APPENDIX B METHODOLOGY AND SCOPING

B METHODOLOGY AND SCOPING

This chapter provides an overview of the methodology applied for the ESIA. The main objective of the ESIA is to comprehensively evaluate all direct, indirect, and cumulative environmental and social risks and impacts throughout the Project's life cycle. It aims to predict potential impacts of the proposed Project and to outline measures to avoid, minimize, or mitigate these impacts according to the mitigation hierarchy.

The direct, indirect, and cumulative impacts are defined as follows in the *World Bank Environmental and Social Framework 2017*:

- A direct impact is an impact which is caused by the Project, and occurs contemporaneously in the location of the Project;
- An indirect impact is an impact which is caused by the Project and is later in time or farther removed in distance than a direct impact, but is still reasonably foreseeable, and will not include induced impacts; and
- The cumulative impact of the Project is the incremental impact of the Project when added to impacts from other relevant past, present and reasonably foreseeable developments as well as unplanned but predictable activities enabled by the Project that may occur later or at a different location.

B.1 IMPACT ASSESSMENT PROCESS

ERM employs a comprehensive framework to direct the ESIA process as depicted in ***Figure B-1***. This framework encompasses specific techniques, models, and assessment criteria tailored to each environmental and social aspect. These methods adhere to globally recognized best practices, such as the WBG ESF. By addressing the unique concerns linked to Project development and associated infrastructure, this framework provides a customized impact identification and evaluation mechanism. As a result, it enables a more targeted and precise assessment of the Project's impact. ***Table B-1*** breakdowns the approach to each step and provides a reference to the respective section in the ESIA.

FIGURE B-1 ERM'S ESIA PROCESS DIAGRAM

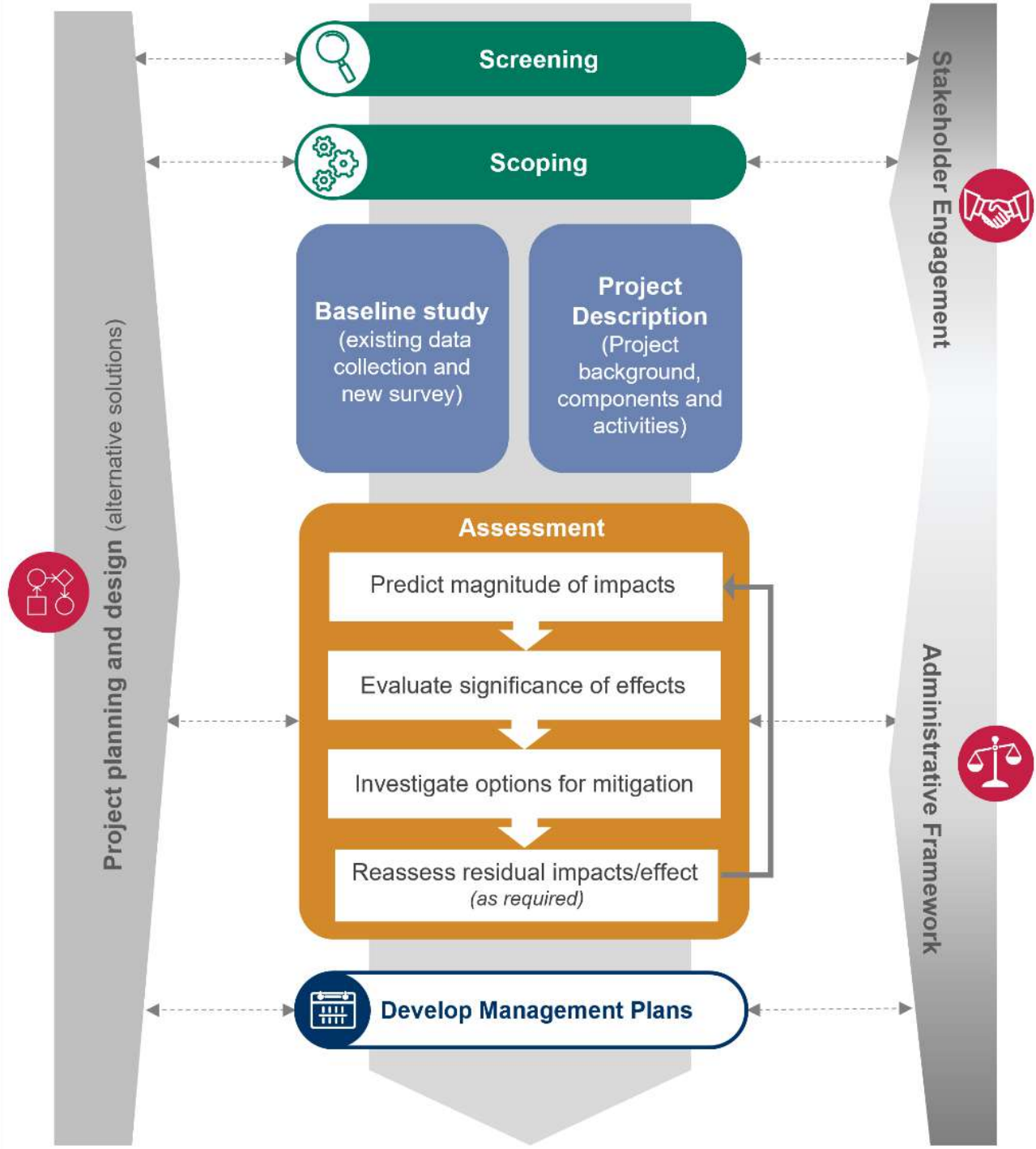


TABLE B-1 ESIA PROCESS DESCRIPTION

ESIA Step	Description
Review Administrative Framework	National regulatory requirements, applicable international treaties and conventions, and internal guidelines and standards voluntarily committed to by the Project Proponent.
Interaction with Project Planning and Design	Detailed information on the Project components, activities, planning, and design is crucial for all stages of ESIA, including screening, scoping, impact assessment, mitigation measures, monitoring, and auditing. Alternatives analysis is a critical step in this process, providing inputs for the scoping and impact assessment stages of ESIA. ERM worked with the project engineers during the initial options study to compare the alternatives for the road layout, road construction and bridge options.
Stakeholder Engagement	**Stakeholder engagement** is a vital part of the ESIA process, and it follows WB ESS10 to ensure the views, interests, and concerns of stakeholders are considered. The ESIA stakeholder engagement involved various approaches to socio-economic analysis, such as interviews and focus group discussions. A separate Stakeholder Engagement Plan (SEP) and Grievance Mechanism has been prepared as a standalone document.
Screening and Scoping	The **screening** process aims to identify potential social and environmental risks of a Project and determine the necessary requirements for further analysis. It involves reviewing relevant standards and guidelines, Project type, location, scale, duration, and potential Impact Areas for the Project. Sources used in screening include the initial options study, the ongoing feasibility study information, published literature, Integrated Biodiversity Assessment Tool (IBAT), satellite images, and client meetings. The **scoping** determines which impacts are likely to be significant and should become the focus of the ESIA. The potential interactions between the Project activities and key receptors in the Impact Areas for the Project (and thus the appropriate Study Area) are identified. A site visit is performed in this stage to solidify the Impact Areas, and confirm the key landmarks, features, locations for baseline sampling, scopes of the baseline survey, modeling, and other requirements. During the scoping study, the potential interactions between the Project and environmental and social resources/receptors that *likely* cause impacts of significant concern are identified (*scope-in*). The scoping exercise also identifies the areas *unlikely* to be significantly affected by the development activities, requiring little further consideration or associated data gathering (*scope-out*). The scoping phase also identifies data availability and gaps, the appropriate spatial and temporal scopes for the assessment, and the suitable survey and research methodologies required to meet WB requirements.
Baseline Studies	The Project's impacts must be assessed within the context of existing physical, biological, socio-economic, and cultural conditions. To establish this context, **baseline studies** were conducted based on literature review and field baseline surveys to comprehensively understand the current

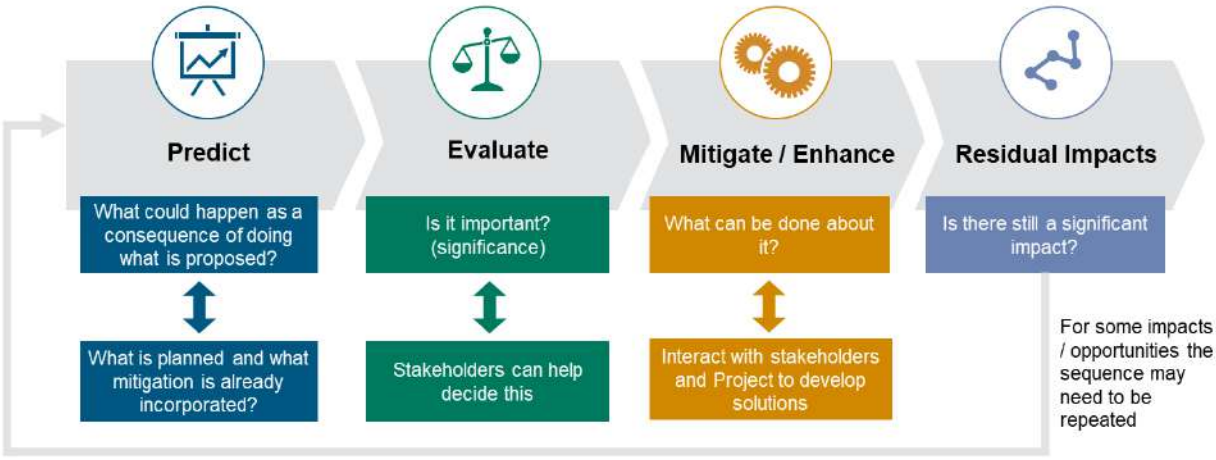
ESIA Step	Description
	conditions of all potential receptors. Baseline data is also used to predict and model impacts and to evaluate the sensitivity, vulnerability, and importance of resources and receptors.
Impact and Risk Assessment	The **impact assessment** for planned activities was conducted through a systematic process that involves the identification, prediction, and evaluation of the positive and negative impacts that the Project may have on the physical, biological, socio-economic, and cultural environment. This process also entails the identification of appropriate mitigation measures that the Project Owner must take to avoid, reduce, mitigate, offset, or compensate for any adverse impacts and to enhance positive impacts where practicable. The **risk assessment** for unplanned and non-routine activities follows a similar approach, with an additional step in the evaluation process that considers the likelihood of the occurrence of such events. The stages of the impact and risk assessment process are thoroughly described below. The stages of the impact and risk assessment process are described in more detail in ***Section B.2*** below.
Management Plan	The final stage in the ESIA Process is the determination of management and monitoring programs and auditing requirements to ensure the potential impacts are reduced and appropriately managed. The monitoring programs should be designed to detect impacts, confirm modeling results, quantify indicators to meet regulatory mitigation measures and ensure that emissions/discharges remain within international standards. An ESMP is then compiled, which summarizes all actions that the Project Owner and their Engineering, Procurement, and Construction (EPC) Contractor will commit to executing with respect to environmental/social/community health performance for the Project. The ESMP will document the proposed set of management, mitigation, and monitoring measures and specific actions to be taken at all stages of the Project development to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels.

B.2 IMPACT ASSESSMENT METHODOLOGY

Impact identification and assessment starts with scoping and continues through the remainder of the impact assessment process, as demonstrated in ***Figure B-2***. The principal steps are:

1. Impact prediction: to determine what could potentially happen to resources/receptors because of the Project and its associated activities.
2. Impact evaluation: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence and the sensitivity, value and/or importance of the affected resource/receptor.
3. Mitigation and enhancement: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts; and
4. Residual impact and risk evaluation: to evaluate the significance of impacts and risks assuming effective implementation of mitigation and enhancement measures.

FIGURE B-2 ESIA IMPACT AND RISK ASSESSMENT PROCESS



B.2.1 PREDICTION OF IMPACTS

The first step in the impact evaluation process involved predicting and quantifying, to the extent possible, the nature, type, magnitude, extent, and duration of the identified impacts on receptors. These terms are identified in ***Table B-2***.

TABLE B-2 DEFINITION OF IMPACT CRITERIA

Criteria	Definition
Nature of impacts on Environment/Community	**Beneficial** - impacts that result in net benefits **Adverse** - impacts that result in net detriments
Type of impact	**Direct** - impacts resulting directly from changes caused by the Project **Indirect** - secondary impacts caused by the Project
Magnitude—the level of impact, takes into consideration importance of the receptor, sensitivity of the receptor to change, likelihood of the impact occurring, and the predicted degree of impact	**Low** - a small, but measurable, change from the baseline conditions, typically that would not result in an exceedance of any applicable national and international standards. **Medium** - a noticeable and readily measurable change from the baseline conditions that may result in an exceedance of any applicable national and international standards. **High** - a substantial change from the baseline conditions that would result in an exceedance of any applicable national and international standards.
Extent—the areal "reach" of the impact	**Site-specific** - impacts confined to within the RoW or ancillary facilities (e.g., laydown areas) **Local** - impacts extend beyond the Project footprint area to affect resources within Impact Areas of the Project **Regional** - impacts observed within 5 km away from the Project.
Duration	**Short-term** - less than two years or during construction phase **Medium-term** - more than two years and less than 10 years **Long-term** - 10 years or more

B.2.2 EVALUATE IMPACT SIGNIFICANCE

The second step of the impact evaluation process involved determining the significance of each identified impact. The magnitude, extent, and duration criteria each are assigned relatively to be in different level, which are then combined in a risk matrix to characterize the overall impact significance ***(Table B-3)***. ***Table B-4*** provides a decision tree illustrating how the various rating criteria combine to determine the impact significance. ***Table B-5*** defines each of the levels of impact significance.

TABLE B-3 ENVIRONMENTAL AND SOCIAL IMPACT RATING CRITERIA

Magnitude	Extent	Duration
Low	Site-specific	Short-term
Medium	Local	Medium-term
High	Regional	Long-term

TABLE B-4 ENVIRONMENTAL AND SOCIAL IMPACT SIGNIFICANCE RATING

Magnitude	Extent	Duration	Significance
Low	Site-specific	Short-term	Low
Low	Site-specific	Medium-term	Low
Low	Local	Short-term	Low
Medium	Site-specific	Short-term	Low
Low	Site-specific	Long-term	Low
Low	Local	Medium-term	Low
Medium	Site-specific	Medium-term	Low
Medium	Local	Short-term	Moderate
Low	Local	Long-term	Moderate
Medium	Site-specific	Long-term	Moderate
Medium	Local	Medium-term	Moderate
Medium	Local	Long-term	Substantial
Low	Regional	Short-term	Substantial
High	Site-specific	Short-term	Substantial
Low	Regional	Medium-term	Substantial
High	Site-specific	Medium-term	Substantial
Medium	Regional	Short-term	Substantial
High	Local	Short-term	Substantial
Low	Regional	Long-term	High
Medium	Regional	Medium-term	High
High	Site-specific	Long-term	High
High	Local	Medium-term	High

Magnitude	Extent	Duration	Significance
Medium	Regional	Long-term	High
High	Local	Long-term	High
High	Regional	Short-term	High
High	Regional	Medium-term	High
High	Regional	Long-term	High

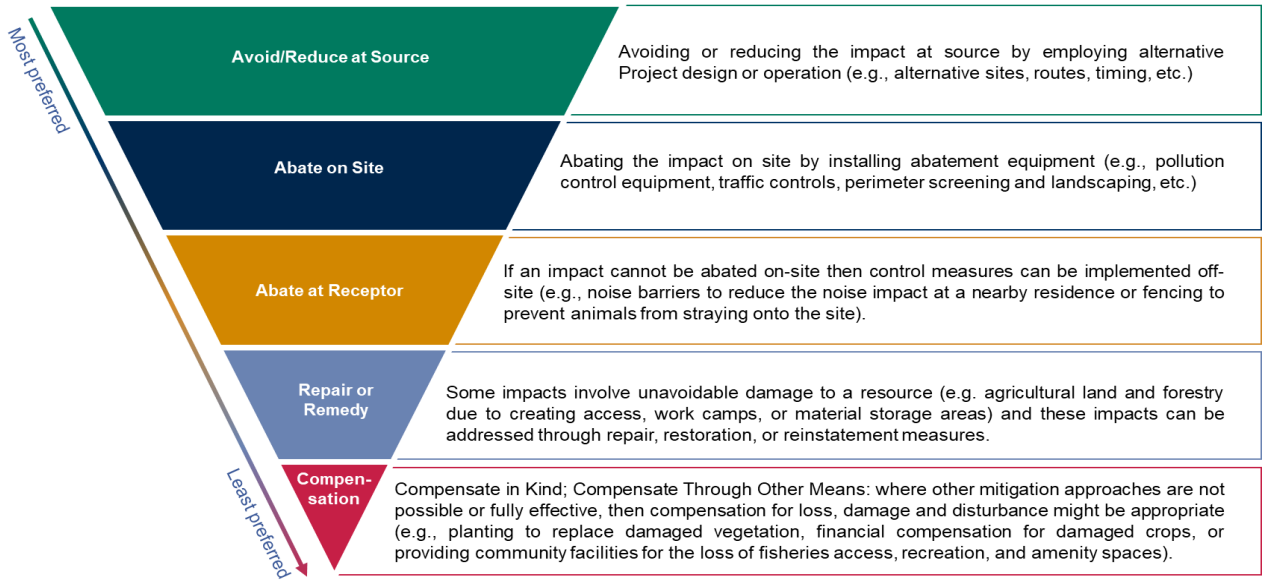
TABLE B-5 IMPACT SIGNIFICANCE RATING DEFINITIONS

Impact Rating	Rating Definition
High	The resource/receptor would likely experience a large magnitude impact that would endure for a long time, extend over a large area, exceed national/international standards, endangers public health and safety, threatens a species or habitat of national or international significance, and/or exceeds a community's resilience and ability to adapt to change. The Project may have difficulty in complying with the applicable ESF requirement, and significant mitigation would likely be required.
Substantial	The resource/receptor would experience a clearly evident change from baseline conditions and would approach but not exceed applicable standards. The Project would comply with the applicable ESF requirement, but mitigation would be required.
Moderate	The resource/receptor would experience a noticeable effect, but the magnitude of the impact is sufficiently small (with or without mitigation) that the overall effect would remain well within applicable standards. The Project would comply with the applicable ESF requirement, but mitigation may be required.
Low	The resource/receptor would either not be affected or the likely effect would be imperceptible or indistinguishable from natural background variation. The Project would comply with the applicable ESF requirement and mitigation would typically not be required.

B.2.3 MITIGATION IMPACTS

The next step in the process was the identification of measures that could be taken to mitigate, as far as reasonably practicable, the identified potential impacts of the Project in accordance with the requirements of the WB ESS-1. The development of mitigation measures followed the mitigation hierarchy of avoidance, minimization, mitigation to the extent feasible, and compensation or offsetting if necessary. Mitigation measures were developed to address the potential impacts identified in the ESIA process and reviewed with affected communities. These are outlined in **Figure *B-3***.

FIGURE B-3 HIERARCHY OF MITIGATION OPTIONS



B.2.4 DETERMINE RESIDUAL IMPACTS

The final step in the impact evaluation process was the assessment of residual impacts and risks. Residual impacts and risks are those that would remain after all relevant avoidance, minimization, and mitigation measures have been taken into consideration. In cases where a residual impact significance rating is **High** or **Substantial**, emphasis is applied to reduce the impact/risk to a level that is as low as reasonably practicable. This is typically done by revisiting Steps 1 and 2 in the process (Predict Impacts and Evaluate Impacts, respectively) to identify ways of reducing impact magnitude or by considering implementation of new or additional avoidance or minimization measures aimed at reducing impact significance.

Several other factors must also be taken into consideration that influence the overall Project risk and residual significance rating and affect the feasibility of successful implementation of proposed mitigation measures:

- The Project Proponent and most local construction contractors have limited experience in developing Projects of this magnitude to international standards.
- Normative context of Bhutan – specifically, the presence of prevailing norms that may complicate the implementation of mitigation measures (e.g. lack of a stringent health and safety culture, elevated threats of natural disasters, low access to basic services like waste management, safely managed water and sanitation, etc.).
- Organizational capacity – the organizational capacity of the Project Proponent and most local construction contractors in implementing proposed mitigation measures and successfully delivering a large, complicated Project to international standards in the event that the proposed mitigation measures are particularly arduous/demanding.
- Institutional capacity - the institutional capacity of the RGoB and its applicable ministries to provide construction monitoring and enforce its regulations and Project approval conditions.

To address these considerations, the residual significance rating for certain impacts can be adjusted where it is determined that the implementation of mitigation measures is particularly complex and/or track record of poor implementation in Bhutan. The areas in which this has been done will be clearly indicated and the reason for the final adjustment rating explicitly noted.

Where this occurs, the residual significance rating will be increased to a high significance/risk rating.

Although a standard goal of an impact assessment is to eliminate all significant residual impacts, for some resources/receptors there may be residual **High** or **Substantial** impacts/risks, even after all practicable mitigation options have been exhausted. In these situations, and especially where contextual and institutional/organizational risks apply, the ESIA may additionally recommend the specific measures such as requirement of third-party monitoring and auditing, institutional strengthening or organization capacity building.

B.2.5 CUMULATIVE IMPACT ASSESSMENT (CIA) PROCESS

As part of the impact assessment process, a CIA was conducted to determine the effect of the Project, in combination with other existing, planned, or proposed Projects and any external drivers, and provide an assessment of the likely significance of any cumulative impacts as detailed in ***Chapter 12***.

B.3 BASELINE DATA COLLECTION

A critical early step in the ESIA process involves collecting and assembling information to understand and characterize baseline condition of physical, biological, and social conditions within the project impact area. This information is gathered from a review of the available literature and secondary sources, as well as primary data collection through field surveys.

B3.1 LITERATURE REVIEW

A review of the publicly available secondary data online and secondary data collected from the site during the scoping site visit in July 2024 was used as the information for the baseline condition to understand and characterize condition of physical, biological, and social conditions within the Project impact area

The objective was to understand the baseline condition of physical environment, biodiversity and social-economic conditions. For the purpose of the desk-based assessment, the following documents have been reviewed:

- First Biennial Update Report to the UNFCC, 2022. National Environment Commission, Royal Government of Bhutan (2022);
- Third National communication to the UNFCC. Royal Government of Bhutan (2020);
- Chapter 5 of the Project for the Formulation of Southern Central Regional Plan (Ministry of Works and Human Settlement Bhutan and Japan International Cooperation Agency, 2021);
- Gelephu Flood Protection Project: ESIA Report (Invest International, 2023). CDR;
- Final Report: Social Assessment for Assessment of Flooding Hazards and Development of Climate-Resilient Flood Mitigation Measures in Shetekheri and Aiepoly (Big and Small) Streams (World Bank, 2018);
- Integrated Biodiversity Assessment Tool (IBAT) for Business;
- International Union for Conservation of Nature (IUCN) Red List for Threatened Species online version;
- Birdlife Data Zone;
- Global Biodiversity Information Facility (GBIF) and iNaturalist;

- World Database on Protected Areas;
- UNESCO World Heritage Site;
- Ramsar Convention on Wetlands;
- Biodiversity Monitoring and Social Surveying Protocol of Bhutan, 2020, Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu, Bhutan;
- Assessment of fish diversity in Bhutan: A systematic approach, 2018, Journal of Bhutan Studies;
- IFC Guidance Note (2019) of PS6 (2012). International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Royal Government of Bhutan. Forest and Nature Conservation Act 1995, Ministry of Agriculture and Forests, Royal Government of Bhutan;
- Bhutan Biodiversity User List, 2021, National Environment Commission, Royal Government of Bhutan;
- 2017 Population & Housing Census of Bhutan: Sarpang Dzongkhag (National Statistics Bureau and Royal Government of Bhutan, 2018);
- Statistical Yearbook of Bhutan 2022. (National Statistics Bureau, 2022);
- Bhutan Living Standard Survey (BLSS), 2022;
- National Land Use Zoning, A Baseline Report, 2023, Royal Government of Bhutan;
- Bhutan Vulnerability Baseline Assessment, 2016, Gross National Happiness Commission Secretariat, Bhutan;
- Labor Force Survey Quarterly Report, Second Quarter, 2024, National Statistical Bureau; and
- Articles and information available in the public domain on aspects such as irrigation, drinking water supply, livelihood patterns, land, local governance, and active NGOs in the area and government development plans for the study area.

B3.2 FIELD BASELINE STUDIES

In addition to the literature review, primary data collection was conducted via field surveys to collect Project-specific data and fill data gaps from the literature. ***Table B-6*** summarized the field baseline studies. The detail baseline methodology is described in ***Appendix C.***

TABLE B-6 FIELD BASELINE STUDIES SUMMARY

Impact	General Location	Sampling Studies	Date	Completed by
Surface Water	• Downstream, midstream and upstream of Mau River • Jengkhurung River • Taklai River	10 grab water samples were collected at 5 locations and tested for various physical and chemical parameters.	20-21 August 2024	Mitra S K Laboratory
Groundwater	• Gelephu Workshop • Gyalsung Site Tareythang	5 grab water samples were collected at 2 locations and tested for	20-21 August 2024	Mitra S K Laboratory

Impact	General Location	Sampling Studies	Date	Completed by
		various physical and chemical parameters.		
Soil	• Land next to National Center for Aquaculture • In the river channel of Mau River • Land next to Bhutan – India border checkpoint • Land in Gelephu Airport • Land in agriculture field in Umling Gewog • Land in agriculture field in Tareythang Gewog • Land in agriculture field in Tareythang Gewog	7 soil samples were collected to determine the heavy metal content and pesticide levels.	20 August 2024	Mitra S K Laboratory
Ambient Air Quality	• Gelephu Workshop • Gelephu Airport Runway • Tareythang Weather Station • Gelephu Town Park • Residence close to road alignments in Umling • Tareythang Gewog Center • Residence close to road alignments in Tareythang Gewog	Baseline ambient air quality monitoring was conducted at 7 locations for parameters including PM2.5, PM10, SO_2, NO_x and NO_2.	24-25 August 2024 for SO_2, NO_x and NO_2 14 August - 20 September 2024 for PM2.5 and PM10.	Department of Energy and Climate Change Gradko International Ltd
Ambient Noise		Baseline noise sampling was conducted at 7 locations to measure ambient noise levels using sound level meters over a period of 48 hours.	14 - 20 September 2024	Department of Energy and Climate Change
Terrestrial Biodiversity	Bhutan is divided into 2424 grids of 4x4 km, called Biodiversity Monitoring Grids (BMG). The survey area includes the road alignment and its buffer of 750m towards both sides of the road.	• Flora • Bird • Herpetofauna • Large and Medium size mammals • Mammals	12 July - 29 August 2024	Department of Forestry and Park Services

Impact	General Location	Sampling Studies	Date	Completed by
Aquatic Biodiversity	• Upstream Mau River • Along Taklai River • Upstream Taklai River	• Fish • Macroinvertebrate • Water Quality	05 - 08 August 2024	College of Natural Resources

B.4 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

An overarching ESMP was prepared that includes all the mitigation measures included in the ESIA and the procedures for the short and long-term environmental management of the Project. The ESMP identifies the phase of the Project when the mitigation will be applied, the entity responsible for implementing the mitigation measure, and monitoring requirements.

Project Impact Area

The Project impact area is defined as the area that may be affected by a Project's direct, indirect, and cumulative impacts resulting from Project construction and operation activities, and also represents the Project study area. This is described in ***Table B-7*** below.

Direct Impact Area – includes all areas of direct impact, which are those areas located within the project's footprint or area of disturbance, as well as those villages and households directly affected by project construction and operation, as well as the area within which ecosystem services could be affected. Project DIA is shown in ***Table B-7*** and ***Figure B-4***.

Indirect Impact Area –includes the areas within the one Thromde and three Gewogs: Gelephu Thromde (Area affected: Namkhaling Demkhong), Umling Gewog, Chhuzanggang Gewog, and Tareythang Gewog which total approximately 31.41 km^2. These areas will have indirect impacts related to the projects from the ongoing construction and the operations of the project that could extend outside the direct impact areas. The indirect impacts expected are mostly related to the changes in social dynamic, changes to hydrology and biodiversity. Project indirect Impact Area is shown in ***Figure B-5***.

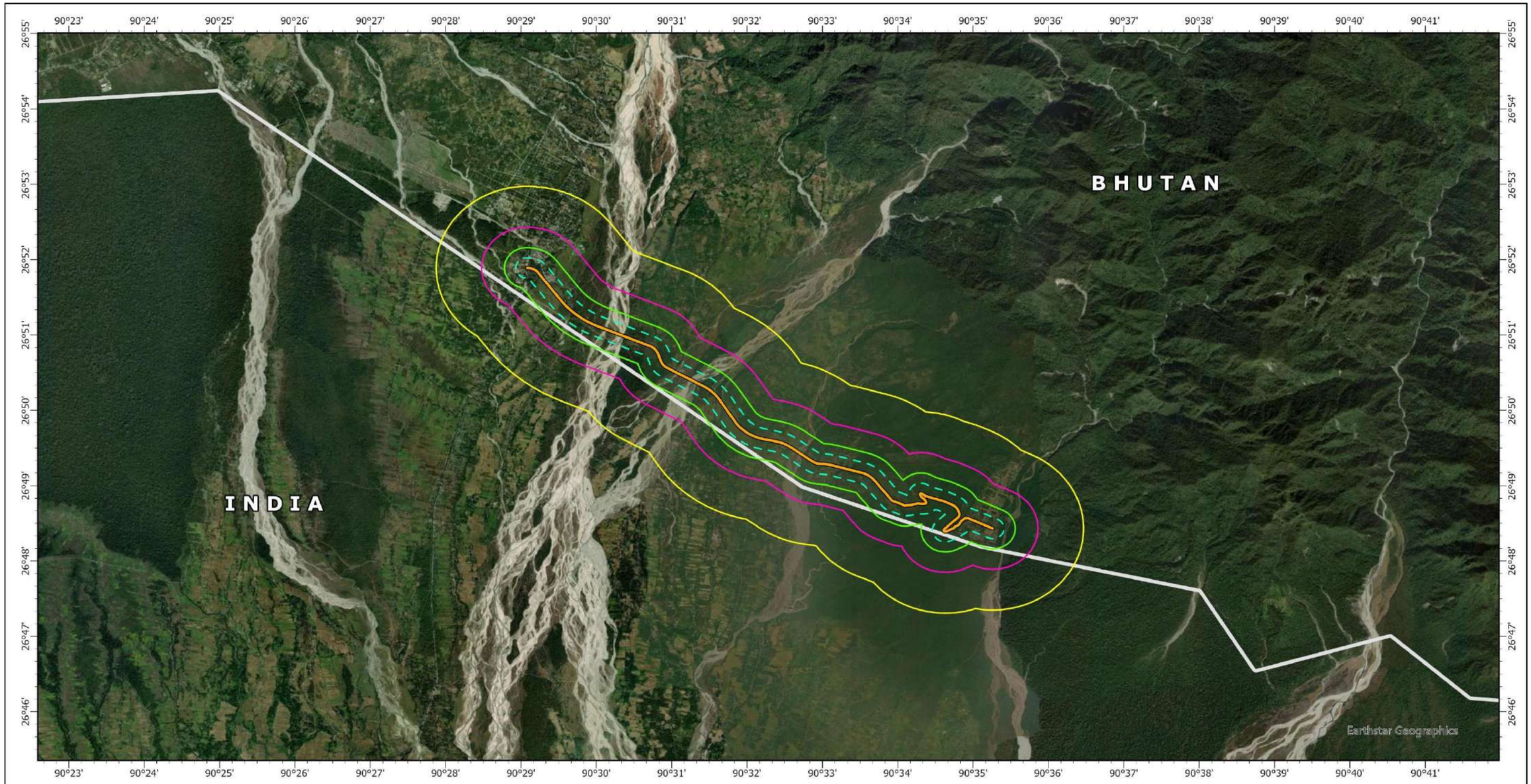
Cumulative Impact Assessment Area – includes the area to be directly affected by the Project activities (the DIA) and the wider area within which the Valued Environmental and Social Components (VECs) may be indirectly affected. The CIA Area is detailed in ***Chapter 15***.

TABLE B-7 PROJECT IMPACT AREA

Project activities	Source of Impact	Direct Impact Area
Site preparation/Land clearing & Earthworks (Cutting and Filling)	Air emission including dust and gaseous exhausts	Within 250 m from the Project's boundary
	Topsoil removal	Within the Project footprint
	Surface runoff	Within 1 km from the Project's boundary
	Generation of noise from equipment and machinery	Within 500 m from the Project's boundary
	Vibration from construction	Within 250 m from the Project's boundary
	Loss of terrestrial habitat and species	Within the Project's footprint
	Increased number of vehicles on roadways	Transportation roadways
Construction of temporary ancillary facilities, Road and Bridge Construction (including river training, retaining walls, culverts / drainage and foundations)	Air emission including dust and gaseous exhausts	Within 250 m from the Project's boundary
	Vibration from construction	Within 250 m from the Project's boundary
	Surface runoff	Within 1 km from the Project's boundary
	Generation of noise from equipment and machinery	Within 500 m from the Project's boundary
Procurement of material and operation of borrow pits	Air emission including dust and gaseous exhausts	Within 250 m from the access roads
	Increased number of vehicles on roadways	Transportation roadways
	Accidental introduction of invasive species	Within the Project's boundary[1]
Wastewater and solid waste generation	Generation of construction and domestic wastewater and solid waste	Within 1 km from the Project's boundary
Worker Influx, Activities, and Management and Operations	Social	Within 2 km from the Project's boundary
Road Operation and Maintenance	Air Emissions	Within 250 m from the Project's boundary
	Noise Emissions	Within 500 m from the Project's boundary

[1] Initially, but if established may spread to a wider area.

FIGURE B-4 DIRECT IMPACT AREA



Legend

- Preferred Road Alignment
- 2 km Radius (Social)
- 1 km Radius (Surface Runoff, Wastewater and Solid Waste)
- 500 m Radius (Noise)
- 250 m Radius (Air & Vibration)

Administrative Boundary

- Country

0 1.6 3.2 km

N

Scale: 1:100,000

Coordinate System: GCS WGS 1984

Service Credit: Esri, NASA, NGA, USGS, Esri, © OpenStreetMap contributors, TomTom, Garmin, Foursquare, METI/NASA, USGS

Project Direct Impact Area

0737107 GMC ESIA Road and Bridges

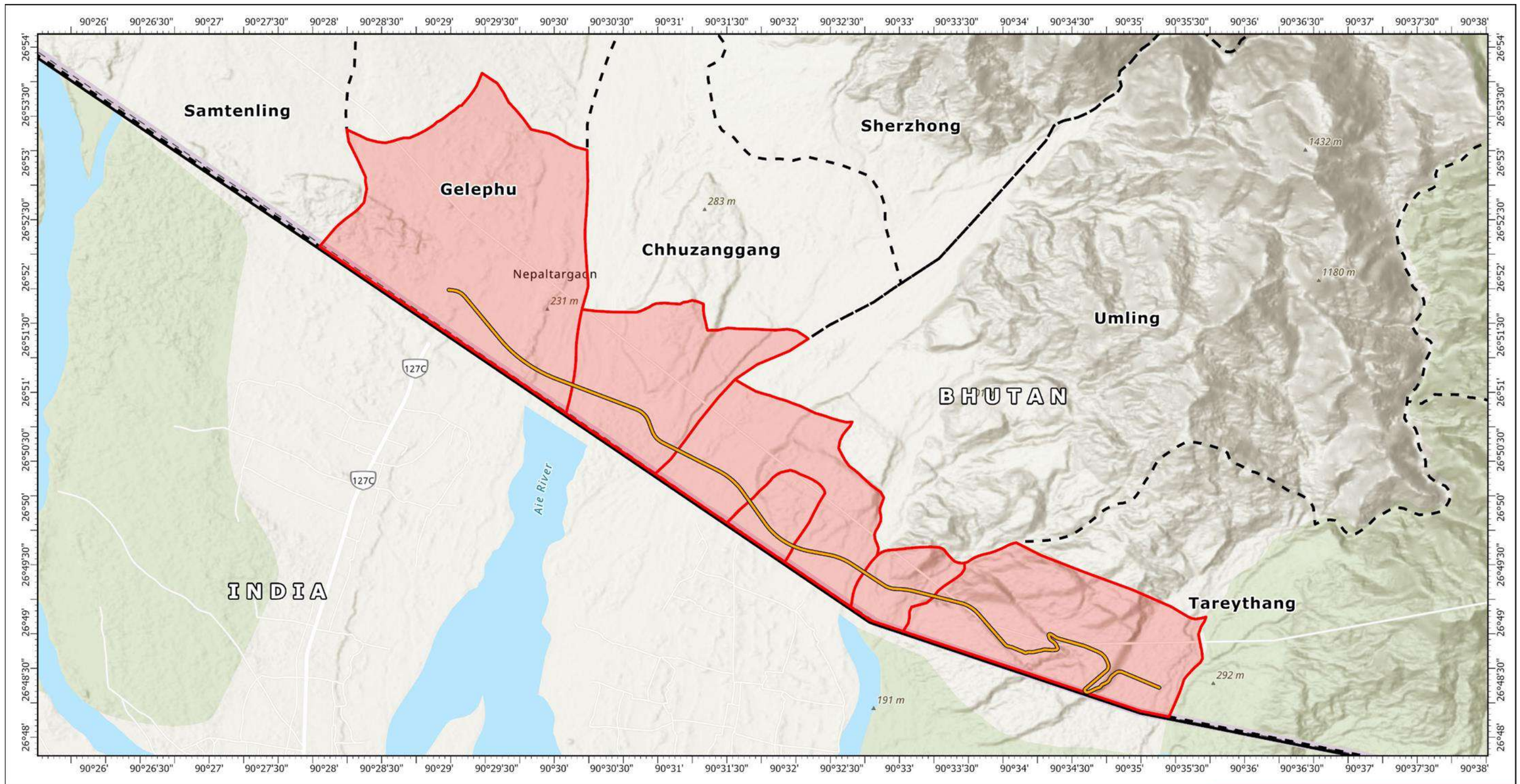
Date: 18/10/2024

Drawn By: NS

Review By: DJ

ERM

FIGURE B-5 INDIRECT IMPACT AREA



Legend

- Preferred Road Alignment
- Project Indirect Impact Area

Administrative Boundary

- Gewog
- Country

0 1.1 2.1 km

N

Scale: 1:65,000

Coordinate System: GCS WGS 1984

Service Credit: Esri, NASA, NGA, USGS, Esri, © OpenStreetMap contributors, TomTom, Garmin, Foursquare, METI/NASA, USGS

Project Indirect Impact Area

0737107 GMC ESIA Road and Bridges

Date: 25/11/2024

Drawn By: NS

Review By: DJ

ERM

B.5 SCOPING

A preliminary Scoping Report was prepared based on ERM's professional judgement, as there was limited information provided at the time of writing. Since the report was submitted, ERM has revisited and updated the impacts that are likely to result in significant impacts as additional information has been gathered.

Potential impacts are identified through a systematic process whereby the features and activities (both planned and unplanned) associated with the pre-construction, construction, operation and decommissioning of the Project have been considered with respect to their potential to interact with resources/receptors.

A scoping matrix is used as the tool for identifying the various Project features and activities within the Impact Areas that could reasonably act as a source of potentially significant impact. Each resulting cell on the scoping matrix thus represents a potential interaction between a Project activity and an E&S resource/receptor.

The Project activities presented in ***Chapter 2***, have been listed down the vertical axis of the matrix. The resources/receptors relevant to the baseline environment are listed across the horizontal axis of the matrix. The emergency events against the risks and impacts to the resources/receptors are also included in the scoping matrix. The 'scoped in' or 'scoped out' of risks and impacts are classified in the matrix with color coding described in ***Table B-8***.

TABLE B-8 SCOPING MATRIX DEFINITIONS

	Key
	Scoped in - Potentially significant impact requiring further assessment
	Scoped out - Potential interaction unlikely to be significant
	Positive impacts - An interaction with positive impact expected
	An interaction is not reasonably expected

The completed scoping matrix is presented in ***Table B-9***. A summary of the interactions that were assessed to be possibly significantly are **scoped in** and shall are assessed at the ESIA stage.

Interactions that were assessed to have possibly insignificant impacts on the environmental and social receptors that are **scoped out** and shall not be further assessed at the ESIA stage as existing control measures were considered sufficient to deem the impacts insignificant. The scoped-out rationale are included in ***Table B-12***.

TABLE B-9 SCOPING MATRIX

No.	Activity	Environmental and Social Resource/Receptor																				
		Physical								Biodiversity			Social									
		Air Quality	Waste	Noise/Vibration	Greenhouse Gas Emission	Surface Water and Quality Hydrology	Ground Water	Sediment/Soil	Traffic	Protected Areas	Aquatic Flora and Fauna	Terrestrial Flora and Fauna	Land Use and Livelihoods	Visual and Landscape	Cultural Heritage	Community Health, Safety and Security	Labour and Working Conditions	Indigenous Peoples	Vulnerable groups	Community Service / Infrastructure	Employment and Local Economy	Community Forests
1	**Pre-Construction Phase**																					
1.1	Land acquisition for right-of-Way (RoW)												■		■			■	■			■
2	**Construction Phase**																					
2.1	Construction of temporary ancillary facilities	■	■	■	■	■	■	■	■		■	■	■	■		■	■		■			■
2.2	Worker mobilization/influx		■	■	■				■	■		■				■			■	■	■	■
2.3	Procurement of material and operation of borrow pits	■	■	■	■	■			■		■	■				■	■					
2.4	Site preparation/Land clearing	■	■	■	■	■	■	■	■		■	■		■	■	■	■		■			■
2.5	Earthworks (Cutting and Filling)	■	■	■	■	■	■	■	■		■	■		■	■	■	■		■			
2.6	Road construction & retaining walls	■	■	■	■		■	■	■			■		■	■	■	■		■			
2.7	Construction of river training works	■	■	■	■	■	■	■	■		■	■				■	■					
2.8	Construction of bridges, including foundations, piers / abutments, and superstructures	■	■	■	■	■	■	■	■		■	■		■	■	■	■		■			
2.9	Construction of culverts / drainage and water management structures	■	■	■	■	■	■	■	■		■	■		■	■	■	■					
3	**Operation and Maintenance Phase**																					
3.1	Road Operation and Maintenance	■		■	■				■			■		■		■	■			■	■	■

B.5.1 KEY ENVIRONMENTAL AND SOCIAL IMPACTS SUMMARY

The key impacts that will be included in the ESIA are summarized in ***Table B-10*** below.

TABLE B-10 KEY IMPACTS TO BE INCLUDED IN ESIA

ESS	Key Environmental Impacts	Key Social Impacts
ESS-1 Assessment and Management of Environmental and Social Risks and Impacts	Air Quality Noise and Vibration Surface Water, Groundwater and Hydrology Soil Quality and land use Physical environment including terrain / Topography, geology, seismicity and climate Waste management Cultural Heritage	Community Health and Safety Socioeconomic Conditions Community Engagement and Stakeholder Consultation Land Acquisition and Resettlement Cultural and Social Dynamics Access to Services and Resources Gender Impacts
ESS-2 Labor and Working Conditions	NA	Labor influx Potential health risks and risks related to gender-based violence (GBV) Occupational Health and Safety (OHS) Risk
ESS-3 Resource Efficiency and Pollution Prevention and Management	Erosion and Sedimentation Riverbed Erosion Wastewater Discharges management Air and Noise Pollution control Greenhouse Gas (GHG) Emissions Spoils Generation Construction Waste management Downstream Water Flows	NA
ESS-4 Community Health and Safety	Landslide Risks Safety Hazards from construction Human-Wildlife Conflicts	Public heath and safety impacts
ESS-5 Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Land Acquisition and Resettlement Impact on Community Forests	Involuntary Resettlement Loss of Livelihoods Cultural Disruption Inadequate Compensation Impacts on vulnerable Groups
ESS-6 Biodiversity Conservation and Sustainable	Critical Habitat Assessment Impact on Aquatic Habitats Impact on Royal Manas National Park	NA

ESS	Key Environmental Impacts	Key Social Impacts
Management of Living Natural Resources	Elephant Movements Forest Clearing and Terrestrial Habitat Loss	
ESS-7 Indigenous Peoples	NA	NA
ESS-8 Cultural Heritage	NA	Protection of Cultural Heritage Community engagement
ESS-9 Financial Intermediaries	NA	NA
ESS-10 Stakeholder Engagement and Information Disclosure	NA	NA

B.5.2 CLIMATE RISK INTERACTIONS

The ESIA will address the potential exposure of the Project's infrastructure to floods and landslides, risks that are expected to intensify due to climate change. The engineering team has proactively incorporated design considerations to enhance the resilience of the infrastructure against future climate scenarios. This section of the ESIA will detail the specific design choices made to reduce the vulnerability of the infrastructure. Additionally, a comprehensive physical risk review will be conducted, focusing on the impact of extreme weather events on the asset.

B.5.3 UNPLANNED EVENTS INTERACTIONS

The scoping process for unplanned events includes identifying the most likely unplanned events leading to environmental, social and/or community health impacts including accidental leaks, road accidents and fire and explosion as detailed in ***Table B-11***.

TABLE B-11 SCOPING REVIEW OF UNPLANNED EVENT INTERACTIONS

Risks	Receptors	Description	Scoping
Accidental leaks and spills in construction phase	Surface water, soil, and groundwater Community health and safety	Oil, lubricants, bitumen, paints or other hazardous material spills and chemical leak to unpaved areas could potentially seep into the soil or make its way to nearby surface water. However, as the infrastructure construction will be phased, the amount of hazardous materials present at any time on site is expected only to generate a negligible, temporary localized impacts that can be promptly remediated through standard hazardous materials	In

Risks	Receptors	Description	Scoping
		handling practices. Therefore, this unplanned event is scoped out from the ESIA	
Hazardous / Chemical waste released to environment	Surface water, soil, and groundwater Community health and safety Terrestrial Flora and Fauna	Improper hazardous / Chemical waste disposal may result in contamination of water and possibly result in disruption of ecosystem. It may contaminate drinking water and may cause air quality issues.	In
Road accidents in construction and operation phases	Surface water, seawater, soil, and groundwater Terrestrial Fauna Community Health and Safety	The rise in road traffic volume during construction and operation amplifies the potential risk of traffic accidents, leading to the risk of mortality of terrestrial fauna and community health and safety. This impact will be discussed in detail in the ESIA.	In
Fire and explosion	Community health and safety Terrestrial Flora and Fauna	The storage of fuel for machinery and bitumen for road pavement may elevate the risk of accidental fire. However, given that the construction sites and storage areas will be dispersed along the length of the road, it is unlikely that fuel will be stored in quantities large enough to pose a significant explosion hazard. Adhering to good international industry practices for fire prevention and response will effectively reduce the fire risk to a negligible level. As a result, this potential impact is scoped out from the ESIA.	Out
Fall and slips in construction site	Community health and safety	Constructing elevated bridges involves working at heights, which carries a risk of falls. Additionally, construction debris on the ground can increase the likelihood of slipping accidents.	In
Struck by moving machinery in construction site	Community health and safety Terrestrial Fauna	Large and movable construction machinery will be used throughout construction period, this will potentially lead to being struck by moving machinery.	In

B.5.4 SCOPED-OUT RISKS AND IMPACTS

All the issues that are marked as "white" in ***Table B-9*** (i.e. an interaction is not reasonably expected) will be all scoped-out from the impact assessment and will not be further assessed during the subsequent ESIA and ESMP. These interactions that were assessed to have possibly insignificant impacts on the environmental and social receptors are presented in ***Table B-12.***

Furthermore, this section provides rationale for scoping out of the potential E&S issues that were marked "grey" (where an interaction is reasonably possible but is unlikely to be significant), where issues are proposed to be scoped out as the likelihood of the interactions leading to significant effects is considered low. Such E&S issues will also not be assessed during the

subsequent ESIA. The rationale for such scoping out is provided broadly against the E&S receptor/ resource.

TABLE B-12 SCOPED-OUT RATIONALE

No.	Receptor/ Resource	Project Activity	Rationale to Scope Out
1.	**Physical Environment**		
1.1	Air Quality	**Construction Phase** • Construction of river training works • Construction of culverts / drainage and water management structures	The dust emissions generated during river training work and the construction of culverts are expected to be negligible. This is due to the relatively wet environment and the coarse granularity of riverbed sediments and soil on the riverbanks, which are less prone to suspension by wind.
1.2	Waste	**Construction Phase** • Construction of temporary ancillary facilities • Road construction & retaining walls • Construction of river training works • Construction of bridges, including foundations, piers / abutments, and superstructures • Construction of culverts / drainage and water management structures	These construction activities are not likely to generate significant waste because materials are expected to be procured locally from the riverbed. Additionally, the use of prefabricated components in bridge and culvert construction further minimizes excess material. Temporary structures like formwork are commonly reusable or recyclable, contributing to overall waste reduction.
1.3	Noise/Vibration	**Construction Phase** • Worker mobilization/influx	Generation of noise from presence of workers is expected to be negligible in comparison to the machineries used in the construction phase. Potential nuisance from the presence of workers and in the vicinity of their accommodation will be discussed in the Community Health, Safety and Security section of the ESIA.
1.4	Greenhouse Gas Emission	**Construction Phase** • Worker mobilization/influx	Presence of workers is expected to have a negligible impact on greenhouse gas emissions as associated mainly to the generation of energy at their accommodation.

1.5	Surface Water Quality and Flow	**Construction Phase** • Construction of temporary ancillary facilities	Temporary facilities are expected to have a small footprint compared to the rest of the infrastructure and will have limited interaction with surface water.
1.6	Hydrology and Ground Water	**Construction Phase** • Construction of temporary ancillary facilities • Site preparation/Land clearing • Earthworks (Cutting and Filling) • Road construction & retaining walls	Those mostly terrestrial operations are unlikely to have any significant interaction with the area's hydrology. The right of way is negligible compared to the effects that the construction of the bridges will have on the rivers. Temporary facilities are expected to have a small footprint compared to the rest of the infrastructure. Given the depth of the groundwater table, it is unlikely that any of these activities will affect this receptor.
1.7	Sediment/soil	**Construction Phase** • Construction of temporary ancillary facilities	Temporary facilities are expected to have a small footprint compared to the rest of the infrastructure and the areas occupied will be rehabilitated upon completion of construction.
1.8	Traffic	**Construction Phase** • Construction of temporary ancillary facilities	The construction of such facilities will be very short and unlikely to affect the traffic on the existing road network.
2.	Biodiversity		
2.1	Protected Areas	**Construction Phase** • Worker mobilization/influx	The presence of workers on the construction site could increase the risk of poaching wild fauna and collecting flora in the forest. However, the road alignment does not intersect with any Protected Areas. Although the section of the road near Tareythang is relatively close to the Royal Manas National Park, access for workers will be restricted by the Tareythang Center, which is equipped with a permanently guarded post.
2.2	Aquatic Flora and Fauna	**Construction Phase** • Construction of temporary ancillary facilities	It is expected that temporary facilities will be installed outside the riverbed and have limited interaction with the aquatic habitat.

2.3	Terrestrial Flora and Fauna	**Construction Phase** • Worker mobilization/influx • Construction of river training works	The potential for poaching due to the presence of workers on site is expected to have a negligible impact on local flora and fauna, as the Project predominantly traverses agricultural land and plantations (i.e., Modified Habitats) where human activity already significantly influences the ecosystem. Works conducted mainly on the riverbed is unlikely to generate a significant impact on the terrestrial flora and fauna.
3.	Social		
3.1	Land Use and Livelihoods	NA	NA
3.2	Visual and Landscape	**Construction Phase** • Construction of temporary ancillary facilities Site preparation/Land clearing • Earthworks (Cutting and Filling) • Road construction & retaining walls • Construction of bridges, including foundations, piers / abutments, and superstructures • Construction of culverts / drainage and water management structures **Operation and Maintenance Phase** • Road Operation and Maintenance	All construction activities will be temporary and are expected to have a negligible effect on the landscape and visual amenity. The road will largely be concealed by existing vegetation and will traverse rural areas with low population density. No major tourist attractions or significant landscape features are anticipated to be impacted by the road. The visual impact of the bridge is also expected to be minimal. The main crossing over the Mau River is being carefully designed by both the engineering and architectural teams to blend with the landscape and traditional architectural elements of Bhutan to potentially become a landmark for Gelephu. As there are limited receptors the visual impact assessment is not included in the scope of work.
3.3	Cultural Heritage	**Construction Phase** • Construction of bridges, including foundations, piers / abutments, and superstructures	The riverbed is subject to strong flow during the wet season and high sediment flow. In such harsh condition, it is unlikely that the riverbed may host significant findings of cultural heritage significance.

3.4	Indigenous People	NA	NA
3.5	Vulnerable groups	**Construction Phase** • Construction of temporary ancillary facilities • Worker mobilization/influx • Site preparation/Land clearing • Earthworks (Cutting and Filling) • Road construction & retaining walls • Construction of bridges, including foundations, piers / abutments, and superstructures	The construction of the road and bridges may affect vulnerable populations. However, the specific individuals and groups at risk will be identified during the Pre-Construction Phase, particularly during land acquisition for the road's Right-of-Way. Prior to the commencement of construction, impacts and mitigation measures, including the preparation and implementation of a Resettlement Action Plan, will be established to address and manage these effects.
3.6	Community Service Infrastructure / Social Infrastructure	NA	NA
3.7	Employment and Local Economy	NA	NA
3.8	Community Forests	**Construction Phase** • Construction of temporary ancillary facilities • Site preparation/Land clearing	Temporary ancillary facilities will be located outside community forests. Land clearing in community forests is expected to be negligible and managed during the Land acquisition for Right-of-Way activity.

APPENDIX C ENVIRONMENTAL BASELINE METHODOLOGY

C ENVIRONMENTAL BASELINE METHODOLOGY

C.1 PHYSICAL ENVIRONMENT

C.1.1 TOPOGRAPHY OF BHUTAN

Bhutan is a landlocked country situated in the eastern Himalayas and the border is defined by rugged terrain including high mountains, valleys and rivers. The country shares boundaries with China to the north and India to the south, east, and west.

Bhutan's topography shaped by its location in the eastern Himalayas that ranges from deep valleys to towering mountains. The country's mountain systems are part of the greater Himalayan range, which extends across Nepal, India, and Bhutan, and are divided into several distinct ranges.

The Northern Bhutan is dominated by the Greater Himalayas, which lies along the Tibetan border, with several notable high peaks such as Gangkhar Peunsum and Jomolhari, ranged from 7,000 meters and above. The glaciers from the northern side of Bhutan feed Bhutan's river systems.

The Black Mountains at central Bhutan divides the eastern and western Bhutan with peaks ranged from 1,500 to 5,000 meters with dense forest area with rich biodiversity.

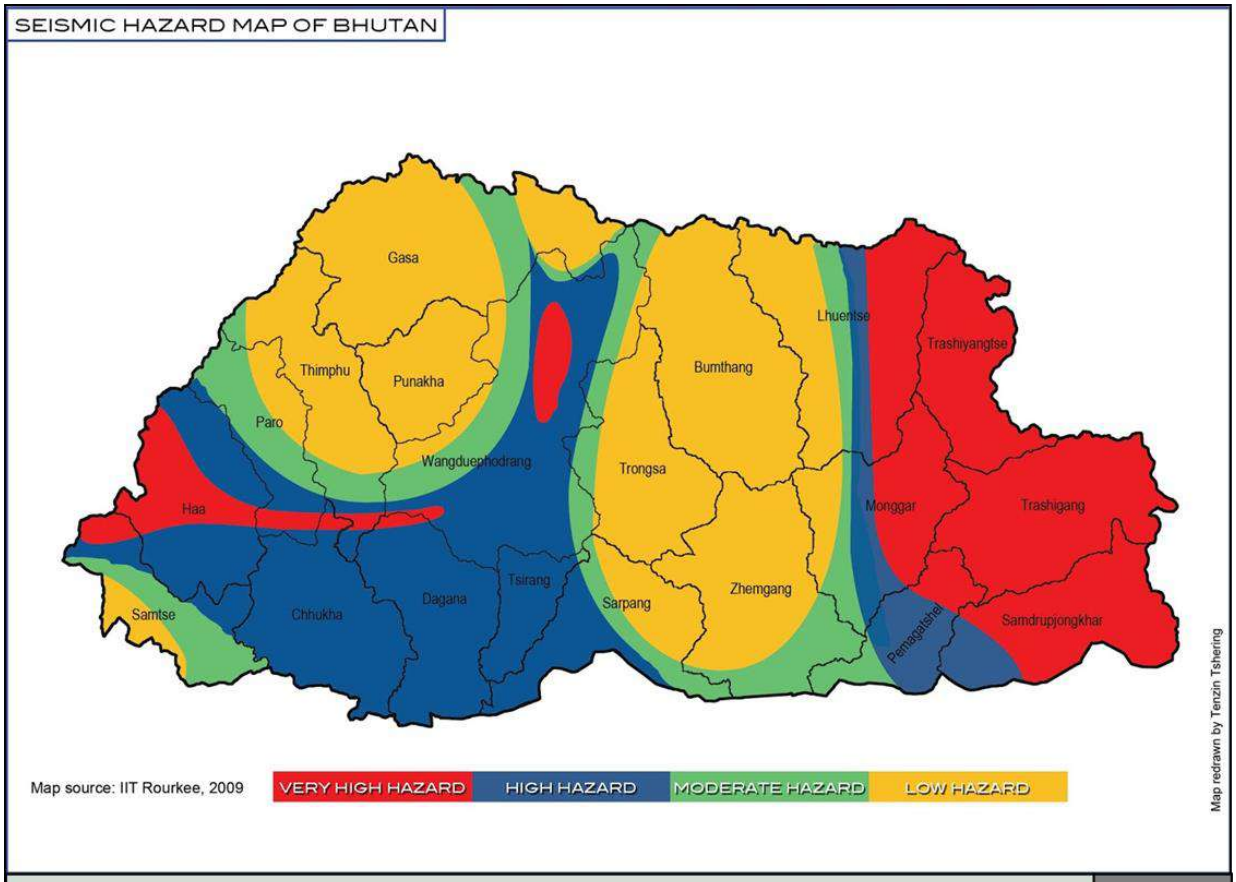
C.1.1 SEISMICITY OF BHUTAN

According to the Indian Regional Seismo-tectonic Zonation Map, Bhutan falls within Zone V, indicating a very high seismic risk. As shown in Figure C-1, the Rourkee Map classifies the west portion of Sarpang as having a high seismic hazard, including part of Gelephu.[2] The estimated seismic hazard levels for northeast India and Bhutan are fell into zone VI based on 1964 MSK Intensity Scale for earthquake ground shaking. The latest map shows Bhutan lies in Seismic Zone VI, which has a PGA of 0.50g and 0.75g for a return periods of 475 and 2,475 years respectively.[3]

[2] IIT Rourkee. (2009). State of Bhutan's hydropower projects.
https://yesheydorji.blogspot.com/2017/06/state-of-bhutans-hydropower-projects.html

[3] Draft Indian Standard Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions [Seventh Revision of IS 1893 (Part 1)] (ICS No. 91.120.25).
https://www.services.bis.gov.in/tmp/WCCED21022343_26042023_2.pdf

FIGURE C-1 SEISMIC HAZARD RISK MAP OF BHUTAN



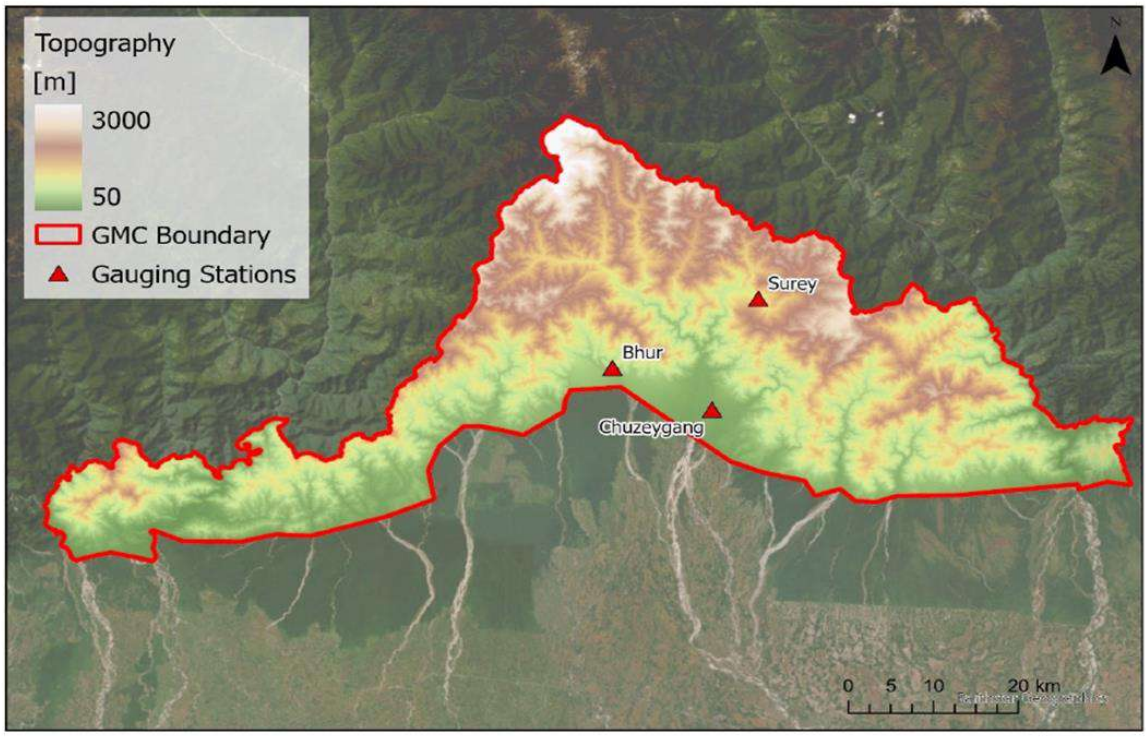
Seismic Hazard Risk Map of Bhutan		
0750493 Gelephu-Tareythang Road Project		ERM
Figure Source: IIT Rourkee (2009)	Date: September 2024	

C.1.2 CLIMATE

The climate of Bhutan varies significantly according to latitude and altitude. The country has three distinct climatic zones: subtropical, alpine and temperate, which encompass numerous micro-climates due to dramatic variations in elevation and topography.[4] Two main factors causing climatic variation of mean temperature and precipitation are the vast differences in altitude in the country and the influence of the North Indian monsoons. The rain gauging stations location is indicated in ***Figure C-2***.

[4] National Center for Hydrology and Meteorology. (2019). Analysis of Historical Climate and Climate Projection for Bhutan

FIGURE C-2 ELEVATION MAP INDICATING THE DIFFERENT RAIN GAUGING STATIONS



Elevation Map Indicating the Different Rain Gauging Stations		
0750493 Gelephu-Tareythang Road Project		ERM
Figure Source: CDR (2024)	Date: October 2024	

C.2 WATER RESOURCES AND HYDROLOGY

Most major rivers in Bhutan originate from glaciers and are replenished by watershed sources. The river system is characterized by main rivers flowing north to south from the Himalayas, with tributaries moving in an east-west direction. They typically feature steep gradients and narrow, steep-sided valleys that occasionally widen to create small, flat areas suitable for cultivation. Short rain-fed tributaries descend steeply from the east or west to join the major rivers.

The distinct rainy and dry seasons in Bhutan cause significant seasonal variations in river flows. During the monsoon season, rivers carry large volumes of water and often high sediment loads. Conversely, flow levels are relatively low during the dry season due to reduced rainfall and the limited presence of major groundwater reservoirs.

Bhutan has four major river systems: the Drangme Chhu (or Manas River System), the Punatsang Chhu (Sankosh River System), the Wang Chhu (Raidak River System), and the Amo Chhu (Torsa River System).

C.3 WATER QUALITY

C3.1 SURFACE WATER QUALITY

The baseline data for surface water quality assessment was done based on the parameters given in Baseline sampling plan. Five Surface water (n=10) sampling sites have been chosen for the investigation based on the physiographical condition. The selection of sites was done considering the location of different Project components, junction of streams course, spots of high-water velocity and some of the stagnated pools along with the areas having human interference. Both sites were targeted based on availability of human activities.

Surface water sampling was conducted on 20-21 August 2024 at five (05) sites, conducted by Mitra S K Laboratory (***Figure C-3***). A total of ten (10) grab water samples were collected and tested for various physical and chemical parameters, as well as microbiological, and radioactivity. The sampling water was analyzed by an accredited laboratory (Mitra S K Laboratory) and the results were compared to the Ambient Water Quality Criteria, Environmental Standards, 2020[5] and Guidelines for Drinking-Water Quality 4th edition[6].

For carrying out the Compliance Monitoring and assessing its conformance to the regulation the standard for the Environmental Commodity following specified national and international standard used in this study which are the Indian Standard Specifications for Surface Water Quality Standards (as per IS:2296) for Surface water.

[5] National Environment Commission Royal Government of Bhutan, June 2020.
[6] World Health Organization, 2022.