



Attachment 1

Reconciliation with Relevant State of Papua New Guinea Guidelines

DISCLAIMER

This disclaimer applies to and governs the disclosure and use of this Environmental Impact Statement ("EIS"), and by reading, using or relying on any part(s) of the EIS you accept this disclaimer in full.

This Environmental Impact Statement, including the Executive Summary, and all chapters of and attachments and appendices to it and all drawings, plans, models, designs, specifications, reports, photographs, surveys, calculations and other data and information in any format contained and/or referenced in it, is together with this disclaimer referred to as the "**EIS**".

Purpose of EIS

The EIS has been prepared by, for and on behalf of Wafi Mining Limited and Newcrest PNG 2 Limited (together the "**WGJV Participants**"), being the participants in the Wafi-Golpu Joint Venture ("**WGJV**") and the registered holders of exploration licences EL 440 and EL1105, for the sole purpose of an application (the "**Permit Application**") by them for environmental approval under the Environment Act 2000 (the "**Act**") for the proposed construction, operation and (ultimately) closure of an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (the "**Project**") in Morobe Province, Independent State of Papua New Guinea. The EIS was prepared with input from consultants engaged by the WGJV Participants and/or their related bodies corporate ("**Consultants**").

The Permit Application is to be lodged with the Conservation and Environment Protection Authority ("**CEPA**"), Independent State of Papua New Guinea.

Ownership and Copyright

The EIS is the sole property of the WGJV Participants, who reserve and assert all proprietary and copyright ©2018 interests.

Reliance and Use

The EIS is intended and will be made available to CEPA, for review by CEPA and other applicable agencies of the Government of the Independent State of Papua New Guinea ("**Authorised Agencies**"), for the purpose of considering and assessing the Permit Application in accordance with the Act ("**Authorised Purpose**"), and for no other purpose whatsoever.

The EIS shall not be used or relied upon for any purpose other than the Authorised Purpose, unless express written approval is given in advance by the WGJV Participants.

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This disclaimer must accompany every copy of the EIS.

The EIS is meant to be read as a whole, and any part of it should not be read or relied upon out of context.

Limits on investigation and information

The EIS is based in part on information not within the control of either the WGJV Participants or the Consultants. While the WGJV Participants and Consultants believe that the information contained in the EIS should be reliable under the conditions and subject to the limitations set forth in the EIS, they do not guarantee the accuracy of that information.

No Representations or Warranties

While the WGJV Participants, their Related Bodies Corporate and Consultants believe that the information (including any opinions, forecasts or projections) contained in the EIS should be reliable under the conditions and subject to the limitations set out therein, and provide such information in good faith, they make no warranty, guarantee or promise, express or implied, that any of the information will be correct, accurate, complete or up to date, nor that such information will remain unchanged after the date of issue of the EIS to CEPA, nor that any forecasts or projections will be realised. Actual outcomes may vary materially and adversely from projected outcomes.

The use of the EIS shall be at the user's sole risk absolutely and in all respects. Without limitation to the foregoing, and to the maximum extent permitted by applicable law, the WGJV Participants, their Related Bodies Corporate and Consultants:

- do not accept any responsibility, and disclaim all liability whatsoever, for any loss, cost, expense or damage (howsoever arising, including in contract, tort (including negligence) and for breach of statutory duty) that any person or entity may suffer or incur caused by or resulting from any use of or reliance on the EIS or the information contained therein, or any inaccuracies, misstatements, misrepresentations, errors or omissions in its content, or on any other document or information supplied by the WGJV Participants to any Authorised Agency at any time in connection with the Authorised Agency's review of the EIS; and
- expressly disclaim any liability for any consequential, special, contingent or penal damages whatsoever.

The basis of the Consultants' engagement is that the Consultants' liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of their engagement with the WGJV Participants and/or their related bodies corporate.

Disclosure for Authorised Purpose

The WGJV Participants acknowledge and agree that, for the Authorised Purpose, the EIS may be:

- copied, reproduced and reprinted;
- published or disclosed in whole or in part, including being made available to the general public in accordance with section 55 of the Act. All publications and disclosures are subject to this disclaimer.

Development of Project subject to Approvals, Further Studies and Market and Operating Conditions

Any future development of the Project is subject to further studies, completion of statutory processes, receipt of all necessary or desirable Papua New Guinea Government and WGJV Participant approvals, and market and operating conditions.

Engineering design and other studies are continuing and aspects of the proposed Project design and timetable may change.

NEWCREST MINING LIMITED DISCLAIMER

Newcrest Mining Limited ("**Newcrest**") is the ultimate holding company of Newcrest PNG 2 Limited and any reference below to "Newcrest" or the "Company" includes both Newcrest Mining Limited and Newcrest PNG 2 Limited.

Forward Looking Statements

The EIS includes forward looking statements. Forward looking statements can generally be identified by the use of words such as "may", "will", "expect", "intend", "plan", "estimate", "anticipate", "continue", "outlook" and "guidance", or other similar words and may include, without limitation, statements regarding plans, strategies and objectives of management, anticipated production or construction commencement dates and expected costs or production outputs. The Company continues to distinguish between outlook and guidance. Guidance statements relate to the current financial year. Outlook statements relate to years subsequent to the current financial year.

Forward looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the Company's actual results, performance and achievements to differ materially from statements in this EIS. Relevant factors may include, but are not limited to, changes in commodity prices, foreign exchange fluctuations and general economic conditions, increased costs and demand for production inputs, the speculative nature of exploration and project development, including the risks of obtaining necessary licences and permits and diminishing quantities or grades of reserves, political and social risks, changes to the regulatory framework within which the Company operates or may in the future operate, environmental conditions including extreme weather conditions, recruitment and retention of personnel, industrial relations issues and litigation.

Forward looking statements are based on the Company's good faith assumptions as to the financial, market, regulatory and other relevant environments that will exist and affect the Company's business and operations in the future.

The Company does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of the Company. Readers are cautioned not to place undue reliance on forward looking statements. Forward looking statements in the EIS speak only at the date of issue. Except as required by applicable laws or regulations, the Company does not undertake any obligation to publicly update or revise any of the forward looking statements or to advise of any change in assumptions on which any such statement is based.

Non-IFRS Financial Information

Newcrest results are reported under International Financial Reporting Standards (IFRS) including EBIT and EBITDA. The EIS also includes non-IFRS information including Underlying profit (profit after tax before significant items attributable to owners of the parent company), All-In Sustaining Cost (determined in accordance with the World Gold Council Guidance Note on Non-GAAP Metrics released June 2013), AISC Margin (realised gold price less AISC per ounce sold (where expressed as USD), or realised gold price less AISC per ounce sold divided by realised gold price (where expressed as a %), Interest Coverage Ratio (EBITDA/Interest payable for the relevant period), Free cash flow (cash flow from operating activities less cash flow related to investing activities), EBITDA margin (EBITDA expressed as a percentage of revenue) and EBIT margin (EBIT expressed as a percentage of revenue). These measures are used internally by Management to assess the performance of the business and make decisions on the allocation of resources and are included in the EIS to provide greater understanding of the underlying performance of Newcrest's operations. The non-IFRS information has not been subject to audit or review by Newcrest's external auditor and should be used in addition to IFRS information.

Ore Reserves and Mineral Resources Reporting Requirements

As an Australian Company with securities listed on the Australian Securities Exchange (ASX), Newcrest is subject to Australian disclosure requirements and standards, including the requirements of the Corporations Act 2001 and the ASX. Investors should note that it is a requirement of the ASX listing rules that the reporting of Ore Reserves and Mineral Resources in Australia comply with the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) and that Newcrest's Ore Reserve and Mineral Resource estimates comply with the JORC Code.

Competent Person's Statement

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

HARMONY GOLD MINING COMPANY LIMITED DISCLAIMER

Harmony Gold Mining Company Limited ("**Harmony**") is the ultimate holding company of Wafi Mining Limited and any reference below to "Harmony" or the "Company" includes both Harmony Gold Mining Company Limited and Wafi Mining Limited.

Forward Looking Statements

These materials contain forward-looking statements within the meaning of the safe harbor provided by Section 21E of the Securities Exchange Act of 1934, as amended, and Section 27A of the Securities Act of 1933, as amended, with respect to our financial condition, results of operations, business strategies, operating efficiencies, competitive positions, growth opportunities for existing services, plans and objectives of management, markets for stock and other matters. These include all statements other than statements of historical fact, including, without limitation, any statements preceded by, followed by, or that include the words "targets", "believes", "expects", "aims", "intends", "will", "may", "anticipates", "would", "should", "could", "estimates", "forecast", "predict", "continue" or similar expressions or the negative thereof.

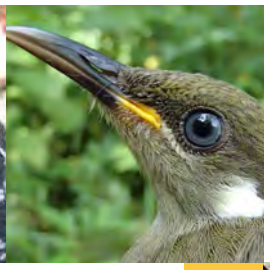
These forward-looking statements, including, among others, those relating to our future business prospects, revenues and income, wherever they may occur in this EIS and the exhibits to this EIS, are essentially estimates reflecting the best judgment of our senior management and involve a number of risks and uncertainties that could cause actual results to differ materially from those suggested by the forward-looking statements. As a consequence, these forward-looking statements should be considered in light of various important factors, including those set forth in these materials. Important factors that could cause actual results to differ materially from estimates or projections contained in the forward-looking statements include, without limitation: overall economic and business conditions in South Africa, Papua New Guinea, Australia and elsewhere, estimates of future earnings, and the sensitivity of earnings to the gold and other metals prices, estimates of future gold and other metals production and sales, estimates of future cash costs, estimates of future cash flows, and the sensitivity of cash flows to the gold and other metals prices, statements regarding future debt repayments, estimates of future capital expenditures, the success of our business strategy, development activities and other initiatives, estimates of reserves statements regarding future exploration results and the replacement of reserves, the ability to achieve anticipated efficiencies and other cost savings in connection with past and future acquisitions, fluctuations in the market price of gold, the occurrence of hazards associated with underground and surface gold mining, the occurrence of labour disruptions, power cost increases as well as power stoppages, fluctuations and usage constraints, supply chain shortages and increases in the prices of production imports, availability, terms and deployment of capital, changes in government regulation, particularly mining rights and environmental regulation, fluctuations in exchange rates, the adequacy of the Group's insurance coverage and socio-economic or political instability in South Africa and Papua New Guinea and other countries in which we operate.

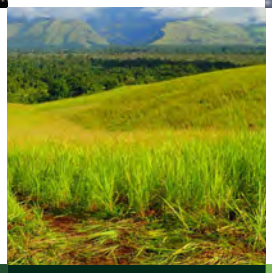
For a more detailed discussion of such risks and other factors (such as availability of credit or other sources of financing), see the Company's latest Integrated Annual Report and Form 20-F which is on file with the Securities and Exchange Commission, as well as the Company's other Securities and Exchange Commission filings. The Company undertakes no obligation to update publicly or release any revisions to these forward-looking statements to reflect events or circumstances after the date of this EIS or to reflect the occurrence of unanticipated events, except as required by law.

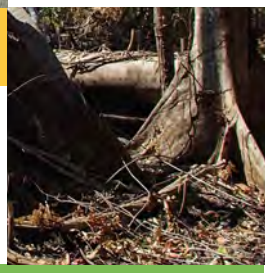
Competent Person's Statement

The Wafi-Golpu Joint Venture is an unincorporated joint venture between a wholly-owned subsidiary of Harmony Gold Mining Company Limited and a wholly-owned subsidiary of Newcrest Mining Limited.

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/ or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.







Reconciliation with Relevant State of Papua New Guinea Guidelines

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This attachment provides a reconciliation between the contents of the Wafi-Golpu Project (Project) Environmental Inception Report (EIR) and Environmental Impact Statement (EIS) with relevant guidelines prepared by the State of Papua New Guinea (PNG).

Reconciliation between the Project EIR and EIS and the *Guideline for Preparation of Environmental Inception Report DEC, January 2004* and the *PNG Government Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement DEC, January 2004*, are presented in Table 2.1 and Table 3.1.

Preparation of the EIS also considered the Draft General Guidelines for DSTP in PNG (SAMS, 2010), as did the siting and design of the Project's DSTP Outfall System. Table 4.1 presents the reconciliation of these draft guidelines with the information presented in this EIS.

2. RECONCILIATION OF ENVIRONMENTAL INCEPTION REPORT WITH STATE OF PAPUA NEW GUINEA ENVIRONMENTAL INCEPTION REPORT GUIDELINES

Table 2.1 demonstrates that the Wafi-Golpu Project EIR addresses the requirements set out in the *Guideline for Preparation of Environmental Inception Report DEC, January 2004*. The EIR was submitted on 28 April 2017 and approved by the Conservation and Environment Protection Authority (CEPA) on 8 June 2017.

Table 2.1: Reconciliation with State of PNG EIR Guidelines

PNG Government EIR Guideline Requirement (DEC, 2004)	Response in the Wafi-Golpu Project EIR
1. Introduction	Section 1 - Introduction
2. Purpose of the Development	Section 2 - Purpose of the Development
3. Viability of the Project	Section 3 - Viability of the Project
4. Description of the Proposed Development	Section 4 - Description of the Proposed Development
5. Development Timetable	Section 5 - Permitting and Development Timetable
6. Bio-physical Environmental Issues	Section 6 - Terrestrial Biophysical Environment Section 7 - Marine Biophysical Environment
7. Socioeconomic Issues	Section 8 - Socioeconomics and Cultural Heritage Section 9 - Stakeholder Engagement
8. Availability of Baseline Information/Data	Section 10 - Availability of Baseline Information / Data
9. Site Selection	Section 1.3 - Project Background Section 1.5 - Alternative Project Options and Designs
10. Qualification of Environmental Consultants	Section 11 - Project Team

3. RECONCILIATION OF ENVIRONMENTAL IMPACT STATEMENT WITH STATE OF PAPUA NEW GUINEA ENVIRONMENTAL IMPACT STATEMENT GUIDELINES

Table 3.1 demonstrates that the Wafi-Golpu Project EIS addresses the requirements set out in the *Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement DEC, January 2004*.

Table 3.1: Reconciliation with State of PNG EIS Guidelines

PNG Government EIS Guideline Requirement	Response in the Wafi-Golpu Project EIS
Letter of transmittal or cover letter It is important that an Environmental Impact Statement on the proposal must be transmitted to DEC [now CEPA] with a cover letter signed by the responsible company official or its authorised representative (i.e., consultant - engaged by the company to act on its behalf). If an external consultant is used, the letter must also authorise the consultant to make statements and provide further information on behalf of the company in relation to the application.	Cover letter
1. Executive summary or overview of proposal One of the main objectives of this section is to provide an explanation of the Project for non-technical readers. Information provided in the Executive Summary shall concisely describe: • The proposed development activity and its objectives • Anticipated bio-physical and socio-economic impacts (direct/indirect, reversible/irreversible) of the activity • Details of remedial actions that are proposed • All benefits to be derived from the project • Details of consultation program undertaken by the applicant, including degree of public interest • Rehabilitation and/or end-use plans for the development activity in relation to community needs	Executive Summary
2. Purpose of the Development The purpose of this section is to ensure that only development activities that are in the best interest of all Papua New Guineans, and therefore in line with the PNG Government's overall development strategy and planning guidelines, are considered for approval. NOTE: Demonstrate commitment to the conservation of natural ecosystems and protection of environmental values within the proposed development area. This section shall include but not be limited to the following: • Describe if the development is in line with the Fourth National Goal and Directive Principle of the National Constitution of PNG • Explain if the proposed development is compatible with National, Provincial and Local Level Government development goals and planning guidelines • Detail the economic benefits to the Nation, Province, Local Level Governments and to the local community being impacted	Chapter 2
3. Viability of the Project Provide information on the viability of the proposed development activity. These details shall include but not be limited to the following: • Information on the capital cost associated with the development • Details of the proponent's technological expertise and resources • Results of any feasibility investigations that have been carried out	Chapter 1 Chapter 2 Chapter 5 Chapter 6 Chapter 7

PNG Government EIS Guideline Requirement	Response in the Wafi-Golpu Project EIS
• Information on the extent of landowner and/or resource owner support, including a copy of the formal written approval of their consent • Details of the life-span and development phases of the project	
4. Description of the Proposed Development Activity All details on the proposed development activity required under this section should be provided where applicable to the proposal. Details to be provided under this section may include the following: • Background information to the proposal, process technologies to be employed, etc. • Detailed location maps (drawn to scale), site layout, etc. • Information on method of site selection including alternatives investigated, plant or building designs, relevant diagrams and drawings • Detailed flowcharts, mass balances (including feedstocks, products and wastes generated, etc.) • Description of nearby development activities that may contribute to background pollution levels or other baseline conditions • Information on associated infrastructure/facilities to be constructed	Chapter 6 Chapter 7
5. Development Timetable Information on the development timetable provided under this section should be clear and easy for DEC [now CEPA] to understand the different phases in the development proposal. For reasons of clarity, a flow chart, Gantt or PERT chart should be used where appropriate. Information provided in this section shall include but not be limited to the following: • Information on funding arrangements for proposed activity or if availability of funds subject to this or other approvals being granted • Details of preconstruction activities • Information on consultation program with all affected parties (i.e., parties that may be directly and indirectly affected) • Details of construction schedule, staging, etc. • Details of commissioning and operational schedules • Details of infrastructure development schedule • Details of closure and rehabilitation schedule	Chapter 1 Chapter 2 Chapter 5 Chapter 6
6. Characteristics of the Receiving Environment Available Environmental Studies & Investigations: • Historic or current baseline data on physical, biological and social systems • Written estimate of research and/or study time already expended and to be undertaken	Chapter 8 Chapter 9 Chapter 10 Chapter 11 Chapter 12 Chapter 13 Appendix A, B, C, D, E, F, G, H, K, M, O, P, Q, R, S, T, U

PNG Government EIS Guideline Requirement	Response in the Wafi-Golpu Project EIS
Physical Environment: • Geomorphological, topographical and geological characteristics • Any natural or induced hazard in the area (e.g., flood, earthquake, volcanic zone etc.) • Climatic regime (e.g., rainfall, temperature) • Air quality and meteorological data set for air dispersion modelling, etc. • Seasonal surface water quality and hydrological information • Seasonal ground water quality and flow regime • Noise levels	Chapter 8 Chapter 9 Chapter 10 Chapter 11 Appendix A, B, E, F, M, O
Biological environment: • Presence of a protected area Conservation Area or Wildlife Management Area, if any • Details of any special purpose areas (e.g., wetland area, etc.) • Aquatic and terrestrial ecology of the area • Information on vulnerable (endangered) species • Other relevant biological information	Chapter 8 Chapter 9 Chapter 10 Chapter 11 Appendix C, D, G, H, K, M, O, P, Q, R, S
Social environment: • Demographic information • Information on existing infrastructure • Information on public health issues (if applicable) • Information on present economic status of the project area • Description of existing social services • Details of archaeological, historical, cultural or religious features of the project area	Chapter 12 Chapter 13 Appendix S, T, U, W
7. Potential impacts of the proposal • Details of predicted impacts of the proposal on the physical, biological and social environment • Details of ambient and emission standards used to assess project effects against, and later to be met in any discharge permit issued for the proposal • An assessment of resilience of the environment to cope with the expected changes • In assessing predicted impacts the applicant must cover aspects such as - worst case scenarios, potential risks, emergency situations, confidence of prediction of impact, etc.	Chapter 14 Chapter 15 Chapter 16 Chapter 17 Chapter 18 Chapter 19 Chapter 20 Chapter 21 Chapter 22 Appendix A, B, E, F, I, J, K, L, M, N, U, W, X, Y
8. Waste minimisation, cleaner production and energy balance • Details of other alternative “cleaner production” technologies or processes that has been considered • Information on the basis for choosing the proposed technology or process • Available technical background on the process chosen • Details of the Waste Minimisation Strategy developed for the proposal • Details of an “energy balance” for the proposal	Chapter 6

PNG Government EIS Guideline Requirement	Response in the Wafi-Golpu Project EIS
9. Environmental management, monitoring and reporting: • Details of information on plant operating conditions, including management and monitoring strategy • Information on socio-economic management and monitoring strategy • Mechanism and frequency for reporting monitoring results to DEC and other stakeholders, especially to directly affected stakeholder groups • Availability of contingency and/or emergency plans drawn up for the proposal • Details of Environment Improvement Plan • Details of Waste Minimisation and/or Management Plans • Information on potential rehabilitation issues and its strategies including Rehabilitation Plan	Chapter 6 Chapter 14 Chapter 15 Chapter 16 Chapter 17 Chapter 18 Chapter 19 Chapter 20 Chapter 21 Chapter 23 Attachment 3 Attachment 4 Attachment 5 Attachment 6
10. Other statutory decisions Provide the draft or finalised Project Development Contract, Memorandum of Agreements or other similar legal decisions that are relevant to the proposal	In progress and a subject of separate consultations with relevant PNG government departments and agencies.
11. Confidential information	Noted
12. References	Chapters 1 to 24 include references relevant to each EIS chapter
13. Acknowledgements	Chapter 24
14. Study team Information on persons involved should be the same as those approved in the EIR	Chapter 24

4. RECONCILIATION WITH PAPUA NEW GUINEA DRAFT DEEP SEA TAILINGS PLACEMENT GUIDELINES

This section presents a reconciliation of the EIS with the *Draft General Guidelines and Criteria for mining operations in Papua New Guinea (PNG) involving Deep Sea Tailings Placement (DSTP).* Table 4.1 demonstrates how the Wafi-Golpu Project EIS addresses the SAMS Draft General Guidelines for DSTP in PNG (SAMS, 2010).

Table 4.1: Reconciliation between the Project EIS and the Draft General Guidelines for DSTP in PNG

Draft General Guidelines and Criteria	Wafi-Golpu Project EIS Studies and Scopes
1. Preamble	
These guidelines are general guidelines and a set of specific guidelines are required for each site being considered for DSTP taking into account local social and environmental conditions. These site-specific guidelines should be consistent with existing PNG legislation and regulations.	Noted. No site-specific guidelines were available for the Wafi-Golpu Project at the time of preparation of the EIS. On this basis, the WGJV has prepared the EIS consistent with the CEPA-approved scope of investigations outlined in the Wafi-Golpu Project EIR, and the SAMS Draft General Guidelines.
2. Best Practice	
2.1. Regulatory framework	
Fundamental requirements to ensure DSTP is implemented to international best practice are:	
• State of the Art legislation	Noted.
• Competent regulatory authorities with appropriate funding mechanisms to ensure regulatory compliance monitoring both in terms of the discharge quality and its environmental effects	Noted.
• Specific operational regulations for the operation and maintenance of the tailings placement system	Noted.
• Standardised methods for assessment of risk associated with the tailings placement system	Noted.
• Establishment of a transparent EIA process where the environmental protection outcomes and the most hazardous aspects of the tailings placement activity are identified and appropriate mitigation measures are identified; and where the interests of all stakeholders are identified and considered	Requirement met.
• A permitting/licensing process that details the site-specific requirements that are needed to protect the marine environment and achieve the identified environmental protection outcomes in terms of the discharge system specification and operation, and which includes appropriate environmental monitoring informed by the identified protection outcomes and the risk analysis	Requirement met.
• Scientifically robust and transparent methodology for setting sediment and water column Environmental Quality Standards (EQS) for potentially ecotoxic discharge components	Requirement met. International and national water quality and sediment guidelines used for assessment in addition to State of PNG standards. Additionally, safe dilutions are determined based on ecotoxicity testing.

Draft General Guidelines and Criteria	Wafi-Golpu Project EIS Studies and Scopes
• A clear process for reviewing all the information gathered through the EIA process, showing how this has been assessed in coming to a decision, and confirming that all required procedures have been followed must be implemented	Requirement met.
2.2. Environmental Considerations for DSTP	
A permitting process is necessary, with permits detailing site-specific requirements including mitigation measures identified by the EIA.	Requirement met. A Level 3 environment permit for the Wafi-Golpu Project is expected to be issued in the event the Minister for Environment, Conservation and Climate Change provides approval in principle.
The target area for ultimate storage of the tailings should not be of high conservation and/or socio-political value and the environmental conditions of the area should be such that maximum deposition of tailings occurs, the physical environment ensures adequate flushing to disperse contaminants in the upper water column, does not experience upwelling of tailings and there is a low probability of post-depositional redistribution of tailings where it could negatively impact areas identified for environmental protection.	Requirement met, notwithstanding the inherent difficulty of determining what is high conservation value in the deep sea. The area does not experience upwelling. The frequent down-canyon mass movements of sediment will result in depositional redistribution of tailings, however mass movement events are advantageous in ensuring adequate flushing in the water above the density current flow, and mixing and eventual burial of the tailings with the much larger quantities of natural sediment at closure. The target area for tailings storage has been selected to ensure contaminants are not released in the upper water column, i.e., above the depth of discharge or within the surface mixed layer or where tailings could negatively impact areas identified for environmental protection.
The gradient of the path to the target area must be such that a coherent density current is formed to minimise dispersion to surrounding areas and any accumulation near the discharge.	Requirement met. The seafloor gradient below the proposed DSTP outfall is sufficiently steep (15°) to avoid excessive deposition that could cause a blockage of the DSTP outfall. Modelling has shown the discharged tailings slurry will form a density current and run down the seafloor all the way to the floor of the Markham Canyon at around 650m to 700m water depth and then turn towards the east before flowing further down the floor of the Markham Canyon. Modelling has shown that dilute subsurface tailings plumes will shear off the descending density current into the water column and be moved laterally by ocean currents until the tailings solids settle.
The delivery of tailings to the target area must be sufficiently deep to ensure: • No entrainment or advection of tailings into the euphotic zone • Minimal production of plumes due to density differences in the water column • There is sufficiently small diffusion of dissolved toxic material into the euphotic zone	Requirement met.
The EIA and its resultant Environmental statement should include the issues that are normally required for marine developments including appropriate environmental baseline, social, economic and human health issues. An assessment of the biomagnification of contaminants within the food chain should be made. Mitigation options for all potential impacts should be fully evaluated.	Requirement met.

Draft General Guidelines and Criteria	Wafi-Golpu Project EIS Studies and Scopes
Construction, operational, decommissioning and post-decommissioning aspects should be comprehensively addressed.	Requirement met. Preliminary details of decommissioning and post-decommissioning are addressed in the Conceptual Closure and Rehabilitation Plan and these will be updated in the detailed closure plan due five years before closure of the mine, as typically required for mines in PNG.
3. Draft Guidelines	
In the context of international best practice, the general guidelines for the use of DSTP in PNG should consider an examination of: 1. Feasibility studies / initial mine planning and development, 2. Mining operations, including monitoring, 3. Future mine closure plans and 4. Post mining monitoring.	Requirement met for point 1 (Pre-Feasibility and Feasibility Studies), and for point 2 and 3 (conceptually). For point 4, the monitoring plan will continue pending a detailed closure and rehabilitation plan nominally due five years before closure of the mine.
The main aim of the guidelines should be to minimise the impact on the marine environment including biodiversity, social, economic, cultural and human health issues.	Requirement met. Design and operation of system is protective of all these values in the zone above the discharge depth.
The potential environmental risks to be considered should include:	
• Assessment of the potential toxicity of the tailings, i.e. they should be stable and where ecotoxic components are present they should be reduced to concentrations below environmental quality standards (EQS)	Requirement met by water quality characterisation, seawater mixing tests and ecotoxicological testwork, notwithstanding the regulatory site-specific mixing zone within which water quality standards are allowed to be exceeded, but must comply at the mixing zone boundary.
• Assessment of the diffusion and dispersion of any dissolved potentially toxic materials in the water column	Requirement met by three-dimensional hydrodynamic modelling.
• Assessment of impact on seabed e.g. increased sediment accumulation, change in grain size	Requirement met by sampling and analysis of the existing seafloor sediments and modelled predictions of deposition from both terrestrial sediment from riverine discharges and tailings solids on the seabed of the Huon Gulf. The modelling also includes processes such as slumping, erosion by bottom currents, redistribution and redeposition.
• Assessment of impact on the pelagic zone during the production period e.g. increased turbidity and transfer of toxic components to the pelagic food web	Requirement met. The EIS includes modelled predictions of turbidity from dilute subsurface tailings plumes in the water column and in the bottom-attached density current expressed as incremental increases over already high background turbidity levels due to terrestrial sediment input from riverine discharges and the resultant surface, midwater and bottom turbid plumes in the water column. The EIS quantitatively estimates potential exposure of marine organisms to both the mine-derived and natural sources of turbidity and the potential for transfer of metals into the pelagic food web.
• Assessment of impact on biodiversity during production period e.g. burial, dilution of natural organic carbon input, bioavailability of toxins, biomagnification, and bioaccumulation	Requirement met. The EIS includes the results of ecotoxicological testing of both tailings solids and natural seafloor sediment from the Huon Gulf and assesses the behaviour and fate of metals in tailings deposits on the seafloor and the potential for biomagnification and bioaccumulation.

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• Influence on marine resources e.g. fisheries	Requirement met and reported in the EIS with a particular focus on potential impacts to tuna processing facilities in Lae (Chapter 17, Offshore Marine Environment Impact Assessment and Chapter 18, Socioeconomic Impact Assessment).
• Influence on vulnerable ecosystems including culturally important habitats	Requirement met, notwithstanding the inherent difficulty of determining vulnerable ecosystems in the deep sea.
• Impact of technical failure e.g. pipeline fractures	Requirement met. The EIS includes the DSTP system engineering design report and measures to minimise the risk of technical failure. The environmental impact of credible failure scenarios is evaluated in Chapter 21 of the EIS.
• Potential redistribution of tailings e.g. production of under water slides of deposited tailings, formation of plumes within the water column	Requirement met. These are normal deposition processes for both tailings solids and natural seafloor sediments. Such events have been recorded by deployed instrumentation and are addressed by modelling in the EIS.
All analytical data collected from environmental baseline studies, operational monitoring and post closure monitoring must be quality assured to auditable standards and deposited in a database managed by the competent government authority. A competent government authority or a designated third-party expert reviewer must review the data to ensure that the performance is consistent with the EIA protection outcomes and that no significant environmental impacts are emerging.	All data relevant to the EIS and supporting DSTP studies will be retained in a database managed by the WGJV and can be made available to the PNG regulatory authorities. It is standard practice for the PNG government to undertake periodic independent audits of environmental performance at operating mines.
3.1 Feasibility Studies and Initial Mine Development	
Each development should be assessed with regards to: • Prior experience gained from all previous tailings placement systems, both currently operating and closed systems • Latest scientific and engineering knowledge • Appraisal of societal benefits, impacts of human communities, risks to human health and environmental impact of all practical waste management options – DSTP – On land storage, tailings ponds – No tailings e.g. no mine	Requirement met. These are addressed in the EIS.

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Critical factors regarding disposal of tailings utilising DSTP: • Properly designed outfall system e.g. durability and length/depth of pipe • Location of the outfall to utilise natural topography to minimise the tailings dispersion and deposition footprint • A duplicate pipeline should be considered to allow mine operations to continue during times of pipe inspection or technical failure, where this is not implemented then an entire pipe replacement unit must be kept on site for immediate use in case of failure of the pipeline • The safety of the pipeline must be assessed, e.g. to determine the physical risks to the offshore pipeline from wave action, seismic activity, or other stresses • Ensuring the correct density range of the discharge to minimise suspended particulate plumes and maximise placement on the deep sea bed, considering the following – Understanding of particle size and settling behaviour - in some cases – the use of flocculants may be considered – The temperature of the tailings slurry – Ratio between solids, freshwater and seawater in the pipeline – De-aeration of the system	Requirement met. With the exception of the third bullet point, the DSTP system engineering design report addresses all of these points and measures to optimise the design while also minimising the risk of technical failure. The DSTP system engineering design report is an appendix to the EIS. In relation to the third bullet - although a duplicate pipe is not installed both intake and delivery pipe systems comprise twin pipes thus allowing some continued operation during inspection of pipelines. Spare pipes will be retained on site. Potential impacts on the pipeline from seismic events and tsunamis are considered in Chapter 21, Unplanned Events (Natural Hazards and Accident Events). While the SAMS guidelines prompt the consideration of flocculants, the design of the DSTP system for discharge of tailings onto the seabed as a density current does not warrant the addition of flocculants. The majority of tailings would be deposited directly onto the seabed.
3.1.1. Preliminary site evaluation	
1) Each site should be considered on a case by case approach, i.e. the evaluation **must be site specific**.	Requirement met. The EIS oceanographic and ecological studies have obtained primary data from the Project study area. Potential DSTP sites included three sites (A, B and C) to the east of Lae and one site (D) to the south of Lae. Bathymetric surveys and assessments of seabed stability at the four sites were undertaken to provide site-specific bathymetric and slope stability data. Processed sonar data from the oceanographic surveys were used to evaluate seabed slope stability as part of Project DSTP engineering investigations. These studies identified the presently proposed location (Site A) of the DSTP Outfall location with the most stable seabed suitable for the DSTP Outfall pipeline, as well as a steep slope (15°) to encourage tailings density flow and avoid tailings solids accumulation at the DSTP Outfall pipeline terminus.
2) A full evaluation of all waste management options must be carried out to ascertain whether DSTP is the **BEST** option for dealing with tailings waste. The environmental impact statement (EIS) and supporting studies should compare DSTP with other land based options to ascertain the relative environmental and social impacts/risks from DSTP and other tailings disposal options.	Requirement met. A preferred option has been selected based on comparing the environmental, social, cultural heritage, economic and engineering risks and benefits of both on-land storage and DSTP options. Investigations of potential land-based tailings storage options at 45 sites found that: (a) the required storage volumes would result in a large disturbance footprint over an area which can have high traditional heritage and economic value, high biodiversity, and/or displacement of communities and their livelihoods, (b) the Project Area has high seismicity

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	and complex geology, including active faulting, which could at some sites result in liquefiable soils and complex design would be required to partly mitigate such factors, and that would carry high risk and high cost in both construction and ongoing operation, (c) high rainfall and large water catchment dimensions would require significant and costly water management treatment solutions and any structure would contain very large amounts of water with commensurate risks, (d) due to terrain and geotechnical complexity, multiple storage sites and types of tailings management would be required for a life of mine solution and (e) the mining operation would be exposed to complex tailings operations, closure and rehabilitation risk and the residual risks for terrestrial tailings storage facilities would remain high in perpetuity. Dry stacking of tails has also been examined as an option and is detailed in the EIS. Regarding the alternative tailings management option of DSTP, year-long oceanographic and environmental studies in the Western Huon Gulf have confirmed the area to be a highly suitable environment for DSTP. It hosts a deep canyon leading to a very deep oceanic basin with no evidence of upwelling of deeper waters to the surface. Tailings discharged from an outfall at approximately 200m are expected to mix and co-deposit with some 60Mtpa of natural sediments discharged from the Markham, Busu and other rivers which also are conveyed via the Markham Canyon to the deep sea. The pelagic, deep-slope and seafloor receiving environment has a very low biodiversity as a result of the riverine sediment transport, deposition and regular mass movements (underwater landslides). These same riverine sediments are expected to also bury the co-deposited tailings at closure and promote benthic recovery to pre-mine conditions. In the light of the factors considered in relation to on-land tailings storage, the outcomes from the study of 45 terrestrial sites, dry stacking of tailings and the outcomes of the DSTP studies, the updated Feasibility Study identified the use of DSTP as the preferred tailings management option for the Project. Ultimately, it is the PNG Government's decision whether or not to accept the preferred option for tailings management.

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3) This process should involve all available data on every one of the options being considered. If sufficient data are not available then further research (scientific and engineering) should be carried out before a decision on the best waste management option is made. In particular a site specific study should be made of the proposed receiving waters to determine: i) flushing characteristics (including upwelling) ii) size of any tidally induced mixing zone iii) vertical mixing iv) vertical plankton migration zone v) horizontal dispersion vi) and depth of the euphotic zone	Requirement met. The site for the DSTP option is based on extensive site specific studies of: i) flushing characteristics based on high-resolution bathymetry and conductivity, temperature and depth (CTD) ocean profiling along two transects of five sites in each; deployment of Acoustic Doppler Current Profiler (ADCP) arrays at multiple locations (initially at 300m, 800m and 1,800m) with full water column current metering and fixed temperature loggers over a 12 month period and hydrodynamic modelling. An assessment of the potential for upwelling is based on the CTD data, fixed temperature measurements, satellite imagery of sea surface temperatures and wind stress analysis. ii) As above plus wave measurement ADCP located near to the proposed outfall location. iii) As above. iv) Midwater plankton/micronekton sampling. v) Input of wind, tide, ADCP current, CTD and bathymetric data into the three-dimensional hydrodynamic modelling. vi) Direct measurement of the euphotic zone thickness using a photosynthetically active radiation (PAR) sensor on the CTD profiling equipment. The results of these studies are described in the EIS.
4) The data, historical and current, should be made available from a database managed by the competent government authority or their designated third-party reviewer.	Not directly applicable to the WGJV. This is applicable to the PNG Government and the Conservation and Environment Protection Authority (CEPA). Notwithstanding, all data relevant to the EIS and supporting DSTP studies will be retained in a database managed by the WGJV and can be made available to the PNG regulatory authorities.
5) After careful scrutiny of the existing data if DSTP is the best available option and is deemed **acceptable**, then a **detailed environmental** baseline of the site should be carried out as part of the tailings management alternatives analysis.	The EIS presents DSTP as the preferred option for tailings management for the Project, that is assessed to be an acceptable option by the Project based on the engineering, environmental, social and cultural heritage studies completed for the on-land storage and DSTP options and the potential benefits and risks of each. Environmental baseline data has been collected for the DSTP site and is presented in this EIS and its supporting technical investigations and reports presented in its appendices. Further, more detailed environmental baseline studies are proposed to be undertaken between Project approval and the start of operations. Final determination regarding the acceptability of the preferred option is a matter for the PNG Government.

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6) The location of the site should be chosen to: a. be close to the coastline and have safe overland transport b. have sufficient depth of water and gradient to achieve a coherent gravity flow c. have sufficiently high flushing characteristics to ensure no local build up of conservative potentially toxic materials and d. avoid locations of environmental, social or economic significance	Requirement met. The site selection process is described in the EIS. a. The DSTP location was selected after extensive evaluation of different outfall locations and overland pipeline routes. b. Depth and seabed gradient determined from high-precision swath bathymetry work from Xiang Jian (August 2016 and February 2017), and Kongsberg (Munin) autonomous underwater vehicle (AUV) survey in September 2016. c. The bottom slope is ~15° at the proposed outfall terminus, and modelling predicts the tailings will form a coherent density current that will run down the sloping seafloor and will cause no local build-up of tailings solids. A steep gradient continues all the way down the slope to the floor of the Markham Canyon where direct measurements indicate episodically high rates of flushing and transport of natural river-borne sediments towards the New Britain Trench. These processes are expected to also transport tailings solids towards the New Britain Trench. Detailed site investigations have also assessed that no upwelling has been observed, nor is it expected to occur. d. Assessed from: onshore relocation of proposed mix/de-aeration tank to protect a cultural heritage site, nearshore study, resource use study, seafloor video study (to 1,800m), deep slope fishing study and high resolution multibeam echosounder (MBES) and AUV data. The deep-slope and pelagic fish characterisation study has assessed that there is no existing or potential fishery resources of the potentially affected deep-slope below the DSTP outfall. Within the Coastal Area a location has been identified as a potential nesting site for a small number (e.g. three per year) of west Pacific leatherback turtles. This has been incorporated into the impact assessment for nearshore marine fauna (Chapter 16, Nearshore Marine Environment Impact Assessment) and incorporated into the Project EMP (Attachment 3) to avoid and/or mitigate potential impacts wherever practicable.

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7) The construction of the DSTP pipeline must be robust and the length of the pipe should ensure that the discharge is a. at a minimum depth of 120 m where the maximum depth of the euphotic zone is 80 m or less b. where the euphotic zone is deeper than 80m the discharge should be **below** the maximum observed depths of the surface mixed layer or the euphotic zone, whichever is deepest, + 50% of that length c. formation of plumes of tailings in the water column must be **minimised**. In the event of density changes in the water column occurring the length of the pipe should enable the discharge of tailings to occur below low-density weakly stratified surface waters as detailed in the site specific hydrographic measurements	Requirement met. A full annual cycle of CTD measurements has been collected and the proposed DSTP outfall is located at a depth of approximately 200m, which is 140m below the maximum measured depth of the base of the euphotic zone of 60m. At approximately 200m depth, the proposed DSTP outfall will be more than double the depth of the deepest surface mixed layer depth measured over more than a year which is 96m. Therefore, the 50% factor of safety required by guidelines will be easily achieved. The DSTP system is engineered to include pre-dilution to minimise plume dissolved metals concentrations, de-aeration of the tailings slurry prior to discharge to avoid transportation of the tailings to the ocean surface by air bubbles, and ensure that the tailings slurry has a higher density than the receiving ocean water so that a density current will form and flow down the sloping seafloor. The outfall depth of approximately 200m also ensures that any plume formation will occur below productive and low-density weakly stratified surface waters.
8) There should be no potential to adversely impact on rare or valuable ecosystems identified in the EIA.	Requirement met. The nearshore study has included assessment of IUCN-listed species and important local resource uses. Seabed benthos sampling and underwater benthic video characterisation work showed the benthic environment to be entirely muddy and it is not considered that any rare or valuable ecosystems will be impacted.
9) There should be no potential to adversely affect natural bioresources long term. It is recognised that there will be unavoidable adverse impacts to benthos from a DSTP system. However consideration must be given to the significance and reversibility of any potential impacts.	Requirement met. Expected effects on natural bioresources are assessed by deep-slope fish study, resource use study and fish market sampling study. There are no existing or proposed deep-slope fisheries either commercial, artisanal or subsistence based at the Outfall Area or adjacent submarine slopes along the north coast of the Huon Gulf. During DSTP operation, monitoring will be carried out on sampled fish on sale at the Lae fish markets and other fish caught by local fishers to determine their trace metal content and confirm the absence of negative impacts on human health. Unavoidable adverse impacts to benthos are described in the EIS. The significance and reversibility of effects on natural bioresources and benthos are assessed in the context of finite effects on the ocean water column for the duration of mine life and in the context of high rates of natural river-borne sediment input to the Huon Gulf and episodically high rates of flushing and transport of natural river-borne sediments and tailings solids down the Markham Canyon towards the New Britain Trench.
10) The prospective area of tailings deposition must have sufficient volumetric storage capacity to receive the entire volume of tailings over the life time of the mine.	Requirement met. The Huon Gulf currently receives an estimated 60Mtpa of suspended sediment from terrigenous sources via river inflows. The additional 16.5Mtpa of tailings solids for 28 years can be readily accommodated within the very large volumetric storage capacity of the Markham Canyon.

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11) Coastal installations, pipelines and mixing tanks must be designed and constructed with appropriate safety factors to withstand storm damage, include the range of El Niño / Southern Oscillation (ENSO) variability. For mines with a predicted long life, forecasts from a reputable climate model (where available) should be used to determine the likelihood of storm increase/decrease due to climate change.	Requirement met and included in the DSTP engineering design. The mixing/de-aeration tank (Outfall Area) have all been designed and constructed with appropriate safety factors to withstand storm damage, be located above 1 in 500-year ARI flooding, and includes the range of El Niño / Southern Oscillation (ENSO) variability, the WGJV construction and building codes and standards. Front End Engineering Design (FEED) criteria for the DSTP system have been developed and further detailed engineering design will take account of appropriate safety factors related to natural hazards.
3.1.2. Environmental Baseline	
Research and monitoring objectives need to be defined by the appropriate specialists (scientists and engineers).	Requirement met. See points 1-10 below.
1) Sampling of sediment, water column, suspended particulate material and benthic and pelagic communities must be carried out using **internationally recognised and validated methods and sampling gear and must be statistically valid**. It is recognised that for some components such as mega benthos and pelagic fish it may be difficult to obtain the number of samples required to be statistically valid, however every effort should be made to obtain the necessary sample size.	Requirement met. A comprehensive baseline sampling program was carried out to provide baseline characterisations of water quality, suspended particulate material, bed sediments and benthic communities, benthic video, pelagic and deep-slope fish, zooplankton and micronekton, nearshore marine resources, and fisheries and resource use. Ecological studies were designed to characterise the existing conditions in sufficient detail to identify Project-related risks and potential impacts, and to initiate longer-term baseline studies for statistical validity. The latter will form part of future baseline monitoring to be completed prior to any Project disturbance, and will continue into future construction and operational monitoring. Major items of sampling equipment are described in EIS technical reports and included: • Kongsberg EM 122 multibeam echosounder for high-resolution bathymetric data to full ocean depth, and interfaced to a Kongsberg SeaPath 320 unit to provide vessel positioning, attitude and heading data (deployed from Xiang Jian) • Kongsberg Munin AUV equipped with high resolution multibeam echosounder, Sub-Bottom Profiler (SBP), and dual frequency Side Scan Sonar (SSS), and suite of advanced navigational sensors • Saiv CTD, model SD208, 2000m rated, with turbidity, PAR and dissolved oxygen (DO) sensors • Rowe SeaWatch ADCP (75-600KHz) profilers as necessary for each mooring array and wave measurement • Kongsberg EA400 single beam echosounder - for mooring deployment, and acoustic seabed classification • Acoustic releases - EdgeTech PORT LF • Technicap PPS 4/3 Sediment Trap fitted with 12 x 500ml bottles • EchoLogger AA400 Autonomous Altimeter - integrated to base of each sediment trap. Tilt sensors also attached to detect any deviation of

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	the array from vertical • Biosonics DT-X Portable Echosounder with 38kHz and 120kHz split beam dual transducers, for bioacoustic monitoring • Bongo and tucker trawl nets for midwater plankton/micronekton sampling • Valeport VA500 Altimeter and oceanographic cable - to determine depth of equipment (bongo and tucker trawl nets etc) and to control deployment of benthic box and multi corers to obtain intact samples • GoPro underwater video and housing rated to 1,750m depth • 12V Daiwa Marine Power 3000 electric reels - for deep slope fishing to ~700m • GPS-coupled Simrad NSS12 plotter and Furuno NAVnet single-beam echosounder for deep slope fishing positioning
2) A validated numerical modelling investigation of tailings flow, dispersion and deposition must be made.	Requirement met. Validated numerical modelling of the behaviour and fate of tailings discharged to the Huon Gulf was undertaken which addressed tailings flow, dispersion and deposition. This has included validated numerical modelling of the behaviour and fate of existing riverine sediment discharge to the Huon Gulf.
3) An assessment should be made of the **stability** of tailings and likelihood of **re-dispersion** through slumping, density gradients and current flow. It is recognised that slumping of sediment on steep slopes is a natural process, however the addition of tailings will greatly increase the natural rate of sediment accumulation and may lead to slope failures. In these cases it is important to understand the impact of remobilisation of previously deposited tailings.	Requirement met. The stability of tailings solids deposition and likelihood of re-dispersion through slumping, density gradients and current flow has been comprehensively modelled and additional information on mass movements events in the Markham Canyon has been addressed. Tailings deposition will be a two-stage process whereby deposits of tailings solids on the floor of the Markham Canyon will be periodically eroded by turbidity current events, mixed with natural sediment, transported further down the Markham Canyon and then redeposited in deeper water. Numerical modelling has identified the predicted footprint of deposition from both processes. High rates of natural river-borne sediment input will mean that the contribution of tailings solids will be subordinate to the natural sediment input in the Huon Gulf and the tailings and the natural river-borne sediments will become mixed on the ocean floor. Flocculation, settling, consolidation and re-suspension testwork has been carried out at CSIRO Process Science and Engineering (Melbourne) on a representative tailings sample.
4) Simple box models of the physical environment, using observed or realistic flushing and exchange parameters, should be produced to determine a budget for the long term distribution of fine scale tailings and any associated dissolved toxic constituents.	Requirement met. Numerical modelling of the behaviour and fate of tailings liquor and tailings solids in the receiving marine environment has been undertaken. The toxicity of tailings liquor and tailings solids contaminants at various dilutions were assessed by the CSIRO for bench-scale toxicity testing of tailings contaminants in various liquor-seawater dilutions and for contaminant geochemistry, release and bioavailability in deposited tailings-sediment mixture.

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5) The environmental baseline should include the measurement of: a. The physical oceanographic environment (hydrography), **near and far field**, which should be measured for the **minimum of 1 year** to determine seasonal variations in mixing and flushing. b. The distribution of the depth of the weakly stratified surface layer, monitored for the **minimum of 1 year** to determine seasonal variations. c. **Geochemical characterisation** of the area, including, mineralogy, particle size distribution, total organic carbon, biogeochemical cycling of trace elements, flux of trace elements across the benthic water interface is required. This must be done using accepted **methods of sampling and analysis** and must be to an internationally accepted level of **quality assurance.**	Baseline geochemical characterisation of the existing seabed environment has been carried out. River gauging (Markham and Busu rivers and two other rivers) has been undertaken to provide estimates of natural input of suspended sediments. Sediment traps on each ADCP mooring array provide estimates of settlement through the water column and samples for characterisation of the naturally settling sediment. The fluxes of trace elements across the benthic sediment-water interface have been addressed. The methods used by CSIRO (bioavailability of tailings contaminants and toxicity of tailings liquor contaminants) are of a high standard and conducted to an internationally accepted level of quality assurance and quality control. Tetra Tech used the internationally recognised US EPA (1999) screening level ecological risk assessment (SLERA) protocol to assess bioconcentration factors between different tropic levels.
d. Sediment accumulation and mixing rates of the area of likely impact and control sites should be measured. In addition, areas of erosion and sediment deposition should be identified. e. The **benthic community** should be enumerated and characterised using sampling techniques appropriate to the three major organism body size classes (meiofauna, macrofauna and mega fauna). In the absence of universally accepted distinction between meio- and macrofauna, the method used to distinguish them (e.g., sieve mesh size or taxonomic identity) should be **clearly stated and consistently applied**. Protocols for sample quality control, level of replication, preservation and laboratory processing should be rigorous and sufficient to meet standards required for publication in the modern peer-reviewed deep-sea literature. Requirement met. Physical oceanographic baseline investigations have been carried out which provides for more than one year's data collation to assess seasonal variations in mixing and flushing. The depth of the surface mixed layer is an integral component of the oceanographic program.	The benthic communities (meiofauna, benthic macroinvertebrate fauna and mega fauna (e.g., benthic, epibenthic and demersal fish)) have been characterised. Sampling and identification of macro- and meio-fauna in benthos from deep (to 1,800m) and nearshore (to 20m) seabed sediment samples have been collected by controlled deployment of box corer and ponar grab sampler respectively. Samples have also been collected using a multi-corer for comparison of results between different sampling methods. Replicate samples were used to enumerate sediment benthic infauna and epifauna.
6) An assessment of the degree of benthic–pelagic coupling should be made to allow future modelling of possible bioaccumulation and biomagnification of contaminants.	Requirement met. Data sources include sediment, plankton, deep slope fish and fish market studies and analyses of trace metal content of plankton (bulk samples) micronekton individuals and in the muscle / livers of deep slope fish species and selected market species. Quantitative bioaccumulation and biomagnification modelling completed. The EIS has assessed trace metal toxicity, bioaccumulation and biomagnification in the food web to be a low risk. The findings are backed by detailed assessments of bioaccumulation and biomagnification at the Lihir Gold Mine's DSTP operation, with the conclusion that there was no detectable or significant trace metal bioaccumulation or biomagnification up the food web.

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7) Samples of sediment and benthic biota should be collected, preserved and archived before start-up of the mine to provide a suite of pre mining reference samples at stations predicted to be impacted and also at reference stations that will not be impacted to control for natural variability over time.	Requirement met. Samples of plankton and benthos have been identified against appropriate texts and are currently preserved and stored by the specialists conducting the identification. Samples of deep slope gulper sharks have been sent to CSIRO in Hobart for further DNA 'fingerprinting' of the shark species.
8) Leaching experiments with tailings should be conducted to ascertain the level of heavy metals, and other potentially toxic components and exchange between the sediment/water column systems.	Requirement met. The mobilisation of metals from settled tailings solids to pore (interstitial) water and overlying water was assessed using a series of laboratory elutriate tests as part of the CSIRO study.
9) The results from the environmental baseline should be used to test and re-educate the box models. There must be a strong feedback between the monitoring of impact and the earlier determination of impact both to improve the models and to modify the monitoring in the light of real information.	Requirement met. The results from the environmental baseline will be used to test models and their assumptions. The proposed environmental monitoring program will include an intensive validation phase to confirm predictions of the behaviour and fate of post-discharge tailings liquor and tailings solids. This is a future commitment, which will form part of a future environment permit and its accompanying approval conditions. The EIS predicts the behaviour and fate of tailings and the extent, duration and severity of impacts during the operation of the mine. The proposed monitoring needed to verify predictions is outlined in the environmental management plan, which is an attachment to the EIS (Attachment 3).
10) All data obtained from the environmental baseline, including calibration data, should be independently peer assessed by internationally recognised independent scientists and engineers and then deposited in a central database maintained by the competent government authority or their designated third party reviewers. (Independent being defined as appropriately skilled persons that are not included in the monitoring and analysis, design and operation of the tailings placement system).	Requirement met. Specialists in each field of study have been engaged to undertake the EIS supporting studies. Each supporting study report is also further reviewed by selected Competent Independent Reviewers. The Project's EIS, including its supporting technical appendices, will be held by the PNG Governments Conservation and Environment Protection Authority (CEPA). CEPA will appoint an independent consultant or consultants to review the EIS for which will be funded by the WGJV under the *Environment Act 2000*. At the present time, CEPA does not operate or maintain a 'central database' and their information management system is being developed. At this stage the EIS will be held by CEPA in the form of physical hard copies, as well as electronic copies. Notwithstanding, the WGJV will have its own protocols, standards and data management system for maintaining a database of environmental data generated from its baseline and monitoring programs.
3.2. Mining Operations	
1. Assessment and validation of the outfall performance should be made, e.g. fluorometric dye experiment to provide information on plume formation and dilution within and at the boundary of the mixing zone.	Noted.

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2. Monitoring programmes to assess system performance and impact on the seabed in terms of geochemical and benthic change should be carried out. Pelagic measurements of zooplankton and nekton abundance and diversity should be made to ascertain any change over the lifetime of the mine operation.	Noted.
3. Monitoring of physical, chemical and biological conditions of marine system (i.e., sediment and water column) is required, to ensure that Environmental Quality Standards (EQS) for both water and suspended particulate material are not exceeded outside a mixing zone agreed in the discharge permit. Internationally accepted sampling and analysis methods must be used.	Noted.
4. Characterisation and behaviour of tailings to be disposed, including grain size distribution, chemical composition and settling behaviour must be assessed and controlled in real time to ensure best performance of the tailings gravity flow.	Noted.
5. An assessment of trace element concentrations within the: a) sediment b) water column c) suspended particulates d) benthic biota e) zooplankton and nekton	Noted.
6. Data need to be of a high standard and full QA system should be in place.	Noted.
7. Results require to be documented and kept in a central database by the competent government authority or designated third party expert reviewer. The database should be accessible to all those with a genuine need to access and use the data. The database will need to be managed in such a way that confidential market information is restricted and remains confidential. Typically this is done by using a set length of time after which data can be made publicly available.	Noted.
8. Use of automated systems for detecting failures in pipeline, i.e. remote sensors. Such devices should be part of an approved Emergency Response Plan.	Noted.
9. Automated system for monitoring of the marine environment surrounding the DSTP discharge site: intelligent moorings delivering real time data where applicable.	Noted.
10. Require independent marine scientist to advise on monitoring regimes and plans and review monitoring data and reports produced by consultants. The financing of independent advice needs to be considered but should be financed via the relevant department, possibly by a levy obtained from granted licences. This should be administered by an independent steering committee.	Noted.

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11. Agreed internationally accepted sampling methods, analysis methods, calibration methods and methods of data interpretation should be adopted and maintained.	Noted.
12. Risk assessment and monitoring regimes should be linked.	Noted.
13. Periodic ground truthing of models and re-calibration as appropriate.	Noted.
14. Preparation of an Emergency Response Plan	Noted.
3.3. Future Mine Closure Plans	Addressed in the conceptual closure and rehabilitation plan in the EIS.
3.4. Post Mining Monitoring	Addressed in the conceptual closure and rehabilitation plan in the EIS.

5. REFERENCES

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