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<b>Nickel Impact Programme Indonesia</b> Internal Order: 12971040500	<b>Project number/ cost centre:</b> G-012971-001
<b>Baseline Assessment of the Current Environmental and Ecological Conditions of Weda Bay, North Maluku</b>	<b>Tender number</b> <b>21000687</b>
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## **0. List of abbreviations**

AG	Commissioning party
AN	Contractor
AVB	General Terms and Conditions of Contract for supplying services and work
FK	Expert
FKT	Expert days
KZFK	Short-term expert
ToRs	Terms of reference

## **1. Context**

Indonesia has experienced rapid growth in the nickel mining and processing sector, driven by rising global demand for nickel as a critical material for electric vehicle batteries and stainless-steel production. In 2023, Indonesia produced approximately 1.8 million metric tons of nickel nearly 50% of global supply and production is projected to increase further in the coming years. A significant share of this expansion is concentrated in the Weda Bay area, Central Halmahera, North Maluku, where PT Weda Bay Nickel and the Indonesia Weda Bay Industrial Park (IWIP) have developed one of the world's largest nickel-processing hubs. While this growth has strengthened Indonesia's strategic position in global supply chains, it has also intensified environmental pressures on terrestrial, freshwater, and marine ecosystems, as well as socio-economic challenges for local communities that depend on natural resources for their livelihoods.

To address these challenges, the Nickel Impact Programme Indonesia (NIPI) has been established as a collaborative initiative aimed at reducing community-prioritized environmental and social impacts associated with nickel mining and processing activities in the Weda Bay area. Implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the programme focuses on ten communities surrounding the IWIP industrial area and adopts a community-centred and evidence-based approach.

The Nickel Impact Programme Indonesia (NIPI) is a collaborative initiative aimed at addressing environmental and social impacts associated with nickel mining and processing activities in the Weda Bay area, Central Halmahera, North Maluku. As one of the world's major nickel production hubs, Weda Bay plays an important role in the global nickel supply chain, particularly in supporting the rapidly growing electric vehicle industry. However, the rapid expansion of mining and industrial activities has also increased environmental pressures on coastal and marine ecosystems and raised concern regarding their implications for local communities.

Under Topic3: Aquatic Biodiversity, NIPI seeks to support the protection and restoration of freshwater and marine ecosystems in the Weda Bay area. To support this objective, the programme will commission a baseline assessment of the current environmental and ecological conditions of Weda Bay and its associated coastal and freshwater systems, incl. an analysis of pressures (sediment, heavy metals, pH etc.) on said conditions.

The study will adopt an integrated ecosystem assessment approach, combining ecological surveys, environmental quality monitoring, oceanographic and hydrological analysis, and socio-ecological assessment. The results will provide a scientifically robust baseline of ecosystem conditions and support the development of management trigger values, monitoring indicators, and a long-term ecosystem monitoring framework to inform conservation, restoration, and evidence-based environmental management in Weda Bay.

## **2. Tasks to be performed by the contractor**

The contractor is responsible for providing the following services:

- Undertake a comprehensive interdisciplinary baseline assessment of the environmental and ecological conditions of Weda Bay and adjacent coastal and freshwater ecosystems.

- Prepare and submit final reports and deliverables, synthesizing all study outputs into a coherent, scientifically rigorous, and policy-relevant set of documents.
- Prepare an Ecosystem Action Plan and a Long-term Monitoring Framework that translate baseline study findings into practical, science-based guidance for the sustainable management of Weda Bay.
- Conduct a stakeholder dissemination and validation workshop to present and validate study findings, and to support their incorporation into relevant management and policy processes.

The contractor also:

- The contractor is responsible for selecting, preparing, training and steering the international and national, short and long-term experts assigned to perform the advisory tasks.
- The contractor provides equipment and supplies (consumables) and assumes the associated operating and administrative costs.
- The contractor manages costs and expenditures, accounting processes, and invoicing in line with the requirements of GIZ.
- The contractor reports regularly to GIZ in accordance with the current AVB of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

The contractor will undertake a comprehensive and interdisciplinary baseline assessment of the current environmental and ecological conditions of Weda Bay and its surrounding coastal and freshwater systems. The scope of work will encompass the assessment of key ecological components, environmental quality parameters, and exposure pathways associated with mining and industrial activities in the area. The study will integrate ecological, oceanographic, hydrological, and socio-ecological dimensions to provide a holistic understanding of ecosystem status and the interactions between environmental pressures and ecosystem responses. Attention will be given to identifying and analysing specific pressures related to nickel mining, industrial processing, coastal infrastructure development, and associated maritime activities.

The assessment will cover coastal and marine habitats such as mangroves, seagrass beds, and coral reefs, as well as key biological communities including reef fish, plankton, and benthic organisms. In addition, the study will evaluate water quality, sediment characteristics, metal concentrations, sedimentation processes, and potential bioaccumulation in sentinel species. Oceanographic and hydrological processes such as currents, plume dynamics, and riverine sediment inputs will be analysed to better understand environmental connectivity and exposure pathways within the bay. Socio-ecological aspects, particularly fisheries dynamics and community use of coastal resources, will also be incorporated to ensure that ecological findings are interpreted within the broader context of community livelihoods and ecosystem services.

The study will be structured into a series of thematic Work Packages (WP) covering habitat mapping, ecological surveys, water and sediment quality analysis, oceanographic and hydrological assessment, socio-ecological analysis, and integrated environmental risk assessment. The outputs of these work packages will be synthesised to support the development of management trigger values, an ecosystem monitoring framework, and a science-based action plan for the protection and restoration of aquatic biodiversity in Weda Bay under the Nickel Impact Programme Indonesia (NIPI).

All tasks shall be implemented in alignment with the parameter specifications presented in Annex 1 (Gap Analysis Matrix) and Annex 2 (Work Packages).

**Task-1: Inception and Study Design Finalization** to establish a robust and operational study design aligned with the TOR and ensure readiness for field implementation.

**Key Activities:**

- Review of secondary data (ESIA, previous studies, spatial datasets)
- Reconnaissance survey and validation of priority locations
- Finalization of **BACI/gradient-based station design** (near-field, plume, transition, far-field, control)
- Rapid screening to confirm suitability of control sites
- Finalization of methodologies for all Work Packages (Annex 2)
- Development of **QA/QC protocols** and a **Data Management Plan**
- Installation of field instruments (e.g., turbidity and temperature loggers)
- Definition of **event-based sampling triggers and SOPs**

**Task-2: Seasonal Survey I and Initial Data Collection** to collect baseline data during the first seasonal period and establish initial environmental and ecological conditions across all study components.

**Key Activities:**

1. Implementation of field surveys across all Work Packages (WP1–WP14), including:
  - **Habitat and benthic ecosystem surveys** (mangroves, seagrass, coral reefs)
  - **Coral reef assessment** (benthic cover, community composition, bleaching/disease, rugosity)
  - **Reef fish surveys** (abundance, biomass, trophic structure)
  - **Key invertebrate assessment** (e.g., sea cucumbers, clams, urchins)
  - **Plankton surveys** (phytoplankton composition, chlorophyll-a, zooplankton abundance)
  - **Soft-bottom benthos sampling** (macrofauna, diversity indices, functional groups)
  - **Water quality and sediment sampling** (TSS, turbidity, nutrients, metals, sediment characteristics)
2. Deployment and monitoring of field instruments (loggers)
3. Laboratory analysis of samples
4. Implementation of QA/QC procedures
5. Initial socio-ecological surveys (CPUE, fishing grounds mapping)

**Task-3: Preliminary Data Analysis and Adaptive Refinement:** to analyse initial findings and refine the study design where necessary.

**Key Activities:**

- Preliminary statistical and spatial analysis
- Identification of gradients, anomalies, and data gaps
- Validation of exposure pathways (plume dynamics, turbidity gradients)
- Minor adjustments to sampling design (if justified)
- Review of event-based sampling readiness

**Task-4: Seasonal Survey II and Event-Based Sampling** to capture seasonal variability and episodic environmental events, strengthening pressure–response attribution.

**Key Activities:**

- Repeated surveys across all ecological and environmental components:
  - coral reefs, seagrass, mangroves

- reef fish and key invertebrates
- plankton communities
- soft-bottom benthos
- Repeated water quality, sediment, and metal sampling
- Implementation of **event-based sampling** (rainfall, overflow, turbidity spikes, thermal exceedance)
- Oceanographic measurements (currents, plume tracking)
- Continued socio-ecological data collection
- QA/QC validation and data consolidation

**Task-5: Integrated Data Analysis and Risk Assessment** to integrate multi-component datasets and establish robust relationships between environmental pressures and ecosystem responses.

**Key Activities:**

- Integration of water–sediment–biota datasets
- Statistical analyses (BACI/gradient analysis, multivariate ecological analysis)
- GIS-based risk mapping, including:
  - turbidity and sedimentation
  - metal contamination
  - thermal plume exposure
  - habitat vulnerability
- Identification of ecological hotspots and areas of concern
- Analysis of socio-ecological interactions (fisheries dynamics and spatial conflicts)

**Task-6: Preparation of the Ecosystem Action Plan and Long-term Monitoring Plan:** to translate the scientific findings of the baseline study into a comprehensive and actionable framework for the sustainable management of Weda Bay ecosystems.

**Key Activities:**

- Development of a Weda Bay Ecosystem Action Plan, including:
  - identification of priority areas for conservation and restoration
  - definition of site-specific management measures (e.g., sediment control, habitat protection, pollution mitigation)
  - alignment with local and national policy frameworks
  - identification of responsible stakeholders and implementation pathways
- Formulation of management trigger values, including:
  - turbidity and TSS thresholds
  - sedimentation rates
  - dissolved and particulate metal thresholds
  - thermal plume thresholds ( $\Delta T$ )
- Development of Standard Operating Procedures (SOPs) for:
  - rapid response to environmental exceedances
  - event-based monitoring and verification
- Design of a Long-term Environmental Monitoring Plan, including:
  - parameters, stations, and frequency
  - BACI/control–impact structure
  - data management and reporting procedures
  - adaptive management mechanisms
- Integration of socio-ecological considerations into management planning (e.g., fisheries use, spatial conflicts)

**Task-7 Final Reporting and Deliverable Submission:** to compile and present all study outputs in a coherent, scientifically robust, and policy-relevant format.

- Baseline Study Report
- Aquatic Biodiversity Report
- Freshwater Assessment Report
- Integrated Management Action Plan
- Monitoring Framework and Indicators
- Executive Summary for Stakeholders (Maximum 12 pages)

**Task-8 Stakeholder Dissemination and Validation Workshop** to disseminate findings and ensure uptake into management and policy processes.

**Key Activities:**

- With GIZ-NIPI organization of dissemination workshops at:
  - District level (Central Halmahera Regency)
  - National level (relevant Ministries and agencies)
- Presentation of:
  - baseline findings
  - risk maps
  - action plan and monitoring framework
- Facilitation of stakeholder feedback and validation
- Incorporation of feedback into final outputs

*In addition to the reports required by GIZ in accordance with the AVB, the contractor submits the following reports:*

- *Inception report*
- *Contributions to reports to GIZ's commissioning party*
- *Brief quarterly or half-yearly reports on the implementation status of the project*

Certain milestones, as laid out in the table below, are to be achieved during the contract term:

Milestones/process steps/deliverables	Language & number of pages (for deliverables)	Deadline
Kick-off meeting with GIZ (and Bapperida & LH)	n/a	05 July 2026
Task-1: Inception and Study Design Finalization		
Deliverable-1a: Inception Report (final design, methodology, Quality Assurance/ Quality Control, workplan)	Full doc: Word/Excel format, page count as required, English.	30 July 2026
Deliverable-1b: Final station map and coordinates	GIS-Format: Shapefile (.shp), pdf format (with print quality of A0 size), English.	
Task-2: Seasonal Survey I and Initial Data Collection		

Milestones/process steps/deliverables	Language & number of pages (for deliverables)	Deadline
<b>Deliverable-2a:</b> Interim dataset (raw and processed with metadata)	English, data Incl. photos (minimum size per photo is 2.0 MB)	30 Sept 2026
<b>Deliverable-2b:</b> QA /QC documentation (initial)	Word format, English	
<b>Deliverable-2c:</b> Interim / Progress Report	Full doc: Excel/Word format, English, page count as required.	
<b>Task-3: Preliminary Data Analysis and Adaptive Refinement</b>		
<b>Deliverable-3a:</b> Interim analytical report	Combined with <b>deliverable 2c</b> , English	30 Sept 2026
<b>Deliverable-3b:</b> Updated sampling plan (if applicable)	Coordinates - along with the rationale for the changes (2-3 pages), English	
<b>Deliverable-3b:</b> Preliminary thematic and time-series maps of habitat distribution: <ul style="list-style-type: none"><li>- Map of the study area</li><li>- Time-series maps of coral reefs distribution (20-10-0)</li><li>- Time-series maps of seagrass distribution,</li><li>- Time-series maps of mangroves distribution</li><li>- Map of community fishing grounds</li></ul>	Pdf format (with print quality of A0 size), English	
<b>Task-4: Seasonal Survey II</b>		
<b>Deliverable-4a:</b> Complete dataset (Season I + Season II + event-based data)	Excel/Word format, English	30 Nov 2026
<b>Deliverable-4b:</b> Updated QA/QC report	Word format, English	
<b>Deliverable-4c:</b> Updated (final) thematic and time-series maps of habitat distribution: <ul style="list-style-type: none"><li>- Map of the study area</li><li>- Time-series (20, 10 years ago, &amp; current status) maps of coral reefs distribution</li><li>- Time-series maps of seagrass distribution,</li><li>- Time-series maps of mangroves distribution</li><li>- Map of community fishing grounds</li></ul>	GIS-Format: Shapefile (.shp), pdf format (with print quality of A0 size), English	30 Nov 2026
<b>Task-5: Integrated Data Analysis and Risk Assessment</b>		
<b>Deliverable-5a:</b> Integrated dataset and analytical outputs	n/a	



Milestones/process steps/deliverables	Language & number of pages (for deliverables)	Deadline
<b>Deliverable-5b:</b> Thematic risk maps <ul style="list-style-type: none"><li>- Turbidity and sedimentation</li><li>- Metal contamination</li><li>- Thermal plume exposure</li><li>- Habitat vulnerability</li></ul>	GIS-Format: Shapefile (.shp)/ GeoPackage (.gpkg), pdf format (with print quality of A0 size), English.	15 Dec 2026
<b>Deliverable-5c:</b> Draft analytical summary	The summary: format as required, English, page count as required.	
<b>Task-6: Preparation of the Ecosystem Action Plan and Long-term Monitoring Plan</b>		
<b>Deliverable-6a:</b> Ecosystem Action Plan for Weda Bay	Full doc: Word/Excel format, English & Bahasa, page count as required.	15 Dec 2026
<b>Deliverable-6b:</b> Management Trigger Values and SOP Document	Full doc: Word/Excel format, Bahasa, page count as required.	
<b>Deliverable-6c:</b> Long-term Environmental Monitoring Framework and Indicators	Full doc: Word/ Excel format, Bahasa, page count as required.	
<b>Task-7 Final Reporting and Deliverable Submission</b>		
<b>Deliverable-7a:</b> Final Baseline Report (Current Status of Weda Bay)	<ul style="list-style-type: none"><li>- Full doc: Word/Excel format, English, page count as required.</li><li>- Summary: Word format, Bahasa, 10-15 pages;</li></ul>	15 Jan 2027
<b>Deliverable-7b:</b> Complete dataset (raw + processed + GIS layers)	Format as required, English, page count as required.	
<b>Deliverable-7c:</b> Technical annexes and supporting documentation	Full doc: Word format, English, page count as required.	
<b>Task-8 Stakeholder Dissemination and Validation Workshop</b>		
<b>Deliverable-8a:</b> Presentation materials	PowerPoint: slide count as required, Bahasa.	20 Jan 2027
<b>Deliverable-8b:</b> Stakeholder Workshop Report	Word format, Bahasa, max 10 pages;	10 Feb 2027
<b>Deliverable-8c:</b> Final Validated Action Plan (if revised)	Full revised doc: Word/Excel format, English & Bahasa, page count as required.	19 Feb 2027

Period of assignment: from **29.06.2026** until **31.03.2027**

### 3. Concept

In the tender, the tenderer is required to show *how* the objectives defined in Chapter 2 (Tasks to be performed) are to be achieved, if applicable under consideration of further method-related requirements (technical-methodological concept). In addition, the tenderer must describe the project management system for service provision.

Note: The numbers in parentheses correspond to the lines of the technical assessment grid.

#### Technical-methodological concept

**Strategy (1.1):** The tenderer is required to consider the tasks to be performed with reference to the objectives of the services put out to tender (see Chapter 1 Context) (1.1.1). Following this, the tenderer presents and justifies the explicit strategy with which it intends to provide the services for which it is responsible (see Chapter 2 Tasks to be performed) (1.1.2).

The tenderer is required to present the actors relevant for the services for which it is responsible and describe the **cooperation (1.2)** with them. The bidder is expected to conduct presentations, facilitate communication, and maintain effective interaction with relevant stakeholders within the contractor's scope of responsibility to ensure coordination, alignment, and smooth implementation of project activities (1.2.1). The bidder should outline an approach for establishing collaborative relationships and ensuring continuous engagement and coordination with relevant actors to support effective project delivery (1.2.2).

The tenderer is required to present and explain its approach to **steering** the measures with the project partners (1.3.1) and its contribution to the **results-based monitoring system** (1.3.2).

The tenderer is required to describe the key **processes** for the services for which it is responsible and create an **operational plan** or schedule (1.4.1) that describes how the services according to Chapter 2 (Tasks to be performed by the contractor) are to be provided. In particular, the tenderer is required to describe the necessary work steps and, if applicable, take account of the milestones and **contributions** of other actors (partner contributions) in accordance with Chapter 2 (Tasks to be performed) (1.4.2).

The tenderer is required to describe its contribution to knowledge management for the partner (1.5.1) and GIZ and to promote scaling-up effects (1.5.2) under **learning and innovation**.

#### Project management of the contractor (1.6)

The tenderer is required to explain its approach for coordination with the GIZ project. In particular, the project management requirements specified in Chapter 2 (Tasks to be performed by the contractor) must be explained in detail. (1.6.1)

The tenderer is required to draw up a **personnel assignment plan** with explanatory notes that lists all the experts proposed in the tender; the plan includes information on assignment dates (duration and expert days) and locations of the individual members of the team complete with the allocation of work steps as set out in the schedule. (1.6.2)

The tenderer is required to describe its backstopping concept (1.6.3). The following services are part of the standard backstopping package, which (like ancillary personnel costs) must

be factored into the fee schedules of the staff listed in the tender in accordance with Section 3.1 of the GIZ AVB:

- Service-delivery control
- Managing adaptations to changing conditions
- Ensuring the flow of information between the tenderer and GIZ
- Assuming personnel responsibility for the contractor's experts
- Process-oriented steering for implementation of the commission
- Securing the administrative conclusion of the project

#### **Further requirements (1.7)**

Tenderers shall present a comprehensive methodological approach for undertaking the assessment in Weda Bay, covering at a minimum: (i) Sampling Design and Ecosystem Assessment Methodology; (ii) Environmental Quality Assessment Methodology; (iii) Data Integration and Analytical Framework; and (iv) Management Recommendations and Ecosystem Action Planning Methodology.

#### **4. Personnel concept**

The tenderer is required to provide personnel who are suited to filling the positions described, on the basis of their CVs (see Chapter 7), the range of tasks involved and the required qualifications.

The below specified qualifications represent the requirements to reach the maximum number of points in the technical assessment.

##### **Team leader**

###### Tasks of the team leader

- Overall responsibility for the advisory packages of the contractor (quality and deadlines)
- Coordinating and ensuring communication with GIZ, partners and others involved in the project
- Personnel management, in particular identifying the need for short-term assignments within the available budget, as well as planning and steering assignments and supporting local and international short-term experts
- Regular reporting in accordance with deadlines.
- Provide overall scientific and technical leadership for the Current Baseline Study in Weda Bay.
- Lead the development of BACI (Before–After–Control–Impact) and gradient-based sampling design.
- Ensure application of the Source–Pathway–Receptor analytical framework
- Lead development of management trigger values and monitoring indicators
- Lead interpretation of results and preparation of ecosystem management recommendations.
- Finalise all deliverables in accordance with deadlines.

###### Qualifications of the team leader

- Education/training (2.1.1): Doctoral degree in Marine Science, Oceanography, Environmental Science.
- Language (2.1.2): B2-level language proficiency in English

- General professional experience (2.1.3): 15 years of professional experience in the Environmental Assessment sector
- Specific professional experience (2.1.4): 7 years in Marine Environmental Assessment or ESIA
- Leadership/management experience (2.1.5): 10 years of management/leadership experience as project team leader or manager in a company
- Regional experience (2.1.6): Three years of experience in projects in Eastern Indonesia (region),
- Development cooperation (DC) experience (2.1.7): 10 years of experience in DC projects
- Other (2.1.8): 3 publications in accredited scientific journals, and include proof of the paper

### **Key expert 1: Marine Ecology Expert**

#### Tasks of key expert 1

- Lead the assessment of coastal and marine ecosystems, including coral reefs, seagrass meadows, and mangrove forests.
- Design and implement ecological survey methodologies.
- Assess ecological condition using appropriate indicators such as cover, species composition, structural complexity, and ecological health metrics.
- Evaluate environmental stressors, including sedimentation, turbidity, and potential industrial impacts.
- Support the development of habitat distribution maps in collaboration with the GIS specialist.
- Identify key ecological indicators for long-term monitoring and management.
- Provide technical input to the development of ecosystem management recommendations.

#### Qualifications of key expert 1

- Education/training (2.2.1): Master's degree or higher in Marine Ecology, Marine Biology, or Coastal Ecology
- Language (2.2.2): B2 -level language proficiency in English
- General professional experience (2.2.3): 10 years of experience in marine ecological monitoring programs or environmental impact assessment.
- Specific professional experience (2.2.4): 8 (eight) years of professional experience in ecological studies, with demonstrated specialization in mangrove, seagrass, coral reef, or coastal ecosystem ecology.
- Regional experience (2.2.6): Have conducted a baseline study in Eastern Indonesia

### **Key expert 2: Water Quality and Environmental Chemistry Specialist Expert**

#### Tasks of key expert 2

- Design water quality and sediment sampling protocols
- Analyse turbidity, sedimentation, and water quality parameters
- Assess metal contamination related to nickel industry (Ni, Co, Cr, Mn, Fe)
- Evaluate thermal discharge impacts from PLTU
- Interpret laboratory results and exposure pathways

Contribute to environmental risk assessment

#### Qualifications of key expert 2

- Education/training (2.3.1): Master's degree in environmental chemistry, Environmental Science.
- Language (2.3.2): B2 -level language proficiency in English,
- General professional experience (2.3.3): 8 years' experience in water quality assessment,
- Specific professional experience (2.3.4): 3 years' experience in marine or coastal water quality analysis and industrial pollution assessment.
- Other (2.3.8): Three reference projects of a similar scope.

### **Key expert 3: Coastal Oceanography and Hydrology Specialist**

#### Tasks of key expert 3

- Analyse current patterns and tidal dynamics
- Assess plume dispersion and sediment transport
- Evaluate residence time and environmental connectivity
- Analyse riverine inputs into Weda Bay and sources of potential contaminants
- Support sampling design and control site selection
- Support interpretation of environmental exposure pathways
- Contribute to environmental risk assessment

#### Qualifications of key expert 3

- Education/training (2.4.1): Master's degree in Oceanography
- Language (2.4.2): B2 -level language proficiency in English,
- General professional experience (2.4.3): 8 years' experience of professional oceanography experience.
- Specific professional experience (2.4.4): 5 years' experience in in coastal hydrodynamics preferred.

### **Key expert 4: Fisheries and Marine Biodiversity Expert**

#### Tasks of key expert 4

- Design and implement fisheries and marine biodiversity surveys.
- Conduct reef fish and benthic biodiversity assessments across sampling gradients.
- Analyse fish abundance, biomass, size structure, and trophic composition.
- Assess benthic biodiversity including key indicator taxa and ecological functional groups.
- Identify fisheries-relevant species and biodiversity indicators.
- Assess potential impacts of environmental changes on fisheries resources.
- Support socio-ecological interpretation of fisheries dynamics.
- Contribute to the development of biodiversity indicators for long-term monitoring
- Provide technical input to ecosystem management and fisheries sustainability recommendations

#### Qualifications of key expert 4

- Education/training (2.5.1): Master's degree in Fisheries Science, Marine Biology, Marine Ecology.
- Language (2.5.2): B2 -level language proficiency in English,
- General professional experience (2.5.3): 7 years of experience in fisheries and marine biodiversity assessment.
- Specific professional experience (2.5.4): 5 years' experience in reef fish and benthic biodiversity surveys,
- Regional experience (2.5.6): 3 years' experience in the Coral Triangle and Eastern Indonesia.

#### **Key expert 5: GIS and Remote Sensing Specialist**

##### Tasks of key expert 5

- Lead spatial analysis and geospatial data management for the Weda Bay baseline study.
- Develop habitat distribution maps for coral reefs, seagrass beds, mangroves, and intertidal ecosystems.
- Integrate spatial datasets from ecological, water quality, and oceanographic surveys.
- Conduct spatial analysis of environmental gradients and potential impact zones.
- Support identification of control and impact sites using spatial criteria.
- Develop environmental risk maps using spatial overlay analysis.
- Analyse plume dispersion patterns in collaboration with the oceanography specialist.
- Support mapping of fisheries uses areas and socio-ecological interactions.
- Develop spatial database and GIS data management system.
- Prepare high-quality maps and geospatial outputs for technical reports and decision-making.
- Support development of long-term monitoring station maps and spatial monitoring framework.

#### Qualifications of key expert 5

- Education/training (2.6.1): Master's degree in GIS, Remote Sensing, Geography, Marine Science, Environmental Science
- Language (2.6.2): B1 -level language proficiency in English,
- General professional experience (2.6.3): 7 years of experience in GIS and spatial analysis.
- Specific professional experience (2.6.4): Proficiency in GIS software (e.g., ArcGIS, QGIS, or equivalent); 5 years' experience in remote sensing analysis (e.g., satellite imagery, drone imagery, or aerial photography).

#### **Key expert 6: Environmental Monitoring Expert**

##### Tasks of key expert 6

- Lead the preparation of the ecosystem action plan and environmental monitoring framework for Weda Bay, based on the findings of the baseline assessment.
- Identify appropriate ecological and environmental indicators for long-term monitoring.
- Develop monitoring protocols and sampling frequency recommendations.

- Establish trigger values and management thresholds where appropriate.
- Ensure integration of ecological, water quality, and oceanographic indicators.
- Develop adaptive monitoring framework and early warning indicators.
- Support development of long-term ecosystem management and monitoring plan.
- Provide recommendations for institutional implementation of monitoring programs.

#### Qualifications of key expert 6

- Education/training (2.7.1): Master's degree in environmental science, Marine Science, Environmental Management,
- Language (2.7.2): B2 -level language proficiency in English,
- General professional experience (2.7.3): 8 years of experience in environmental monitoring program design,
- Specific professional experience (2.7.4): 5 year demonstrated experience in development monitoring program design in industrial coastal environments.
- Other (2.7.8): Knowledge of adaptive monitoring frameworks and environmental management systems

#### **Key expert 7: Health, Safety, and Environment (HSE) Officer**

##### Tasks of key expert 7

- Develop field safety plans
- Conduct risk assessments for field operations
- Ensure safety compliance for marine operations
- Manage emergency response procedures
- Ensure safety compliance in industrial areas
- Support logistics and safety coordination

#### Qualifications of key expert 7

- Education/training (2.8.1): University degree in Occupational Health and Safety,
- Language (2.8.2): B2 -level language proficiency in English,
- General professional experience (2.8.3): 8 years of experience in field survey safety management,
- Specific professional experience (2.8.4): 5 years demonstrated experience in marine and coastal safety management in industrial areas.

#### Soft skills of team members

In addition to their specialist qualifications, the following qualifications are required of team members:

- Team skills
- Initiative
- Communication skills
- Socio-cultural skills
- Efficient, partner- and client-focused working methods
- Interdisciplinary thinking

**Short-Term Expert Pool for Research and Data Collection: with minimum 4, maximum 5 members.**

For the technical assessment, an average of the qualifications of all specified members of the expert pool is calculated. Please send a CV for each pool member (see below Chapter 7 Requirements on the format of the bid) for the assessment.

Tasks of the short-term expert pool

- Provide specialized technical support for specific components of the baseline study, as required.
- Contribute to analysis of ecological conditions of ecosystems and ecological components.
- Contribute to the assessment of ecological risks.
- Assess habitat and hydrological connectivity.
- Assess ecosystem services provisioning.
- Ensure proper data management and data quality assurance/quality control (QA/QC).
- Contribute to advanced data interpretation and technical review of study outputs.
- Contribute to the development of management recommendations and monitoring strategies.
- Lead the assessment of toxic contaminants and bioaccumulation pathways in marine organisms and environmental media within the study area.
- Analyse the potential ecological risks associated with industrial activities and provide recommendations for environmental management and monitoring.

Qualifications of the short-term expert pool

- Education/training (2.9.1): Master's degree in environmental science, Marine Science, Environmental Management, Toxicology and Bioaccumulation.
- Language (2.9.2): 5 experts with B2-level language proficiency in English
- General professional experience (2.9.3): The team shall include
  - 3 experts with 8 years of professional experience in marine ecology, biology and biodiversity,
  - one expert with 5 years of professional experience in the socio-ecology or fisheries livelihood, and
  - An expert with 5 years of professional experience in the toxicology or bioaccumulation.
- Specific professional experience (2.9.4): The team shall include
  - Three (3) experts with 7 years of professional experience in mangrove, seagrass, coral reef ecology study; plankton and soft-bottom benthos ecology,
  - An (1) expert with five years of professional experience in socio-ecology or fisheries livelihoods, and
  - An (1) expert with 5 years' experience in toxicology and bioaccumulation studies in marine ecosystems affected by industrial activities.
- Regional experience (2.9.5): 3 experts with 3 years of experience in Eastern Indonesia (region).

The Tenderer must provide a clear overview of all proposed short-term experts and their individual qualifications.



## **Field Support Staff Pool for Assistant Data Collectors,**

(A concept needs detailing number of days per support staff group and required qualifications, e.g. divers or research assistants)

### Tasks of the Field support staff pool

- Provide technical assistant for specific components of the baseline study, as required.
- Support data collection activities in the field.
- Assist in communication and coordination with local communities in the study area.
- Provide operational support for field surveys and sampling activities.

### Qualifications of Field Support staff pool

- Education/training (2.10.1): University Degree in Fisheries, Marine Sciences, Biology.
- General professional experience (2.10.3): 3 years' experience in marine ecology or coastal area studies.
- Specific professional experience (2.10.4): Served as a Technical Assistant in underwater marine research and survey activities
- Regional experience (2.10.5): 3 years of experience in Halmahera Island

## **5. Costing requirements**

### **Assignment of personnel and travel expenses**

Per diem allowances are reimbursed as a lump sum up to the maximum amounts permissible under tax law for each country as set out in the country table in the circular from the German Federal Ministry of Finance on travel expense remuneration (downloadable from the [German Federal Ministry of Finance – tax treatment of travel expenses and allowances for international business travel as of 1 January 2026 \(GERMAN ONLY\)](#)).

Accommodation allowances are reimbursed as detailed in the specification of inputs below.

With special justification, additional Accommodation costs up to a reasonable amount can be reimbursed against evidence.

All business travel must be agreed in advance by the officer responsible for the project

### **Sustainability aspects for travel**

GIZ has undertaken an obligation to reduce greenhouse gas emissions (CO<sub>2</sub> emissions) caused by travel. When preparing your tender, please incorporate options for reducing emissions, such as selecting the lowest-emission booking class (economy) and using means of transport, airlines and flight routes with a higher CO<sub>2</sub> efficiency. For short distances, travel by train (second class) or e-mobility should be the preferred option.

CO<sub>2</sub> emissions caused by air travel must be offset. GIZ specifies a budget for this, through which the carbon offsets can be settled against evidence.

There are many different providers in the market for emissions certificates, and they have different climate impact ambitions. The [Development and Climate Alliance \(German only\)](#)

has published a [list of standards \(German only\)](#). GIZ recommends using the standards specified there.

#### Specification of inputs

Fee days	Number of experts	Number of days per expert	Total	Comments
Team leader	1	65	65 days	Lump sum, Timesheet required,
Marine Ecology Expert	1	40	40 days	Lump sum, Timesheet required,
Water Quality and Environmental Chemistry Specialist	1	40	40 days	Lump sum, Timesheet required,
Coastal Oceanography and Hydrology Specialist	1	35	35 days	Lump sum, Timesheet required,
Fisheries and Marine Biodiversity Expert	1	40	40 days	Lump sum, Timesheet required,
GIS and Remote Sensing Expert	1	35	35 days	Lump sum, Timesheet required,
Environmental Monitoring Expert	1	30	30 days	Lump sum, Timesheet required,
Health, Safety, and Environment (HSE) Officer	1	20	20 days	Lump sum, Timesheet required,
Expert pool	5	22	110 days	Lump sum, Timesheet required,
Designation of Field Support Staff pool	5	14	70 days	Lump sum, Timesheet required,
Travel expenses	Quantity	Number per expert	Total	Comments
Per-diem allowance in North Maluku (Weda)			298 days	Lump sum, GIZ Regulation

Accommodation in Ternate / Weda			298 nights	Against evidence, Travel within Indonesia
<b>Transport</b>	<b>Quantity</b>	<b>Number per expert</b>	<b>Total</b>	<b>Comments</b>
Domestic flights		Team	25 return flights	Travel within Indonesia, Against evidence
CO <sub>2</sub> compensation for air travel		Team	50 trips	Against evidence
Ground Transport: Airport Transfer (to/from Airport)		Team	25 return trips	Lump sum
Ground Transport: Local Transport (Sofifi-Weda & Weda to field)		Team	25 trips	Against evidence
Speedboat rental		Team	28 boat trips	Against evidence
<b>Other costs</b>	<b>Number</b>	<b>Price</b>	<b>Total</b>	<b>Comments</b>
Lab analyses (River & Marine Water, Sediment, Biota)	40 sample		40 sample	Against evidence
Rental : Field Survey Equipment such as Underwater Camera Systems, Remotely Operated Vehicles (ROVs), etc	14 times		14 times	Against evidence
Rental fo Field Safety Equipment: Personal Protective Equipment (PPE), Onboard Life-Saving & Distress Equipment, etc	14 times		14 times	Against evidence
Procurement of Sampling bottles & preservatives: sampling bottles, Aquades, gloves, etc (consumable)	1 package		1 package	Against evidence
Diving gear rental: including diving tank, regulator, snorkeling gear, wet suit, etc	6 times		6 times	Against evidence
Data Processing & Final Reporting (Dual Language)	2 report		2 report	Against evidence

VAT 11%	1 package		1 package	Against evidence
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## 6. Inputs of GIZ or other actors

GIZ and/or other actors are expected to make the following available:

- Logistics for Stakeholder Dissemination and Validation Workshop: meeting venues and equipment, catering, participant transport costs.
- Available existing data in the study region

## 7. Requirements on the format of the tender

The structure of the tender must correspond to the structure of the ToR. In particular, the detailed structure of the concept (Chapter 3) should be organised in accordance with the positively weighted criteria in the assessment grid (not with zero). The tender must be legible (font size 11 or larger) and clearly formulated. It must be drawn up in English.

The complete tender must not exceed **15** pages (excluding CVs). If one of the maximum page lengths is exceeded, the content appearing after the cut-off point will not be included in the assessment. External content (e.g. links to websites) will also not be considered.

The CVs of the personnel proposed in accordance with Chapter 4 of the ToRs must be submitted using the format specified in the terms and conditions for application. The CVs shall not exceed 4 pages each. They must clearly show the position and job the proposed person held in the reference project and for how long. The CVs can also be submitted in English.

Please calculate your financial tender based exactly on the parameters specified in Chapter 5 Quantitative requirements. The contractor is not contractually entitled to use up the days, trips, workshops or budgets in full. The number of days, trips and workshops and the budgets will be contractually agreed as maximum limits. The specifications for pricing are defined in the price schedule.

## 8. Annexes

- Annex 1 – Gap Analysis Matrix
- Annex 2 - Work Packages Baseline Study in Weda Bay

## **Annex 1 – Gap Analysis Matrix**

### **A. Habitat and Ecological Components**

<b>No</b>	<b>Component/ Module</b>	<b>Minimum Measurements</b>	<b>Scientific and Management Considerations</b>	<b>Key Design &amp; Methods</b>	<b>Minimum Frequency</b>	<b>Priority Locations</b>	<b>Management Outputs</b>
1	Habitat mapping (GIS)	Extent and distribution of seagrass, coral reefs, mangroves, intertidal habitats; habitat connectivity	Basis for zoning, station selection, and risk-overlay analyses	Drone/satellite imagery + field verification (ground-truthing); GIS	Baseline + annual update	Entire Weda Bay; stratified verification across near-field, estuary/plume, transition, far-field, and control strata	Habitat maps; priority maps for protection/rehabilitation
2	Mangroves – extent and change	Extent/distribution; canopy density classes; degradation hotspots; indicators of erosion/accretion	Basis for zoning, rehabilitation planning, and change evaluation	Satellite/drone imagery + field verification; GIS	Baseline + annual update	Main estuaries (SRE/Sake, GRE/Gemaf, SLC/Sagea); bay-fringing mangroves; mangrove controls	Zoning basis; rehabilitation priorities; change evaluation
3	Mangroves – stand structure and regeneration	Species composition; density by size/age class (trees/poles/saplings/seedlings); DBH; height; basal area; regeneration	Indicators of stand condition and recovery	Standard plots/transects (e.g., 10×10 m + regeneration subplots); species identification	Two seasonal periods + annual (priority sites)	Mangroves near estuaries/drainage; rehabilitation sites; controls	Stand health indicators; recovery performance indicators
4	Mangroves – function and sediment/chemical exposure	Nursery indicators; porewater salinity; sediment texture; (optional) TOC/metals at the mangrove–estuary interface	Assessment of ecological function and role as a sink/buffer for sediments and	Rapid assessment + porewater sampling; co-located sediment grab/core	Two seasonal periods + event-based (critical estuaries)	Mangrove–estuary interface; channels/lagoon (SLC/Sagea); near-field gradients	Basis for catchment (DAS) actions and mitigation; indicators of mangrove buffering function

No	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
			particle-bound contaminants			(estuaries/outfalls); controls	
5	Seagrass – taxonomy	Validated species list; reference specimens (vouchers)	Closes historical baseline identification gaps and enables auditability of identifications	Transect–quadrat; voucher specimens/photogra phic references; expert verification as needed	Two seasonal periods + annual audit	Major seagrass patches; historical baseline sites (Lelilef, Tanjung Lipe, Tanjung Uli, Sagea estuary/village); seagrass controls	Species-specific indicators and rehabilitation targets
6	Seagrass – condition	% cover by species, shoot density, canopy height, epiphyte load, stress indicators	Sensitive indicators of turbidity and sediment deposition	Transect–quadrat + photo-quadrat; standardized stress scoring	Two seasonal periods (+ quarterly for sensitive sites)	Near-field gradients (reclamation/jetty/outfall ) → transition → control; estuary/plume corridors (SRE/GRE/SLC)	Turbidity/deposition trigger thresholds; rehabilitation priorities
7	Seagrass – function (optional)	Nursery indicators; (optional) blue carbon	Strengthens ecosystem- services-based action planning	Small-scale RAE/BRUVS; sediment cores/TOC	Baseline + every 2–3 years	1 near-field site + 1 estuary/lagoon (Sagea) + 1 control; priority fishing-use areas	Economic–ecological value case; protection priorities
8	Coral reefs – benthic condition	Live coral/algae/rubble cover; bleaching/disease; rugosity	Health/resilience status and mitigation effectiveness evaluation	PIT/LIT + photo documentation; rugosity; stress scoring	Two seasonal periods + annual	Exposure gradient: near-field facilities (where habitat exists), transition, far-field, reef controls	Protection zones; resilience indicators; stress trigger thresholds

No	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
9	Reef fish	Abundance, size, biomass; trophic structure; target species	Fisheries status and ecosystem function	Size/biomass UVC and/or BRUVS	Two seasonal periods + annual	Co-located with reef stations (No. 8) along near-field–transition– far-field–control gradient	Fisheries rules/zoning basis; functional indicators
10	Key invertebrates	Sea cucumbers/giant clams/urchins; COTS if present	Indicators of harvest pressure and reef stability	Belt transects/photo methods	Two seasonal periods + annual	Co-located reef/intertidal stations; focus on high-use zones + controls	Protection targets; exploitation control priorities

## B. Water-Column Biota and Soft-Bottom Benthos

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
11	Phytoplankton	Chlorophyll-a; functional composition; indicative HAB screening	Early warning for eutrophication/thermal effects	Pigments + microscopy; integration with nutrient data	Monthly for 6–12 months + event- based	Near-field outfalls/PLTU; estuary/plume (SRE, GRE, SLC/Sagea); transition; far-field; controls	Bloom-risk detection; support for nutrient/operational decisions
12	Zooplankton	Abundance; dominant group composition	Food-web baseline and recruitment context	Plankton net tows; group- level identification	Monthly for 6–12 months + event- based	Co-located with No. 11 (to ensure interpretive consistency)	Productivity and recruitment indicators

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
13	Soft-bottom benthos	Abundance, biomass, richness, indices; functional feeding groups	Integrative indicators of sedimentation and sediment-bound contamination	Grab/core + sieving; taxonomic identification	Two seasonal periods + annual	Estuaries/channels/lagoon (SRE, GRE, SLC/Sagea) + near-field (drainage/outfalls/reclamation) + habitat-matched soft-bottom controls	Sensitivity mapping; sediment management guidance

### C. Water Quality, Metals, Sediment, Sedimentation, Bioaccumulation

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
14	Physical/optical water quality	TSS, turbidity, Secchi/Kd(PAR), temperature, salinity	Light limitation and smothering mechanisms; basis for triggers	Continuous loggers + grab sampling + laboratory analysis	Monthly for 6–12 months + event- based	Near-field (reclamation/PLTU/outfalls/jetty); estuary/plume; transition; far-field; controls	Turbidity thresholds; response SOPs
15	Core chemical water quality	pH, DO, alkalinity, chlorophyll-a, DIN/DIP	Eutrophication/hypoxia assessment; context for plankton	Grab + lab; sonde measurement	Monthly + event- based	Co-located with No. 14; emphasis on estuaries/plumes and near- field outfalls	Nutrient/DO thresholds; source-control guidance
16	Dissolved and particulate metals	Ni, Co, Cr, Mn, Fe, Al; Hg/As if context-relevant; dissolved vs	Chronic exposure and transport pathways	0.45 µm filtration +	Monthly initially → quarterly + event- based	Near-field (outfalls/drainage/PLTU/reclamation); estuary/plume; transition;	Metal trigger thresholds;



No .	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
		particulate fractions		ICP; stringent QA/QC		controls (event-based emphasis on estuaries/outfalls)	source-mitigation priorities
17	Sediment – chemistry and bioavailability	Total metals, fine fraction, TOC; (optional) SEM– AVS	Contaminant reservoir; bioavailability indication	Grab/core; granulometry; laboratory analysis	Two seasonal periods (or quarterly near- field)	Near-field reclamation/outfalls; estuaries/channels/lagoon; deposition hotspots; habitat- matched sediment controls	Sediment risk mapping; sediment management guidance
18	Sedimentation rate	Deposition (g/m <sup>2</sup> /day)	Direct indicator of seagrass/coral smothering risk	Sediment traps	Monthly for ≥6 months + event- based	Sensitive seagrass and reef sites across near-field, estuary/plume, transition, and controls	Deposition thresholds; evaluation of erosion mitigation effectiveness
19	Bioaccumulation (sentinels)	Metals in bivalves/demersal fish/seagrass tissues	Biological exposure and seafood safety relevance	Sentinel sampling + tissue analysis	Quarterly/biannual	Near-field + estuary/plume + controls; aligned with priority fishing grounds	Risk communication basis; rapid- response actions

#### D. Oceanography, Hydrology, and Source Inventory

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
20	Oceanography and plume dynamics	Currents, tides, plume mapping, residence time	Pressure–response attribution; validation of exposure gradients	ADCP/drifters + remote sensing + transects	Two seasonal periods + event- based (rainfall- driven)	Near-field–estuary/plume– transition–far-field–control corridors; focus on pathways toward sensitive habitats	Exposure pathway maps; optimization of control-site placement
21	River hydrology	Discharge, river TSS, sediment loads	Catchment (DAS) action targeting and sediment inputs	Discharge measurements + TSS sampling	Monthly + event- based (rainfall)	Main rivers: Sake, Gemaf, Sagea (+ other major drainage outlets)	DAS intervention priorities; plume load projections
22	Source/pressure inventory	Outfalls, drainage, reclamation, stockpiles; land- cover change	Links mitigation actions to specific sources	Field audits + time-series imagery analysis	Semi- annual/annual	All coastal source points; emphasis on outfalls/drainage, slag reclamation, stockpiles/open areas, jetty/port, priority sub- catchments	Prioritized source register; source- control plan

## E. Socio-Ecology, Ecosystem Services, Triggers, and Monitoring Design

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
23	Fisheries and resource use	CPUE, fishing locations, seasonality, size structure	Ensures realistic and legitimate action planning	Surveys/logbooks; FGDs; participatory mapping	Seasonal + annual	Fishing villages near industrial areas + far- field/control comparators; key fishing grounds identified through mapping	Use-zoning; governance recommendations
24	Ecosystem services and critical areas	Nursery hotspots; culturally important areas	Prioritization for protection/compensation and trade-off management	FGDs + RAE + GIS overlay	Baseline + annual review	Mangrove–seagrass– estuary–lagoon zone (Sagea) + identified cultural/economic areas	Maps of critical areas; trade-off mitigation options
25	Management trigger thresholds and response SOPs	Thresholds for turbidity/TSS, deposition rate, thermal exceedance ( $\Delta T$ ), and metals; ecological targets for habitat cover and fish biomass	Thresholds for turbidity/TSS, deposition rate, thermal exceedance ( $\Delta T$ ), and metals; ecological targets for habitat cover and fish biomass	Thresholds for turbidity/TSS, deposition rate, thermal exceedance ( $\Delta T$ ), and metals; ecological targets for habitat cover and fish biomass	After 6–12 months of data; annual review	Near-field (slag reclamation, drainage/outfalls, power plant outfall); estuary/plume corridors (SRE/GRE/SLC); sensitive habitats (priority seagrass and reefs); matched control stations	Response SOPs; management KPIs; basis for corrective actions and mitigation effectiveness evaluation
26	BACI monitoring design	Control vs impact; replication; consistency	Impact evaluation and effectiveness assessment	Sampling plan + SOP + QA/QC	Developed upfront; annual review	Paired impact–control per major habitat (priority near-field and estuary/plume) +	Defensible monitoring plan

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
						transition/far-field comparators	

## F. Specific Pressures

No.	Component/ Module	Minimum Measurements	Scientific and Management Considerations	Key Design & Methods	Minimum Frequency	Priority Locations	Management Outputs
27	Slag-based reclamation (pressure)	Leach tests; fine fraction; TSS/turbidity; deposition; water/sediment metals	Smothering and leaching risk assessment	Slag sampling + leach tests; traps; metals analysis	Baseline + quarterly + event-based (during works)	Active reclamation zone (near- field) + distance gradient + habitat-matched controls	Reclamation SOPs; fine- fraction limits; compliance monitoring
28	Power plant thermal discharge (pressure)	$\Delta T$ plume; DO/pH; bleaching indicators; biotic responses	Thermal stress and DO risk	Continuous temperature loggers + transects; coral/seagrass surveys	Continuous + two seasonal periods; intensified at peak load	PLTU intake–outfall (near-field) + plume gradient + habitat- matched controls	Operational SOPs; outfall/diffuser design inputs
29	Tailings/leakage (pressure)	Source inventory; metals; TSS; pH/redox (context- specific); sediments; sentinels	Episodic and chronic risk characterization	Water–sediment– biota triad; event- based sampling	Monthly–quarterly + event-based (rainfall/overflow)	High-risk sources/outfalls/drainage + main estuaries (SRE/GRE/SLC) + plume corridors toward sensitive habitats + controls	Early warning and rapid response; source-control actions

## **Annex 2 – Work Packages Baseline Study in Weda Bay**

### **WP1 — Habitat Mapping and GIS**

Habitat mapping will be conducted using drone and/or high-resolution satellite imagery, complemented by systematic ground-truthing surveys. The mapping will cover coral reefs, seagrass beds, mangroves, intertidal habitats, and soft-bottom environments. Spatial analyses will include habitat distribution, patchiness, connectivity, and exposure gradients.

Outputs will include geospatial habitat maps, spatial extent estimates, and GIS layers to support sampling station selection, risk analysis, and management zoning.

### **WP2 — Mangrove Ecosystem Assessment**

Mangrove distribution and condition will be assessed using remote sensing combined with field-based vegetation surveys. Standardized plots and transects will be applied to measure species composition, density, size-class structure, regeneration, and health indicators.

At the mangrove–estuary interface, sediment samples and environmental parameters will be collected to evaluate exposure to sedimentation and potential metal contamination. The ecological role of mangroves as sediment and contaminant sinks will also be assessed.

### **WP3 — Seagrass Ecosystem Assessment**

Seagrass surveys will use line transect–quadrat and photo-quadrat methods. Parameters will include species-specific cover, shoot density, canopy height, epiphyte load, and stress indicators such as smothering and turbidity impacts.

Taxonomic identification will be validated through voucher specimens. Optional ecosystem service modules, including nursery habitat and blue carbon potential, may be incorporated where relevant.

### **WP4 — Coral Reef Assessment**

Coral reef surveys will employ PIT/LIT transects and photo-transects to quantify benthic cover, substrate composition, and coral health indicators including bleaching, disease, and partial mortality. Structural complexity will be assessed using rugosity measurements.

Sediment stress indicators and turbidity-related impacts will be evaluated where relevant.

### **WP5 — Reef Fish and Key Invertebrates**

Reef fish surveys will use underwater visual census and/or BRUVS. Parameters include abundance, biomass, size structure, and trophic composition.

Key invertebrates such as sea cucumbers, giant clams, sea urchins, and crown-of-thorns starfish will be recorded using standardized methods.

## **WP6 — Water Quality and Sedimentation**

Continuous monitoring will be conducted using turbidity and temperature loggers. Discrete water sampling will measure:

- TSS
- Turbidity
- Secchi/Kd(PAR)
- DO
- pH
- Nutrients
- Chlorophyll-a

Sediment traps will measure sedimentation rates across exposure gradients.

## **WP7 — Water–Sediment Chemistry and Metals**

Water and sediment samples will be analyzed for:

- Dissolved metals
- Particulate metals
- Grain size
- TOC
- Fine fraction

QA/QC protocols will include blanks, duplicates, and certified reference materials.

## **WP8 — Bioaccumulation (Sentinel Biota)**

Sentinel organisms will be sampled to assess bioaccumulation of metals. Potential species include:

- Bivalves
- Demersal fish
- Seagrass tissue

Exposure pathways and potential risks will be evaluated.

## **WP9 — Coastal Oceanography and Plume Mapping**

Hydrodynamic measurements will include:

- Current measurements (ADCP)
- Drifters
- Remote sensing

Seasonal surveys and event-based sampling will be conducted.

## **WP10 — River Hydrology and Sediment Loads**

River discharge and sediment loads will be measured at key river systems. Event-based sampling during rainfall events will be conducted.

Source–pathway analysis will be developed.

## **WP11 — Socio-Ecology and Resource Use**

Socio-economic data collection will include:

- CPUE
- Fishing patterns
- Cost structures
- Participatory mapping

Focus group discussions will be conducted.

## **WP12 — Water Column Biota and Soft-Bottom Benthic Community**

Phytoplankton, zooplankton, and macrozoobenthos will be assessed.

Parameters include:

- Abundance
- Diversity
- Functional groups
- Biomass

Relationships with sedimentation and water quality will be analysed.

## **WP13 — Integration, Management Trigger Values, and Action Plan**

Pressure–response relationships will be analysed. Risk maps will be developed.

Management trigger values will be established.

Outputs include:

- Action Plan
- Monitoring priorities
- Management recommendations

## **WP14 — Environmental Monitoring Framework Development and Indicator Design**

A comprehensive environmental monitoring framework will be developed based on baseline results. Indicators will be developed for:

- Coral reefs
- Seagrass
- Mangroves
- Fish
- Benthos
- Water quality
- Sediment
- Metals

Monitoring stations, frequency, and trigger thresholds will be defined.

Outputs include:

- Monitoring framework
- Indicator matrix
- Monitoring roadmap
- Adaptive management framework