INITIAL ENVIRONMENTAL EVALUATION (IEE) REPORT

THE PROGRAMME FOR EMERGENCY REHABILITATION OF PRINCIPAL ECONOMIC INFRASTRUCTURE AFFECTED BY THE EARTHQUAKE

Port Vila, Efate Island, Republic of Vanuatu

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Executive Summary

The Government of Vanuatu, through the Ministry of Infrastructure and Public Utilities (MIPU) and the Public Works Department (PWD), is undertaking the *Programme for Emergency Rehabilitation of Principal Economic Infrastructure Affected by the Earthquake*. This project focuses on replacing the seismically damaged Tagabe Bridge, upgrading the Smet–Huarere Studio Road, and constructing a permanent detour bridge to maintain connectivity during works. The 17 December 2024 earthquake caused significant structural distress to the existing Tagabe Bridge, compromising its safety and threatening access between Bauerfield International Airport, key residential areas, and the Port Vila Central Business District. The initiative is funded through Japan's post-earthquake recovery grant assistance, implemented with technical support from the Japan International Cooperation Agency (JICA).

The project area lies along the Tagabe River corridor, which is critical for Port Vila's urban water supply and contains urban settlements that will experience temporary but manageable construction-related impacts. All works occur within the existing road reserve; therefore, no land acquisition or physical displacement is required.

Environmental baseline assessments indicate that the Tagabe River is generally healthy in its upper reaches but shows declining microbial quality and light turbidity downstream due to urban influences. Air quality in the area is fair, with occasional dust contributions from roadside activity, while noise levels are moderate near the road corridor. Riverbanks, although locally degraded, present strong potential for ecological improvement through strategic revegetation and stabilization.

Key impacts during construction include temporary increases in dust, noise, sediment runoff, and traffic delays. These impacts are short-term, predictable, and reversible. The project incorporates a comprehensive Environmental and Social Management Plan (ESMP) that includes erosion and sediment controls, careful waste management, revegetation of riparian areas, monitoring of air, noise, and water quality, and clear communication with nearby communities. Special emphasis is placed on safeguarding the Tagabe River, given its role in supplying the Port Vila water system, by implementing stringent pollution and spill-prevention measures.

Community consultation results indicate a high level of awareness and strong support for the project, with feedback primarily focused on short-term construction concerns such as dust control, detours, and traffic delays. These concerns have been incorporated into the ESMP. The project also integrates climate- and seismic-resilient design elements, including strengthened foundations, improved drainage, and flood-resistant structures, contributing to Vanuatu's broader disaster recovery and climate adaptation goals.

Overall, the Initial Environmental Examination (IEE) finds that the proposed works will not result in significant or irreversible environmental or social impacts. With proper implementation of mitigation measures, the project will deliver long-term benefits through restored connectivity, enhanced transport safety, improved resilience, and strengthened community access between key urban areas. The project is therefore suitable for implementation and recommended for approval.

Acronyms

Acronym	Definition
ARAP	Abbreviated Resettlement Action Plan
CBD	Central Business District
CLO	Community Liaison Officer
DEPC	Department of Environmental Protection and Conservation
DoWR	Department of Water Resources
EIA	Environmental Impact Assessment
ECoP	Environmental Code of Practice
EMP / ESMP	Environmental and Social Management Plan
ESMMP	Environmental and Social Management and Monitoring Plan
ESS	Environmental and Social Standards (World Bank)
GBV	Gender-Based Violence
GRM	Grievance Redress Mechanism
IEE	Initial Environmental Examination
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
MIPU	Ministry of Infrastructure and Public Utilities
OHS	Occupational Health and Safety
OCHS	Occupational and Community Health and Safety
PWD	Public Works Department
PVMC	Port Vila Municipal Council
VMGD	Vanuatu Meteorology and Geo-Hazards Department
WHO	World Health Organization

1. Introduction

1.1 Background and Rationale

The '*The Programme for Emergency Rehabilitation of Principal Economic Infrastructure Affected by the Earthquake*' Project is a priority infrastructure rehabilitation initiative aimed at restoring and strengthening critical transport connectivity between Bauerfield International Airport and Port Vila city centre on Efate Island, Vanuatu. The Tagabe Bridge serves as the primary link along the main arterial corridor connecting the airport, industrial areas, and central business district. This route supports high daily traffic volumes, including public transport, logistics, and emergency services. The bridge's strategic importance to the urban economy and mobility network makes its structural reliability a national concern.

On 17 December 2024, a significant earthquake struck the central part of Efate, causing extensive damage to urban infrastructure within Port Vila. The Tagabe Bridge sustained substantial structural distress due to ground shaking and foundation movement, rendering it unsafe for continued heavy vehicular use. The event also caused localized failures in approach roads, drainage systems, and embankments along the Tagabe River corridor. In response, the Government of Japan, through the Japan International Cooperation Agency (JICA), provided a grant assistance package as part of its post-earthquake recovery aid to the Government of Vanuatu. The project is therefore aligned with the broader national disaster recovery and resilience-building program, aiming to restore essential transport links while enhancing climate and seismic resilience in bridge and road design.

The project comprises three key components:

1. **Reconstruction of the Tagabe Bridge with a new two-lane reinforced concrete structure, improved abutments, revetment, and stormwater drainage;**
2. **Construction of a Detour Bridge, which will serve as an alternate crossing during construction and will remain as a permanent secondary bridge to improve network redundancy and traffic management; and**
3. **Upgrading of the existing tar-sealed road from Smet to Huarere Studio to a concrete pavement, ensuring durable access for both construction and long-term use.**

The Tagabe River, which flows beneath the project site, is the primary water source for the Port Vila urban water system operated by UNELCO. The Tagabe Bridge lies approximately 1.6 kilometres downstream from the UNELCO Pump Station, while the proposed Detour Bridge is located about 1.2 kilometres from the river source. Given this proximity, special attention is required to protect the river's water quality and prevent construction-related contamination that could affect the urban water supply. Appropriate sediment control, wastewater management, and spill prevention measures will therefore be integrated into the project's environmental management plan.

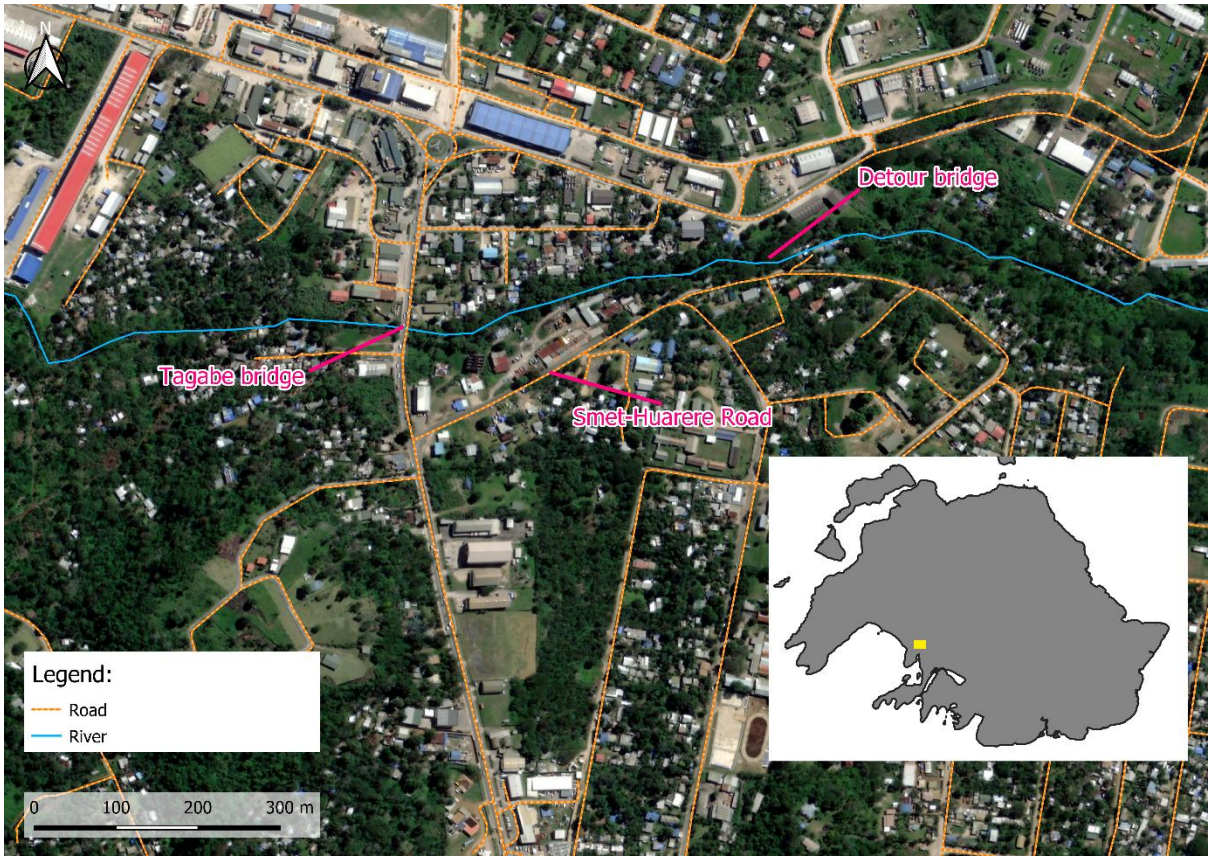


Figure 1: Location of the project site. Yellow box in insert indicates map area.

Several settlement clusters and small communities are situated adjacent to both bridge sites, comprising residents from diverse island and cultural backgrounds residing on urban leased land. While these communities are not expected to be physically displaced, the project will engage them through consultation and participation mechanisms to manage temporary construction impacts such as noise, dust, and access restrictions.

In summary, the project's rationale lies in ensuring the safe, reliable, and climate-resilient connectivity between Vanuatu's international gateway and its capital city. It contributes directly to post-earthquake recovery, disaster risk reduction, and sustainable infrastructure development, while safeguarding the Tagabe River water catchment and minimizing disturbance to the surrounding urban communities.

1.2 Objectives of the IEE

The objective of this Initial Environmental Examination (IEE) is to assess the potential environmental and social impacts associated with the project, which includes the reconstruction of the Tagabe Bridge, construction of a permanent Detour Bridge, and upgrading of the Smet–Huarere Studio Road section. The IEE provides the basis for informed decision-making by identifying potential risks, evaluating their significance, and recommending appropriate mitigation and monitoring measures in accordance with JICA Environmental and Social Considerations Guidelines (2022) and the national Environmental Protection and Conservation Act [CAP 283].

Specifically, the IEE aims to:

- Establish the existing environmental and social baseline conditions in and around the project area;
- Identify and assess the potential positive and negative impacts of the proposed works during both construction and operation phases;
- Recommend feasible mitigation and enhancement measures to prevent, minimize, or offset any adverse impacts;
- Develop an Environmental and Social Management and Monitoring Plan (ESMMP) to ensure effective implementation, supervision, and compliance with national and donor safeguards; and
- Facilitate stakeholder engagement and transparency by incorporating community inputs into project planning and environmental management.

Through this assessment, the IEE ensures that the project is designed and implemented in a socially acceptable, environmentally responsible, and technically sound manner, supporting both national recovery priorities and sustainable infrastructure development objectives.

1.3 Scope and Methodology

The scope of this IEE covers all activities associated with the project, including the reconstruction of the existing Tagabe Bridge, construction of the permanent Detour Bridge, and upgrading of the Smet–Huarere Studio Road section to a concrete pavement standard. The assessment considers the entire project lifecycle—from design and pre-construction through construction, operation, and maintenance—within the defined project influence area along the Tagabe River corridor in Port Vila.

The IEE examines key environmental and social components likely to be affected by the project, including physical conditions (topography, hydrology, water quality, air and noise environment, and soils), biological conditions (terrestrial and aquatic habitats, vegetation, and biodiversity), and socio-economic and cultural aspects (land use, community health and safety, livelihoods, and cultural heritage). Special attention is given to the proximity of the project to the Tagabe River water source, which supplies the Port Vila urban water system managed by UNELCO.

The methodology followed both JICA Guidelines for Environmental and Social Considerations (2022) and the Vanuatu DEPC screening and review procedures. It included:

- Desk review of relevant policies, legislation, technical reports, and design drawings;
- Field reconnaissance and site inspections to establish baseline environmental conditions and identify potential impact zones;
- Stakeholder consultations with government agencies, local communities, and utility providers to gather concerns and recommendations;
- Impact identification and evaluation using qualitative and quantitative criteria based on project characteristics and site sensitivity; and
- Formulation of mitigation and monitoring measures guided by the mitigation hierarchy (avoid, minimize, restore, offset) to ensure compliance with national and donor standards.

The findings of the IEE provide a comprehensive understanding of the project's environmental and social implications and form the basis for the Environmental and Social Management and Monitoring Plan (ESMMP), which will guide implementation, supervision, and reporting throughout the project cycle.

1.4 IEE Process and Compliance Framework

The IEE for the project has been undertaken to meet the environmental safeguard requirements of both the Government of Vanuatu and the Japan International Cooperation Agency whilst aligning with the World Bank's Environmental and Social Standards (ESSs). It serves as the principal instrument to ensure that the proposed works are environmentally sound, socially acceptable, and in full compliance with applicable national laws and international donor standards.

Under the Environmental Protection and Conservation Act [CAP 283], all development activities that may cause environmental impacts are subject to environmental assessment and clearance from the DEPC. The Act requires the project proponent to submit a project description and supporting assessment (in this case, the IEE) to DEPC for screening and review. Depending on the potential level of impact, DEPC determines whether a full Environmental Impact Assessment (EIA) is necessary.

In parallel, the project must comply with JICA Guidelines for Environmental and Social Considerations (2022), which outline the process of screening, scoping, and environmental categorization. Based on the nature and scale of the proposed interventions, the project has been classified as Category B, indicating that while adverse impacts may occur, they are expected to be less significant, localized, and mitigable. The IEE therefore provides an appropriate level of assessment consistent with JICA's requirements for Category B projects.

The IEE process followed for this project included several key stages:

1. **Screening** – to confirm the environmental categorization (Category B) and define the scope of study;
2. **Scoping** – to identify key environmental and social issues, potential receptors, and relevant study boundaries;
3. **Baseline data collection** – through field surveys, site inspections, and literature review to describe existing environmental and social conditions;
4. **Impact assessment** – to predict and evaluate the magnitude, extent, and duration of potential impacts during design, construction, and operation phases;
5. **Mitigation planning** – to identify measures that prevent, minimize, or compensate for adverse effects using the mitigation hierarchy;
6. **Formulation of an Environmental and Social Management and Monitoring Plan (ESMMP)** – outlining implementation responsibilities, monitoring indicators, and reporting mechanisms; and
7. **Public consultation and disclosure** – to ensure that affected communities and stakeholders have been informed and given the opportunity to provide feedback.

Compliance with these processes ensures that the project adheres to international best practice in environmental and social management, promotes transparency and accountability,

and strengthens institutional capacity for sustainable infrastructure development. The IEE also supports the preparation of permit documentation for submission to DEPC, and establishes a monitoring framework that will be maintained throughout project implementation and operation.

2. Policy, Legal and Institutional Framework

This section outlines the environmentally-related policy, legal, and institutional context governing the project. It describes the national regulatory framework, institutional roles, and international safeguard systems under which the project will be implemented. As the project is financed through the JICA as part of Japan's post-earthquake recovery assistance to Vanuatu, the IEE has been prepared to comply with JICA's environmental guidelines, while also aligning with Vanuatu's national environmental requirements administered by the DEPC.

2.1 National Legislation

Environmental Protection and Conservation (EPC) Act [CAP 283] and EIA Regulations (2011/2012)

The EPC Act is the principal environmental legislation in Vanuatu, establishing the Department of Environmental Protection and Conservation (DEPC) and mandating environmental impact assessment (EIA) for developments that may have significant environmental or social impacts.

The EIA Regulations outline the procedural requirements for screening, scoping, consultation, impact assessment, and approval, including the requirement for an Environmental Management and Monitoring Plan (EMMP) and DEPC's responsibility to conduct annual environmental audits.

Relevance: The Tagabe Bridge reconstruction triggers mandatory environmental assessment due to its scale and potential impacts on the river, surrounding communities, traffic, and public safety.

Pollution Control Act (2013)

This Act regulates pollution to land, air, and water and establishes offences for the discharge of contaminants without appropriate controls.

Relevance: Bridge demolition, piling, earthworks, and riverbank stabilisation must comply with pollution control measures to prevent contamination of the Tagabe River and surrounding environment.

Waste Management Act (2014) and Waste Management Regulations (2019)

These instruments provide a comprehensive framework for waste identification, transport, disposal, recycling, and licensing of waste operators.

Relevance: Construction and demolition waste must be managed responsibly, including hazardous materials and riverine debris.

Water Resources Management Act (2002) and Water Supply Act [CAP 24]

These laws regulate the use, protection, and quality of surface and groundwater resources. The national drinking water standards (2016) set minimum thresholds for potable water safety.

Relevance: The Tagabe River is a sensitive water body, requiring strict erosion, sediment and spill control measures to protect water quality and downstream users. The project will require a Water-Works Permit for the construction of the Detour and Tagabe bridge.

Physical Planning Act [CAP 193] (Amended 2021)

This Act empowers municipal and provincial authorities to regulate land use and development by issuing planning and construction approvals.

Relevance: The project requires compliance with Port Vila Municipal Council (PVMC) development and construction requirements.

Public Health Act

This Act regulates sanitation, public health protection, and environmental hygiene.

Relevance: Dust suppression, noise management, vector control, wastewater handling, and site sanitation during construction fall under its provisions.

Control of Nocturnal Noise [CAP 40]

Noise generation between 9:00 pm and 5:00 am is restricted.

Relevance: Construction scheduling must avoid night works unless specifically authorised.

Forestry Act (2001)

Provides for conservation forest designation and sustainable resource management.

Relevance: Vegetation clearing along riverbanks must comply with forestry requirements and ensure minimal disturbance.

Quarry Act [CAP 190]

Regulates quarrying, mining, and extraction of aggregate materials.

Relevance: Contractors must source construction materials from licensed quarries.

Public Roads Act (2013/2020 Consolidation) and Road Traffic (Control) Act [CAP 29]

These Acts regulate road construction, road safety, access, traffic management, and protection of public roads.

Relevance: Temporary detours, roadside occupation, safety barriers, and traffic control plans must comply with national and municipal requirements.

Labour and Employment Legislation

Key Acts include the Employment Act, Labour (Work Permits) Act, Minimum Wage Order, and Health and Safety at Work Act. Together, they regulate employment standards, foreign worker permits, minimum wages, and worker health and safety.

Relevance: All contractors must ensure fair wages, safe working conditions, adequate PPE, and compliance with labour rights.

Social Inclusion Policies

- **National Gender Equality Policy (2020–2030)** promotes gender-responsive development.
- **National Disability Inclusive Development Policy** ensures accessibility and inclusion of persons with disabilities.
- **Protection of Traditional Knowledge and Expressions of Culture Act (2019)** requires FPIC for use of traditional knowledge.

Disaster Risk Management Act (2019)

Strengthens national resilience, early warning systems, and disaster response.

Relevance: Bridge design and construction must integrate resilience to cyclones, floods, and climate change risks.

Land Surveyors Act [CAP 175]

Regulates cadastral and boundary surveys.

Relevance: Required for verifying land boundaries for temporary access and any land acquisition.

Table 1: Key National Legislation, Regulations and Policies Relevant to the Project.

Laws & Regulations of Vanuatu	Summary of Legislation/Policy	Relevance to the Project
Environmental Protection and Conservation Act No. 12 of 2002 [CAP 283] (Amended 2010, 2019)	Principal environmental law establishing DEPC, environmental protection measures, conservation areas, biodiversity protection, and environmental permitting requirements. Provides legal basis for Environmental Impact Assessment (EIA).	Requires an environmental assessment for the project; compliance with environmental permits; ensures mitigation of impacts on ecosystems, watercourses, and surrounding communities.
Public Health Act [CAP 234]	Regulates matters related to public health, sanitation, pollution, disease prevention, and environmental hygiene.	Construction activities must uphold public health standards—control dust, noise, waste, and prevent contamination of water sources near communities.
Pollution (Control) Act No. 10 of 2013	Controls pollution affecting land, water, and air, including licensing of activities that may cause pollution. Establishes offences for unlawful discharge.	Construction works (bridge demolition, earthworks) must avoid pollution of the Tagabe River; requires proper waste, sediment and spill management.
Physical Planning Act [CAP 193] (Amended 2021)	Establishes planning areas, development consents, and oversight of land-use planning by municipal and provincial authorities.	Project must comply with Port Vila Municipal Council (PVMC) planning requirements, including construction approvals and land-use compliance.
Environmental Impact Assessment Regulations No. 175 of 2011 (Amended 2012)	Sets procedures for conducting EIA based on project category; outlines format, public consultation, EMMP requirements, and audit obligations.	Project must undergo screening, review, and approval by DEPC; must comply with EMMP and facilitate public consultations; subject to annual environmental audits.
Water Supply Act [CAP 24] & Vanuatu National Drinking Water Quality Standards (2016)	Provides standards for drinking water quality and management of water supply systems.	Works must avoid pollution of community water supplies; ensure construction does not compromise potable water sources and meets quality thresholds.
Water Resources Management Act No. 9 of 2002	Governs the use, protection, and management of surface and groundwater. Allows declaration of Water Protection Zones.	Construction near the Tagabe River requires erosion, sediment, and spill controls to protect water resources; water-works permit required for abstraction.

Control of Nocturnal Noise [CAP 40] (1965)	Prohibits noise emissions between 9:00 p.m. and 5:00 a.m.; penalties apply for violations.	Construction schedule must avoid night-time noise; relevant during pile driving, machinery use, and demolition.
Waste Management Act No. 24 of 2014	Establishes national, provincial, and municipal roles for waste collection, treatment, recycling, and disposal; mandates licensing for waste operators.	Requires proper disposal of construction and demolition waste; contractor must comply with PVMC waste management systems.
Waste Management Regulations (Amendment) Order No. 128 of 2019	Details licensing requirements, enforcement, and procedural rules for waste management activities.	Regulates transport and disposal of hazardous and non-hazardous waste during construction.
Forestry Act No. 26 of 2001	Provides for sustainable forest management, conservation forests, and preservation forest designation.	Vegetation clearing near the riverbank must comply; permits required for removal of significant trees or timber resources.
Land Surveyors Act [CAP 175]	Governs registration and practice of licensed surveyors, standards for cadastral and topographic surveys.	Applicable to land boundary verification for temporary land access, easements, and bridge construction footprint.
National Water Strategy 2018–2030	National framework for water resource sustainability, climate resilience, and watershed protection.	Guides water-sensitive project design, supports adaptation planning for flooding and storm impacts on the bridge.
Quarry Act No. 9 of 2013	Regulates exploration, extraction, and use of quarry materials such as aggregates and sand.	Contractor must source aggregates (sand, gravel, rock) from licensed/quarry sites only.
Disaster Risk Management Act No. 23 of 2019	Establishes national disaster risk reduction, emergency response coordination, and resilience standards.	Construction must integrate disaster resilience, including cyclone-resistant bridge design; aligns with national DRR strategies.
National Gender Equality Policy 2020–2030	Promotes gender inclusion, reducing inequalities in infrastructure, land access, and disaster risk management.	Requires gender-responsive consultation processes, safety measures, and equitable employment opportunities during construction.

National Disability Inclusive Development Policy	Ensures accessibility, mobility, and inclusion of persons with disabilities in infrastructure and service delivery.	Bridge design must incorporate universal access principles (e.g., pedestrian pathways, handrails).
Protection of Traditional Knowledge and Expressions of Culture Act No. 21 of 2019	Protects customary knowledge and cultural expressions; requires FPIC and benefit sharing when using traditional knowledge.	Relevant if works involve cultural sites, traditional land boundaries, or require community consent; ensures cultural respect.
Road Traffic (Control) Act [CAP 29]	Provides rules for vehicle registration, road safety, traffic violations, and driver licensing.	Regulates traffic management during construction; requires traffic control plans and compliance with safety protocols.
Public Roads Act No. 35 of 2013 (Consolidated 2020)	Defines public roads and frameworks for construction, repairs, access, and safety obligations of road authorities.	Governs bridge construction works, temporary road closures, detours, and safety requirements for the project.
Employment Act (Cap. 160) (1983, consolidated 2019)	Regulates employment contracts, hours, leave, termination, and protections for women and young persons.	Contractor must provide fair working conditions, wages, leave entitlements, and compliance with labor standards.
Labour (Work Permits) Act (Cap. 187)	Regulates work permits for non-citizen workers and reserved occupations.	Relevant if expatriate engineers or specialists are engaged; contractor must secure permits.
Minimum Wages and Wage Order No. 116 of 2019	Sets national minimum wage standards.	Ensures contractors pay workers at or above the minimum wage.
Health and Safety at Work Act (Cap. 195)	Establishes employer obligations for workplace safety, machinery, hazardous substances, and inspection authority.	Requires a Construction Safety Plan, PPE provision, training, and safe work practices during bridge works.
Trade Unions Act (Cap. 161)	Regulates trade unions and collective bargaining.	Ensures workers' rights to organize and raise issues through unions if needed.
Workplace Health & Safety Management Plan (Government Standard)	Provides guidelines for managing WHS risks on construction sites, including hazard controls and reporting systems.	Forms part of contractor obligations; required for site-specific WHS plan for the Tagabe Bridge works.

2.2 Institutional Responsibilities

The implementation and oversight of environmental safeguards for the project involve several key institutions at national and local levels:

- **Ministry of Infrastructure and Public Utilities (MIPU):** The **Executing Agency** responsible for overall project management, policy oversight, and ensuring compliance with both donor and national environmental regulations.
- **Public Works Department (PWD):** The **Implementing Agency** responsible for day-to-day project supervision, ensuring that all mitigation and monitoring measures outlined in the IEE and ESMMP are implemented during construction.
- **Department of Environmental Protection and Conservation (DEPC):** The **national environmental authority** responsible for screening projects under the PEA system, reviewing environmental documentation, issuing Development Consents, and conducting compliance inspections.
- **Port Vila Municipal Council (PVMC):** Provides local-level permits, coordinates construction within the municipal boundary, manages waste and traffic arrangements, and supports community engagement processes.
- **Japan International Cooperation Agency (JICA):** The **funding and oversight agency** ensuring that environmental and social considerations are consistent with JICA Guidelines for Environmental and Social Considerations (2022). JICA reviews and endorses the IEE prior to final approval of the grant assistance.

2.3 JICA Guidelines for Environmental and Social Considerations (2022)

The JICA Guidelines for Environmental and Social Considerations (2022), promulgated in January 2022 and effective from April 2022, outline the environmental and social safeguard framework applicable to all JICA-assisted projects. These Guidelines emphasize that development cooperation must promote sustainability, inclusiveness, resilience, and respect for human rights in accordance with the 2030 Agenda for Sustainable Development, the Paris Agreement, and internationally accepted best practices such as the World Bank Environmental and Social Framework (ESF).

The Guidelines ensure that potential environmental and social impacts are systematically assessed, mitigated, and monitored throughout a project's life cycle—from planning to decommissioning. JICA requires project proponents to apply the mitigation hierarchy—to first avoid, then minimize, reduce, and finally compensate for any residual adverse impacts.

The Guidelines' scope of assessment covers the full range of environmental, health, and social dimensions, including:

- Air, water, and soil quality; biodiversity and ecosystem services; and climate change impacts.
- Human health, occupational and community safety, and working conditions.
- Land acquisition, involuntary resettlement, and livelihood restoration.

- Consideration for vulnerable groups, including women, children, elderly people, indigenous peoples, and persons with disabilities.
- Cultural heritage protection, gender equality, and equitable sharing of project benefits and burdens.

The 2022 revision also strengthens the integration of human rights-based development, climate change mitigation and adaptation, and stakeholder engagement. Meaningful consultations must be conducted with affected communities, ensuring inclusive participation and information disclosure in accessible and understandable formats. Project proponents are further required to establish a Grievance Redress Mechanism (GRM) to ensure transparency, accountability, and responsiveness to public concerns.

Projects are classified into four categories according to their potential impact significance:

- **Category A** – Projects with significant and potentially irreversible impacts requiring a full Environmental Impact Assessment (EIA).
- **Category B** – Projects with site-specific, manageable impacts requiring an Initial Environmental Examination (IEE).
- **Category C** – Projects with minimal or negligible adverse impacts.
- **Category FI** – Financial intermediary projects where subprojects are not yet defined.

The following table shows gaps between the JICA Guidelines (2022) and laws and regulations of Vanuatu.

Table 2: Gap Analysis between Vanuatu Environmental Laws and JICA Guidelines (2022).

No	Subject	JICA Environmental Guidelines (2022)	National Law of Vanuatu	Difference
1.	**Basic Principles**	In implementing a project, the environmental and social impacts of the project should be studied and examined as early as possible in the planning stage, and alternatives and mitigation measures to avoid or minimize such impacts should be considered, the results of which should be reflected in the project plan.	In accordance with the Environmental Protection and Conservation Act [CAP 283] and the Environmental Impact Assessment Regulations, it is mandatory for project proponents to obtain an Environmental Permit (EP) prior to project implementation. An application for the EP shall be submitted together with relevant supporting documents, such as the project description, maps and design drawings, land ownership certificates, and letters of approval from relevant authorities. Upon submission, a Preliminary Environmental Assessment (PEA) is carried out to identify and assess potential environmental and social impacts of the proposed project. If the anticipated impacts are assessed as minor, the project is exempted from conducting a full EIA. However, when the PEA determines that the impacts are moderate to major, the project proponent is required to undertake a full-scale EIA, which will be subject to review by the competent authority. When an EIA is required, the proponent shall prepare and submit an Environmental Impact Assessment Report, which includes: 1) a description of the existing environmental and social conditions; 2) assessment and prediction of potential impacts;	No difference.
2	**Examination of Measures**	1. Multiple alternatives must be examined in order to avoid or minimize adverse impacts by the project and to choose better project options in terms of environmental and social considerations. In the examination of measures, priority is to be given to avoidance of environmental impacts. When this is not possible, minimization, reduction, and then mitigation of the impacts must be considered, in accordance with the mitigation hierarchy. Compensation measures must be examined only when significant impacts are still remained even with the aforementioned measures. 2. Appropriate plans and systems for measures, such as monitoring plans and environmental management plans, must be prepared. The costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. For projects with particularly significant impacts, detailed environmental management plans must be prepared.		No difference.

			3) proposed mitigation and enhancement measures; 4) an environmental management and monitoring plan; and 5) records of stakeholder and public consultations. The report is reviewed from the perspectives of technical adequacy and accuracy, reflection of public opinions, and effectiveness of proposed mitigation measures. Upon satisfactory review, an EP is issued by the competent authority. The acquisition of the EP prior to the commencement of any project activities is obligatory. Commencement of works without a valid permit is considered a violation of the law.	
3	**Scope of Impacts to Be Assessed**	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water use, climate change, biodiversity, and ecosystem services, including transboundary or global scale impacts. These also include social considerations such as: Migration of population including involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor peoples and indigenous peoples, equality of benefits and losses	In addition to the Environmental Protection and Conservation Act [CAP 283] and the Environmental Impact Assessment Regulations, the items to be assessed are determined in consideration of the relevant provisions stipulated under other national legislations, such as the Forestry Act, the Water Resources Management Act, the Land Surveyors Act [CAP 175], the Physical Planning Act [CAP 193], the Mines and Minerals Act [CAP 190], the Disaster Risk Reduction and Disaster Management Act, the Cultural Heritage Protection Act, the Customary Land Management Act, and the Land Reform Act [CAP 123].	No difference.

		and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.		
4	**Scope of Impacts to Be Assessed**	1. Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by host country governments, including local governments. Projects must also conform to the environmental and social consideration policies and plans of the host country governments. 2. In principle, Projects must be undertaken outside of areas that are specifically designated for conservation of nature or cultural heritages by the host country governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects shall not cause significant adverse impacts on such designated conservation areas.	1. As described above. 2. In accordance with the Environmental Protection and Conservation Act [CAP 283] and the Forestry Act No. 26 of 2001, development activities within protected areas are restricted. These Acts also stipulate the necessity to conserve native flora and fauna and to ensure the proper management of protected areas.	No difference.
5	**Social Acceptability**	1. Projects must be adequately coordinated so that they are accepted in a socially appropriate manner for the countries and areas where the projects are planned. For Projects with potentially significant environmental and social impacts, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans are examined. The	1. For projects requiring an EIA, it is necessary to examine not only avoidance and minimization measures but also appropriate mitigation measures. In addition, consultations with local communities, rights holders, and other stakeholders are required, including the identification of stakeholders, a summary of the consultation process, records of consultation outcomes, and measures taken in response.	No difference.

		outcome of such consultations must be incorporated into the project plans. 2. Appropriate considerations must be given to vulnerable social groups, such as women, children, elderly peoples, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities. Such vulnerable social groups are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	2. Although there is no explicit provision in the national legislation of Vanuatu regarding the consideration of socially vulnerable groups, policies have been established on gender and persons with disabilities. These policies emphasize the need to address women's vulnerability in relation to infrastructure development, land issues, and disaster risk management, as well as to ensure mobility, accessibility, and equitable access to services for persons with disabilities.	
6	**Climate Change**	For projects that are expected to generate more than a certain amount of GHG emissions, the total amount of GHG emissions will be estimated and disclosed before the project implementation.	N/A	Measures applied in this Project: Estimate total GHG emissions in the Preparatory Survey
7	**Biodiversity**	Projects must not involve significant conversion or significant degradation of critical habitats or critical forests.	The conservation of ecosystems and biodiversity, as well as the protection and proper management of protected areas, is required.	No difference.
8	**Involuntary Resettlement and Loss of Livelihood**	1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. 2. Project affected people, such as people to be resettled involuntarily and/or people who may lose their livelihoods by the project, must be provided sufficient compensations and supports by the project proponents in a timely manner. Compensations must be calculated at full	In Vanuatu, land acquisition and involuntary resettlement are strictly regulated under the Constitution and several related laws. In particular, for lands under customary ownership, obtaining the Free, Prior and Informed Consent (FPIC) of customary landowners and concerned communities is indispensable. Therefore, careful consensus-building and transparent procedures are required in the implementation of development projects.	Measures applied in this Project: When involuntary resettlement and loss of livelihoods are anticipated, RAP or ARAP shall be developed in accordance with JICA guidelines to avoid,

		replacement cost as much as possible, and provided in advance. Project proponents must make efforts for the affected people to improve or at least restore their standards of living, income opportunities and production levels to the pre-project levels. 3. Compensation standards are disclosed and consistently applied. The project affected persons need to be aware of the compensation standards. 4. Appropriate participation of the project affected people and their communities must be promoted in the planning, implementation and monitoring of measures against involuntary resettlement and loss of livelihood.	There are no specific provisions for compensation for loss of livelihood. In addition, the preparation of a Resettlement Action Plan (RAP) or Abbreviated Resettlement Action Plan (ARAP) is not legally required.	minimize, reduce, or compensate for the loss.
9	**Monitoring**	1. During the project implementation, project proponents monitor whether any unforeseeable situations occur, and the performance and effectiveness of the planned mitigation measures. Project proponents take appropriate measures based on the results of such monitoring. 2. In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, Project proponents must ensure that the project plans include feasible monitoring plans.	When an EIA is prepared, it is required to obtain public comments on the draft report. In addition, consultations with local communities, rights holders, and other stakeholders are necessary. The preparation and implementation of an Environmental Management and Monitoring Plan (EMMP) is mandatory. During both the construction and operation phases of the project, the proponent is required to submit regular monitoring reports, and the DEPC conducts audits on an annual or quarterly basis. In the event of non-compliance, corrective orders and penalties may be imposed.	No difference.

		3. Project proponents should make efforts to make the monitoring results available to local stakeholders involved in the project. 4. When third parties point out specifically that environmental and social considerations are not being fully undertaken, project proponents should make efforts to reach an agreement on the procedures to resolve the problems, through forums for discussions and examinations of the countermeasures with participation of stakeholders involved in the projects, based on sufficient information disclosure.		
10	**Grievance Redress Mechanism**	1. A mechanism for handling concerns and grievances from people and communities affected by the project's environmental and social impacts must be in place. 2. The grievance redress mechanism needs to be easily accessible for the project affected people and communities. Project proponents disseminate the information about the grievance redress mechanism through consultations with local stakeholders. The project affected people and communities must not be disadvantaged by filing a grievance. 3. Project proponents should make efforts to respond promptly to the grievances they receive, taking into account the concerns and needs of the project affected people and communities.	N/A.	Measures applied in this Project: Provide information to residents during construction period, collect residents' opinions, and ensure a grievance mechanism.

11	**Information Disclosure**	Information disclosure related to environmental and social considerations of the project is to be carried out proactively by the partner country. Information to be disclosed includes not only information on environmental and social considerations but also information on the cooperation project itself. When the partner country conducts consultations with local stakeholders, information must be disclosed well in advance, and materials must be prepared in the official language or widely used language of the partner country and in a format understandable to local people, with support as needed. Disclosure must be made with the consent of the partner country, and non-disclosure is permitted only when legally required or agreed.	Under the Right to Information Act, No. 13 of 2016, the right of access to information held by government agencies and certain private organisations and related individuals is established. Transparency, accountability, and promotion of informed public participation are stipulated, and government agencies and related private organisations are obliged to proactively publish information they hold. Provisions are also made for confidential information, personal information, and commercial or law enforcement restrictions.	No differences.

Application to the Project

Through the preparation and application of this IEE, the Project demonstrates full alignment with the principles and procedural requirements of the JICA Environmental Guidelines (2022) as it is being implemented under the grant aid assistance of JICA. The project integrates environmental safeguards, social inclusion, climate resilience, and participatory governance as core components of its design and implementation. This ensures that the project will deliver sustainable infrastructure benefits while safeguarding the wellbeing of local communities and the surrounding environment.

The project is classified as a Category B Project with moderate, site-specific, and reversible environmental and social impacts. This IEE therefore has followed JICA's procedural and substantive requirements for Category B projects by ensuring that:

- Potential impacts during construction and operation phases have been identified and assessed;
- Appropriate mitigation, management, and monitoring measures have been proposed;
- Meaningful consultations have been carried out with affected residents and community stakeholders; and
- The project aligns with both Vanuatu's environmental regulatory framework and JICA's safeguard principles.

The Tagabe Bridge design integrates climate-resilient and inclusive infrastructure principles, incorporating hydrological analyses, improved drainage, and resilient materials to address future flood risks linked to climate change. Socially, the project enhances community access, mobility, and safety, thereby contributing to JICA's broader objective of fostering sustainable, inclusive, and resilient development.

Table 3: Compliance of the project with JICA Guidelines (2022).

JICA Guideline Principle / Requirement	Application to the Project
Environmental and Social Screening	Project classified as **Category B** – impacts are localized and mitigable.
Scope of Impacts to be Assessed	IEE includes assessment of air, water, noise, waste, biodiversity, and socio¬ economic impacts.
Mitigation Hierarchy	Mitigation hierarchy shall be applied through ESMP and site¬ specific control measures.
Information Disclosure	IEE findings and consultation outcomes shall be disclosed to communities and authorities.
Stakeholder Consultation	Consultations shall be held with local communities, businesses, and municipal authorities.
Human Rights and Social Inclusion	Vulnerable groups (women, elderly, pedestrians, local vendors) shall be well considered in design and mitigation plans.

Involuntary Resettlement / Livelihoods	If physical resettlement is anticipated; replacement cost shall be applied for estimation of compensation (either cash or in-kind), and restoration of livelihood means and income shall be considered.
Biodiversity and Ecosystems	Vegetation clearance shall be minimized and revegetation included.
Climate Change and Resilience	Bridge design shall incorporate flood resilience and drainage improvements.
Health, Safety, and Working Conditions	Comprehensive OHS and community safety plans shall be included in ESMP.
Monitoring and Reporting	Monitoring Plan shall be included in IEE with indicators, frequency, and responsibilities defined.
Grievance Redress Mechanism (GRM)	GRM shall be established; local contact points identified for community feedback and complaints.

Reference:

- https://www.jica.go.jp/english/about/policy/environment/guideline/__icsFiles/afieldfile/2023/12/25/kankyoEN_1.pdf

2.4 World Bank Environmental and Social Framework (2018)

To ensure alignment with global best practices, the IEE also references the World Bank's Environmental and Social Framework (ESF). Although the project is financed by JICA, the ESF's Environmental and Social Standards (ESSs) provide a complementary benchmark. The most relevant ESSs to this project include:

- **ESS1:** Assessment and Management of Environmental and Social Risks and Impacts;
- **ESS2:** Labour and Working Conditions;
- **ESS3:** Resource Efficiency and Pollution Prevention;
- **ESS4:** Community Health and Safety;
- **ESS5:** Land Acquisition, Restrictions on Land Use and Involuntary Resettlement;
- **ESS6:** Biodiversity Conservation and Sustainable Management of Living Natural Resources; and
- **ESS8:** Cultural Heritage
- **ESS10:** Stakeholder Engagement and Information Disclosure.

These standards guide project activities to ensure protection of community wellbeing, sustainable resource use, and effective environmental governance throughout implementation.

Table 4: Summary of the World Banks ESSs and applicability to the project.

ESS No.	Title	Objective / Purpose	Key Requirements and Focus Areas	Applicability to the Project
ESS1	Assessment and Management of Environmental and Social Risks and Impacts	To identify, assess, and manage environmental and social risks and impacts of projects.	- Requires Environmental and Social Assessment (e.g., ESIA, IEE). - Preparation of Environmental and Social Commitment Plan (ESCP). - Application of mitigation hierarchy (avoid, minimize, mitigate, offset). - Establishment of Environmental and Social Management Plan (ESMP).	**YES**
ESS2	Labor and Working Conditions	To promote fair treatment, non-discrimination, and safe and healthy working conditions.	- Prohibits child and forced labor. - Requires Labor Management Procedures (LMP). - Occupational Health and Safety (OHS) compliance. - Worker grievance mechanism.	**YES**
ESS3	Resource Efficiency and Pollution Prevention and Management	To promote sustainable use of resources and prevent pollution.	- Efficient use of energy, water, and raw materials. - Control of air, water, and soil pollution. - Proper management of hazardous and non-hazardous waste. - Greenhouse gas (GHG) emission estimation and reduction.	**YES**
ESS4	Community Health and Safety	To avoid or minimize risks to community health, safety, and security.	- Safe design and operation of infrastructure. - Emergency preparedness and response. - Traffic and road safety management. - Security personnel conduct and oversight.	**YES**
ESS5	Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	To avoid or minimize displacement and ensure fair compensation and livelihood restoration.	- Preparation of Resettlement Plans (RP) or Frameworks (RPF). - Compensation at full replacement cost. - Livelihood restoration and transitional support. - Consultation and grievance redress.	**YES**

ESS6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	To protect biodiversity and promote sustainable management of natural resources.	- Avoidance of impacts on critical habitats. - Biodiversity management plans. - Sustainable forestry, fisheries, and agriculture practices. - Invasive species control.	**YES**
ESS7	Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	To ensure respect for the rights, dignity, and culture of Indigenous Peoples.	- Free, Prior, and Informed Consent (FPIC) where applicable. - Preparation of Indigenous Peoples Plans (IPP). - Culturally appropriate benefits and mitigation measures.	**NO**
ESS8	Cultural Heritage	To protect tangible and intangible cultural heritage.	- Identification and protection of heritage resources. - Chance Finds Procedure during construction. - Consultation with affected communities and cultural authorities.	**YES**
ESS9	Financial Intermediaries (FIs)	To ensure FIs manage environmental and social risks of subprojects.	- Establishment of Environmental and Social Management System (ESMS). - Screening and monitoring of subprojects. - Reporting and capacity building.	**NO**
ESS10	Stakeholder Engagement and Information Disclosure	To ensure meaningful engagement and transparency with stakeholders.	- Preparation and implementation of Stakeholder Engagement Plan (SEP). - Disclosure of project information. - Grievance Redress Mechanism (GRM).	**YES**

References:

1. World Bank (2018). *Environmental and Social Framework (ESF): Environmental and Social Standards.* Available at: https://www.worldbank.org/en/projects-operations/environmental-and-social-framework
2. World Bank (2023). *ESF Good Practice Notes and Guidance Materials.*
3. World Bank (2020). *Environmental and Social Framework – Interim Note on COVID-19 Considerations.*

2.6 International Conventions

Vanuatu is a signatory to several international environmental treaties that reinforce its national commitment to sustainable development and environmental protection. These include:

- The Convention on Biological Diversity (CBD) – guiding biodiversity conservation and ecosystem protection;
- The United Nations Framework Convention on Climate Change (UNFCCC) – driving climate change adaptation and low-carbon development; and
- The Stockholm Convention on Persistent Organic Pollutants (POPs) – regulating hazardous substances and waste management.

The project's environmental management plan aligns with these international obligations by emphasizing pollution control, climate resilience, and the protection of natural and water resources. In particular, measures to prevent sedimentation and contamination of the Tagabe River, which supplies Port Vila's urban water system, contribute directly to Vanuatu's commitments under the CBD and UNFCCC frameworks.

3. Project Description

3.1 Overview

The project forms a central component of the post-earthquake recovery and transport resilience program with Japan's grant aid[1] provided by JICA. The project seeks to reconstruct and strengthen a critical bridge crossing that connects Bauerfield International Airport to Port Vila city centre, serving as the principal arterial link for people, goods, and services entering and leaving the capital.

It comprises three interrelated components:

1. **Reconstruction of the Tagabe Bridge**,
2. **Construction of a permanent Detour Bridge**, and
3. **Upgrading of the Smet–Huarere Studio Road section** to reinforced concrete pavement.

Each component has been designed to complement the others in restoring safe, resilient, and climate-adaptive transport infrastructure along the Tagabe River corridor, while minimizing environmental disturbance and maintaining community access during construction.

[1] Grant agreement for "the Programme for Emergency Rehabilitation of Principal Economic Infrastructure Affected by the Earthquake" was signed on July 14, 2025. See the following URL (accessed as of Oct 2025): https://www.jica.go.jp/english/information/press/2025/20250714_12.html#:~:text=On%20July%2014%2C%20the%20Japan%20International%20Cooperation%20Agency,of%20Principal%20Economic%20Infrastructure%20Affected%20by%20the%20Earthquake.

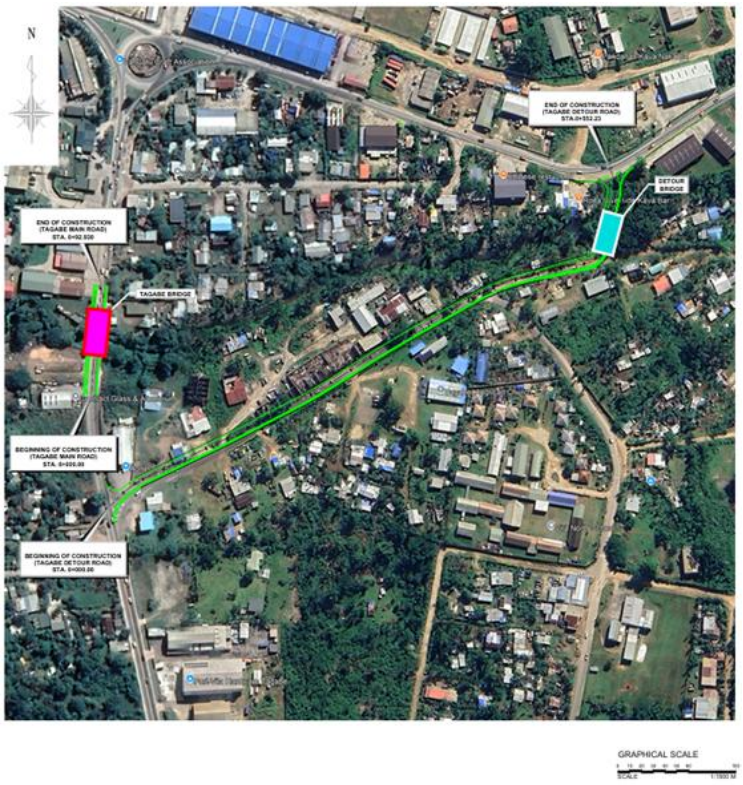


Figure 2: Project outline.

3.2 Existing Condition and Need for Replacement of Tagabe Bridge

The existing Tagabe Bridge was originally constructed several decades ago as a reinforced concrete structure carrying two traffic lanes over the Tagabe River. Over the years, the bridge has experienced progressive deterioration due to heavy traffic loading, flood exposure, and corrosion in the marine-influenced environment. The December 17, 2024 earthquake caused severe structural cracking in the deck slab and abutments, dislodging bearing supports and compromising the bridge's stability. Emergency inspections by the Public Works Department (PWD) and JICA technical teams confirmed that the bridge was no longer structurally safe for sustained heavy use, and immediate replacement was recommended.

The Tagabe bridge is a lifeline infrastructure, linking the international airport, northern residential suburbs, and the central business district (CBD). Closure or failure of this bridge would disrupt logistics, tourism, and emergency response routes, particularly during severe weather or natural disasters. Its replacement is therefore a national priority under Vanuatu's Post-Earthquake Recovery and Reconstruction Program.

3.3 Construction Work and Methodology

Reconstruction of the existing Tagabe Bridge and Main Road

The proposed new bridge and main road will be a 11.0 meter-wide with two lane driveways, footpath, and shoulders. The design will conform to specified standards, adapted to Vanuatu Road Design Guide (VRDG) 2023. The structural alignment will remain within the existing road

corridor, minimizing land acquisition and disturbance to surrounding communities. The new bridge and main road will incorporate the following key features:

- Adoption of earthquake-resistant design measures in accordance with relevant standards;
- Higher load capacity to accommodate modern traffic volumes and heavy vehicles;• Seismic-resistant foundations with improved bearing strength and ductility;
- Increased hydraulic clearance to safely convey flood discharges and debris;
- Prevention of water infiltration and subsequent corrosion of reinforcement by using epoxy-coated reinforcing bars in concrete deck slabs;
- Provision of adequate concrete cover as a countermeasure against salt-damage;
- Guardrails on both sides of two-lane of 3.5-meter wide carriageways and 2.0-meter wide guard-railed footpath to improve safety;
- The design speed shall be set at 50 km/h, and the design service life of Tagabe Bridge shall be set at 100 years.
- Main road is paved with concrete, and new Tagabe Bridge is RC slab bridge.

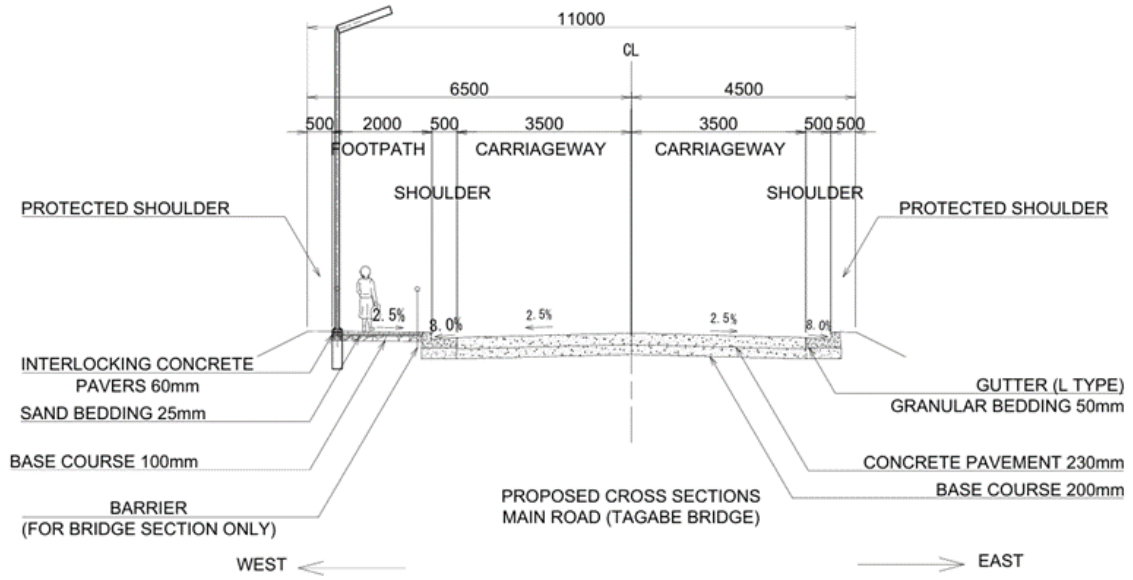


Figure 3: Proposed cross-section of the Main Road.

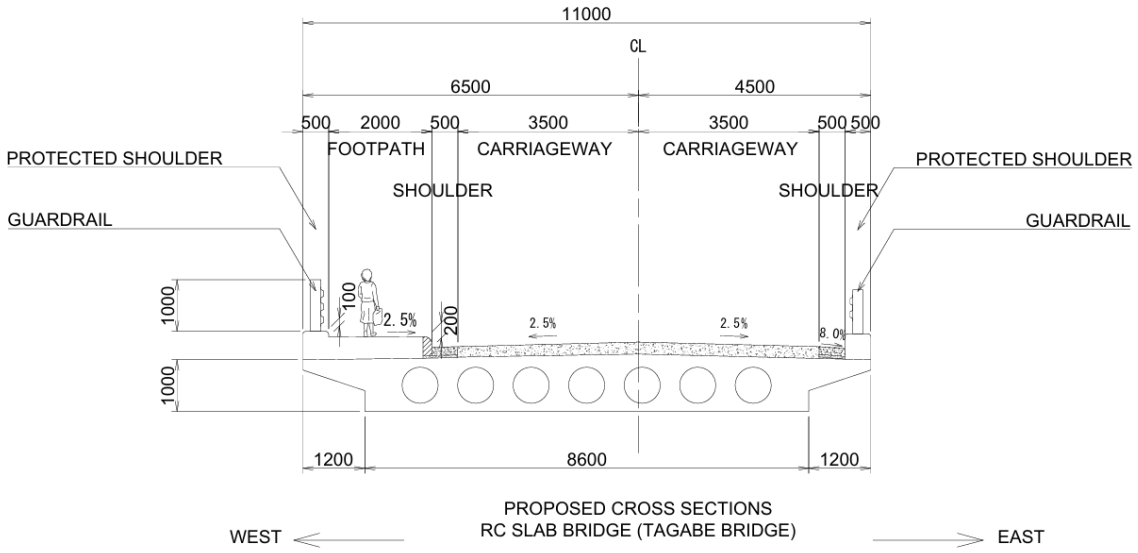


Figure 4: Proposed cross-section of the Tagabe Bridge (RC Slab Bridge).

New Construction of Detour Bridge and Detour Road (Improvement of the existing Smet-Huarere Studio Road)

The Detour Road and Bridge serves dual purposes: first, as a temporary traffic diversion to maintain access during reconstruction of the main Tagabe Bridge; and second, as a permanent secondary crossing providing redundancy and road network resilience. It will help ensure that, even during future maintenance or emergency events, traffic along the Tagabe corridor will not be entirely dependent on a single crossing point.

The Detour Bridge will be installed approximately 450-meter upstream of the existing Tagabe Bridge, on public land, minimizing the need for new right-of-way or private land acquisition. The area is semi-urban with scattered households and small commercial structures, all on urban leased land under the jurisdiction of the government. It is designed as concrete bridge for two-way vehicular traffic (3.5-meter wide each) and 1.5-meter wide guard-railed footpath. The structure will be designed to meet long-term service requirements rather than temporary-use standards, with 30 years of design service life, ensuring durability and justifying its status as a permanent facility. Key design elements include:

- Seismic-resistant foundations with improved bearing strength and ductility;
- Adoption of earthquake-resistant design measures in accordance with relevant standards;
- Prevention of water infiltration and subsequent corrosion of reinforcement by using epoxy-coated reinforcing bars in concrete deck slabs;
- Provision of adequate concrete cover as a countermeasure against salt-damage;
- Installation of concrete barriers as protective measures against vehicle collision
- Adequate hydraulic opening to prevent overtopping during flood events;
- Abutment protection through precast concrete and gabion mattresses;

The existing Smet to Huarere Studio Road segment is approximately 400–500 metres in length, connecting the main Tagabe corridor to nearby community access points. The road is

currently tar-sealed, with surface cracking, potholes, and poor drainage performance, particularly during heavy rainfall. The road serves local traffic including public transport minibuses, delivery vehicles, and pedestrians accessing commercial and residential areas.

The road section will be upgraded to a reinforced concrete pavement standard, ensuring high durability and load-bearing strength suitable for urban traffic. Design specifications include:

- Concrete pavement thickness of 200 –250 mm over a compacted sub-base;
- Proper crossfall and side drains for stormwater conveyance;
- Reinforced edge curbs and concrete-lined side drains;
- Intersection installation , road marking and signage for road safety;
- Installation of street lights;
- Utility relocation (water, electricity, telecommunications).

The road upgrading works will also include shoulder widening and pavement strengthening near the approach to both bridges, integrating seamlessly into the reconstructed structures.

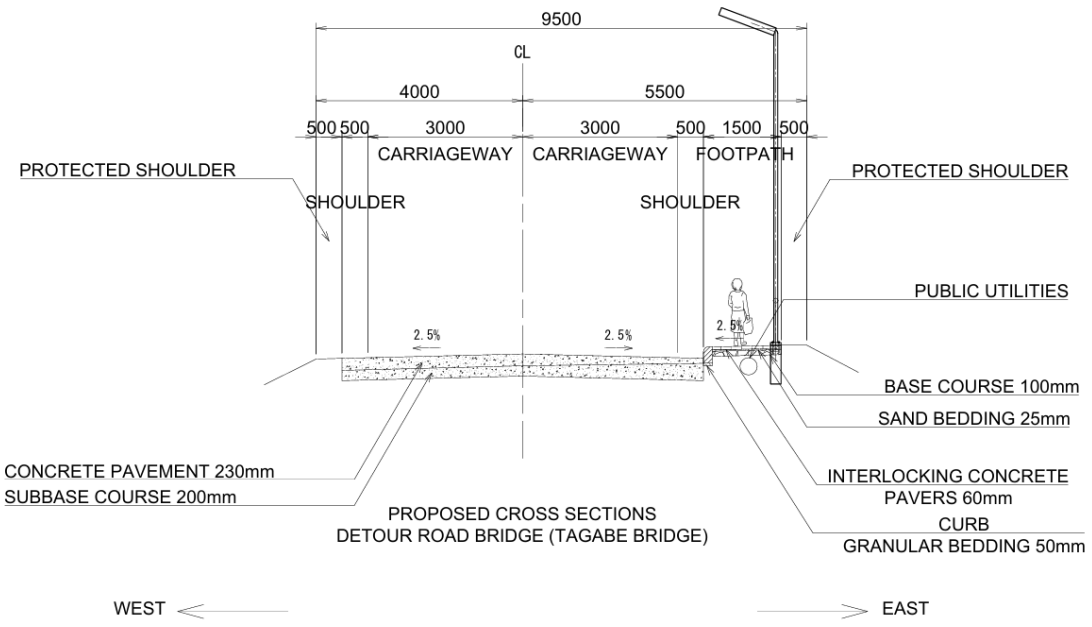


Figure 5: Proposed cross-section of the Detour Road improvement (Smet-Huarere Road).

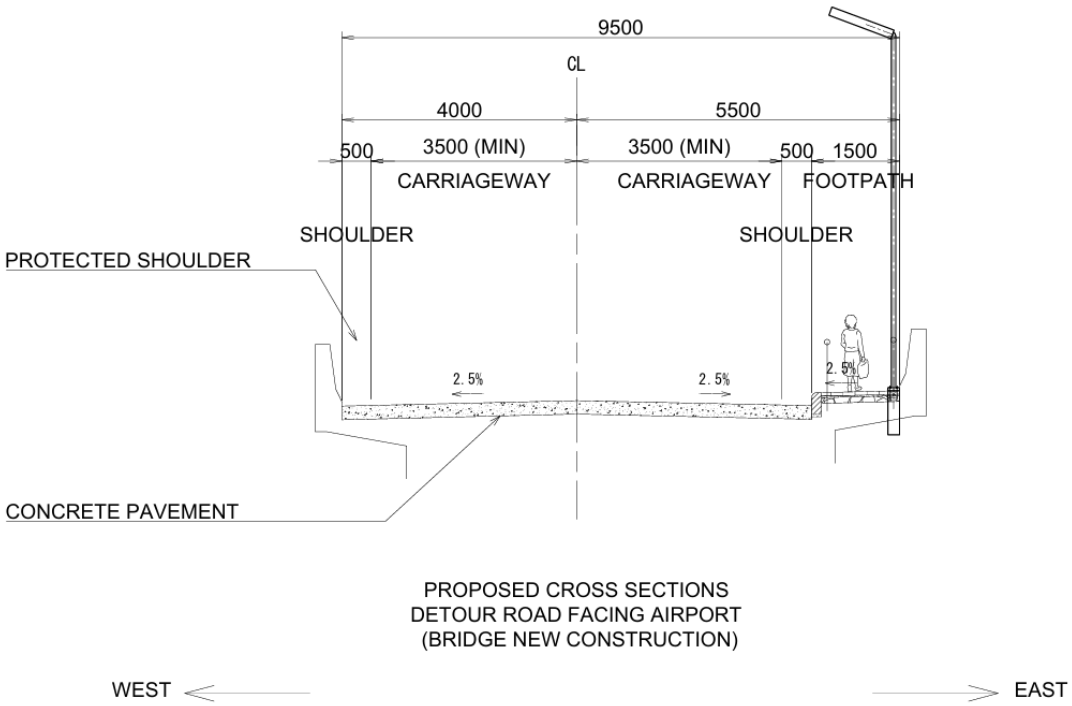


Figure 6: Proposed Cross Section of the Detour Bridge (New).

River Bank Protection

Findings from geotechnical studies have been incorporated, and modelling of the Tagabe River to ensure that both bridges – main and detour – function complementarily and do not alter natural flow patterns or increase flood risk.

- The water level corresponding to the 50-year return period discharge is calculated and adopted as the design high water level based on one-dimensional unsteady flow analysis.
- The bank protection is planned for a range of 10 m upstream and downstream from both bridge abutments, in accordance with the "River Management Facility Structural Standards."
- The slope ratio is assumed to be approximately 1:1.0 (1:0.5 – 1:1.5). Detailed examination will be conducted considering the bridge beam structure and the topography.
- The bank protection structure is assumed to be made of riprap or concrete.
- The foundation is basically assumed to be a direct foundation.
- The ground on the left bank at the Detour Bridge site is weak (N-value = 0 – 3), and a pile foundation is assumed for its bank protection.
- Around both bridge areas, since the site is used for activities such as laundry and river recreation, the installation of steps and river-friendly facilities are planned.

3.4 Construction Method

The construction method will be with due consideration for construction in proximity to general commercial facilities and residential buildings, the management and diversion of nearby road traffic, and works carried out within the Tagabe River. The construction work is split into two phases:

1st Phase: Detour Road (Existing Road Widening) and Detour Bridge Construction

During the construction of the detour road, works will proceed after implementing necessary road closures. The detour road and the northern intersection along the detour route will be constructed. Once these sections are completed, traffic will be diverted to the new road.

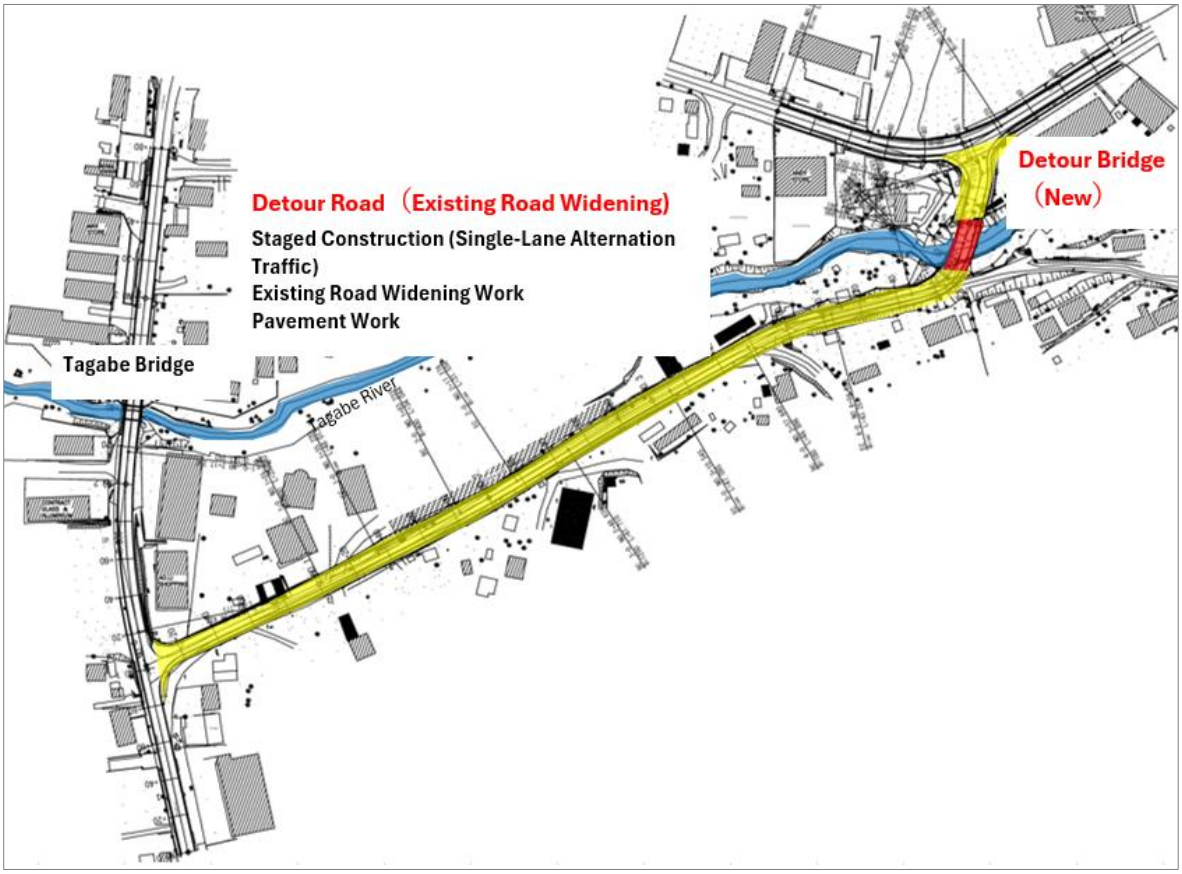


Figure 7: Construction Works during 1st Phase.

All works will be carried out with due consideration for safety at intersections with branch roads, as well as nearby commercial facilities and residential areas. All road works will be confined within the existing right-of-way, avoiding private properties or natural habitats. Construction activities will involve removal of the old asphalt surface, base preparation, formwork installation, and concrete placement.

2nd Phase: Reconstruction of Tagabe Bridge

Subsequently, construction will proceed within the Tagabe Bridge area. The bridge replacement will be undertaken after completion of the Detour Bridge, ensuring continuous traffic flow and emergency access. Construction of the new bridge will involve staged

demolition of the existing structure, excavation for abutments, placement of formwork and reinforcement, and casting of the bridge deck. Temporary steel pipes will be installed to isolate work areas from flowing water during abutment construction and to prevent downstream turbidity. (See the Figure below)

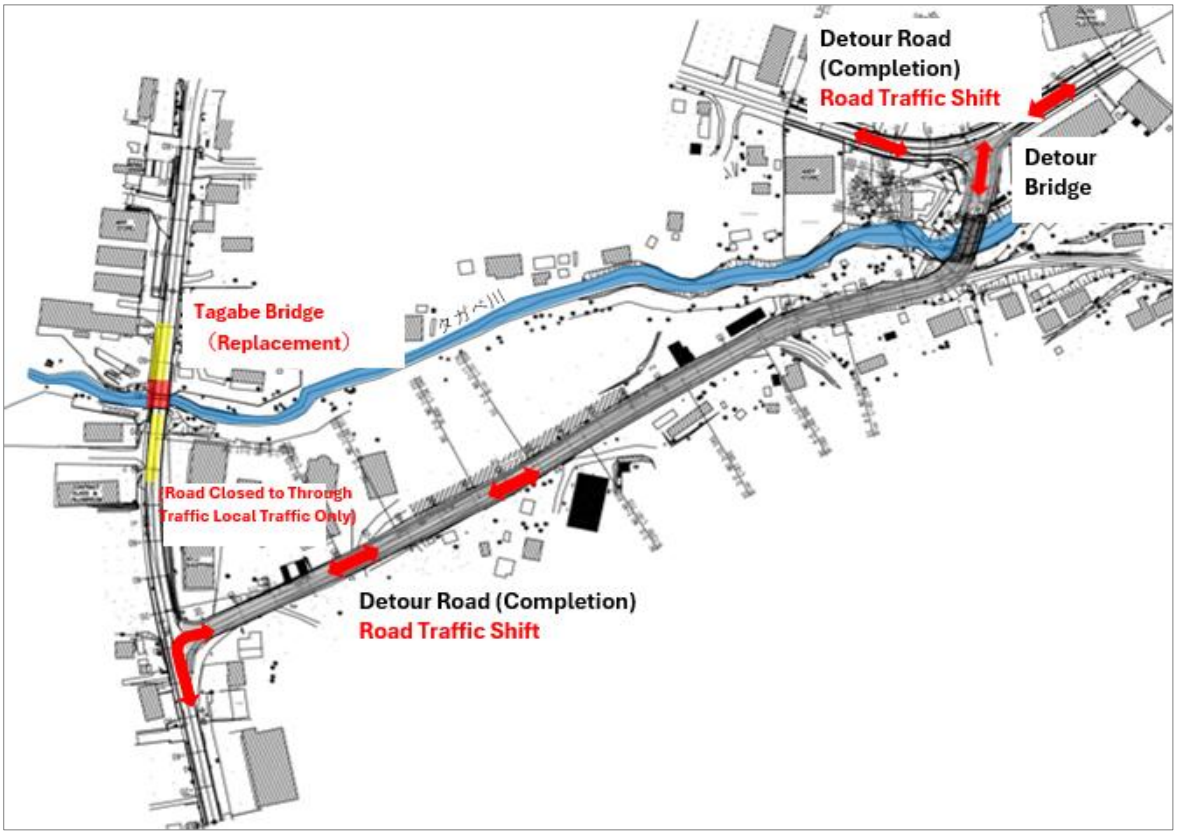


Figure 8: Construction Works during 2nd Phase.

3.5 Construction Schedule and Duration

The project will follow an estimated **20-month construction timeline including preparation work**, beginning in April 2026 after completion of detailed design, bidding, and conclusion of contractor contract. The implementation sequence will be as follows: (See the Figure next page)

1. Mobilization and site preparation – 3 months;
2. Upgrading of Smet–Huarere Studio Road section and Construction of Detour Bridge – 6 months;
3. Demolition of existing Tagabe Bridge, foundation preparation and construction of new bridge – 11 months

Construction scheduling will consider seasonal rainfall patterns, avoiding high-rainfall months to reduce erosion and sedimentation risks. Night works will be limited to essential traffic diversions or emergency repairs.

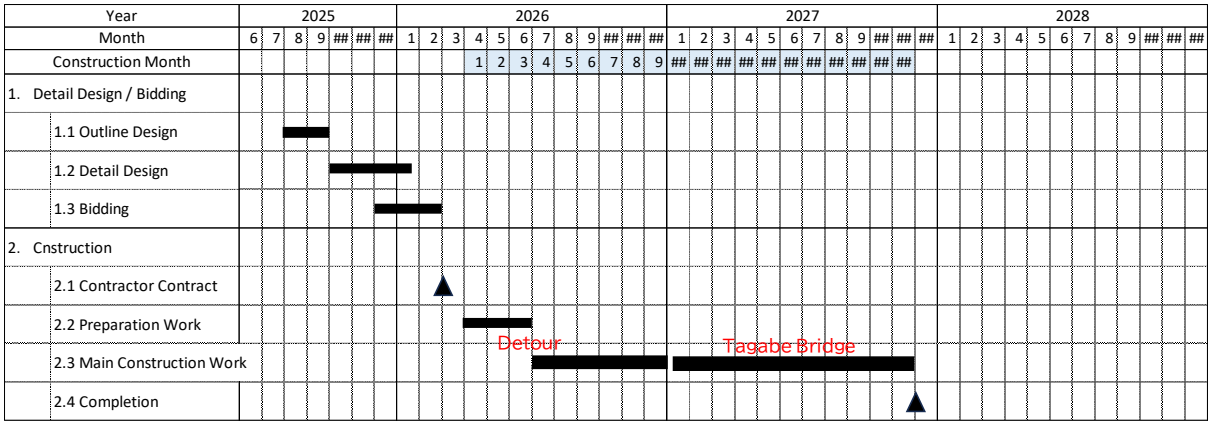


Figure 9: Construction Schedule.

3.6 Associated Facilities

The project will use several temporary associated facilities required for construction activities but located entirely within public or municipal land:

- Construction camp and site office, to accommodate workers and equipment;
- Laydown and storage areas for aggregates, steel reinforcement, and concrete materials;
- Temporary batching area for concrete mixing, with proper drainage and containment;
- Stockpile zones for excavated material and demolition waste before transport to disposal sites;
- Access tracks and temporary parking areas for machinery.

To secure a temporary construction yard of approximately 5,000 m², it will be necessary to lease land on a temporary basis during the construction period. The proposed site is privately owned land that has already been leveled, and the a local private company is the titleholder. A lease agreement, based on monthly payments and requiring restoration of the land to its original condition, will be concluded between MIPU and the landowner.

3.7 Resource Requirements

Construction materials and resources required for the project include:

- Concrete and aggregates from licensed local quarries;
- Steel reinforcement and cement imported or procured through authorized suppliers;
- Stone riprap and gabions for riverbank protection;
- Fuel and lubricants for machinery stored in bunded areas; and
- Temporary construction water drawn from designated water source.

Construction materials can be collected from several facilities on Efate Island, including two concrete plants that are 1 to 2 km away and three quarries (borrow pits) that are 8 to 30km away from the project site. Construction wastes, soils, debris and others will be collected and carried to Bouffa Landfill for dumping, that is approximately 13.0 km away from the project site.

Electricity for lighting and equipment will be drawn from the grid through temporary connections. The project will employ a good number of workers during peak construction, including local labour for semi-skilled and unskilled roles. Worker welfare facilities (water supply, sanitation, waste bins) will be provided on site, and an Occupational Health and Safety (OHS) officer will oversee compliance with the OHS Act (2017).

Figure 10: Locations of Concrete Plants, Quarries and Disposal Site.

3.8 Project Alternatives

Without-Project Option

The "Without-Project" alternative would avoid short-term construction impacts. However, it would perpetuate the safety risks associated with the existing earthquake-damaged bridge and seismic fragility against future earthquakes. This would compromise emergency access and connectivity between the airport and the CBD, potentially isolating Port Vila during future disasters. If the project did not take place, the main road will be further congested, without redundancy or alternative ways out, burdening not only CBD but also the connecting area from the airport. In addition, air pollution, noise and stress caused by the traffic jam will increase the environmental and social costs of the local communities. The no-action option is therefore **not viable** given the strategic importance of the bridge.

Design Alternatives

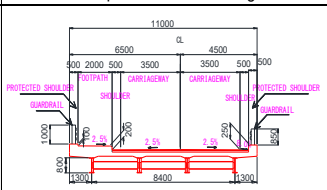
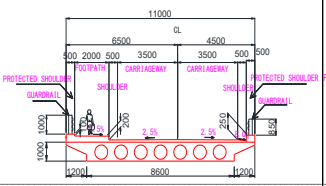
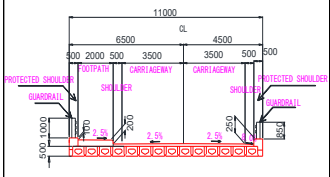
Two structural design options were examined during feasibility assessment:

1. **Box Culvert Bridge:** Offers simplicity, reduced maintenance, less costs, and good hydraulic capacity for an urban setting.
2. RC Slab, **Beam or Girder Bridge:** Provides greater span flexibility but involves higher costs, more complex foundations, and greater maintenance requirements.

Considering cost, constructability, and maintenance, the box culvert bridge design is preferred. However, literature research has revealed that there is water flow beneath the bed of Tagabe River, and the results of the boring survey in the Tagabe River confirmed that the subsurface consists of alluvial deposits, pumice layers, and weathered volcanic ash rock, which are generally of low strength and insufficient bearing capacity. Therefore, installing a box culvert directly on the ground surface would pose a high risk of differential settlement and difficulty in ensuring structural stability. It would require ground improvement for box culvert to be installed, which may potentially cause significant impacts on the river environment. As a consequence, the box culvert is declined, and a bridge structure, which can secure a stable supporting foundation, is regarded as the more appropriate option.

As for the rest options, H-shaped steel girder bridge, RC slab bridge and PC pre-tensioned slab bridge were examined and compared with each other in terms of economic conditions, structural integrity and seismic resistance, construction conditions, and impact on surrounding environment. As a result, RC slab bridge is found most strong and favourable option to choose.

Table 5: Comparison among Three Options for the Replaced Tagabe Bridge Design.

Structural Types		No.1 H-shaped Steel Girder Bridge		No.2 RC Slab Bridge		No.3 PC Pre-tensioned Slab Bridge	
Cross Section						
Girder Procurement		H-beam Girders from Japan (Relatively heavy)		Form Material from Japan (Light)		PC girders from Japan (Heavy)	
Economical Conditions	Cost	Relatively High	△	Relatively less expence (Use local materials for concrete)	◎	Relatively High	△
	Maintainability	Repainting is required every 20 to 30 years	△	No repainting	◎	No repainting	◎
Structural Integrity and Seismic Resistance	Track record	Common bridge type	◎	Common bridge type	◎	Common bridge type	◎
	Dead load	Relatively less dead load	◎	Moderate dead load	○	Moderate dead load	○
Construction Conditions	Period of construction	Relatively short (erection + deck slab construction)	○	Moderate(formwork, falsework, and curing)	○	Moderate(erection and transverse work: curing and tensioning)	◎
	Ease of construction	Medium-capacity crane	◎	Medium-sized crane and fixed support	◎	High-capacity crane	△
	Construction in the river	Almost none	◎	Fixed support is required in river	○	Almost none	◎
Impact on Surrounding Environment	Vibration and noise	Steel bridge may cause vibration and noise	○	Relatively less vibration and noise	◎	Relatively less vibration and noise	◎
	Clearance above the river	Allowable (Girder height: 800mm)	◎	Allowable (Girder height: 1000mm)	◎	Allowable (Girder height: 500mm)	◎
Comprehensive Evaluation		○ (◎=5, ○=2, △=2)		◎ (◎=6, ○=3, △=0)		○ (◎=6, ○=1, △=2)	

Alignment Alternatives

Furthermore, as a result of the comparison, Plan A-1 was considered the most optimal. Plan B involves using the Blacksand Bridge as the detour bridge and the existing road as the detour route; however, the length of the existing road requiring widening reaches approximately 2 km. Compared to A-1 (detour length approximately 400 m) and A-2 (approximately 130 m), it was anticipated that the social impacts along the detour route—such as the need for tree felling along the route, relocation of utility poles, power lines, and water pipes, and restrictions on access for households along the route—would be relatively greater due to the length. In addition, the hilly section of the existing road, which is winding and has elevation differences, is a steep road with an estimated width of about 6 m, making it difficult for vehicles to pass each other. Road widening and alignment improvements (such as reducing steep gradients to gentler slopes) are required, resulting in lower advantages in terms of technical difficulty, construction period, and cost. Although it was predicted that there would be no relocations due to the alignment improvements, partial acquisition of land plots (around 20 houses) scattered along the road would be unavoidable, which would further increase the social impact.

Figure 11: Locations of Three Options for Detour Bridge.

The detour bridge in A-2 crosses the Tagabe River to the north using the same existing road as A-1, and the detour length is about one-third that of A-1, making it advantageous in terms of social impact when comparing detour lengths. However, for the A-2 detour bridge to cross the Tagabe River, it is necessary to permanently acquire at least one plot (or part thereof) of private land on the south bank (Huarere Studio Community) and on the north bank (21 Jump Street Community, with one household residing), totalling approximately 1,200 m², which would result in relocation. Including the temporary occupation of surrounding land for construction purposes, the total area would be at least 4,000 m², making the land acquisition and occupation area larger than that of Plan B, and it was anticipated that the procedures would take longer (i.e., construction delays) and that there would be cost issues.

Although A-1 is inferior to A-2 in terms of detour length, it is possible to construct an access road using public land on the north bank of the Tagabe River, so land acquisition is basically

unnecessary. Furthermore, as the public land was vacant at the time of this survey, construction could commence promptly. In view of the urgency of this project, A-1 was judged to have a high level of advantage.

The results of the comparative study of the three plans are shown in Table 6 below.

Table 6: Comparison among Three Options for Detour Bridge Location.

Alternative	A-1 Plan (bridge length 40m)		A-2 Plan (bridge length 40m)		B Plan (bridge length 30m)	
Operability (safety)	・Road section:R=86~195m (i=5.5~7.0%) ・Bridge section:R=195～Straight line (i= 5.5~7.0%) ・The existing road will be widened, so the road will be mostly straight up to the crossing point.	◎	・Road section:R= 90~110m (i=2.0~6.0%) ・Bridge section:R=straight line (i= 3.0~6.0%) ・The existing road will be widened, so the road will be mostly straight up to the crossing point.	◎	・Road section:R= 86~300m (i=3.0~6.2%) ・Bridge section:R=straight line (i=3.0~6.0%) ・The hilly areas have steep gradients and many small curves.	△
Construction consideration	・The south side is close to the slope, so the yard is narrow, but the north side is open space and heavy machinery can be placed there.	◎	・The south side is a construction company's material storage area, and the north side requires passing through private land. *The material storage area may be used as a rubble storage area.	○	・Road construction is necessary in the narrow hilly areas. ・Blacksand Bridge is a daily road, so there are concerns that a simple temporary bridge will be required.	△
environmental and social considerations	・400m-long road widening is required, which needs utulity relocation, tree felling, and access restriction of nearby residents during construction period. ・Private land acquisition is not anticipated. Two households living on public land of riverbank will be affected and likely need resettlement. ・Measures to prevent vibration and noise from construction on nearby buildings are required.	◎	・130m-long road widening is required, which needs utulity relocation, tree felling, and access restriction of nearby residents during construction period. ・In order for the reroute bridge to cross the Tagabe River, permanent acquisition of at least one plot (or part thereof) of private land on each side of the river banks, totalling approximately 1,200m2. In addition, when including the temporary occupation of surrounding land for construction purposes, the total area will be at least 4,000m2. At least 1 household of the plot on the North side of the river need to be relocated. The private land plot on the South side of the river is presently vacant and no relocation is anticipated. ・Measures to prevent vibration and noise from construction on nearby buildings are required.	△	・2,000m-long road widening is required, which needs utulity relocation, tree felling, and access restriction of nearby residents during construction period. ・As the hilly part of the road is sharply steep and narrow (about 6-m wide), not only widening but road alignment improvements will be required to reduce steep gradients to gentler slopes. It will require partial acquisition of approximately 20 land plots along the road (totalling more or less 50 - 100m2). No resettlement, however, is anticipated ・Measures to prevent vibration and noise from construction on nearby buildings are required.	△
Estimated project cost	Inexpensive	○	Expensive (large land acquisition required)	△	Expensive (long construction length)	△
Construction period	relatively short term	○	relatively short term	○	Long term (long construction period)	△
comprehensive evaluation	High feasibility with the least number of challenges	◎	Large-scale land acquisition required, high risk of project delay	△	The extension is long and there are many issues, so it is unlikely to be realized in the short term.	△
[Legend] ◎: Best ○: Good (no negative impact or small negative impact) △: Issues remain (large negative impact)						

The Detour Bridge shall be permanent one to provide network redundancy; and the road from Smet to Huarere Studio shall be paved with concrete to enhance connectivity. This configuration ensures cost efficiency, environmental protection, and long-term resilience against floods and seismic events.

3.9 Environmental Integration and Linkages

Environmental safeguards are embedded throughout the project's planning and design process. Key linkages include:

- Hydrological consistency: Hydraulic models ensure both bridges maintain natural river flow and minimize flood risk.
- Riverbank protection: Revetments and gabions stabilize embankments and prevent sedimentation.
- Water source protection: Construction methods avoid contamination of the Tagabe River, which supplies Port Vila's urban water system.
- Climate resilience: Structural elevations, drainage, and materials are designed for projected sea-level rise and intense rainfall.
- Community safety: Traffic management, signage, and pedestrian facilities protect residents during and after construction.

These integrated design considerations align with JICA's environmental and social considerations, Vanuatu's legal framework, and the mitigation hierarchy (avoid, minimize, restore, offset).

3.10 Summary

The Tagabe Bridge Project is a critical national infrastructure initiative that combines engineering resilience, environmental stewardship, and social responsibility. Through the reconstruction of the Tagabe Bridge, construction of the Detour Bridge, and upgrading of the Smet–Huarere Studio Road, the project will:

- Reinstate and enhance a vital transport link;
- Protect the Tagabe River and its role as a water source;
- Strengthen Port Vila's resilience to earthquakes and floods; and • Deliver long-term socio-economic benefits to surrounding communities.

This comprehensive, integrated approach demonstrates Vanuatu's commitment to **"building back better"** in line with its National Sustainable Development Plan (NSDP) and disaster resilience objectives

4. Environmental and Social Baseline Conditions

4.1 Climate and Meteorology

The project area is located within Port Vila on Efate Island, Shefa Province. The area experiences a tropical maritime climate—warm and humid all year, with a clear wet season from November to April and a drier season from May to October.

The climate is influenced by the South Pacific Convergence Zone (SPCZ) and the El Niño–Southern Oscillation (ENSO), which cause rainfall and temperature to vary from year to year.

Two broad seasons define the local climate:

- Wet season (November–April): hot, humid, and rainy, often with thunderstorms and occasional cyclones.
- Dry season (May–October): relatively cooler with less rainfall, though brief showers still occur.

The ENSO cycle drives inter-annual variability:

- El Niño years: The SPCZ shifts north-eastward, resulting in below-normal rainfall and delayed wet-season onset in the southern islands (including Efate).
- La Niña years: The SPCZ shifts south-westward, producing above-normal rainfall, more frequent storms, and earlier wet-season onset.

Temperature

Records from Bauerfield Airport, compiled by VMGD and the Pacific Climate Change Data Portal (COSPPac), show that Port Vila maintains warm temperatures year-round with little seasonal fluctuation.

The monthly mean temperature record for 2020 (Figure 13) illustrates the pattern:

- The warmest months, January to March, average 26–27 °C.
- The coolest months, July and August, average 22–23 °C.
- The annual mean temperature is approximately 25 °C.

This small seasonal range reflects the strong ocean influence that moderates extremes. Night-time temperatures rarely drop below 19 °C, and daily highs seldom exceed 31 °C. Relative humidity remains high, between 80 % and 88 %, contributing to a persistently humid climate.

Long-term records indicate a gradual warming trend of about 0.1 °C per decade, consistent with broader Pacific patterns (VMGD & NIWA, 2023). Warmer nights and higher average temperatures are now more common than in the 1970s.

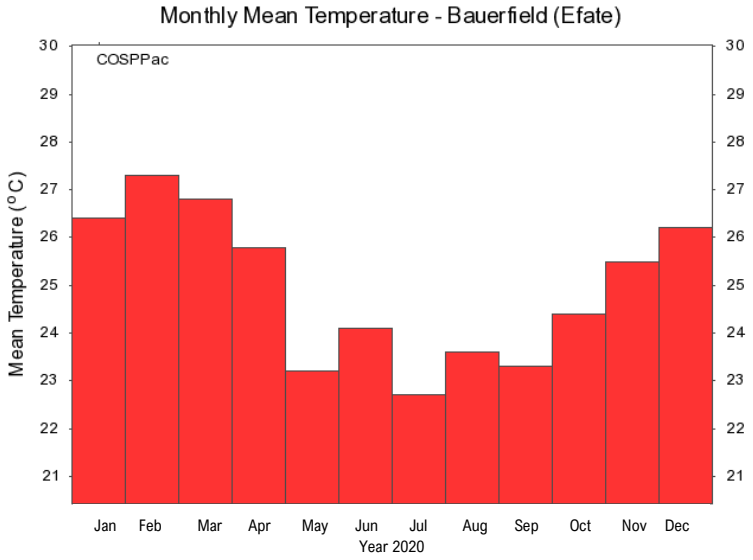


Figure 12: Monthly Mean Temperature for Port Vila for the Year 2020.

** Graph extracted from the Pacific Climate Change Data Portal* – (Pacific Climate Change Site Data)

Rainfall

Rainfall at Bauerfield (Efate) is abundant but highly variable. The long-term annual rainfall record (1972–2022) from the Pacific Climate Change Data Portal (Figure 14) shows large year-to-year fluctuations ranging from around 1 500 mm to more than 4 000 mm.

- Years such as 1999, 2002, and 2022 were extremely wet, exceeding 3 500–4 000 mm.
- Drier years, often linked to El Niño events, recorded totals near 1 600 mm.
- Despite variability, there is no clear long-term decline, but rainfall extremes have become more frequent.

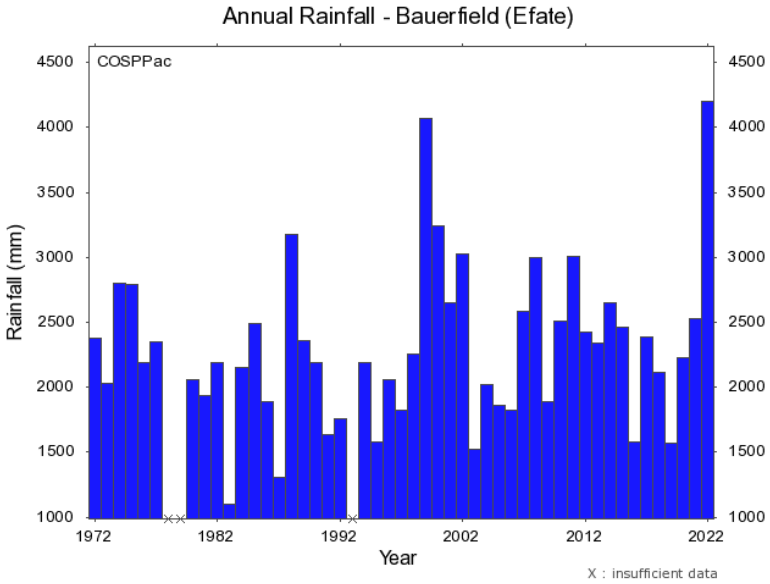


Figure 13: Annual Rainfall for Port Vila for the period 1972 - 2022.

** Graph extracted from the Pacific Climate Change Data Portal* – (Pacific Climate Change Site Data)

The monthly rainfall chart for 2022 (Figure 15) reflects the typical pattern:

- January to April form the wettest period, each month often exceeding 250–600 mm.
- July to September are the driest months, with only 80–120 mm of rain.
- Occasional heavy downpours can cause flash flooding in river catchments such as Tagabe.

On average, 70 % of annual rainfall occurs during the wet season, while the dry months are comparatively stable but still humid. These patterns are important for construction scheduling and erosion-control planning.

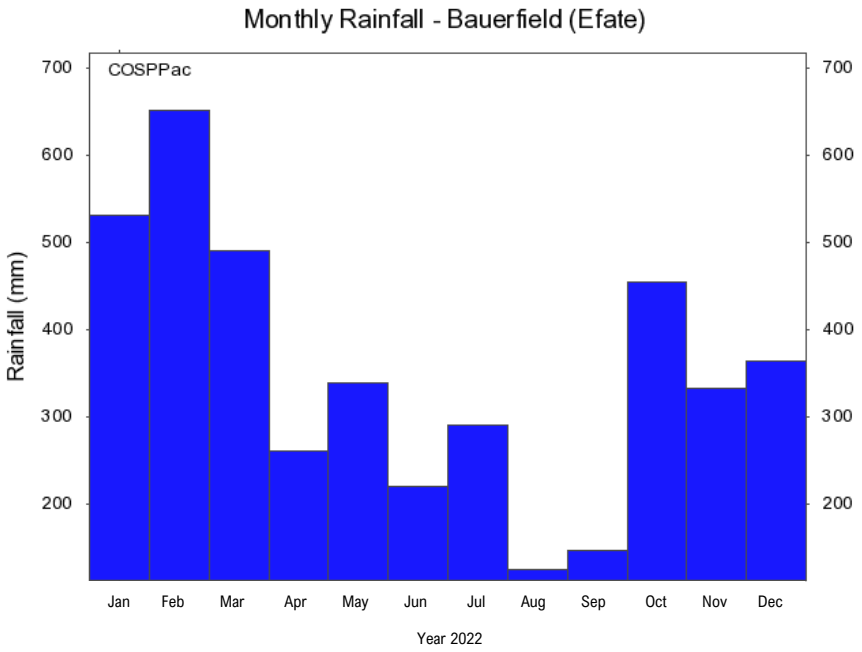


Figure 14: Annual Rainfall for Port Vila for the Year 2022

** Graph extracted from the Pacific Climate Change Data Portal* – (Pacific Climate Change Site Data)

Winds and Cyclones

Wind observations from VMGD show that the prevailing direction throughout the year is from the east to southeast, dominated by the southeast trade winds.

- Trade winds are strongest between May and October (dry season), producing steady breezes that range from 10 – 25 km/h.
- During the wet season, winds become more variable, sometimes shifting north or northwest with tropical systems.

The tropical cyclone season extends from November to April, coinciding with the wet season. Vanuatu lies in one of the most active cyclone regions in the South Pacific, and on average two to three cyclones affect its waters each year.
Recent years have shown increasing cyclone intensity—for example:

- Tropical Cyclones Judy and Kevin (2023) brought strong winds and flooding across Efate;

- Tropical Cyclone Lola (October 2023) reached Category 5, striking unusually early in the season.

VMGD data suggest that although the total number of cyclones may not be increasing, severe (Category 4–5) systems are becoming more common. Cyclones contribute significantly to Port Vila's annual rainfall and can cause short-term surges exceeding 300 mm per day.

These wind and cyclone conditions are critical factors for the design of bridge structures, drainage, and riverbank protection, ensuring resilience against high wind loads and flood events.

Table 7: Summary of Key Climate Features.

Parameter	Typical Range / Value	Source
Mean annual temperature	~ 25 °C	VMGD & NIWA (2023)
Mean monthly temperature	22 °C (Jul–Aug) – 27 °C (Jan–Mar)	VMGD / PCCDP (2020)
Annual rainfall range	1 500 – 4 000 mm	PCCDP (1972–2022)
Wettest months	Jan – Apr (250 – 600 mm per month)	PCCDP (2022)
Driest months	Jul – Sep (80 – 120 mm per month)	PCCDP (2022)
Prevailing winds	East–southeast trade winds	VMGD (2023)
Cyclone season	November – April	VMGD (2024)
Relative humidity	80 – 88 % year-round	VMGD (2023)

Implications for the Project

- Construction scheduling: Major earthworks and in-stream works should be planned outside the wet season (Nov–Apr) to avoid heavy rainfall and flooding.
- Design considerations: Drainage, culverts, and bridge abutments should accommodate intense rainfall events observed in recent years.
- Erosion control: Continuous maintenance of silt fences and vegetated buffers is required during the rainy season.
- Health and safety: High humidity and temperature require heat-stress management for workers.

References

- **Vanuatu Meteorology and Geo-Hazards Department (VMGD)** (2024). *Current and Future Climate of Vanuatu.*
- **VMGD & NIWA** (2023). *Vanuatu Climate Atlas (1991 – 2020 Normals).* VanKIRAP / Pacific Met Service.
- **Pacific Climate Change Data Portal (PCCDP / COSPPac)** (2024). *Bauerfield (Efate) Station – Rainfall and Temperature Records (1972 – 2022).*

4.2 Hydrology and Water Resources (Tagabe River)

The Tagabe River catchment (TRCA) is a hydrologically and socioeconomically critical system for Port Vila, serving as the sole source of potable water supply for the capital city and its surrounding suburbs. The catchment drains from the central highlands of Efate Island through mixed forested, agricultural, and urbanized zones before discharging into Mele Bay. Its total contributing area is approximately 24 km², encompassing both surface drainage networks and groundwater recharge zones that form a single, interconnected hydrological system.

Catchment and Hydrological Regime

Rainfall across Efate and the Tagabe catchment is seasonally variable, with a distinct wet season from November to April and a dry season from May to October. Mean annual rainfall ranges between 2,000 mm and 4,000 mm, depending on elevation and exposure to prevailing southeast trade winds (Pacific R2R, 2020). During the wet season, storm events contribute to high surface runoff, increased river discharge, and elevated sediment and nutrient transport, whereas during the dry season, baseflow in the Tagabe River is largely sustained by groundwater discharge from the underlying fractured basalt and alluvial aquifer systems (Pacific R2R, 2021).

Hydrologically, the Tagabe River demonstrates strong surface–groundwater connectivity. In upper and midstream reaches, groundwater contributes to maintaining dry-season baseflow (gaining stream behaviour), while in the lower coastal sections, particularly near Mele Bay, the river interacts dynamically with the coastal aquifer and tidal influences (Sharan et al., 2024). During high tides or sea-level rise events, brackish water intrusion can extend upstream, affecting both flow dynamics and water quality near the lower riverbanks.

The river's hydrological regime is further influenced by land use within the catchment. The upper catchment retains natural vegetation that supports infiltration and recharge, while the lower urbanized corridor exhibits impervious surfaces, roadside drainage channels, and informal wastewater discharges, all of which alter natural flow paths and increase sediment and contaminant loads during rainfall events.

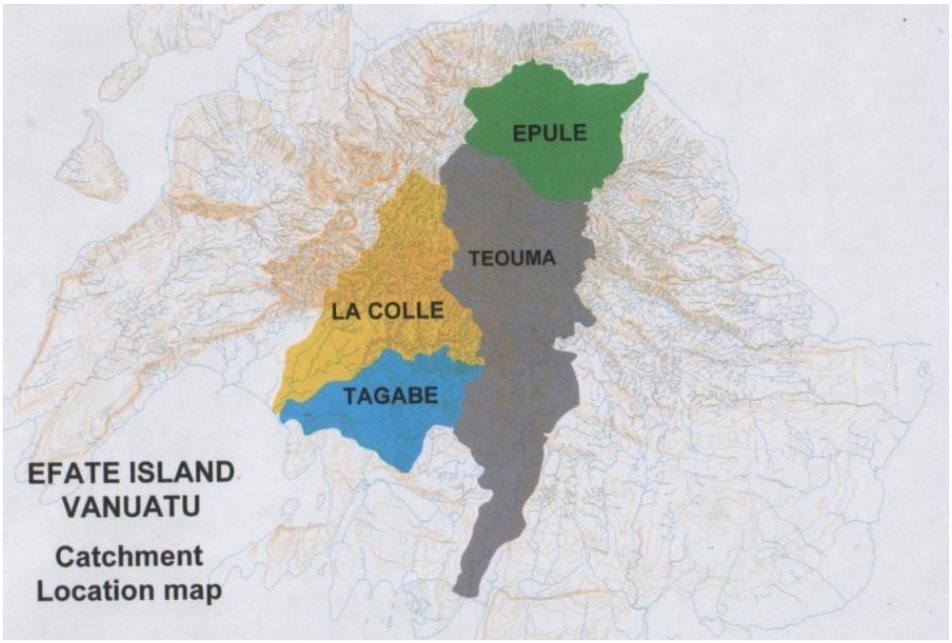


Figure 15: Tagabe River Catchment area (extracted from the Tagabe River Catchment Management Plan, 2017 – 2030).

Groundwater–Surface Water Interface

The Tagabe aquifer lies within fractured volcanic and alluvial deposits that store and transmit groundwater. The aquifer is characterized by moderate to high permeability zones that support production boreholes for municipal supply. Numerical modelling studies (Sharan et al., 2024) indicate that hydraulic connectivity between the river and aquifer is significant — with recharge occurring during periods of high river stage and baseflow contribution dominating in dry months. However, this connection also makes the system vulnerable to saltwater intrusion, over-abstraction, and contaminant migration from the surface.

Recent hydrogeochemical and geophysical assessments (Luo et al., 2024) have confirmed saltwater intrusion in the lower Tagabe coastal aquifer due to over-pumping, reduced recharge, and sea-level rise. The study recommends the implementation of managed abstraction rates, hydraulic barriers, and aquifer monitoring to ensure the long-term sustainability of Port Vila's water supply.

Water Abstraction and Usage in Port Vila

Port Vila's entire piped water supply is drawn from the Tagabe River Catchment. The water utility company, UNELCO Engie, operates a series of six to eight production boreholes within the TRCA, extracting both surface and groundwater for municipal use (Pacific Water, 2018; Sharan et al., 2024).

Recent operational data indicate that UNELCO supplies approximately 10,825 cubic metres per day (m^3/day) of potable water to Port Vila — equivalent to 3.95 million m^3 per year (UN-Habitat, 2021). This represents about 80% of the total piped water supply for the capital city. The remaining portion is supplemented by private boreholes, rainwater harvesting, and small decentralized systems.

Earlier records from the Pacific Regional Water Supply Assessment (2002) indicated abstraction of about 9,000 m³/day (~3.5 million m³/year) when system losses were around 50%. Through infrastructure upgrades and leakage reduction, UNELCO has since reduced losses to approximately 25%, improving network efficiency and reliability (SPC, 2002).

The Tagabe River Catchment Management Plan (2017–2030) reaffirms that TRCA is the only source supplying Port Vila's households, businesses, and institutions, serving an estimated 50,000–70,000 residents in the metropolitan area (Pacific R2R, 2020; SPREP, 2023). On a per-capita basis, the current abstraction equates to 150–216 litres per person per day, aligning with typical usage levels in small Pacific urban systems.

Flow Variability and Flooding

The Tagabe River experiences high seasonal flow variability, with discharge peaks occurring during intense rainfall events in the wet season. Flash floods can result in overbank flows, sediment deposition, and temporary deterioration of water quality due to runoff from urban areas. Conversely, prolonged dry periods lead to reduced baseflow, increased water temperatures, and concentrated pollutant loads.

Flooding risks are exacerbated near the river mouth and bridge site due to tidal backflow and urban drainage constraints. These interactions must be accounted for in the hydrological design of the bridge and associated drainage infrastructure to ensure resilience to both high-flow and low-flow extremes under projected climate change and sea-level rise scenarios.

Sustainability and Management Implications

Given the heavy dependence of Port Vila on the Tagabe system, sustainable management of both surface water and groundwater resources is imperative. Ongoing challenges include:

- **Over-abstraction pressures**, particularly during extended dry seasons, that lower groundwater heads and risk saline intrusion;
- **Catchment degradation** and reduced infiltration due to deforestation, informal settlement expansion, and road construction;
- **Pollution loading** from urban runoff, sewage effluent, and waste disposal near the river;
- **Climate variability** influencing recharge rates and seasonal flows.

To address these issues, the Tagabe Catchment Management Plan (2017–2030) outlines the need for integrated catchment management, controlled abstraction licensing, water quality monitoring, and riparian restoration. For the project, it is essential that hydrological connectivity, flood conveyance capacity, and aquifer recharge zones are preserved through environmentally sensitive design and construction practices.

The key hydrological and water resource characteristics of the Tagabe River Catchment are summarized in Table 1. These data highlight the catchment's vital role as the sole water supply source for Port Vila, supported by a coupled surface–groundwater system of high environmental and economic importance. The catchment's relatively small area (≈24 km²) sustains both perennial streamflow and municipal groundwater abstraction through six to

eight production boreholes operated by UNELCO. Seasonal rainfall between 2,000 mm and 4,000 mm/year governs flow variability, while baseflow contributions from the fractured volcanic aquifer maintain river discharge during dry periods. With an estimated 10,825 m³/day of abstraction supplying approximately 50,000–70,000 residents, the hydrology of the Tagabe system underpins urban water security for the capital. Effective management of recharge areas, abstraction pressures, and floodplain stability is therefore critical to maintaining long-term hydrological balance and ensuring resilience of both the river and aquifer systems.

Table 8: Summary of Hydrology and Water Resources – Tagabe River Catchment (TRCA).

Parameter	Description / Data	Source / Reference
Catchment area	Approx. 24 km² (Tagabe River Catchment – TRCA)	Pacific R2R, 2020
River length	~9 km from uplands to Mele Bay estuary	Pacific R2R, 2021
Mean annual rainfall	2,000–4,000 mm/year, highly seasonal (wet: Nov–Apr; dry: May–Oct)	Pacific R2R, 2020
Main hydrological characteristics	Perennial river with strong surface–groundwater connectivity; tidal influence in lower reaches	Pacific R2R, 2021; Sharan et al., 2024
Groundwater aquifer type	Fractured volcanic and alluvial aquifer system with moderate-to-high permeability	Luo et al., 2024
Baseflow contribution	Dominant during dry season; sustained by groundwater discharge	Pacific R2R, 2021
Surface–groundwater interaction	Gaining stream in mid-upper reaches; losing near coast during high groundwater conditions	Sharan et al., 2024
Tidal and saline influence	Brackish intrusion observed near river mouth during high tides and dry periods	Luo et al., 2024
Number of production boreholes	**6–8 active boreholes** operated by UNELCO for municipal supply	Pacific Water, 2018; Sharan et al., 2024
Total water abstraction (Port Vila)	**≈10,825 m³/day** (≈3.95 million m³/year)	UN-Habitat, 2021
System losses (non-revenue water)	~25% (reduced from ~50% in 2002 through network upgrades)	SPC, 2002; UN-Habitat, 2021
Population served	Approx. **50,000–70,000** residents (Greater Port Vila)	SPREP, 2023; Pacific R2R, 2020
Flood risk areas	Lower reaches near bridge site subject to overbank flows and tidal backflow	Pacific R2R, 2021
Key hydrological risks	Over-abstraction, saltwater intrusion, catchment degradation, and altered recharge	Luo et al., 2024; Pacific R2R, 2020
Management framework	*Tagabe River Catchment Management Plan (2017–2030)* – Integrated surface–groundwater management and abstraction control	Pacific R2R, 2020

- Rainfall and abstraction values represent average conditions and may vary seasonally.
- All boreholes are located within the Tagabe River Catchment Protection Zone, regulated under the *Tagabe River Catchment Management Plan (2017–2030)*.
- Data are referenced to published sources and validated secondary studies (UN-Habitat, 2021; Pacific Water, 2018; Sharan et al., 2024).

References

- Pacific R2R (2020). *Tagabe River Catchment Management Plan 2017–2030.* Pacific Community (SPC).
- Pacific R2R (2021). *Rapid Coastal Assessment of Tagabe River Catchment, Port Vila, Vanuatu.*
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- SPC (2002). *Environmental Report ER0007 – Vanuatu Water Sector Assessment.*
- SPREP (2023). *Tree Planting on Tagabe Riverbanks Increasing Vanuatu's Climate Resilience.*
- Luo, X., et al. (2024). *Hydrogeochemical Assessment of Tagabe Coastal Aquifer, Vanuatu. Hydrology*, 11(2): 108.

4.3 Water Quality (Surface and Drinking-Water Interface)

Water quality is a key environmental component influencing the health of aquatic ecosystems and the well-being of nearby communities. For the Project, water quality assessment is particularly important given the bridge's proximity to the Tagabe River, one of the primary freshwater systems supplying the Port Vila water supply network. The river flows from the upland areas through mixed residential and commercial zones before discharging into Mele Bay, and serves as a critical source of raw water for the UNELCO pumping stations situated along its lower reach. Consequently, any disturbance to the riverbanks, foreshore, or adjacent drainage systems during the bridge construction could potentially affect both surface water quality and the drinking-water interface connected through the underlying aquifer system.

The Tagabe River catchment exhibits a dynamic hydrological regime influenced by seasonal rainfall patterns, urban runoff, and periodic tidal backflow near the river mouth. These natural and anthropogenic processes interact to shape variations in water quality parameters such as turbidity, dissolved oxygen, electrical conductivity, and nutrient concentrations. The catchment's lower section is particularly sensitive due to its urbanized setting — with runoff from paved surfaces, household discharges, and small commercial activities contributing to

sedimentation, nutrient enrichment, and localized bacterial contamination. Maintaining good water quality within this stretch is therefore essential to protecting both aquatic life and potable water resources downstream.

Given the project's location and potential influence on surface and subsurface hydrological systems, a baseline water quality assessment was conducted as part of the environmental study. This assessment aimed to (i) characterize existing water quality conditions of the Tagabe River, (ii) identify any spatial variations in key physicochemical and microbiological parameters, and (iii) establish a reliable reference point for future monitoring during and after project implementation. The survey specifically considered the interaction between surface water (the Tagabe River flow) and the drinking-water interface, recognizing the river's hydrological connection to the underlying aquifer system used for municipal water abstraction.

Five representative sampling locations were selected along the Tagabe River — including upstream, midstream, and downstream sections relative to the proposed bridge sitse — to capture spatial differences and potential influences from surrounding land uses. Sampling was conducted during dry weather conditions to represent baseline, low-flow water quality. Measured parameters included temperature, pH, electrical conductivity, turbidity, dissolved oxygen, nutrients (nitrate, nitrite, ammonia, total phosphorus), trace metals (copper, iron), and bacteriological indicators (Enterococci). These parameters were selected based on their relevance to both ecological integrity and public health standards.

The collected samples were analyzed by an accredited laboratory following standard analytical procedures. Results were then interpreted with reference to World Health Organization (WHO) Guidelines for Drinking-Water Quality (2022) and applicable Vanuatu national water quality standards, providing an integrated understanding of both environmental and potable water conditions within the Tagabe system.

A detailed summary of the analytical results for the five sampling sites is presented below and discussed in relation to key physicochemical and microbiological indicators. These findings form an essential part of the environmental and social baseline for the project and will guide the development of the project's Environmental and Social Management and Monitoring Plan (ESMMP).

4.3.1 Water Quality Assessment (03 October 2025)

Water quality sampling was undertaken at five locations (TR01–TR05) covering upstream, midstream, and downstream reaches of the Tagabe River on the 3rd of October 2025. The purpose was to establish baseline conditions before project implementation and to identify possible spatial variations arising from community or urban influences.

The sampling network comprised five sites: an upstream control point (TR03) located near the UNELCO Pump Station; a midstream site (TR04) before the Detour Bridge; another midstream site adjacent after the Detour Bridge (TR05); TR02 before the Tagabe Bridge and TR01 after the Tagabe Bridge, where human activity is more pronounced.

Table 9: Water sampling locations and description.

Site Code	Location Description	Relative Position to the Project Site	Key Characteristics
TR03	Control Point (Near UNELCO Pump Station)	Upstream (Control)	Baseline site with minimal anthropogenic influence
TR04	Before Detour Bridge	Midstream	Transitional site reflecting gradual land-use change and human influence
TR05	After Detour Bridge	Midstream	Influenced by nearby settlement and commercial activities
TR02	Before Tagabe Bridge	Downstream	Increased human activity; potential runoff zone
TR01	After Tagabe Bridge	Downstream	Cumulative impacts from upstream and bridge vicinity

The analysis provides insight into the physico-chemical, nutrient, and microbiological characteristics of the river system prior to project works. The parameters analyzed comprised physical, chemical, and microbiological indicators relevant to aquatic ecosystem health and public safety, namely: temperature, conductivity, pH, dissolved oxygen, turbidity, nitrate, nitrite, ammonia, total phosphorus, copper, iron, and Enterococci.

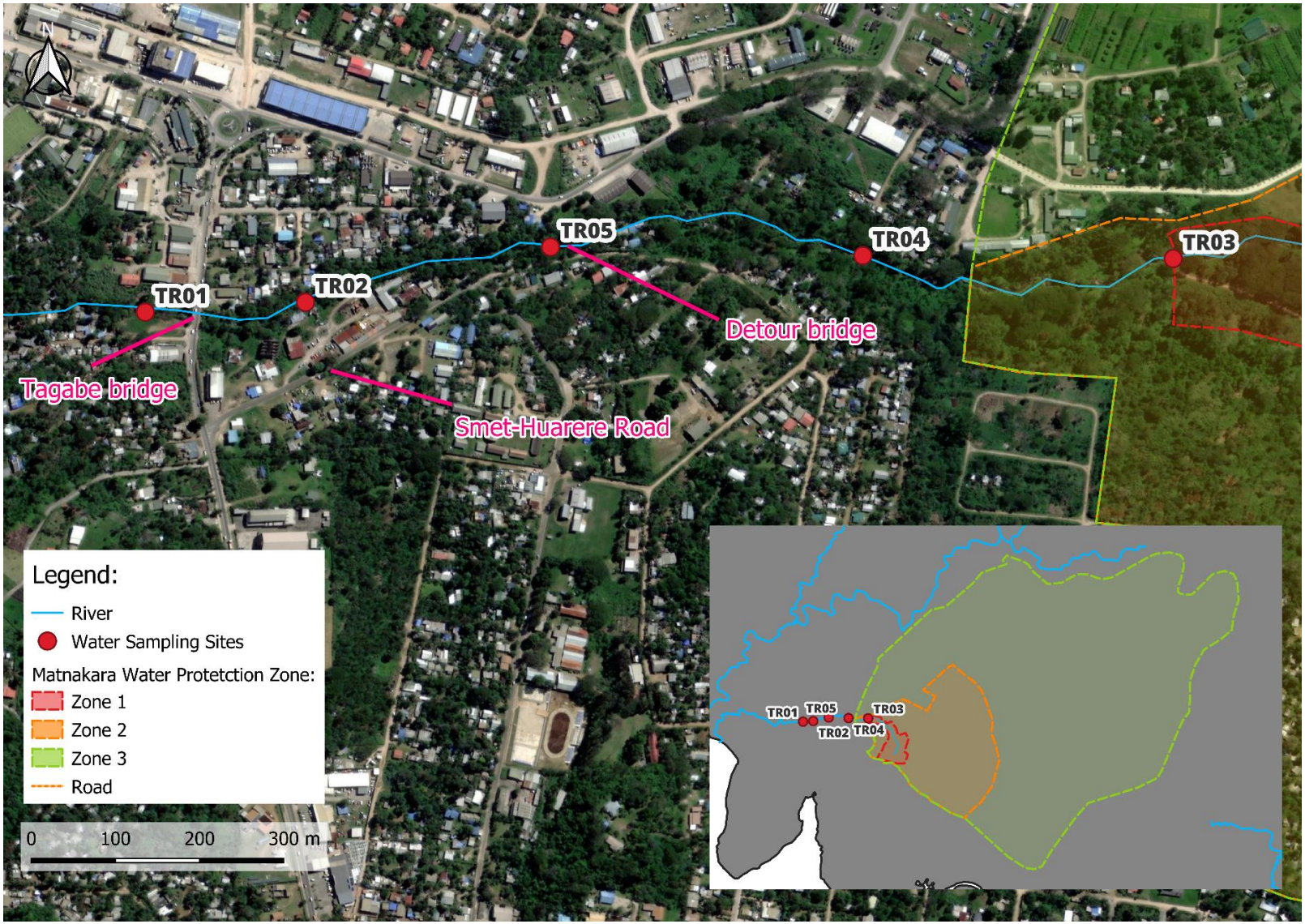

Figure 16: Water Quality sampling sites. Insert show the Matnakara Water Protection Zone.

Results

The table below provides a summary of the analytical sampling results.

Table 10: Summary of Analytical Results.

Parameter	TR01 (After Tagabe Bridge)	TR02 (Before Tagabe Bridge)	TR03 (Control)	TR04 (Before Detour Bridge)	TR05 (After Detour Bridge)	Typical Range / Guideline*	Interpretation
Temperature (°C)	27	28	27	27	28	25–30°C (tropical rivers)	Within normal tropical range; slightly higher near TR05 due to solar exposure and slower flow.
Conductivity (µS/cm)	465	461	458	463	466	<1,000 µS/cm (freshwater)	Moderate mineral content; within acceptable limits.
pH	7.8	7.8	7.51	7.6	7.56	6.5–8.5 (ANZECC/WHO)	Neutral to slightly alkaline; stable across sites.
Dissolved Oxygen (%)	84	86	74	83	83	>80% (good ecological condition)	Satisfactory oxygenation except at TR03 (74%), possibly slower flow.
Turbidity (NTU)	7.25	4.73	0.97	4.96	**15.5**	<5 NTU (drinking/recreation)	Elevated turbidity downstream; high at TR05 due to bank erosion or human activity.
Nitrate (mg/L)	0.514	0.502	0.543	0.453	0.501	<10 mg/L (WHO drinking water)	Very low; no eutrophication risk.
Nitrite (mg/L)	0.009	0.009	0.007	0.007	0.013	<1 mg/L (WHO)	Well within limits; slightly elevated near TR05.
Ammonia (mg/L)	0.012	0.019	0.011	0.006	**0.023**	<0.5 mg/L (ANZECC)	Low but higher near TR05, reflecting organic input.

Total Phosphorus (mg/L)	0.117	0.147	0.126	0.141	**0.219**	<0.1 mg/L (trophic guideline)	Elevated at TR05 — nutrient enrichment risk.
Copper (mg/L)	0.031	0.009	0.018	0.017	0.003	<1.0 mg/L (ANZECC aquatic life)	Within safe limits; decreasing trend downstream.
Iron (mg/L)	0.061	0.033	0.021	0.037	0.041	<0.3 mg/L (aesthetic / ANZECC)	Acceptable; natural mineral variation.
Enterococci (cfu/100ml)	**208**	**214**	**190**	**260**	**200**	<35 cfu/100ml (WHO recreational)	Exceeds safe levels — indicates widespread faecal contamination.

*Sources: WHO (2022) *Guidelines for Drinking-Water Quality*; ANZECC (2000) *Water Quality Guidelines for Fresh and Marine Waters*; UNESCO (2023) *Tropical River Baseline Values.*

Interpretation and Discussion

Physico-Chemical Quality

The Tagabe River exhibits stable physico-chemical parameters, with temperature, pH, and conductivity within acceptable tropical freshwater ranges. Conductivity values (458–466 µS/cm) reflect moderate dissolved solids, typical of semi-urban catchments. Slightly higher readings at TR05 suggest urban runoff or groundwater input containing dissolved ions.

Dissolved Oxygen (DO)

Dissolved oxygen levels are adequate for sustaining aquatic life (>80% saturation) across most sites. The slightly reduced value at the control point (TR03, 74%) may be attributed to slower-moving water or decomposition of organic matter in shaded zones.

Turbidity

Turbidity ranges from 0.97 to 15.5 NTU, with a notable increase at TR05 near the Nakamal area. Elevated suspended solids at this location likely result from soil disturbance, riverbank erosion, or domestic runoff. Persistent turbidity can affect aquatic organisms and light penetration, potentially reducing photosynthesis.

Nutrients (Nitrogen and Phosphorus)
Nutrient concentrations (nitrate, nitrite, and ammonia) remain low, signifying minimal agricultural runoff influence. However, total phosphorus exceeds 0.1 mg/L at TR05, indicating localised nutrient enrichment, possibly from greywater discharge or detergent residues. This condition may promote algal growth if persistent.

Metals
Copper and iron concentrations are within ANZECC thresholds for aquatic ecosystems. The slight spatial variation reflects natural geochemical conditions and suspended sediment input. No indication of heavy metal contamination is observed.

Microbiological Quality
Enterococci counts are significantly above WHO's recreational guideline (<35 cfu/100ml) at all sites, indicating widespread faecal contamination. The highest count (260 cfu/100ml) at TR04 suggests inputs from nearby settlements or septic effluent. This contamination presents a public health concern, particularly for communities using the river for recreation or washing. The enterococci count at the Control Point (TR03) is heavily influenced by cattle farms within close proximity of the river.

Table 11: Comparative Evaluation.

Parameter Category	Compliance with WHO / ANZECC Guidelines	Remarks
Temperature, pH, Conductivity	Within acceptable range	Indicates stable baseline conditions
Dissolved Oxygen	Generally compliant	Adequate for aquatic life
Turbidity	Exceeds guideline at TR05	Sediment and erosion influence
Nutrients (Nitrate/Nitrite/Ammonia)	Within limits	Minimal agricultural input
Total Phosphorus	Exceeds at TR05	Possible domestic or greywater source
Heavy Metals (Cu, Fe)	Within limits	No contamination detected
Enterococci	Exceeds at all sites	Indicates faecal pollution; sanitation issue

Interpretation by Sample Location (Control Point – Detour Bridge – Tagabe Bridge)

The following analysis considers water quality data in the context of the river's flow orientation:

TR03 – Pump Station Bridge (Control Point)

- **Character:** Controlled point with slower-moving water.
- **Findings:** Oxygen level is lower than ideal (74%), suggesting less mixing or buildup of organic matter. Water is very clear (turbidity 0.97 NTU).

- **Interpretation:** Even though this is a control site, low oxygen hints at slow flow and possible organic buildup. Chemical quality remains good.

TR04 – Before Detour Bridge

- **Character:** Transition to semi-urban influence.
- **Findings:** Oxygen is satisfactory (83%). Water is moderately cloudy (turbidity 4.96 NTU). Phosphorus and bacteria levels are higher, pointing to human activity.
- **Interpretation:** Early signs of pollution likely from nearby homes and recreational areas. Runoff or leaking septic systems may be contributing to contamination.

TR05 – After Detour Bridge

- **Character:** Mid reach with highest human influence.
- **Findings:** Water is most cloudy here (turbidity 15.5 NTU). Nutrient and bacteria levels are elevated, showing strong human influence.
- **Interpretation:** Pollution is likely from household waste, runoff, and riverbank disturbance. Slower flow and frequent use (washing, dumping) may be worsening water quality.

TR02 – Before Tagabe Bridge

- **Character:** Headwater zone with moderate flow and minimal disturbance.
- **Findings:** Water temperature (27°C) and pH (7.8) are normal. Oxygen levels are good (84%). Water is slightly cloudy (turbidity 7.25 NTU), likely from natural erosion.
- **Interpretation:** Water quality is generally clean, showing natural conditions (good vegetation cover on riverbank) with only minor sediment from riverbanks.

TR01 – After Tagabe Bridge

- **Character:** Transitional section below the bridge.
- **Findings:** Water is a bit warmer (28°C) and clearer (turbidity 4.73 NTU) than TR01. Oxygen remains high (86%). Nutrients show a small increase.
- **Interpretation:** Water is still in good condition but starts to show slight signs of urban runoff from the bridge or nearby drains.

Conclusion

The baseline water quality survey carried out on 3 October 2025 at five points (TR01–TR05) along the Tagabe River gives a good picture of the river's condition before the project begins. Overall, the river water is still in good condition, with normal temperature, pH, conductivity, and oxygen levels that support healthy aquatic life. There were no signs of heavy metal or industrial pollution, meaning that the river is mostly affected by community activities rather than factories or industry.

However, the results show that water quality becomes poorer downstream, especially in terms of turbidity (cloudiness), phosphorus (nutrients), and bacteria.

At the control site (TR03), the water chemistry is good, but the oxygen level is a bit lower because the water moves slowly and organic material may be building up.

At TR04 and TR05, near and after the Detour Bridge, the results show clear signs of human influence, with higher turbidity, more nutrients, and high bacteria counts (Enterococci) — likely from septic tanks, household waste, or people using the river directly.

Downstream near the Tagabe Bridge (TR02–TR01), the results also reflect runoff and surface pollution from nearby roads and settlements.

In short, the Tagabe River still has moderate water quality, but the lower parts of the river are being affected by human activities such as waste discharge and erosion. These results provide an important baseline reference to help monitor changes in water quality during and after the project.

Recommendations

1. **Protect and Restore Riverbanks**
    - Plant more trees and grasses along the riverbanks to stop soil erosion and reduce muddy water.
    - Where possible, establish a buffer area beside the river to act as a natural filter for runoff.
2. **Control Pollution During Construction**
    - Use barriers like silt fences, drains, and sediment traps around the bridge site to stop dirty water and soil from entering the river.
    - Plan in-water works during dry weather to reduce disturbance and pollution.
3. **Improve Wastewater and Septic Systems**
    - Nearby communities to check and upgrade septic tanks so that waste does not leak into the river.
    - Stop people and businesses from dumping household wastewater or rubbish into the river.
4. **Regular Water Testing**
    - Continue to test river water every three months for key indicators like oxygen, turbidity, nutrients, and bacteria.
    - Compare the new results with this baseline data to see if construction affects water quality.
5. **Community Awareness**
    - Teach nearby residents about the importance of keeping the river clean.
    - Encourage them to manage their waste properly and protect the riverbanks.
6. **Include in the Environmental Plan**

- Make sure all these water protection actions are included in the Environmental Management and Monitoring Plan (EMMP) for the project.
- Contractors should follow these rules and be checked regularly by the project's environmental team.

Linkage to Hydrology and Impact Assessment

The water quality results show that the Tagabe River is still healthy, but the lower parts are sensitive to pollution and erosion. During construction, changes in river flow and soil disturbance could make the water muddier and reduce quality.

This means the project must carefully manage stormwater, erosion, and drainage to protect the river. The baseline data collected will help compare future results and see if the project causes any changes.

Good hydrology management and protection of riverbanks will be important to keep the river clean and support a healthy ecosystem during and after construction.

4.4 Geology, Soils & Soil Quality

Regional Geological Setting

Efate Island forms part of the Vanuatu (New Hebrides) island arc system, created by the westward subduction of the Australian Plate beneath the Pacific Plate along the New Hebrides Trench. This tectonically active zone has generated a complex geological environment comprising volcanic, volcaniclastic, and coral limestone formations (Carney & Macfarlane, 1977; Greene & Johnson, 1984).

The geology of the Port Vila–Tagabe area is dominated by uplifted reef limestone terraces interbedded with volcaniclastic deposits from the Efate Pumice Formation and associated tuffs and ash flows. These materials overlie older andesitic and basaltic basement rocks. Faulting and episodic uplift have shaped the landscape, resulting in alternating high terraces and low alluvial plains (Greene et al., 1988).

Within the Tagabe River catchment, the upper reaches are characterized by volcanic bedrock and weathered pyroclastic soils, while the lower reaches near the coast comprise more recent alluvial and colluvial deposits derived from riverine sedimentation and slope wash (Tagabe River Management Plan, 2017–2030). The proposed bridge sites sit within this lower alluvial zone.

Local Soils and Genesis

Soil formation in Efate is strongly influenced by its volcanic origin and tropical climate. The primary parent materials are volcanic ash, tuff, and coral limestone, leading to heterogeneous soil profiles even within short distances. The seminal pedological study by Quantin (1982) classified Vanuatu's soils into three dominant types according to parent material and degree of weathering:

1. Ferrallitic soils, on older volcanic materials in humid upland zones;

2. Fersiallitic soils, on moderately weathered materials in drier mid-slopes; and
3. Andic soils, developed on recent volcanic ash with high water-holding capacity and low bulk density.

In the Port Vila–Tagabe plains, soils are typically young and moderately developed, consisting of loamy sands to sandy loams formed from alluvial and volcaniclastic sediments. These soils are relatively deep but may show stratified layering, reflecting alternating depositional events from fluvial flooding and slope erosion (Tagabe River Catchment Assessment, Pacific–R2R Project, 2020).

Areas overlying limestone terraces generally possess thin, stony soils with weak profile development and limited organic content. Conversely, lower-lying alluvial areas tend to exhibit finer textures and higher organic matter, particularly where vegetation remains intact or where periodic sediment deposition occurs during flooding.

Soil Quality Characteristics

Fertility and Nutrient Status.
Volcanic-derived soils in Vanuatu typically exhibit moderate to high inherent fertility due to mineral nutrient inputs from volcanic ash (Quantin, 1982; FAO, 2019). However, in the Tagabe basin, fertility varies spatially depending on land use and organic matter content. In urban and peri-urban areas, repeated disturbance, compaction, and topsoil loss have reduced nutrient availability and microbial activity (Vanuatu State of Environment Report, 2020).

Soil Acidity and Structure.
The pH of local soils ranges from slightly acidic to neutral (pH 6.5–7.5), reflecting the buffering effect of calcareous materials in the substratum (IWRM Diagnostic Report – Tagabe River, 2010). Soils are generally friable with moderate porosity; however, prolonged disturbance may cause compaction, reduced infiltration, and increased surface runoff.

Erosion and Stability.
Bank and slope instability are significant issues along the Tagabe River, where unconsolidated sandy and silty materials are prone to erosion, particularly during high-intensity rainfall events. Observations from the Tagabe Riverbank Stabilization Study (NAB, 2022) confirm active slumping, scouring, and undercutting in several reaches due to poor soil cohesion and removal of riparian vegetation. Uncontrolled runoff from roadways and construction sites exacerbates sediment transport downstream, affecting river water quality and coastal sedimentation.

Salinity and Coastal Influence.
Hydrogeological assessments indicate that the Tagabe coastal aquifer is experiencing increasing salinity due to seawater intrusion and groundwater over-abstraction (Luo et al., 2024, *Hydrology*, 11: 108). In low-lying coastal soils, this process may elevate electrical conductivity and sodium content, degrading soil structure and reducing plant growth potential. Periodic marine flooding during storm surges can further contribute to surface salinization.

Environmental Sensitivity and Implications for the Project

The heterogeneous geology and young, unconsolidated soils of the Tagabe River plains imply moderate to high environmental sensitivity. Key implications include:

- **Erosion risk**: Soils are easily mobilized during heavy rains or construction disturbance, requiring robust erosion and sediment control measures.
- **Bearing capacity variability**: Alluvial and sandy soils may exhibit low bearing strength, necessitating geotechnical investigation and foundation design suited to site conditions.
- **Soil and water interaction**: The proximity of the Tagabe River and shallow groundwater table heightens risks of sedimentation and contamination during earthworks.
- **Salinity effects**: Any construction in the lower catchment should consider salt-affected soils and design drainage systems to minimize infiltration of saline groundwater.
- **Soil conservation**: Re-vegetation, mulching, and topsoil management will be required to maintain fertility and reduce erosion during and after construction.

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4.5 Seismicity and Earthquake Hazard

Vanuatu lies along the Pacific "Ring of Fire", a region of intense tectonic activity where the Indo-Australian Plate is being subducted beneath the Pacific Plate along the New Hebrides

Trench. This subduction zone, located approximately 150–200 km west of the main island chain, is among the most seismically active in the world. Consequently, the country experiences frequent earthquakes and occasional tsunamis. Efate Island, where Port Vila and the project are situated, is located near the central segment of this subduction system, which remains highly active and capable of generating damaging seismic events.

Regional Seismic Setting

The New Hebrides Arc accommodates rapid plate convergence, producing hundreds of small-to-moderate earthquakes annually and periodic major events (Mw >7.0). While most earthquakes occur offshore at depths of 10–100 km, the felt intensity in Efate and Port Vila can be significant due to the proximity to fault systems that extend beneath the central islands.

Efate's geological composition—consisting largely of coralline limestone and volcanic pumiceous tuff – amplifies seismic waves, especially in reclaimed or unconsolidated foreshore areas like Tagabe. For this reason, both structural design and emergency management must consider earthquake hazard as a key environmental risk.

Historical Seismicity in Efate and Surrounding Region

Efate and the central Vanuatu region continue to be affected by seismic events, with occasional large earthquakes causing strong shaking, structural damage, landslides, and even a modest tsunami in recent times. A particularly significant event occurred on 17 December 2024, which had a notable impact on Port Vila and surrounding areas. Below is a summary of selected earthquakes (not exhaustive), focusing on those likely felt on Efate or with relevant consequence.

Table 12: Summary of key seismic events in Efate.

Year / Date	Location (Relative to Efate / Port Vila)	Magnitude (Mw or equivalent)	Depth (km)	Reported / Observed Effects and Notes
26 March 1875	Offshore Efate	~7.0 (estimated)	Unknown	Historical accounts of strong shaking and local coastal disturbances.
5 August 1958	West of Efate	7.2	~35	Felt strongly in Port Vila; masonry cracks, minor rockfalls.
2 January 2002	NW of Efate (~120 km)	7.5	33	Strong shaking across Port Vila; minor structural damage, localized landslides.
28 April 2016	NW of Efate (~80 km)	7.0	25	Strong motions; tsunami warning issued but no major inundation recorded.
15 December 2018	S of Efate	6.2	10	Intense but brief shaking; some non-structural damage in light buildings.

17 December 2024	~24 km WNW of Port Vila / ~30-34 km offshore Efate	7.3	~57.1	Widespread and severe shaking in Port Vila and surrounding areas; 14 fatalities confirmed; structural damage to many buildings (including the Tagabe bridge); triggered landslides; a modest tsunami (~0.6 m peak-to-trough) measured in Port Vila harbor.
11 May 2025	~5 km NNW of Port Vila	5.9	60.0	Moderate depth event; felt locally, but little to no structural damage reported.
13 June 2025	~27 km SE of Port Vila	5.0	156.8	Deep event; felt weakly; minimal observed impacts.

Notes:

- Depths and magnitudes are drawn from the USGS, VMGD catalogs, and news/situational reports.
- The December 2024 quake was particularly impactful given its proximity, magnitude, and shallower depth, causing extensive damage, casualties, and triggering local tsunami warnings.
- The table focuses on events most relevant to Efate / Port Vila; many smaller, deeper, or more distant events are omitted.

Associated Seismic Hazards

1. **Ground Shaking and Structural Damage:**
   Strong earthquakes (Mw >6.0) may induce horizontal accelerations on Efate. Infrastructure such as bridges, retaining walls, and culverts could experience cracking or displacement if not adequately reinforced.
2. **Soil Liquefaction:**
   The Tagabe River corridor is characterized by coastal alluvium, sand, and fill materials, which are susceptible to liquefaction during high-intensity shaking. Liquefaction could lead to settlement, loss of bearing capacity, or lateral spreading near bridge abutments.
3. **Landslides and Slope Failures:**
   Though Efate's topography around Tagabe is generally low-lying, nearby slopes or cut embankments could become unstable during seismic events, particularly under wet soil conditions.
4. **Tsunami Hazards:**
   Major offshore earthquakes along the New Hebrides Trench may generate tsunamis. While Port Vila Bay and Mele Bay are relatively sheltered, VMGD has identified them as potentially vulnerable to tsunami inundation, based on historical modeling and sea-level observations.
5. **Secondary Effects:**
   Earthquakes can also cause ground fissuring, damage to underground utilities, and

temporary blockage of drainage systems, increasing the risk of flooding or contamination in low-lying urban areas.

Implications for the Project

The Tagabe Bridge is situated within a zone of moderate-to-high seismic risk. To ensure resilience:

- Bridge and foundation design should comply with relevant national and international standards.
- Geotechnical site investigations should evaluate subsurface profiles for liquefaction susceptibility and dynamic response.
- Structural components such as pile caps, abutments, and retaining walls should incorporate ductile reinforcement detailing and flexible expansion joints.
- A post-earthquake inspection and emergency response protocol should be integrated into the Environmental and Social Management Plan (ESMP) to ensure timely structural assessment after significant seismic activity.

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4.6 Air Quality and Acoustic Environment

This section describes baseline ambient air quality and acoustic (noise) conditions in the study area. It combines publicly available monitoring / modeled data, where available, and outlines recommended measurement approaches to fill gaps.

4.6.1 Ambient Air Quality Baseline

Key Pollutants, Guidelines, and Metrics

The principal pollutants of concern in many islands and coastal settings include:

- **$PM_{2.5}$** (particles ≤ 2.5 µm)
- **PM_{10}** (particles ≤ 10 µm)
- **Ozone (O_3, ground-level / 8-h mean)**
- **Nitrogen dioxide (NO_2)**
- **Sulfur dioxide (SO_2)**
- **Carbon monoxide (CO)**

Common air quality benchmarks to compare against include WHO Air Quality Guidelines (2021):

Table 13: WHO Air Quality Guidelines (2021).

Pollutant	Annual Mean (WHO)	24-hour / Short-term Guideline*
$PM_{2.5}$	5 µg/m³	15 µg/m³ (24-h)
NO_2	10 µg/m³	25 µg/m³ (24-h)
O_3	—	100 µg/m³ (8-h)
SO_2	—	40 µg/m³ (24-h)
CO	—	4 mg/m³ (8-h)

** These are guideline (not legal) levels.*

Because continuous monitoring stations are scarce in many Pacific Island countries, baseline characterization often relies on short-term campaigns, satellite-derived or modeled data, and community / mobile monitoring.

Status of local data. No project-specific air quality sampling was undertaken for this IEE, and there is no government-operated ambient air quality monitoring network in Port Vila (or Vanuatu more broadly) publicly reporting criteria pollutants. As a result, the baseline below relies on third-party, model/observation–assimilated platforms (Plume Labs and derivatives) to provide contextual indications of typical conditions. These data are suitable for background context but do not replace regulatory-grade monitoring at the project site.

Benchmarks (for interpretation only)

The WHO Global Air Quality Guidelines (2021) recommend: $PM_{2.5}$ 5 µg/m³ (annual) and 15 µg/m³ (24-h); PM_{10} 15 µg/m³ (annual) and 45 µg/m³ (24-h); NO_2 10 µg/m³ (annual) and 25 µg/m³ (24-h); O_3 100 µg/m³ (8-h). These are health-based guidelines, not legal standards; use national standards where applicable. (World Health Organization)

Interpretive proxy for Port Vila (Plume Labs)

Publicly accessible Plume Labs feeds for Port Vila (also syndicated via AccuWeather/Weather.com) typically indicate "Good/Fair" air quality with $PM_{2.5}$ as the dominant pollutant. Recent live snapshots show AQI ≈ 30–40 and low gaseous co-pollutants (NO_2, O_3) relative to WHO guideline levels. Example live report for Port Vila shows AQI ~36 (Fair) with $PM_{2.5}$ identified as the main driver. (Plume Labs Air Report)

Table 14: Interpretive baseline summary (contextual, non-regulatory).

Item	Indicative status for Port Vila	Source/notes
Overall AQI	Typically, Good–Fair, often ~30–40	Plume Labs live map & feeds for Port Vila; syndicated to AccuWeather/Weather.com. (Plume Labs Air Report)
Dominant pollutant	$PM_{2.5}$	Plume displays $PM_{2.5}$ as the main driver of the composite AQI when elevated. (plumelabs.zendesk.com)
$PM_{2.5}$ level (context)	Commonly in the single-digit to low-20s µg/m³ (hourly variability), with episodic peaks possible	Interpreted from Plume feeds for Port Vila; compare to WHO 24-h AQG = 15 µg/m³ and annual = 5 µg/m³. (Plume Labs Air Report)
NO_2 / O_3	Generally low relative to WHO guidelines in snapshots	Plume pages list low NO_2/O_3 alongside PM indicators for Port Vila. (Plume Labs Air Report)
Data caveats	Model/assimilation product, variable siting/representativeness; not equivalent to certified monitors	Treat as screening context pending site monitoring. (plumelabs.com)

Implications and next steps

- **Screening conclusion.** Based on Plume Labs, Port Vila's urban airshed is generally good to moderate, with $PM_{2.5}$ the principal risk driver and occasional short-term exceedance of the WHO 24-h guideline plausible during stagnant conditions, biomass burning, dust, or localized construction/traffic.
- **Project application.** Use these indicative conditions only as a context baseline. For construction and operations where compliance decisions are required, undertake site-specific monitoring (e.g., gravimetric/filter or reference-grade optical $PM_{2.5}$/PM_{10} with co-located meteorology), and compare to WHO AQGs (or applicable national standards).
- **Recommended monitoring design.** Deploy short-term (e.g., 2–4 week) baseline sampling spanning work hours and night periods; capture wind, humidity, precipitation; position samplers away from immediate point sources to represent community exposure; and align methods with GIIP so the dataset can be used for screening-level dispersion checks and before/after comparisons.

Important: Until site data are collected, treat all air-quality risk conclusions as provisional and update the IEE baseline once field measurements are available.

Sources:

- Plume Labs – Port Vila live air quality page (real-time AQI, pollutant dominance). (Plume Labs Air Report)
- AccuWeather Port Vila AQ page (Plume Labs–sourced; indicates $PM_{2.5}$ dominance and "Good/Fair" categories). (AccuWeather)

- Weather.com – Port Vila AQ (contextual feed; primary pollutant $PM_{2.5}$). (The Weather Channel)
- WHO (2021) Global Air Quality Guidelines ($PM_{2.5}$/PM_{10}, O_3, NO_2, SO_2, CO). (World Health Organization)

4.6.2 Acoustic (Ambient Noise) Baseline

Twenty-four–hour unattended noise logging was completed at five monitoring locations along the Tagabe Bridge Road corridor, with each deployment starting at 06:00 on consecutive days between 15–19 September 2025 (Locations 1–5). All measurements are A-weighted and reported as hourly LAeq, with complementary LAmax/LAmin. For interpretation, the 24-h traces were parsed into daytime (07:00–19:00), evening (19:00–22:00) and night (22:00–07:00).

Key findings (measured baseline)

- **Overall levels.** The 24-h mean LAeq ranged from 52 dB (Location 4) to 67 dB (Location 2). Locations 1 and 5 were also elevated (≈ 65–66 dB), Location 3 was moderate (57 dB). Hourly LAmax values reached ~85–86 dB at the busiest roadside sites, indicating intermittent high-energy pass-bys (e.g., heavy vehicles or motorbikes).
- **Diurnal pattern.** All sites show the expected road-traffic signature: a rapid rise after 06:00–07:00, sustained daytime plateau, shoulder peak in the late afternoon, and decline after 20:00.
- **By period**. Typical daytime LAeq were 56–74 dB, evening LAeq 51–68 dB, and night LAeq 41–50 dB across sites. Night-time was quietest at Location 4 (~42 dB) and highest at Location 1 (~50 dB).

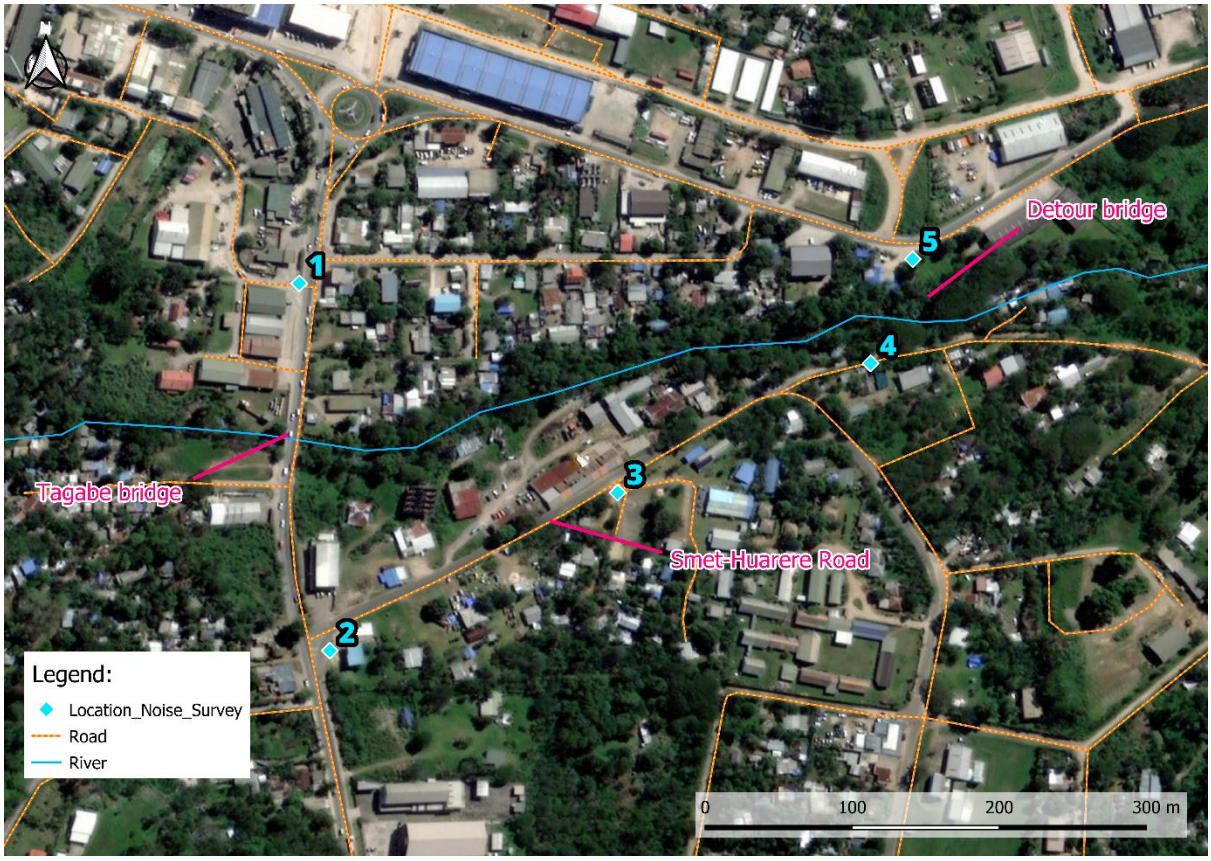


Figure 17: Location map for the Noise Survey stations.

- **Spatial differences.** Results align with site context previously described:
    - **Location 1** (shops/residences, busy road): Highest night LAeq (~50 dB) and high day LAeq (~72 dB), consistent with sustained traffic and mixed commercial activity.
    - **Location 2** (junction/retail, busy daytime): Highest 24-h mean (~67 dB) and day LAeq (~74 dB); frequent LAmax >75 dB suggests turning/acceleration events near the junction.
    - **Location 3** (residential on secondary road): Moderate baseline (24-h ~57 dB; night ~44 dB), peaking with commuter flows.
    - **Location 4** (mainly pedestrian/low traffic): Quietest site (24-h ~52 dB; night ~41–42 dB), representing the local lower-noise reference.
    - **Location 5** (shops/residences, busy road): Elevated baseline (24-h ~65 dB; day ~71 dB), with LAmax ~81 dB from occasional heavy pass-bys.

Table 15: Summary of noise survey result at Locations 1-5.

Location	Survey date	24h mean LAeq (dB)	Day mean LAeq 07–19 (dB)	Evening mean LAeq 19–22 (dB)	Night mean LAeq 22–07 (dB)	24h max LAmax (dB)	24h min LAmin (dB)
Location 1	2025-09-15	66.5	72.1	65.7	50.4	85.0	31.9
Location 2	2025-09-16	67.4	73.8	67.9	47.6	85.7	30.8
Location 3	2025-09-17	57.3	62.1	56.5	43.6	76.4	25.5
Location 4	2025-09-18	52.1	56.1	50.5	41.5	68.3	24.9
Location 5	2025-09-19	64.8	70.7	64.4	47.2	81.1	30.4

Benchmarking against international guidance

- **IFC/World Bank General EHS Guidelines (community noise).** For residential receptors the outdoor guideline is 55 dBA (day) and 45 dBA (night); where existing ambient levels already exceed the guideline, project noise should not increase the hourly ambient by more than 3 dB at the nearest receptor.
- **WHO environmental noise health guidance.** For road-traffic noise, WHO recommends Lnight ≤ 45 dB to protect sleep and health and highlights health risks (annoyance, cardiovascular outcomes) when thresholds are exceeded.

Implications for Tagabe baseline.

- **Daytime:** Locations 1, 2, and 5 exhibit day LAeq ~71–74 dB, clearly above the 55 dB residential comfort criterion; Location 3 is moderately above (~62 dB), while Location 4 is closer (~56 dB).
- **Night-time:** Locations 1, 2, and 5 report night LAeq ~47–50 dB, at or above WHO's Lnight 45 dB; Locations 3–4 (≈ 42–44 dB) align more closely with WHO night guidance.
- **Design target for the Project:** Because several locations already exceed residential guideline values, the appropriate EHS performance goal is the incremental criterion (≤ 3 dB increase in hourly LAeq at receptors) rather than absolute 55/45 dB compliance. This will be the relevant test for construction and operational noise management.

The acoustic environment around the Tagabe Bridge is dominated by road-traffic noise with a clear commuter-driven diurnal cycle. Hourly LAeq values rise sharply after 06:00–07:00 and remain elevated through the day, particularly at locations flanking the main road and the junction, where acceleration/braking and turning movements generate frequent maximum sound pressure levels (~80–86 dB). Evening levels taper but remain above quiet-background conditions due to continued commercial activity and through-traffic. Night-time LAeq generally falls into the low- to mid-40s, except at the busiest roadside sites where ~48–50 dB persists because of intermittent pass-bys.

Spatially, Locations 1, 2, and 5 (mixed retail/residential fronting the main carriageway) define the highest baseline (24-h mean ~65–67 dB), while Location 4 offers a local lower-noise reference (~52 dB) representative of less trafficked streets. Location 3 is intermediate (~57 dB), consistent with a secondary road serving nearby dwellings. This pattern mirrors conditions along other Pacific urban corridors, where transport demand and constrained junction performance concentrate noise exposure near roadside receptors.

Against international benchmarks, daytime roadside levels at several Tagabe locations exceed the residential 55 dB guideline and night-time levels at the busiest sites exceed WHO's 45 dB night-noise recommendation, indicating potential for sleep disturbance and annoyance in the most exposed dwellings if façade insulation is poor or windows remain open (a common condition in tropical climates). Accordingly, the IFC/WB "≤ 3 dB" incremental criterion is the appropriate performance goal for both construction and operation: project noise should not raise the existing hourly ambient by more than 3 dB at the nearest residences.

Baseline considerations for mitigation planning

- Most sensitive periods: Early morning (07:00–09:00) and late afternoon (16:00–19:00) peaks at Locations 1, 2, and 5; night-time near 50 dB at Locations 1–2 suggests heightened sensitivity to any additional out-of-hours activity.
- Most sensitive receptors: Dwellings and retail-residential mixed-use premises fronting the main road or adjacent to the junction; the quieter back streets near Location 4 provide opportunities for low-impact access routing.
- Indicative good practice: Scheduling high-noise works away from night-time; traffic management to smooth flow at the junction; temporary site barriers or plant enclosures for construction; and proactive complaints management. These measures are consistent with IFC/EHS guidance for community noise.

References

- WHO (2021). *Global Air Quality Guidelines* ($PM_{2.5}$/PM_{10}, O_3, NO_2, SO_2, CO). (World Health Organization)
- **IFC/World Bank (General EHS Guidelines – Noise).* Community noise: 55 dBA (day), 45 dBA (night), or ≤ 3 dB above ambient when ambient already exceeds guideline. (IFC)
- WHO (2018). *Environmental Noise Guidelines (Europe)* – road-traffic recommendations including Lnight 45 dB; EEA/WHO summaries of 53 dB Lden for adverse-effect thresholds. (World Health Organization)
- World Bank (2023). *Samoa PEAR* – cites compliance with PUMA Noise Policy 2011. (World Bank)

4.7 Terrestrial and Aquatic Ecology

A rapid biodiversity assessment (BioRAP) was undertaken along the Tagabe River on the 28th August 2025, to establish baseline ecological conditions within and near the project area. Two sites were surveyed:

- **Site 1 – Existing Tagabe Bridge**, and
- **Site 2 – Proposed Detour Bridge**.

The survey aimed to identify flora and fauna species within the riparian zone, evaluate habitat condition, and determine the presence of any endemic or conservation-significant species.

The Tagabe River and its surroundings within the project area support a small patch of disturbed riparian (riverbank) vegetation. This area has been affected for many years by housing, gardens, and other human activities. Although the natural environment is no longer intact, some native species of plants and animals still survive. These include local trees, small reptiles, freshwater prawns, and several birds. The overall biodiversity is low, but the riverbank still provides limited ecological functions such as soil protection, shade for the river, and habitat for insects and birds.

The results confirm that the Tagabe River ecosystem is highly degraded, reflecting intense anthropogenic pressure, pollution, and informal land use along its banks.

4.7.1. Flora Diversity

The vegetation along the river is a mixture of native, introduced, and cultivated plants. Common native species include *Cyperus alternifolius* (umbrella sedge), *Macaranga tanarius* (macaranga), *Barringtonia racemosa* and *B. edulis* (cut-nut trees), *Ficus obliqua* (banyan), and *Hibiscus tiliaceus* (beach hibiscus). Many introduced trees are also present, such as rain tree (*Samanea saman*), African tulip (*Spathodea campanulata*), and bamboo (*Schizostachyum glaucifolium*). Around settlements, residents have planted fruit and food trees including mango, papaya, breadfruit, banana, cassava, taro, and avocado. A list of recorded flora species identified during the assessment is listed in Appendix B.

Overall, the vegetation is secondary and highly disturbed. Invasive and fast-growing species dominate most areas, while native forest species are only found in small patches. None of the recorded plants are considered threatened at the global level, but the condition of the vegetation has been greatly reduced by clearing, gardening, and pollution. The presence of floating plants such as water lettuce (*Pistia stratiotes*) indicates nutrient enrichment from household waste and runoff.

4.7.2 Fauna Diversity

Animal life in the project area is typical of a disturbed urban river system. The fauna list include a mix of native and introduced species that can live close to people. Three endemic species were identified:

- Vanuatu Fruit Dove (*Ptilinopus tannensis*)
- Vanuatu White-eye (*Zosterops flavifrons*)

- Vanuatu skink (*Emoia sanfordi*)

A list of recorded fauna species identified during the assessment is listed in Appendix B.

Birds are the most common group and include the Pacific Emerald Dove, Glossy Swiftlet, Grey Fantail, and Grey-eared Honeyeater. Introduced birds such as the House Sparrow and Common Myna are widespread. One endemic species, the Yellow-fronted White-eye (*Zosterops flavifrons*), is listed as *Near Threatened* globally.

Reptiles include two species of small skinks (*Emoia sanfordi* and *E. cyanogaster*). *E. sanfordi* is a Vanuatu endemic species and is classed as *Data Deficient* due to lack of information.

Aquatic fauna consists mostly of introduced fish such as Mosquitofish (*Gambusia affinis*) and Mozambique Tilapia (*Oreochromis mossambicus*). Both are hardy species that can tolerate poor water conditions but may compete with native fish. The native freshwater prawn (*Macrobrachium lar*) and several aquatic snails such as *Neritina pulligera* were also recorded. The presence of freshwater prawns, molluscs, and aquatic insects such as dragonflies indicates that portions of the river still maintain moderate oxygen levels and residual habitat value.

Insects and spiders are common along the river. Dragonflies such as the Painted Grass Hawk (*Neurothemis stigmatizans*) and Chalky Percher (*Diplacodes trivialis*) show that the river still provides suitable breeding sites. Wasps and orb-weaver spiders occur around open and vegetated areas.

Overall, the fauna diversity is low, but several native and endemic species still persist, indicating that the habitat retains some ecological value.

4.7.3 Ecological Condition and Key Indicators

The overall ecological condition of the Tagabe River and its surrounding riparian zone can be described as moderately to highly disturbed. The river passes through residential and semi-urban areas where vegetation has been cleared or replaced by gardens, invasive trees, and human structures. The aquatic environment has been affected by waste disposal, soil erosion, and nutrient runoff.

Field observations show that the river ecosystem has lost much of its natural complexity. Most native vegetation has been replaced by fast-growing or cultivated plants, and many native animal species have disappeared or are now uncommon. A few tolerant and adaptable species continue to survive in the remaining habitat patches. The key ecological indicators and their meanings are summarized in Table below.

Table 16: Ecological Condition and Key Indicators.

Indicator	Observation	Ecological Implication
Low flora diversity	Vegetation dominated by invasive and cultivated species such as Rain Tree, African Tulip, and fruit trees	Indicates major habitat modification, loss of native plant communities, and limited natural regeneration

Low endemic fauna presence	Only three endemic species recorded (Tanna Fruit Dove, Yellow-fronted White-eye, and *Emoia sanfordi* skink)	Shows that the natural niches and shelter for endemic species have been greatly reduced
Presence of pollution-tolerant species (e.g., snails, mosquitofish, tilapia)	These species are abundant and widespread in the river	Reflects degraded water quality, low oxygen levels, and altered food webs typical of urban streams
Presence of dagonflies and damselflies	Only a few individuals observed near shaded, vegetated spots	Suggests small areas of cleaner, better-oxygenated water still exist and could support recovery if protected
Evidence of waste dumping and lease encroachment	Solid waste and informal structures observed along riverbanks	Demonstrates continuing human pressure leading to further decline in riparian and aquatic habitat quality

Overall, the ecological indicators confirm that the **Tagabe River corridor is under significant environmental stress**. The system supports mostly tolerant or generalist species, while sensitive and specialist species are largely absent. Despite the degraded condition, the scattered presence of dragonflies, native prawns, and remnant native trees suggests that pockets of ecological potential remain.

With appropriate restoration actions—such as replanting native vegetation, controlling invasive species, improving waste management, and stabilizing eroded banks—the river environment could gradually recover and provide better habitat for native flora and fauna in the future.

4.7.3 Key Threats

- Riparian vegetation clearance and lease encroachment.
- Waste dumping and nutrient loading from households.
- Erosion and sedimentation from disturbed banks.
- Competition and predation by invasive flora and fauna (e.g., *Samanea saman*, *Gambusia affinis*, *Achatina fulica*).
- Informal settlement expansion reducing habitat continuity.

4.7.4. Habitat Condition

The riverbank habitat is in poor to fair condition. Most of the natural riparian forest has been cleared and replaced by crops, invasive trees, and bare soil. The banks are narrow and fragmented, with patches of erosion and litter. In many places, short-rooted plants and ornamentals have replaced deep-rooted native trees, making the banks unstable. Water quality is affected by domestic wastewater, sediment, and solid waste entering the river from nearby settlements.

Despite these problems, some natural features remain. Shade from trees helps cool the water, and root mats and fallen branches provide shelter for prawns, skinks, and insects. With better management, the area could recover moderate ecological function.

4.7.5. Potential Impacts

Construction of the new bridge and temporary detour bridge will require clearing some vegetation and disturbing the riverbank. This could increase erosion and sediment in the water and temporarily drive away birds, reptiles, and small animals. Machinery, fuel storage, and waste from workers could also contaminate the river if not properly managed.

During operation, long-term impacts are expected to be minor if the banks are stabilized, replanted, and maintained. With good design and mitigation, the project could even improve habitat conditions along the Tagabe River.

4.7.6. Mitigation and Enhancement Measures

1. **Protect and restore riparian vegetation** wherever possible. Replant disturbed areas with native trees such as *Hibiscus tiliaceus*, *Barringtonia racemosa*, *Ficus obliqua*, *Macaranga tanarius*, and *Cyperus alternifolius*.
2. **Remove or control invasive species** like rain tree, African tulip, and water lettuce to allow native plants to recover.
3. **Use erosion and sediment control measures** such as silt fences, coir logs, and re-vegetation to prevent soil from entering the river during construction.
4. **Prevent water pollution** by keeping fuel and lubricants away from the river, using spill kits, and managing waste properly on site.
5. **Reduce disturbance to fauna** by clearing vegetation in stages and retaining logs or woody debris where safe.
6. **Involve nearby communities** through awareness activities and provide clear signage to protect the river during works.

4.7.7. Monitoring

Environmental monitoring should continue through construction and early operation to ensure rehabilitation measures are successful.

- **Vegetation:** Measure native plant cover and check for invasive regrowth.
- **Erosion control:** Inspect banks after heavy rain for stability.
- **Water quality:** Monitor turbidity and basic water parameters upstream and downstream of works.
- **Fauna:** Record sightings of birds, dragonflies, prawns, and other indicator species.

4.7.8. Summary

Overall, biodiversity along the Tagabe River is limited but still important for local ecology. The Tagabe River ecosystem within the project area is severely modified, exhibiting:

- Low terrestrial and aquatic species diversity,
- Limited endemic fauna, and
- Dominance of invasive and introduced species.

However, the occurrence of sensitive bioindicators (dragonflies, damselflies) shows that ecological recovery remains possible.

By following good construction practices, restoring riverbank vegetation, and preventing further pollution, the bridge project can protect and even enhance the remaining natural values of the Tagabe River.

References

- Rolenas & Bethel (2024). *Tagabe Bridge Biodiversity Assessment Report.*
- Rolenas Tavue (2020). *Study of the Distribution of Freshwater Fish Species in Tagabe River.*
- Department of Water Resources & SPREP (2017). *Tagabe River Catchment Management Plan 2017–2030.*

4.8 Socio-Economic and Cultural Setting

Overview

A comprehensive socio-economic household survey was conducted across four designated areas (A–D) surrounding the Tagabe Bridge Project site to establish a clear understanding of the local population's demographic, economic, and social characteristics.
The survey gathered first-hand information on household composition, income, education, land tenure, access to basic services, health, and community perceptions related to the proposed project.

This section presents the results and interpretation of the survey data, providing an evidence-based profile of the communities within the project's influence area.
All findings reflect actual responses recorded during field enumeration, ensuring that the socio-economic baseline accurately represents local conditions and informs subsequent impact assessment and management planning.

Figure 18: Location of the Household Survey Areas A-D.

4.8.1 Demographic Profile

Demographic information was collected from all 88 surveyed households across four defined areas (A–D) surrounding the Tagabe Bridge Project. Each household identified the number of occupants and the gender of individuals living within the dwelling. These data provide an accurate depiction of the population structure within the project zone.

Table 17: Demographic Profile by Survey Area.

Parameter	Overall	Area A	Area B	Area C	Area D
Total Households Surveyed	**88**	7	17	40	24
Average Household Size (persons)	**5.2**	5.4	6.6	4.8	4.9
Male (%)	**68.7**	69.2	69.5	68.6	67.5
Female (%)	**31.3**	30.8	30.5	31.4	32.5

The survey results indicate moderately large households across all four zones, with an overall average of 5.2 persons per household. The variation between areas is minor, though Area B stands out with the largest average household size (6.6 persons), possibly reflecting extended family living arrangements or shared dwellings common in dense residential areas near the main road.

The gender distribution is fairly consistent across the study area, averaging approximately 69% male and 31% female among recorded individuals. This ratio likely reflects the enumeration conditions—such as the availability of household members at the time of interview—rather than an actual demographic imbalance.

Overall, these data portray the Tagabe community as a typical peri-urban population characterized by moderately large families and stable gender representation.

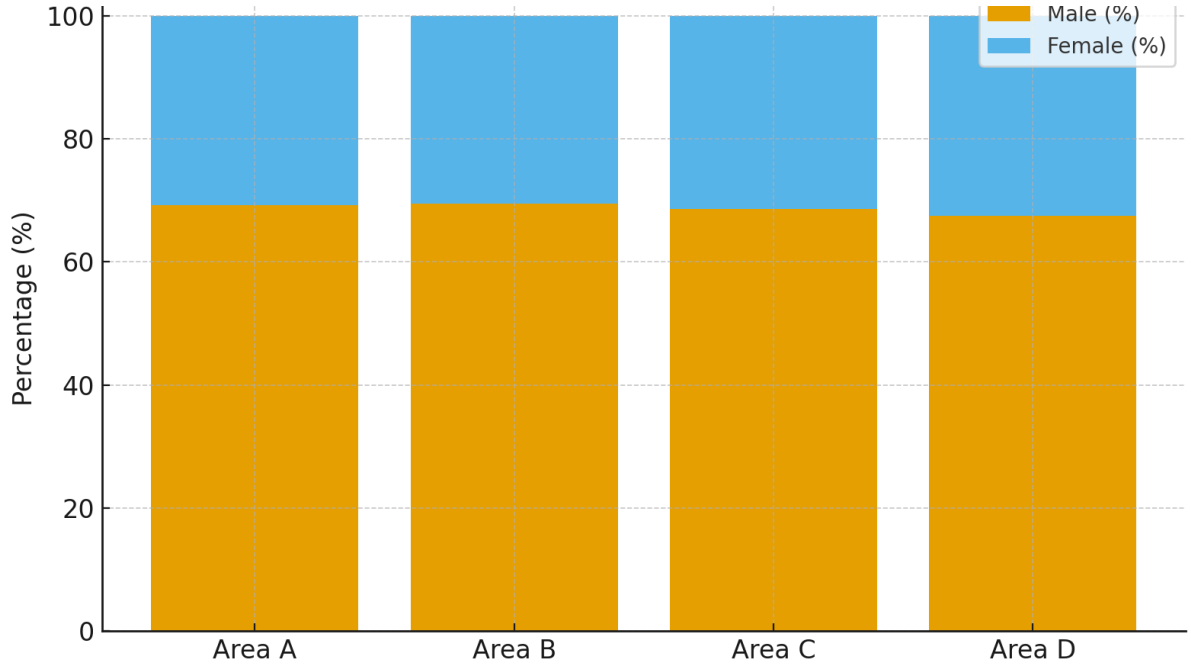


Figure 19: Gender Distribution by Survey Area.

4.8.2 Age Distribution

Age data were captured for every household member in the survey. Individuals were classified into three standard population groups:

- **Children and Young Adolescents (<15 years)**
- **Working-Age Population (15–64 years)**
- **Elderly Population (65+ years)**

Table 18: Population Distribution by Age Group.

Population Group	Overall	Area A	Area B	Area C	Area D
Children & Young Adolescents (<15 years)	**114**	10	23	48	33
Working-Age Population (15–64 years)	**297**	18	75	134	70
Elderly Population (65+ years)	**12**	2	3	3	4
Total Individuals Counted	**423**	30	101	185	107

The total recorded population across all households is 423 individuals. The working-age group (15–64 years) represents 70% of the total population, confirming the community's strong labor force potential. The children and adolescent group (<15 years) comprises 27%, while the elderly population (65+) accounts for just 3% of the recorded individuals.

Area C shows the largest individual count (185 persons), consistent with its higher number of surveyed households. The proportionally smaller elderly cohort suggests a low dependency ratio, indicating that most households are supported by actively working adults.

The data depict a youthful and economically active community, with a demographic profile well-suited for local labor participation in infrastructure development and service industries.

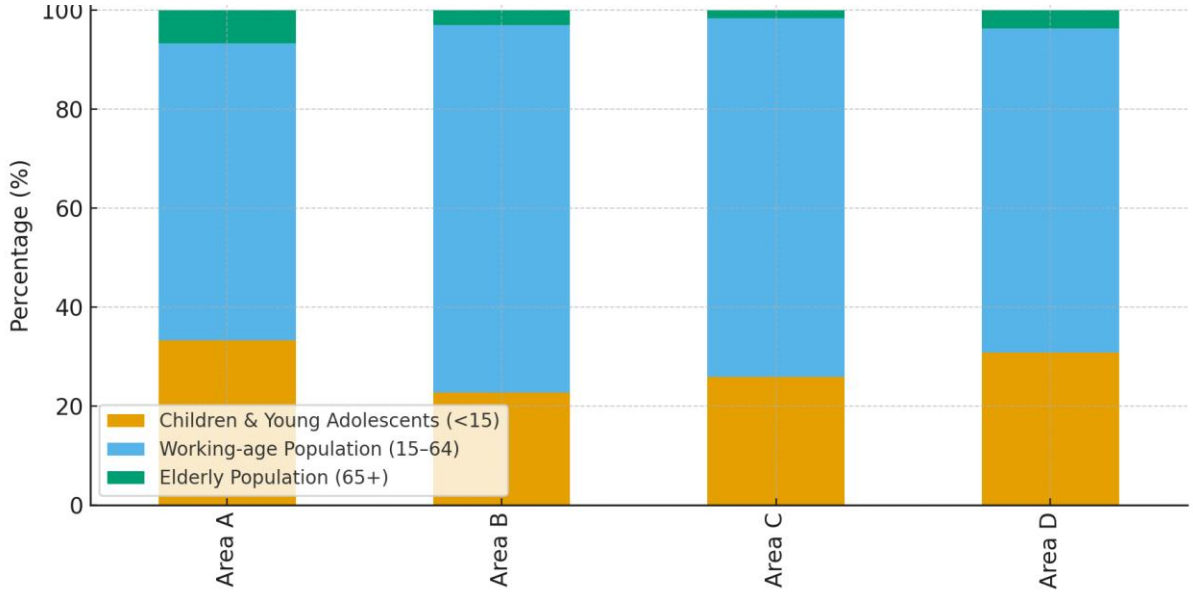


Figure 20: : Population Distribution by Age Group (Percentage by Area).

4.8.3 Household Income

Each household reported its total monthly income from all working members. The following table presents the actual mean and median income values derived directly from the survey datasets for each area.

Table 19: Monthly Household Income by Survey Area.

Survey Area	Mean Income (VUV/month)	Median Income (VUV/month)
Area A	81,833	75,000
Area B	95,938	80,000
Area C	69,406	50,000
Area D	73,150	50,000
Overall	**77,162**	**50,500**

The income data show moderate but stable household earnings across the Tagabe community.

- Area B reports the highest mean (95,938 VUV) and median (80,000 VUV) income levels, consistent with its proximity to Port Vila's commercial and service centers.
- Areas C and D record lower median incomes (50,000 VUV), reflecting a concentration of lower-income or informal households.

- The narrow gap between mean and median values across all areas suggests only modest income inequality, with limited influence from high-income outliers.

Taken together, these figures confirm that the Tagabe community sustains a modest semi-urban economy, reliant on both wage-based and informal activities, but with relatively balanced income distribution among households.

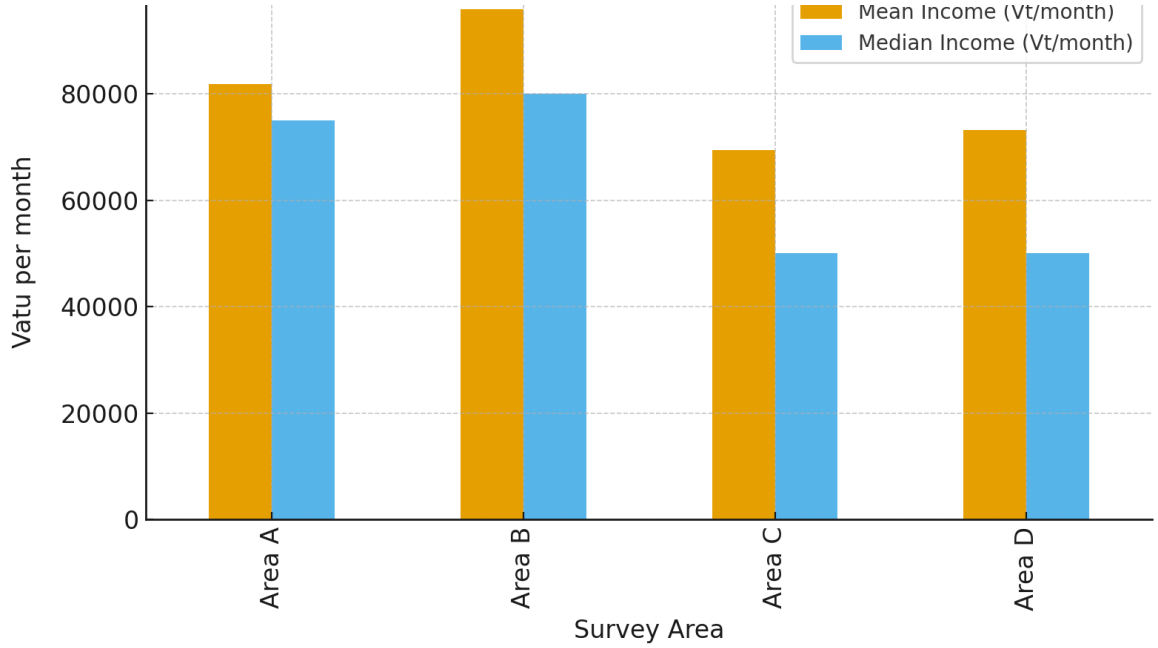


Figure 21: Average and Median Monthly Household Income by Survey Area.

4.8.4 Land Tenure

Land-tenure information was collected from all surveyed households to determine patterns of ownership, leasing, and land-use rights within the Tagabe Bridge Project area. The results provide a clear understanding of the tenure diversity across the four surveyed zones and reflect the transitional nature of the community between customary and urban tenure systems.

Table 20: Land Tenure by Survey Area.

Tenure Type / Category	Area A (%)	Area B (%)	Area C (%)	Area D (%)	Overall Trend
Renting	57.1	17.6	30.0	54.2	Widespread across A and D; moderate in C; least common in B
Hold Land Title (Titled Ownership)	42.9	41.2	—	12.5	Formal ownership mainly in A and B
Land Not Registered / Customary	—	29.4	20.0	25.0	Common in B, C, and D
Other Forms (Family, Customary, Shared)	—	—	5.0	8.3	Minor category, found mainly in C and D

The data reveal a diverse and semi-formal tenure system across the Tagabe area, with no single tenure form dominating the landscape.

- Renting emerges as the most common form of tenure, particularly in Areas A (57.1%) and D (54.2%), where proximity to the main transport corridor and Port Vila's commercial zone encourages temporary housing and short-term rentals. These results reflect a high degree of residential mobility and indicate a growing rental market along the urban fringe.
- Titled ownership is most prominent in Areas A (42.9%) and B (41.2%), suggesting gradual formalization of land rights among long-term residents. These households likely represent more established families with documented tenure or registered plots within municipal boundaries.
- Unregistered or customary tenure remains significant in Areas B (29.4%), C (20%), and D (25%), highlighting ongoing reliance on traditional or informal occupancy arrangements where legal documentation has not yet been completed.
- Family or customary shared arrangements, recorded in Areas C (5%) and D (8.3%), represent smaller but culturally important tenure practices that continue to provide access to land for extended families or new settlers.

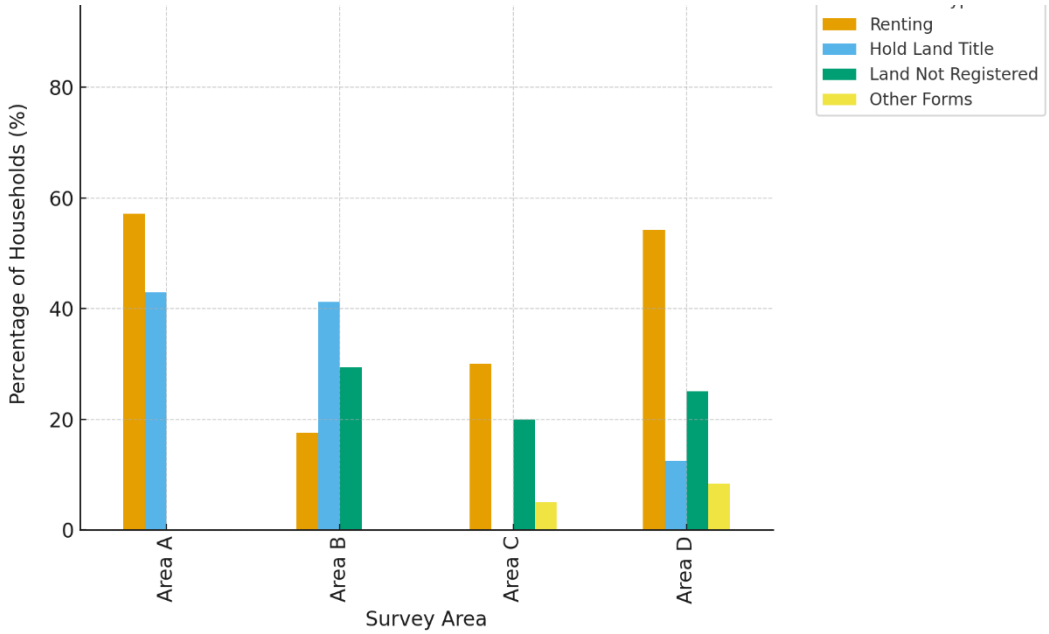


Figure 22: Land Tenure Composition by Survey Area.

The grouped bar chart illustrates the distribution of renting, titled ownership, unregistered land, and other tenure forms across the four survey areas.
The visualization reinforces the data pattern:

- High rental occupancy in Areas A and D;
- Stronger titled ownership in Areas A and B;
- Greater prevalence of unregistered or customary holdings in Areas B, C, and D; and
- Smaller family or shared land arrangements in Areas C and D.

Overall, the figure and tabulated results collectively confirm that Tagabe's land-tenure system is complex and transitional, combining both formal and informal practices. For project planning, this pattern emphasizes the need for clear, inclusive, and transparent land verification and compensation procedures that recognize the rights of both titled landowners and informal occupants.

4.8.5 Water Supply and Healthcare Access

Survey questions captured each household's primary water source and their access to healthcare. The following tables show the actual responses recorded.

Table 21: Primary Water Sources by Survey Area.

Water Source Category	Overall	Area A	Area B	Area C	Area D
UNELCO Water Supply (only)	21	4	14	1	2
UNELCO + River/Well (mixed)	66	3	3	38	22
River / Well only	1	0	0	1	0
Total Households	**88**	7	17	40	24

The data show that water access is uneven across the project area:

- Areas A and B enjoy the best infrastructure coverage, with most households connected solely to the UNELCO supply.
- In Areas C and D, over 90 percent of households rely on mixed sources—combining piped water with wells or the Tagabe River.
- Only one household reported exclusive use of an unprotected river or well.

This pattern highlights a progressive reduction in service reliability moving outward from the urban core. It also implies potential vulnerability of outer-area residents to supply interruptions or contamination. Any construction activity should therefore maintain access to both municipal and supplementary water points.

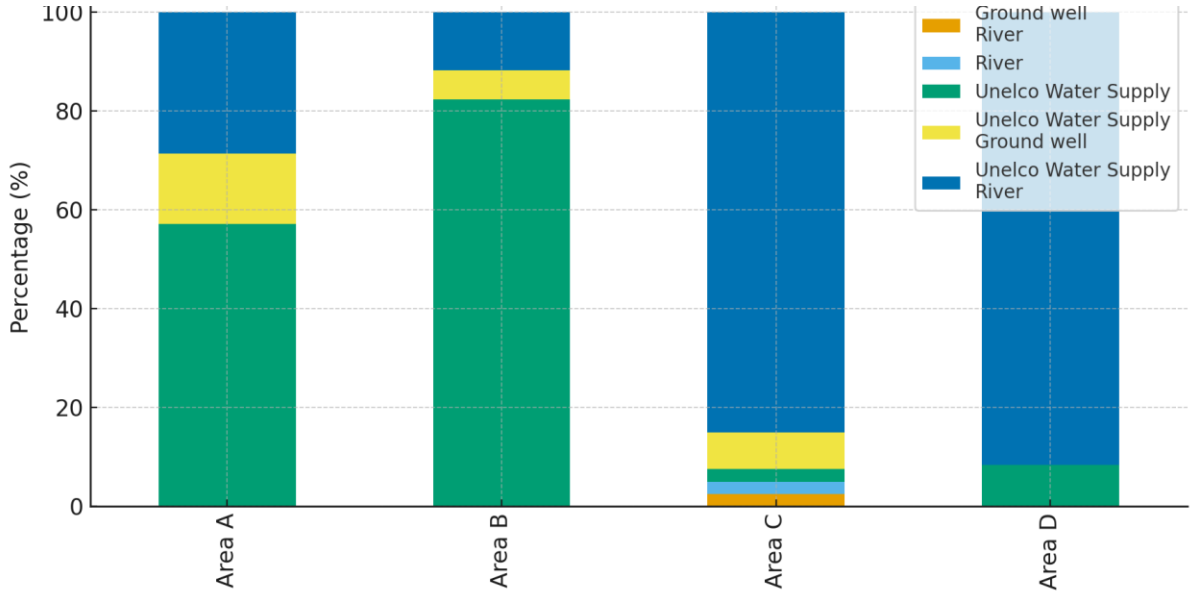


Figure 23: Primary and Combined Water Sources by Survey Area.

Table 22: Access to Healthcare by Survey Area.

Healthcare Access Response	Overall	Area A	Area B	Area C	Area D
Easy – Local Clinic/Hospital Nearby	86	7	16	39	24
Hard – Clinic Far	2	0	1	1	0
Total Households	**88**	7	17	40	24

Nearly every household—98 percent of those surveyed—reported easy access to a nearby health facility. Only two households, one each in Areas B and C, considered access difficult.

This finding confirms that basic medical services are readily available across the community, an important asset for managing health and safety during construction. The consistency of "easy" responses also demonstrates strong spatial coverage of clinics and hospitals within a five-kilometre radius of the project site.

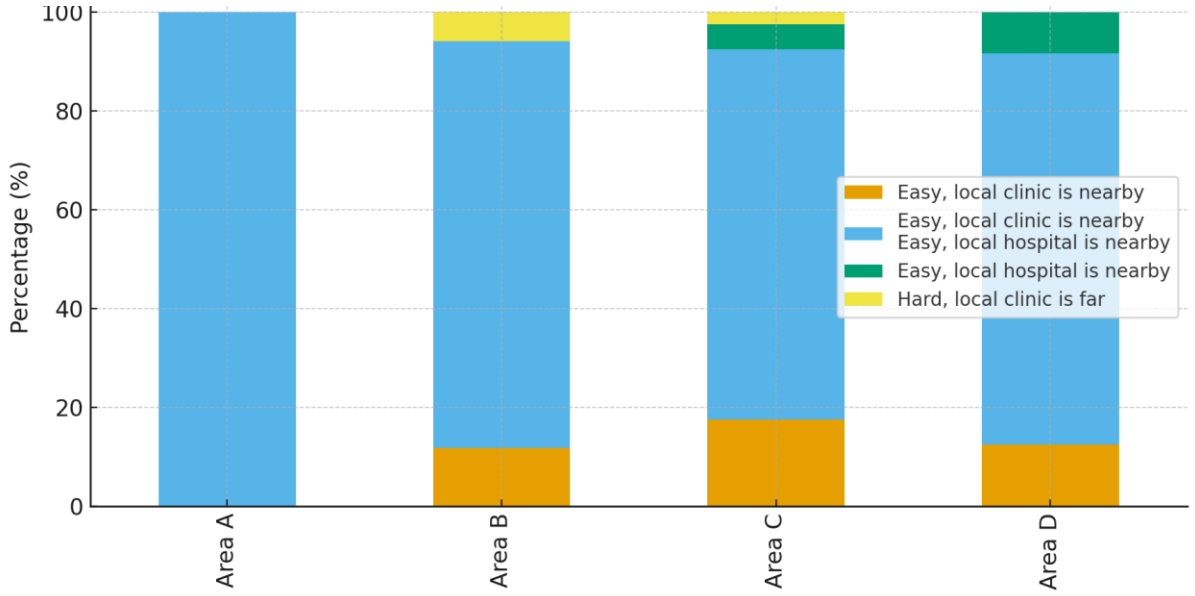


Figure 24: Healthcare Access Responses by Survey Area.

4.8.6 Education and Special Needs

Educational attainment and special-needs information were collected for all individuals recorded in the household census. The data provide a picture of the education profile and inclusivity within the project community.

Table 23: Education Attainment by Survey Area.

Education Level	Area A	Area B	Area C	Area D	Overall
Primary Education	11	26	54	36	**127**
Secondary Education	8	22	33	28	**91**
Vocational Education	3	8	4	5	**20**
Tertiary Education	2	6	3	3	**14**
Total Individuals Recorded	**24**	**62**	**94**	**72**	**252**

The education data show that the Tagabe population has broad participation in basic education and limited access to advanced or technical training.

- Primary and secondary schooling dominate across all areas, together representing approximately 86 percent of all individuals recorded.
- Area C has the highest count of primary-level students (54 individuals), consistent with its larger household population and higher proportion of young dependents.
- Area B shows the greatest representation in vocational and tertiary education (8 and 6 individuals respectively), reflecting its proximity to Port Vila's secondary schools and training institutions.

- Areas A and D demonstrate steady but smaller participation in post-secondary education, which is typical for semi-urban households where higher-education access depends on distance and affordability.

Overall, the results confirm that the community maintains strong literacy and school enrolment at lower levels, but limited progression into vocational or tertiary studies. This pattern underscores the importance of skills-development and livelihood training programs under the project's social-benefit initiatives, especially for youths from the outer survey zones (C and D).

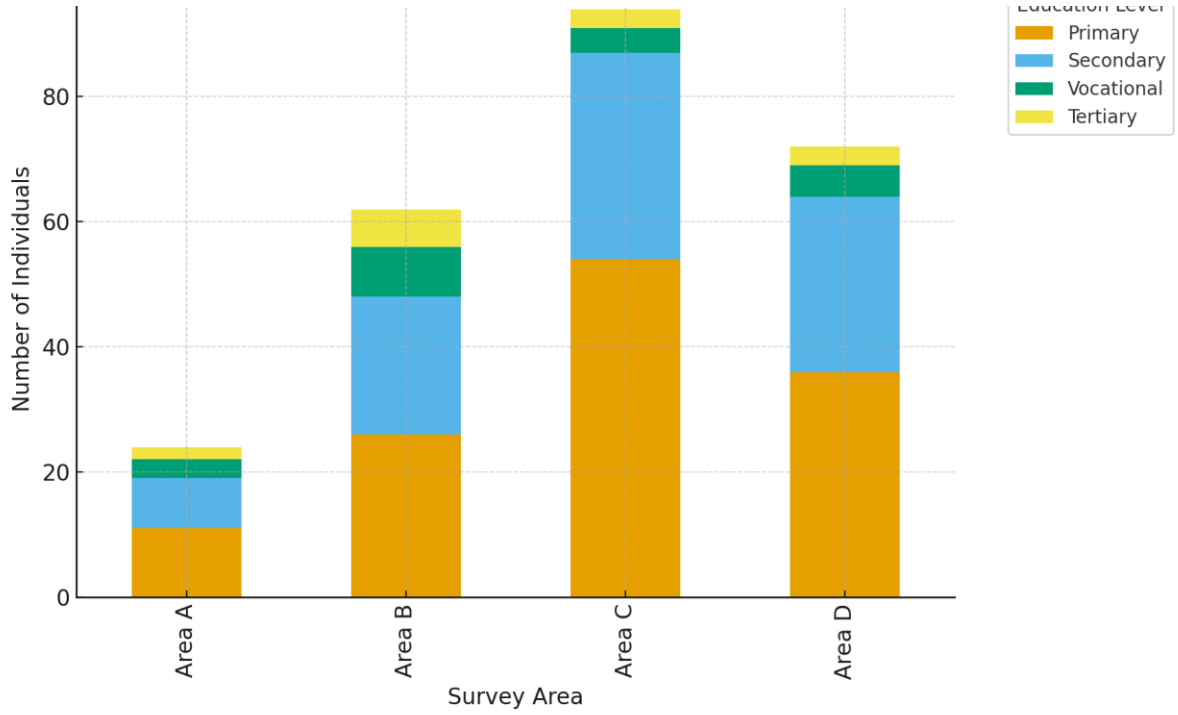


Figure 25: Education Attainment by Survey Area.

The chart clearly demonstrates the dominance of primary and secondary education and visually highlights the higher tertiary participation in Area B compared with other areas.

Special Need (Inclusivity)

Only six individuals (2.4 percent of all respondents) reported living with special needs across the four areas. These responses are evenly distributed, with one or two individuals recorded in each zone.

The data confirm that persons with disabilities are a small but present group within the project community. Their inclusion in the suvey highlights the survey's attention to inclusivity and provides a factual basis for integrating universal-access design features—such as ramped pedestrian access, handrails, and barrier-free walkways—into the bridge and adjoining infrastructure.

Summary

The combined education and inclusivity data depict a community with a well-established base of literacy and schooling, limited higher-education participation, and a small but recognized

population of individuals with disabilities.
This profile supports the development of social programs that focus on:

1. Expanding vocational and technical training opportunities, particularly for youth and informal-sector workers; and
2. Ensuring universal accessibility in all project facilities to promote equitable participation.

4.8.7 Community Awareness and Perception

Community perception and awareness data were collected to gauge the level of understanding, acceptance, and concern regarding the proposed Tagabe Bridge Project. Respondents were asked whether they were aware of the project, whether they supported it, and to list any specific concerns or issues.

This information provides a clear indicator of local engagement and social readiness for project implementation.

Table 24: Awareness of Project by Survey Area.

Response	Area A	Area B	Area C	Area D	Overall (%)
Yes	4 (57.1%)	12 (70.6%)	29 (72.5%)	20 (83.3%)	**74.0%**
No	3 (42.9%)	5 (29.4%)	11 (27.5%)	4 (16.7%)	**26.0%**
Total Households	**7**	**17**	**40**	**24**	**88**

The data show high levels of awareness of the Tagabe Bridge Project across all four survey areas. Overall, 74 percent of all households reported being aware of the project prior to consultation.

- Area D recorded the highest awareness (83.3%), reflecting its proximity to the bridge site and more active community engagement.
- Areas B and C also show strong awareness levels (70–72%), consistent with their location along the project corridor and visibility to construction activity.
- Area A shows the lowest awareness (57.1%), likely due to its smaller population and partial distance from the project footprint.

The results indicate that most residents were already informed or had prior knowledge of the project before formal disclosure and that public information had reached all survey zones to varying degrees.

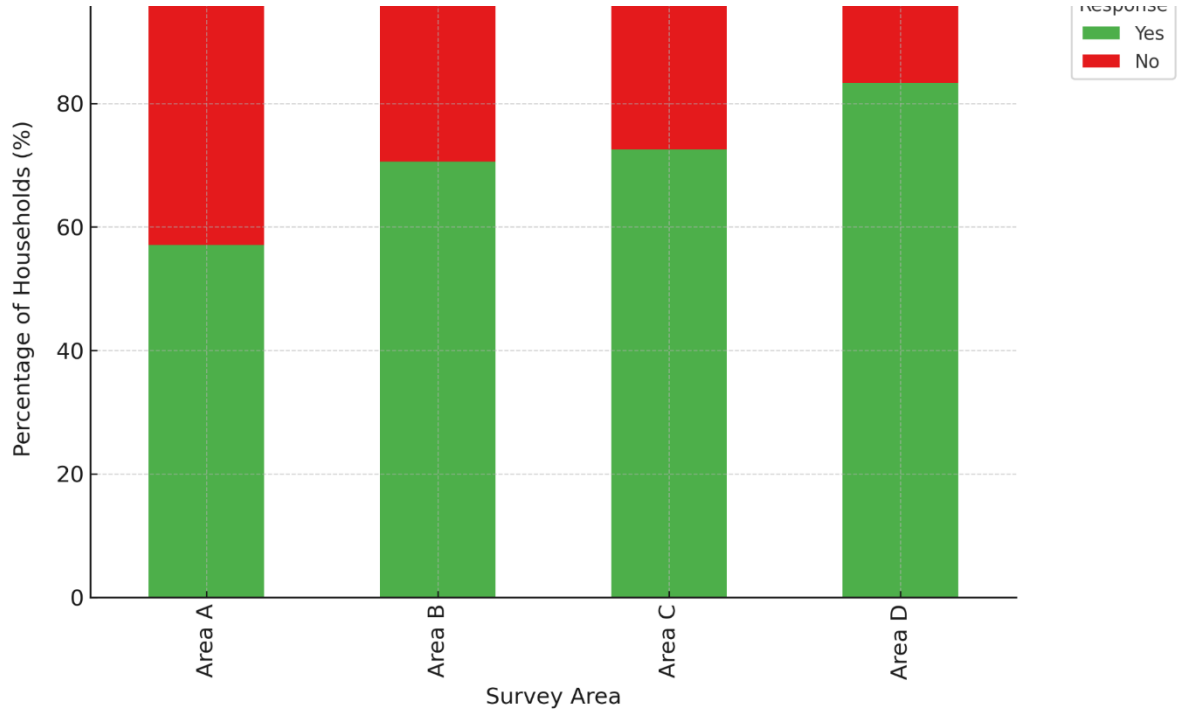


Figure 26: Awareness of Project – Percent "Yes" by Area.

The bar chart highlights the consistent pattern of high awareness across the four zones, with Area D exhibiting the greatest concentration of informed respondents.

Table 25: Support for Project by Survey Area.

Response	Area A	Area B	Area C	Area D	Overall (%)
Yes	5 (71.4%)	10 (58.8%)	29 (72.5%)	21 (87.5%)	**72.7%**
No	2 (28.6%)	7 (41.2%)	11 (27.5%)	3 (12.5%)	**27.3%**
Total Households	**7**	**17**	**40**	**24**	**88**

The level of project support is broadly positive across all areas, averaging approximately 73 percent of respondents in favor of the Tagabe Bridge works.

- Area D again records the highest level of support (87.5%), reflecting a strong recognition of the bridge's anticipated benefits for connectivity and safety.
- Areas A and C also show high levels of support (71–73%), suggesting that residents in both the semi-urban and informal zones share optimistic views of the project.
- Area B, while still majority supportive, records a comparatively lower figure (58.8%), which may reflect concerns over temporary access disruption during construction, as mentioned in open responses.

Overall, the data reveal a community that is well-informed and largely supportive of the project's objectives.

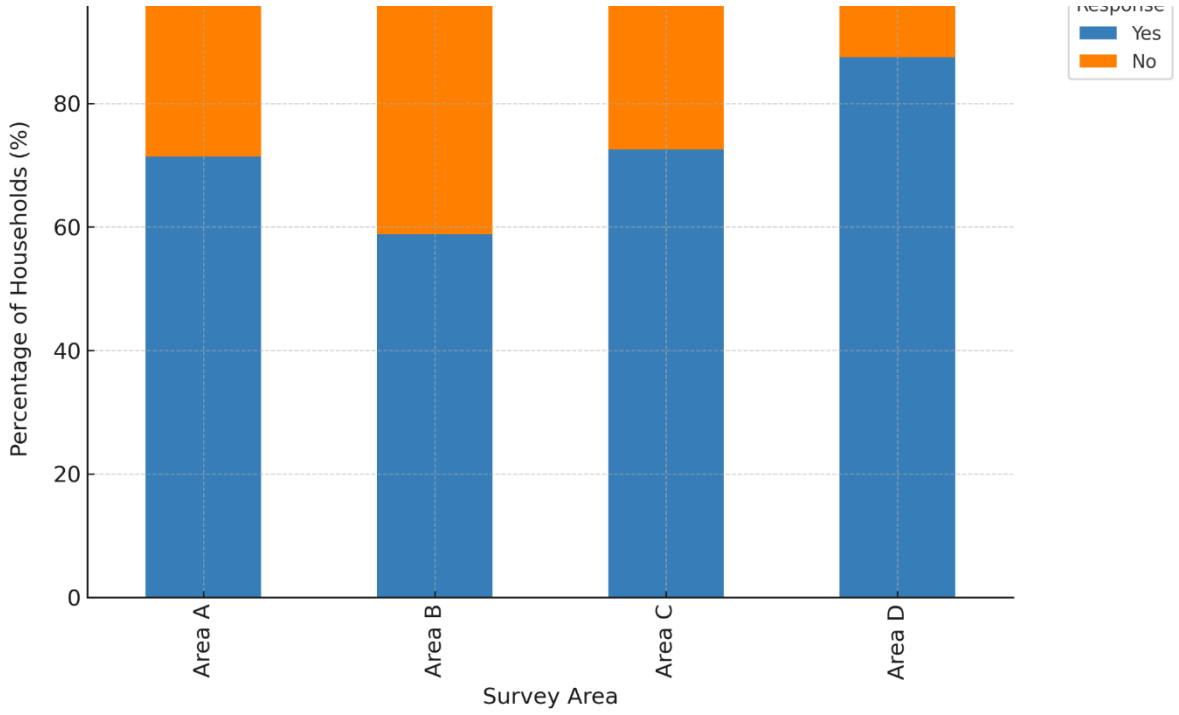


Figure 27: Support for Project – Percent "Yes" by Area.

The figure shows a clear majority of "Yes" responses in every area, with only minor variations between the zones.

Table 26: Common Concerns Expressed by Respondents.

Type of Concern (Keyword)	Area A	Area B	Area C	Area D	Overall Mentions
Dust	1	3	6	2	**12**
Noise	1	2	5	2	**10**
Access / Detour	0	3	7	3	**13**
Traffic Delay	0	1	3	2	**6**
Safety Concerns	1	0	2	1	**4**
Other General Comments	0	1	4	1	**6**

The open-response analysis shows that most concerns relate to temporary construction impacts—specifically dust, access, and noise.

- Access and detour issues received the highest number of mentions (13 total), followed closely by dust (12) and noise (10).
- Concerns were most frequent in Areas B and C, which are directly along the bridge approach roads and most likely to experience short-term disruptions.
- A few respondents noted traffic and safety concerns, but none expressed strong opposition or long-term objections to the project.

The overall tone of responses indicates that residents are pragmatic and understanding of the short-term inconveniences associated with construction, provided that mitigation measures—such as dust suppression and clear signage—are implemented.

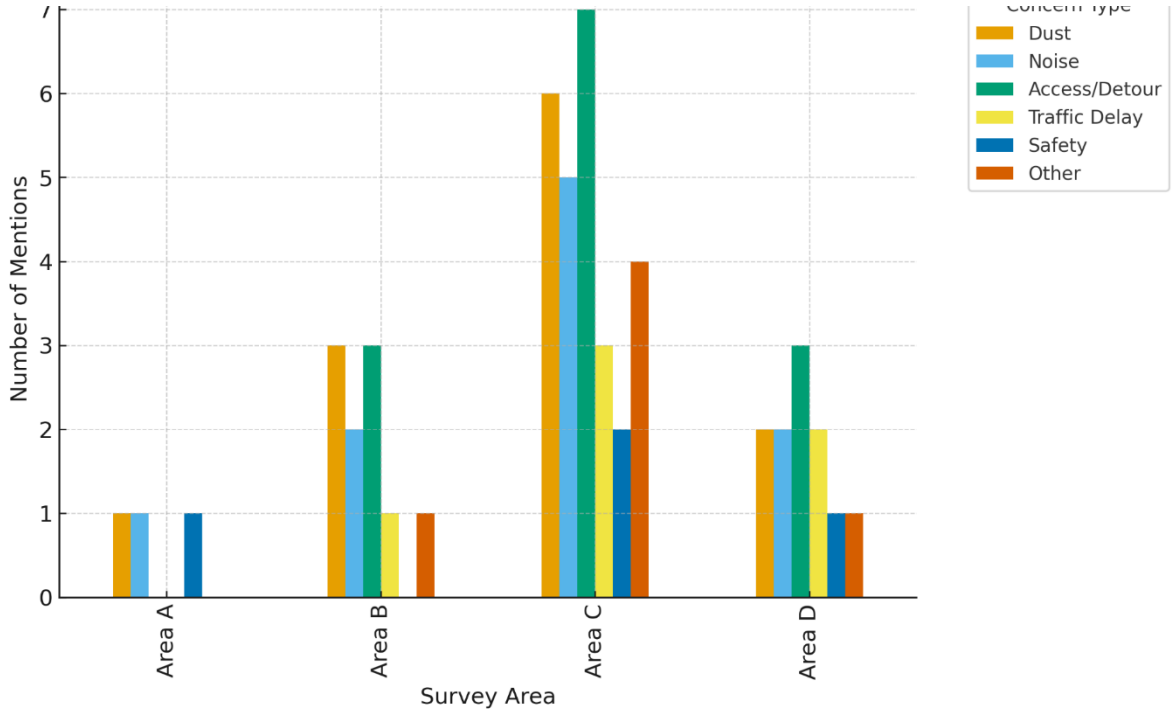


Figure 28: Common Concerns by Survey Area.

The figure shows that Areas B and C generate the highest counts of concern mentions, consistent with their location nearest to the project site and detour route.

Summary

The verified community perception data clearly indicate a well-informed, highly supportive, and cooperative population. A large majority of households across all areas are aware of the project and express strong support for its implementation. Concerns raised are constructive and impact-specific, focusing on manageable short-term issues such as dust, noise, and access during construction. These findings demonstrate strong social acceptance of the Tagabe Bridge Project, a high level of local trust in the process, and readiness for continued engagement.

4.8.9 Overall Socio-Economic Summary

Aspect	Key Findings (Recorded Data)	Implications for Project
Demographics	Average household size **5.2 persons** across 88 households; population predominantly **working-age (70%)** with **27% youth (<15 years)** and only **3% elderly**.	Readily available **local labor pool** for construction; design and safety planning should consider youth and family populations.
Income	Mean household income **≈77,000 VUV/month**, median **≈50,500 VUV**; Area B	Indicates **moderate economic vulnerability** but potential for **local employment** and livelihood

	has the highest earnings; outer zones (C & D) show lower informal-based income.	enhancement during project implementation.
Land Tenure	Diverse tenure: **rented (45%)**, **titled (≈40%)**, and **unregistered/customary holdings (20–25%)**; strong rental presence in Areas A & D.	Requires **transparent land verification and compensation** processes recognizing both formal and informal occupants.
Water / Health	**UNELCO piped water dominant** in inner zones; mixed sources (piped + well/river) common in outer areas; **98% of households** report **easy access to healthcare** within 5 km.	Maintain **uninterrupted access** to water points and clinics during construction; health access can support **worker and community safety**.
Education	High participation in **primary (50%)** and **secondary (36%)** education; **limited vocational/tertiary (<10%)**; Area B shows highest post-secondary enrolment.	Strengthen **capacity building, skills training, and youth employment** under social development components.
Special Needs	**Six individuals (2.4%)** with recorded disabilities evenly distributed across survey areas.	Integrate **universal access** features (ramps, handrails, safe crossings) in bridge and pedestrian design.
Community Perception	**Awareness 74%**, **Support 73%**; key concerns: **dust, noise, access/detour**; overall sentiment positive and cooperative.	Continue **stakeholder engagement, disclosure, and mitigation** (dust control, traffic management, clear communication).

Demographic Structure:
The Tagabe community exhibits a youthful and economically active population, with 70 % in the working-age group and a small elderly share (3 %). Household sizes average just above five persons, indicating extended family structures typical of peri-urban settlements. Gender balance is relatively even, suggesting social stability and minimal gender disparity in household participation.

Economic Conditions:
Average monthly household income is ≈ 77 000 Vatu, with Area B showing the highest mean and median levels due to its closeness to Port Vila's employment hubs. Income patterns demonstrate moderate equality—the narrow gap between mean and median values indicates that a few high earners do not distort the overall income profile. The economy blends formal wage employment with informal trade and small-scale agriculture, reflecting resilience and diversification.

Land and Housing Tenure:
Tenure patterns confirm a transitional land system—a mix of titled plots, unregistered customary holdings, and rentals. Renting predominates in Areas A and D, while titled ownership concentrates in Areas A and B. Customary or unregistered holdings persist in the

outer zones (C and D). This mix underscores the need for inclusive land verification and equitable compensation procedures during project implementation.

Basic Services – Water and Health:
Water supply is broadly available but uneven: households near the urban core depend primarily on UNELCO piped service, whereas those farther out combine piped, river, and well sources. Healthcare access is nearly universal (98 %), ensuring that construction activities can proceed within a community that already enjoys basic medical coverage.

Education and Inclusivity:
Education levels are strong at the primary and secondary stages (≈ 86 %), but vocational and tertiary participation remain low (< 10 %). Only six individuals (2.4 %) reported living with special needs. The data emphasize opportunities for targeted skills-training programs and universal-access design in all project facilities.

Community Awareness and Perception:
Awareness (74 %) and support (73 %) for the project are consistently high, confirming widespread acceptance and social readiness. Reported concerns center on dust, noise, and access detours—issues that can be readily mitigated through construction-phase management measures. The tone of responses is constructive, indicating a cooperative and informed community.

Survey Conclusion

The socio-economic baseline portrays a cohesive, semi-urban community with moderate income levels, strong literacy, secure health access, and high project support.
The Tagabe population demonstrates the characteristics of a resilient peri-urban economy—active labor participation, transitional land tenure, and adaptive use of mixed service infrastructure.

These findings have direct implications for the project:

1. Employment and livelihood programs can effectively engage a skilled, youthful workforce.
2. Land and resettlement actions must recognize both titled and informal tenure systems.
3. Construction-phase management should prioritize dust and access control to maintain community confidence.
4. Social-benefit initiatives should focus on vocational training and universal accessibility.

Together, these socio-economic insights establish a strong baseline for impact assessment, mitigation planning, and inclusive development within the Tagabe Bridge Project corridor.

5. Environmental and Social Impact Assessment

5.1 Overview

This section outlines the process of identifying, forecasting, and assessing potential environmental and social impacts linked to the proposed project across its planning, construction, and operational stages. The assessment is based on baseline environmental and socio-economic data, field observations, consultation outcomes, and applicable national legislation and JICA environmental guidelines.

The analysis follows the impact assessment hierarchy of *avoidance, minimization, restoration, and offset*, consistent with both JICA Environmental Guidelines (2022) and the Environmental Protection and Conservation Act [CAP 283].

The bridge site lies within an urbanized corridor along the Port Vila–Tagabe road, where existing infrastructure and human activity are already prominent. While the project footprint is relatively small, its construction activities have the potential to cause short-term physical and social disturbances, which must be effectively mitigated through appropriate planning and environmental management.

5.2 Impact Identification Methodology

The assessment used the following steps:

1. **Scoping:** Determination of valued environmental and social components relevant to the project.
2. **Baseline Analysis:** Review of site-specific conditions including land use, water quality, noise levels, vegetation, and community settings.
3. **Impact Prediction:** Assessment of the nature, magnitude, extent, duration, and reversibility of potential impacts.
4. **Significance Evaluation:** Each impact was rated as *Low*, *Moderate*, or *High* significance, based on its severity and the effectiveness of proposed mitigation measures.
5. **Mitigation and Management:** Measures were proposed according to the mitigation hierarchy.

5.3 Anticipated Environmental Impacts

5.3.1 Land and Topography

Excavation for bridge abutments, approach roads, and revetments will disturb unconsolidated alluvial soils with low cohesion and moderate erosion potential. Given the high rainfall intensity typical of Port Vila's wet season (Nov–Apr), unprotected slopes may experience sediment wash-off to the river.

Mitigation

- Schedule bulk earthworks during the dry season.

- Install coffer dams, sediment basins, and toe bunds.
- Stockpile and reuse topsoil for final landscaping.
- Re-vegetate disturbed surfaces promptly with native riparian species.

Residual Impact: Minor, short-term, reversible.

5.3.2 Surface Water, Hydrology, and Drainage

Construction near the Tagabe River, which sustains Port Vila's potable water source, may cause short-term increases in turbidity, total phosphorus, and bacterial loading from sediment runoff or accidental spills. Given the good physicochemical but poor microbial quality recorded downstream (Enterococci > 200 cfu/100 ml), strict control is essential to prevent further degradation.

Mitigation

- Undertake in-stream works only under low-flow conditions.
- Use cofferdams to isolate works.
- Store fuels, oils, and cement within bunded zones ≥ 50 m from the river.
- Prohibit wash-down or refuelling on riverbanks.
- Monthly turbidity monitoring upstream/downstream against baseline values.

Residual Impact: Low; local improvement expected from stabilized banks.

5.3.3 Air Quality

No continuous monitoring network exists for Port Vila; modeled Plume Labs data show "Good–Fair" AQI (~30–40) dominated by $PM_{2.5}$ 5–25 µg/m³. Construction dust, diesel exhaust, and unpaved haul roads will be the main emission sources.

Mitigation

- Regular water spraying on exposed surfaces.
- Cover trucks and stockpiles.
- Maintain engines to reduce visible smoke.
- Avoid open burning and prolonged idling.
- Baseline and periodic $PM_{2.5}$ sampling using portable monitors to verify compliance with WHO AQGs (15 µg/m³ 24 h).

Residual Impact: Minor, temporary, localized.

5.3.4 Noise and Vibration

Baseline 24-h LAeq values range 52–67 dB(A) along the corridor—already above the IFC 55/45 dB day/night residential guideline at busy junctions. Additional construction noise from pile-driving, concrete batching, and trucks could elevate ambient levels by > 3 dB at nearest dwellings if unmanaged.

Mitigation

- Restrict high-noise works to 07:00–18:00.
- Maintain plant mufflers and use low-noise equipment.
- Advance community notice of noisy operations.
- Apply the IFC "≤ 3 dB incremental" criterion rather than absolute limits.
- Post-construction monitoring at baseline sites (Locations 1–5).

Residual Impact: Low, short-term; compliance achievable with controls.

5.3.5 Flora and Fauna

Riparian vegetation is degraded secondary growth dominated by invasive species; limited habitat exists for native or endemic fauna (*Ptilinopus tannensis, Zosterops flavifrons*). Temporary removal of roadside shrubs may reduce shading and bank stability.

Mitigation

- Minimize clearing and retain mature native trees.
- Replant banks with native *Hibiscus tiliaceus*, *Ficus spp., Cyperus alternifolius* after works.
- Implement a Riparian Revegetation Plan under PWD/Forestry supervision.
- Ban hunting or collection of fauna by workers.

Residual Impact: Negligible; potential net ecological gain post-restoration.

5.3.6 Waste Management

Spoil, concrete debris, packaging, and domestic refuse may contaminate land or waterways if not properly handled.

Mitigation

- Segregate recyclable and hazardous waste.
- Dispose of residues only at PVMC-approved landfill.
- Maintain waste inventory logs and receipts.
- Prohibit dumping within 100 m of the river.

Residual Impact: Low; managed through contractor's Waste Management Plan.

5.3.7 Climate and Seismic Resilience

Climate projections show +0.7–1 °C warming and 20–40 % increase in extreme rainfall by 2070; earthquakes of Mw ≥ 7 remain possible (e.g., Dec 2024 Mw 7.3 event). Improper design could increase flood and structural risks.

Mitigation

- Bridge deck elevation based on ≥ 1:50 year design flood.

- Scour-resistant foundations and reinforced abutments.
- Seismic design per AASHTO LRFD / Japanese Standard (S2 zone).
- Post-quake inspection protocol integrated into ESMP.

Residual Impact: Positive (long-term resilience).

5.4 Anticipated Social Impacts

5.4.1 Land, Access, and Livelihoods

All works occur within existing public right-of-way. Some physical displacement is expected based on project design. Temporary access disruption to small vendors and residents may occur.

Mitigation – Advance notification, alternate pathways, and compensation for verifiable short-term income loss following the Simplified Resettlement and Compensation Protocol.

5.4.2 Community Health and Safety

Risks include traffic accidents, dust inhalation, and noise annoyance. Worker–community interaction must be carefully managed.

Mitigation – Traffic Management Plan, signage, flagmen, PPE for pedestrians in work zones, Code of Conduct, and grievance hotline.

5.4.3 Employment and Economic Benefits

The project will employ local labour for unskilled and semi-skilled work, stimulating household income and small-business procurement.

Enhancement – Target a certain percentage of local employment; training on safety and environmental awareness.

5.4.4 Gender and Vulnerable Groups

Women and vulnerable persons could face limited access or exposure to construction hazards.

Mitigation – Gender-inclusive consultation, equal hiring, separate sanitation facilities, and gender-based-violence (GBV) awareness sessions.

5.4.5 Cultural Heritage

No recorded sites; however, a Chance Find Procedure will remain in force for any artifacts encountered.

5.5 Summary of Potential Impacts and Mitigation Measures

The assessment of potential environmental and social impacts for the project identifies a series of localized, short-term construction effects and long-term beneficial outcomes.

The impacts are predictable, of moderate to low magnitude, and fully manageable through application of established mitigation measures and standard construction practices. Most potential effects are temporary—occurring during site preparation, earthworks, and bridge construction—and will subside once the works are completed.

Physical impacts relate primarily to soil disturbance, erosion, sedimentation, dust generation, and noise emissions, while social impacts concern community access, traffic safety, and occupational health and safety. Because the project footprint lies within an already urbanized and disturbed road corridor, and all activities occur within the public right-of-way, no displacement, habitat loss, or irreversible environmental change is expected.

The key environmental concerns include temporary increases in turbidity and suspended solids in the Tagabe River due to earthworks near the watercourse, localized dust emissions from material transport, and construction noise potentially affecting adjacent residential and commercial areas. These impacts will be mitigated by seasonal scheduling of in-stream works, installation of silt curtains and sediment traps, regular dust suppression and equipment maintenance, and restricting noisy operations to daytime hours. Baseline acoustic data (LAeq ≈ 52–67 dB A) will be used to apply the IFC incremental criterion (≤ 3 dB above existing levels) to ensure compliance with international good practice.

Water-quality protection remains a priority due to the proximity of UNELCO's water intake upstream of the bridge site. Mitigation measures include fuel and cement storage within bunded containment, prohibition of wastewater discharge into the river, and monthly turbidity monitoring (target < 50 NTU). All runoff will be directed through sedimentation controls prior to release.

Other anticipated effects, such as solid-waste generation, minor vegetation removal, and potential community disturbance, will be addressed through a Waste Management Plan, careful delineation of work zones, and implementation of a Traffic Management Plan (TMP) ensuring safe pedestrian and vehicle movement.

A Community Liaison Officer (CLO) will maintain communication with nearby residents and manage the Grievance Redress Mechanism (GRM) for any issues arising during construction. Socially, the project is expected to yield positive impacts through employment creation, local procurement, and improved transport reliability. Short-term inconveniences to roadside vendors or pedestrians will be managed through early notification, signage, and temporary access arrangements.

The integration of Gender and Vulnerable Group considerations—including equal employment opportunities, gender-based-violence (GBV) awareness, and separate sanitation facilities—will further strengthen social outcomes.

Residual impacts after mitigation are assessed as Low to Negligible, while cumulative effects are minimal given the limited spatial footprint and urban context.
Implementation of the Environmental and Social Management Plan (ESMP) will ensure that mitigation and monitoring measures are consistently applied, with oversight by PWD and DEPC.

Consequently, the project's environmental and social risks are manageable, and its overall net impact is positive, enhancing infrastructure resilience, community safety, and environmental stewardship within the Tagabe corridor.

Table 27: Summary of Potential Impacts and Mitigation Measures.

Environmental / Social Aspect	Potential Impact	Duration	Key Mitigation Measures	Residual Impact	Significance
Soil / Erosion	Sediment runoff during earthworks	Temporary	Silt fences, drainage, re-vegetation	Minimal	Low
Water Quality	Turbidity, nutrient, microbial increase	Temporary	Silt curtains, bunded storage, spill control	Slight	Low
Air Quality	Dust and exhaust	Temporary	Watering, covering, maintenance	Minor	Low
Noise / Vibration	Construction noise near dwellings	Temporary	Work-hour limits, silencers, barriers	Minor	Low
Flora / Fauna	Loss of riparian vegetation	Short	Selective clearing, native replanting	None	Low
Waste	Improper disposal	Short	Segregation, PVMC landfill	None	Low
Community Safety	Traffic and pedestrian risk	Temporary	TMP, signage, flagmen	Slight	Low
Employment	Local job creation	Short	Local hiring, fair wages	Beneficial	Positive

5.6 Cumulative Impacts

Cumulative impacts are expected to be minimal, given the small project footprint and urban location. The bridge will, however, contribute positively to the overall transport efficiency and reduce flooding and road maintenance costs, supporting the resilience of the Port Vila transport network.

5.7 Residual and Net Impacts

After applying mitigation, all adverse impacts are low-magnitude and reversible. Positive residual effects include:

- Enhanced traffic safety and flood resilience,
- Stabilized riverbanks and improved riparian vegetation,

- Local employment and economic stimulation.

The project is therefore environmentally and socially acceptable under both JICA Category B and national DEPC criteria.

6. Environmental and Social Management Plan (ESMP)

6.1 Introduction

The Environmental and Social Management Plan (ESMP) translates the assessment results into actionable mitigation, monitoring, and capacity-building measures to ensure the project is implemented in full compliance with Vanuatu's Environmental Protection and Conservation Act [CAP 283], JICA (2022) Guidelines, and international good practice (IFC EHS Guidelines).

The ESMP defines:

- Mitigation measures to avoid, minimize, or offset adverse impacts;
- Monitoring requirements to verify performance;
- Institutional responsibilities and reporting procedures;
- Capacity-building programs to strengthen safeguard implementation; and

It applies to all project phases—pre-construction, construction, and operation/maintenance—and is binding for all contractors and subcontractors engaged by the Ministry of Infrastructure and Public Utilities (MIPU) / Public Works Department (PWD).

6.2 Institutional Responsibilities

Effective ESMP implementation depends on clear delineation of institutional responsibilities among the key stakeholders. The main institutions involved are:

Institution / Stakeholder	Primary Roles and Responsibilities
Ministry of Infrastructure and Public Utilities (MIPU) / Public Works Department (PWD)	Executing agency with overall responsibility for ESMP implementation; integrates environmental clauses in contracts; supervises contractors; submits quarterly reports to DEPC and JICA.
Contractor	Prepares site-specific Construction Environmental and Social Management Plan (CESMP) and method statements (erosion, waste, noise, spill control); appoints Environmental & Safety Officer; implements all mitigation and monitoring measures.
Supervising Engineer / Environmental Specialist	Monitors field compliance; validates Contractor reports; conducts audits; provides technical advice on corrective actions.
Department of Environmental Protection and Conservation (DEPC)	Regulatory authority—reviews environmental performance, conducts inspections, issues Development Consent and compliance verification.
Port Vila Municipal Council (PVMC)	Oversees traffic, waste disposal, and public safety within municipal boundaries; assists with community liaison.
Japan International Cooperation Agency (JICA)	Funding and oversight agency—ensures conformity with JICA Guidelines (2022); reviews safeguard performance.

Community Liaison Officer (CLO)	Manages day-to-day community communication, grievance handling, and awareness activities.

The dedicated **Environmental and Social Officers** within PWD will coordinate with the Contractor's ESO to consolidate monitoring results and liaise with DEPC and JICA.

6.3 Mitigation Plan

The mitigation plan outlines the measures required to prevent, minimize, or offset potential adverse impacts at each project phase. It also specifies the responsible parties, monitoring indicators, and estimated costs.

Table 28: Environmental and Social Management Plan.

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
Pre-construction Phase						
1	Land Acquisition and Resettlement	Relocation of two families living on the riverbank	• Compensation and assistance measures including moving expenses, etc. based on RAP	PWD	PWD	PWD
2	The Poor	Economic hardship of two families living on the riverbank	• Assistance through livelihood restoration and improvement activities	PWD	PWD	PWD
Construction Phase (including Tagabe Bridge demolition/removal, site preparation, public utility coordination, etc.)						
1	Ambient Air	Generation of dust and exhaust gas from transportation, construction vehicles, and machinery operation	• Spray water at dust-generating construction sites and regularly • Reduce the amount of emissions by limiting the speed of transport vehicles, etc. • Conduct regular maintenance and proper management of vehicles and machinery, and maintain the operation of transport and construction vehicles and machinery in good condition to reduce emissions. • Notify residents in advance of the construction plan and ensure thorough communication. • Revise and improve measures that reflect residents' opinions as necessary	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
2	Water Quality	• Discharge of construction waste and soil into the river • General drainage (leakage and spillage	• Develop and implement a drainage management plan to reduce or minimise soil runoff. • Promote construction progress during fine weather, dry season, and low water periods.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		during transport, storage, and handling of fuel and oil) • Disposal of sewage, wastewater, and other liquid waste • River water pollution (turbidity, etc.)	• Use secondary containment/collection containers for fuel and oil, etc., as spill prevention measures. • Install steel sheet piles for construction and prevent the spread of turbid water. If turbid water occurs, monitor the runoff and revise measures as necessary. • Regularly check the turbidity of river water. • Maintain natural and existing drainage channels. • Regularly clean drainage ditches.			
3	Soil	Removal of topsoil and soil erosion/runoff due to excavation work	• Install measures to prevent erosion and runoff (such as gravel, etc.) at the work site. • Install pollution prevention facilities against erosion and sedimentation, and implement measures to prevent and limit soil runoff into surrounding areas. • Promote construction progress during fine weather and dry season. • Preserve and reuse removed topsoil, and restore cut grass.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
4	Sediment	• Decreased water quality during the rainy season due to soil erosion.	• Install pollution prevention facilities against erosion and sedimentation, and implement measures to prevent and limit soil runoff into surrounding areas.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
5	Noise and Vibration	Noise and vibration impacts on the local community	• No night-time construction work • Implement mitigation measures (such as use of low-noise machinery and mufflers) to reduce noise and vibration levels to acceptable levels. • Maintain construction vehicles and machinery in good condition and manage them properly to suppress noise and vibration emissions.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			• Notify residents in advance of the construction plan and ensure thorough communication. • Revise and improve measures that reflect residents' opinions as necessary			
6	Offensive Odors	• Domestic waste from workers' accommodation and site office	• Prohibit on-site burning of waste, install temporary toilets and septic tanks, and minimize and regularly collect domestic waste.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
7	Waste	• Generation of construction waste	• Develop and implement a hazardous materials management plan (including material safety data sheets, avoidance/minimisation of hazardous materials use, handling, storage, use of secondary containment systems, handling procedures, etc.). • Establish appropriate processes for material handling, storage, transportation, and disposal (including recycling/reuse options), including establishment of a waste inventory and details regarding waste minimisation. • Develop a waste management plan for the site, and minimize contamination of soil and water and impacts on ambient air. The contents of waste management plan are, for example, prohibition of on-site burning of waste, installation of temporary toilets and septic tanks, removal of solid waste and contaminated soil from the site, recycling of construction waste and debris, and minimization of the waste volume. • Transport and dispose the construction waste at Bouffa Landfill	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
8	Ground Subsidence	• Possibility of uneven subsidence or tilting • If ground improvement is necessary, possible impacts on groundwater and aquifer layers	• Apply RC slab bridge design that can ensure a stable supporting foundation. • Avoid ground improvement.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
9	Ecosystems	• Deterioration of water quality in the Tagabe River due to turbid water and sediment and negative impact on lives of river fauna	• Install pollution prevention facilities against water pollution, and implement measures to control floating soil caused by construction activities. • Develop and implement a drainage management plan to reduce or minimise soil runoff. • Use secondary containment/collection containers for fuel and oil, etc., as spill prevention measures. • Install steel sheet piles for construction and prevent the spread of turbid water. If turbid water occurs, monitor the runoff and revise measures as necessary. • Regularly check the turbidity of river water. • Maintain natural and existing drainage channels. • Regularly clean drainage ditches. • Monitor the lives of river fauna. In case there is an incident of massive death of fish at certain location, identify the cause and effect relations with the construction work, and revise countermeasures as required.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
		• Tree cutting along the riverbank, removal of flowers and grasses	• Avoid unnecessary tree cutting. • Prohibit the collection and capture of flora and fauna.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		• Changes due to partial loss of shade	• Replant riverbank trees after construction is completed.	PWD	PWD	PWD
10	**Hydrology**	Possible impacts on groundwater and aquifer layers depending on bridge structure	• Refer to 8. Ground Subsidence above.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
11	**Topography, Geology**	Impacts on riverbank strength due to bridge replacement, detour bridge construction, and tree cutting along the riverbank	• Conduct revetment work	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
12	Land Acquisition and Resettlement	• Temporary use and site preparation of land for construction yard (material storage, site office, and accommodation) (rental fee is required) • Temporary use of small land portion around Tagabe Bridge (rental fee is not required) • Land use restrictions in restricted entry areas for safety considerations	• Pay costs for use and borrowing of land for construction yard. • Restore to original condition after construction is completed. • Notify residents in advance of the construction plan and ensure thorough communication.	Contractor	PWD / Construction Supervision Consultant	Construction yard: PWD Others: Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
13	The Poor	• The relocated two families may find difficulty in finding employment opportunities at new places • The relocated two families may fall into destitute	• Conduct RAP monitoring to figure out their economic situation and livelihoods, and take assistance measures as necessary. • Conduct the livelihood restoration and improvement activities, evaluate their effectiveness and take measures as necessary.	PWD	PWD	PWD
14	Local Economy, including Employment and Means of Livelihood	• The relocated two families may find difficulty in finding employment opportunities at new places • The relocated two families may fall into destitute	• Conduct RAP monitoring to figure out their economic situation and livelihoods, and take assistance measures as necessary. • Conduct the livelihood restoration and improvement activities, evaluate their effectiveness and take measures as necessary.	PWD	PWD	PWD
		Possible impacts on livelihood activities at shops in surrounding area	• To provide continued access for surrounding properties. • To provide warning signs at the periphery of work site warning the public not to enter the active construction site and stated in the EMP. • To keep providing information regarding traffic control and others and communicate with the area residents and the public prior to the event.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
15	Land Use and Local Resource Use	• Restricted entry for safety considerations	• Install a temporary pedestrian bridge. • Provide continuous access to surrounding land. • Install signs regarding restricted entry to the construction site and promote caution.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		• Land use restrictions in restricted entry areas • Difficulty accessing both banks of the Tagabe River	• Provide information on traffic control, and notify and ensure thorough communication with local residents and the general public in advance.			
16	**Water Use**	Impacts on washing and bathing using river water downstream of Tagabe Bridge	• Implement measures against turbid water (refer to "2. Water Quality" mitigation measures above). • Provide direct water supply from upstream by pump.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
17	**Existing Social Infrastructure and Social Services**	Removal and relocation of existing electric poles, underground water pipes, and communication facilities	• Coordinate with relevant agencies (UNELCO, Vodafone) for relocation and switchover. • If services are to be temporarily interrupted, notify residents widely in advance and ensure thorough communication.	UNELCO, Vodafone	PWD / Construction Supervision Consultant	PWD
18	Landscape	Temporary changes in cityscape due to tree cutting along the riverbank, construction work, material storage, site office, and accommodation	• Remove materials and equipment from the site immediately after construction is completed.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
			• Replant trees after construction is completed.	PWD	PWD	PWD
19	**Gender**	• Harassment of local women by construction workers • Difficulty for local community to move within the area	• Provide regular guidance and on-site instructions to workers from outside the area regarding workplace codes of conduct. • Install a temporary pedestrian bridge. • Provide continuous access to surrounding land. • Install signs regarding restricted entry to the construction site and promote caution.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			• Provide information on traffic control, and notify and ensure thorough communication with local residents and the general public in advance.			
20	**Children's Rights**	Difficulty for children to access school and move within the area from the local community	• Install a temporary pedestrian bridge. • Provide continuous access to surrounding land. • Install signs regarding restricted entry to the construction site and promote caution. • Provide information on traffic control, and notify and ensure thorough communication with local residents and the general public in advance.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
		Possibility of child labor	• Prohibit child workers under 18 years of age • Monitor the employment record	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
21	**Infectious Diseases such as HIV/AIDS**	Possible occurrence and spread of infectious diseases through construction workers from outside	• Provide guidance to workers from outside the area regarding workplace codes of conduct. • Implement health management and measures against diseases and infectious diseases for workers.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
22	Working Environment (Including Occupational Safety)	• Occurrence of occupational accidents/injuries • Exposure to excessive noise and vibration • Health impacts due to hot environments	• All workers shall receive pre-orientation and on-site training on occupational health and safety. • Workers from outside the area shall receive guidance on workplace codes of conduct. • Develop a health and safety plan, and in addition to safety measures, manage working hours, health, and implement measures against diseases and infectious diseases for workers. • Provide PPE to construction workers and train them in its use. Avoid exposure to excessive noise.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost

#	Impact Item	Anticipated Impact	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			• Install separate toilets for men and women, and consider female workers. • Properly maintain and operate construction vehicles and machinery. • Promptly remove solid waste from the site and ensure a proper working environment.			
23	Accident	• General safety risks around the construction site • Possibility of personal accidents	• Restrict access to the construction site. • Separate the construction site with fences, etc., and install security guards. • Install high-visibility tape and barriers at excavation sites. • Notify residents in advance of activities with noise and vibration and haulage routes, and ensure thorough communication. • Explain safety and health precautions and requirements, and set up information boards.	Contractor	PWD / Construction Supervision Consultant	Included in construction cost
Operation Phase						
None						

Monitoring data will be summarized in Monthly Environmental and Social Monitoring Reports (ESMRs) and verified by the Supervising Engineer. DEPC and JICA will review quarterly performance.

6.4 Environmental and Social Monitoring Plan

The monitoring table presented below outlines the key environmental and social impacts anticipated during the pre-construction and construction phases of the project, together with the mitigation measures required to manage these impacts. The table also identifies the responsible implementing and supervising organizations, ensuring clear lines of accountability throughout project execution.

Environmental and social monitoring is an essential component of the project's Environmental and Social Management Plan (ESMP). It enables the project proponent, contractor, and supervising entities to systematically track the performance of mitigation measures, verify compliance with national legislation and JICA safeguard requirements, and respond promptly to any unanticipated impacts. The monitoring framework also integrates community feedback and aligns with the mitigation hierarchy to avoid, minimize, restore, or compensate for adverse impacts.

The impacts and mitigation measures listed cover a broad range of environmental, social, health, and safety considerations—including air quality, water quality, soil erosion, noise and vibration, ecosystem protection, worker welfare, community health and safety, land use restrictions, and support for vulnerable households. Special attention is given to the two families relocated from the riverbank area, with ongoing livelihood restoration and socio-economic monitoring stipulated to ensure that no household is left worse off as a result of the project.

The table also distinguishes between responsibilities for implementation (typically the contractor for construction-related impacts and PWD for resettlement and social support) and oversight responsibilities (PWD and the Construction Supervision Consultant). This structure ensures robust supervision, transparent reporting, and continued alignment with both national environmental requirements and JICA Environmental and Social Considerations Guidelines (2022).

Overall, the monitoring plan provides a practical and enforceable mechanism to ensure that the project is carried out in a manner that protects the environment, safeguards community wellbeing, and supports sustainable development throughout the project lifecycle.

A draft Environmental and Social Monitoring Form has been prepared to support implementation of the monitoring framework. This form is included in Annex D and provides a standardised template for recording site observations, compliance checks, mitigation actions, and follow-up requirements throughout the construction period. It serves as a practical tool for the Contractor, PWD, and the Construction Supervision Consultant to ensure consistent, transparent, and well-documented monitoring.

Table 29: Environmental and Social Monitoring Plan.

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
Pre-construction Phase								
1	Land Acquisition and Resettlement	Relocation of two families living on the riverbank	Progress of relocation (provision of cash compensation [or in-kind compensation], moving and other assistance, etc.)	None	Relocation site	Before and after relocation, during relocation (based on RAP)	PWD	PWD
2	The Poor	Economic hardship of two families living on the riverbank	Implementation of assistance through livelihood restoration and improvement activities	None	Relocation site	Before and after relocation, during relocation (based on RAP)	PWD	PWD
Construction Phase (including Tagabe Bridge demolition/removal, site preparation, public utility coordination, etc.)								
1	Ambient Air	Generation of dust and exhaust gas from transportation, construction vehicles, and machinery operation	Visual observation PM10, PM2.5	N/A WHO Air Quality Guidelines (2021)	Construction site and surrounding area	As needed (daily) • Once at the start of construction (baseline) • Once each in the morning and afternoon every week • Once at the end of construction	Contractor	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
						(endline)		
2	Water Quality	• Discharge of construction waste and soil into the river • General drainage (leakage and spillage during transport, storage, and handling of fuel and oil) • Disposal of sewage, wastewater, and other liquid waste	• Visual observation	None	Construction site	As needed	Contractor	Included in construction cost
		• River water pollution (turbidity, etc.)	• Measurement and analysis (turbidity [suspended solids (SS)], pH, electrical conductivity (EC), water temperature, dissolved oxygen (DO), total dissolved solids (TDS), visual observation	Water Supply Act [CAP24] (amendment as No.31 of 2016), Vanuatu National Drinking Water Quality Standards (2016), WHO (2022) Guidelines for Drinking-Water Quality、ANZECC (2000) Water Quality Guidelines for Fresh and Marine Waters	Bridge construction site (embankment, piling, etc.)	• Once at the start of construction (baseline) • Once a week during bridge demolition / construction work • Once at the end of construction (endline)		

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
3	Soil Pollution	Removal of topsoil and soil erosion/runoff due to excavation work	Visual observation	None	Construction site	Weekly	Contractor	Included in construction cost
4	Sediment	Decreased water quality during the rainy season due to soil erosion.	See above 2. Water quality (measurement and analysis)					
5	Noise and Vibration (*Note: Labour noise and vibration are listed in 21. Working Environment)	Noise and vibration impacts on the local community	Noise Level	IFC Environmental, Health and Safety Guidelines, Pollution (Control) Act No. 10 of 2013, Control of Nocturnal Noise [CAP 40] (1965)	Community around the construction site	• Once at the start of construction (baseline) • Once a week during bridge demolition / construction work • Once at the end of construction (endline) *Resident response as needed	Contractor	Included in construction cost
			Vibration Level	BS 5228-2:2009	Community around the construction site	• Once at the start of construction (baseline) • Once a week during bridge demolition / construction work • Once at the end	Contractor	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
						of construction (endline) *Resident response as needed		
6	Offensive Odors	Domestic waste from workers' accommodation and site office	Waste Management Records	N.A.	Workers' accommodation, site office	Once a month	Contractor	Included in construction cost
7	Waste	Generation of construction waste	Waste Transfer Records	Waste Management Act No. 24 of 2014, Waste Management Regulations (Amendment) Order No. 128 of 2019, Pollution (Control) Act No. 10 of 2013, Environmental Protection and Conservation Act [CAP 283]	Construction site	Once a month	Contractor	Included in construction cost
8	Subsidence	• Possibility of uneven subsidence or tilting • If ground improvement is necessary, possible impacts	Visual observation	None	Bridge construction site	Once a month	Contractor	Included in construction cost |

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		on groundwater and aquifer layers						
9	Ecosystems	Deterioration of water quality in the Tagabe River due to turbid water and sediment	See above 2. Water quality (measurement and analysis)				Contractor	Included in construction cost
		• Deterioration of fauna lives in the Tagabe River due to turbid water and sediment	Visual observation	None	Bridge construction site (embankment, piling, etc.)	• Once a week during bridge demolition / construction work		
		• Tree cutting along the riverbank, removal of flowers and grasses • Changes due to partial loss of shade	Restoration of vegetation	N.A.	Around the construction site	At the end of construction		
10	**Hydrology**	Possible impacts on groundwater and aquifer layers depending on bridge structure	• See above 8. Ground Subsidence				Contractor	Included in construction cost
11	**Topography, Geology**	Impacts on riverbank strength due to bridge replacement, detour bridge construction, and	• See above 8. Ground Subsidence				Contractor	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		Impacts on riverbank strength due to tree cutting along the riverbank	• See above 9. Ecosystem					
12	Land Acquisition and Resettlement	• Temporary use and site preparation of land for construction yard (material storage, site office, and accommodation) (rental fee is required) • Temporary use of small land portion around Tagabe Bridge (rental fee is not required) • Land use restrictions in restricted entry areas for safety considerations	• Management of use and borrowing status • Land management (entry restrictions, boundary management, etc.)	N.A.	Material storage, site office, accommodation, land around Tagabe Bridge construction site	• At the start • Once every three months • At the end (confirmation of restoration to original condition)	Contractor	Construction yard: PWD Others: Included in construction cost
13	The Poor	• The relocated two families may find difficulty in finding employment opportunities.	• Employment status after relocation • Household income level after relocation • Basic	N.A.	Relocated two families	Once every three months	PWD	PWD

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		• The relocated two families may fall into destitute	infrastructure for living • Implementation status of livelihood assistance measures (skill development training, etc.)					
14	Local Economy, including Employment and Means of Livelihood	• The relocated two families may find difficulty in finding employment opportunities. • The relocated two families may fall into destitute	See above 13. The Poor				PWD	PWD
		Possible impacts on livelihood activities at shops in surrounding area	Land management (entry restrictions, boundary management, etc.)	N.A.	construction site	Once every three months *Resident response as needed	PWD	PWD
15	Land Use and Local Resource Use	• Restricted entry for safety considerations • Land use restrictions in	Land management (entry restrictions, boundary management, etc.)	None |	Construction site |	Once every three months *Resident response as needed |	Contractor |	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		restricted entry areas • Difficulty accessing both banks of the Tagabe River						
16	Water Use	Impacts on washing and bathing using river water downstream of Tagabe Bridge	See above 2. Water Quality (measurement and analysis)	None |	Tagabe Bridge construction site |	Once every three months *Resident response as needed |	Contractor |	Included in construction cost |
17	Existing Social Infrastructure and Social Services	Removal and relocation of existing electric poles, underground water pipes, and communication facilities	Land management (entry restrictions, boundary management, etc.)	None |	Construction site |	As needed during relevant construction work *Resident response as needed |	UNELCO, Vodafone |	PWD
18	Landscape	• Temporary changes in cityscape due to tree cutting along the riverbank	Restoration of vegetation	N.A.	Riverbank around the construction site	At the end of construction	PWD	PWD
		• Temporary changes in cityscape due to construction work, material storage, site	Removal of materials	N.A.	construction site	At the end of construction	Contractor	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		office, and accommodation						
19	Gender	• Harassment of local women by construction workers	Regular guidance and on-site instructions to workers	None	Construction site	Weekly	Contractor	Included in construction cost
		• Difficulty for local community to move within the area	Land management (entry restrictions, boundary management, etc.)	None	Construction site |	Once every three months *Resident response as needed |		
20	Children's Rights	• Difficulty for children to access school and move within the area from the local community	Land management (entry restrictions, boundary management, etc.)	None	Construction site |	Once every three months *Resident response as needed |	Contractor |	Included in construction cost
		• Possibility of child labor	Employment of children under 18 years of age	None	Employment record Work record Visual observation	Once every three months		
21	Infectious Diseases such as HIV/AIDS	Possible occurrence and spread of infectious diseases through construction	Health check records	None	Health check records	Once every six months	Contractor |	Included in construction cost

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
		workers from outside						
22	Working Environment (Occupational Safety and Health)	• Occurrence of occupational accidents/injuries • Exposure to excessive noise and vibration • Health impacts due to hot environments	Number of safety training sessions, contents, and No. of participants	Employment Act (Cap. 160) (1983), Health and Safety at Work Act (Cap. 195) (1987), Workplace Health & Safety Management Plan *For labour noise in specific construction work, since there are no standards set in Vanuatu domestic law or IFC, Japanese guideline will be applied as a substitute.	Training and TBM (toolbox meeting) record	Once every three months *For PPE wearing and daily safety management, confirm implementation in the TBM every morning. Health check once every six months	Contractor	Included in construction cost
			Availability of PPE		Equipment registration			
			Labour noise and vibration measurement		Construction site			
			Work Contents		Work records			
			Health check records		Health check records			
			Number of occupational accidents		Occupational accident records			
			Working hours		Working hours records			
23	Accident	• General safety risks around the construction site • Possibility of personal accidents	Work contents at the time of post-occurrence	None	Work records	at the time of an accident	Contractor	Included in construction cost
			Vehicle operation records		Vehicle operation record			

#	Impact Item	Anticipated Impact	Monitoring Item	Standards	Monitoring Point / Record	Frequency	Implementing Agency	Cost
			Number of accidents involving the general public		Accident record (at police)			
Operation Phase								
None.								

6.5 Capacity Building and Training

Capacity building is essential to ensure that all personnel involved understand and effectively carry out ESMP requirements.

Training Program Overview:

Training Topic	Target Participants	Trainer	Frequency	Objective
ESMP implementation & compliance	Contractor supervisors, operators	PWD / Env. Specialist	Pre-mobilization	Ensure understanding of ESMP duties
OHS & Emergency Response	All workers	Contractor HSE Officer	Monthly	Accident prevention & first-aid skills
Erosion & sediment control	Equipment operators	Contractor HSE Officer	Pre-earthworks	Proper installation of controls
Dust & noise management	Site managers & foremen	ESO	Quarterly	Minimize air/noise nuisance
Waste & spill response	All workers	ESO	Quarterly	Pollution prevention skills
Gender / GBV awareness	All personnel	Social Safeguard Officer	Semi-annual	Promote respectful conduct and community safety

Records of attendance and materials will be annexed to quarterly ESMP reports.

6.7 ESMP Implementation Budget

The ESMP implementation budget provides an estimate of financial resources required to implement mitigation, monitoring, and capacity-building activities. These costs are indicative and may be refined during detailed design and construction. They will be all incorporated in the Contractor's contract.

Table 30: Tentative budget for ESMP Implementation.

ESMP Component	Estimated Cost (VUV)	Funding Source	Remarks
Construction-phase mitigation measures	2,400 ,000	Contractor	Erosion, dust, waste, traffic controls
Environmental & social monitoring equipment	500,000	Contractor	Noise meter, $PM_{2.5}$ sampler, turbidity tube
Capacity building / training	350,000	Contractor	Workshops and awareness sessions

Reporting & supervision	250,000	Contractor	Quarterly report preparation
Contingency (10 %)	370,000	Contractor	Unforeseen safeguard costs
Total Estimated Budget	**≈ 3.87 million VUV**		

The ESMP provides a clear framework for mitigating, monitoring, and managing environmental and social issues during all phases of the project.

With the full implementation of the proposed measures and the defined institutional responsibilities, the project is expected to maintain compliance with Vanuatu's environmental regulations and JICA safeguard policies.

The ESMP also ensures that environmental protection and community welfare remain integral components of the project's execution, contributing to its long-term sustainability and public benefit.

7. Occupational and Community Health and Safety

7.1 Introduction

This section outlines the framework for managing Occupational Health and Safety (OHS) and Community Health and Safety (CHS) for the project. The proposed works—spanning pre-construction, construction, and operational phases—will involve civil works near a public road and residential areas, exposing workers and the surrounding community to various safety and health risks.

Effective management of occupational and community safety is therefore essential to minimize the likelihood of injuries, health hazards, property damage, or disruptions to local residents and road users.

The OCHS approach follows the principles of:

- Prevention and preparedness rather than reaction,
- Compliance with Vanuatu's Labour (Occupational Health and Safety) Regulations (CAP 160), and
- Consistency with JICA Environmental Guidelines and the World Bank Group's Environmental, Health, and Safety (EHS) Guidelines (2007).

7.2 Objectives

The main objectives of the Occupational and Community Health and Safety Plan are to:

1. Protect all workers, visitors, and the public from injury, illness, or accidents associated with project activities.
2. Ensure safe working conditions through proper planning, training, supervision, and use of protective measures.
3. Maintain safe and accessible routes for vehicles and pedestrians near the construction site.
4. Minimize community disturbances due to dust, noise, and traffic.
5. Establish clear procedures for emergency preparedness, incident reporting, and corrective actions.

7.3 Occupational Health and Safety (OHS) Management

Occupational health and safety is a shared responsibility between the Contractor, Supervising Engineer, and the Public Works Department (PWD). The Contractor will develop and implement a Project-specific Occupational Health and Safety Plan (OHSP) that aligns with the ESMP and national labour standards.

7.3.1 Key Occupational Hazards

The main occupational risks expected during construction include:

- Falls from height (e.g., bridge deck, scaffolding);

- Contact with moving machinery and heavy equipment;
- Electrocution and fire hazards from electrical tools or welding;
- Manual handling injuries and fatigue from repetitive work;
- Dust inhalation and exposure to cement or chemicals;
- Noise and vibration exposure during pile driving or demolition;
- Heat stress and dehydration during fieldwork.

These hazards are manageable through adherence to international good practices in construction safety management.

7.3.2 Occupational Safety Measures

The Contractor shall implement the following preventive and control measures:

1. Safety Induction and Training
    - All workers will undergo OHS induction before site mobilization, covering worksite hazards, emergency procedures, and PPE requirements.
    - Toolbox talks will be conducted daily before the start of work.
2. Personal Protective Equipment (PPE)
    - Mandatory use of PPE, including helmets, safety boots, reflective vests, gloves, earplugs, and safety goggles, depending on task.
    - PPE must be replaced periodically and stored hygienically.
3. Site Safety Controls
    - Clear demarcation of work zones and exclusion of unauthorized personnel.
    - Guardrails, warning signage, and barricades at excavation or elevated areas.
    - Provision of adequate lighting during early morning or evening operations.
4. Machinery and Equipment Safety
    - All machinery shall be inspected daily for leaks, loose parts, and malfunction.
    - Operators must hold valid training or certification.
    - Maintenance records will be maintained and audited regularly.
5. Sanitation and Worker Welfare
    - Provision of clean drinking water, first-aid facilities, rest shelters, and sanitary toilets.
    - Wastewater and solid waste from worker camps will be properly managed.
6. Emergency Preparedness and Response
    - Emergency Response Procedures (ERP) shall cover fire, flood, and injury scenarios.
    - A first aid officer will be present on-site at all times, and emergency contact numbers displayed prominently.
    - All incidents and near-misses will be logged, investigated, and corrective actions documented.
7. Health Surveillance
    - Periodic health checks for workers exposed to dust, noise, or chemicals.
    - Vaccination and medical clearance may be required for high-risk tasks.

7.4 Community Health and Safety (CHS) Management

Community health and safety measures are aimed at protecting the residents, pedestrians, businesses, and road users located near the Tagabe Bridge site from risks posed by construction works and traffic activities.

7.4.1 Key Community Risks

The main CHS risks identified include:

- Vehicular accidents due to construction traffic and reduced road width;
- Pedestrian safety risks near excavations and equipment movement;
- Increased dust, noise, and vibration affecting nearby households and schools;
- Temporary access restrictions to local businesses or footpaths;
- Water quality degradation affecting downstream users;
- Worker–community interaction risks (e.g., communicable diseases, harassment, or disputes).

7.4.2 Community Safety Measures

1. Traffic Management
    - A comprehensive Traffic Management Plan (TMP) will be implemented, including signage, detour routes, and speed limits.
    - Flagmen will control traffic flow at the bridge approaches during active works.
    - Pedestrian access paths will remain open at all times and properly marked.
2. Public Information and Consultation
    - The Contractor will provide advance notice to the community regarding major construction milestones, detours, or service interruptions.
    - Regular community meetings will be held to gather feedback and resolve grievances.
    - A grievance redress mechanism (GRM) will be established and made accessible to all stakeholders.
3. Dust, Noise, and Air Emissions
    - Water spraying on dusty surfaces and limiting noisy works to daytime hours.
    - Use of well-maintained equipment to minimize emissions.
    - Monitoring of noise levels near sensitive receptors (schools, residences).
4. Construction Site Security
    - Secure fencing, night lighting, and restricted entry to prevent unauthorized access and accidents.
    - Signage in local Bislama and English languages warning of hazards.
5. Public Health Protection
    - Ensure no stagnant water forms on-site to prevent mosquito breeding.
    - Worker camps will be located away from residential areas and equipped with proper sanitation.
    - All workers will receive awareness training on communicable disease prevention (e.g., COVID-19, STIs).
6. Emergency Preparedness

- In coordination with Port Vila Municipality and local health services, emergency response plans will cover both worker and public incidents.
- Nearby clinics and hospitals will be identified in advance for medical referral.

7.5 Roles and Responsibilities

Entity	Responsibilities for OCHS Implementation
Contractor	Prepare and implement the Occupational and Community Health and Safety Plan (OCHSP); ensure all site workers receive induction and PPE; maintain accident logs and safety statistics; and report incidents to the Supervising Engineer within 24 hours. Coordinate traffic management, signage, and waste management; assist with public communication.
Supervising Engineer / ESO	Conduct routine safety audits; verify Contractor's compliance with OCHS procedures; report to PWD.
Public Works Department (PWD)	Oversee safety performance; ensure compliance with national OHS regulations; coordinate with DEPC and municipal authorities.
Community Leaders	Disseminate safety information; participate in awareness programs and feedback channels.

7.6 Training and Awareness

All workers and supervisors will receive structured training in:

- Basic OHS principles and first aid;
- Fire prevention and emergency response;
- Safe equipment operation;
- Traffic and community interaction;
- Gender awareness and respectful behaviour.

Community outreach sessions will also be organized jointly with local authorities to raise awareness of safety precautions near construction zones.

7.7 Monitoring and Reporting

The Contractor's Environmental and Safety Officer will carry out daily inspections, and the Supervising Engineer will verify compliance through weekly audits.

Monitoring parameters include:

- Number of incidents and near-misses;
- PPE usage rate;
- Community complaints related to noise, dust, or safety;
- Frequency of traffic disruptions;
- Emergency drills conducted.

Monthly safety reports will be submitted to the PWD and DEPC. Non-compliance will trigger immediate corrective actions and, if necessary, work stoppage until compliance is achieved.

7.8 Emergency Response and Preparedness

An Emergency Response Plan (ERP) will be prepared by the Contractor before works commence. It will include:

- Clear communication hierarchy and contact lists;
- Procedures for accidents, fires, floods, or hazardous material spills;
- Evacuation routes and assembly points;
- Coordination with local police, fire services, and clinics;
- Post-incident review and corrective action procedures.

Mock drills will be held quarterly to test readiness and worker awareness.

The implementation of a robust Occupational and Community Health and Safety framework will ensure that all construction and operational activities for the project are conducted in a safe, responsible, and compliant manner.

Through preventive planning, regular monitoring, and community engagement, the project will minimize risks to both workers and the public, aligning with JICA's safeguard standards and Vanuatu's national safety regulations.

This commitment to safety underpins the project's goal of improving infrastructure while safeguarding human health, community wellbeing, and sustainable development outcomes.

8. Stakeholder Engagement and Grievance Redress

8.1 Introduction

Stakeholder engagement is an integral part of the environmental and social assessment process. It ensures that project-affected persons, local communities, authorities, and other stakeholders have meaningful opportunities to participate in planning, decision-making, and monitoring of the project.

This section outlines the strategy and procedures for information disclosure, consultation, participation, and grievance redress throughout the project lifecycle.

Engagement for the project aims to:

- Promote transparency and accountability in project implementation;
- Identify and address stakeholder concerns early;
- Build community trust and ownership;
- Ensure compliance with JICA's consultation requirements and Vanuatu DEPC guidelines for public participation.

8.2 Objectives of Stakeholder Engagement

The objectives of stakeholder engagement are to:

1. Provide timely, relevant, and accessible information about the project;
2. Obtain local knowledge to inform environmental and social assessments;
3. Understand and address community expectations and concerns;
4. Maintain open communication channels during implementation;
5. Establish a fair and transparent **Grievance Redress Mechanism (GRM)**;
6. Ensure inclusion of women, youth, and vulnerable groups in consultation processes.

8.3 Stakeholder Identification

Stakeholders include all individuals, groups, and institutions who may be affected by or have an interest in the project. These have been identified and categorized as follows:

Stakeholder Category	Representative Stakeholders	Interest / Relevance
Government Agencies	Public Works Department (PWD), Department of Environmental Protection and Conservation (DEPC), Department of Lands, Port Vila Municipal Council (PVMC), National Disaster Management Office (NDMO), and Department of Water Resources (DoWR)	Oversight of infrastructure design, environmental compliance, permitting, and community safety.
Local Communities and Households	Residents along Tagabe Road and nearby settlements	Directly affected by construction traffic, noise, and access restrictions.

Businesses and Vendors	Roadside shops, transport operators, food vendors	May experience temporary disruption during construction.
Utility Providers	UNELCO (electricity and water), TVL (telecommunications)	Coordination for utility relocation and service continuity.
Educational and Religious Institutions	Nearby schools and churches	Concerned with safety, noise, and accessibility during works.
Civil Society and NGOs	Local community groups, environmental NGOs, women's associations	Interested in social inclusion, environmental protection, and public safety.
Vulnerable Groups	Women-headed households, the elderly, persons with disabilities	Require targeted engagement to ensure access to information and safety.

8.4 Engagement Process and Methods

Engagement activities were conducted during the preparation of this IEE and will continue throughout implementation.

8.4.1 Consultations During IEE Preparation

On July 2025, consultations were conducted with key stakeholders and community representatives to gather views on:

- Environmental concerns (dust, noise, drainage);
- Social impacts (temporary access restrictions, pedestrian safety);
- Community benefits (local jobs, improved transport safety).

Consultations included:

- Public meetings and focus group discussions with residents and vendors;
- Key informant interviews with PVMC and PWD officials;
- Site visits and informal discussions with business owners near the Tagabe corridor.

Main outcomes of these consultations:

- Strong community support for the project due to its flood resilience and safety benefits;
- Requests for clear communication regarding construction schedules and road detours;
- Recommendations to employ local workers where possible;
- Emphasis on maintaining safe pedestrian access, especially for schoolchildren.

All feedback was integrated into the Environmental and Social Management Plan (ESMP), particularly under the traffic, safety, and community engagement measures.

8.4.2 Ongoing and Future Engagement

During project implementation, stakeholder engagement will continue through:

- **Monthly coordination meetings** between PWD, Contractor, PVMC, and DEPC;
- **Community information sessions** prior to major construction milestones;
- **Public notices and signage** (in Bislama and English) regarding traffic detours, work hours, and safety procedures;
- **Consultation summaries** documented and appended to quarterly reports.

A **Community Liaison Officer (CLO)** will be appointed by the Contractor to facilitate day-to-day communication with local residents, manage feedback, and disseminate project updates.

8.5 Information Disclosure

Project-related information will be disclosed publicly through:

1. Notice boards at the project site and municipal offices (in both Bislama and English);
2. Printed leaflets summarizing project objectives, potential impacts, and mitigation measures;
3. Public briefings at community venues;
4. Digital dissemination through official PWD or JICA websites where feasible.

Disclosure will include the Environmental Permit, IEE Summary, and ESMP to ensure full transparency.

8.6 Inclusive Participation

Special attention will be given to ensuring the participation of vulnerable and underrepresented groups:

- Women will be encouraged to attend meetings through scheduling at accessible times and providing safe, inclusive venues;
- Elderly and persons with disabilities will receive tailored communication support;
- Feedback mechanisms will be simplified to accommodate literacy and mobility constraints.

Where possible, gender-segregated group discussions will be held to capture specific concerns and promote equitable participation.

8.7 Grievance Redress Mechanism (GRM)

A Grievance Redress Mechanism provides a structured process for stakeholders to raise concerns, complaints, or suggestions about project activities. It ensures timely and fair resolution of issues while preventing escalation.

8.7.1 Objectives of the GRM

- Provide accessible and transparent channels for complaint submission;
- Ensure fair, confidential, and timely resolution of grievances;

- Strengthen accountability and responsiveness of project management;
- Reduce potential conflicts between project stakeholders.

8.7.2 GRM Structure and Process

The grievance process will operate at **three levels**:

Level	Responsible Entity	Description and Timeline
Level 1 – Site Level	Contractor's Community Liaison Officer (CLO)	Receives verbal or written grievances from community members. Logs the complaint in a Grievance Register and attempts resolution within 7 working days.
Level 2 – Project Management Level	PWD Environmental and Social Officer	Reviews unresolved complaints, conducts investigations, and coordinates with PVMC or DEPC for action. Resolution within 14 working days.
Level 3 – Appeal Level	DEPC	Final level of appeal for cases not resolved at lower levels. Written response issued within 21 working days.

Complaints may be lodged through:

- Verbal reporting to the CLO or site office;
- Written forms available at the PWD or PVMC offices;
- Email or telephone contact (numbers displayed on public notices);
- Anonymous submissions (if preferred).

All complaints will be logged with details of the issue, date, responsible parties, actions taken, and final outcomes.

8.8 Roles and Responsibilities for Stakeholder Engagement and GRM

Entity	Roles and Responsibilities
Public Works Department (PWD)	Overall coordination and supervision of engagement and grievance activities; disclosure of reports; oversight of the Community Liaison Officer.
Contractor	Implements site-level engagement activities, maintains the grievance register, and ensures timely responses.
Community Liaison Officer (CLO)	Primary interface with local stakeholders; conducts community awareness sessions; manages grievance intake and resolution.
Port Vila Municipal Council (PVMC)	Supports information dissemination, traffic notices, and coordination with local authorities.

Department of Environmental Protection and Conservation (DEPC)	Provides oversight and guidance on compliance with public consultation requirements.
Consultant	Ensures that stakeholder engagement meets safeguard standards and reviews grievance outcomes during supervision missions.

8.9 Monitoring and Reporting

Monitoring indicators for stakeholder engagement and grievance management will include:

- Number of consultation meetings conducted;
- Number and type of participants (with gender disaggregation);
- Frequency and type of information disclosed;
- Number of grievances received, resolved, and pending;
- Average resolution time;
- Community satisfaction feedback.

The Community Liaison Officer will compile monthly engagement and grievance summaries, verified by the Supervising Engineer, and submitted to PWD and DEPC for quarterly review.

Summary

Stakeholder engagement and grievance redress mechanisms are vital to maintaining transparency, accountability, and community trust in the project.

Through early and continuous consultation, inclusive participation, and an effective grievance process, the project ensures that community voices are heard and concerns are addressed promptly.

This participatory approach not only meets the JICA safeguard requirements but also enhances the project's long-term sustainability, ensuring that the benefits of the Tagabe Bridge are realized equitably and with broad local support.

9. Conclusion and Recommendation

The IEE confirms that the *Programme for Emergency Rehabilitation of Principal Economic Infrastructure Affected by the Earthquake Project* can be implemented in an environmentally sound, socially acceptable, and technically resilient manner. All identified environmental and social impacts are localized, temporary, and reversible, provided that recommended mitigation and monitoring measures are effectively implemented. No critical habitats, cultural heritage sites, or households requiring resettlement will be adversely affected.

Extensive baseline studies—covering climate, hydrology, water quality, geology, noise, air quality, ecology, and socio-economic conditions—demonstrate that the project area is an established urban corridor with moderate existing environmental pressures including microbial contamination of the Tagabe River, traffic-related noise, and partially degraded riparian vegetation. These conditions reinforce the need for robust construction-phase environmental controls but do not pose constraints to development.

The engineering design incorporates robust climate and seismic resilience, including scour-resistant foundations, ductile detailing, flood-resilient embankments, and improved stormwater drainage. The project directly supports national disaster recovery priorities by restoring a vital link between Bauerfield International Airport and Port Vila's commercial and residential zones.

Social assessments show strong local support and acceptance of the project. Concerns expressed by communities—mainly dust, detour access, traffic delays, and noise—have been addressed through the ESMP and targeted mitigation measures such as dust suppression, signage, controlled working hours, and clear communication. No involuntary resettlement is triggered, and no households will be physically displaced.

With the ESMP, ESMMP, and stakeholder engagement framework in place, the project complies with Vanuatu's Environmental Protection and Conservation Act [CAP 283], DEPC requirements, JICA Guidelines for Environmental and Social Considerations (2022), and is well aligned with World Bank Environmental and Social Standards for best practice. The project therefore meets all regulatory and donor safeguard requirements.

Recommendation

It is therefore recommended that:

1. The Department of Environmental Protection and Conservation (DEPC) grant an Environmental Permit for project implementation, subject to compliance with the approved ESMP.
2. The Public Works Department (PWD) ensure that environmental clauses are fully incorporated into construction contracts and that qualified Environmental and Safety Officers remain on-site throughout implementation.
3. The Contractor maintain continuous monitoring and reporting (monthly) on air, noise, water, and safety parameters, with adaptive measures applied where exceedances occur.

4. JICA and DEPC conduct periodic joint reviews and mid- and post-construction environmental audits.
5. Post-construction, the project transition into a maintenance and monitoring phase to sustain ecological restoration, community safety, and long-term infrastructure resilience.

With these safeguards and governance measures in place, the project is environmentally acceptable and strongly recommended for implementation under the oversight of MIPU, DEPC, and JICA.

ANNEX A: Water Quality Sampling Data

Tagabe River Sampling Sites

Sample ID	Site name	GPS Coordinates
TR01	Before Tagabe river	-17.708141, 168.307793
TR02	After Tagabe river	-17.708030, 168.309588
TR03	Pump Station bridge - Control point	-17.707541, 168.319311
TR04	Before Detour Bridge	-17.707507, 168.315833
TR05	After Detour Bridge	-17.707411, 168.312334

Methods used for analyses and their guideline values are tabulated below.

Parameter	Method	Guideline Value (WHO)
Enterococci	ISO 7899-2:2000	<35cfu/100ml
Temperature	Electrometric	16^0C-34^0C
Conductivity	Electrometric	NA
pH	Electrometric	6.5 – 8.5
Turbidity	Electrometric	<25NTU
% Dissolve Oxygen	Electrometric	80% - 120%
Nitrate	HACH 8039, 8192	NA
Nitrite	HACH 8135, 8192	NA
Ammonia	Colorimetric	NA
Total Phosphorus	HACH 8048	NA
Copper	HACH 10238	NA
Iron	HACH 10229	NA

Analytical Results

Sample ID	Date	Sampling sites	Temperature (°C)	Conductivity (µS/cm)	pH	%Dissolve Oxygen	Turbidity (NTU)	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Copper (mg/L)	Iron (mg/L)	Enterococci (<35cfu/100ml)
TR01	03 October 2025	Before Tagabe Bridge	27	465	7.8	84	7.25	0.514	0.009	0.012	0.117	0.031	0.061	208
TR02	03 October 2025	After Tagabe Bridge	28	461	7.8	86	4.73	0.502	0.009	0.019	0.147	0.009	0.033	214
TR03	03 October 2025	Control Point – Near UNELCO Pump Station	27	458	7.51	74	0.97	0.543	0.007	0.011	0.126	0.018	0.021	190
TR04	03 October 2025	Before Detour Bridge	27	463	7.6	83	4.96	0.453	0.007	0.006	0.141	0.017	0.037	260
TR05	03 October 2025	After Detour Bridge	28	466	7.56	83	15.5	0.501	0.013	0.023	0.219	0.003	0.041	200

ANNEX B: Species List from BioRAP

FLORA SPECIES

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
1	Grass blo baby moses	Umbrella papyrus	*Cyperus alternifolius*	Native	Least Concern (LC)	
2	Wael kava	Mexican piper leaf	*Piper auritum*	Introduced	Least Concern (LC)	
3	Benuar	Rain Tree	*Samanea saman*	Invasive	Least Concern (LC)	
4	Avocado	Avocado	*Persea americana*	Domesticated	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
5	Bamboo	Bamboos	*Schizostachyum glaucifolium*	Native	Least Concern (LC)	
6	Bettel nut	Bettel Nut	*Areca catechu*	Introduced	Least Concern (LC)	
7	Navenue	Macaranga	*Macaranga tanarius*	Native	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
8	Palm Tree	Montgomery Palm	*Veitchia arecina*	Native	Endangered (EN)	
9	Glyricidi	Gliricidia	*Gliricidia sepium*	Introduced	Least Concern (LC)	
10	Navele	Cut nut	*Barringtonia edulis*	Native	Data Deficient (DD)	
11	Nakatambol	Fiji Dragonplum	*Dracontomelon vitiense*	Native	Data Deficient (DD)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
12	Mango	Mango	*Mangifera indica*	Domesticated	Data Deficient (DD)	
13	Bredfrut	Breadfruit	*Artocarpus altilis*	Domesticated	Data Deficient (DD)	
14	Nabanga	Banyan tree	*Ficus obliqua*	Native	Least Concern (LC)	
15	Namambe	Tahitian Chest Nut	*Inocarpus fagifer*	Domesticated	Least Concern (LC)	
16	Pispis tree	African Tulip	*Spathodea campanulata*	Invasive	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
17	Water Lily	Water lettuce	*Pistia stratiotes*	Invasive	Least Concern (LC)	
18	Manioc	Cassava	*Manihot esculenta*	Domesticated	Not Evaluated (NE)	
19	Taro	Taro	*Colocasia esculenta*	Domesticated	Least Concern (LC)	
20	Naus tree	Polynesian apple	*Spondias dulcis*	Domesticated	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
21	Cordia	Cordia	*Cordia alliodora*	Invasive	Least Concern (LC)	
22	Wael Navele	Powder puff tree	*Barringtonia racemosa*	Native	Least Concern (LC)	
23	Natapoa	Tropical Almond tree	*Terminalia catappa*	Native	Least Concern (LC)	
24	Caster oil-plant	Caster oil-plant	*Ricinus communis*	Introduced	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
25	Burao	Beach Hibiscus	*Hibiscus tiliaceus*	Common Native	Least Concern (LC)	
26	Pawpaw	Papaya	*Carica papaya*	Domesticated	Least Concern (LC)	
27	Banana	Banana	*Musa* (genus)	Domesticated	Not Evaluated (NE)	
28	Nandao	Island Lychee	*Pometia pinnata*	Domesticated	Least Concern (LC)	

#	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
29	Margot	Grapefruit	*Citrus grandis*	Domesticated	Least Concern (LC)	
30	Pamblemouse	Pomelo	*Citrus paradisi*	Domesticated	Not Evaluated (NE)	
31	Sopsop wud	Native Mulberry	*Pipturus argenteus*	Native	Least Concern (LC)	

* https://www.iucnredlist.org/

FAUNA SPECIES

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
1	Birds	Sotleg	Pacific Emerald Dove	Chalcophaps longirostris	Native	Least Concern (LC)	
2	Birds	Sako	Indian/Common Myna	Acridotheres tristis	Invasive	Least Concern (LC)	
3	Birds	Pidgin	Common Waxbill	Estrilda astrild	Introduced	Least Concern (LC)	

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
4	Birds	Grin pidgin	Tanna Fruit Dove	Ptilinopus tannensis	Endemic	Least Concern (LC)	
5	Birds	Nil	Glossy Swiftlet	Collocalia esculenta	Common	Least Concern (LC)	
6	Birds	Nalaklak	White-breasted Woodswallow	Artamus leucorynchus	Common	Least Concern (LC)	

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
7	Birds	Nalaklak	House Sparrow	Passer domesticus	Invasive	Least Concern (LC)	
8	Birds	Nalaklak	Yellow-fronted White-eye	Zosterops flavifrons	Endemic	Least Concern (LC)	
9	Birds	Nalaklak	Grey-eared Honeyeater	Lichmera incana	Common	Least Concern (LC)	

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
10	Birds	Nalaklak	Grey Fantail	Rhipidura albiscapa	Common	Least Concern (LC)	
11	Fish	Fish blo Mosquito	Western Mosquitofish	Gambusia affinis	Introduced	Least Concern (LC)	
12	Fish	Tilapia	Mozambique Tilapia	Oreochromis mossambicus	Introduced	Near Threatened (NT)	

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
13	Crustaceans	Naura	Tahitian Prawn	Macrobrachium lar	Common	Least Concern (LC)	
14	Reptiles	Grin lizet	Green Lizard	Emoia sanfordi	Endemic	Data Deficient (DD)	
15	Reptiles	Grin lizet	Small Green Lizard	Emoia cyanogaster	Native	Least Concern (LC)	
16	Insects	Butaflae	Common Crow Butterfly	Euploea core	Common	Least Concern (LC)	

#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
17	Insects	Butaflae	Common Grass Yellow Butterfly	Eurema hecabe	Common	Least Concern (LC)	
18	Insects	Drakon flae	Painted Grass Hawk (Dragonfly)	Neurothemis stigmatizans	Common	Least Concern (LC)	
19	Insects	Drakonflae	Chalky Percher (Dragonfly)	Diplacodes trivialis	Common	Least Concern (LC)	
20	Insects	Onet	Yellow Oriental Paper Wasp	Polistes olivaceus	Common	Not Evaluated (NE)	

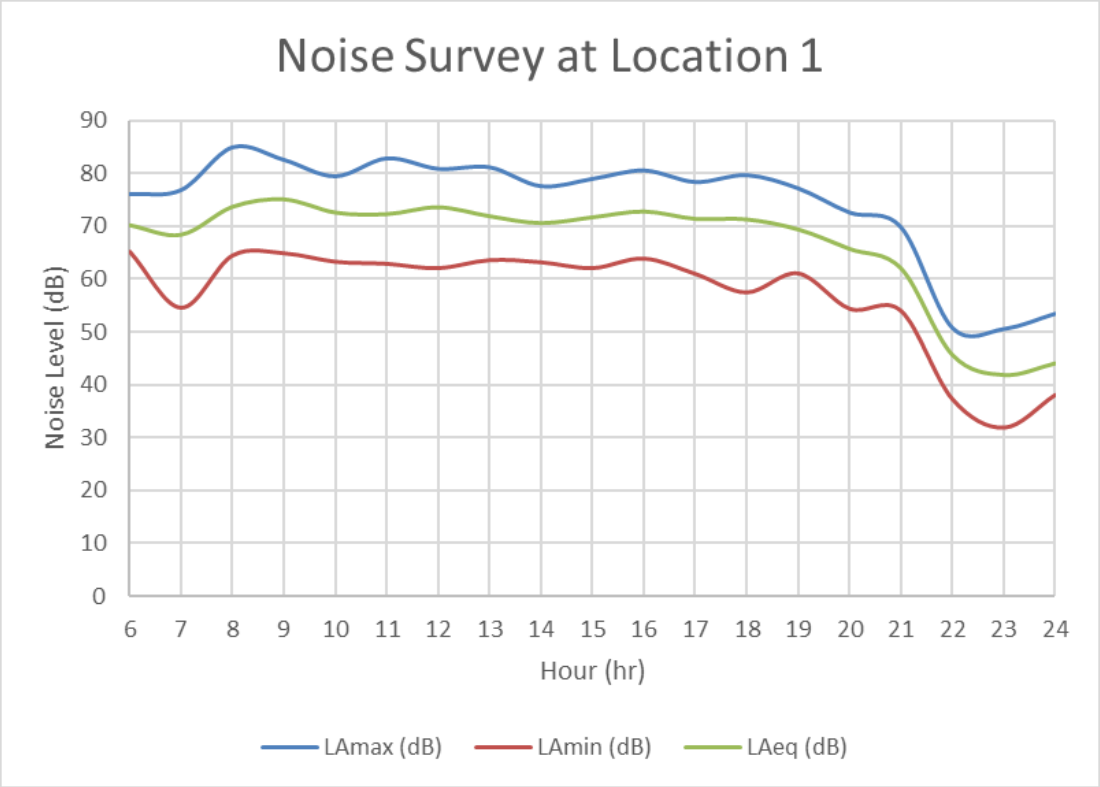
#	Category	Bislama Name	Common Name	Scientific Name	Origin / Status	IUCN Red List (Global Status)*	
21	Molluscs	Sel	Aquatic spiral shell / Augur snail	Terebra sp.	Common	Not Evaluated (NE)	
22	Molluscs	Sel	Black Helmet Snail	Neritina pulligera	Common	Least Concern (LC)	
23	Molluscs	Snel	Giant African Snail	Achatina fulica	Invasive	Not Evaluated (NE)	
24	Arachnids	Spida	Tiger Spider (Golden Orb-weaver)	Trichonephila plumipes	Common	Not Evaluated (NE)	

* https://www.iucnredlist.org/

ANNEX C: Results of the Acoustic Survey

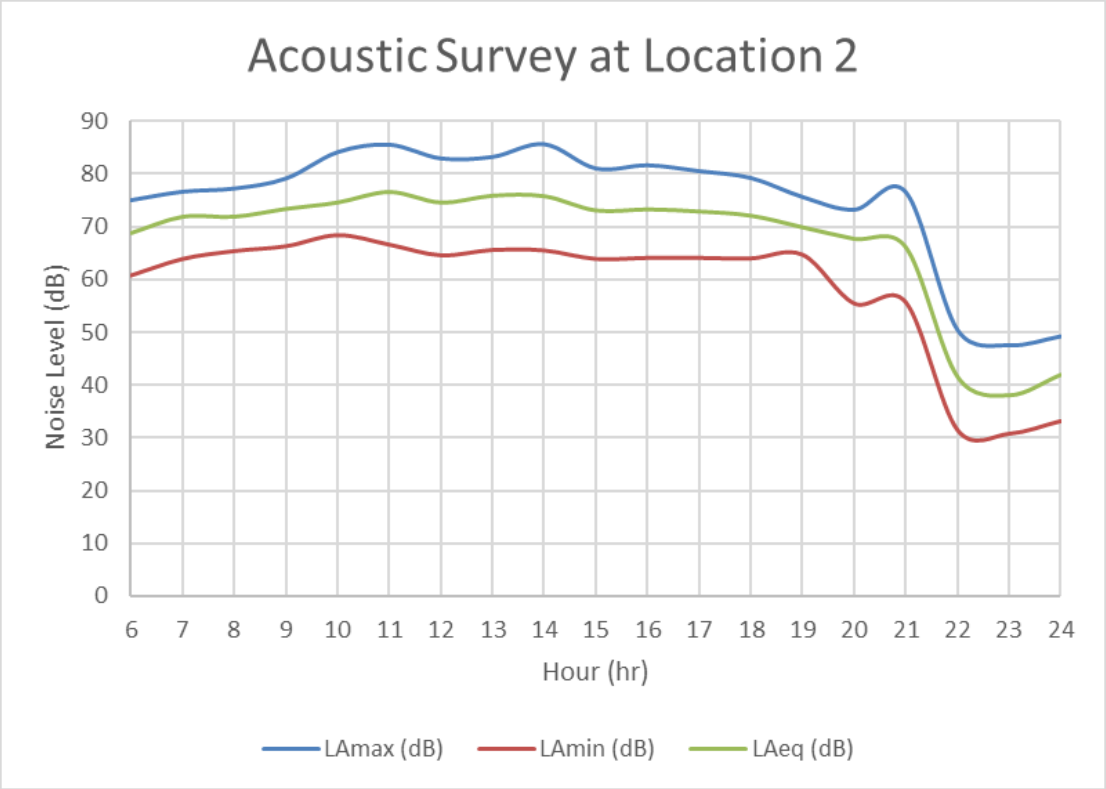
Location 1 (-17.7071552428, 168.3084154859)

Date	Time	LAeq (dB)	LAmax (dB)	LAmin (dB)	Freq. Weighting	Hour
2025-09-15	06:00:00	70.2	76.1	65.2	A	6
2025-09-15	07:00:00	68.4	76.9	54.6	A	7
2025-09-15	08:00:00	73.7	85	64.5	A	8
2025-09-15	09:00:00	75.1	82.6	64.9	A	9
2025-09-15	10:00:00	72.6	79.5	63.3	A	10
2025-09-15	11:00:00	72.3	82.9	62.9	A	11
2025-09-15	12:00:00	73.6	80.9	62.1	A	12
2025-09-15	13:00:00	71.9	81.2	63.6	A	13
2025-09-15	14:00:00	70.6	77.6	63.2	A	14
2025-09-15	15:00:00	71.7	79	62.1	A	15
2025-09-15	16:00:00	72.8	80.6	63.9	A	16
2025-09-15	17:00:00	71.4	78.4	61	A	17
2025-09-15	18:00:00	71.3	79.7	57.5	A	18
2025-09-15	19:00:00	69.4	77.2	61.1	A	19
2025-09-15	20:00:00	65.7	72.6	54.4	A	20
2025-09-15	21:00:00	62	69.8	54	A	21
2025-09-15	22:00:00	45.6	50.7	37.3	A	22
2025-09-15	23:00:00	41.8	50.5	31.9	A	23
2025-09-15	00:00:00	44	53.4	38.1	A	24



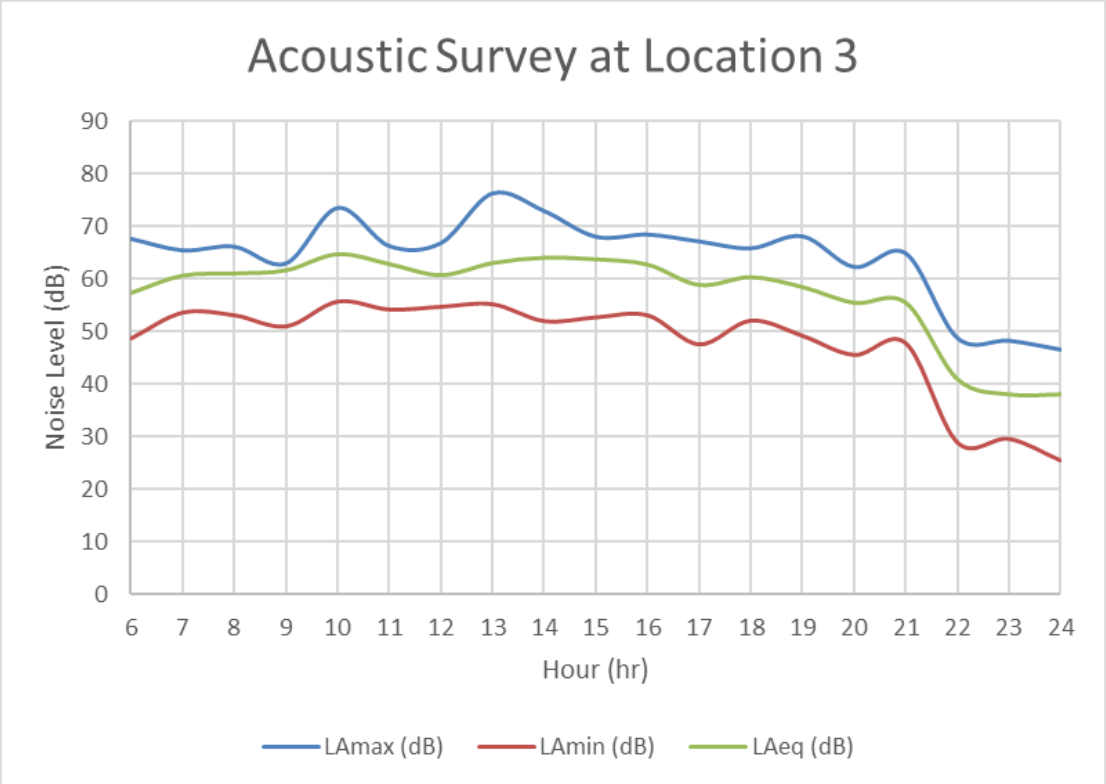
Location 2 (-17.7095064435, 168.3086109402)

Date	Time	LAeq (dB)	LAmax (dB)	LAmin (dB)	Freq. Weighting	Hour
2025-09-16	06:00:00	68.8	75.1	60.7	A	6
2025-09-16	07:00:00	71.9	76.7	63.8	A	7
2025-09-16	08:00:00	71.9	77.3	65.3	A	8
2025-09-16	09:00:00	73.4	79.2	66.2	A	9
2025-09-16	10:00:00	74.6	84.2	68.3	A	10
2025-09-16	11:00:00	76.6	85.6	66.5	A	11
2025-09-16	12:00:00	74.6	83	64.5	A	12
2025-09-16	13:00:00	75.9	83.3	65.5	A	13
2025-09-16	14:00:00	75.8	85.7	65.4	A	14
2025-09-16	15:00:00	73.1	81.1	63.8	A	15
2025-09-16	16:00:00	73.3	81.7	64	A	16
2025-09-16	17:00:00	72.9	80.6	64	A	17
2025-09-16	18:00:00	72.1	79.3	63.9	A	18
2025-09-16	19:00:00	69.9	75.7	64.6	A	19
2025-09-16	20:00:00	67.7	73.3	55.4	A	20
2025-09-16	21:00:00	66.1	76.6	55.6	A	21
2025-09-16	22:00:00	41.5	50.5	31.5	A	22
2025-09-16	23:00:00	38	47.6	30.8	A	23
2025-09-16	00:00:00	41.9	49.3	33.2	A	24



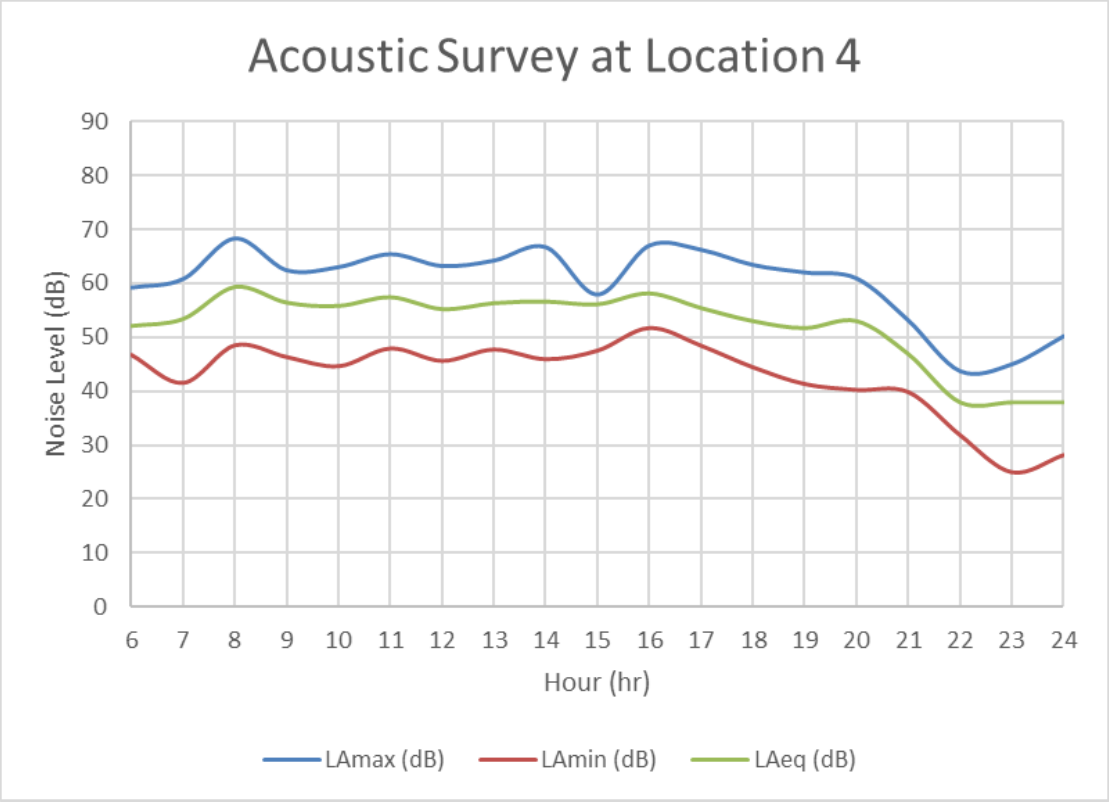
Location 3 (-17.7084946799, 168.3104562591)

Date	Time	LAeq (dB)	LAmax (dB)	LAmin (dB)	Freq. Weighting	Hour
2025-09-17	06:00:00	57.4	67.7	48.6	A	6
2025-09-17	07:00:00	60.7	65.5	53.5	A	7
2025-09-17	08:00:00	61.1	66.2	53	A	8
2025-09-17	09:00:00	61.7	63	50.9	A	9
2025-09-17	10:00:00	64.8	73.6	55.6	A	10
2025-09-17	11:00:00	62.9	66.3	54.1	A	11
2025-09-17	12:00:00	60.8	66.9	54.6	A	12
2025-09-17	13:00:00	63.1	76.4	55.1	A	13
2025-09-17	14:00:00	64.1	73	51.9	A	14
2025-09-17	15:00:00	63.8	68.1	52.6	A	15
2025-09-17	16:00:00	62.8	68.5	53	A	16
2025-09-17	17:00:00	58.9	67.2	47.5	A	17
2025-09-17	18:00:00	60.4	65.9	52	A	18
2025-09-17	19:00:00	58.5	68.2	49.1	A	19
2025-09-17	20:00:00	55.5	62.3	45.5	A	20
2025-09-17	21:00:00	55.5	64.9	47.7	A	21
2025-09-17	22:00:00	40.9	48.7	28.9	A	22
2025-09-17	23:00:00	38	48.2	29.6	A	23
2025-09-17	00:00:00	38	46.5	25.5	A	24



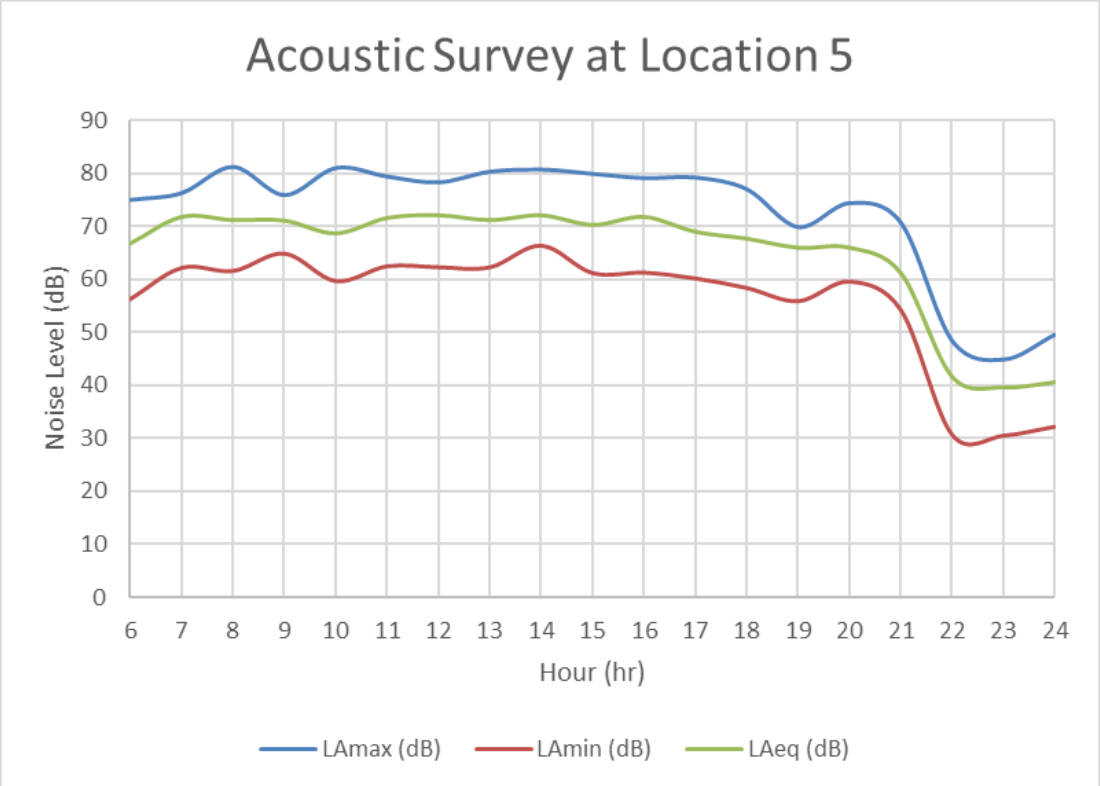
Location 4 (-17.7076668732, 168.3120773804)

Date	Time	LAeq (dB)	LAmax (dB)	LAmin (dB)	Freq. Weighting	Hour
2025-09-18	06:00:00	52.1	59.2	46.7	A	6
2025-09-18	07:00:00	53.4	60.8	41.5	A	7
2025-09-18	08:00:00	59.3	68.3	48.5	A	8
2025-09-18	09:00:00	56.4	62.4	46.3	A	9
2025-09-18	10:00:00	55.8	63	44.6	A	10
2025-09-18	11:00:00	57.4	65.4	47.9	A	11
2025-09-18	12:00:00	55.2	63.2	45.6	A	12
2025-09-18	13:00:00	56.3	64.2	47.7	A	13
2025-09-18	14:00:00	56.6	66.7	45.9	A	14
2025-09-18	15:00:00	56.1	57.9	47.5	A	15
2025-09-18	16:00:00	58.1	67	51.7	A	16
2025-09-18	17:00:00	55.4	66.2	48.4	A	17
2025-09-18	18:00:00	53	63.4	44.4	A	18
2025-09-18	19:00:00	51.7	62	41.3	A	19
2025-09-18	20:00:00	53	60.9	40.2	A	20
2025-09-18	21:00:00	46.9	53.1	39.8	A	21
2025-09-18	22:00:00	38	43.7	31.8	A	22
2025-09-18	23:00:00	38	45	24.9	A	23
2025-09-18	00:00:00	38	50.2	28.1	A	24



Location 5 (-17.7070000290, 168.3123475673)

Date	Time	LAeq (dB)	LAmax (dB)	LAmin (dB)	Freq. Weighting	Hour
2025-09-19	06:00:00	66.8	74.9	56.2	A	6
2025-09-19	07:00:00	71.8	76.2	62.1	A	7
2025-09-19	08:00:00	71.2	81.1	61.5	A	8
2025-09-19	09:00:00	71.1	75.8	64.8	A	9
2025-09-19	10:00:00	68.7	80.9	59.6	A	10
2025-09-19	11:00:00	71.6	79.3	62.4	A	11
2025-09-19	12:00:00	72.1	78.2	62.2	A	12
2025-09-19	13:00:00	71.2	80.2	62.2	A	13
2025-09-19	14:00:00	72.1	80.6	66.3	A	14
2025-09-19	15:00:00	70.3	79.8	61.1	A	15
2025-09-19	16:00:00	71.8	79	61.2	A	16
2025-09-19	17:00:00	69	79.1	60.1	A	17
2025-09-19	18:00:00	67.7	76.9	58.3	A	18
2025-09-19	19:00:00	66	69.8	55.8	A	19
2025-09-19	20:00:00	66	74.3	59.5	A	20
2025-09-19	21:00:00	61.2	70.6	54.1	A	21
2025-09-19	22:00:00	41.7	48.4	30.5	A	22
2025-09-19	23:00:00	39.7	44.9	30.4	A	23
2025-09-19	00:00:00	40.7	49.6	32.1	A	24



ANNEX D: Draft Environmental and Social Monitoring Form

This form contents are subject to change according to the results of detailed design and contractor's construction plan.

Pre-construction stage

1. Land acquisition and resettlement

- Monitoring item: Progress of relocation of two families living on the riverbank (provision of cash compensation [or in-kind compensation], moving and other assistance, etc.)
- Monitoring method: Grasping the status of relocation progress
- Monitoring frequency: Before and after relocation, during relocation (based on RAP)

	Date	Household Name	Status and Progress of Relocation	Remarks
1				
2				
3				

2. The Poor

- Monitoring item: Livelihood of two families iving on the riverbank
- Monitoring method: Grasping household status
- Monitoring frequency: Before and after relocation, during relocation (based on RAP)

	Date	Household Name	Status of Household Economy and Progress	Remarks
1				
2				
3				

Construction Phase

1. Ambient Air

(1) Daily site observation

- Monitoring item: Dust and gas emissions that deteriorate air quality
- Monitoring method: Site observations
- Monitoring frequency: as needed (every day)

	Date	Work contents	Location	Incidents of Pollution*1	Actions*2
1				-	
2					
3					

(Note 1) Dust, exhaust gas, etc. (Note 2) Water spraying, installation of covers, access restrictions, etc.

(2) Measurement

- Monitoring item: PM10, PM2.5
- Monitoring method: measurement
- Monitoring frequency: (i) Once before construction starts (baseline), (ii) Once each in the morning and afternoon every week during construction, (iii) Once after completion (endline)

(Date)

(Location)

Item (Unit)	Baseline value	Measured value (Average value)	Measured value (Max. value)	WHO Air Quality Guidelines (2021)*	Remarks (Location, Frequency, Method, etc.)
PM10 (μg/m^3)				15 μg/m^3 (annual) and 45 μg/m^3 (24-h)	Measured by PM meter for 30 minutes
PM2.5 (μg/m^3)				5 μg/m^3 (annual) and 15 μg/m^3 (24-h)	Measured by PM meter for 30 minutes

(Note 1) The WHO standards are a guideline values.

2. Water pollution

(1) Wastewater treatment records

- Monitoring item: (i) Discharge of construction waste and soil into the river, (ii) General drainage (contamination due to fuel, oil transport, storage, handling), (iii) Disposal of sewage, wastewater, and other liquid waste
- Monitoring method: Site observations
- Monitoring frequency: As required

	Date	Work Content	Location	Incidents of Pollution*1	Actions*2
1					
2					
3					

(Note 1) Runoff water, contamination, wastewater, etc. (Note 2) Installation of facilities to prevent water pollution, on-site wastewater treatment, etc.

(2) Water Quality

- Monitoring item: River water pollution (turbidity [suspended solids (SS)], pH, electrical conductivity (EC), water temperature, dissolved oxygen (DO), total dissolved solids (TDS))
- Monitoring method: measurement and analysis
- Monitoring frequency: (i) Once at the start (baseline), (ii) Once a week during bridge demolition/construction, (iii) Once at the end (endline)

(Date)
(Location) (TR01, TR02, TR03, TR04, TR05)

Item (unit)	baseline value	measured value (Average value)	measured value (Max. value)	WHO / ANZECC*	National Standard* (Reference)	Remarks (Location, Frequency, Method, etc.)
Turbidity (SS)				< 5 NTU	-	Turbidity meter/sensor
pH				6.5–8.5	6.5–8.5	pH meter
EC				<1,000 µS/cm	-	TDS meter
water temperature (°C)				25-30 °C	-	Water thermometer
DO				>80%	5 mg/L or more	DO meter/sensor
TDS				1,000mg/L	-	TDS meter

(Note 1) WHO (2022) Guidelines for Drinking-Water Quality and ANZECC (2000) Water Quality Guidelines for Fresh and Marine Waters. They are guideline values. (Note 2) The national standard values are "environmental standards", which are different from effluent standards or discharge standards, and are established as targets and conditions to ensure the quality of public water bodies.

3. Soil Pollution

- Monitoring item: Removal of topsoil and soil runoff due to excavation work
- Monitoring method: Site observations
- Monitoring frequency: Weekly

	Date	Work Stage	Location	Incidents of Pollution*1	Actions*2
1				-	
2					
3					

(Note 1) Removal of topsoil, soil runoff, fuel/oil leaks, wastewater, etc. (Note 2) Installation of facilities to prevent water pollution, on-site wastewater treatment, etc.

4. Sediment

- Monitoring item: Refer to 2.(2) Water Quality (measurement and analysis)
- Monitoring method: Refer to 2.(2) Water Quality (measurement and analysis)
- Monitoring frequency: Refer to 2.(2) Water Quality (measurement and analysis)

5. Noise and vibration

(1) Noise level

- Monitoring item: Noise impacts on the local community (noise level)
- Monitoring method: Measurement of Noise Level
- Monitoring frequency: (i) Before construction (baseline), (ii) Once each in the morning and afternoon every week during construction, (iii) After completion (endline).

(Date)
(Location)

Item (unit)	baseline value	measured value (Average value)	measurement (Max. value)	Vanuatu Standard	IFC Standard （L-max, L-min, Leq-day, Leq-night）	Remarks (Location, Frequency, Method, etc.)
Noise level (dB A)				None	Daytime: 55 dBA, Night: 45 dBA, or < background noise+3dB	Measured by sound level meter for 24 hours

(Note 1) Vanuatu has no standard, so IFC standard is applied. (Note 2) Labour noise in specific construction work is monitored under 21. Working Environment.

(2) Vibration level

- Monitoring item: Vibration impacts on the local community (vibration level)
- Monitoring method: Measurement of Vibration Level
- Monitoring frequency: (i) Before construction (baseline), (ii) Once each in the morning and afternoon every week during construction, (iii) After completion (endline).

(Date)
(Location)

Item (unit)	baseline value	measured value (Average value)	measurement (Max. value)	Vanuatu Standard	Local Conformity and Grievance Level (BS 5228-2:2009)	Remarks (Location, Frequency, Method, etc.)
Vibration level (PPV)				None	≤1.0 mm/s	Measured by vibration level meter for 30 minutes

(Note 1) Since there are no standards in Vanuatu, BS 5228-2:2009, which is widely adopted as a code of practice for the prediction, assessment, and management of construction vibration, will be applied. (Note 2) PPV stands for Peak Particle Velocity. (Note 3) Vibration standards in residential area in Japan are 65dB during daytime and 60dB during nighttime.

(3) Complaints

- Monitoring item: Complaints from residents regarding noise and vibration
- Monitoring frequency: as needed

	Date	Work contents	Location	Complaint Content	Actions
1				-	
2					
3					

6. Offensive Odors

- Monitoring item: Amount of general waste generated at workers' accommodation and site office
- Monitoring method: waste management records
- Monitoring frequency: once a month

	Date	Location*1	Waste contents*2	Actions*3
1				
2				
3				

(Note 1) Workers' accommodation, site office, etc. (Note 2) Food waste, recyclable/non-recyclable waste, etc. (Note 3) "Delivered to landfill", "recycled", "reused", etc.

7. Waste

- Monitoring item: Construction waste
- Monitoring method: waste management records
- Monitoring frequency: once a month

	Date	Work Content	Location	Amount Collected/Content*1	Actions*2
1					
2					
3					

(Note 1) Debris, wood, materials, concrete, etc. (Note 2) "Delivered to landfill", "recycled", "reused", etc.

8. Subsidence

- Monitoring item: Presence of uneven subsidence or tilting, impacts on groundwater and aquifer layers
- Monitoring method: Visual observation
- Monitoring frequency: Once a month

	Date	Work Content	Location	Actions
1				
2				
3				

9. Ecosystems

(1) Deterioration of river environment due to turbid water and sediment

- Monitoring item: Refer to 2.(2) Water Quality (measurement and analysis)
- Monitoring method: Refer to 2.(2) Water Quality (measurement and analysis)
- Monitoring frequency: Refer to 2.(2) Water Quality (measurement and analysis)

(2) Deterioration of fauna lives in the Tagabe River due to turbid water and sediment

- Monitoring item: Fauna lives in the Tagabe River nearby bridge construction site (embankment, piling, etc.)
- Monitoring method: Visual observation
- Monitoring frequency: Once a week during bridge demolition / construction work

	Date	Contents of construction work	Location	Conditions of fauna lives	Actions*
1				-	
2					
3					

(Note) Actions can be the implementation of river water quality test, installation of facilities to prevent water turbidity, discharge water treatment, etc.

(3) Tree Cutting and Removal of Flowers and Grasses

- Monitoring item: Restoration of vegetation
- Monitoring method: Planting/replanting
- Monitoring frequency: at the end of construction work

Date	Location	Tree Species	Remarks

10. Hydrology

- Monitoring item: Refer to 8. Ground Subsidence
- Monitoring method: Refer to 8. Ground Subsidence
- Monitoring frequency: Refer to 8. Ground Subsidence

11. Topography, Geology

(1) Impact on riverbank strength due to bridge replacement and detour bridge construction

- Monitoring item: Refer to 8. Ground Subsidence
- Monitoring method: Refer to 8. Ground Subsidence
- Monitoring frequency: Refer to 8. Ground Subsidence

(2) Impact on riverbank strength due to tree cutting along the riverbank

- Monitoring item: Refer to 9.(2) Ecosystem
- Monitoring method: Refer to 9.(2) Ecosystem
- Monitoring frequency: Refer to 9.(2) Ecosystem

12. Land acquisition and resettlement

- Monitoring item: Temporary land use, management of usage and rental status, land management (entry restrictions, boundary management, etc.)
- Monitoring method: Management of land usage and rental status
- Monitoring frequency: (i) Before construction, (ii) Once every three months during construction, (iii) After project completion (confirmation of restoration)

(Date)
(Location)

Purpose of Usage/Rental	Usage Period	Site Management Status	Issues	Actions for Solution

13. The Poor

- Monitoring item: Relocated families' employment status, household income and basic infrastructure for living after relocation, implementation status of livelihood assistance measures (skill development training, etc.)
- Monitoring method: Interview with relocated families
- Monitoring frequency: Once every three months during construction

(Date)
(Location)

	Item	Findings	Issues	Actions for Solution
1	Employment Status			
2	Household Income			
3	Basic Infrastructure			
4	Implementation status of Livelihood Assistance measures			

14. Local Economy, including Employment and Means of Livelihood

(1) Impact on the relocated families

- Monitoring item: Refer to 13. The Poor
- Monitoring method: Refer to 13. The Poor
- Monitoring frequency: Refer to 13. The Poor

(2) Impact on the local economy

- Monitoring item: Site management (e.g., entry restrictions and boundary management)
- Monitoring method: Status of land use
- Monitoring frequency: Once every three months

	Date	Work contents	Exact location	Issues, Complaints	Actions
1				-	
2					
3					

(3) Complaints

- Monitoring item: Complaints from residents
- Monitoring frequency: as needed

	Date	Work contents	Location	Complaint Content	Actions
1				-	
2					
3					

15. Land Use and Local Resource Utilization

- Monitoring Item: Land management (such as access restrictions and boundary management)
- Monitoring Method: Status of land use
- Monitoring Frequency: Once every three months

(Date)
(Location)

Purpose of Usage/Rental	Usage Period	Site Management Status	Issues	Actions for Solution

16. Water Use

(1) Impact on Local Life

- Monitoring Item: Refer to 2. (2) Water Quality (Measurement and Analysis)
- Monitoring Method: Refer to 2. (2) Water Quality (Measurement and Analysis)
- Monitoring Frequency: Refer to 2. (2) Water Quality (Measurement and Analysis)

(2) Complaints

- Monitoring Item: Complaints from residents
- Monitoring Frequency: As needed

	Date	Construction Progress	Location	Contents of Complain	Response
1				-	
2					
3					

17. Existing Social Infrastructure and Social Services

(1) Impact on Local Life

- Monitoring Item: Land management (such as access restrictions and boundary management)
- Monitoring Method: Removal/relocation of existing utility poles, underground water pipes, and communication facilities
- Monitoring Frequency: At the time of relevant construction work

(Date)
(Location)

Utilities for Removal/Relocation	Date/Time	Site Management Status	Issues	Actions for Solution

(2) Complaints

- Monitoring Item: Complaints from residents
- Monitoring Frequency: As needed

	Date	Utilities for Removal/Relocation	Location	Contents of Complain	Response
1				-	
2					
3					

18. Landscape

(1) Vegetation

- Monitoring item: status of vegetation recovery
- Monitoring method: planting
- Monitoring frequency: At the end of construction

Date	Location	Tree Species	Remarks

(2) Material removal

- Monitoring item: Removal of materials from the site
- Monitoring method: Work progress monitoring
- Monitoring frequency: at the end of construction work

Date	Location	Removed Items	Remarks

19. Gender

(1) Harassment of Local Women by Construction Workers

- Monitoring Item: Regular guidance and content for workers, on-site guidance
- Monitoring Method: Supervision of workers
- Monitoring Frequency: Once a week

Date	Location	Details of Incident	Response

(2) Movement within Surrounding Community

- Monitoring Item: Land management (access restrictions, boundary management, etc.)
- Monitoring Method: Land use status
- Monitoring Frequency: Once every 3 months

Date	Location	Details of Incident	Response

20. Children's Rights

(1) Movement within Surrounding Community (to school and others)

- Monitoring Item: Refer to 18.(2) Gender (Movement within Surrounding Community) above
- Monitoring Method: Refer to 18.(2) Gender (Movement within Surrounding Community)

above
- Monitoring Frequency: Refer to 18.(2) Gender (Movement within Surrounding Community) above

Date	Location	Details of Incident	Response

(2) Children's Rights

- Monitoring Item: Employment of children under 18 years of age
- Monitoring Method: Employment record, work record and visual observation
- Monitoring Frequency: Once every three months

Date	Record	Details of Incident	Response

21. Infectious Diseases such as HIV/AIDS

- Monitoring Item: Health status of workers
- Monitoring Method: Health check
- Monitoring Frequency: Once every 6 months

Date	Record	Review Period and Content	Remarks

22. Working environment (occupational safety and health)

- Monitoring item: Occurrence of occupational accidents/injuries, exposure to excessive noise, health impacts due to heat
- Monitoring method: Number of safety training sessions, content, number of participants, PPE availability, noise and vibration measurement, work details, health status of workers, number of occupational accidents, working hours
- Monitoring frequency: Once every 3 months (once every 6 months for health status)

Date	Record	Review Period and Content	Remarks
	Training and TBM (toolbox meeting) record	*Number of training, content and number and characteristics of participants, etc.*	
	Equipment registration	*Number of PPE, etc.*	
	Labor noise measurement		*Since specific construction noise standards cannot be confirmed in Vanuatu or by the IFC Guidelines,*
	Labor vibration measurement		

Date	Record	Review Period and Content	Remarks
			the Japanese regulatory values will be followed, setting 85dB for noise and 75dB for vibration as the upper reference limits.
	Operation record		
	Health Examination Record		
	Workers' Accident Records	*Location, number of accidents and work when accident occurred, etc.*	
	Labor time record		

(Note) Ensure that PPE is worn and daily safety precautions are confirmed every morning at TBM.

23. Accident

- Monitoring item: General safety risks around the construction site, occurrence of personal accidents
- Monitoring method: Work details at the time of accident, operation status of construction/transport vehicles, number of accidents involving the general public
- Monitoring frequency: When an accident occurs

Date	Record	Content	Remarks
	Operation record		
	Vehicle operation record		
	Accident record (at police)	Location of the accident, map, circumstances and details of the accident, and response to the parties involved.	