantations threaten its habitat.
<i>Syzygium pergamaceum*</i>	A widespread PNG endemic tree up to 30 m high found from swamp forest to montane forest from sea level up to 1,150 m. In Western Province, it is recorded from Stuart Island and above Fly River and Elevala River junction in Kiunga area (Conn 1995).
<i>Pandanus iwen*</i>	This pandanus is likely found only in PNG as it has been recorded from Kiunga only). It is likely to occur in the proposed TSF development area.
<i>Aporosa ledermanniana</i>	A widespread understorey tree in a range of forest types and conditions found in West Sepik, East Sepik, Western and Milne Bay Provinces.

SCIENTIFIC NAME	NOTES
<i>Bridelia macrocarpa</i>	A large, lowland forest tree found in primary rainforest, tall secondary and monsoon rainforest and widespread from Maluku to New Guinea. Known from collections in Madang and Central province and Indonesia New Guinea the collection at Site 2 is the first in Western Province.
<i>Cleistanthus insignis</i>	An understory tree broadly distributed in disturbed rainforests and along creek banks across the lowlands and foothills of PNG and on several islands in Milne Bay Province. The species is used locally for fencing and house construction but has no commercial value. Habitat loss from subsistence gardening and timber use is a major threat.
<i>Discocalyx latepetiolata</i>	This small understory tree is found above 1,000 m along the central cordillera of New Guinea and the Huon Peninsula. The records at Sites 1 and 2 are at a significantly lower elevation.
<i>Helicia latifolia</i>	A widespread tree up to 24 m high in primary and secondary rainforest to an elevation of 800 m, known only from PNG.
<i>Acronychia pullei</i>	Generally a montane tree up to 24 m high and endemic to New Guinea. A record from Site 5 may be the first for Western Province.
<i>Psychotria ramuensis</i>	There is much taxonomic uncertainty in <i>Psychotria</i> taxonomy in New Guinea, This species is a small lowland tree with scattered records from West Sepik to Madang Province. The record from Site 4 is the first for Western Province and a considerable extension of range.
<i>Madhuca leucodermis</i>	A tree to 30 m high in lowland forest with scattered records across Madang, Morobe, Western, Central and Milne Bay Provinces and Obi Island in Maluku lowland forests between 30-500 m.
<i>Palaquium supfianum</i>	This species has a broad distribution in northern and eastern PNG. It may also occur west to Borneo. There is one collection record for the Palmer River in Western Province. This species was documented at Site 2.
<i>Palaquium warburgianum</i>	A large lowland forest tree in northern New Guinea from Indonesia to West New Britain province. The record at Site 1 may be the first for Western Province.
<i>Planchonella thyrsoidea</i>	A lowland tree found in a range of intact and degraded forest and swamp forest formations known from Madang, Simbu, Eastern Highlands, Manus, New Ireland and Bougainville. The record at Site 2 may be the first for Western Province.

25 ANNEX 1 CONSOLIDATED FAUNA CATALOGUE

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Mammals															
Tachyglossidae	<i>Zaglossus bartoni</i>	Eastern Long-beaked Echidna	VU	P	X			X	X			X			
Dasyuridae	<i>Dasyurus albopunctatus</i>	New Guinea Quoll	NT		X							X		X	
Dasyuridae	<i>Myoictis wallacei</i>	Wallace's Three-striped Dasyure	LC									X			
Dasyuridae	<i>Murexia longicaudata</i>	Short-furred Dasyure	LC									X			
Dasyuridae	<i>Murexia melanura</i>	Black-tailed Antechinus	LC									X			
Peramelidae	<i>Echymipera kalubu</i>	Common Echymipera	LC					X	X	X	X	X	X		
Peramelidae	<i>Echymipera oriamo*</i>	Oriomo Echymipera	NE			X									
Peroryctidae	<i>Echymipera echinista*</i>	Menzies' Echymipera	DD												
Peramelidae	<i>Echymipera rufescens</i>	Long-nosed Echymipera	LC					X	X			X	X	X	
Peroryctidae	<i>Peroryctes raffrayanus</i>	Raffray's Bandicoot	LC								X				
Macropodidae	<i>Dendrolagus stellarum*</i>	Seri's Tree Kangaroo	VU	P	X										
Macropodidae	<i>Dendrolagus spadix*</i>	Lowlands Tree-kangaroo	VU	P											
Macropodidae	<i>Dorcopsis luctuosa</i>	Gray Forest Wallaby	VU										X	X	
Macropodidae	<i>Dorcopsulus vanheurni</i>	Small Dorcopsis	NT									X			
Acrobatidae	<i>Distoechurus pennatus</i>	Feather-tailed Possum	LC					X	X			X	X		X
Petauridae	<i>Dactylopsila trivirgata</i>	Striped Possum	LC					X	X			X	X		X
Petauridae	<i>Petaurus papuanus</i>	New Guinea Glider	LC					X	X			X		X	
Pseudocheiridae	<i>Pseudochirulus canescens</i>	Lowland Ringtail	LC					X				X			
Phalangeridae	<i>Phalanger gymnotis</i>	Ground Cuscus	LC					X	X			X	X	X	X
Phalangeridae	<i>Phalanger mimicus</i>	Southern Common Cuscus	LC					X	X				X	X	
Phalangeridae	<i>Spilocuscus maculatus</i>	Common Spotted Cuscus	LC					X	X			X	X	X	X
Muridae	<i>Anisomys imitator</i>	Uneven-toothed Rat	LC								X	X			
Muridae	<i>Chiruromys vates</i>	Lesser Tree-mouse	LC					X						X	
Muridae	<i>Hydromys chrysogaster</i>	Common Water-rat	LC					X	X			X		X	
Muridae	<i>Melomys leucogaster</i>	White-bellied Melomys	LC					X	X			X	X	X	
Muridae	<i>Melomys rufescens</i>	Black-tailed Melomys	LC					X				X		X	
Muridae	<i>Paramelomys lorentzii</i>	Lorentz's Mosaic-tailed Rat	LC										X		
Muridae	<i>Paramelomys moncktoni</i>	Monckton's Mosaic-tailed Rat	LC										X		
Muridae	<i>Paramelomys cf. platyops</i>	Lowland Mosaic-tailed Rat	LC							X					
Muridae	<i>Paramelomys platyops</i>	Lowland Melomys	LC					X		X	X	X			
Muridae	<i>Pogonomys loriae</i>	Large Tree-mouse	LC									X			
Muridae	<i>Uromys caudimaculatus</i>	Mottled-tailed Giant-rat	LC					X	X	X	X	X		X	
Muridae	<i>Xenuromys barbatus</i>	Rock-dwelling Giant-rat	LC									X			
Muridae	<i>Rattus leucopus</i>	Cape York Rat	LC										X		
Emballonuridae	<i>Emballonura diana</i> [†]	Large-eared Sheath-tailed Bat	LC										X		
Emballonuridae	<i>Emballonura furax</i> [†]	New Guinea Sheath-tailed Bat	LC										X		
Emballonuridae	<i>Emballonura raffrayana</i> [†]	Raffray's Sheath-tailed Bat	LC										X		
Emballonuridae	<i>Mosia nigrescens</i> [†]	Lesser Sheath-tailed Bat	LC					X	X			X	X		
Hipposideridae	<i>Aselliscus tricuspidatus</i> [†]	Trident Leaf-nosed Bat	LC					X	X			X	X		
Hipposideridae	<i>Doryrhina corynophyllus</i> [†]	Telefomin Leaf-nosed Bat	LC					X	X						
Hipposideridae	<i>Doryrhina muscinus</i>	Fly River Leaf-nosed Bat	LC					X	X			X			

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Hipposideridae	<i>Hipposideros calcaratus</i> [†]	Spurred Leaf-nosed Bat	LC										X		
Hipposideridae	<i>Hipposideros cervinus</i> [†]	Fawn Leaf-nosed Bat	LC						X	X			X		
Hipposideridae	<i>Hipposideros diadema</i>	Diadem Leaf-nosed Bat	LC						X	X		X	X		
Hipposideridae	<i>Hipposideros maggietae</i> [†]	Maggie Taylor's Roundleaf Bat	LC									X	X		
Miniopteridae	<i>Miniopterus tristis grandis</i> [†]	Great Bent-winged Bat	LC							X			X		
Miniopteridae	<i>Miniopterus</i> sp. cf. <i>australis</i> "small" ^{††}		NE									X	X		
Pteropodidae	<i>Aproteles bulmerae</i> ^{*†}	Bulmer's Fruit Bat	CR	P											
Pteropodidae	<i>Dobsonia magna</i> [†]	New Guinea Naked-backed Fruit Bat	LC										X		
Pteropodidae	<i>Macroglossus minimus</i>	Dagger-toothed Long-nosed Fruit Bat	LC									X			
Pteropodidae	<i>Nyctimene albiventer</i>	Common Tube-nosed Fruit Bat	LC						X	X		X	X		
Pteropodidae	<i>Nyctimene draconilla</i>	Lesser Tube-nosed Bat	DD										X		
Pteropodidae	<i>Syconycteris australis</i>	Common Blossom Bat	LC						X	X		X	X		
Pteropodidae	<i>Paranyctimene raptor</i>	Lesser Tube-nosed Bat	LC						X	X					
Rhinolophidae	<i>Rhinolophus euryotis</i> [†]	New Guinea Broad-eared Horseshoe Bat	LC									X	X		
Rhinolophidae	<i>Rhinolophus mcintyre</i> [†]	McIntyre's Horseshoe Bat	DD									X	X		
Rhinolophidae	<i>Rhinolophus philippinensis</i> [†]	Large-eared Horseshoe Bat	LC			X						X	X		
Rhinolophidae	<i>Rhinolophus roberts</i> [†]	Greater Large-eared Horseshoe Bat	NE			X						X	X		
Vespertilionidae	<i>Phoniscus papuensis</i> ^{*†}	Golden-tipped Bat	VU												
Vespertilionidae	<i>Pipistrellus papuanus</i> [†]	Papuan Pipistrelle Bat	LC						X	X			X		
EXOTICS															
Canidae	<i>Canis familiaris</i>	Dog	NE							X					
Muridae	<i>Rattus rattus</i>	Black Rat	LC							X			X		
Muridae	<i>Rattus exulans</i>	Pacific Rat/Polynesian rat	LC									X	X		
Suidae	<i>Sus scrofa</i>	Pig	LC							X	X				
BIRDS															
Casuariidae	<i>Casuarus casuarus</i>	Southern Cassowary	LC						X	X			X	X	X
Casuariidae	<i>Casuarus bennetti</i>	Dwarf Cassowary	LC			X							X		
Anatidae	<i>Dendrocygna guttata</i>	Spotted Whistling Duck	LC						X						
Anatidae	<i>Aythya australis</i>	Hardhead	LC											X	
Megapodiidae	<i>Aepyodius arfakianus</i>	Wattled Brushturkey	LC			X							X		
Megapodiidae	<i>Talegalla fuscirostris</i>	Black-billed Brushturkey	LC						X	X	X		X	X	
Megapodiidae	<i>Megapodius reinwardt</i>	Orange-footed Scrubfowl	LC						X			X		X	X
Phasianidae	<i>Synoicus ypsilophorus</i>	Brown Quail	LC						X						
Caprimulgidae	<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	LC						X					X	
Podargidae	<i>Podargus ocellatus</i>	Marbled Frogmouth	LC						X						
Podargidae	<i>Podargus papuensis</i>	Papuan Frogmouth	LC						X	X				X	X
Hemiprocnidae	<i>Hemiprocne mystacea</i>	Moustached Treeswift	LC											X	
Apodidae	<i>Aerodramus vanikorensis</i>	Uniform Swiftlet	LC						X	X		X	X	X	
Apodidae	<i>Mearnsia novaeguineae</i>	Papuan Spinetail	LC											X	
Cuculidae	<i>Centropus menbeki</i>	Ivory-billed Coucal	LC						X	X	X	X	X	X	
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Coucal	LC							X				X	
Cuculidae	<i>Microdynamis parva</i>	Dwarf Koel	LC							X			X		
Cuculidae	<i>Cacomantis castaneiventris</i>	Chestnut-breasted Cuckoo	LC						X	X					
Cuculidae	<i>Cacomantis variolosus</i>	Sahul Brush Cuckoo	LC						X	X					
Columbidae	<i>Macropygia amboinensis</i>	Amboyna Cuckoo-Dove	LC						X	X		X	X		
Columbidae	<i>Macropygia mackinlayi</i>	Spot-breasted Cuckoo-Dove	LC											X	

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Columbidae	<i>Reinwardtoena reinwardti</i>	Great Cuckoo-Dove	LC					X	X		X	X	X		
Columbidae	<i>Chalcophaps stephani</i>	Stephan's Emerald Dove	LC					X	X				X		
Columbidae	<i>Trugon terrestris</i>	Thick-billed Ground Pigeon	LC							X					
Columbidae	<i>Gallicolumba rufigula</i>	Cinnamon Ground Dove	LC									X	X		
Columbidae	<i>Pampusana beccarii</i>	Bronze Ground Dove	LC											X	
Columbidae	<i>Otidiphaps nobilis</i>	Pheasant Pigeon	LC		X							X			
Columbidae	<i>Goura sclaterii</i>	Sclater's Crowned Pigeon	NT					X	X			X	X	X	
Columbidae	<i>Ptilinopus magnificus</i>	Wompoo Fruit Dove	LC					X	X				X		
Columbidae	<i>Ptilinopus perlatus</i>	Pink-spotted Fruit Dove	LC					X	X		X	X	X		
Columbidae	<i>Ptilinopus superbus</i>	Superb Fruit Dove	LC					X	X		X	X	X		
Columbidae	<i>Ptilinopus coronulatus</i>	Coroneted Fruit Dove	LC					X	X			X	X		
Columbidae	<i>Ptilinopus nainus</i>	Dwarf Fruit Dove	LC									X			
Columbidae	<i>Ducula rufigaster</i>	Purple-tailed Imperial Pigeon	LC					X				X			
Columbidae	<i>Ducula pinon</i>	Pinon's Imperial Pigeon	LC					X	X			X	X		
Columbidae	<i>Ducula mullerii</i>	Collared Imperial Pigeon	LC								X				
Columbidae	<i>Ducula zoeae</i>	Zoe's Imperial Pigeon	LC					X	X						
Columbidae	<i>Gymnophaps albertisii</i>	Papuan Mountain Pigeon	LC					X	X		X	X			
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	LC					X							
Rallidae	<i>Rallina tricolor</i>	Red-necked Crake	LC										X		
Rallidae	<i>Gymnocrex plumbeiventris</i>	Bare-eyed Rail	LC							X					
Charadriidae	<i>Charadrius dubius</i>	Little Ringed Plover	LC					X							
Ardeidae	<i>Nycticorax caledonicus</i>	Nankeen Night Heron	LC										X		
Ardeidae	<i>Zonerodius heliosylus</i>	Forest Bittern	NT					X							
Ardeidae	<i>Ardea plumifera</i>	Plumed Egret	LC	P				X					X		
Ardeidae	<i>Ardea sumatrana</i>	Great-billed Heron	LC					X					X		
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican	LC										X		
Accipitridae	<i>Henicopernis longicauda</i>	Long-tailed Honey Buzzard	LC					X	X				X		
Accipitridae	<i>Harpyopsis novaeguineae</i>	Papuan Eagle	VU	P				X			X	X			
Accipitridae	<i>Tachyspiza cirrocephala</i>	Collared Sparrowhawk	LC					X							
Accipitridae	<i>Tachyspiza poliocephala</i>	Grey-headed Goshawk	LC					X							
Accipitridae	<i>Tachyspiza hiogaster</i>	Variable Goshawk	LC					X							
Accipitridae	<i>Haliastur indus</i>	Brahminy Kite	LC					X					X		
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	LC					X							
Accipitridae	<i>Ichthyophaga leucogaster</i>	White-bellied Sea Eagle	LC										X		
Strigidae	<i>Ninox connivens</i>	Barking Owl	LC					X	X						
Strigidae	<i>Ninox theomacha</i>	Papuan Boobook	LC								X		X		
Bucerotidae	<i>Rhyticeros plicatus</i>	Blyth's Hornbill	LC					X				X	X	X	
Coraciidae	<i>Eurystomus orientalis</i>	Oriental Dollarbird	LC					X							
Alcedinidae	<i>Melidora macrorrhina</i>	Hook-billed Kingfisher	LC					X	X			X	X		
Alcedinidae	<i>Tanysiptera galatea</i>	Common Paradise Kingfisher	LC						X						
Alcedinidae	<i>Tanysiptera sylvia</i>	Buff-breasted Paradise Kingfisher	LC					X	X						
Alcedinidae	<i>Dacelo gaudichaud</i>	Rufous-bellied Kookaburra	LC					X	X		X	X	X	X	
Alcedinidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	LC					X		X	X	X	X		
Alcedinidae	<i>Syma torotoro</i>	Yellow-billed Kingfisher	LC					X	X			X	X		
Alcedinidae	<i>Ceyx solitarius</i>	Papuan Dwarf Kingfisher	LC											X	
Alcedinidae	<i>Ceyx azureus</i>	Azure Kingfisher	LC					X	X			X	X	X	
Alcedinidae	<i>Ceyx pusillus</i>	Little Kingfisher	LC										X		
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	LC					X					X		
Cacatuidae	<i>Probosciger aterrimus</i>	Palm Cockatoo	NT	P				X					X		

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	LC						X	X		X	X	X	
Psittaculidae	<i>Psitttrichas fulgidus</i>	Pesquet's Parrot	VU	P					X			X	X		
Psittaculidae	<i>Micropsitta keiensis</i>	Yellow-capped Pygmy Parrot	LC							X		X	X		
Psittaculidae	<i>Eclectus polychloros</i>	Papuan Eclectus	LC						X	X		X	X	X	
Psittaculidae	<i>Geoffroyus geoffroyi</i>	Red-cheeked Parrot	LC						X	X		X	X	X	X
Psittaculidae	<i>Hypocharmosyna placentis</i>	Red-flanked Lorikeet	LC						X	X		X	X		
Psittaculidae	<i>Lorius lory</i>	Black-capped Lory	LC						X			X	X	X	X
Psittaculidae	<i>Pseudeos fuscata</i>	Dusky Lory	LC						X	X		X	X	X	X
Psittaculidae	<i>Chalcopsitta scintillata</i>	Yellow-streaked Lory	LC						X	X				X	
Psittaculidae	<i>Trichoglossus haematodus</i>	Coconut Lorikeet	LC									X	X		
Psittaculidae	<i>Cyclopsitta melanogenia</i>	Dusky-cheeked Fig Parrot	LC						X	X		X	X	X	
Psittaculidae	<i>Cyclopsitta diophthalma</i>	Double-eyed Fig Parrot	LC											X	
Pittidae	<i>Erythropitta macklotii</i>	Papuan Pitta	LC											X	
Pittidae	<i>Pitta novaeguineae</i>	Eastern Hooded Pitta	LC						X			X		X	
Meliphagidae	<i>Conopophila albogularis</i>	Rufous-banded Honeyeater	LC											X	
Meliphagidae	<i>Melilestes mearghynchus</i>	Long-billed Honeyeater	LC							X		X	X		
Meliphagidae	<i>Myzomela obscura</i>	Dusky Myzomela	LC							X					
Meliphagidae	<i>Philemon meyeri</i>	Meyer's Friarbird	LC						X	X		X			
Meliphagidae	<i>Philemon buceroides</i>	Helmeted Friarbird	LC						X	X		X	X	X	
Meliphagidae	<i>Xanthotis flaviventer</i>	Tawny-breasted Honeyeater	LC						X	X		X	X		
Meliphagidae	<i>Meliphaga aruensis</i>	Puff-backed Honeyeater	LC						X	X					
Meliphagidae	<i>Microptilotis analogous</i>	Mimic Honeyeater	LC							X		X	X		
Meliphagidae	<i>Caligavis obscura</i>	Obscure Honeyeater	LC												X
Acanthizidae	<i>Origma murina</i>	Rusty Mouse-warbler	LC						X			X	X		
Acanthizidae	<i>Gerygone chrysogaster</i>	Yellow-bellied Gerygone	LC						X						
Acanthizidae	<i>Gerygone chloronota</i>	Green-backed Gerygone	LC							X					
Acanthizidae	<i>Gerygone magnirostris</i>	Large-billed Gerygone	LC							X		X			
Maluridae	<i>Chenorhamphus campbelli</i> *	Campbell's Fairywren	NE				X								
Pomatostomidae	<i>Garritornis isidorei</i>	Papuan Babbler	LC						X					X	
Melanocharitidae	<i>Melanocharis arfakiana</i>	Obscure Berrypecker	LC			X						X	X		
Melanocharitidae	<i>Oedistoma iliolophus</i>	Spectacled Longbill	LC							X					
Melanocharitidae	<i>Toxorhamphus novaeguineae</i>	Yellow-bellied Longbill	LC												X
Cinclosomatidae	<i>Ptilorrhoa caeruleascens</i>	Blue Jewel-babbler	LC						X	X		X	X		
Cinclosomatidae	<i>Ptilorrhoa castanonota</i>	Chestnut-backed Jewel-babbler	LC			X							X		
Acanthizidae	<i>Machaerirhynchus flaviventer</i>	Yellow-breasted Boatbill	LC									X	X		
Artamidae	<i>Peltops blainvillii</i>	Lowland Peltops	LC						X						
Artamidae	<i>Melloria quoyi</i>	Black Butcherbird	LC						X	X		X	X		
Artamidae	<i>Cracticus cassicus</i>	Hooded Butcherbird	LC						X	X				X	X
Campephagidae	<i>Coracina lineata</i>	Barred Cuckooshrike	LC							X		X	X		
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckooshrike	LC						X				X		
Campephagidae	<i>Coracina papuensis</i>	White-bellied Cuckooshrike	LC						X			X	X	X	
Campephagidae	<i>Edolisoma melas</i>	Black Cicadabird	LC						X	X			X		
Campephagidae	<i>Lalage leucomela</i>	Varied Triller	LC						X	X		X	X		
Pachycephalidae	<i>Pseudorectes ferrugineus</i>	Rusty Pitohui	LC							X		X	X		
Pachycephalidae	<i>Colluricincla megarhyncha</i>	Arafura Shrikethrush	LC						X	X		X	X		

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Pachycephalidae	<i>Pitohui uropygialis</i>	Southern Variable Pitohui	LC									X	X		
Oriolidae	<i>Oriolus szalayi</i>	Brown Oriole	LC					X							
Dicruridae	<i>Dicrurus bracteatus</i>	Spangled Drongo	LC					X	X		X	X	X		
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	LC											X	
Rhipiduridae	<i>Rhipidura threnothorax</i>	Sooty Thicket Fantail	LC						X		X				
Monarchidae	<i>Symposiachrus guttula</i>	Spot-winged Monarch	LC					X	X		X	X			X
Monarchidae	<i>Carterornis chrysomela</i>	Golden Monarch	LC					X	X		X	X			
Monarchidae	<i>Arses telescopthalmus</i>	Frisled Monarch	LC					X	X		X	X	X	X	
Monarchidae	<i>Myiagra rubecula</i>	Leaden Flycatcher	LC											X	
Corvidae	<i>Corvus tristis</i>	Grey Crow	LC					X			X				
Paradisaeidae	<i>Manucodia ater</i>	Glossy-mantled Manucode	LC	P				X	X					X	
Paradisaeidae	<i>Ptiloris magnificus</i>	Magnificent Riflebird	LC	P										X	
Paradisaeidae	<i>Cicinnurus regius</i>	King Bird-of-paradise	LC	P				X	X		X	X	X	X	X
Paradisaeidae	<i>Paradisaea raggiana</i>	Raggiana Bird-of-paradise	LC	P				X	X		X	X	X		
Paradisaeidae	<i>Paradisaea apoda</i> *	Greater Bird-of-paradise	LC	P											
Petroicidae	<i>Poecilodryas hypoleuca</i>	Black-sided Robin	LC					X			X	X			
Hirundinidae	<i>Hirundo javanica</i>	Pacific Swallow	LC											X	
Hirundinidae	<i>Cecropis daurica</i>	Eastern Red-rumped Swallow	LC					X							
Sturnidae	<i>Aplonis metallica</i>	Metallic Starling	LC						X			X	X		
Sturnidae	<i>Aplonis cantoroides</i>	Singing Starling	LC					X							
Sturnidae	<i>Mino dumontii</i>	Yellow-faced Myna	LC					X	X		X	X	X		
Dicaeidae	<i>Dicaeum geelvinkianum</i>	Red-capped Flowerpecker	LC						X		X	X			
Nectariniidae	<i>Leptocoma aspasia</i>	Black Sunbird	LC						X		X	X			
Nectariniidae	<i>Cinnyris frenatus</i>	Sahul Sunbird	LC											X	
Passeridae	<i>Passer montanus</i>	Eurasian Tree Sparrow	LC											X	
Locustellidae	<i>Poodytes albolimbatus</i> *	Fly River Grassbird	VU			X									
Estrildidae	<i>Lonchura stygia</i> *	Black Manakin	LC			X									
Estrildidae	<i>Neochmia phaeton</i>	Crimson Finch	LC											X	
FROGS															
Ceratobatrachidae	<i>Cornufer papuensis</i>		LC									X			
Dicroglossidae	<i>Limnonectes grunniens</i>		LC											X	X
Microhylidae	<i>Asterophrys slateri</i>		LC									X	X	X	
Microhylidae	<i>Asterophrys turpicola</i>	New Guinea Bush Frog	LC									X	X	X	X
Microhylidae	<i>Austrochaperina</i> sp. 1 (fast call)		NE		X								X		
Microhylidae	<i>Callulops marmoratus</i>		DD											X	
Microhylidae	<i>Callulops</i> sp.		NE									X	X		
Microhylidae	<i>Choerophryne</i> cf. <i>tuberculus</i>		NE		X								X		
Microhylidae	<i>Choerophryne</i> sp. 1 cf. <i>gracilirostris</i>		NE				N	X							
Microhylidae	<i>Copiula derongo</i>		LC									X	X		
Microhylidae	<i>Copiula lennarti</i>		LC			X		X	X		X	X			
Microhylidae	<i>Hylophorbus</i> sp. 1 (fast call)		NE			X	N	X	X		X	X	X*		
Microhylidae	<i>Hylophorbus</i> sp. 2 (slow call)		NE			X	U	X			X	X	X*	X	
Microhylidae	<i>Mantophryne lateralis</i>		LC								X	X	X		
Microhylidae	<i>Oreophryne oviprotector</i>		LC			X			X			X			
Microhylidae	<i>Oreophryne pseudunicolor</i>		LC			X		X	X			X			
Microhylidae	<i>Oreophryne</i> sp. 1		NE			X	U	X	X		X	X			
Microhylidae	<i>Sphenophryne</i> cf. <i>cornuta</i>		NE				U	X	X		X	X			
Microhylidae	<i>Sphenophryne schlaginhaufeni</i>		LC								X	X			
Microhylidae	<i>Xenorhina lacrimosa</i>		NE								X				

Family	Scientific Name ^A	Common Name	Conservation Significance ^B					Sites Recorded ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Microhylidae	<i>Xenorhina cf. pohleorum</i>		NE				U	X							
Microhylidae	<i>Xenorhina tillacki</i>		LC										X		
Pelodryadidae	<i>Amnihyla cf. arfakiana</i>		NE				U					X			
Pelodryadidae	<i>Amnihyla longicrus</i>		DD									X			
Pelodryadidae	<i>Chlorohyla auae</i>		LC										X	X	
Pelodryadidae	<i>Colleeneremia pygmaea</i>		LC												
Pelodryadidae	<i>Exochohyla prora</i>		LC										X		
Pelodryadidae	<i>Ischnohyla gracilis</i>		NE									X			
Pelodryadidae	<i>Kallistobatrachus majikthise</i>		LC		X	X						X			
Pelodryadidae	<i>Litoria nasuta</i>		LC										X		
Pelodryadidae	<i>Mahonabatrachus timidus</i>		LC			X						X		X	
Pelodryadidae	<i>Pengilleyia amboinensis</i>		LC											X	
Pelodryadidae	<i>Sandyrana infrafronata</i>	White-lipped Treefrog	LC						X				X	X	
Pelodryadidae	<i>Sandyrana pallidofemora</i>		LC			X		X	X		X	X			
Pelodryadidae	<i>Sandyrana sanguinolenta</i>	Sabang Treefrog	LC					X	X		X	X			
Pelodryadidae	<i>Spicicalyx eucnemis</i>	Fringed Treefrog	LC					X				X	X	X	
Pelodryadidae	<i>Spicicalyx</i> sp. 1 cf. <i>genimaculata</i>		NE			X	U	X				X	X	X	
Ranidae	<i>Hylarana cf. grisea</i>		NE				?		X		X	X	X	X	
Ranidae	<i>Hylarana daemeli</i>	Wood Frog	LC						X			X	X		
Ranidae	<i>Hylarana novaeguineae</i>		LC						X					X	
EXOTIC AMPHIBIANS															
Bufonidae	<i>Rhinella marina</i>	Cane Toad	LC					X							
REPTILES															
Agamidae	<i>Hypsilurus magnus</i>		LC								X				
Agamidae	<i>Hypsilurus modestus</i>	Modest Forest Dragon	LC						X			X			
Agamidae	<i>Lophosaurus dilophus</i>	Crowned Forest Dragon	LC										X	X	
Gekkonidae	<i>Cyrtodactylus capreoloides</i>		LC									X			
Geckonidae	<i>Cyrtodactylus derongo*</i>		DD			X									
Gekkonidae	<i>Cyrtodactylus papuensis</i>		LC								X		X		
Gekkonidae	<i>Cyrtodactylus serratus</i>		LC									X			
Gekkonidae	<i>Gehyra baliola</i>	Short-tailed Dtella	LC						X						
Gekkonidae	<i>Gehyra</i> sp.		NE										X		
Gekkonidae	<i>Nactus</i> sp.		NE								X				
Scincidae	<i>Carlia diguliensis</i>	Digul River Rainbow Skink	LC					X					X		
Scincidae	<i>Emoia caeruleocauda</i>	Pacific Bluetail Skink	LC						X						
Scincidae	<i>Emoia kordoana</i>	Slender Tree Skink	LC						X						
Scincidae	<i>Emoia longicauda</i>		LC								X				
Scincidae	<i>Emoia</i> sp. (strongly keeled)		NE									X			
Scincidae	<i>Eugongylus rufescens</i>	Unicolor Recluse Skink	LC						X						
Scincidae	<i>Sphenomorphus meyeri</i>		LC								X		X		
Scincidae	<i>Sphenomorphus simus</i>		LC								X	X			
Scincidae	<i>Sphenomorphus</i> sp. 1.		NE									X			
Varanidae	<i>Varanus indicus</i>		LC										X		
Varanidae	<i>Varanus salvadori</i>		LC										X		
Boidae	<i>Candoia aspera</i>	New Guinea Ground Boa	LC					X	X						
Elapidae	<i>Toxicocalamus</i> sp.		NE									X			
Colubridae	<i>Boiga irregularis</i>	Brown Tree Snake	LC					X	X		X		X		
Colubridae	<i>Stegonotus</i> sp.	Ground Snake	NE						X				X		
Colubridae	<i>Tropidonophis multiscutellatus</i>		NE										X		
Colubridae	<i>Tropidonophis</i> sp.	Keelback Snake	NE									X			
Pythonidae	<i>Leiopython fredparkeri</i>	White-lipped Python	LC						X						
Trionychidae	<i>Pelochelys bibroni</i>	Southern New Guinea Giant Softshell Turtle	VU								X		X		
Carettocheylidae	<i>Carettochelys insculpta*</i>		EN												

FAMILY	SCIENTIFIC NAME ^A	COMMON NAME	CONSERVATION SIGNIFICANCE ^B					SITES RECORDED ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Chelidae	<i>Chelodina parkeri</i> *		NT												
Chelidae	<i>Chelodina reimanni</i> *		NT												
Chelidae	<i>Emydura subglobosa</i>	Red-bellied Short-necked Turtle	LC									X			
Crocodylidae	<i>Crocodylus novaeguineae</i>	New Guinea Freshwater Crocodile	LC									X		X	
DAMSELFIES															
Argiolestidae	<i>Argiolestes muller</i>		DD						X					X	
Argiolestidae	<i>Metagrion furcatum</i>		NE									X	X		
Argiolestidae	<i>Metagrion cf. pseudolamprostoma</i>		NE											X	
Argiolestidae	<i>Podopteryx roseonotata</i>		DD							X				X	
Calopterygidae	<i>Neurobasis australis</i>		LC										X		
Calopterygidae	<i>Rhinocypha tincta</i>		LC						X	X		X	X		
Coenagrionidae	<i>Agriocnemis femina</i>		LC							X					
Coenagrionidae	<i>Agriocnemis rubescens</i>		LC							X					
Coenagrionidae	<i>Papuagrion magnanimum</i>		LC						X					X	
Coenagrionidae	<i>Papuagrion occipitale</i>		LC											X	
Coenagrionidae	<i>Papuagrion sp. (short legs)</i>		NE		?									X	
Coenagrionidae	<i>Pseudagrion ignifer</i>		LC							X					
Coenagrionidae	<i>Pseudagrion parafarinicollae</i> *		DD		?	X									
Coenagrionidae	<i>Teinobasis cuneata</i> *		DD		X	X									
Coenagrionidae	<i>Teinobasis flavolineata</i> *		DD		X	X									
Coenagrionidae	<i>Teinobasis scintillans</i>		LC						X					X	
Coenagrionidae	<i>Teinobasis sp. 1 (long, slender)</i>		NE			X	N	X				X	X		
Coenagrionidae	<i>Teinobasis sp. 2 (yellow)</i>		NE		?	X	N					X			
Isostictidae	<i>Selysionura servicornu</i>		NE											X	
Platycnemididae	<i>Idiocnemis schorri</i> *		DD		X	X									
Platycnemididae	<i>Idiocnemis cf. australis</i>		NE						X	X		X	X		
Platycnemididae	<i>Idiocnemis sp. 1</i>		NE					U	X	X				X	
Platycnemididae	<i>Nososticta marina</i> *		DD			X									
Platycnemididae	<i>Nososticta nigrifrons</i>		LC									X			
Platycnemididae	<i>Nososticta oculata</i> *		DD		X	X									
Platycnemididae	<i>Nososticta ovimacula</i>		DD			X			X	X					
Platycnemididae	<i>Nososticta paraconifera</i> *		DD			X									
Platycnemididae	<i>Nososticta rangifera</i>		DD			X			X	X		?			
Platycnemididae	<i>Nososticta sp. 1</i>		NE			X	N			X					
Platycnemididae	<i>Papuargia brevistigma</i> *		DD		?	X									
Platycnemididae	<i>Palaargia sp. 1</i>		NE		X	X	N							X	
Platycnemididae	<i>Papuargia sp. 1</i>		NE		X	X	N							X	
Platycnemididae	<i>Drepanosticta sp.</i>		NE		?							X			
DRAGONFLIES															
Aeshnidae	<i>Agyrtacantha dirupta</i>		LC						X	X					
Corduliidae	<i>Hemicordulia continentalis</i>		LC									X	X		0
Libellulidae	<i>Agrioptera longitudinalis</i>		LC							X					
Libellulidae	<i>Diplacina anthaxia</i>		LC							X					
Libellulidae	<i>Diplacina cyrene</i> *		DD												
Libellulidae	<i>Diplacina sp.</i>		NE											X	
Libellulidae	<i>Huonia epinephela</i>		LC											X	
Libellulidae	<i>Hydrobasileus brevistylus</i>		LC							X		X			
Libellulidae	<i>Lyriothemis hirundo</i>		LC		?									X	
Libellulidae	<i>Lyriothemis meyeri</i>		LC						X						
Libellulidae	<i>Nannophlebia amphyccillis</i>		LC											X	
Libellulidae	<i>Nannophlebia sp. 1</i>		NE		?									X	
Libellulidae	<i>Nannophya pygmaea</i>		LC							X					
Libellulidae	<i>Nesoxenia mysis</i>		LC						X	X					

FAMILY	SCIENTIFIC NAME ^A	COMMON NAME	CONSERVATION SIGNIFICANCE ^B					SITES RECORDED ^C							
			I	P	U	R	N	1	2	3	4	5	B	O	
Libellulidae	<i>Neurothemis stigmatizans</i>		LC					X	X						
Libellulidae	<i>Orthetrum glaucum</i>		LC									X			
Libellulidae	<i>Orthetrum serapia</i>		LC					X	X						
Libellulidae	<i>Orthetrum villosovittatum</i>		LC					X	X		X	X			
Libellulidae	<i>Pantala flavescens</i>		LC					X	X						
Libellulidae	<i>Protorthemis coronata</i>		LC					X	X						
Libellulidae	<i>Rhyothemis hurleyi</i> *		DD												
Libellulidae	<i>Rhyothemis princeps</i>		LC					X	X		X	X			
Libellulidae	<i>Rhyothemis resplendens</i>		LC						X						
Libellulidae	<i>Tetrathemis irregularis</i>		LC						X						
Libellulidae	<i>Tramea eurybia</i>		LC						X			X			
Libellulidae	<i>Zyxomma elgneri</i>		LC					X	X						
Macromiidae	<i>Macromia eurynome</i> *		DD												
Macromiidae	<i>Macromia melpomene</i>		LC		X							X			
Macromiidae	<i>Macromia viridescens</i>		LC						X						
Sythemistidae	<i>Palaeosynthemis</i> sp.		NE								X	X			

A: Species with an asterisk are possibilities only.

B: I - IUCN status; P – protected nationally; U – upland species, R restricted range; N New to science (N = new species, U = undescribed).

C: 1 to 5 – Sites 1 to 5 (Sagata and Richards 2026), B – Bige (BMT WBM 2016), TSF site (BMT WBM 2015).

†: Cave rooster.