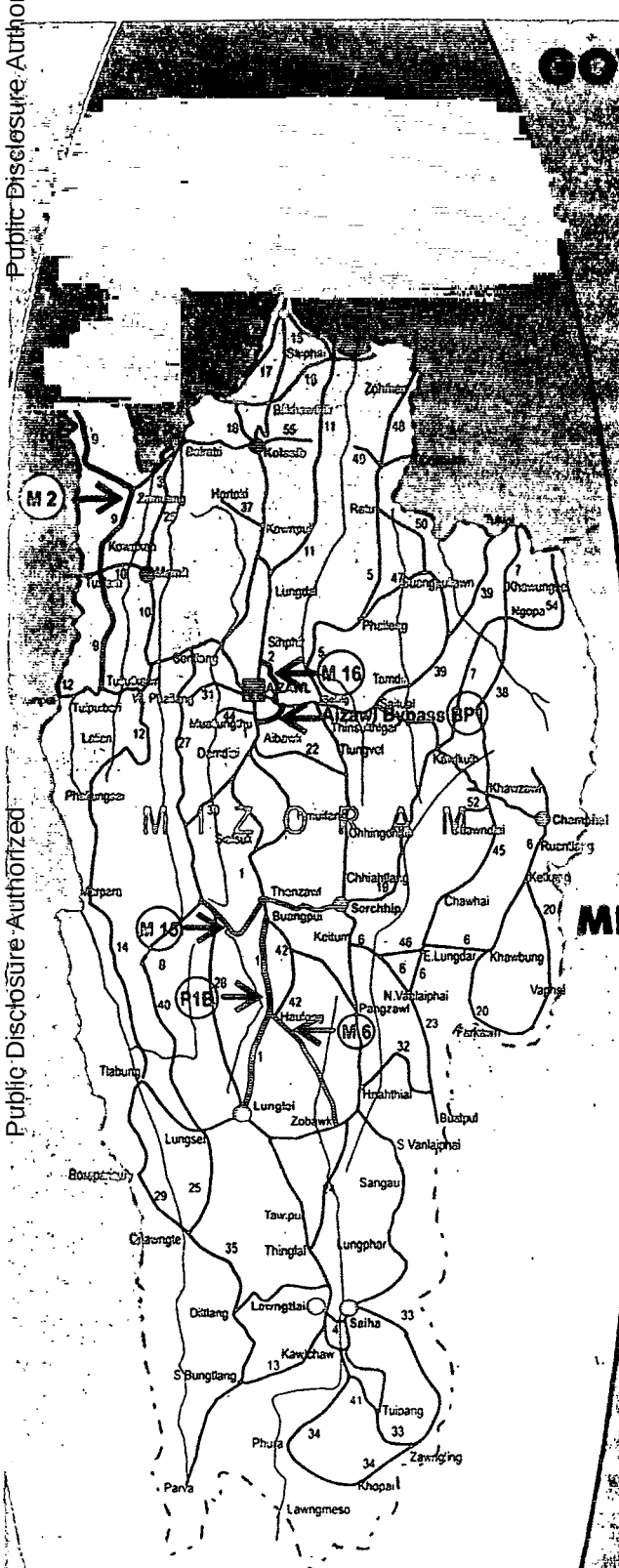
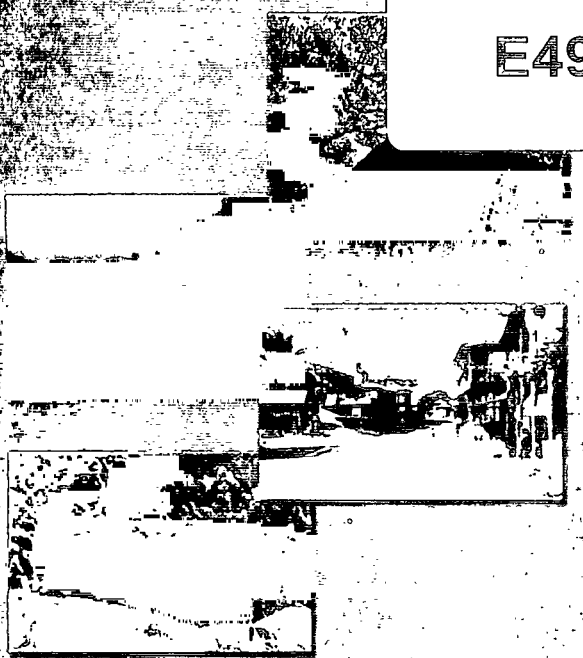
GOVERNMENT OF MIZORAM
Public Works Department





MIZORAM STATE ROADS PROJECT
(PHASE-II)

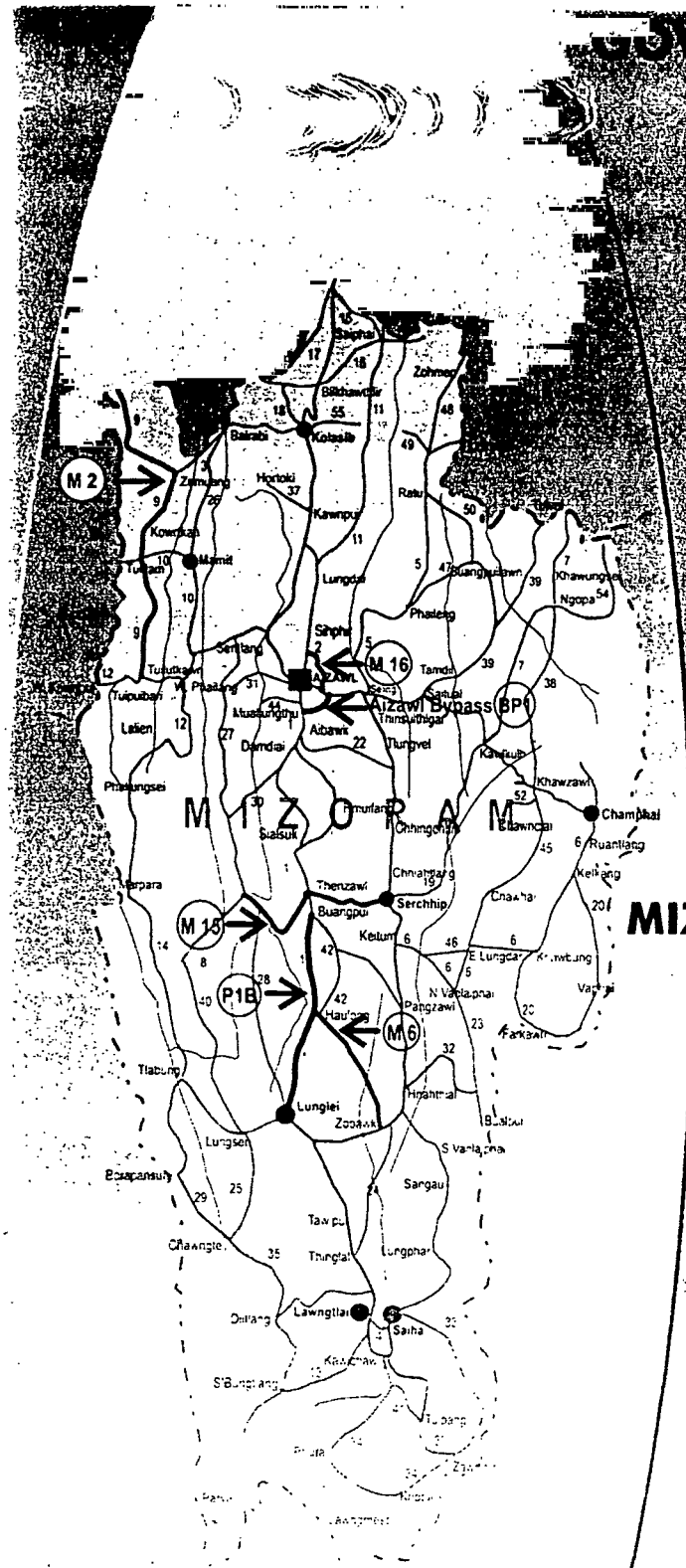
Environmental Impact Assessment
for Buangpui-Lunglei Section P1B

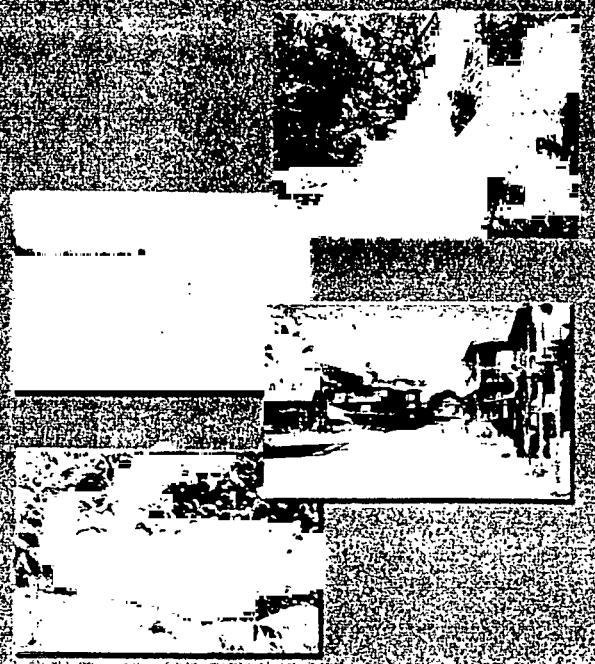
June 2003

LEA Associates South Asia Pvt. Ltd.
New Delhi

GOVERNMENT OF MIZORAM

Public Works Department





MIZORAM STATE ROADS PROJECT (PHASE-II)

Environmental Impact Assessment for Buangpui-Lunglei Section P1B

June 2003

LEA Associates South Asia Pvt. Ltd.
New Delhi

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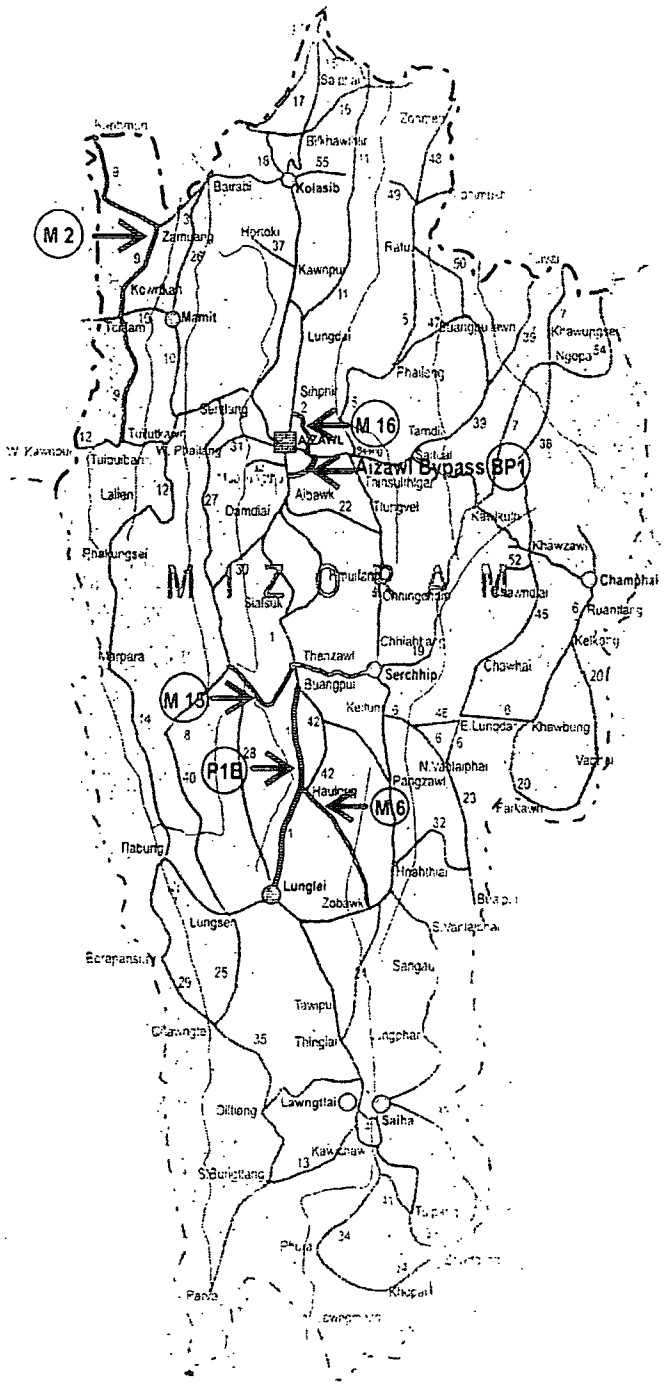


1. Introduction

1. INTRODUCTION

1.1. OVERVIEW

The Mizoram State Roads Project (MSRP) is being prepared and implemented by the Mizoram Public Works Department (MPWD) with World Bank (WB) assistance. Phase I of the project is under construction following appraisal by the Bank in 2002. The project preparation for Phase II is underway since late 2001. A consortium[1], acting as Project Co-ordinating Consultants (PCC), is assisting the MPWD during project preparation. Their inputs will continue (in limited capacities) throughout the project duration. In addition, MPWD will also hire the services of a Construction Supervision Consultant as the Engineer for the implementation along similar lines as Phase I. Like all Category 'A' transport projects funded by the World Bank, MSRP is subject to an Independent Environmental Review[2]. This Environmental Impact Assessment and its companion reports, covering the activities to be carried out in Phase II, have been scrutinized during the IER. These reports are now updated addressing the observations made during the Review.

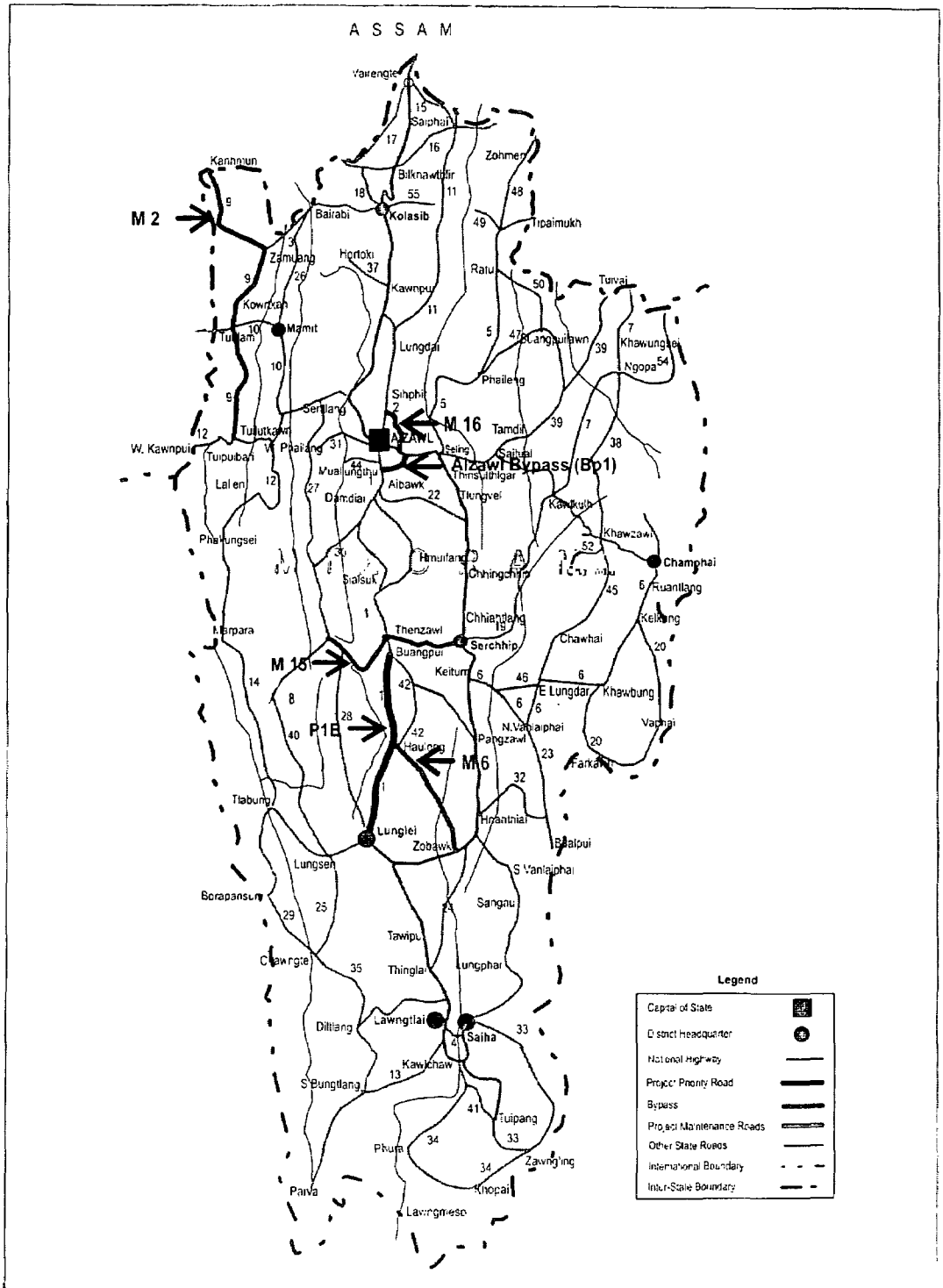
1.2. PHASE II ACTIVITIES IN MSRP

Phase II of MSRP endeavours to complete the enhanced connectivity of two of the most important cities in Mizoram – Aizawl and Lunglei, initiated in Phase I. The Upgradation of the MPWD's old Aizawl – Lunglei road will reduce the distance traffic has to travel by 65km when compared to NH 54. A new alignment bypassing Aizawl city from the east will connect NH 54 near Zemabawk to the state highway near Km 4.5. In addition, 230 km of existing state highways will also undergo major maintenance. **Table 1.1** summarises the works to be undertaken during Phase II of MSRP. These routes are also shown in **Figure 1.1**.

This report relates to the assessment of impacts on the Upgradation along P1B route. It is built on the work done during Phase I, which included a Sectoral Environmental Assessment and Environmental Impact Assessment for the P1A stretch. A stand-alone Environmental Management Plan is prepared to facilitate implementation of environmental management measures. Aizawl bypass (BP1) is studied separately and a combined EIA-cum-EMP is prepared. The socio-economic impacts of all activities

[1] The PCC consortium comprised M/s. Intercontinental Consultants and Technocrats (I) Ltd. (ICT) and M/s. Consulting Engineering Services Pvt. Ltd. (CES).

[2] M/s. LEA Associates South Asia Pvt. Ltd. (LASA) were selected as the Independent Reviewers with the responsibilities of updating the documents in light of the observations.



	Location of Phase II Project Roads	MIZORAM STATE ROADS PROJECT, PHASE II, PWD, GOVERNMENT OF MIZORAM
	Figure 1.1	N — LEA Associates South Asia Pvt. Ltd. New Delhi

Table 1-1 : Overview of MSRP Phase II

COMPONENT	ROAD DESCRIPTION	LENGTH (KM)	PROPOSED IMPROVEMENTS	REMARKS
UPGRADATION	P1B: Buangpui – Lunglei	67.943	Widening to intermediate lane and strengthening	Mostly along existing alignment; with hill-side widening predominant
	BP1: Aizawl Bypass	13.480	Intermediate width bituminous road	New alignment east of Aizawl city connecting NH-54 with P1
	TOTAL	**81.423**		
MAJOR MAINTENANCE	M2: Manhmun – Zamuang – Tuilutkawn	92.400	Resurfacing, Resurfacing with base course Rebuilding of pavement from subgrade upwards	28.1km Resurfacing 52.1km Resurfacing with base course 12.1 km Rebuilding of pavement from subgrade upwards
	M6: Zobawk – Haulawng	29.700	Conversion to bituminous road	Existing road is an earthen road
	M15: Serchipp – Thenzawl – Thenhlum	97.700	Resurfacing, Resurfacing with base course Rebuilding of pavement from subgrade upwards	33.4km Resurfacing 38.5km Resurfacing with base course 25.8km Rebuilding of pavement from subgrade upwards
	M16: Selesih – Thuampui	12.000	Resurfacing, Resurfacing with base course Rebuilding of pavement from subgrade upwards	2.0km Resurfacing 8.0km Resurfacing with base course 2.0km Rebuilding of pavement from subgrade upwards
	TOTAL	**231.800**		

included in the upgradation component, for P1B and BP1, are analysed and a single Resettlement and Indigenous Peoples' Development Plan (R&IPDP) is prepared. Management of environmental and social aspects for all routes covered in the major maintenance programme are addressed in Environmental and Resettlement Management Plan.

1.3. PROPOSED WORKS UNDER UPGRADATION COMPONENT

Activities under the Upgradation component are geared to widen the road along the existing alignment for most of the stretch to intermediate lane standards (5.5m) with side drains and shoulders. Most of the widening will be affected by cutting on the hillside, with only short realignments to smoothen curves on the valley side. New culverts and bridges are to be constructed including one major bridge across Mizoram's longest river, the Tlawng. Adequate slope protection works are included in design and the pavement is being rebuilt to structurally sound designs. Adequate provision is made for road signs and other road furniture. **Figure 1.2** shows the typical cross-section of the finished road for straight sections. Along curves, instead of 7.1m wide section along straight portions, the bench would be slightly wider at 8.0m.

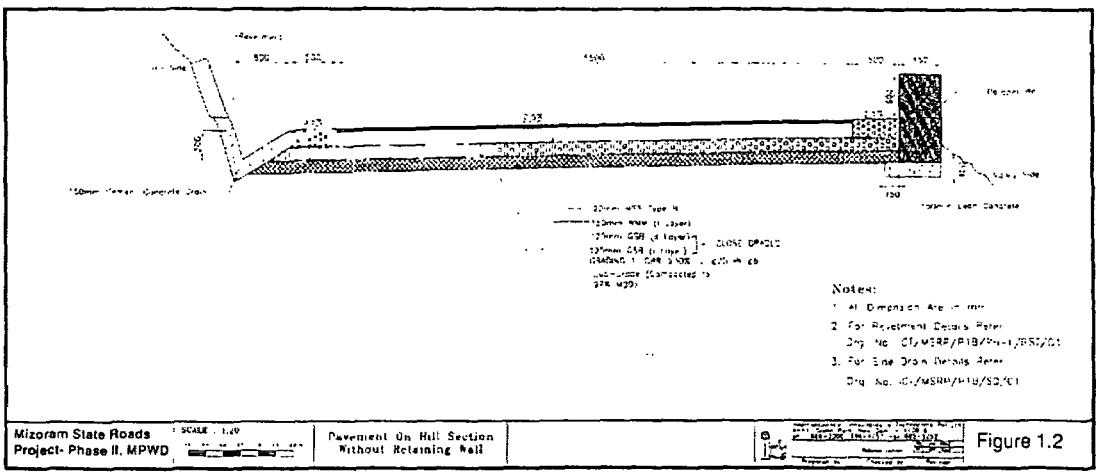


Figure 1.2

1.4. IMPACTS ENVISAGED DUE TO THE PROJECT

The beneficial impacts of the project, including the Upgradation component have been detailed out as part of the project justification. To summarise, these are:

- Shortening distance between Aizawl and Lunglei. It will result in reduced fuel consumption, vehicle operating costs improving competitiveness and market access for forest and agro products.
- Improved connectivity for the settlements along P1.
- Building road to improved standards will result in safer and more informed travel.
- Better drainage of the road and adjoining areas which can also reduce the chances of erosion and landslides.
- Provision for roadside amenities such as passenger sheds and toilets
- Generation of employment directly in terms of road & allied construction activities and indirectly due to socio-economic and commercial development that is expected to follow.

However, the focus of this impact analysis is on the adverse impacts of the project on various components of the environment with a view to develop effective mitigation and management measures. It is also to provide inputs to the highway design team on avoidance, compensation and/or enhancement measures for incorporation into design. Some of the impacts associated with the project are:

- On the stability of slopes-both above and below the road section
- Habitats (if any) of important species in the area
- Use and storage of water to be used in construction and
- Sensitive receptors located along the alignment being improved under the project

Due to the low volumes of present and anticipated traffic the impacts on the quality of air, noise and water environment are expected to be relatively insignificant.

Mitigation measures commensurate with the anticipated impacts have been worked out during project preparation. The process followed for this endeavour is described in

a later section of this chapter. Adoption of these measures as part of the project will ensure that the residual impacts are within the acceptable range.

1.5. STUDY METHODOLOGY

The study is built on the SEA carried out for the entire project, where the important environmental issues were identified. Major activities of the study are concisely described in this section. The collection, assembly and analysis of data from primary and secondary sources have followed the methodology developed during the EA review and updations for Phase I. Detailed procedures for individual components are given later in this section.

The inferences drawn have included specialist inputs such as floral diversity and slope stability assessments. Public Consultations were carried out to ascertain public opinion regarding the improvements and to provide the roadside communities with advance information regarding the project. Analysis of alternatives considered has been constrained by an earlier decision to improve the existing alignment, remote location of the project site, and the difficult terrain. Mitigation measures developed during the study are incorporated in the design drawings and/or Bills of Quantities as appropriate. For several items, which would not be executed by the Civil Works contractor, separate arrangements have been worked out. Budgetary allocations are made for all the environmental mitigation and enhancement measures. Implementation arrangements including responsibilities of all the actors are streamlined and documented for future guidance.

1.5.1. Air & Water

The air quality data and water quality data was collected by the PCC and Mizoram Pollution Control Board as part of the project preparation. The procedures prescribed by the CPCB were followed for the pollutants of concern.

1.5.2. Noise

The noise levels were recorded at four different locations using a hand-held noise meter during the study. Sampling locations selected were representative of the various land-uses along the P1B – Sensitive, Residential and Commercial, as per the classification used in the national standards.

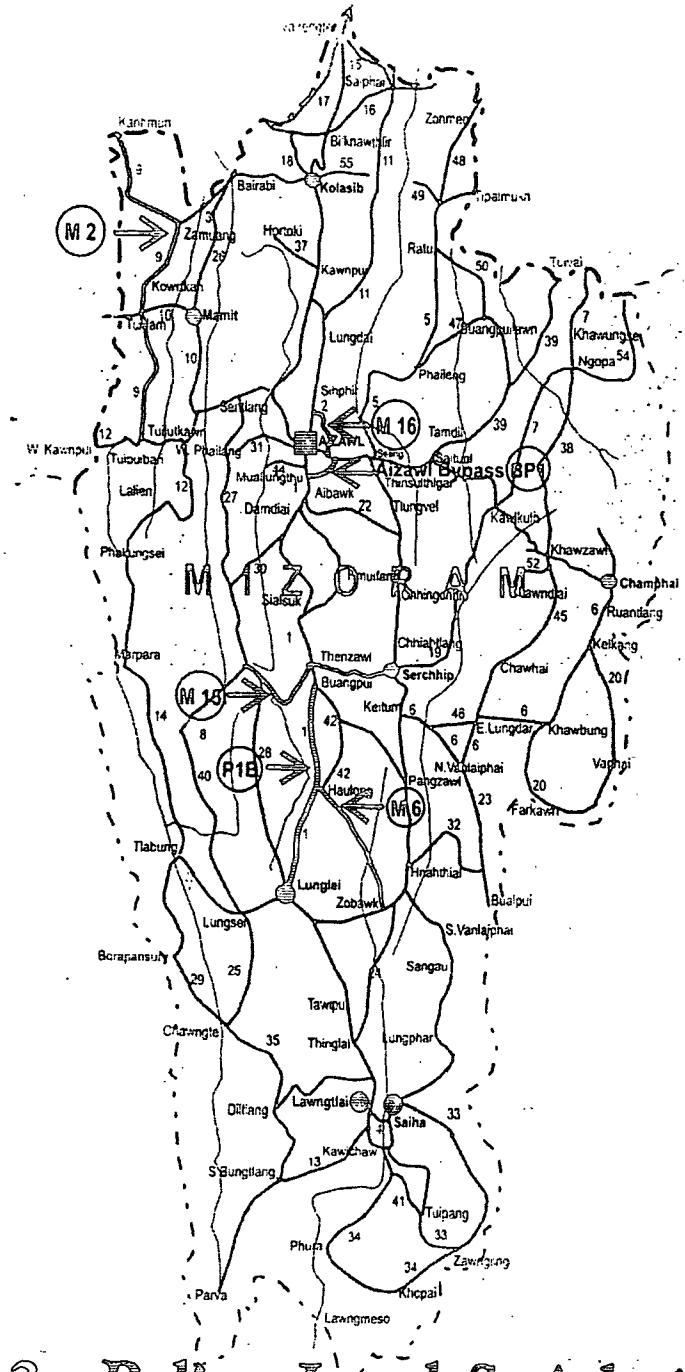
1.5.3. Natural Habitats

A tree survey has been carried out for the entire P1B route where trees of girth size over 30cm were enumerated. A floral diversity assessment has been carried out for the entire stretch during project preparation. As part of the review, an additional study was carried out within the designated Riverine Reserve, during which in addition to the floral diversity, fish species in the River Tlawng was also studied.

1.6. REPORT STRUCTURE

The following chapters complete the Environmental Impact Assessment for the P1B route:

- **Chapter 2** deals with the **Policy, Legal and Administrative Framework** for the project. It reviews the existing set-ups and establishes the various regulatory and administrative requirements that need to be fulfilled before and during project implementation.
- **Chapter 3** describes the **Existing Environmental Conditions**. Aspects covered include meteorology, topography and geology, water resources, air and noise pollution, flora and fauna species in the area, and the socio-economic profile summarised from the R&IPDP prepared.
- **Chapter 4** documents the **Consultations** carried out along the project road and meetings held with other stakeholders such as government officials such as those from the Forests Department. It also describes how the project intends to take this forward during implementation.
- **Chapter 5** analyses the **Alternatives** and provides the rationale for the selection of particular treatment for each.
- **Chapter 6** assesses the **Impacts** envisaged and proposed **Mitigations and Enhancement** for the same. Quantitative and Qualitative comparisons are made for arriving at implementable measures to be included in the Management Plan.
- **Chapter 7** details out the **Implementation Arrangements** to be put in place for the Environmental Management component. The PIU's capacity to handle the activities envisaged is analysed and training programme is suggested for ensuring smooth progress of the project.



2. Policy, Legal & Administrative Framework

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This section reviews the existing legislative setup pertaining to MSRP Phase II at the national and state levels. The chapter also elaborates on environmental clearance requirements for the project from Government of Mizoram, Ministry of Environment and Forests, New Delhi and the World Bank.

2.1. IMPLEMENTATION AND REGUALTORY AGENCIES

The Mizoram Public Works Department (MPWD) is the nodal agency for project preparation and implementation of MPSRP-II. Various other agencies are indirectly involved in regulation of activities under the project through statutes/laws governing them. The agencies involved, their role in the project is presented in the **Table 2-1**.

Table 2-1 Regulatory Agencies and their roles

Agency	Statute/policy	Relevant objectives
Ministry of Environment and Forests	Environment (Protection) Act, 1986 Environmental Impact Assessment Notification, 1994	To protect and improve the quality of the environment and to prevent, control and abate environmental pollution
	Forest (Conservation) Act 1980 (as amended 1998) and Rules, 1981	To restrict deforestation by restricting clearing of forested areas.
Pollution Control Board	Water (Prevention and Control of Pollution) Act 1974, as amended 1988.	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water.
	Air (Prevention and Control of Pollution) Act 1981, as amended in 1987.	To provide for the prevention, control and abatement of air pollution
Department of Environment and Forests	Wildlife (Protection) Act 1972	To protect wild animals and birds through the creation of National Parks and Sanctuaries
Department of Transport	Motor Vehicles Act 1988	To control vehicular air and noise pollution from motor vehicles
Archaeological Survey of India	Ancient Monuments and Archaeological sites and Remains Act 1958	To protect and conserve cultural and historical remains found in India

2.2. LEGAL FRAMEWORK AND THE ENVIRONMENTAL CLEARANCE STIPULATIONS

The Government of India has formulated various policy guidelines; acts and regulations aimed at the protection and management of Environmental resources. The applicable laws are described in the **Table 2-2**.

Table 2-2 Existing laws applicable for the Project

Law/Regulation/Guidelines	Relevance
The Forest (Conservation) Act, 1980	Applies to natural forest areas - Authority to issue clearance: (i) if area of forest >20ha (10ha in hilly area), Central Government; (ii) 5ha-20ha, Regional Office of Chief Conservator of Forests; (iii) <=5ha, State Government; (4) if tree density >40%, permission for any work must come from the Central Government, regardless of area of forest to be cleared. Clearance for the project under this statute is obtained from the Regional Chief Conservator of Forests, Shillong.
The Environmental (Protection) Act, 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Various aspects of the Environment (Protection) Act and Rules apply to the road construction projects. They establish the standards for emission of noise in the atmosphere. These standards are directed primarily at the industrial pollution but are also applicable to road construction activity. The alignment passes through riverine reserve forests and hence clearance under this statute is obtained.
The Environmental Impact Assessment Notification 1994	Identifies highways (item 21 of schedule I) as one of the projects requiring prior clearance from the GoI, MoEF. The GoI, MoEF Notification of 10 April

Law/Regulation/Guidelines	Relevance
	1997 provides that environmental clearance need not be obtained from the MoEF for... Highway projects relating to improvement work including widening and strengthening of roads with marginal land acquisition along the existing alignments provided the highways do not pass through ecologically sensitive areas such as National Park, Sanctuaries, Tiger Reserve, Reserve Forest, etc.
The Wildlife (Protection) Act, 1972	Provides for the creation, conservation and protection of National Parks and Sanctuaries. The proposed alignment does not pass through National park / sanctuary protected under this act. However, a notice for intension to declare an area of approx. 20 sq km, with road forming the boundary is issued. The boundary is for approximately 7km from River Tlawng towards Pukpui. No clearances are required under this statute at present.
The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish/enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction/operation of certain facilities. No clearances are required under the statute for the project.
The Air (Prevention and Control of Pollution) Act, 1981	Empowers SPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission. The project requires consent to establish and consent to operate hot mix plant under the project.
The Motor Vehicle Act, 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. In August 1997 the "Pollution Under Control Certificate" was launched to reduce vehicular emissions. All vehicles used for construction will need to comply with the provisions of this act.
Ancient Monuments and Archaeological sites and Remains Act 1958	To protect and conserve cultural and historical remains found. The project does not pass through any archeologically protected areas. Hence no clearances are required.
The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting, quarrying. Provisions of this act have to be complied with in the construction stage.
The Mizoram Highways Act, 2002	Provides for protection and maintenance of highways assets, enforce mechanisms to control ribbon developments, encroachments and road safety. Provisions of this act shall be enforced on the project road when it is fully operational. No clearances are to be obtained at present

The MPWD has obtained all necessary clearances from the regulatory authorities for implementation of the project. Various clearances required by the project and the status of clearances is presented in the **Table 2-3**. Apart from these, the contractor has to obtain consent to establish and consent to operate hot mix plant before setting up the plant. He also needs to obtain PUC certificates for all the vehicles used for construction.

Table 2-3 Status of Clearances for MSRP-II

S. No.	Statutory Authority	Statute under which clearance is required	Current status of clearance
1	Ministry of Environment and Forests, Government of India	Environmental Impact Assessment Notification, 1994 issued under EP Act, 1986	Clearances Obtained
2	Mizoram Pollution Control Board	Water (P&CP) Act, 1974 & Air (P&CP) Act, 1981	NoC Obtained
3	Department of Environment and Forests, Government of Mizoram	Forests Conservation Act, 1980	Clearances obtained

2.3. WORLD BANK REQUIREMENTS

In accordance with the WB requirements for Category 'A' projects, an Independent Environmental Review has been taken up as part of the project preparation activities of MSRP-II. World Bank has formulated certain policies, which need to be complied, for it to be able to fund projects. Applicability of various World Bank Policies for the project is presented in **Table 2-4**.

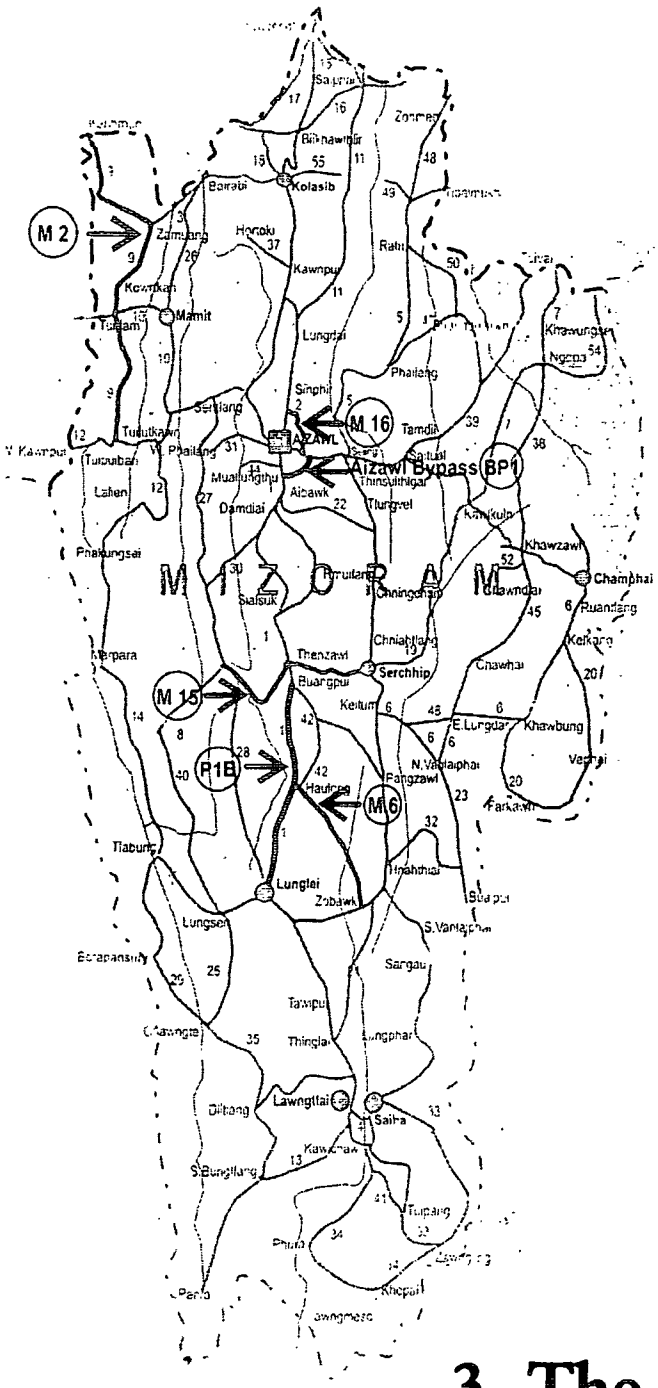
Table 2-4 Applicability of World Bank Policies for the Project

S. No.	World Bank Policy	Applicability	Compliance measures
1.	OP/BP/GP 4.01: Environmental Assessment	MSRP-II is a category 'A' project. The corridors pass through sensitive areas and are likely to have impacts on environmental and social components. Hence the policy is triggered	A detailed EIA, EMP & RAP is prepared for the implementation of Environmental mitigation and corrective actions
2.	OD 4.30: Involuntary Resettlement	Project involves acquisition of land and displacement of people. Hence the policy is triggered	Resettlement Action Plan is and will be fully implemented.
3	OD 4.20 Indigenous Peoples	Most of the affected people are indigenous. Hence the policy is triggered	IPDP has been prepared to mitigate the potentially adverse effects on these people due to the project.
4.	Physical Cultural Resources (OPN11.03)	No cultural properties are being impacted. However, chance finds and accidental impacts on the resources cannot be ruled out	Protection of chance finds is included in the management plan
5.	Natural Habitats (OP 4.04)	The proposed alignment does not pass through any critical natural habitat area. The policy is triggered due to Tlawng Riverine Reserve Forest.	No impacts envisaged. Precautionary measures to avoid any impacts are incorporated into the EMP.
6.	Consultation and Disclosure Requirements (BP 17.50)	The project requires having continuous interaction with the community and disclosing the project proposals when the Draft EIA is available.	The project has undertaken consultation at all stages of project preparation. Follow up consultations will be undertaken by the NGOs with representation of PIU. All draft reports have been disclosed to the public.

Safeguard policies of the World Bank that are not triggered are:

- Forestry (OP 4.36)
- Project in disputed areas
- Pest management
- Projects on International Waterways
- Safety of Dams

[3] Environmental Protection Act, 1986, Schedule-I specifies that for the projects falling under the 30 categories mentioned therein, EIA is a mandatory requirement to obtain Environmental clearance for the project.



3. The Existing Environment

3. THE EXISTING ENVIRONMENT

This chapter presents the baseline information on the biophysical environment and socio-economic conditions. Information on the environmental components was generated by primary surveys conducted during project preparation and independent review, interactions at various levels with local people and other stakeholders like officials of the Forests Department. The socio-economic profile has been distilled from the R&IPDP.

3.1. THE PHYSICAL ENVIRONMENT

3.1.1. Meteorological Conditions

The climate is generally pleasant with summer temperatures ranging between 18°C to 32°C and winter temperatures between 8°C to 24°C. The seasonal cycle consists of four seasons namely summer, spring, autumn and winter. The average annual rainfall recorded is 2371mm. However, annual rainfall varies from 2000mm – 3500mm. Relative humidity in the dry season is 40% while in the monsoon period, it is about 90%.

3.1.2. Land

Geology And Soil

The common rocks found are sandstone, limestone, silt stone, slates and shale. The rock system is weak and unstable, prone to frequent seismic influence. The terrain seems entirely immature with regard to recent structural /geological changes in earth's crust. In general, the geomorphology of the Mizoram State Roads Project – Phase II area is characterized by the presence of weathering products of typical varying thickness on original hilltops. The geo-morphological formations consist of steep hill slopes and deep valleys oriented on the topographic surface in a linear fashion. The presence of valleys and ravines show physiographic expressions of the faults or structural patterns, giving origin to different types of drainage patterns. Faulting has resulted in creation of steep faulty curves, highly dissected ranges with deep ravines, spurs etc. vulnerable to comprehensive erosion. The rocks are fractured and hence susceptible to failure during monsoon resulting in landslides.

Soils vary from sandy loam, clayey loam to clay, generally mature but leached due to steep gradient and heavy rainfall. Soils are porous with poor water holding capacity, deficit in potash, phosphorous, nitrogen and humus and hence poor in productivity. The p^H shows acidic to neutral reaction due to excessive leaching.

The subject stretch is an old road bench and is perceptibly in a stabilised state. Some sporadic distress points viz. road cuts exhibiting mini to macro collapses on both uphill & downhill faces and quite steep slope at locations are observed. However, these do not look to be immediately vulnerable.

Mostly the derived products as observed in this stretch being cohesive, exhibit coherent faces and generally stable for the exposed heights, despite high silt content. In the above general and local scenario, this route length may be considered as it is, in a better status compared to the stretch under P1A. The recee[4] notes on the project road is appended in the **Annexure 3.1**.

Topography

The entire territory of Mizoram is mostly mountainous and hilly with precipitous slopes forming deep gorges culminating into several streams and rivers. Almost all the hill ranges traverse in the North-South direction. Phawngpui or Blue Mountain is the highest peak at 2157 m whereas the lowest place is Bairabi at 40 m above Mean Sea Level (MSL). The average height of hill ranges in Mizoram is 920 m.

The project road passes through hilly terrain with alternate steep slopes and deep valleys with gorges.

Land Slides

The terrain with fractured rock having unstable steep slopes is further weakened by heavy rain during the monsoon season resulting in landslides. Deforestation by felling of trees for timber, animal fodder requirements, removal of vegetation cover by slash and burn technique for agricultural needs are other factors for destabilization of slopes resulting in landslides. The landslide locations identified for Buangpui – Lunglei Road Phase-II are given in **Table 3.1** below. Prominent landslides at Km 140.725 and Km 141.340 are depicted in **Figure 3.1**

Table 3-1: Lists of Major Landslide Locations along Buangpui – Lunglei Road Phase-II

Sl. No.	Chainage		Sl. No.	Chainage	
	From	To		From	To
1	104.939	105.001	10	119.639	119.701
2	105.369	105.431	11	120.700	120.750
3	105.660	105.710	12	130.759	130.821
4	105.729	105.791	13	132.119	132.181
5	106.100	106.150	14	133.480	133.580
6	106.450	106.505	15	137.124	137.186
7	108.439	108.501	16	140.694	140.756
8	110.769	110.831	17	141.309	141.371
9	111.680	111.750	18	151.424	151.486

Quarries

A number of quarry sites have been identified and aggregate samples investigated along P1B for MSRP Phase-II. The investigations however, revealed that none of these

[4] The IER team conducted a rapid survey in the project corridor.

samples satisfied the specifications of MoRTH for bituminous work viz. premix carpet/MSS wearing course (wherein the water absorption limit laid down is 1% max). Hence, material is available only from the quarries identified during MSRP Phase-I. These quarries are listed in **Table 3.2**. A map as shown in **Figure 3.2** depicts the quarry chart.

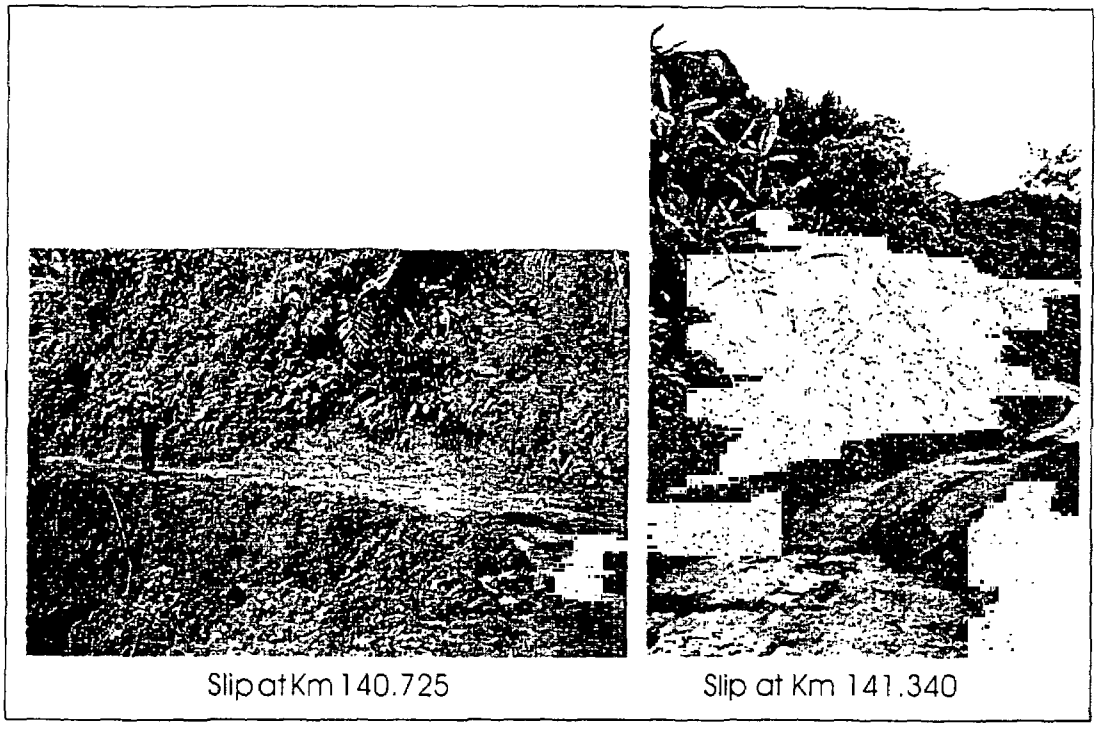
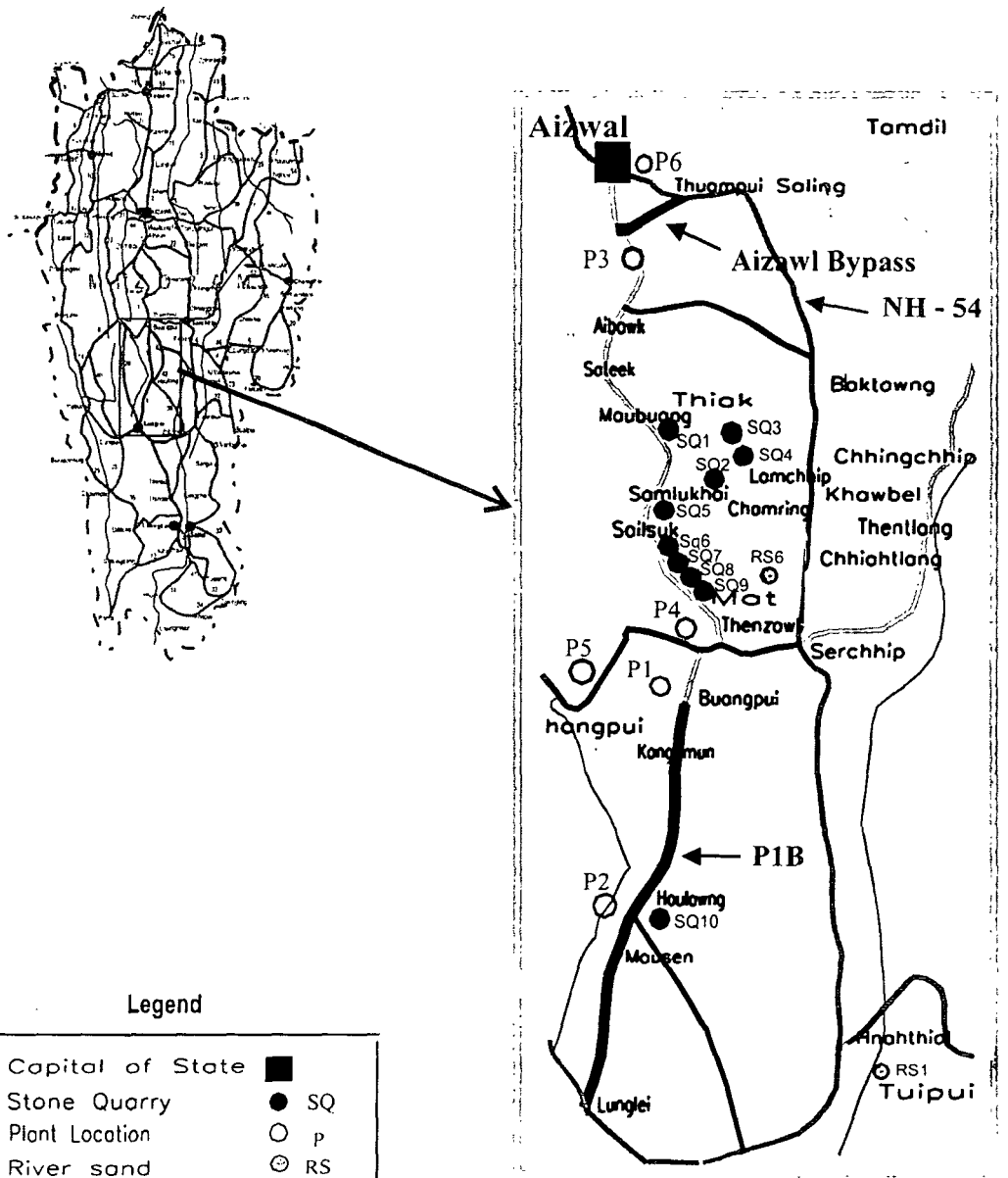


Figure 3.1: Photographs of Prominent Landslides locations

Table 3-2 Identified Quarry Locations

Quarry Name & Location	Tentative Yield (Cum)
Zawmgekham – km 41 on ATL-Left	200000
Sentezel – km 78.115 – ATL – Left Fangfar – km 78.860 – ATL – Left }	7,50,000
Km 12.60 (NA) near village Samsuih	Not indicated
Ramrikawn, 6.0 km from Keifang towards Mualpheng	67,000
CH. 70.6 km on ATL (Left)	2,50,000
Dilkawnlui – km 74+020 – ATL – Left	1,000.00
Sailam – km 66+760 – ATL – Left	600
Quarry of Mr. C. Lalduhawma (Haulawng) Km 131.9 Left	11,700
Km 57.5, 4.5 km from Hmuifang towards Sialsuk	8,300
Lungpuizawl-Duilova 11 Km from Lunglei on NH-54	96,000



	Quarry Chart	MIZORAM STATE ROADS PROJECT. PHASE II, PWD, GOVERNMENT OF MIZORAM
	Figure 3.2	N — LEA Associates South Asia Pvt. Ltd. New Delhi

Borrow Pits / Areas

Excess cut material produced from cutting the hillside can be used as fill where required. No additional borrow areas may be need to be opened along the entire stretch. Samples of sand from different riverbeds on testing, was found that this contained considerable amount of pebbles and gravels, which does not make it suitable for road construction. Also, the transportation cost of river sand from valleys at lower levels to the high levels, where road construction will take place, will be high.

Hence, as an alternative to sand, it is proposed to use dust from stone crushers as a binder material for road construction. It can also be utilized for blending with sub-base and base course granular material.

3.1.3. Water Resources

In Mizoram, major surface water sources are rivers running at the bottom of the valleys and mountain streams. Few stagnant water bodies like ponds created for human use have also been recorded along P1B. Due to the steep slope and the soil conditions, little infiltration takes place and the ground water levels are relatively deep. However, the quality of water is quite pristine in most locations due to absence of major sources of pollution.

Surface Water and Cross Drainage Channels

There are three ponds, eight waterfalls, one marshy area and one river along the Buangpui – Lunglei Road. Out of the three ponds, the pond at Km 102.380 is a fishpond; the pond at Km 128.060 is a pond used for watering within a nursery and the pond at Km 128.120 is another private pond. A complete list of water bodies present in the project corridor is in **Table 3.3. Figure 3.3 and Figure 3.4** shows location of ponds and waterfalls respectively.

Table 3-3: Water bodies in P1B

No.	Water body	Chainage	RHS/LHS[5]
1	Marshy area	100.160	LHS
2	Pond	102.380	LHS
3	Pond	128.060	LHS
4	Pond	128.120	RHS
5	Tlawng River	150.300	
6	Waterfall	150.960	LHS
7	Waterfall	151.480	LHS
8	Waterfall	151.600	LHS
9	Waterfall	151.660	LHS
10	Waterfall	151.780	LHS

[5] Hereinafter, the LHS/RHS convention is assuming that the direction of travel is from Buangpui to Lunglei

No.	Water body	Chainage	RHS/LHS[5]
11	Waterfall	151.840	LHS
12	Waterfall	151.940	LHS
13	Waterfall	152.200	LHS

Cross-drainage Channels/Work

There are 217 culverts to convey water flowing in minor streams and accumulating on the hillside during monsoon across the existing road. However, the drainage is not adequate as sheet flow over the formation during monsoon exists. Some of the existing culverts are clogged by deposition of soil and growth of vegetation while some are damaged due to the excessive flow and rocks and debris flowing down with it. Details of the culverts, both existing and proposed are given in the engineering design

- **Tlawng River Bridge**

Currently, a 45 m long steel bridge is available to cross the River Tlawng at Km 150.300. It is a complete steel structure with a narrow deck made out of steel plates and can allow traffic in one direction at a time. The water flow below it is unhindered since there are no piers within or outside the waterway.

Ground Water and Water Harvesting

The ground water potential in the Mizoram State is on the whole very low. On hilltops where most of the population lives, there is acute shortage of drinking water. The PHE department traps water from streams for piped water supply to some settlements. Hand pumps are dug at a number of locations along the corridor. However, these are, seasonal in nature and provide water mainly during rainy season when the water table is relatively high.

Pond at Chainage 126.850 *Fish Pond at Chainage 101.900*

Figure 3.3: Photographs of Ponds

Waterfall at Chainage 151.480 *Waterfall at Chainage 149.400*

Figure 3.4: Photographs of Prominent Waterfalls

Water Quality

Sample for Examining

Surface water quality from river Tlawng was collected near Km 150.300. The sample was analysed at the Public Health Engineering Department, Aizawl. The results of the analysis are as given in **Table 3.4** along with standards prescribed by Central Pollution Control Board and as per Indian Standard Drinking Water Specifications IS: 10500:1991[6]. The results indicate that water quality parameters are within the prescribed standards, except for the high Coliform values.

Table 3-4: Water Quality - Tlawng River

Sl.No.	Water quality parameter	Tlawng River water near 150.300 km	Indian Drinking Water Specifications, IS 10500:1994
Physical parameters			
1	pH	6.8	6.5 to 8.5
2	Turbidity	<5 NTU	5 NTU *
3	Colour (Hazen units)	Colourless	5
4	Conductivity (in umhos/cm)	103.6 at 17.30C	
5	Odour	Odourless	Unobjectionable
6	Taste	Tasteless	Agreeable
7	Water temperature	17°C	-
Chemical parameters			
1	Fluoride (mg/l)	Trace	1
2	Nitrate (mg/l)	Nil	45
3	Total alkalinity ppm	50	150 **

[6] Drinking Water Specification IS: 10500, First Revision, (Fourth Reprint July 1990)

Sl.No.	Water quality parameter	Tlawng River water near 150.300 km	Indian Drinking Water Specifications, IS 10500:1994
4	Total chloride ppm	Nil	250 mg/l
5	Total hardness ppm	60	300 mg/l
6	Total iron ppm	Trace	0.3 mg/l
Biological parameters			
1	Faecal Coliform (MPN)	2400 MPN per 100 ml sample	0
2	Total Coliform (MPN)	2400 MPN per 100 ml sample	500 MPN per 100 ml sample or less for bathing #

**** Prescribed by Indian Council of Medical Research***

***** Prescribed by World Health Organisation***

 # Prescribed by Central Pollution Control Board

Marshy Area

A marshy area has been identified along the priority road P1B near Km 100.160. (Buangpui - S.Kanghmun). This land supports predominantly hydrophytes and is a breeding ground for dragonfly and other amphibians. This marshy area is about 100 m away from the road alignment.

3.1.4. Air Quality

The air quality in state of Mizoram is generally pristine. This is expected because Mizoram is an industrially backward state and has lush green vegetation. Volume of the traffic on the roads is low and hence the pollutant concentration close to the roads is quite low.

Air quality data measurements taken along Buangpui – Lunglei road are given in the **Table 3.5**. While the values of SO_2 and CO are below detectable limits, the values of NO_x are within the prescribed National Ambient Air Quality Standards. The high values of SPM in case of Lunglei market could be accounted for the temporary roadside works being undertaken during sampling.

Table 3-5: Air Quality Data

Location & Zone	Pollutant	Measured Value in µg / m³	Prescribed Standards as per CPCB norms in µg / m³
Serkawn Christian Hospital Lunglei (Sensitive Zone)	SO_2	Not Dectable (N.D.)	30
	NO_x	4.9	30
	CO	N.D	1000
	SPM	122.4	100
Lunglei Market (Residential Zone)	SO_2	N.D	90
	NO_x	14.63	91
	CO	N.D	2000
	SPM	1167.2	200

Source: Mizoram Pollution Control Board and PCC

3.1.5. Noise Quality

Observed noise levels along the Buangpui – Lunglei Road are presented in **Table 3.6.** The data shows that noise levels are slightly on higher side in comparison with the prescribed values. Adequate mitigation measures have been suggested under the section 6.4.4. These shall be followed during the project implementation.

Table 3-6: Observed Noise Levels along Buangpui – Lunglei Road

Location	Observed Noise Levels in Leq[7], dB (A)		Prescribed Ambient Noise Quality Standards in dB (A)[8]	
	Leq Day	Leq Night	Leq Day	Leq Night
Serkawn Christian Hospital, Lunglei (Silence / Sensitive Zone)	61.90	45.15	50	40
Lunglei market 169.094 km (Commercial / Residential Zone)	71.5	51.5	65	55

Source: Data collected by Mizoram Pollution Control Board and PCC

3.2. ECOLOGICAL ENVIRONMENT

3.2.1. *Terrestrial Ecology*

Flora

- **Forest Resources**

Mizoram has a large area under forest cover; over 80% of the state, admeasuring 18,388 sq. km. and is under dense, open or scrub type of forest. However, the forests are under increasing stress, due to increasing area under Jhum (slash and burn agricultural practice which follows a 5 to 8 year cycle) and increased area under plantations. The forests are classified as Protected areas, Reserve Forests, Protected Forests and Unclassified forests. None of the currently notified 7 Protected Areas (totalling 840.75 sq. km) are located adjacent to the proposed alignment. The project route passes through Reserve forests as described below.

- **Riverine Reserve forest**

The reserve forest of Tlawng was declared by the erstwhile Mizo District Council and notified in the Gazette of Assam on May 19, 1965. The notification covers 800m on either side of several rivers, including the Tlawng. PWD has obtained permission for diversion of Forest Department land from the Regional Chief Conservator of Forests' Shillong Office.

- **Proposed Saza Tlawng Sanctuary**

In early 2002, the Forest Department, Government of Mizoram, has notified its intention to declare the Saza hill and the adjoining area, along the project road on the Pukpui side; and the Tlawng River as a bird sanctuary with an area of 15 sq. km. Thus, project road P1B forms the western boundary of this proposed Saza-Tlawng sanctuary for a

[7] Leq is defined as the hypothetical steady-state sound level that contains the same amount of acoustical energy as the actual time-varying sound over a specified time interval. The day time is reckoned in between 6 AM to 10 PM while night time is reckoned in between 10 AM to 6 AM.

[8] Ambient Air Quality in respect to Noise, Schedule III, Environment Protection Rules, 1986.

length of just over 7km. For very short stretches, less than 1km in length over several locations, widening on the hillside will require land within the area proposed to be included within the sanctuary. A copy of the notification is appended to the report as **Annexure 3.2**. This proposal has been sent to the District Commissioner, Lunglei (an official of the Revenue Department) for further processing and is open for suggestions from general public[9]. Government of Mizoram has already notified 5m wide strip on both sides of several important roads in the state including P1 (Aizawl – Lunglei). **Figure 3.5** shows the current location of the proposed sanctuary and riverine reserve in relation to the project corridor.

- **Roadside Trees**

Due to strengthening and widening of the Buangpui – Lunglei Road, a number of trees and plants are likely to the uprooted. Trees of different species having girth more than 30cm within 15 m of the existing bench were counted and tree inventory was prepared. **Table 3.7** summarises the girth-wise distribution of the trees. Details including species are provided in **Annexure 3.3**.

Table 3-7: Tree Inventory within COI of 15 m for Buangpui - Lunglei Road

Chainage		Girth							Total
From	To	G1	G2	G3	G4	G5	G6	G7	
100.00	110.00	548	186	102	74	32	48	28	1018
110.00	120.00	335	146	180	89	44	67	51	912
120.00	130.00	938	213	53	25	10	5	1	1245
130.00	140.00	898	467	219	13	6	7	5	1615
140.00	150.00	725	151	42	13	6	7	2	946
150.00	160.00	720	209	58	1	5	2	6	1001
160.00	170.00	512	153	85	4	2	10	15	781
TOTAL		4676	1525	739	219	105	146	108	7518

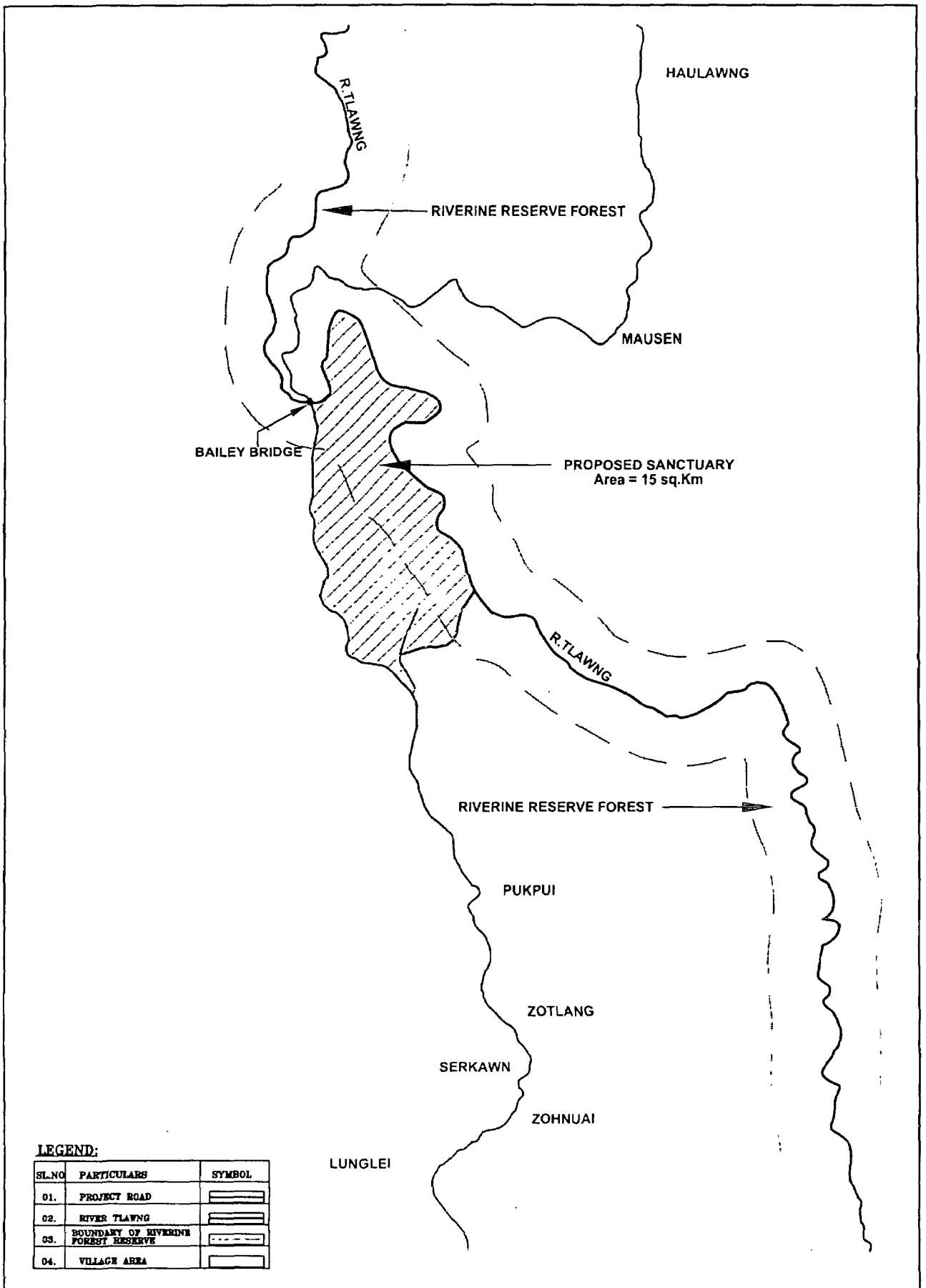
G1= (30-60) Cm, G2=(60-90) Cm, G3=(90-120) Cm, G4=(120-150) Cm, G5=(150-180) Cm, G6=(180-270) Cm, G7=>270 Cm

- **Biodiversity Assessments**

Methodology adopted

The species-richness as well as the densities of Trees and ground flora was estimated with the help of 1m^2 quadrates, with 30 replicate samples in each 10km section. Tree and shrub densities were estimated using the line transact method, with each

[9] Discussions with a senior Forest Department Official, during the site visit to Lunglei for the Independent Review have revealed that there is strong opposition from the locals to the proposal. Some moves are afoot to change the location to the other side of the river. However, there is no documentation available in this regard.


HAULAWNG
R.TLAWNG
RIVERINE RESERVE FOREST
MAUSEN
BAILEY BRIDGE
PROPOSED SANCTUARY
Area = 15 sq.Km
R.TLAWNG
RIVERINE RESERVE FOREST
PUKPUI
ZOTLANG
SERKAWN
ZOHNUAI
LUNGLEI
LEGEND:
SL.NO | PARTICULARS | SYMBOL
01. | PROJECT ROAD
02. | RIVER TLAWNG
03. | BOUNDARY OF RIVERINE FOREST RESERVE
04. | VILLAGE AREA
Source
ENVIRONMENT AND FOREST DEPT GOVERNMENT OF MIZORAM
PROJECT ROAD, PROPOSED SANCTUARY AND RIVERINE RESERVE
MIZORAM STATE ROADS PROJECT, PWD, GOVERNMENT OF MIZORAM
1km 0.5 0 1 2km
Figure 3.5
N
LEA ASSOCIATES SOUTH ASIA PVT.LTD (LASA), NEW DELHI

longitudinal traverse of 100m, and 10 replicate samples were taken in each section. Besides, the valley slope and floor were scanned with a powerful binocular to note the presence of any rare species of plant.

Besides species-richness and density component, the diversity of the plant communities was also measured. Species diversity index was measured using the Menhinick's diversity index, and uniformity with relative frequency using the following formulae:

$$D = \frac{S}{\sqrt{N}}$$

Where D= Menhinick's diversity index, S= Number of species and N=Number of individuals.

Uniformity was estimated as:

$$\text{R.F.} = \frac{\text{Number of point of occurrences of a species}}{\text{Total number of points taken for all species}} \times 100$$, where R.F. is relative frequency

The Diversity was also measured using the Shannon-Wiener Diversity Index and calculated using the following formulae:

Shannon-Wiener Index of Diversity, $H = -\Sigma\ pi \log pi$

Where, $pi = ni/N$, ni = number of individuals of the ith species,
N = total number of individuals of all the species

The indices were employed to get a comprehensive, easily comparable, and quantitative estimate of the diversity of the plant community.

Inventory of floral diversity Assessment along P1B (Buangpui-Lunglei) Road

An inventory of the flora diversity along the proposed road from Buangpui to Lunglei is provided in **Table 3.8**.

Table 3-8: Inventory of Floral Biodiversity along priority project road (Buangpui-Lunglei)

Section	Chainage	Location	Description
1.	100.00-105.00	Buangpui to Kanghmun	This stretch of the project corridor has 20 species of trees and 43 species of herbs and shrubs including *Costus Speciosus*. The diversity as reflected in the Menhinick's diversity index is 1.32 for trees, 1.64 for herbs and shrubs, while Shannon-Weiner index are 2.89 for trees and 3.12 for shrubs and herbs. The frequency, abundance and density of different plant communities can be seen at **Annexure 3.4 & 3.5**. In this section *Castanopsis tribuloides* has highest density among trees, and between shrub & herb *Saccharum longisetosum* has highest density. *Cyathea* spp. has density of 0.1. It may be noted that highest Menhinick's diversity index for shrub & herb has been recorded here.
2.	105.00-110.380	S. Kanghmun to Ramlaitui	This stretch of the project corridor has 22 species of trees and 14 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.30 for trees, 0.64 for herbs and shrubs while Shannon-Weiner

Section	Chainage	Location	Description
			index are 2.95 for trees and 2.28 for Herbs and shrubs. The frequency, abundance and density of different plant communities can be seen at **Annexure 3.6 & 3.7**. In this section *Saurauia napaulensis* has highest density. One endangered species of orchid, *vandai coreulea* (local name Lawhlei) has been identified at chainage 111.320 (Ramlaitui).
3.	110.380-117.460	Ramlaitui to Sekhum	This stretch of the project corridor has 24 species of trees and 35 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.38 for trees, 1.40 for herbs and shrubs while the Shannon-Weiner index are 2.98 for trees and 3.01 for herbs and shrubs respectively. The frequency, abundance and density of different plant communities can be seen at **Annexure 3.8 & 3.9**. In this section *Schima wallichi* and *Duabanga grandiflora* have highest density among trees, and among shrub and herb *saccharum longisetosum* has highest density. *Cyathea spp* has density of 0.13.
4.	117.460-120.940	Sekhum to N. Mualthuam	This stretch of the project corridor has 29 species of trees and 23 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.89 for trees, 0.92 for herbs and shrubs. The Shannon-Weiner index recorded for trees is 3.28 and 0.95 for herbs and shrubs. The frequency, abundance and density of different plant communities can be seen at **Annexure 3.10 & 3.11**. In this section *Lithocarpus xylocarpa* has highest density among trees, and among shrub and herb *Saccharum longisetosum* has highest density. It may be noted that highest Menhinick's diversity index for tree has been recorded here.
5.	120.940-127.640	N. Mualthuam to Haulawng	This stretch of the project corridor has 23 species of trees and 23 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.66 for trees, 1.13 for herbs and shrubs. The Shannon-Weiner index for trees is 3.03 and 2.81 for herbs and shrubs. The frequency, abundance and density of different plant communities can be seen at **Annexure 3.12 & 3.13**. In this section *Macaranga indica* has highest density.
6.	127.640-137.700	Haulawng to Mausen	This stretch of the project corridor has 25 species of trees and 33 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.71 for trees, 1.24 for herbs and shrubs while Shannon-Weiner index measured are 3.12 for trees and 3.24 for herbs and shrubs. The frequency, abundance and density of different plant communities can be seen at **Annexure-3.14 & 3.15**. In this section *Castanopsis tribuloides* has highest density among trees, and between shrub & herb *Mikania micrantha* has highest density. *Cyathea spp* has density of 0.63.
7.	137.700-164.040	Old Mausen to Pukpui	This stretch of the project corridor has 25 species of trees and 34 species of herbs and shrubs. The diversity as reflected in the Menhinick's diversity index is 1.82 for trees, 1.35 for herbs and shrubs; while the Shannon-Weiner index for trees is 3.10 and 2.94 for herbs and shrubs. The frequency, abundance and density of different plant communities can be seen at **Annexure – 3.16 & 3.17**. In this section *Duabanga grandiflora* has highest density among trees, and between shrub and herb *Saccharum longisetosum* has highest density. *Cyathea spp* has density of 0.03. The proposed Saza Tlawng bird sanctuary is located in this stretch.

The biodiversity assessment survey identified 69 species of herbs and shrubs (see **Annexure 3.18**), 45 species of trees (**Annexure 3.19**) and 26 species of ethno-medicinal plants (**Annexure 3.20**) along the Buangpui to Lunglei road. The Annexure may be referred for uses of ethno – medicinal plants by the local people. The overall biodiversity indices for trees and combined shrubs and herbs are given in the **Table 3.9** below.

Table 3-9: Overall Bio-Diversity indices for Trees and Shrubs & Herbs Combined

Road Section	Location	Categories	Number of Species	Total Number of Individuals of All Species	Overall Menhinick's Index	Overall Shannon-Weiner's Index
100.000-105.000	Buangpui – S.Kanghmun	Trees	20	229	1.32	2.89
		Shrubs & Herbs	43	686	1.64	3.12
		Trees	22	286	1.30	2.95

Road Section	Location	Categories	Number of Species	Total Number of Individuals of All Species	Overall Menhinick's Index	Overall Shannon-Weiner's Index
105.00-110.380	S. Kanghmun-Ramlaitui	Trees	22	286	1.30	2.95
105.000-110.380	S.Kanghmun-Ramlaitui	Shrubs & Herbs	24	309	0.38	2.98
		Shrubs & Herbs	35	622	1.40	3.09
117.460-120.940	Sekhum-N.Mualthuam	Trees	29	237	1.88	3.28
		Shrubs & Herbs	23	583	0.95	2.81
120.940-127.640	N.Mualthuam - Haulawng	Trees	23	192	1.66	3.03
		Shrubs & Herbs	23	416	1.13	2.81
127.640-137.700	Haulawng - Mausen	Trees	25	213	1.71	3.12
		Shrubs & Herbs	33	708	1.24	3.24
		Trees	25	189	1.82	3.10
		Shrubs & Herbs	34	638	1.35	2.94

- **Riparian Flora**

An extensive biodiversity assessment on the riparian ecology of the river Tlawng near 150.300km is conducted as part of updation of reports. This survey was done as the area around Tlawng has been declared as Riverine Reserve Forest (discussed in the preceding sections). The forests around the river Tlawng can be mainly classified as tropical moist deciduous forest type. These forests are heavily degraded as a result of shifting cultivation; secondary forests have been regenerated in the form of extensive bamboo bushes. The dense or climax forests are quite far away from the riverine reserve area of Tlawng. The forests along the slopes are mainly seral in nature and dominated by bamboo.

Methodology adopted

The species as well as the densities, frequency and abundance of herbs and shrubs were estimated randomly with the help of $2m^2$ least-count quadrate with 30 replicate samples in the project area. Tree densities, frequency and abundance were also estimated using the line transect method, with each longitudinal traverse measuring a distance of 100m in which 20 replicate samples were taken randomly in the study area.

Inventory of floral diversity Assessment along River Tlawng

A total number of 35 species of herbs and shrubs and 26 species of trees were found in the adjoining area of the riverbanks. The riparian vegetation was composed mainly of *Ageretum conyzoides, Saccharum* sp., *Cynodon dactylon, Mikania micrantha* and *Imperata cylindrica* species. The highest Menhinick's index of 0.26 was shown by *Melocanna baccifera* and *Mikania micrantha*. The total Menhinick's index and Shannon-Weiner Index as shown by the herbs and shrubs are 0.91 and 2.91 respectively. Similarly for trees the total Menhinick's index and Shannon-Weiner Index are 2.32 and 2.86 respectively. The species list along with the density abundances and indices are shown in **Annexure 3.21**. No endangered or rare species were reported during the survey.

- **Rare and Endangered Plant Species**

During biodiversity survey along the Buangpui-Lunglei road, endangered tree fern (*Cyathea* spp) was found at a number of locations all throughout the project corridor. These locations are 110.140 (S. Kanghmun – Ramlaitui), 111.680, 111.900, 112.680, 115.700, 117.420 (Ramlaitui - Sekhum), 134.206, (Haulawng - Mausen), 138.020, 139.860, 140.020, 140.040, 140,300, 140.455, 142.100, and 151.320 (Mausen - Lunglei). This tree fern despite being included as endangered species by the IUCN is found everywhere in the State of Mizoram and may not be threatened by the road construction. **Figure 3.6** shows photograph of the *Cyathea* spp. taken on National Highway 54. Other than *Cyathea* spp., *Vanda coerulea* has been located at chainage 111.320 and proper measures are to be taken to protect the orchid.

Figure 3.6: Photograph of Cyathea spp. On NH 54

- **Important Biodiversity Areas**

The biodiversity survey identified Important Biodiversity Area based upon the condition of the existing ecosystem and the biodiversity indices. The reasons for choosing these areas as IBA are:

- The biodiversity indices are the highest, therein suggesting the existence of greater diversity of species.
- The existence of endangered species viz. *Cyathea* spp. in large numbers.
- The existence of the Riverine reserve forest of Tlawng.
- The proposed Saza-Tlawng Bird Sanctuary is located in the area.

These areas are to be protected from unauthorised disposal of debris (other than at sites identified and listed in **Table no. 6.7and 6.9**.) and other activities. These IBAs are

mainly located within 117.460 to 120.940 i.e., Sekhum and N. Mualthum and 127.640 to 157.900 i.e., Haulawng to Pukpui. The IBAs are:

i. 100.110 to 100.210,
ii. 111.630 to 111.750,
iii. 117.370 to 117.470,
iv. 137.770 to 138.870,
v. 139.810 to 140.090 and
vi. 149.980 to 157.900

Fauna

- **Invertebrates**

Species of 'dragon flies' are reported to exist along the project road. The marshy area (100.160km) is a reported breeding ground for 'dragon flies'.

- **Amphibians and Reptiles**

The marsh at Km 100.160 has dense aquatic Macrophyte and is reported to be a breeding ground of amphibians.

- **Birds**

The biodiversity survey reported 19 species of birds in the project area. Out of these species only one endangered species, the Peregrine Falcon (*Falco peregrinus*) has been reported in the vicinity of the proposed Saza-Tlawng Sanctuary area. The bird species reported within the project area are listed in the **Table 3.10.**

Table 3-10: Bird species reported within the Project area

Chainage	Location	Species sighted
100.00-105.00	Buangpui to Kanghmun	*Hypsipetes flavalus, Dicaeum concolor, Megalaima asiatica, Rhipidura albicollis* and *Pycnonotus melanicterus.*
105.00-110.380	S. Kanghmun to Ramlaitui	*Rhipidura albicollis Pyconotus melanicterus, Enicurus schistaceus, Arachnothera magna, Lonchura striata, Anthus hodgson* and *Phaenicophaeus tristis* have been sighted.
110.380-117.460	Ramalaitui to Sekhum	*Dendrocitta formosae* and *Aethopyga gouldiae*
117.460-120.940	Sekhum to N. Mualthuam	*Garrulax delesserti*
120.940-127.640	N. Mualthuam to Haulawng	*Hypsipetes flavalus.*
127.640-137.700	Haulawng to Mausen	*Hypsipetes flavalus, Rhipidura albicollis, Muscicapa sundara, Pycnonotus jacosus, Zosterops palbebrosa, Orthotomus cucullatus, Arachmothera magna, Enicurus schistaceus* and *Pycnonotus melanicterus*
137.700-164.040	Mausen to Lunglei	*Streptopellia chinesis* and *Pycononotus melanicterus* The existence of Peregrine falcon (*Falco peregrinus*) at Soza hill (near Pukpui village) is reported.

- **Mammals**

The project corridor forms the western boundary of the proposed Saza-Tlawng Sanctuary, which is supposed to house endangered species like the Saza (*Capricornis sumatraensis*), Leopard (*Panthera* sp.) slow loris, Chinese pangolin (*Manis pentadactyla*), hoolock gibbon, etc., besides a host of other mammalian species. *But during the survey no rare or endangered mammalian species were noticed and reported in the project area.*

3.2.2. Aquatic ecology

Flora

During the biodiversity survey, Green algae (Chlorophyta) like *Ulothrix* spp. and *Fontinalis* spp. were identified among the phytoplankton. No aquatic plant species, which are endangered, threatened or rare, were reported during the period of the survey.

Fauna

- **Fish survey on the River Tlawng**

The fish survey on the river Tlawng was done as part of assessing the biodiversity in the declared Riverine Reserve Forest. The objective of the survey was to identify the possible negative impacts of the construction of the bridge and widening of the P1B within the Reserve forest on the fish species, identify existence of rare or endangered species, if any within the study area and to draw inference on the condition of the aquatic ecosystem. Photographs of the flora and faunal survey on the river Tlawng are given in **Figure 3.7**.

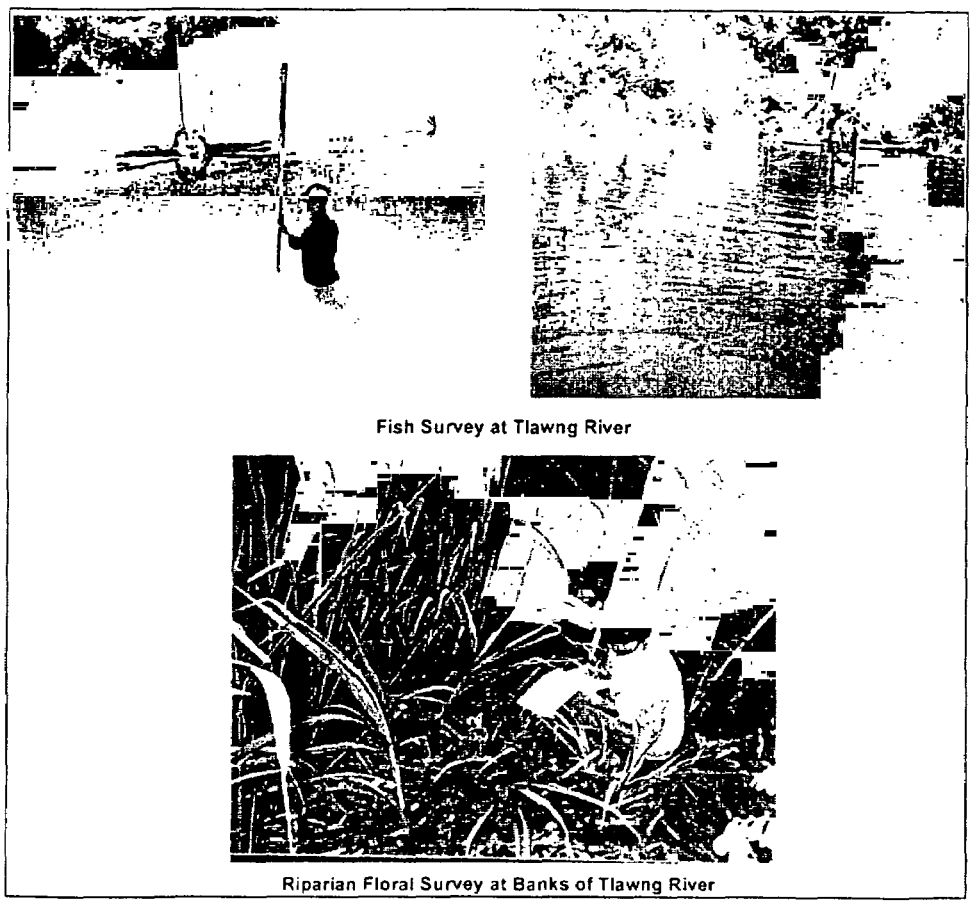
Methodology adopted for fish sampling:

Random experimental fishing was done in the lotic water of Tlawng by local made fishing net of 152 x 900 cm. at upstream and downstream of the proposed construction site of bridge for a period of one week. The sizes of the aperture of the local nets that had been used were 1.0 x 1.0 cm, 1½ x 1½ cm and 3.0 x 3.0 cm respectively. Altogether, 6 stations were made for random sampling for a period of one week and of which percentage; average weight and size of each species were determined from the total number of collected specimens. In addition, water sampling was also done to know the physio-chemical characteristics of water of the study area. The average depth of Tlawng River is 98cm, while 196cm was recorded as deepest.

Inventory of floral diversity Assessment along River Tlawng

During the ichthyological survey only three species of fish could be found and collected, viz. *Puntius ticto, Amblypharyngodon mola* and *Channa striatus*. The presence of some species like, *Mastacembelus armatus, Barbus tor tor, Channa*

orientalis, Xenentodon cancila, Chanda manarays, Notopterus chitala, Noemacheilus spp., *Puntius filamentosus, Maraena thyroidae*, etc. were reported to be found by the local fisher flock which generally reappear during rainy season. The fish species identified are common and found all over the country. During the study, 52 fishes were collected and *Puntius ticto* was the dominant species. Thus, the percentage, average weight and size of each species were determined from the total number of collected specimens. By mere observation, only fingerlings of Puntius ticto can be sighted at different stations. Below is a fish sampling data sheet.



Fish Survey at Tlawng River

Riparian Floral Survey at Banks of Tlawng River

Figure 3.7 : Floral and Faunal Survey at Tlawng River

Table 3-11 : Fish sampling data sheet

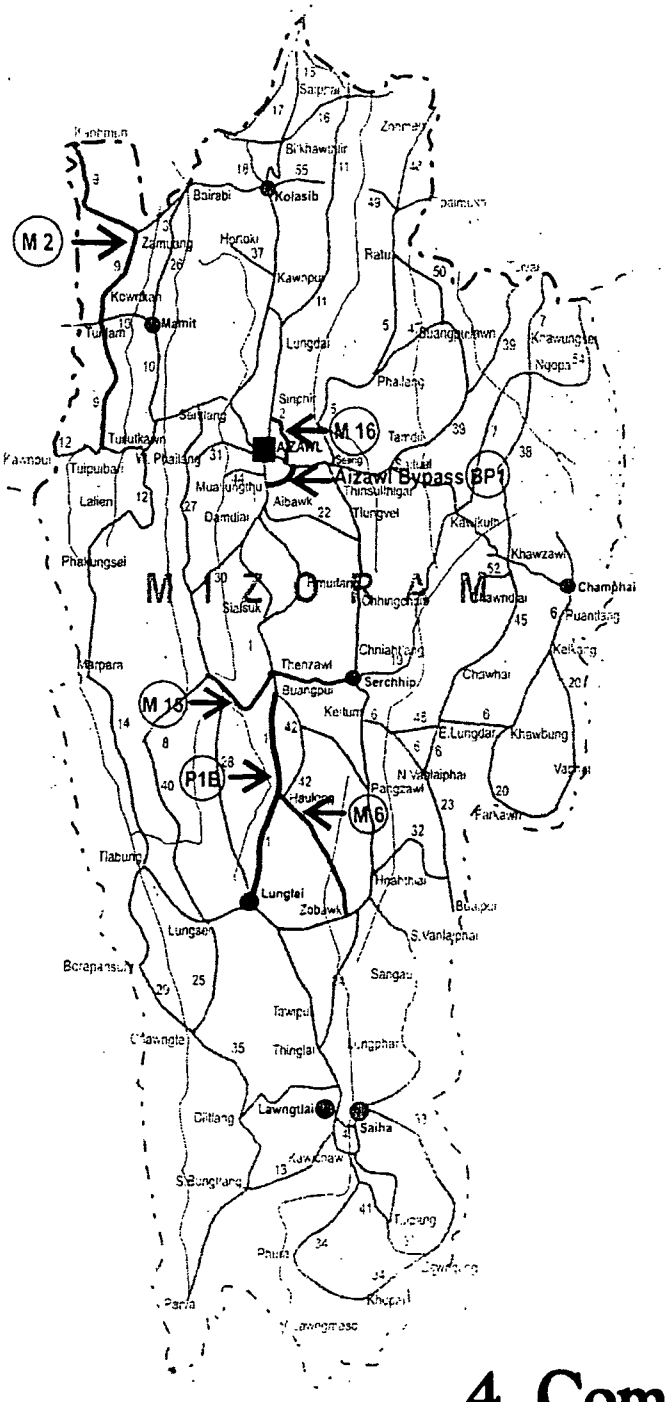
No.	Name of Species	Total count	Average length (in cm)	Average weight (in gm)	Percentage from grand total count
1.	*Puntius ticto*	50	5cm	6gm	96.15
2.	*Amblypharyngodon mola*	1	8cm	10gm	1.92
3.	*Channa striatus*	1	14cm	40gm	1.92
	Grand total count	52			

Note: The total length of a fish is measured from the tip of the snout to the end of the tail fin.

The survey didn't find any spawning grounds within the study area. On analysing the fish sampling data, the collected specimens cannot be in any way categorized as abundant, rare, threaten or endangered.

- **Other Aquatic Fauna**

Other than the fish species the ichthyological surveys identified Larva and adults of various benthic micro invertebrates and large colonies of tadpoles during installation of the nets. Calls of frogs were also heard during the night and evening. A number of avian species (water fowls) e.g., Kingfisher were also identified by sighting and calls during installing the nets.



4. Community Consultation

4. COMMUNITY CONSULTATION

Extensive Community Consultation has been taken up during the Environmental and Social Assessment for MSRP. Building on the phase I feedback on the documentation aspects of consultation sessions, increased attention on recording the information generated during the Phase II sessions has led to substantial inputs into the project preparation – including influencing design. This chapter documents the issues that are close to the community, their aspirations and their addressal by the project. Information source for the chapter has been the similar documentation as part of the R&IPDP, with the social team conducting these sessions.

A three-stage consultation process has been followed in the project. The first two stages of consultation with the people have already been carried out during the pre-design stage and the post-design verification stage. The follow up consultation program would be conducted during the implementation of the project by the NGOs. The objectives of consultation sessions, the procedure adopted and the outputs of the consultation conducted have been briefly described in the following sections.

4.1. PRE-DESIGN CONSULTATION PROCESS

4.1.1. Objective

The pre-design consultations were conducted by the PCC. Objectives of the consultation were:

- Information dissemination on the Project;
- Identification of stakeholders in the project; and
- Identification of issues of the stakeholders concerning the project.

4.1.2. The Process

Several tools for consultation were applied and the views, suggestions and the concerns of the community with respect to the project were obtained. The following paragraphs describe the consultation process in detail.

The consultation process established for the project employed a range of formal and informal consultation tools including, in depth interview with key informants, village meetings, workshops and door-to-door personal contacts. Consultation sessions were held with:

- Heads of the households likely to be impacted;
- Members of the households likely to be impacted;
- Clusters of PAPs;
- Villagers;
- Village Council Presidents;
- Local voluntary organisations, and CBOs/NGOs;
- Government agencies and departments;

- Other project-stakeholders, such as women, prominent persons from the villages (such as teachers, health workers, doctors).

All households were covered under the initial rounds of consultation (door-to-door personal interviews). The household level consultations were carried out with the help of a checklist prepared and circulated in advance to the various groups through the Village Council Presidents. Village level meetings (See **Table 4.1**) were also conducted. The information regarding the meeting schedule was announced over the Public Address System[10].

Table 4-1: Participation in Consultation Meetings

Project Impacted Villages	Questionnaire Based Surveys		Group Discussions	
	Male	Female	Male	Female
Priority Road (P1B)				
Kanghmun	0	0	16	1
Ramlaitui	7	1	49	5
Sekhum	2	0	2	0
Mualthuam	5	2	13	0
Haulawng	4	1	90	7
Mausen	2	0	1	0
Pukpui	1	1	18	1
Zotlang	1	0	44	8
Lunglei	1	0	2	0

4.1.3. Issues Raised During Consultations

The issues of the community in the Project Impacted Villages were compiled on the basis of questionnaire based surveys and group discussions. **Table 4.2** summarises the questionnaire-based issues. The questionnaire-based surveys were conducted during October and November 2001[11]. The group discussions were conducted on 5th and 6th November 2001. **Table 4.3** gives the issues raised during the discussions. Both specific issues of villages and common issues raised by the villagers have been described.

4.1.4. Perceived Impacts

In almost all meetings, the villagers seem to take their environmental resources for granted. None of the impacts on natural resources identified by the project team were perceived to be a significant. In fact, their perception of important issues focused more on the socio-economic aspects of the proposed development – reduced travel time between two most important cities of the state, timely and fair payment of

[10] Each village in Mizoram has a Public Address System.

[11] (The filled in questionnaires were collected on 4th to 6th & 8th to 10th, 27th, 29th and 31st during the month of October and on 1st, 4th to 6th during the month of November 2001)

compensation, etc. The only environmental issues, which were mentioned, albeit for their social impacts, were the blasting and its impacts as well as disposal site locations, additional disposal for leveling and future use of such locations. Another issue raised was the impacts on the Christian Hospital and the Church at Serkawn. Here too, the concern was due to the impacts on the patients and worshippers. The overall summary of the issues perceived important by the roadside population is summarised below.

Table 4-2: Questionnaire Based Issues and Responses

Issues Raised	Response
Priority Road (P1B)	
Awareness about the Mizoram State Roads Project.	About 50% people were aware about the MSRP Phase II.
Commercial activities relating to agricultural and forest products.	Most of the population depends on agricultural products. However, some people depend on handicraft and forest products;
Economic and Environmental benefits of the project	Majority of people were of the view that implementation of the project shall bring about; Change to horticulture and cash crops from the tribal Jhum; Economic and efficient movement of agricultural/ forest/Industrial products between production centres and market; Improved and increased accessibility to major towns/business centers and public facilities; Promotion of tourism and private investment; and Increase in community benefits such as access to roadside public amenities and improvement in connectivity to the village.
Type of forest products available (bamboo, medicinal/aromatic plants);	People almost from all villages were of the view that there is scope of such activities like horticulture, pisciculture, sericulture in their village and that scope for undertaking these activities will be further augmented by the implementation of the project.
Awareness regarding information about Government Programme (e.g. social forestry)	In almost all villages rural development programs existed and about 50% villagers were aware regarding the same; Government poverty alleviation schemes have benefited village people financially to buy machinery, house materials and agricultural implements.
Labour for project implementation.	Agriculture is the primary occupation followed by service and labour. Skilled and unskilled labour would be available for project implementation.
Health issues like spread of water borne diseases, STD/HIV awareness and availability of health facilities.	Most prevailing disease in the project area is malaria. Few cases of sexually transmitted diseases (STD) and HIV, drug abuse have also been reported. Medical facilities available for such diseases are at Primary Health Center.
Child Labour and Impact on Women	Most villagers reported that there are no child labour problems in their village and that there will be no adverse impact on women of the area during construction and implementation of the project.
Drinking water Availability.	Source of drinking water supply in most villages is through Government piped water supply or by rainwater harvesting which is usually not sufficient for the whole year.

Issues Raised	Response
Awareness of the negative impact of Jhum cultivation.	With regard to cultivation, the villagers are aware of the adverse impacts of Jhum (slash and burn) cultivation (i.e. damage land and forests, kills animals and is a source of air pollution) and were willing to switch over to settled type of cultivation.
Willingness to shift structures to a safe distance from road edge.	As far as shifting of structures from the edge of the road was concerned the people were divided equally, while 50% were of the opinion that structures should not be shifted, the other 50% wanted these to be shifted at a short distance from the village to a safer place.
Locations for water harvesting structures.	Village people gave suggestions regarding construction of tanks for water harvesting and disposal of waste material outside the village.
Locations of labour camps.	As far as the impact of the construction workers on the village is concerned, the villagers expressed that the construction camps, should be sited away from the village and that both positive and negative impacts are expected. Most villagers were of the opinion that both skilled and non-skilled workers could be made available from their villages for the project.
Traffic safety measures	During the construction period, most villagers were of the opinion that traffic should be allowed to move in one direction at a time. Villagers were of the opinion that for safety of children, women, pedestrians and other non-motorised carts of the village, it is essential to put up speed breakers at the entry and exit points of the village along with appropriate signages.

(a) Positive Impacts

- The project would accelerate development of trade and commerce, which in turn would lead to an overall increase in the standard of living in the villages.
- The project would enable the people to save time, money and fuel.
- Travelling to places like Lunglei and Aizawl for medical treatment would be easier.
- PAPs would be able to sell agricultural products more profitably as improved road condition will enable access to a wider market area. More villages would be able to sell perishable goods to the urban centres (which is difficult now due to the long travel time).
- More individual households would be able to open small roadside businesses (such as provision shops, 'vehicle repairing' shops, restaurants) to increase their income.
- Influx of tourists and visitors would help the local entrepreneurs.
- Value of land will increase after the project is implemented.
- Communication with other villages and urban areas will be improved.

(b) Negative Impacts

- The PAPs were apprehensive about just and timely payment of compensation by the Government. People were assured that all possible, and feasible actions would be taken up to ensure that such issues do not arise in the project. They were informed about the compensation and assistances that would be given to them against loss of assets, land and livelihood.

Table 4-3: Group Discussion Based Issues and Responses

Village	Environmental & Social Issues Raised By The Participants	Responses from project officials
Community Structures		
Kanghmun	Kanghmun playground is situated on the hillside of the road. It is felt that it will be destructed if the road is widened. What will be the remedial measure to be taken?	After the finalization of detailed engineering for Phase-II project, it has been ascertained that the Kanghmun playground is not being affected.
Ramlaitui	If Ramlaitui Community Hall is demolished, will it be compensated?	It would be compensated and relocated.
Design		
Kanghmun	The grade of the approach road at Kanghmun village is better than the existing road and it is felt that its construction cost will be more than the existing and will be more beneficial for the villagers. Will it be possible to re-align the existing road to the approach road?	This proposal may be submitted to the Project Director PWD, who may initiate the survey to compare and select the better one.
Pukpui	How will you reconstruct steep gradient of the existing road especially Tlawng River to Pukpui?	From the Engineering Survey Report it will be determined if the road gradient is within permissible limit and if it is not it will be constructed accordingly.
Several locations	If any approach road from main road is destructed, what are the remedial measures to be taken?	The contractor will reconstruct the approach road in the most beneficial way for the user. There is monetary provision for this in the project.
Several locations	What type of road is to be constructed? Will the existing side drain and culvert be reconstructed?	Intermediate lane road measuring 7.1 m formation width and 5.5 m width black topping will be constructed. The existing side drains, culverts and Bridges will be restored and new ones will be constructed wherever necessary
Several locations	Will it be possible to widen the busy area of village road than the other?	It will depend on the attitude of the villagers.
Several locations	What type of stones should be used for pavement?	It will be as per the specifications of the design.
Environmental Issues		
Several locations	It was decided that the earth spoil would be disposed off at the identified disposal sites, but in certain cases it could be necessary to blast up the rock, which may cause damage to the valley side properties. If so, what are the remedial measures to be taken?	If the situation arises, utmost care and maximum precaution will be taken and shall be the responsibility of the contractor, whose work will be supervised by the Supervision Consultants.
Several locations	Fountain which is the water source of the village situated on the down hill side of the road will be filled with earth spoil during construction. What will be the remedial measure to be taken?	All the earth spoil will be disposed off at the identified disposal sites after ensuring that there is no damage to community structures like water fountains. The Construction Supervision Team is there to ensure that no damage is done to water sources and will ensure that remedial measures are taken if this is inevitable.
Several locations	As mentioned a disposal ground for earth spoil has been selected with the intention of constructing Playground, Bus stand etc. If the earth spoil is not sufficient, will it be possible to fill the remaining portion?	At present, final decision cannot be made regarding this matter. The contractor can be requested. But the implications have to be decided on a case-to-case basis.

Village	Environmental & Social Issues Raised By The Participants	Responses from project officials
Several locations	In the questionnaire you had asked whether there was site for debris disposal. We would like to know what debris meant?	Debris mainly refers to the earth spoil or excess cut material.
Several locations	The community has planted Banyan and other trees on the roadside. Will this plantation be damaged?	It is speculated that no plantation will be damaged because of the construction, but if it is damaged it will be compensated as per provisions in the EMP.
Serkawn	Serkawn Church and Hospital are situated besides the road. When the traffic increases, it will be a problem for worshippers and patients. What are the remedial measures to be taken?	A retaining wall, 6m high is being constructed in the area over the existing boundary wall. This will reduce the noise in the church considerably.
Utility Relocation		
Mausen	The road construction will damage the water pipe about 3 km at Mausen village. Will it be possible to construct this damage?	The contractor will reconstruct any damages that may be caused due to construction
Construction Activities and Project Implementation		
Several locations	Where will the construction begin?	It will begin at different places as soon as the contract is awarded.
Several locations	When the actual execution of work will start? Up to what stages this project include?	Phase-I is expected to start between March to April 2002 and Phase-II is expected to start after a lapse of one year. The work envisages widening of carriage way and its geometric improvement, rebuilding the pavement to structurally sound design, construction of bridges and culverts, side drains, slope protection works.
Safety of structure during construction		
Several locations	Has any provision been made for buildings on the hillside of the road, which are not damaged during construction but may be dangerous/instable?	A team of experts will initiate a survey and remedial measures will be taken up such as construction of retaining wall, Brest wall etc. wherever necessary.
Compensation		
Several locations	Will the compensation be awarded before construction?	Yes
Several locations	If the house is to be shifted, will the site for the new house be developed?	According to the World Bank policy, if any house is destructed, a new house whose value is not less than the previous one is to be constructed.
Several locations	When will the special committee for compensation be formed?	It will be formed after the survey report has been finalized.
Several locations	How will you assess the building for compensation, if only a small portion of the building is to be damaged?	The whole building will be assessed for compensation, but only the required land for widening the road will be acquired and compensated, not the whole land.
Land Acquisition		
Several locations	In the beginning of the project study, it is mentioned that 20 m of the land along the roadside will be acquired. Is it still intended?	Only the required portion along the roadside will be acquired for the construction.

- There were apprehensions about timely completion of the project and the quality control mechanism. The implementation schedule and arrangements, including the procurement of supervision consultants and technical auditors were explained to the people.
- Dust and debris due to hill cutting and the adverse impacts on the valley side were the important concerns raised by the community. Appropriate precautions need to be taken for the safety of structures on the valley side.
- There were apprehensions of an increase in landslides due to the cutting of hillside slopes and the trees.
- The project might increase the chances of vehicular accidents since traffic in general would increase after the project is completed.

4.2. POST-DESIGN CONSULTATION

The Independent Environment Review team conducted the post design appraisal of the issues raised by the community. The process adopted for the appraisal includes:

- On site assessment of issues raised by the community;
- Discussions with the stakeholders on specific issues;
- Integration of community issues with the mitigation strategies; and
- Design Response to the issues raised.

The post-design consultation was restricted to specific issues raised by the villagers in the light of the proposed design for the project corridor. The site visits were conducted between 9th and 13th January 2003. The issues have been detailed in **Table 4.4** along with the design response to these issues has been given. Follow up consultations shall be conducted with the final designs displayed for the public

4.3. FOLLOW UP CONSULTATION PROGRAMME

The follow up consultation process is conducted by the NGO with the objective of involving the stakeholders in every stage of project implementation. It involves two components viz, information disclosure and continuous consultation with the PAPs and roadside communities where appropriate.

4.3.1. Information Disclosure

The Phase II EA documents will be disclosed at each of the project-affected villages, for the benefit of the interested community, and the stakeholders. The reports would be kept at a community place so that it is accessible to all the villagers.

The report will also be available, with the PWD headquarters at Aizawl and the PIU office at Aizawl. The report from these places will be available to the public on request for reference. PWD project implementation unit office will provide actual information on policies and other rehabilitation action plan to the people, on a regular basis.

Also, the PAPs would be informed by the NGO of the final project design and the solutions devised for the issues raised by them during the earlier stages of consultation. **Table 4.4** gives the issues and the design responses which need to be disclosed to the villagers.

4.3.2. Continued Consultation

As part of the continued consultation program, the following actions are proposed:

- The NGO involved in implementation of the R&IPDP will organise public meetings, and will appraise the communities about the progress in the implementation of R&R and Environmental works as required.
- The functions of Grievance Redressal Committees (GRCs) through which the project road traverses should be explained to the PAPs. The representatives of the PAPs will be associated with the committee.
- The resettlement sites, other amenities and facilities to be made available to the PAPs will be disclosed to them in consultation sessions.
- The NGO will organise public meetings to inform the community about the entitlements and provisions under the project. Regular update of the progress of resettlement component of the project (summary version of the report submitted by the NGO) will be placed for public display at PIU office.
- All monitoring and evaluation reports of the R&R components of the project will be disclosed in the same manner as suggested in this R&IPDP report.

Table 4.5 summarises the important aspects of continued community participation in the project. Though the focus is on implementation of R&R issues, it is expected that the NGO selected for the plantation component will continue to provide key inputs to the entire consultation process, either on its own, or through the PIU.

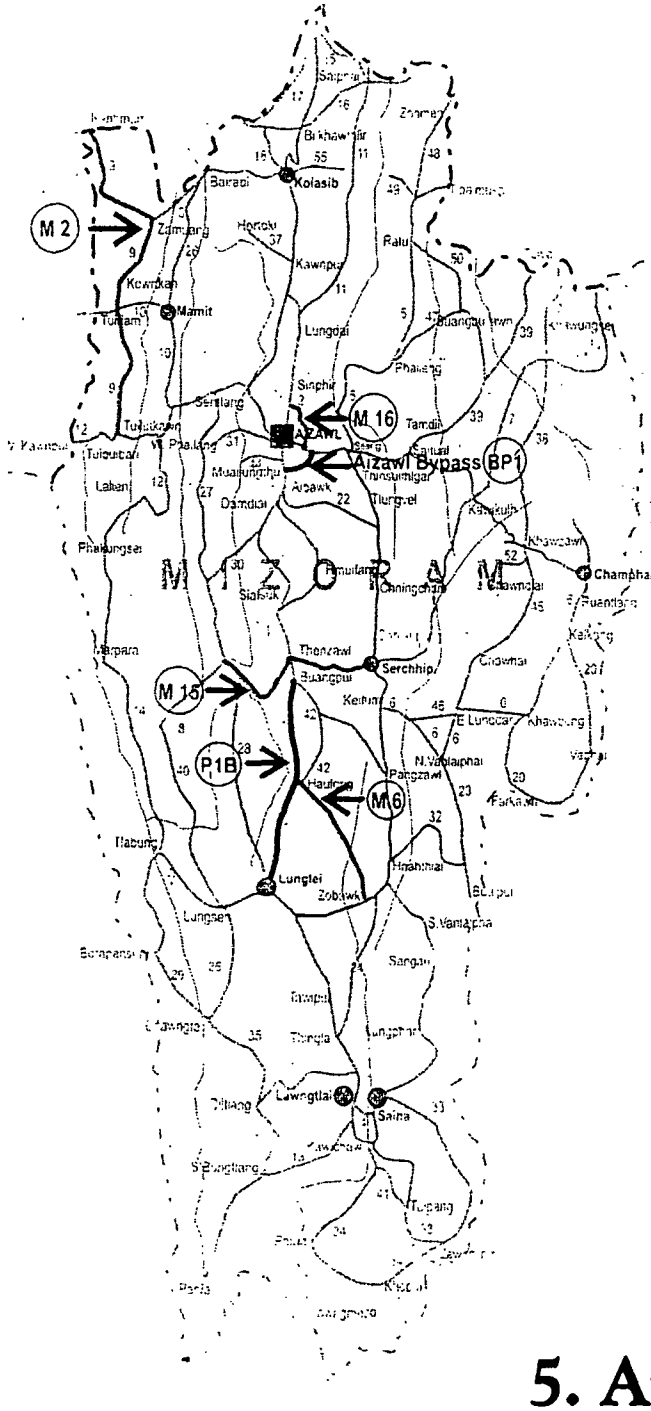
Table 4-4: Specific Issues Raised by the Community

Location	Issue	Design Response
Protection of Community Assets		
Ramlaitui Village at Existing Chainage Km 110.440	The review team during site visit received a representation from the community to save a community hall and its compound to be affected even if requires dismantling of private residential structures on the other (valley) side.	The design team has agreed to the suggestion and hence, the road widening would now be shifted to the valley side thereby causing no damage to the community hall. Further, no additional structures would be affected.
Noise Pollution		
School at Ramlaitui at Existing Chainage Km 111.260	The village community during the site verification by the review team raised the issue of the location of the school along the corridor. They felt that the increased traffic on the road would cause noise pollution and harm to the students.	A noise barrier wall has been proposed for the Government Middle School at Ramlaitui. The proposed noise barrier wall shall be of 2m heights. The contractor as per the direction and satisfaction of the Construction Supervision Consultant shall build the wall. The specifications and budgetary provisions for the same has been made in the EMP.
Christian Hospital, Serkawn	The hospital authority and the church raised the issue of junction improvement, and noise pollution to the hospital with the review team during the site verification.	At the Christian Hospital, a design involving improvement of the existing junction, noise barriers such as rows of plants of different heights to block noise. It is also proposed to make it aesthetically look more pleasing, taking into consideration some minor improvements requested by the Church Officials. (Refer **Figure 6.9** and **6.10** in chapter 6 of the EIA)
Safety		
Lunglei Town Area	Need for a footpath in the Bazaar Veng section of the project.	A 1.2 m wide footpath has been provided towards the valley side. Bills of quantities and specific drawings have been prepared for the same.
Community Structures		
Kanghmun	Kanghmun playground is situated on the hillside of the road. It is felt that it will be destructed if the road is widened. What will be the remedial measure.	After the finalization of detailed engineering for Phase-II project, it has been ascertained that the Kanghmun playground is not being affected. Although 2 structures on valley side are affected who are willing to relocate as per R&R policy.
Design		
Kanghmun	The grade of the approach road at Kanghmun village is better than the existing road and it is felt that its construction cost will be more than the existing and will be more beneficial for the villagers. Will it be possible to re-align the existing road to the approach road?	The project road follows the existing road. The grade shall be improved to the acceptable limits from the design point of view.
Common	What type of road is to be constructed? Will the existing side	Intermediate lane road measuring 7.1 m formation width and 5.5 m

Location	Issue	Design Response
	drain and culvert be reconstructed?	width black topping will be constructed. The existing side drains, culverts and Bridges will be restored and new ones will be constructed wherever necessary
Common	If any approach road from main road is destructed, what are the remedial measures to be taken?	The contractor will reconstruct the approach road in the most beneficial way for the user. There is monetary provision for this in the project.
Utility Relocation		
Mausen	The road construction will damage the water pipe about 3 km at Mausen village. Will it be possible to construct this damage?	The utility relocation plan would incorporate the relocation of the water pipe if affected.
Environmental Issues		
Common	It was decided that the earth spoil would be disposed off at the identified damping sites, but in certain cases it could be necessary to blast up the rock, which may cause damage to the valley side properties. If so, what are the remedial measures to be taken?	If the situation arises, utmost care and maximum precaution will be taken to protect the structures on the valley side. It shall be the responsibility of the contractor, whose work will be supervised by the Supervision Consultants.
Common	As mentioned a disposal ground for earth spoil has been selected with the intention of constructing Playground, Bus stand etc. If the earth spoil is not sufficient, will it be possible to fill the remaining portion?	The contractor shall be asked by the PIU to carry on disposal with prior permission of the Village council as per R&R policy. The villagers can put forward their concerns while granting the permission to the contractor through the village council.
Compensation		
Common	If the house is to be shifted, will the site for the new house be developed?	According to the R&R policy, if any house is destructed, a new house whose value is not less than the previous one is to be constructed.
Land Acquisition		
Common	In the beginning of the project study, it is mentioned that 20 m of the land along the roadside will be acquired. Is it still intended?	Only the required portion along the roadside will be acquired for the construction.
Aizawl Bypass	Will you use the land of Pachhunga University College, Aizawl?	14000 sq. mts of Pachhunga University land would be acquired.

Table 4-5: Mechanisms for Continued Participation in the Project

Project Stage	PAPs and their Representatives	NGOs	Local Officials (In Project and Host Areas)	Village Council
Verification of PAP list	• Receive information on project impacts. • Participate in the coordination committee. • Participate in census surveys. • Participate in consultations to develop IR programs. • Keep records of consultations. • Choose resettlement alternatives or housing schemes. • Inputs of design of resettlement locations. • Participate in grievance tribunal.	• Carry out baseline verification and updation on the basis of formats provided. • Assist in census and socio-economic survey. • Participate in coordination committee. • Organise consultations. • Representation on grievance tribunal. • Facilitate PAP inter-group meetings.	• Assist in baseline verification and updation. • Assist NGO in information dissemination. • Participate in Public Consultations. • Arrange PAP transport to site. • Help to document consultations. • Support the village council's work in implementation. • Examine feasibility of IR programs and discuss with PAPs.	• Improve information and inputs to design of income restoration programs • Identify existing income restoration schemes • Discuss areas of possible conflict with PAPs
Implementation	• Monitor provision of entitlements and convey grievances to NGOs and PIU. • Labor and other inputs at site • Management of site and project input • Management of common property resources • Management of community development funds • Member of implementation committee	• Provide ongoing information for PAPs. • Forward grievances of PAPs and participate in grievance tribunal. • Provide support in group management • Monitor entitlement provision and implementation of IR programs • Members of implementation committee	• Process documents for LA and transfer of land to PAPs for relocation. • Process IR proposals • Participate in grievance redresssal • Provide assistance under local schemes • Membership of implementation committee • Process documents for welfare and socio-economic services (ration card, BPL card)	• Identify lands for relocation of displaced PAPs. • Form joint management groups for common resources
Monitoring and Evaluation	• Participate in grievance tribunal • Report to project on IR schemes • Reports on service quality at site	• Provide information to project staff on vulnerable groups • Act as external monitors for project	• Ongoing interaction with PAPs to identify problems in IR programs • Participants in correctional strategies	• Provide inputs to monitoring and evaluation of R&R



5. Analysis of Alternatives

5. ANALYSIS OF ALTERNATIVES

Activities in Phase II of MSRP, along P1B, are essentially the same as for Phase I and have therefore been already covered in the earlier assessment. As shown in **Figure 5.1**, the scope of SEA covered selection of alignment alternatives. Both phases of the project P1A and P1B are a part of the prioritised alternative of SEA. Hence for the purpose of this report, scope of alternative analysis is limited to evaluation of realignment options for short stretches and mitigation alternatives for the alignment. Both the components are dealt with in the following sections.

5.1. WITHOUT PROJECT AND WITH PROJECT SCENARIOS

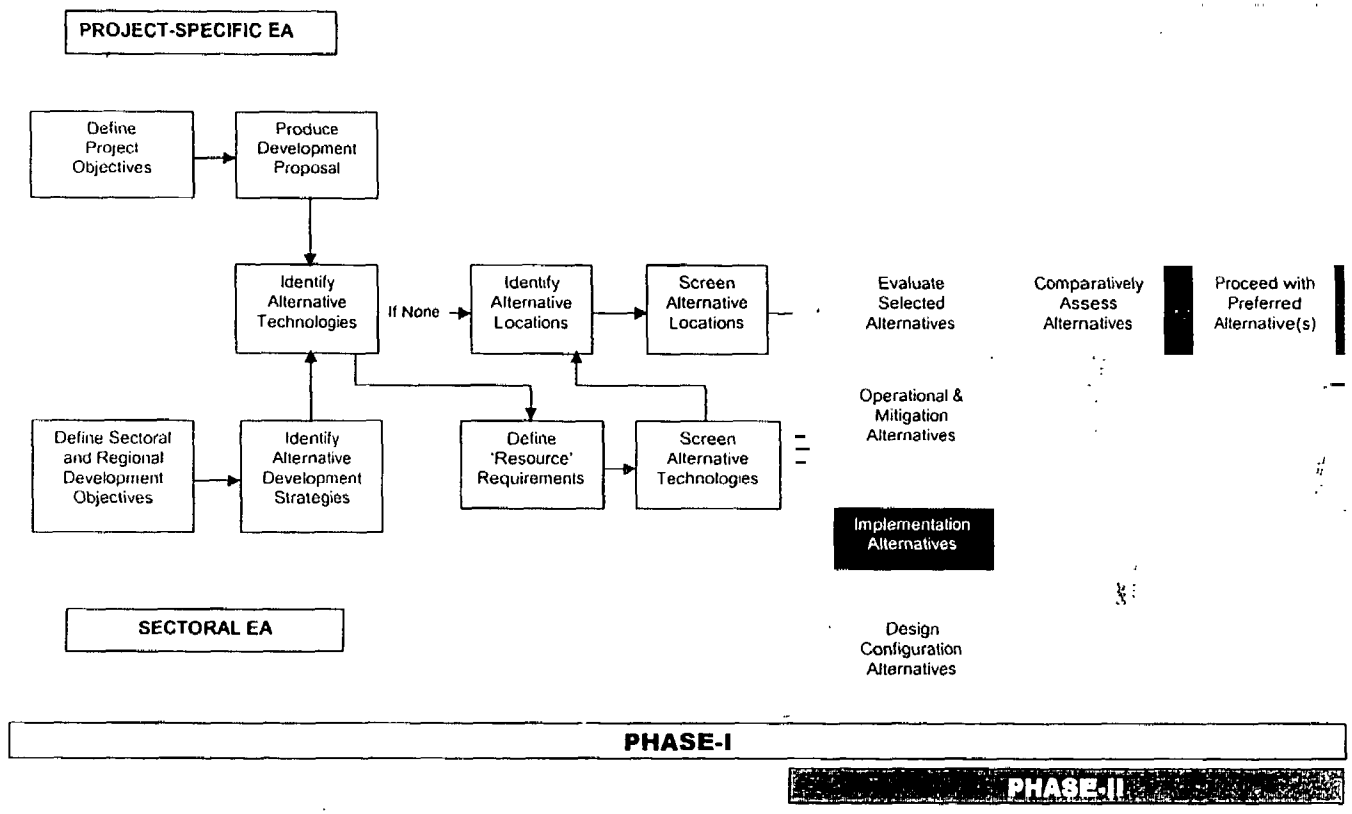
One highly unlikely, but theoretically possible, decision could be not to proceed with P1B Upgradation because of unacceptable residual impacts. There is no information other than that presented in SEA regarding the existing environmental conditions or the anticipated impacts, which would justify without project scenario. Impacts due to the project implementation are not significant and mitigation measures can be built into the project to reduce them to acceptable levels. However, if it is decided not to proceed with the project, the reduced socio-economic development of this remote, relatively poorly connected hill state cannot be justified.

5.2. ALIGNMENT SELECTION (ENTIRE BUANGPUI – LUNGLEI SECTION)

For road projects in hills, provision of new alignments is very expensive and would involve adverse environmental impacts. Even from the environmental perspective, widening along an existing alignment may be more acceptable than a fresh alignment. Phase II of MSRP has few new realistic alternative alignments that remain unexplored. SEA prepared for the project analysed the road sector as a whole from an environmental perspective. Moreover, since the decision to follow the older PWD alignment has already been made, the examination of alternative alignments for P1B would not be useful.

5.3. RE-ALIGNMENTS FOR SHORT STRETCHES

Wherever short re-alignments are required from the geometric and/or safety angle, preference is given to hillside cutting over the filling up of valleys, especially if the slopes are very steep, as is the case in Mizoram. Only in short stretches valley side realignment is recommended, since the creation of the new formation on retaining wall can be prohibitively expensive and lack of stabilisation of fill, in absence of a retaining wall is a real safety risk. However, in cases of valley side widening, one advantage is that the space between the two alignments can be used for filling up the excess cut material. Hill side widening was also a preferred solution from minimising displacement point of view. To assess the likely social impacts the number



Adapted from Update no. 17 of World Bank EA Sourcebook

Figure 5.1: Stages in analysis of alternatives during MSRP

of structures within a likely corridor of impact[12] of 12 m was analysed. **Table 6-2** shows that 628 structures are there on the hill side as compared to 468 on the valley side. However, in the settlements of Kangmun and Haulawng, higher number of structures is located towards the valley side.

In Pukpui (161.820 km – 162.040km) the alignment was further altered **(refer figure 5.2)** to save 3 houses without alternative land for relocation. As a result only one house will be affected and the owner has alternative land to shift his residence. In Haulawng (132.340km to 132.400km) alignment could be shifted hillside **(refer figure 5.3)** to save 5 structures on valley side and affect only 3 on the hillside. In these settlements, minor realignments have been adopted to best fit the proposed cross-section to reduce impacts.

Table 5-1: Preferred Widening Option Analysis to reduce impacts

Settlement	Number of Structures			Preferred option	Final option (given by design team)	Remarks
	Hill Side	Valley Side	Total			
Kangmun	15	8	23	Valley Side	Hill Side	Widening is on Valley side in sections where cluster of houses are located on hill side
Ramlaitui	16	49	65	Hill Side	Hill Side	
Sekhum	33	44	77	Hill Side	Hill Side	
Mualthuam	18	25	43	Hill Side	Hill Side	
Haulawng	54	63	117	Hill Side	Both	
Old Mausen	5	5	10	-	Hill Side	
Mausen	11	29	40	Hill Side	Hill Side	
Pukpui	44	54	98	Hill Side	Hill Side	
Zotlang	45	36	81	Valley Side	Hill Side	Valley side structures are closer to road so hillside widening will cause less impact.
Serkawn	44	49	93	Hill Side	None	
Lunglei	183	266	449	Hill Side	None	

In all cases, it needs to be ensured that the hydraulic continuity of the terrain is maintained since accumulated water can become a potential hazard – by increasing vulnerability of slopes to sliding. An alternative to this can be the disposing only enough debris so that the height of the fill remains below the invert level of the lower culvert, whether on the existing or the proposed alignment. However, this would mean far less disposal space. Therefore, the Contractor and Engineer will have to identify more locations suitable for disposal along the route as the construction progresses.

[12] The likely CoI was fixed at 12m. Measured horizontally, without bias to the slope of the sides, 6m on either side from the center line of the existing carriageway (or center line of the road-width available, where paved carriageway is not available)

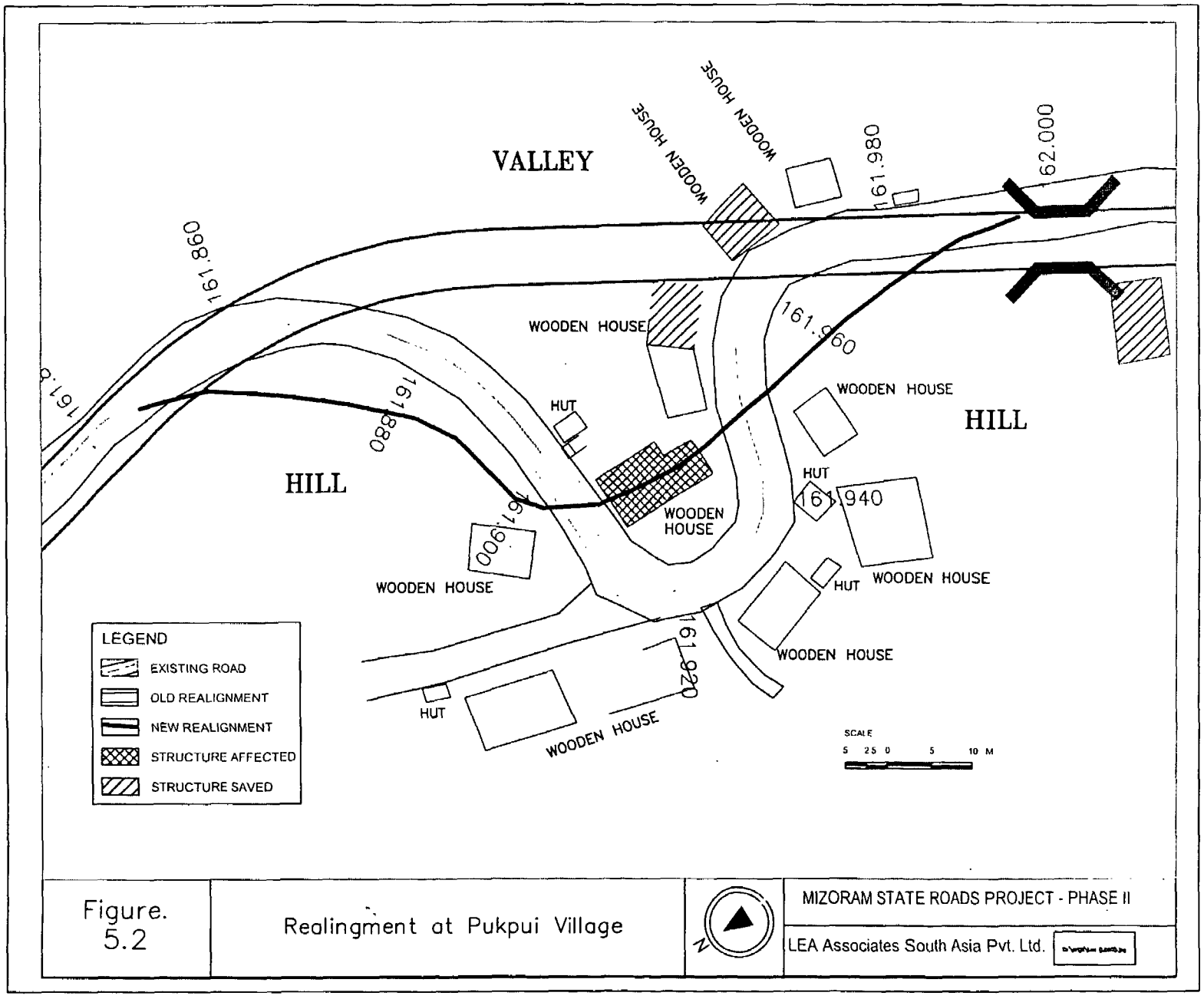


Figure. 5.2	Realingment at Pukpui Village	N	MIZORAM STATE ROADS PROJECT - PHASE II
			LEA Associates South Asia Pvt. Ltd.

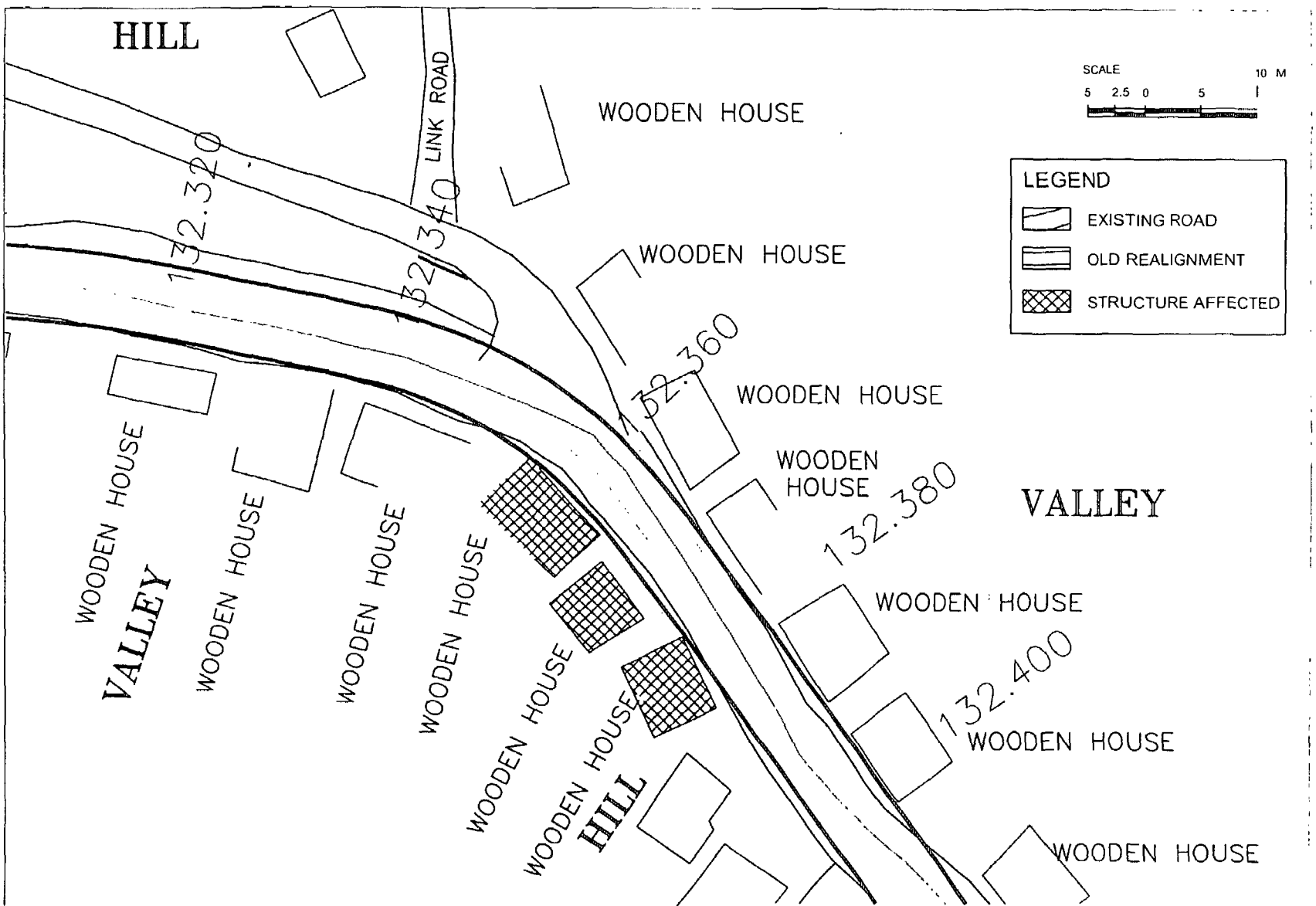


Figure. 5.3	Affected structures at Haulawng Village	N	MIZORAM STATE ROADS PROJECT - PHASE II LEA Associates South Asia Pvt. Ltd.

5.3.1. Design of Road Junction at Christian Hospital in Serkawn

The Christian Hospital in Serkawn is a reminder of the commendable role Missionary activity has played in the overall development of Mizoram. Presently, the approach to the hospital from the project road is by a rising ramp (**Figure 5-4**). Another side of the hospital can be approached from a level road leading to a hydroelectric project and the Baptist Mission's other buildings. The levelling of the junction, by lowering the road from the hydroelectric project site side will have multiple benefits, including reducing noise levels at the hospital.

The consultations with various stakeholders including hospital staff, local representatives and the Mission trustees involving the environmental and design teams of the PCC has led to the evolution of 4 alternative designs (**Figures 5-5, 5-6, 5-7 & 5-8**) a brief about each alternative would be required in addition to the option of maintaining the present conditions. Each alternative has its own advantages over the others. The final alternative involves construction of a retaining wall of 6m high above the existing wall. Hence, the noise gets damped before being transmitted to the hospital, reducing the noise levels. No other measures will be required to reduce the noise levels.

Noise Barrier for the School at Ramlaitui

In Ramlaitui village, the secondary school is located adjacent to the road. It is housed in a wooden building with from the back, away from the road (**Figure 5-9**). The school is not being relocated. Here, in addition to the noise level, safety of students is also an issue to be addressed.

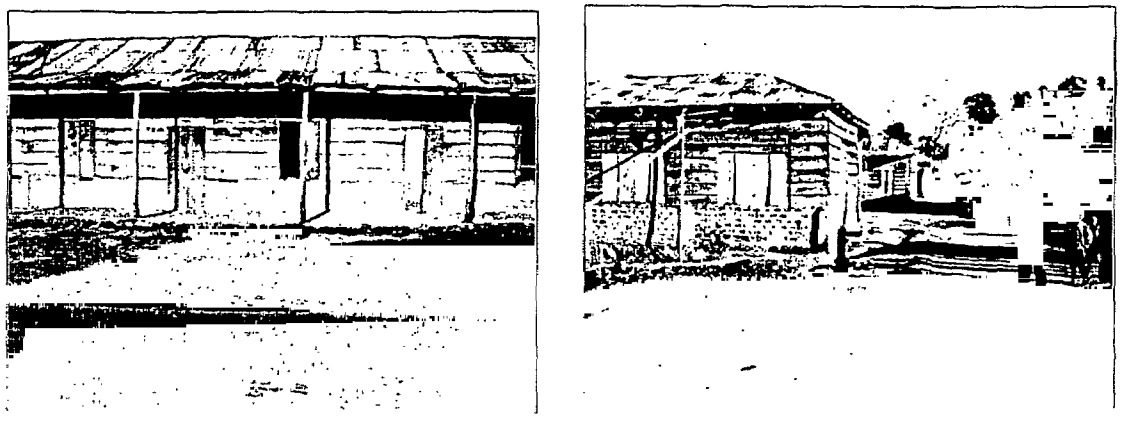


Figure 5-9 : Govt. Middle School at Ramlaitui Village

Here too, the options can be use of barrier or double-glazing. The advantage of barriers in this particular instance stems from the requirement of safety of the students. Since the structure is made from wood, the replacement with double glazed shutters

would be difficult. Therefore, the preferred solution is provision of a barrier on the side of the road with an entry gate on the side.

Once the proposed mitigation method is decided, the choice of the material for the construction of the barrier is the next aspect to be considered. The candidate materials are bamboo and stone. Bamboo is locally available, cheap and easy to install. However, stone masonry is stronger and results in a more integrated structure, which will have, better sound insulation. Moreover, during site visits, the headmaster of the school has specifically requested the provision of a permanent structure. In light of all these, the preferred solution is a 3 m. high stone masonry wall. This item too will be reflected in the civil works contract and executed during the project implementation stage.

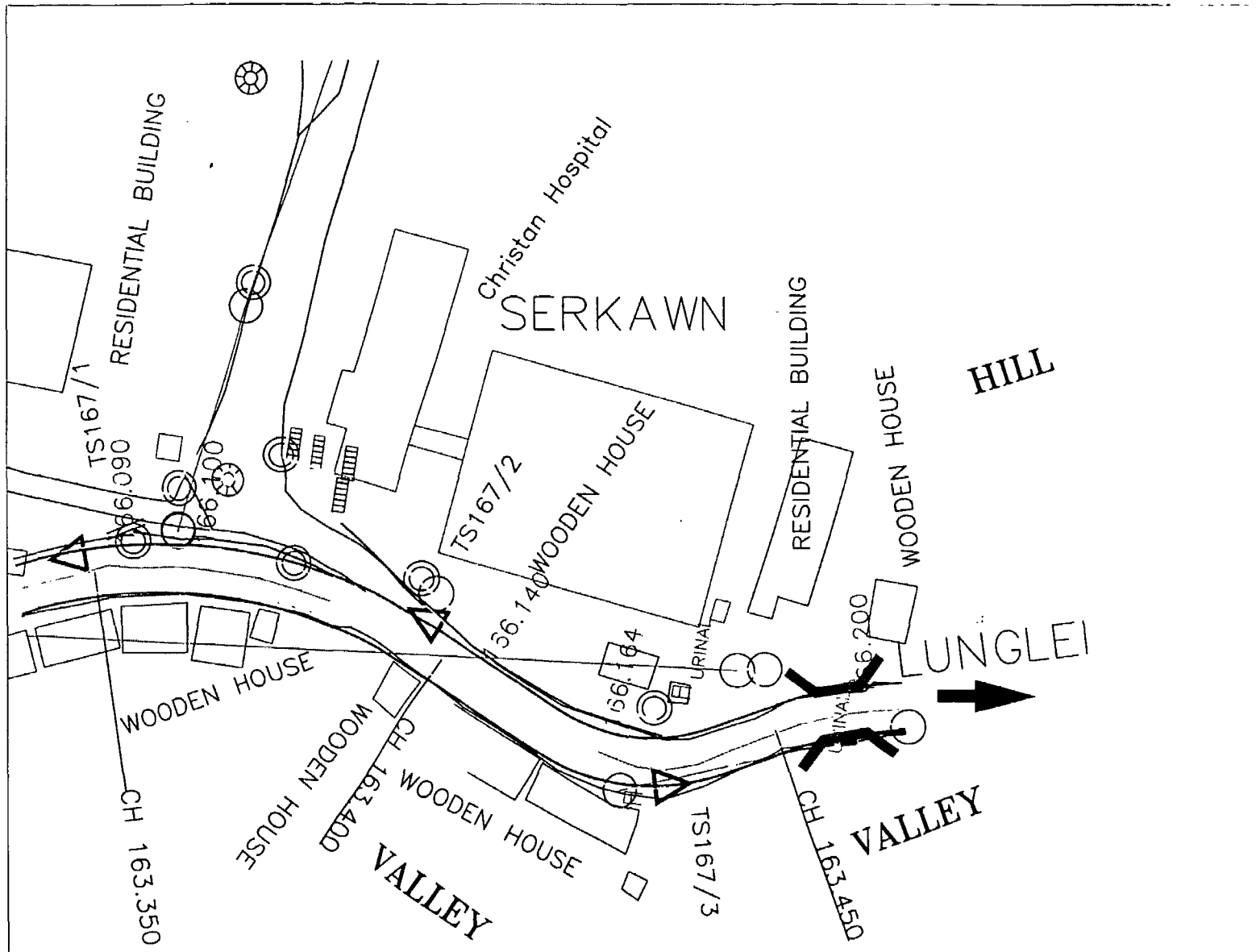
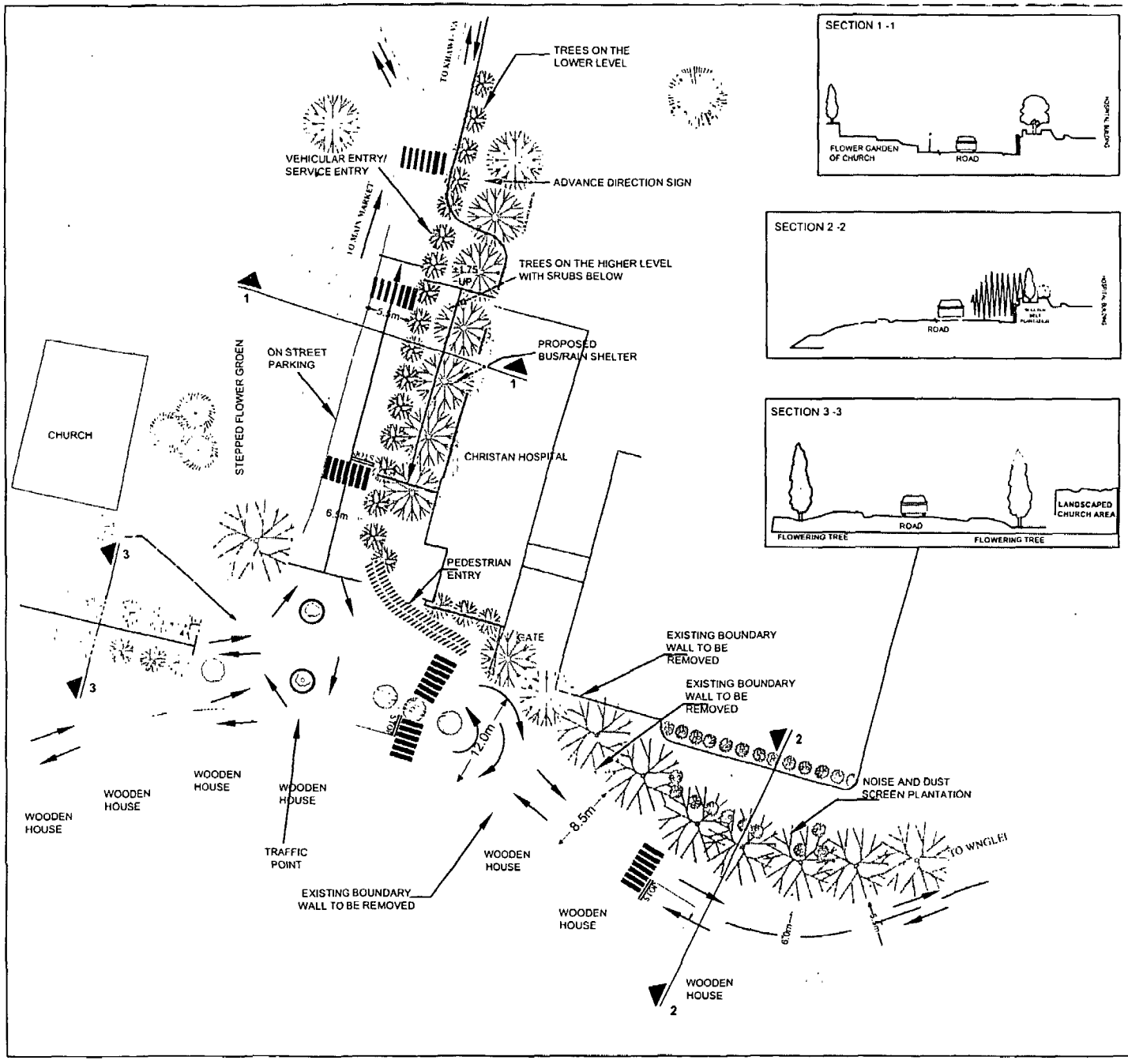


Figure. 5.4	Approach to Christian Hospital in Serkawn from P1B	N	MIZORAM STATE ROADS PROJECT - PHASE II LEA Associates South Asia Pvt. Ltd.



ALTERNATIVE : 3

- REMOVAL OF LEVEL DIFFERENCE BETWEEN MAIN ROAD AND HOSPITAL YARD
- TRAFFIC JUNCTION CREATED INCLUDING ACCESS TO KHAWI - VA HYDEL ROAD
- VEHICULAR RAMP UP TO HOSPITAL ON EXISTING PERIPHERAL ROAD INSIDE THE HOSPITAL COMPLEX

N

SCALE: 5 0 5 10 15

TITLE:

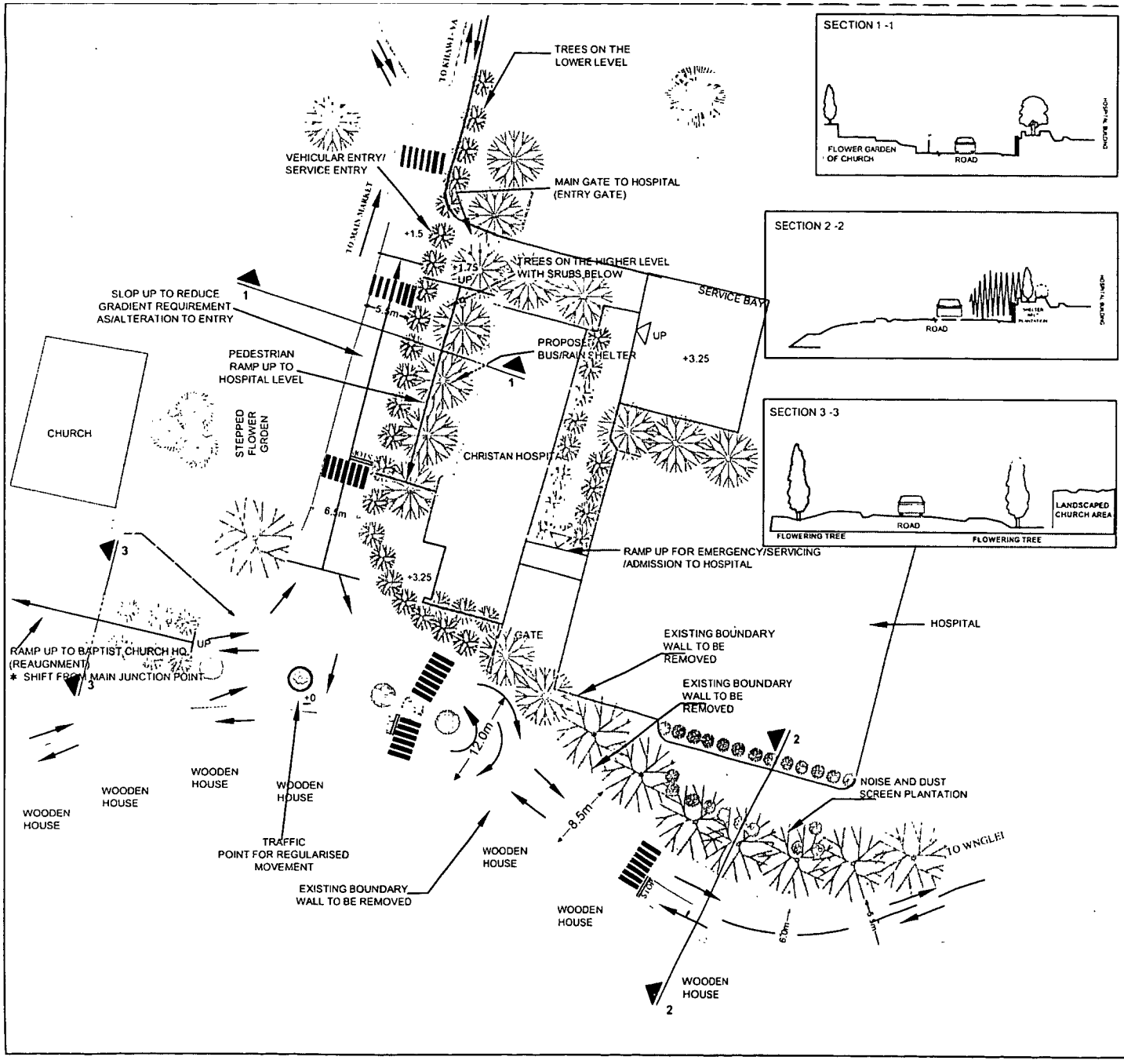
JNUCTION IMPROVEMENT PLAN No. 1 ON AIZAWL - BUNGPUI - LUNGPUI ROAD AT CHRISTIAN HOSPITAL SERKAWN

CLIENT:

GOVERNMENT OF MIZORAM
PUBLIC WORKS DEPARTMENT

DRAWING NO.	ADAPTED FROM ICT'S DESIGN OPTIONS
5.5	

LEA Associates South Asia Pvt. Ltd.



ALTERNATIVE : 4

- SIMILAR TO ALTERNATIVE 3 CEPT FOR SINGLE VEHICULAR + PEDESTRIAN ENTRY
- PEDESTRIAN ENTRY VIA RAMP ON EXISTING HOSPITAL PERIPHERAL ROAD
- PROVISION FOR HANDICAPPED INCLUDED
- SHIFTING OF ENTRY TO BAPTIST CHURCH HQ FROM MAIN TRAFFIC JUNCTION

SCALE: 5 0 5 10 15

TITLE:

JNUCTION IMPROVEMENT PLAN No. 2 ON AIZAWL - BUNGPUI - LUNGPUI ROAD AT CHRISTIAN HOSPITAL SERKAWN

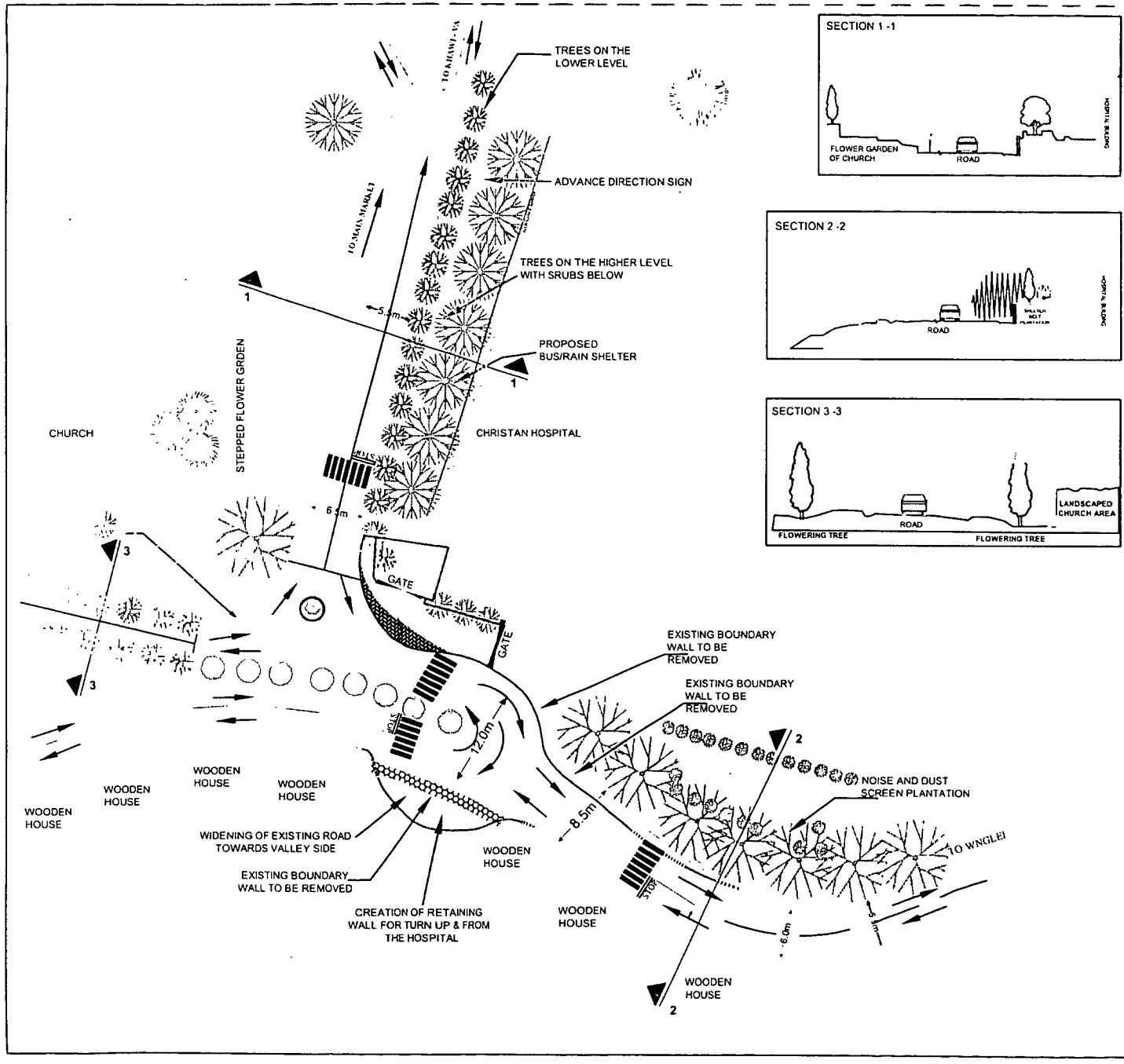
CLIENT:

GOVERNMENT OF MIZORAM
PUBLIC WORKS DEPARTMENT

DRAWING NO. 5.6

ADAPTED FROM ICT'S DESIGN OPTIONS

LEA Associates South Asia Pvt. Ltd.



ALTERNATIVE : 1

- MINIMAL CHANGES TO EXISTING
- FEASIBILITY OF CONSTRUCTION OF RETAINING WALL/ STRUCTURE ON THE VALLY SIDE
- TRAFFIC VOLUME/MODE ANTICIPATED ALONG MAIN ROAD (AIZ-LONGLEI) AND ROAD TO KHAWI - VA

N

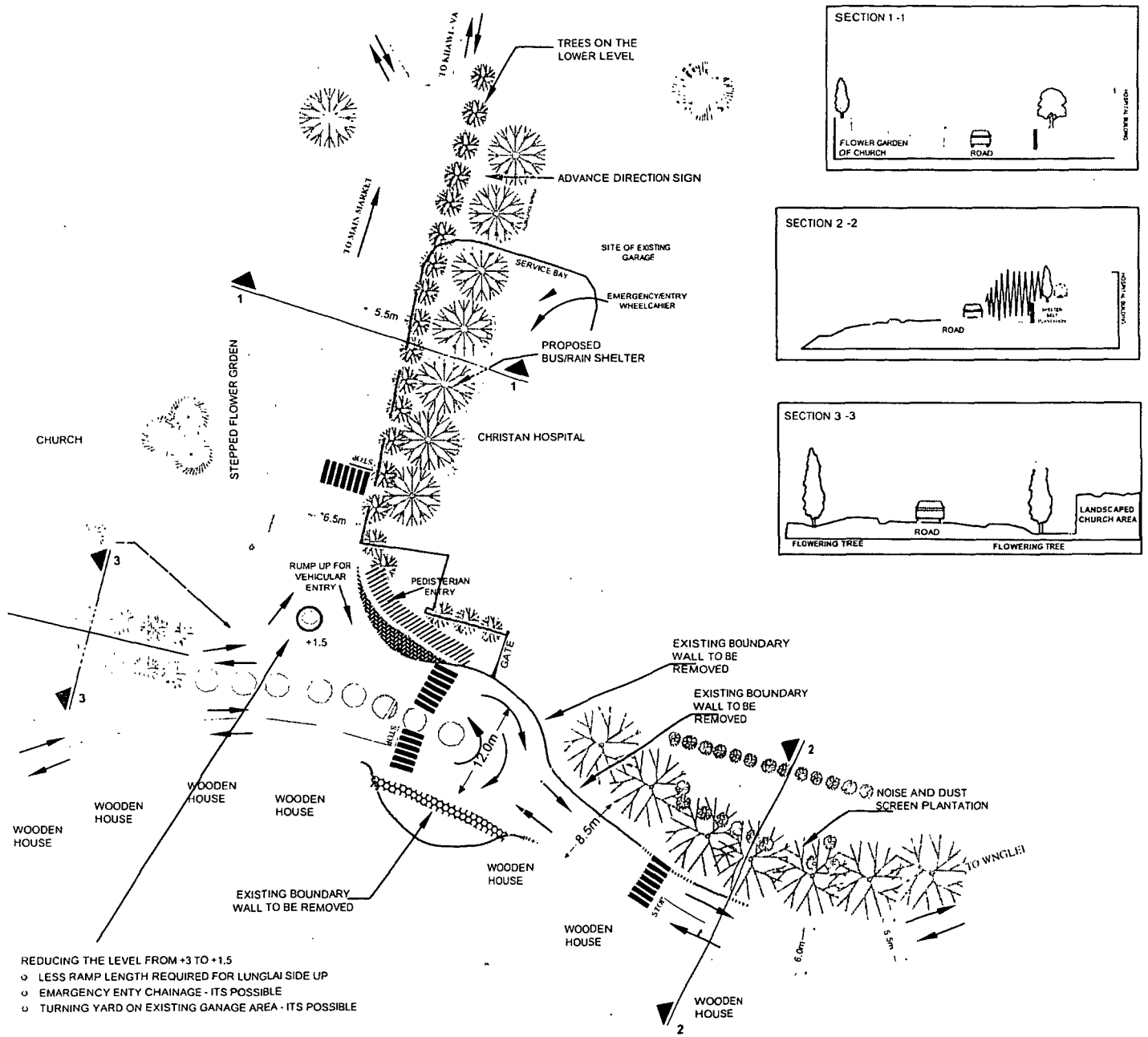
SCALE: 5 0 5 10 15

TITLE:
JNUCTION IMPROVEMENT PLAN No. 3 ON AIZAWL - BUNGPUI - LUNGPUI ROAD AT CHRISTIAN HOSPITAL SERKAWN

CLIENT:
GOVERNMENT OF MIZORAM
PUBLIC WORKS DEPARTMENT

DRAWING NO.	
5.7	**ADAPTED FROM ICT'S DESIGN OPTIONS**

LEA Associates South Asia Pvt. Ltd.



ALTERNATIVE : 2

SCALE: 5 0 5 10 15

TITLE:

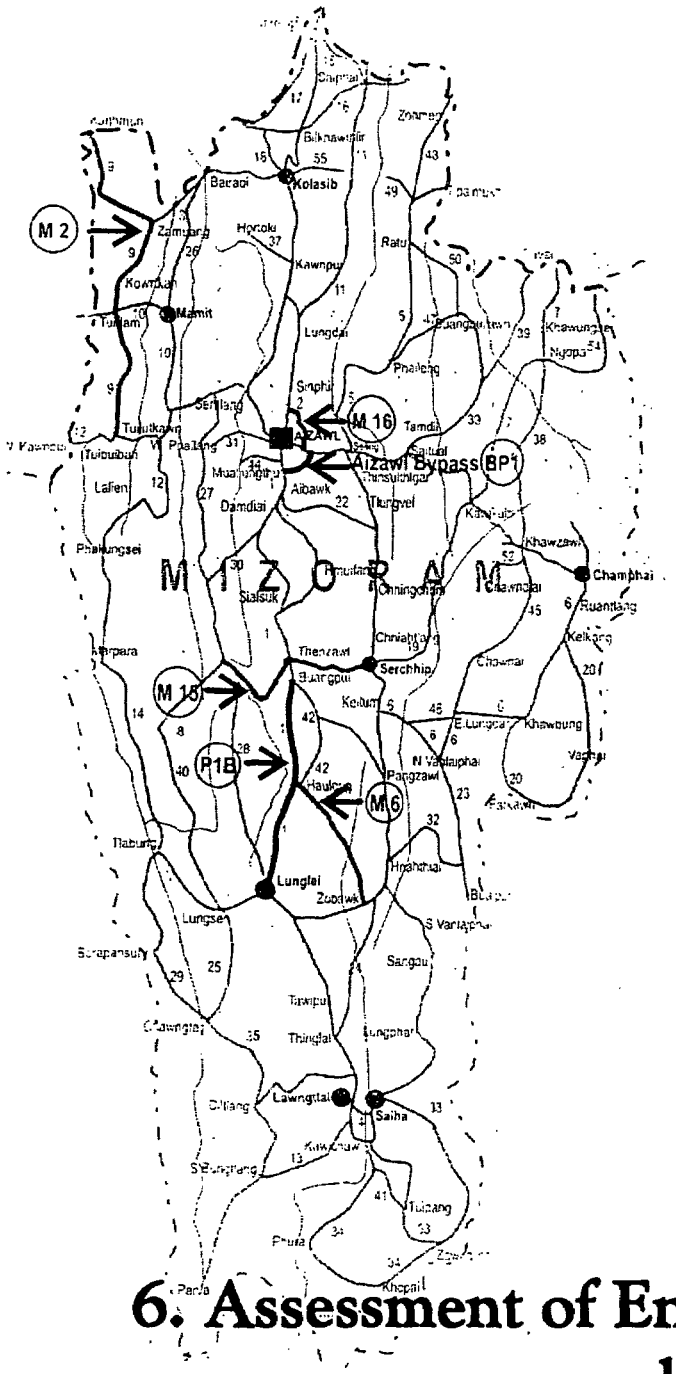
JNUCTION IMPROVEMENT PLAN No. 4 ON AIZAWL - BUNGPUI - LUNGPUI ROAD AT CHRISTIAN HOSPITAL SERKAWN

CLIENT:

GOVERNMENT OF MIZORAM
PUBLIC WORKS DEPARTMENT

DRAWING NO.	ADAPTED FROM ICT'S DESIGN OPTIONS
5.8	

LEA Associates South Asia Pvt. Ltd.



6. Assessment of Environmental Impacts and Mitigation Measures

6. ASSESSMENT OF ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.1. BASIC APPROACH

The environmental components that are impacted during various stages of project planning and implementation have to be mitigated and incorporated in the engineering design.

The Upgradation work of Buangpui – Lunglei (P.IB) road will involve widening and relaying of pavement. Proposed improvements are along the existing alignment except at some critical sections of the road where environmental, social or engineering aspects warranted realignment for short stretches.

The assessment of impacts and subsequent mitigation measures adopted are presented in the following sections. The chapter is built on the experiences derived from implementation of Phase I of the project (refer **Annexure 6.1**).

6.2. IMPACTS ON THE PHYSICAL ENVIRONMENT

6.2.1. Meteorological Conditions

As only roadside hill faces up to a height of 10-20 m are likely to be cut, no significant impacts on wind profile and rainfall pattern shall be observed in the project area. The adverse impacts on the climatic conditions shall only be of temporary nature e.g. increase in temperature due to removal of roadside plantation and vegetation. The localized short-term adverse impacts will be offset by compensatory afforestation of vegetation and tree plantation. No other specific mitigation measures are proposed.

6.2.2. Land

Loss of Cultivable Land and Top Soil

Permanent and temporary acquisition of agricultural land for widening, workers camps, stockyards, storage godowns etc. will also have a negative impact, depriving the local people of their livelihood. Cutting of hill slope will result in removal of topsoil, trees, vegetation cover and loss of cultivable land affecting the livelihood of the landowners. The effects will have direct, long-term and irreversible impacts on the surrounding environment. Cutting of hill slopes will involve elimination of productive topsoil due to loss of micronutrients to sustain growth of vegetation, standing crops and other commercially important vegetation.

Destabilization of Slopes and Soil erosion

- Widening of the priority road will involve rock/soil cutting of hillside, blasting of rocks rendering the hill slopes unstable and vulnerable to landslides.

- Cutting of the hill faces to widen the road will have direct and long term impact e.g. disruption to stability of cut slopes, modification of drainage patterns and erosion, increase in overburden on the valley slopes due to disposal of the debris from cut slopes resulting in their instability.
- Felling of plants/trees, vibrations from construction machinery, passing of heavy vehicles and action of rain on the soil during the construction stage would also contribute to soil erosion and destabilization of hill slopes.

Earthwork for upgradation of corridor

Widening and strengthening of the priority road involves cutting of hillside. Thereby it creates significant amount of earth, which will be utilized for the project. The material shall be utilized for construction of embankments for various realignment sections and other earth works. However, disposal of excess cut material has to be done at designated locations selected as disposal sites. The estimated quantities of earth material to be utilized for road construction and to be disposed off at the designated disposal sites are given below:

- Earth work due to hill cutting = 9,96,575 m^3
- Earth material to be utilized in road works = 5,55,457 m^3
- Earthwork to be disposed off at designated disposal sites = 4,48,733 m^3
- Earthwork that can be absorbed in the identified sites = 1,71,010 m3

Quarrying and Borrowing Operations

As hill cutting shall produce enough earth material for road works and aggregate material shall be procured from quarries located in the Priority road P1A, quarrying and borrowing operations are not envisaged along the project corridor. Though the operation of quarries is an independent and regulated activity, large requirement of stone aggregate for the project will cause resource depletion in the state. Similarly, river sand is a scarce commodity in the entire state and therefore, borrowing of sand from riverbed shall have significant resource depletion. Therefore as an alternative, the possibility of using stone crusher dust has been explored. There are many stone crushers along the route who are willing to supply the material. However haphazard transportation of stone crusher dust from its source to the construction site can have negative impact on the air quality.

6.2.3. Watercourses and Water Bodies

The proposed widening and improvement of P1B will have wide range of impacts on water resources in the project area during construction works. **Table 6.1** presents impacted water bodies along the P1B. The Location of main features such as river, pond, waterfall etc. along the Priority Road is given in **Figure 6.1**.

Mizoram receives a lot of rain, but has no significant water storage capacity as the steep terrain makes water retention extremely difficult. Road construction process which demands continuous supply of clean water will bear considerable pressure on water holdings in the project area. The viability of building water-harvesting structures along the watercourses and streams will need to be worked out. Small check dams (**Figure 6.7**) in the form of cascades shall be constructed to augment water requirement during road construction, and may later be used by the local community.

The water quality of surface waters in the project area may get contaminated temporarily due to accidental spill of construction materials, oil, grease, fuel and paint from the equipment yards and asphalt plant.

Table 6-1: Impacted Water bodies along Buangpui – Lunglei Road

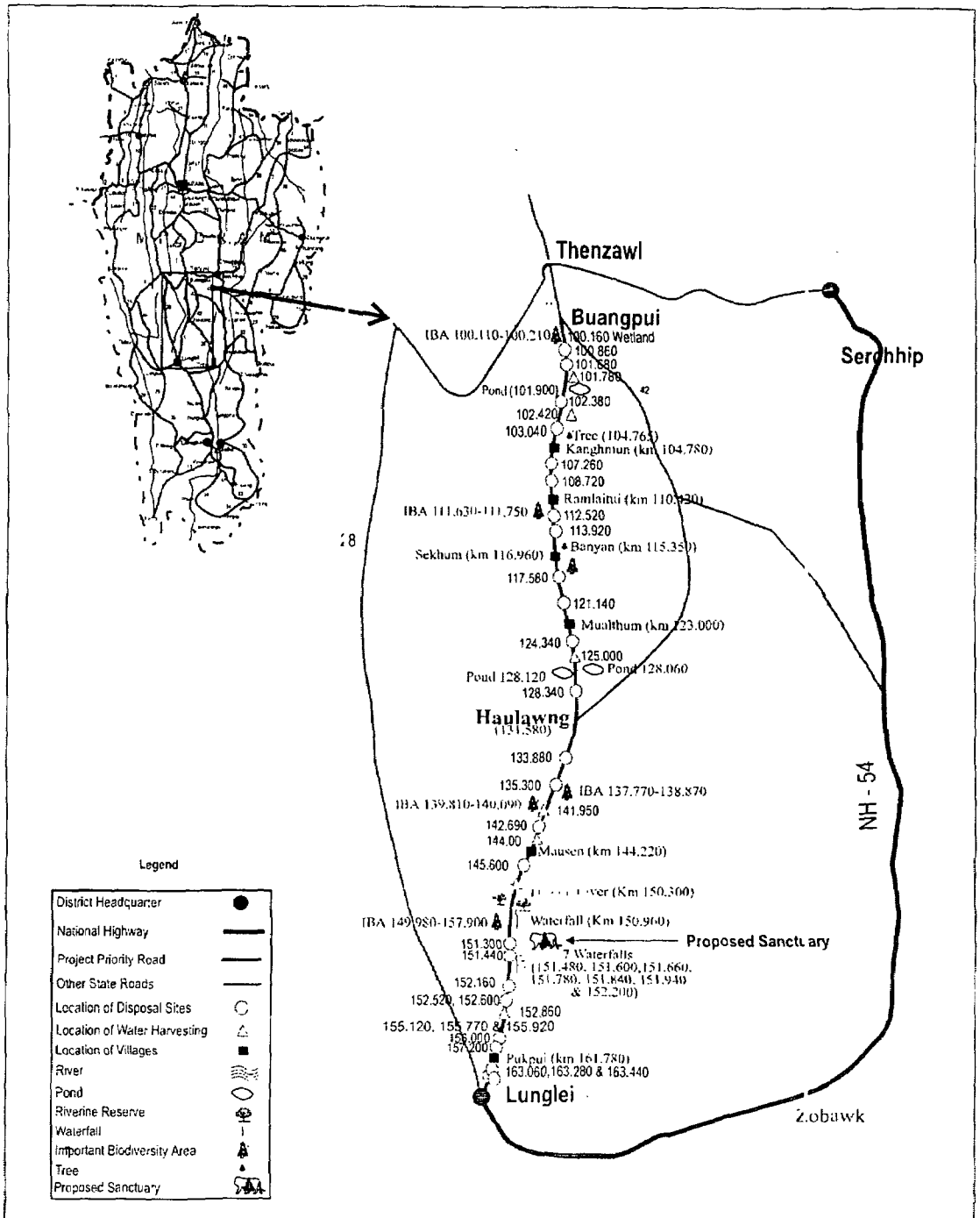
No.	Water body	Chainage	RHS/LHS[13]
1	Marshy area	100.160	LHS
2	Tlawng River	150.300	
3	Waterfall	151.480	LHS
4	Waterfall	151.600	LHS
5	Waterfall	151.660	LHS
6	Waterfall	151.780	LHS
7	Waterfall	151.840	LHS
8	Waterfall	151.940	LHS
9	Waterfall	152.200	LHS

Tlawng River

Single lane steel Bailey bridge with a span of 45 m in between 150.300km and 150.345km shall be replaced with double lane concrete bridge having a span of 92.7m constructed in between 150.160km and 150.480km. The construction of new bridge can cause contamination of the river water due to spillage of construction material. Sediment loading is most likely when large amounts of soil are disturbed and exposed to the erosive forces. In addition to the disposal of soils, the increased sediment load due to the constricted waterway cause increased turbidity downstream of the bridge location.

During the construction of the road, there will be movement of construction machinery and setting up of a construction labour camp near the bridge site. There are chances of oil spills taking place near the site. In addition, construction camp discharges are likely to contaminate the site and water with refuse, garbage etc.

[13] Hereinafter, the LHS/RHS convention is assuming that the direction of travel is from Buangpui to Lunglei



Source	Location of Features along Buangpui Lunglei Road	MIZORAM STATE ROADS PROJECT. PHASE II, PWD, GOVERNMENT OF MIZORAM
	Figure 6.1 N	LEA Associates South Asia Pvt. Ltd. New Delhi

Other Water Bodies - Ponds and Waterfalls

There are eight waterfalls at Km 150.960, 151.480, 151.600, 151.660, 151.780, 151.840, 151.940 and 152.200Kms and three ponds at Km 101.900, 128.060, 128.120 that will be impacted due to construction activity.

The possible causes of adverse impacts could be fuel and lubricant spills or leaks from construction vehicles or from fuel storage and distribution sites or from hot-mix plants or accidental fuel spills etc.

The watercourses are mainly seasonal, flowing with their full capacity during the monsoon season. They however, constitute important outlets as water aquifers from the hills and also below the ground. The cutting of hill slopes for widening and improvement of the priority road will disturb the natural drainage of these streams thus making their present accessibility to the local people extremely difficult or impossible. It is important to note that in a state like Mizoram where water is scare, the local people tap these water streams for use.

Other Water sources

In addition to the water bodies, the local people use a number of hand pumps sited along the Priority Road. Though water from these hand pumps in most cases is not potable, it is utilized for washing and other purposes. Some of these hand pumps are seasonal in nature, while the others supply water throughout the year. Due to the widening of the Priority Road, some of these hand pumps will have to be removed.

6.2.4. Air Quality

Negative impacts on Air Quality during construction will be mostly localized concentrated within the RoW. Due to a large number of activities both dust and polluting gases like SO2, NOx and Hydrocarbons will be generated. However, it is likely that impacts due to dust generation are felt downwind of the site rather than the site itself. Large quantities of dust may have serious implications on the health of the people living in the valleys. Construction workers, especially in quarries, borrow areas and stone crushing units will also be subjected to serious implications by exposure to dust. Operation stage impact due to traffic on the priority road shall not be significant since the project volumes low.

6.2.5. Noise Quality

Noise levels in the project area during the construction stage will increase, though shall be intermittent and temporary in nature.

The noise levels for various construction activities/ equipments, though in excess of the permissible standards, due to their intermittent nature, the impact of increased noise levels would only be temporary. Even so, the extremely high sound levels

present a risk to the workers on the site. Since the anticipated volume of the traffic on the road during operational phase is low, the impacts are of less significance. The noise levels will be much more pronounced during construction stage particularly around settlements and in inhabited areas.

6.3. IMPACTS ON BIOLOGICAL ENVIRONMENT

6.3.1. *Terrestrial Ecology*

Flora

Widening and strengthening of Priority Road shall involve removal of topsoil and cutting of hill face up to heights of almost 5-10 m on an average. It results in clearing of vegetation cover and felling of trees. These activities will exert wide-ranging impacts on the surrounding as summarized in **Table 6.2** below.

Table 6-2: Likely Impacts on Flora for Widening of Priority Road

Activity	Impact
Cutting of hill slope/face, removal of earth/rock Cutting of hill slope/face	Loss of vegetation cover (shrubs &grasses) canopies; Felling of 1,177 trees along priority road; Reduced shade and shelter for roadside fauna Reduction in soil fertility, moisture and humidity;
Workers Camps	Use of plants and trees as fuel wood and wildlife poaching by construction workers

- **Roadside Trees**

7518 trees of different species having girth more than 30cm within 15 m of the existing bench were counted out of which a total number of 1177 trees and plants are likely to be uprooted due to widening of the Buangpui – Lunglei Road.

During the bio-diversity assessment survey carried out along the priority road P1B, a number of locations have been spotted which are rich in species of herbs and shrubs, trees, ethno-medicinal plants and birds. The only endangered tree fern (*Cyathea dealbata*) found along the project road will not be threatened by construction activities since it is available in Mizoram State in abundance.

Fauna

- **Invertebrates**

Species of 'dragon flies' are reported to exist along the project road. The marshy area (100.160km) is a breeding ground for 'dragon flies'. Any disposal in the area can destroy the marshy area.

- **Amphibians and Reptiles**

The marsh has dense aquatic macrophytes and is reported to be a breeding ground of amphibians, which can be threatened due to unwanted disposal of debris.

- **Birds**

The proposed Saza-Tlawng Sanctuary is reported to house the endangered species Peregrine Falcon (*Falco peregrinus*). Besides a host of other species like the *Gallus gallus* (Jungle fowl), partridge etc. are found which can fall prey to hunting and poaching.

- **Mammals**

Rare and endangered animal species like the flying fox; Chinese pangolin, tiger, common leopard etc. have been reported to exist in protected areas of Mizoram. It is however, reported that the priority road P1B (Buangpui-Lunglei Road) does not show presence of any of these animals. The proposed Saza-Tlawng Sanctuary is reported to house endangered species like the Saza (*Capricornis sumatraensis*), Leopard (*Panthera* sp.) etc., besides a host of other mammalian species. However, no records are available to confirm the presence of endangered animal species. Owing to low traffic volume and seclusion from the habitation, impact on fauna will be minimal.

6.3.2. Riverine Reserve forest

The project road passes through the Riverine reserve forest of Tlawng. The riverine reserve, though it is a reserve forest, human interference is evident. Private plantations are also found in the Pukpui side with standing crops on both the banks of Tlawng and private plots are found on Mausen village side. The biodiversity assessment indicates absence of any threatened, endangered or rare species in the riverine reserve. Moreover, the forest cover on both sides of the Tlawng is mainly secondary nature. Only a few small patches of original moist deciduous forests can be seen at higher slope, which will not be affected by the construction of bridge over Tlawng or by widening of P1B.

6.3.3. Proposed Saza-Tlang Sanctuary

The project corridor forming the boundary of proposed sanctuary, very short stretches, less than 1km in length over several locations, widening on the hillside will require land within the area proposed to be included within the sanctuary. However, a 5m strip of land is available for widening along the corridor, declared as a road reserve. Biodiversity survey indicates no presence of threatened, endangered or rare species in the proposed sanctuary area.

6.3.4. Aquatic Ecology

Flora

The Ichthyological survey on the river Tlawng found green algae like *Ulothrix* spp., *Fontinalis* spp. The riparian vegetation is composed mainly of *Ageretum conyzoides, Saccharum* sp, *Cynodon dactylon, Mikania micrantha, Imperata cylindrica* species. The construction of new bridge on the River Tlawng will invariably cause contamination of the river water due to spillage of construction material. Sediment loading is likely to occur as large amounts of soil shall be disturbed and exposed to the erosive forces. In addition to the disposal of soils from the riverbed, the increased sediment load due to the constricted waterway and consequent increased sediment load will cause increased turbidity downstream of the bridge location. Large heavy sediments may smother the flora and change the nature of the substratum resulting in decline in the number and diversity of plants[14].

Fauna

- **Invertebrates**

Larva and adults of various benthic invertebrates were seen during the ichthyological surveys, which are preyed upon by other species. Any change in the water quality due to negligence in the construction activity can disastrously alter the food web.

- **Amphibians**

Large colonies of tadpoles were sighted during the survey installation of the nets. Calls of frogs were also heard during the night and evening. Any change in the present population of the micro invertebrates shall affect them.

- **Pisces**

The on the river Tlawng identified fish species of *Puntius ticto, Amblypharyngodon mola* and *Channa striatus*. During construction if the concentration of the suspended solids exceeds 185mg/l then the gills of the fish may be damaged[15].

- **Birds**

A number of avian species (water fowls) e.g, Kingfisher were identified by sighting and calls during installing the nets, which depend upon the fish and other species for survival. Any alteration to the existing aquatic environment can have repercussions on the avian species.

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[15] Para 4.11, Part 10, Sec 3, Vol. 11, Environmental Assessment, Design Manual for roads and bridges, Dept. of Transport, The Scottish Office Industry Department, The Welsh Office and The Dept. of the Northern Ireland, June 1993

6.4. THE PHYSICAL ENVIRONMENT - MITIGATION MEASURES

6.4.1. *Land*

- **Structural Engineering Techniques**

In order to stabilize the slopes on the hillside, retaining walls shall be incorporated in the project design at vulnerable locations. Three types of design for retaining walls have been proposed to enhance the stability of slopes on the hillside at different locations of the project road. These are:

- RO1 Dry Random Rubble Masonry for Heights < = 2.0 m
- RO1g Bamboo crib walls/ Gabion for Height < = 2.0 m
- RO2g Gabion for Heights > 2.0 m < = 5.0 m
- RO2 Composite Random Rubble Masonry for Heights > = 2.0 m but < = 5.0 m
- RO3 Mortared Random Rubble Masonry for Heights > 3.0 m but < = 6.0 m
- RO4 Reinforced Cement Concrete for Heights > 5.0 m < = 6.0 m

Similarly, to stabilize the slopes on the valley-side when it is required to widen the road by filling on the valley-side, breast walls will be provided at different locations of the project road. Depending on the height of cut to be supported and other site conditions, different types of Breast walls have been provided at different locations of the project road. Five types of Breast Walls designed to stabilize the slopes on valley side are:

- RO1 Dry Random Rubble Masonry for Heights < = 2.0 m
- RO1g Bamboo Crib walls/gabions for Heights < = 2.0 m
- RO2 Composite Random Rubble Masonry for Heights > = 2.0 m but < = 5.0 m
- RO2g Gabions for heights >2.0 m < =5.0 m
- RO3 Mortared Random Rubble Masonry for Heights > 5.0 m

Details of the locations where each type of wall is provided is available in the engineering design. However, No detailed observational data is available on the geomorphology of the specific locations. Hence, it may be prudent to allot fund related to the protection measures carefully segregated, to be expended with necessary features if any major disturbances to slopes are revealed. Based on observations on site, mitigation measures at specific locations are appended in **Annexure 3.1**. Implementation agencies would be required adopt most economical measures after the cuts are further exposed on a case-to-case basis.

- **Bioengineering Techniques for Soil Stabilization**

Bioengineering is the successful use of vegetation in combination with structural engineering techniques to increase slope stability. In comparison to hard armour solutions, bioengineering is cost effective, aesthetically pleasing and environmentally acceptable solution. Various Bioengineering techniques as described below are

proposed to regenerate lost green cover due to cutting of hill slopes. These are also shown in **Figure 6.2**.

- **Species Selection**

Where possible, the use of non-native species should be avoided since they can out compete and displace native plants. To maximize the chances of success, one should try to select species whose growing conditions roughly match the environmental conditions of the project site. Care should also be taken to select species with root systems that match the nature of the soil at the project site. **Table 6.3** and **Table 6.4** gives in details the floral species recommended for bioengineering near settlements within 1km of the last dwelling) and outside settlements.

Beside these recommended species Pterydophyta species like, *Lycopodium* spp., *Selaginella* spp., *Polytrichum* spp., and *Sphagnum* spp., which are found widespread in the area, can be planted to stabilise the soil both on the valley slope and road shoulders. The bryophytes and pteridophytes are provided with rhizoids that have a high cumulative soil-binding capacity. Moreover, these plants, due to their habit forms extensive spongy mats on exposed soil, protecting the soil effectively against the bombardment of raindrops.

Besides serving the purpose of soil binding, plants like broom and thatch grasses could also benefit the local community who could maintain these patches on a sustainable utilization basis, thus boosting the social welfare component of the project.

- **Various Bioengineering techniques**

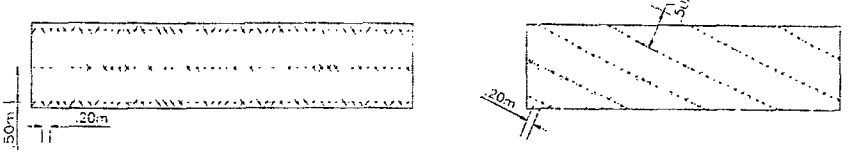
Contour Wattling:

This method is used to control surface erosion by breaking long slopes into shorter slopes. Bundles of branches, called wattles or fascines, are placed in shallow trenches along the slope or stream bank contour. Trenches are excavated by hand to half the diameter of the bundles. Wattles are typically 8 to 10 inches in diameter and branches secured with twine. After the wattle is staked in place, the trench is backfilled until only the top of the bundle is exposed. Wattles can be used for hill slope restoration, road embankments, wide gullies, or slump areas.

Chevron Grass Lines:

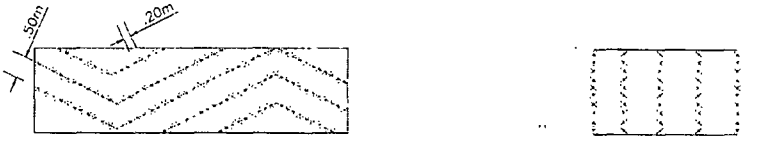
Chevron grass lines are planted as covering diagonal grass at an angle of between 30° - 40° off the horizontal. This grass-planting pattern is recommended on steep, badly riled slopes with coarse surface soils. It is used to direct surface runoff to stable disposal areas such as rill or rip rap channel, or a natural drainage line, thus utilizing the natural drainage pattern. The chevron-planting pattern can also be reversed to divert runoff to the centre of the batter and thereby promote infiltration.

Grass Strip Plantation



Contour Planting

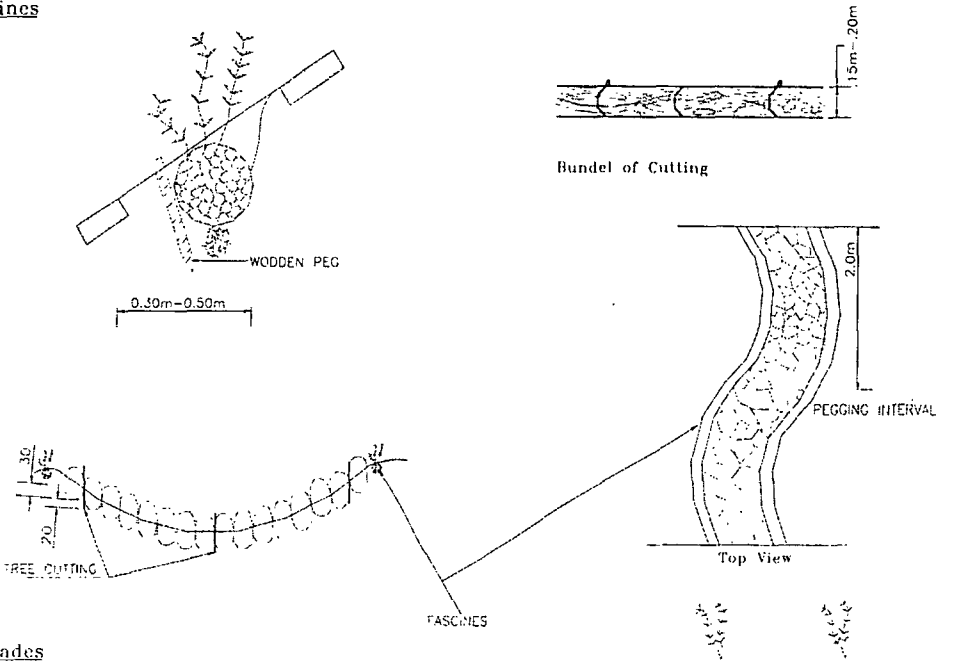
Diagonal Planting



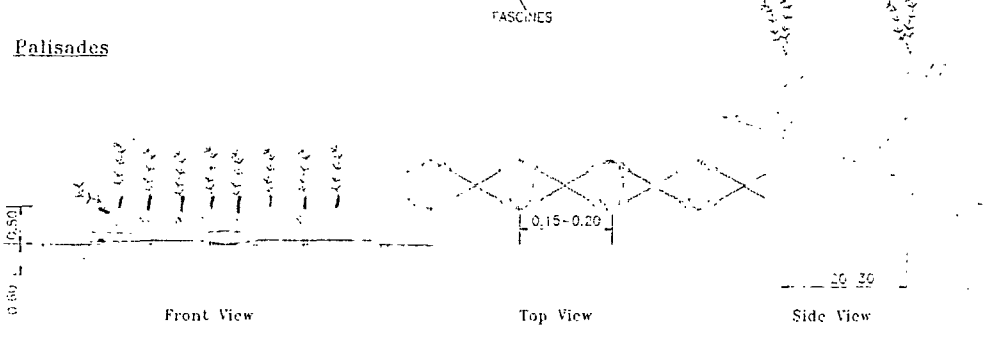
Cheveron Planting

Downslope Planting

Fascines



Palisades



Front View

Top View

Side View

Source

Bio-Engineering Techniques

MIZORAM STATE ROADS PROJECT,
PHASE II, PWD,
GOVERNMENT OF MIZORAM

Figure 6.2

Diagonal Grass Lines:

Diagonal grass lines are planted at an angle of 30⁰ - 45⁰ off horizontal, across the slope. Grass slips are planted at 20 cm intervals, with lines generally spaced at 50 cm intervals. The diagonal configuration is recommended on steep slopes where low volumes of runoff occur (i.e. where a small overland catchment exists above the road). The planting pattern prevents rill formation and retains eroded soil on the slope.

Brush Matting:

This method protects stream banks by placing a mattress-like layer of branches over it to protect soil and slow water velocity. The mat is composed of interwoven, usually dead, branches secured to the soil by live stakes, wire, twine or live branches. Live stakes are often cut from dormant willow. Brush matting helps collect sediment and enables establishment of vegetation on banks. Like brush layering, this method requires large quantities of branches.

Live Cuttings:

Live cuttings can be used to secure materials in place and to increase plantings on a slope. Live cuttings can be from 18 inches to 4 feet in length. Longer cuttings are used for live staking of wattles, while shorter cuttings are used for plantings.

Fascines:

Fascines are made of vegetatively propagated plant cuttings tied together into 15-20 cm bundles and dug into slopes on the contour to this depth. Fascines are recommended to stabilize small, critical slopes, and to protect riprap on slopes. Fascines provide a physical barrier to hold surface soil as well as drainage path, while cuttings rapidly develop roots that bind the slope.

Palisades:

Woody cuttings are planted at 10-15 cm intervals next to each other in lines across the slope, usually on the contour, to form palisades. They form a strong barrier that holds eroded soil, ultimately forming small terraces suitable for the establishment of vegetation. Palisades are recommended for all slopes except where minor slumps are likely. The SALT technique of soil conservation, developed in the Philippines for hill agriculture up to 35°, is based on this technique.

Combinations:

Combinations of the above practices are usually used for most bioengineering designs. For example, brush wattles and live staking is a common combination used to stabilize slopes. A coir fascine can be used with live plantings, brush matting and trench packing to restore marshes or stream channels. New combinations of existing methods, and the use of new materials, will provide creative applications of bioengineering techniques.

In order to stabilize the slopes, species, which have laterally spreading adventitious roots, and clump-forming tendency are planted that results in effective soil binding. Some species gives off roots from nodes while creeping that penetrates the exposed surface and clings to the soil. The bryophytes, on the other hand, are provided with rhizoids that have a high cumulative soil-binding capacity. Besides, these plants, because of their habit of forming extensive spongy mats on exposed soil, protect the soil effectively against the bombardment of raindrops.

Table 6-3: Species recommended near settlements

Scientific name	Mizo Name	Character	Growth Rate	Best Propagation	Flowering Season
Albizia chinensis *	Vang	Deciduous	Quick growing	Seeds	April - June
*Anthocephalus chinensis**	Banphar	Deciduous	Quick growing	Seeds	Nov – Feb
*Artocarpus heterophyllus**	Lamkhuang	Evergreen	Slow growing	Seeds	Nov –Jan
Bauhinia variegata *	Vaube	Deciduous	Quick growing	Seeds	Nov
Betula alnoides *	Hriang	Deciduous (Winter)	Quick growing after 1st year	Seeds, cutting	Nov –Jan
Emblica officinalis *	Sunhlu	Deciduous	Quick growing	Seeds, cutting, budding, inarching	June – July also in Feb, Mar –May
Ficus bengalensis *	Bung	Evergreen	Quick growing	Seeds, cutting	April – June
Ficus religiosa *	Hmawng	Evergreen	Slow in early stages later grows fast	Seeds, cutting	Jan – May
Ficus semicordata *	Theipui	Evergreen	Quick growing	Seeds	Throughout year
Spondias pinnata *	Taitaw	Deciduous	Quick growing after 1st year	Seeds	Feb – April
Trema orientalis *	Belphuar	Evergreen	Quick growing	Seeds, stumps	Throughout year

Table 6-4: Species recommended for the project road excluding settlements

Large Trees

Scientific Name	Character	Altitude	Site	Full Light	Best propagation	Comments
Acacia catechu	Large, thorny	Upto 1000 m	Hot and dry; harsh	Full light	Seeds / polypots	
Albizia lebbeck	Medium – sized deciduous	Upto 1200 m	Hot and dry; harsh	Full light	Seeds / polypots	High grazing risk
Albizia procera	Medium – sized deciduous	Upto1350 m	Moist	Full light	Seeds / polypots	Sensitive to grass competition
Alnus nepalensis	Large broadleaved	900 – 2700 m	Varied and moist	Full light	Seeds / polypots	
Dalbergia sisoo	Large broadleaved	Upto 1400 m	Varied	Full light	Seeds / polypots	Needs reasonably good soil
Erythrina spp.	Three fodder species	900 – 3000 m	Varied	Light	Seeds / hardwoods cuttings up to 2m	Long cuttings are very successful
Ficus semicordata *	Small stature, heavy branching	Upto 2000 m	Hot and dry; varied	Full light	Seeds / polypots	
Schima wallichii *	Large evergreen	900 – 2000 m	Varied; dry to moist	Bears shade	Seeds / polypots	Can colonise existing plantations

Shrubs and Small Trees

Scientific Name	Character	Altitude	Site	Best propagation	Comments
Acacia pennata	Small thorny tree, up to 3m	500-1500	Hot and dry; harsh	Seeds / polypots	36,000 seeds / kg
Lantana camara	Shrub up to 2 m high	Upto 1750 m	Hot and dry	Hardwood cuttings	Not hard cut slopes

Grass Species

Scientific name	Character	Altitude	Sites	Best Propagation	Seed Collection	Comments
Arundo donax	Large clumping & spreading	Upto 1500m	Hot and dry; varied	Slip cuttings/stem	Nov - Jan	
Arunduella nepalensis	Medium sized clumping	700 - 2000m	Varied; stony	Slip cuttings/seeds	Dec - Jan	1,809,000 seeds/kg
Cymbopogon microthea	Medium - Large clumping	500 - 2000m	Hot and dry; varied	Slip cuttings/seeds	Dec - Jan	1,681,000 seeds/kg
Eulaliopsis binata	Medium sized clumping	Upto 1500m	Hot and dry	Slip cuttings/seeds	Jan - Feb	
Neyraudia arundinacea	Large clumping	Upto 1500m	Varied	Slip cuttings/seeds	Dec - Jan	Higher rainfall areas; 16,390,000 seeds/kg
Neyraudia reynaudiana	Large clumping	Upto 2000m	Hot and dry	Stem/Slip cuttings/seeds	Dec - Jan	15,520,000 seeds/kg
Saccharum spontaneum	Large clumping & spreading	Upto 2000m	Hot and dry to moist	Slip cuttings	Nov - Dec	Very tough on all sites
Themda spp.	Large clumping	Upto 2000m	Varied	Slip cuttings/seeds	Oct - Nov	
Thysanolaena maxima *	Large clumping	Upto 2000m	Varied	Slip cuttings	Mar - Apr	Best in damper places
Vetiveria lawsoni	Medium - Large clumping	Upto 1500m	Varied	Slip cuttings	Sep - Nov	Fill slopes only; 1,712,00 seeds/kg

Bamboo species

Scientific Name	Character	Altitude	Sites	Best propagation
Bambusa balcooa	Thick culm, heavy branching	Upto 1600 m	Varied	Culm cuttings
Bambusa nutans cupulata	Strong, straight culms	Upto 1500 m	Dry / varied	Traditional method
Bambusa nutans nutans	Strong, straight clums	Upto 1500 m	Varied	Traditional method
Dendrocalamus hamiltonii	Thin culm, heavy branching	300 – 2000 m	Moist	Culm cuttings

* *Species found in the project area*

Source: International Centre for Integrated Mountain Development (ICIMOD); Guidelines for developing Greenbelts, CPCB March 2000 and Roadside Bio-Engineering Site Handbook, John Howell, DFID & HMG of Nepal.

Disposal of Debris and Relocation of disposal sites

- **Disposal Sites**

Adequate care would have to be taken while disposing the huge quantity of debris that shall be generated because of cutting of hill slopes. A part of this shall be utilized for construction of retaining walls, embankments and as filling materials. However, still a good quantum of this has to be disposed off safely at pre identified disposal sites. **Table 6.5** shows some of the disposal sites identified and selected as a consequence

of change in the alignment of the existing road, which can accommodate as much as 158,530 m³.

Table 6-5: Disposal Stations (DS) Selected for Disposal of Debris

Station	Chainage		RHS/LHS	Station	Chainage		RHS/LHS
	From	To			From	To	
DS 1	100.860	100.980	LHS	DS 13	133.880	133.980	RHS
DS 2	101.680	101.860	LHS	DS 14	135.300	135.340	RHS
DS 3	102.040	102.140	LHS	DS 15	142.690	142.740	RHS
DS 4	103.040	103.220	RHS	DS 16	151.300	151.360	RHS
DS 5	107.260	107.440	LHS	DS 17	151.440	151.500	RHS
DS 6	108.720	108.820	LHS	DS 18	152.160	152.180	RHS
DS 7	112.520	112.560	LHS	DS 19	152.520	152.580	RHS
DS 8	113.920	113.980	LHS	DS 20	152.600	152.620	RHS
DS 9	117.580	117.600	RHS	DS 21	155.120	155.200	RHS
DS 10	121.140	121.240	LHS	DS 22	155.770	155.790	RHS
DS 11	124.960	125.060	RHS	DS 23	155.920	155.960	RHS
DS 12	128.340	128.440	RHS	DS 24	156.000	156.040	RHS

Several disposal sites, earlier proposed for usage, have been cancelled for various reasons. **Table 6.6** lists those sites along with the reasons for omissions.

Table 6-6: Reasons for omitting some Disposal Stations (DS)

Station	Chainage	Reasons for Omissions	Station	Chainage	Reasons for Omissions
DS 1	100.050	Marshy area present	DS 10	144.050	Hill side Alignment
DS 2	101.375	Hill side Alignment	DS 11	146.500	Hill side Alignment
DS 3	107.890	Hill side Alignment	DS 12	149.480	Within Riverine reserve forest land
DS 4	120.170	Hill side Alignment	DS 13	150.540	Within Riverine reserve forest land
DS 5	120.920	Hill side Alignment	DS 14	152.600	Hill side Alignment
DS 6	123.800	Hill side Alignment	DS 15	155.980	Hill side Alignment
DS 7	127.700	Hill side Alignment	DS 16	157.250	Hill side Alignment
DS 8	134.125	Hill side Alignment	DS 17	158.765	Hill side Alignment
DS 9	136.480	Hill side Alignment	DS 18	159.850	Hill side Alignment

Five more disposal sites were identified during the IER survey of the road. These sites are shown in **Table 6.7**. The total amount of debris, which can be dumped in the new sites identified, is 12480 m³.

Table 6-7: Disposal Stations (DS) identified during Survey

Station	Chainage		Volume (m3)	RHS/LHS
	From	To		
DS 1	145.600	145.700	4044.0	RHS
DS 2	157.200	157.240	386.0	RHS
DS 3	163.060	163.220	6694.0	LHS
DS 4	163.280	163.320	367.0	LHS
DS 5	163.440	163.500	989.0	LHS

Certain locations are to be avoided for disposal of waste material, as these locations are ecologically important. **Table 6.8** lists out such locations. **Figure 6.3** and **Figure 6.4** show chainage-wise locations of marsh and fishpond which need to the protected from disposal of waste material. **Figure 6.5** shows pictorial view of sites that need to the avoided from disposal of waste material. In general, the disposal sites were selected keeping in mind the following aspects;

- Water resources such as ponds, rivers should not get polluted;
- The disposal site should have adequate capacity to contain the waste material;
- Sites rich in bio-diversity must be avoided; and
- The disposal site should not be located downwind side of the residential areas.

- **Protection Measures to Contain Disposed Material**

In order that the excavated rock / soil does not spread all over on the valley side, toe walls of the following design will be provided at disposal site depending on the amount of dumped material:

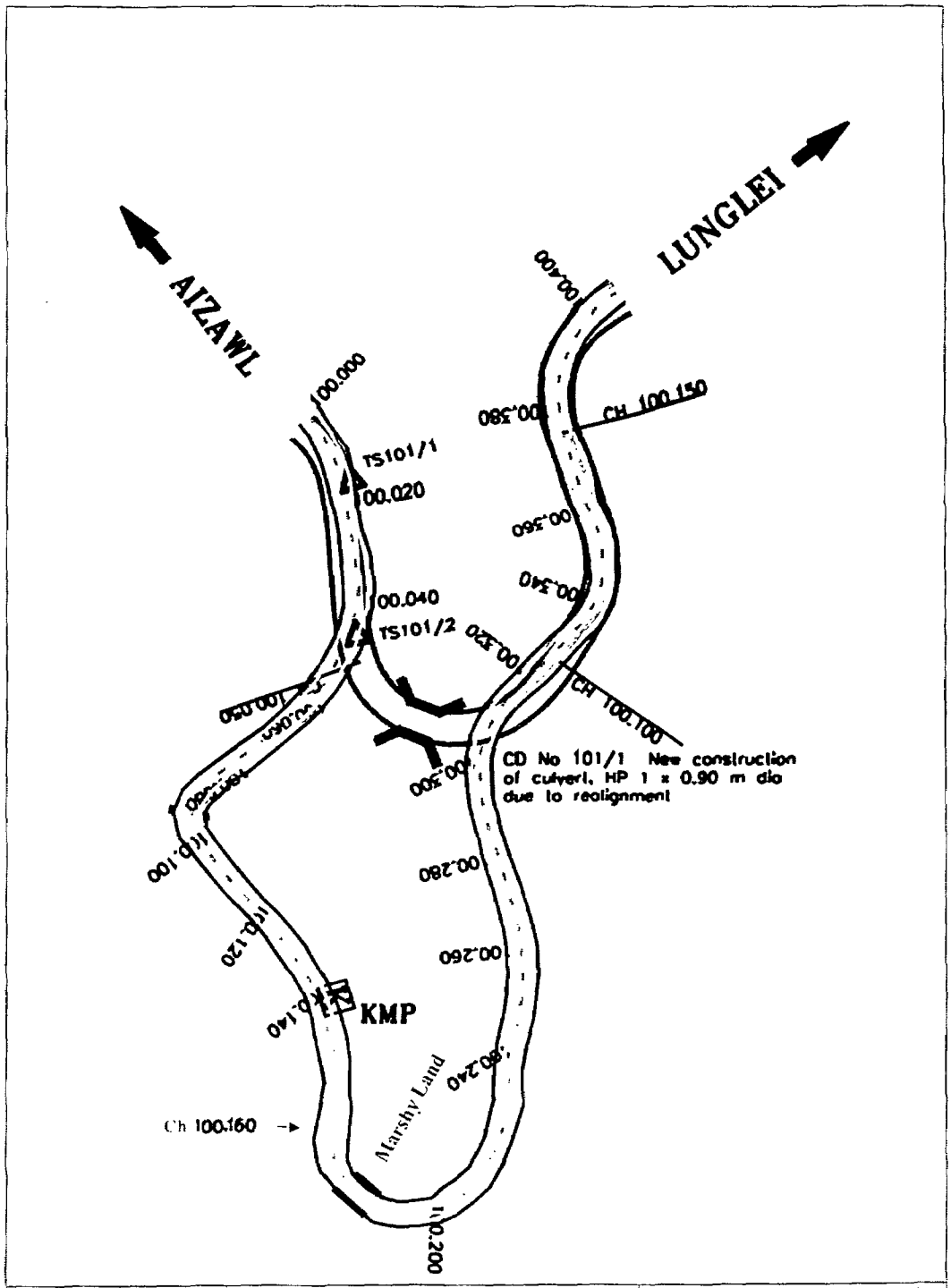
- Dry Random Rubble Masonry for Heights < = 2.0 m
- Bamboo / Gabion Wire Crates / Bamboo Crib Walls for Heights <=2.0 m
- Gabions for Heights > 2.0 m < = 5.0 m
- Composite Random Rubble Masonry for Heights > 2.0 m < = 5.0 m

Precautions to be adopted during debris disposal / waste material are presented in **Annexure 6.2**

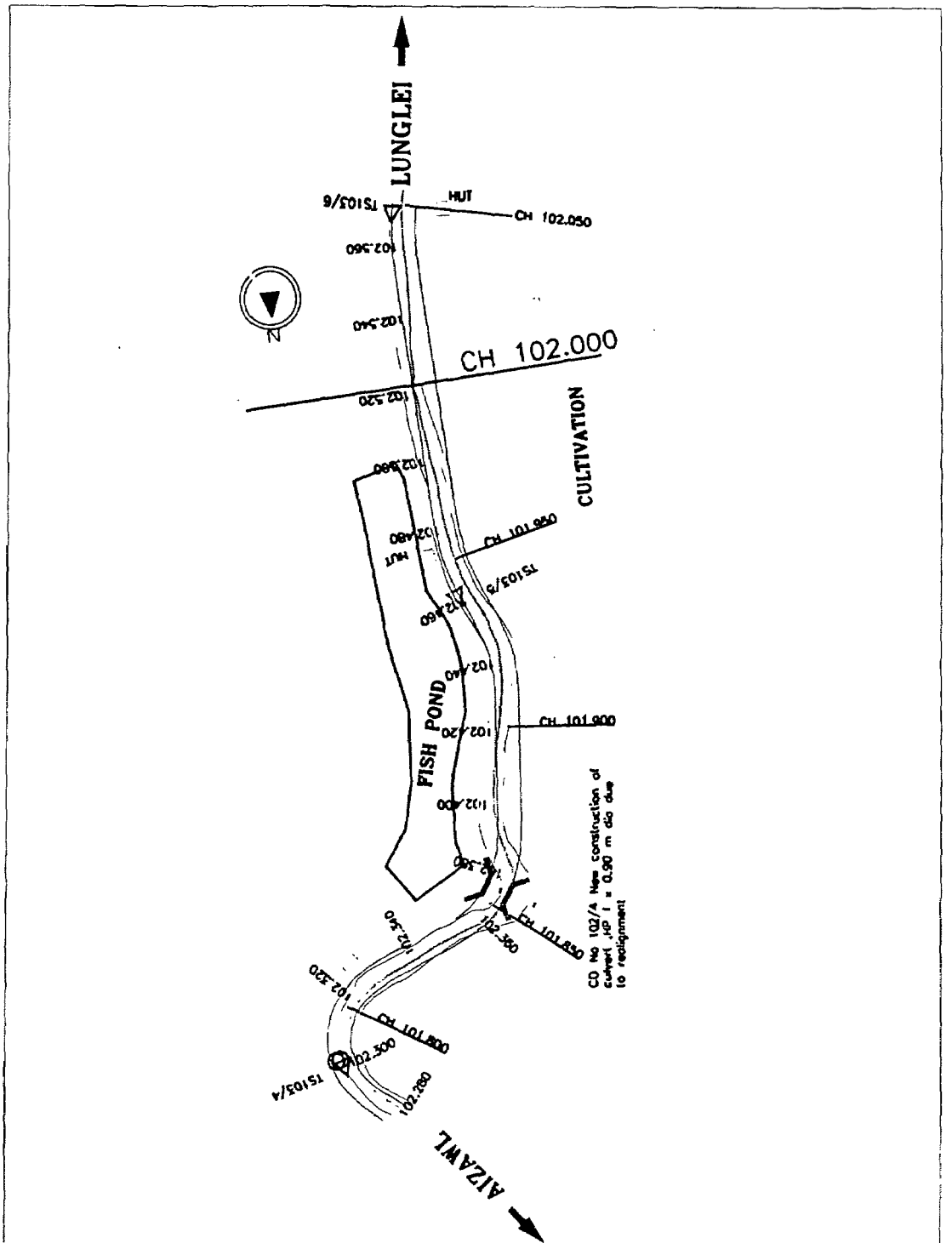
- **Rehabilitation of Dump Sites**

Locations of dumpsites are as indicated in **Table 6.5** and **Table 6.7**

- The disposal sites as given in **Table 6.7** have been selected as a consequence of change in alignment of the road. These sites do not contain any environmental resources, which require protection. The areas surrounding these dump sites have indigenous vegetation available throughout the project corridor.



Source	Location of Marshy Land			MIZORAM STATE ROADS PROJECT, PHASE II, PWD, GOVERNMENT OF MIZORAM
Detail Engineering Drawings prepared by ICT				
	Figure 6.3		N	



Source : Detailed Engineering Drawing Prepared by ICT	Pond to be avoided for Disposal of Cut material	MIZORAM STATE ROADS PROJECT, PHASE II, PWD, GOVERNMENT OF MIZORAM
	Figure 6.4	

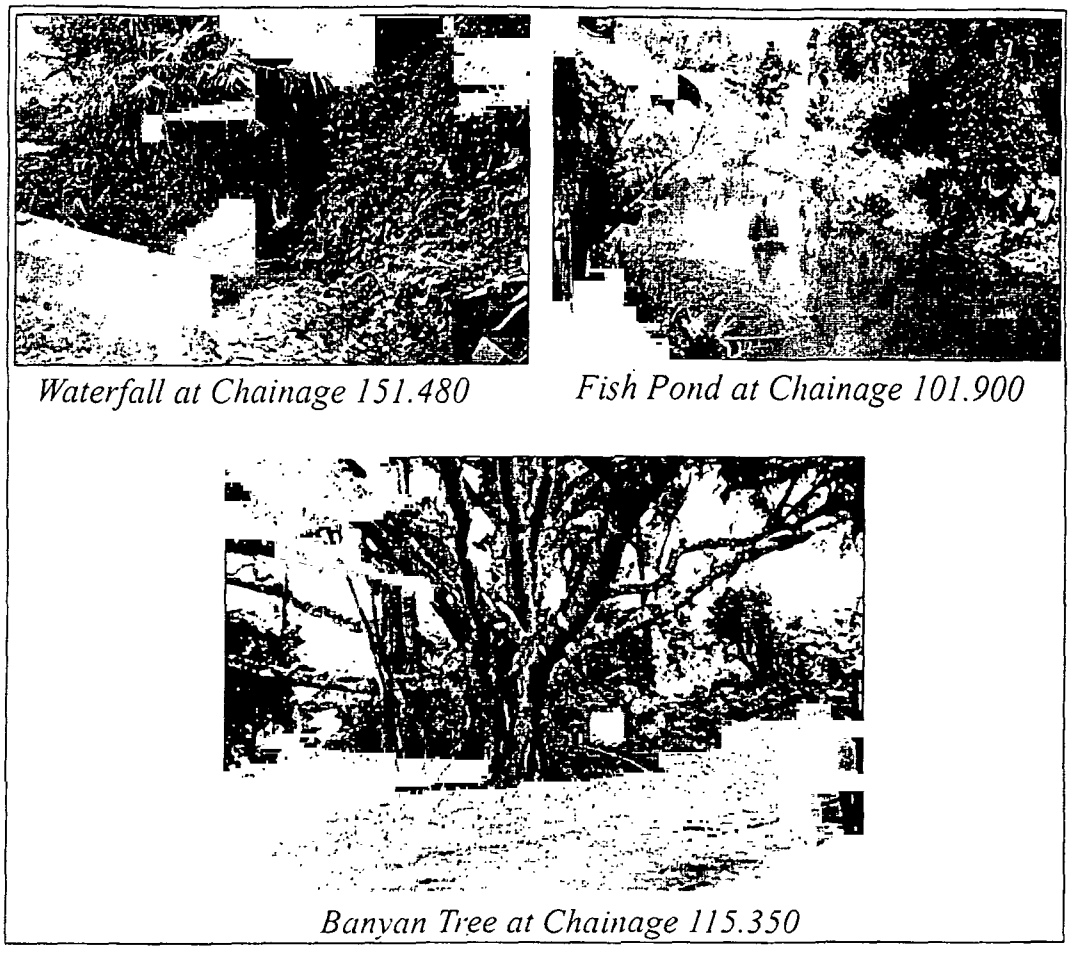


Figure 6.5 : Sites to be Protected from Disposal of Waste Material

Table 6-8: Sites to be avoided for Disposal of Waste Material

Reason to avoid Disposal	Chainage
Marshy area	100.160
Tree fern *Cyathea* Sp.[16]	110.140, 111.680, 111.900, 112.680, 115.700, 117.420, 134.206, 138.020, 139.860, 140.020, 140.040, 140.300, 140.455, 142.100, 151.320
Pond is present	101.900, 128.060, 128.120
Orchid *Vanda coerulea* is present	111.320
Big (Banyan) Trees	104.765, 115.350
Tlawng River	150.300
Waterfalls are present	150.960, 151.480, 151.600, 151.660, 151.780, 151.840, 151.940, 152.200
Important Biological Areas (IBAs)	100.110 to 100.210, 111.630 to 111.750, 117.370 to 117.470, 137.770 to 138.870, 139.810 to 139.910 and 149.980 to 157.900

[16] Some areas where *Cyathea* spp. are found, fall under the IBAs

- The terrain being mountainous, it has been estimated that the amount of spoil and cut material to be disposed off will exceed the amount than the identified dumpsites could absorb.
- These dumpsites have to be suitably rehabilitated by planting local species of shrubs and other plants. Local species of trees (e.g. bamboo etc.) are also to be planted so that the landscape is coherent and is in harmony with its various components.
- Terraces can be made on the dumpsites and converted to plantation or for growing agricultural produce such as ginger, turmeric, and oranges.
- In cases where a dumpsite is close to the local village community settlements, it could be converted into a play field by spreading the dump material evenly on the ground. Such playground could be made coherent with the landscape by planting trees all along the periphery of the playground.

Location of Construction / Labour Camps

Likely candidate locations for construction camps are indicated in **Table 6.9**. However, out of these five locations only two could be found satisfying all the criteria for setting up of construction camp. These two locations are given in **Table 6.10**.

Table 6-9: Locations Identified for construction labour camps

Chainage	Direction	Nearest Village	Chainage of Village
100.490	West	Kanghmun	104.100
101.685	East	Kanghmun	104.100
123.800	West	Mualthum	121.900
124.590	East	Mualthum	121.900
146.500	West	Mausen	142.760

Table 6-10: Locations proposed for construction labour camps that satisfies all conditions

Chainage	Direction	Nearest Village
123.800	West	Mualthum
124.590	East	Mualthum

The construction camps will be located at least 500m away from habitations at identified sites and 1000m away from those listed in **Table 6.8**. All other sanitary and health facilities shall be provided at these locations as per **Annexure 6.3**

Rehabilitation of Quarry / Borrow Pits

As hill cutting shall produce enough earth material for road works and aggregate material shall be procured from quarries located in the Priority road P1A, Quarrying and borrowing operations are not envisaged in the project corridor. But in case earth material produced doesn't meet the required standard and the Contractor has to

make borrow pits/quarry areas, the borrow pits/quarries has to be rehabilitated by following the instructions presented in **Appendix 6.4**.

Compaction of Soil

The construction equipment, vehicles and machinery shall be moved or stationed only in designated areas (COI or ROW as applicable), while operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activity. Topsoil from agricultural land must be removed and preserved, which after the activity is over should be replaced and properly rehabilitated.

6.4.2. Watercourses And Water Bodies

The water resources are likely to be affected during execution of the project. It is therefore, imperative that adequate mitigation measures are adopted and incorporated into the project designs to offset the adverse impacts. In sections below some of these measures are described.

All water sources potable or else used by the public/community e.g. water tanks at the streams if lost due to widening of the road shall be replaced immediately. Relocation of the source of water shall be decided in consultation with the local people. Replacement shall be carried out prior to demolition of the existing structure/source of water.

Drainage and Hydrological flow

- Detailed drainage surveys and hydrological investigations have been carried out and suitable design of bridges and culverts proposed. V-shaped 150mm thick drains of cement concrete having top width of 600mm and depth of 300mm ~ 900mm shall be provided towards the hillside all along the corridor except in inhabited areas.
- In inhabited areas, the cross-drainage structures provided have 100mm thick drain of cement concrete with top and bottom widths of 600mm and 230mm respectively and a depth of 350mm. The existing culverts and other drainage structures will be replaced with new cross-drainage structures of sizes as mentioned above.

In addition to the above design requirements, the contractor shall ensure that during construction work the following are taken care of:

- Construction work near water bodies have to be carried out in such a way that flow of water is not blocked. Even if it has to be blocked, the contractor must ensure that the local communities are informed about the same in advance. Work near the water bodies should be carried out in dry season.
- Flooding of local drainage channels, waterfalls/streams;

- Measures to ensure that remnants from earthwork, stonework and other waste material do not hinder the cross-drainage of rivers, canals, streams and existing irrigation channels; and
- In sections of the road near to watercourses or cross-drainage channels, the construction material waste would be disposed off in a manner not to block the flow of water.
- The wastes arising from the project would be collected, stored and disposed off at approved disposal sites as per State Pollution Control Board norms.

Quality of water in water bodies

The quality of water in the water bodies (Tlawng River, marsh, and Ponds) shall be maintained by adopting following mitigation measures:

- Construction work close to the streams/water bodies and construction of bridges will be avoided during monsoon.
- Silt fencing to be provided near construction area to prevent sediments entering the watercourses.
- The fuel storage and vehicle cleaning area shall be stationed at least 300m away from the nearest drain/water body
- The slope of the embankments leading to water bodies shall be modified and re-channelled to prevent entry of contaminants into the water body.
- Discharge of oil and grease is most likely from construction vehicle parking area, vehicle repair area and workshops. An oil interceptor shall be provided to ensure that all wastewater flows into the interceptor prior to its discharge.

Enhancement of Waterfalls

Though there are a number of waterfalls along the project roads, most of these are seasonal in nature and are dried up as soon as the monsoon season is over. Applying appropriate mitigation measures, however, should preserve some of these waterfalls. One water fall at Km.151.780 is identified for enhancement. **Figure 6.6 (a)** and **Figure 6.6 (b)** depicts how the waterfall could be preserved and developed / enhanced as a recreation spot. At the location enhancement is carried out as explained below:

- This approach of developing the waterfall gives special consideration to the environmental sustainability aspects of the feature. The fall is made visually close but physically- away from viewers.
- On the hillside of the carriageway, a hold up tank is proposed. On the immediate periphery of this will be the flowering shrub plantations of the indigenous species. Beyond this there will be viewing platforms, which allow higher-level view of the fall. Adjacent to this, away from the waterfall, parking is proposed. On the valley side of the carriageway, water is allowed to pass through a culvert to another smaller hold up tank from where it is allowed to fall downward.

- On the hillside, retaining walls can be provided on both sides of the waterfall, depending upon the erosion control requirement. In these walls, soil can be filled and bright floral varieties planted. This shall stabilize as well as beautify the surroundings.
- One prominent waterfall is identified for enhancement. This has considerable flow and is aesthetically appealing. This waterfall needs conservation as per the designs mentioned above and some infrastructure to augment local/regional tourism.
- No built-up development is proposed, unless in co-ordination with the tourism authorities. The possibility of engaging private partners for maintenance and cleaning may be explored.

Water Consumption and Harvesting

Potential water flows in the several natural drainage courses available on the Upgradation road P1B are assessed. Seven locations were identified and recommended for procuring water during construction to avoid shortage of water to the local community. The community can use these water storage structures in the long-term.

Recommendations were made based on the feasibility of constructing the storage considering (a) availability of space; (b) avoiding potential damage to the road; (c) avoiding large/high dams/walls; (d) slope and stability of terrain. The storage tanks should not be washed away during torrents, and therefore restricted storage, allowing for spill over needed to be designed.

- To overcome the impact on water resources, locations as indicated in **Table 6.11** are selected for water harvesting. **Figures 6.7 & 6.8** shows typical design of water harvesting structures

Table 6-11: Water Harvesting Locations

No.	Chainage	Direction
1	101.780	LHS
1	102.420	LHS
3	125.000	LHS
4	141.950	LHS
5	144.000	RHS
6	150.160	Tlawng River
7	152.860	LHS

- Water harvesting structure can be built in stone masonry, oriented to receive the water from the valley side of the contours. The higher levels should be planted with trees and thick shrubs to control the speed of water. This shall also control the erosion on the hillside and avoid silting of the tanks.

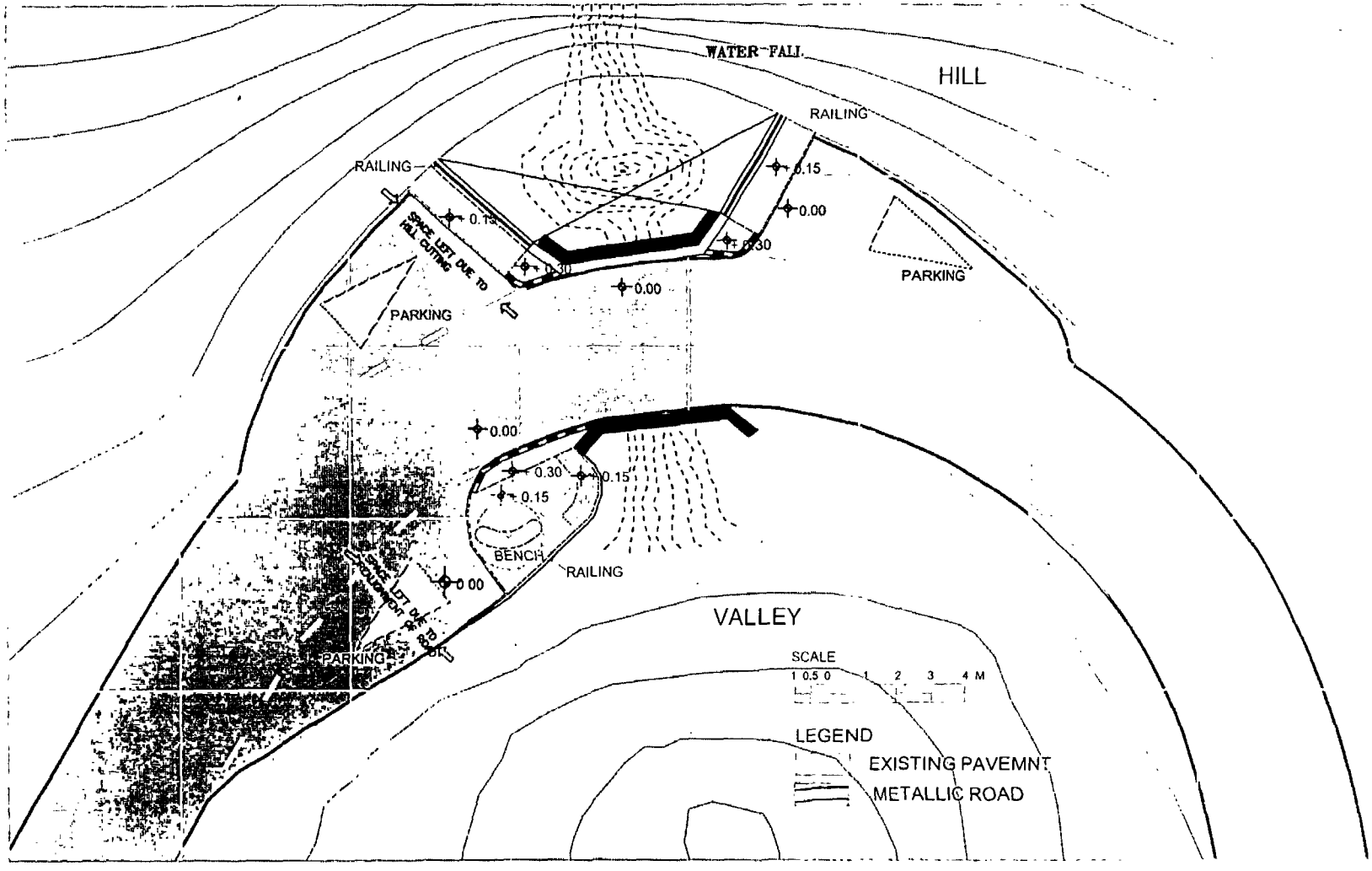


Figure. 6.6 A	WATERFALL: Enhancement of Incidental Space, Km 151.780	N	MIZORAM STATE ROADS PROJECT - PHASE II LEA Associates South Asia Pvt. Ltd.

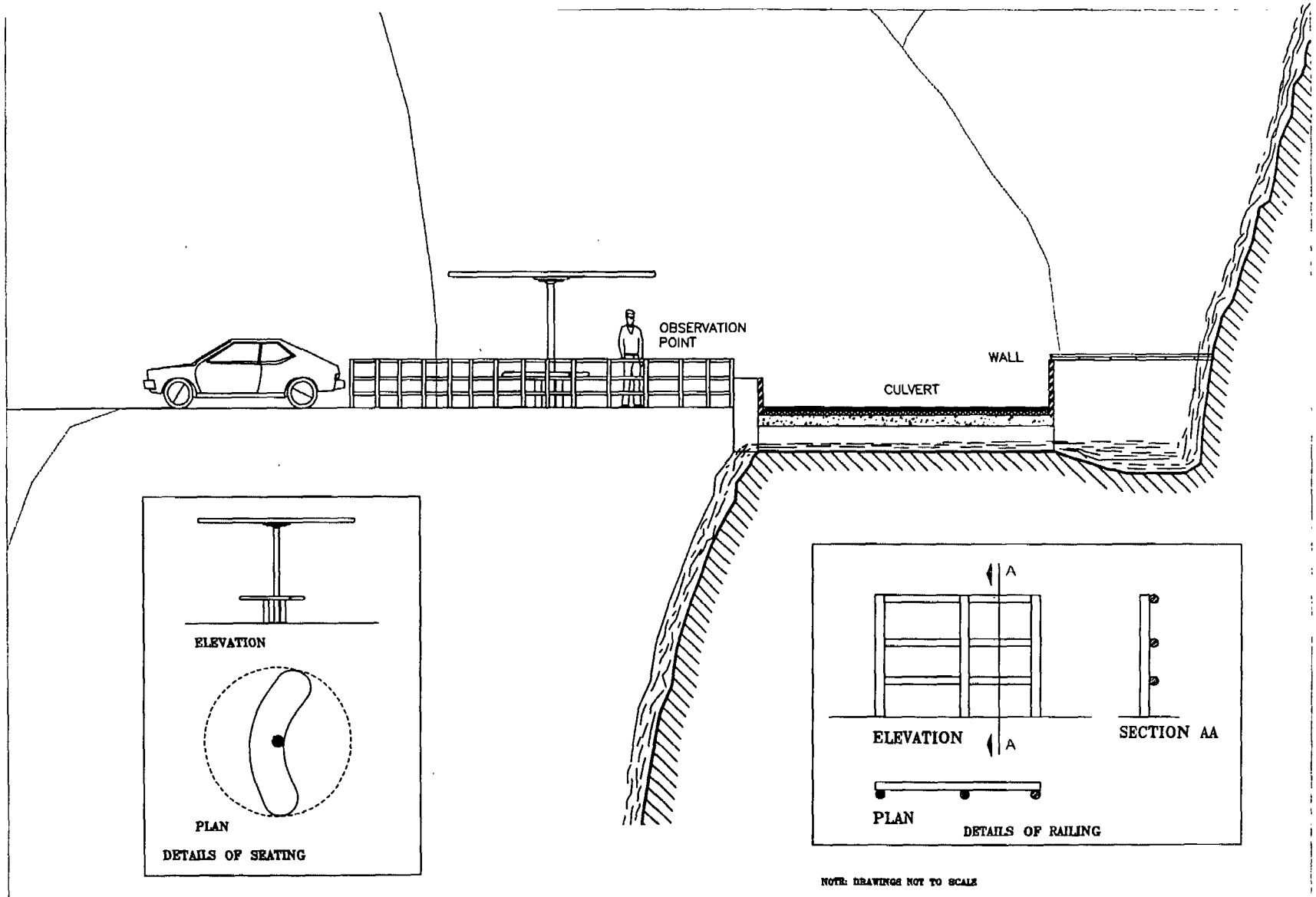
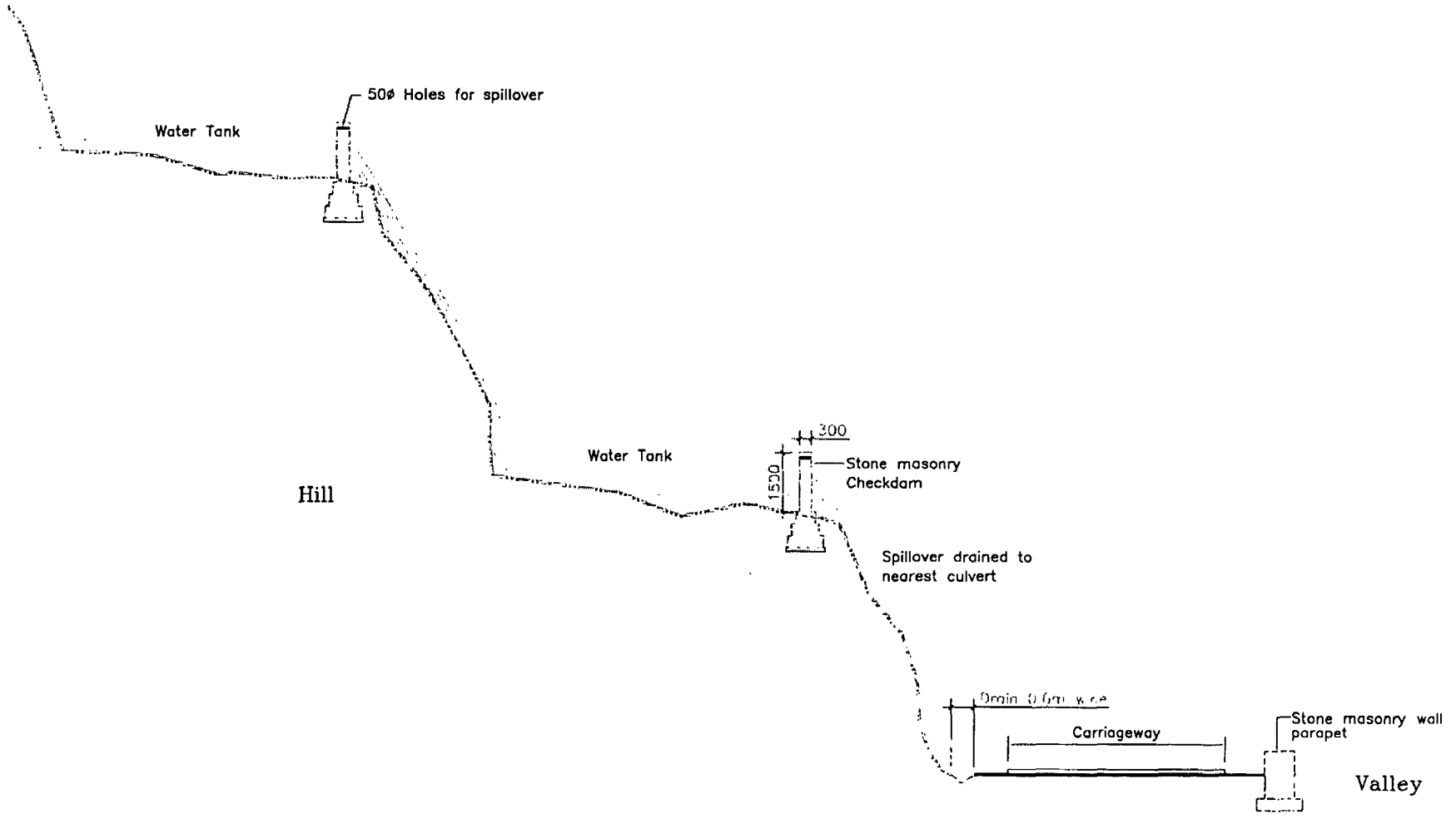
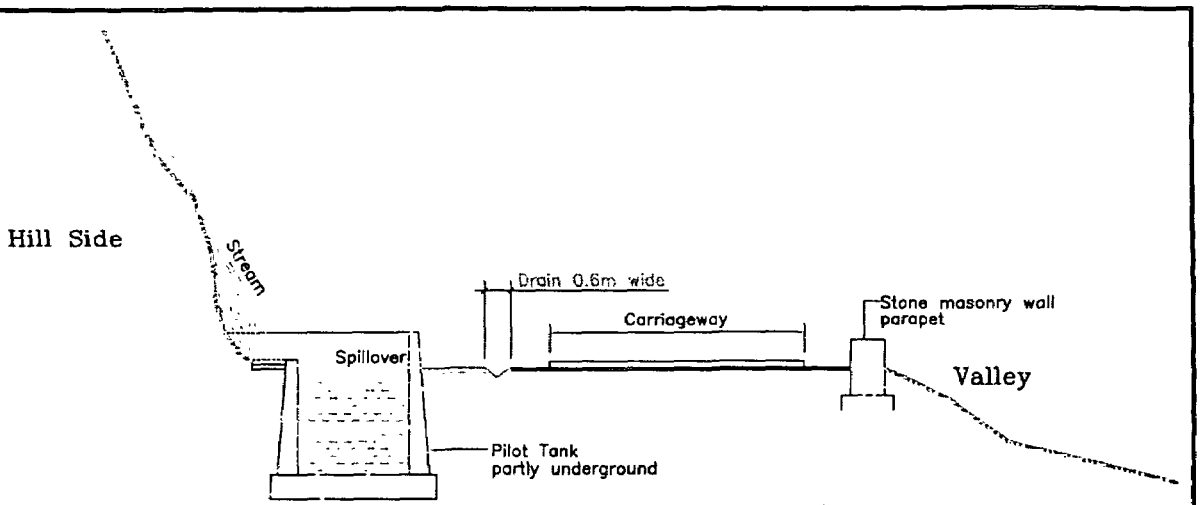


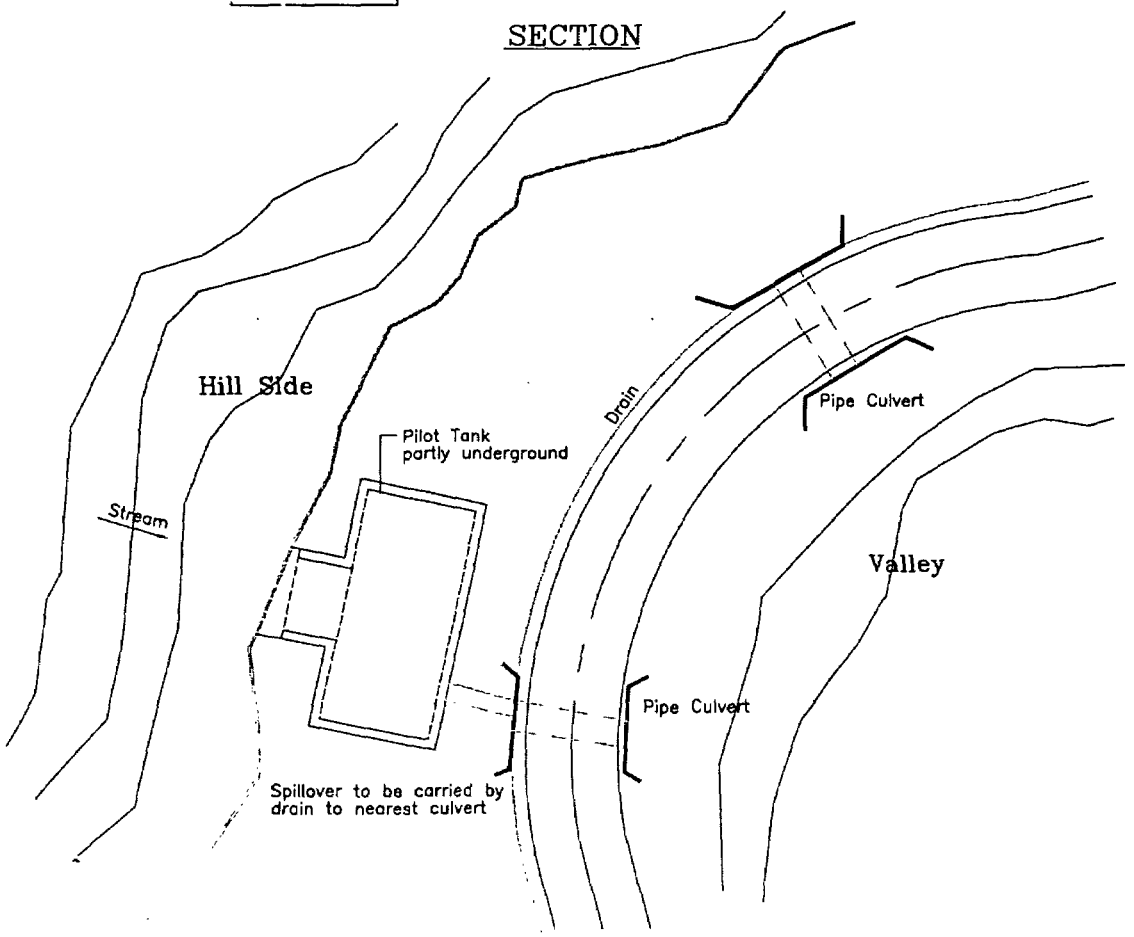
Figure. 6.6 B	WATERFALL: Enhancement of Incidental Space, Km 151.780	N	MIZORAM STATE ROADS PROJECT - PHASE II LEA Associates South Asia Pvt. Ltd.



Drawing No. 6.7	Water Harvesting on Hill Side	MIZORAM STATE ROADS PROJECT - PHASE II
		LEA Associates South Asia Pvt. Ltd.



SECTION



PLAN

Drawing No. 6.8	Water Harvesting at Hill and Road Interface	MIZORAM STATE ROADS PROJECT - PHASE II
		LEA Associates South Asia Pvt. Ltd.

Fuel and Lubricants

- Fuel shall be stored in proper bounded areas.
- All spills and collected petroleum products shall be disposed off in accordance with the guidelines framed by Ministry of Environment & Forests, New Delhi and Mizoram Pollution Control Board.
- Maintenance and refuelling of vehicles, machinery and other construction equipment shall be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground.
- An "Oil Interceptor" **(Figure 6.9)** shall be provided for wash down and refuelling areas.
- After the construction of road is over, the concerned State Government Department must prepare contingency plan so as to contain accidental spills.

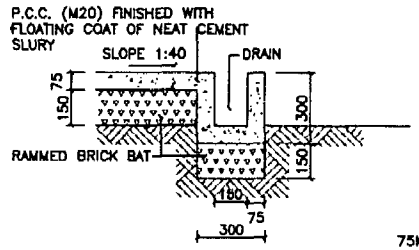
Hot-mix Plant

Effluents from the hot-mix plants in the form of oil, grease, etc., if not contained and disposed properly could lead to pollution of land and water in the adjacent areas. This impact would be more pronounced in the stretch of 101.900, 126.850 & 126.910km, where there are three ponds and a marsh at km 100.160 near the road. The oil and grease generated may be disposed into pits filled with the clay-shale dominant debris that would be produced by earth cutting. This material is a good absorbent and can later be removed and disposed in safer places.

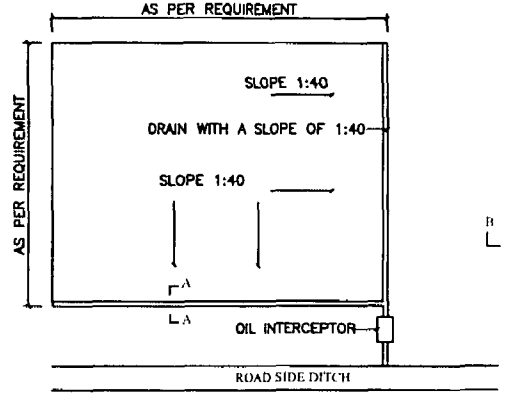
Air Quality

Following mitigation measures shall be implemented to minimise impacts due to air pollution.

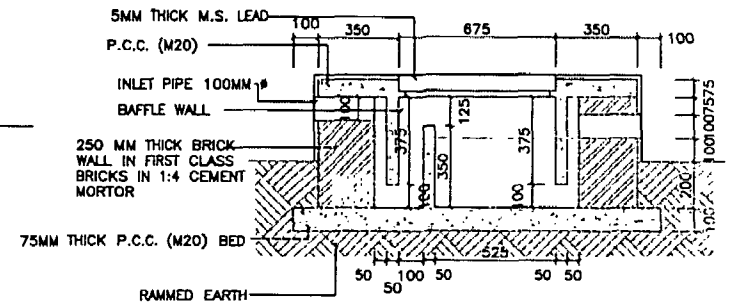
- Location of hotmix plants/asphalt plants/batching plants shall be atleast 1 km down wind of the settlements
- Wind breaking wall shall be provided at sources of dust
- Vehicles transporting fines shall be covered
- Dust extraction units shall be fitted to hot mix plants
- Water will be sprayed on haul roads / temporary detours and on subgrade after compaction
- Emission levels of gases from hotmix plants/asphalt plants shall conform to CPCB norms
- To confirm that pollutant levels are within emission regulations, frequent monitoring shall be carried out



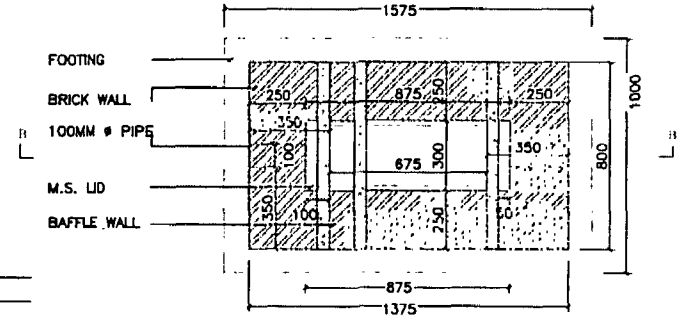
SECTION A-A



KEY PLAN



SECTION -B-B



PLAN OF OIL INTERCEPTOR

SCALE

500MM 200MM 0MM 500MM 1000MM

NOTES. 1) FOLLOW WRITTEN DIMENSIONS ONLY 2) ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED 3) SITE SPECIFIC CHANGES IF ANY, TO BE MADE ONLY ON APPROVAL OF THE ENGINEER		DRAWN: HRUSHIKESH CHECKED. HRUSHIKESH DESIGNED. HRUSHIKESH APPROVED. DIPALI	MIZORAM STATE ROADS PROJECT- PHASE II
	SCALE: 1.20	FIG 6.9. DESIGN AND LOCATION OF OIL INTERCEPTOR	Lea Associates South Asia Pvt. Ltd.

6.4.3. *Noise Quality*

The following measures could be adopted to mitigate the impact of observed noise levels:

- Noise barriers of various barrier-wall shapes and textures along with landscaping (i.e. by planting trees, bushes and shrubs). The important factors that should be taken into account are relative height of the barrier, the noise source and the horizontal distance between the source and the barrier and between the barrier and the noise-affected area.
- Planting of trees, bushes and shrubs could also be utilized to reduce noise levels provided the plantings are very dense and have significant depth.
- Other noise control measures include limitations on allowable grades eg. Open-graded asphalt and avoidance of surface dressings to reduce tire noise in sensitive areas. Maintenance of proper road surface repairs also helps in reducing noise levels.
- Noise problems can be minimized by using silenced equipment, following noise control regulations and limiting work hours near residential areas.
- Facade insulation such as double window glazing, which is usually adopted to dampen noise in buildings.
- Barriers and mounds of various materials, which place a solid obstacle between the road and homes nearby. These usually take the form of earth mounds or solid walls of wood, metal or concrete. These walls are known as sound barriers, fences or sources and can be used in conjunction with noise mounds to give additional effective height. Noise barriers will be most effective if they break the line of sight between noise source and the properties being protected, and if these are thick enough or adsorb or reflect the noise received.

- **Christian Hospital Lunglei**

At the Christian Hospital Lunglei, special noise mitigation measures are proposed. The land around the Lunglei hospital belongs to the Church and they are willing to donate the land involved in the road construction as long as the design takes into account noise and easy accessibility to the hospital and church. A final design (**Figure 6.11**) involving improvement of the existing junction, noise barriers such as rows of plants of different heights to block noise is proposed. The designs are prepared taking into consideration some minor improvements requested by the Church Officials and aesthetics. (**Figure 6.10**)

- **School at Ramlaitui**

A noise barrier wall has been proposed for the Government Middle School at Ramlaitui at chainage 111.260 km. The proposed noise barrier shall be a 3m high masonry wall. The contractor as per the direction and satisfaction of the Supervision Consultant shall build the wall. Design of the noise barrier is given in **Figure 6.12**.

P.C.C & Church Officials Discussing Design of Hospital Area - Lunglei

P.C.C & Church Officials Discussing Design of Hospital Area - Lunglei

Figure 6.10: Consultation with Church Officials regarding development of Hospital Area

6.5. ECOLOGICAL ENVIRONMENT - MITIGATION MEASURES

6.5.1. Terrestrial Ecology

Flora

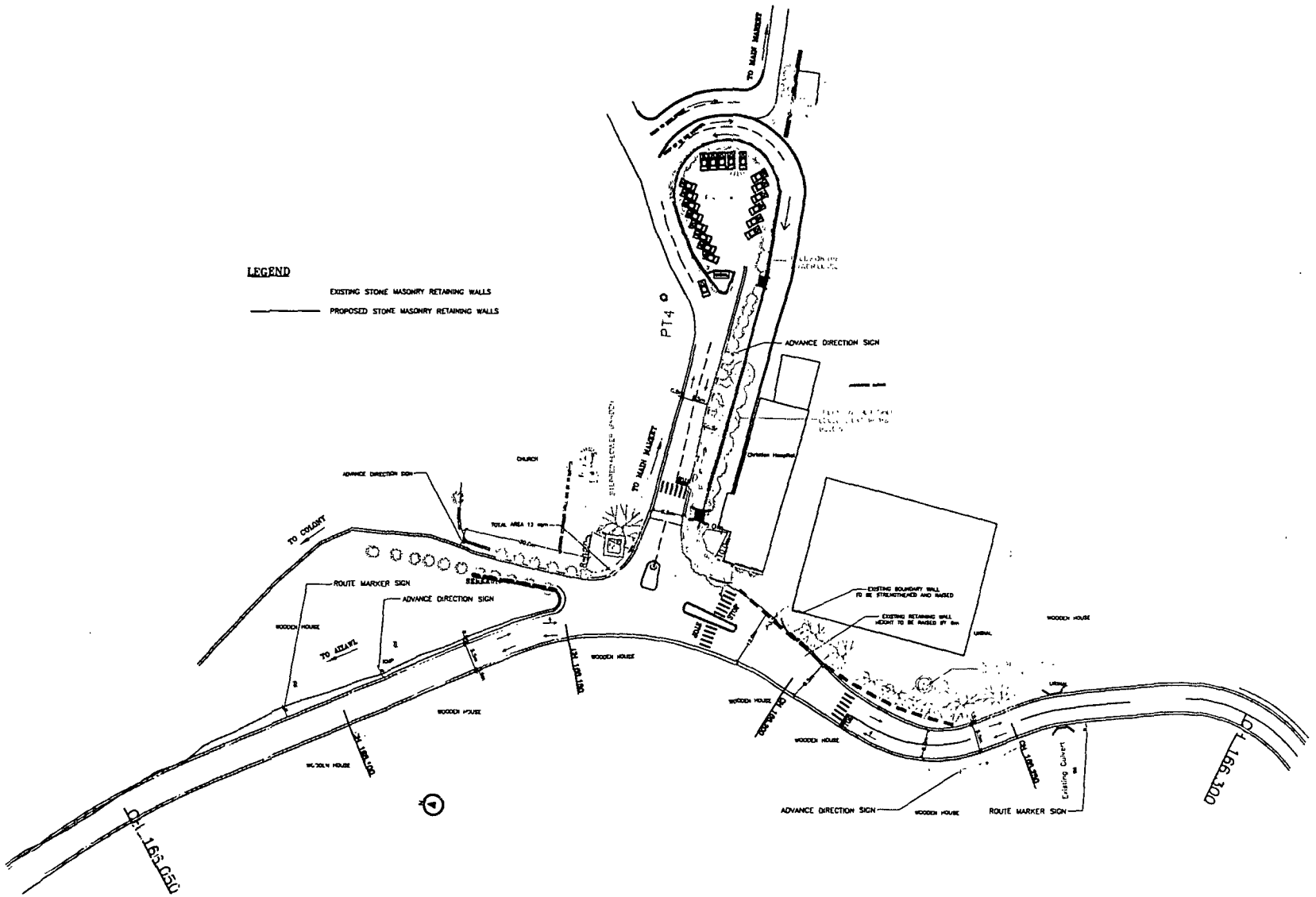
- **Riverine Reserve forest and Proposed Saza-Tlang Sanctuary and IBAs**

Though a reserve forest exists for half a mile on Mausen side of the Tlawng River, there is little enforcement and human intervention is widespread. This is evident, as the Revenue Department of the State has issued ownership/occupation rights on the Pukpui (Lunglei) side of the River Tlawng. This human intervention has seriously degraded the reserve forest. The Regional Chief Conservator of Forests' Shillong Office is also set to clear the diversion of Forestland for the project.

Widening on the hillside shall only involve very short stretches, less than 1km in length over several locations within the proposed Saza-Tlawng sanctuary. Government of Mizoram has also already notified 5m wide strips on both sides of several important roads including P1 (Aizawl – Lunglei) as road reserve and shall be utilised for the project.

The stretches mentioned as Important Biodiversity Areas (IBA) are ecologically important and have the highest species diversity in the project area. Care should be taken to arrest any negative impact on the proposed, reserve forest and IBAs by adopting the following mitigation measures:

- Plantation of trees (species specified) to be undertaken to offset any negative impact on the flora.
- Erection of signboards as specified by the engineer in the area mentioning reserve forest and proposed sanctuary.



GOVERNMENT OF MIZORAM PUBLIC WORKS DEPARTMENT	SCALE : 0 5 10 15 20	Plan For Junction At Km 166.200 On Aizawl-Buangpui-Lunglei Road (SH1) At Christian Hospital Serkawn	MIZORAM STATE ROADS PROJECT PHASE-II IMPROVEMENT AND UPGRADATION OF BUANGPUI-LUNGLEI ROAD KM 100.000 TO 167.943	From: Intercontinental Consultants & Technocrats Pvt Ltd. A-11, Green Park, New Delhi - 110016 ph : 686-3000, 698-4757, Fax 685-5252 R0 JAN 2002 R1 APR 2002 Prepared by / Checked by / Revision	Figure 6.11

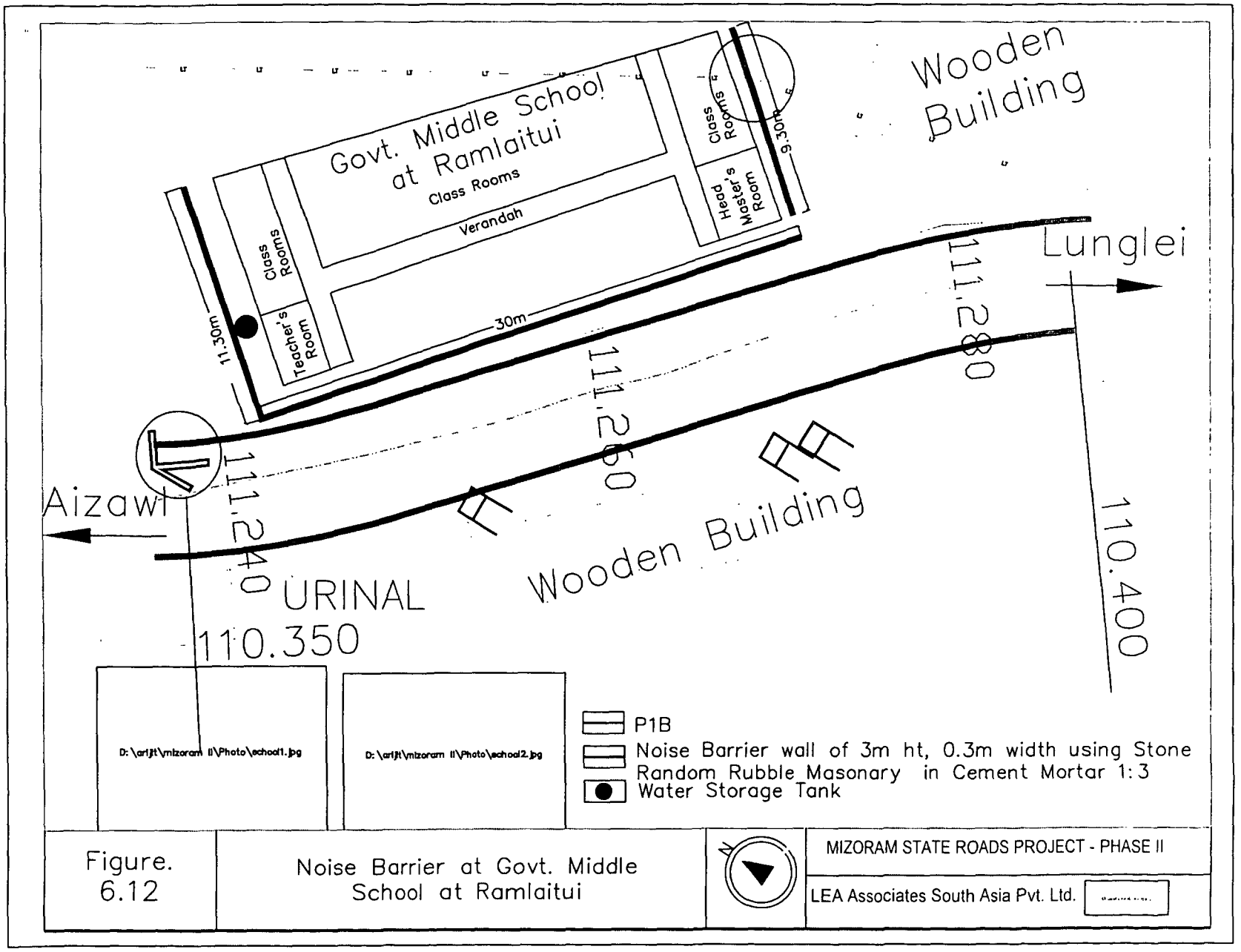


Figure. 6.12

Noise Barrier at Govt. Middle School at Ramlaitui

MIZORAM STATE ROADS PROJECT - PHASE II

LEA Associates South Asia Pvt. Ltd.

- No disposal of debris (other than at areas identified and listed in Table 6.7 and 6.9) to take place within the present area of the Riverine reserve forest, proposed sanctuary and the IBAs[17].
- Protection of floral species according to directions of the engineer.

- **Replantation**

The estimated loss of about 1177 trees would have to be compensated by extensive plantations of about 11770 saplings. The project will involve the local NGOs to re-vegetate the slopes as per the tree plantation strategy developed. While plantation is a onetime cost of the project, there is provision to provide financial incentive to the local NGOs for maintenance.

Species identified in **Table 6.3** and **6.4** should be used as far as practicable, strictly avoiding any exotic (but popular) species like Eucalyptus that can have far-reaching adverse effects on the ecology and water regime of the area. The species in the above mentioned tables have been identified after considering their local availability, growth, adaptability, invasiveness nature and mainly bioengineering capabilities. Detailed specifications have been appended to the EMP.

- **Protection of Important Floral Species:**

Activities during the construction period are likely to have adverse impact on the endangered plant species located along the carriageway. Bamboo fencing is proposed for the trees and the shrubs of the area. Provision of bamboo fencing during construction phase is depicted in the **Figure 6.13.**

For the shrubs, especially *Cyathea* spp., an endangered species in the region, closely spaced bamboo 125-150mm poles shall be erected as a fence at the edge of the corridor of impact to stop the falling debris. A drain shall be dug along the Col to prevent runoff from flowing towards the valley. In case of other plant species requiring shade, a barbed wire fence covered with bamboo mats shall be provided.

Fauna

The contractor shall take responsibility of prohibiting activities like hunting and poaching of avian and other faunal species, by the construction workers all throughout the project corridor and especially within the IBAs.

[17] The IBAs identified are listed in Section 3.2 and includes the whole area under proposed sanctuary and the Riverine Reserve Forest.

6.5.2. *Aquatic Ecology*

If the present water quality is maintained then there shall be no adverse impacts on the aquatic ecology. For this purpose all the mitigation measures adopted to maintain the water quality need to be scrupulously adhered to. Also workers need to be cautioned against unauthorised fishing.

6.6. SOCIO - ECONOMIC SCENARIO – IMPACTS & MITIGATION MEASURES ALSO REHABILITATION AND RESETTLEMENT ISSUES

There will be acquisition of land along the upgradation route P1B. The loss of land, loss of structures and the loss of livelihood are the main socio-economic impacts of the project. Since all the impacted persons are indigenous, a Resettlement and Indigenous Peoples Development Plan has been prepared in accordance with OD4.20 for mitigating these impacts. Details of the losses, their mitigation and implementation of these measures are given in the R&IPDP. However, the major impacts are summarised here:

6.6.1. *Loss of Land*

A total of 49.5 ha of land is required for the proposed improvements to the Buangpui-Lunglei section of the Aizawl-Lunglei Road. Most of the land to be acquired is used for agriculture (permanent or jhum). The maximum land requirement is in Pukpui, where maximum agriculture land is being taken to save a few residential structures. Details are available in **Chapter 5**. **Table 6.12** gives the split of the land requirement for the upgradation along P1B.

Table 6-12: Land requirements for upgradation along Buangpui – Lunglei Section

Name of Village	Residential Area to be Acquired (m2)	Agricultural land to be acquired (m2)	Land to be acquired from Associations (m2)	Government land to be transferred (m2)
Kanghmun 'S'	2189.00	24500.00	800.00	2025
Ramlaitui	3365.00	15010.00	4470.00	9350
Sekhum	1255.00	26025.00	2065.00	75
Mualthuam 'N'	4715.10	14390.00	1150.00	825
Haulawng	2962.59	25975.00	98.00	950
Mausen	2156.40	46455.00	351.00	13250
Pukpui	6273.70	66925.00	834.00	3650
Zotlang	2514.69	0.00	1.00	3250
Serkawn	2906.20	0.00	696.00	354
Zohnuai	1225.40	0.00	0.00	0
Bazar	1912.00	0.00	0.00	0
Total	**31478.08**	**219284**	**10470**	**33735**

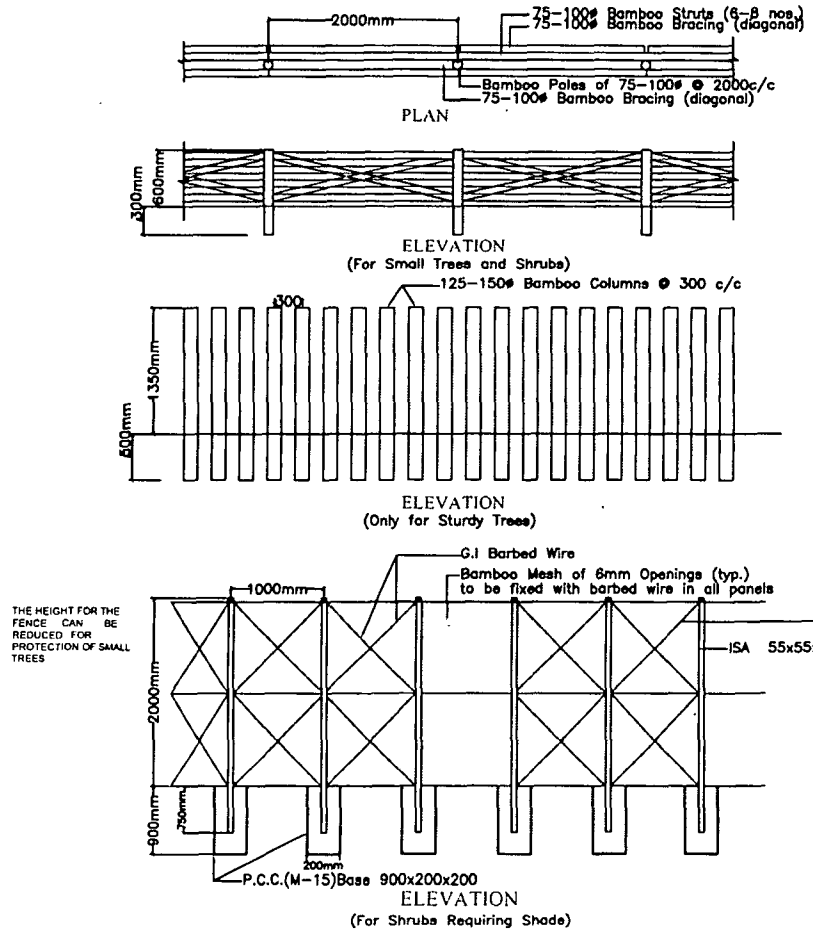


Figure. 6.13	Proposed Bamboo and Barbed Wire Fences	MIZORAM STATE ROADS PROJECT - PHASE II
		LEA Associates South Asia Pvt. Ltd.

6.6.2. *Loss of structures*

Most structures in Mizoram are built on stilts. There are few RCC structures along the road itself. The structures have walls made out of A. C. sheets instead of the traditional bamboo structures. Only one RCC structure is being affected. Most of the affected structures are residential. Only 9 commercial structures are being affected. Details for the private structures are provided in **Table 6.13**. Particulars of the community structures can be obtained from the R&IPDP

Table 6-13: Private Structures being affected along the P1B

Name of Village	Number of residences being impacted	Number of commercial structures being impacted	Total number of structures being impacted	Of which Number of 'Assam' structures	And Number of RCC structures
Kanghmun 'S'	1	0	1	1	0
Ramlaitui	7	0	7	6	1
Sekhum	6	0	6	6	0
Mualthuam 'N'	0	0	0	0	0
Haulawng	2	9	11	11	0
Mausen	3	0	3	3	0
Pukpui	2	0	2	2	0
Zotlang	5	0	5	5	0
Serkawn	3	0	3	3	0
Zohnuai	0	0	0	0	0
Bazar	0	0	0	0	0
Total	**29**	**9**	**38**	**37**	**1**

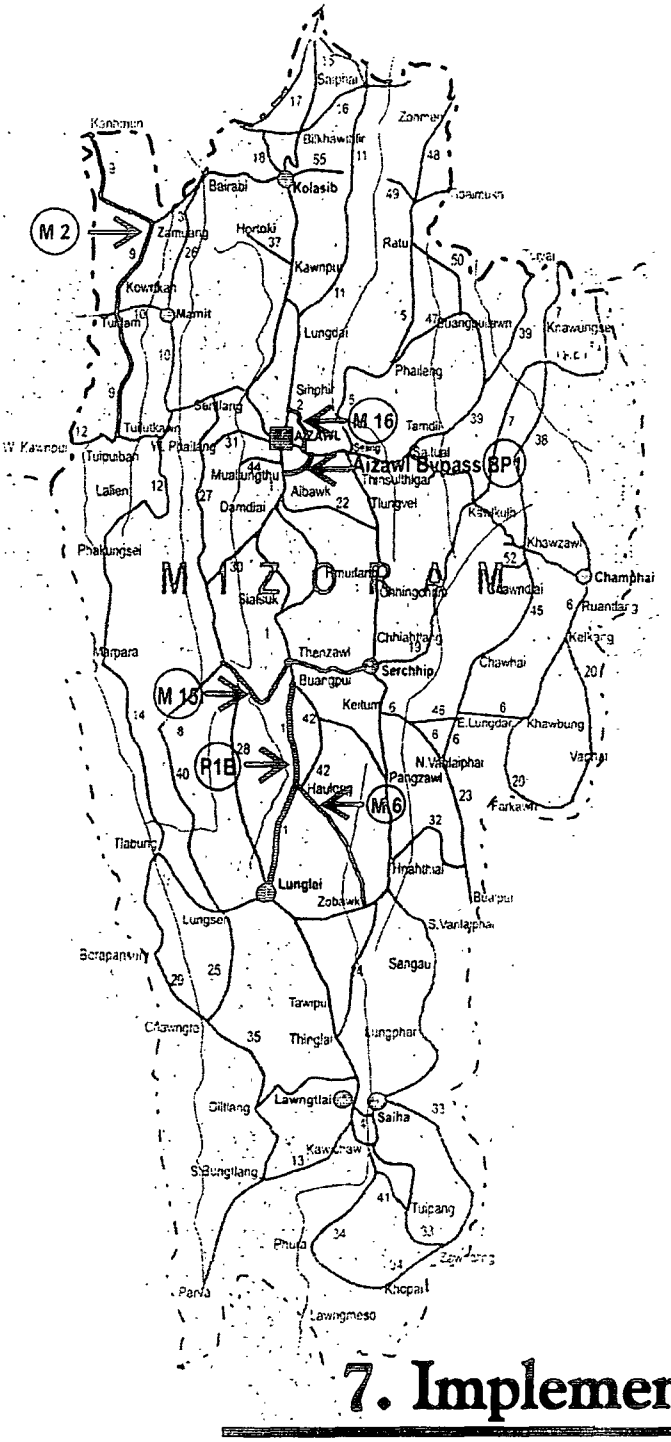
6.6.3. *Loss of Livelihood*

The loss of livelihood is mainly due to the loss of agricultural land. Most Mizos practise shifting cultivation. Therefore, loss of livelihood from loss of agricultural land may not be considered very significant impact as they can easily be granted rights for other plots which they can use. The details of the loss of livelihood are provided in the **Table 6.14.**

Table 6-14: Loss of livelihood along P1B

Project Affected Villages	Loss of Livelihood		
	Commercial	Agriculture	Total
Kanghmun 'S'	0	36	36
Ramlaitui	0	26	26
Sekhum	0	44	44
Mualthuam	0	24	24
Haulawng	19	72	91
Mausen	0	13	13

Project Affected Villages	Loss of Livelihood		
	Commercial	Agriculture	Total
Pukpui	3	8	11
Zotlang	0	0	0
Serkawn	0	0	0
Zohnuai	0	0	0
Bazar Veng	0	0	0
Total	22	223	245



7. Implementation Arrangements

7. IMPLEMENTATION ARRANGEMENTS

Since Phase I of MSRP is already being implemented by the MPWD, the arrangements for the Phase II is built on the suggestions of the Sectoral Environmental Assessment using the experiences of Phase I. By-and-large, the project implementation is going on as envisaged. There are a few aspects of the work, particularly those relating to the procurement of small service contractors, where streamlining is required during Phase II. These are addressed at appropriate locations in sections that follow.

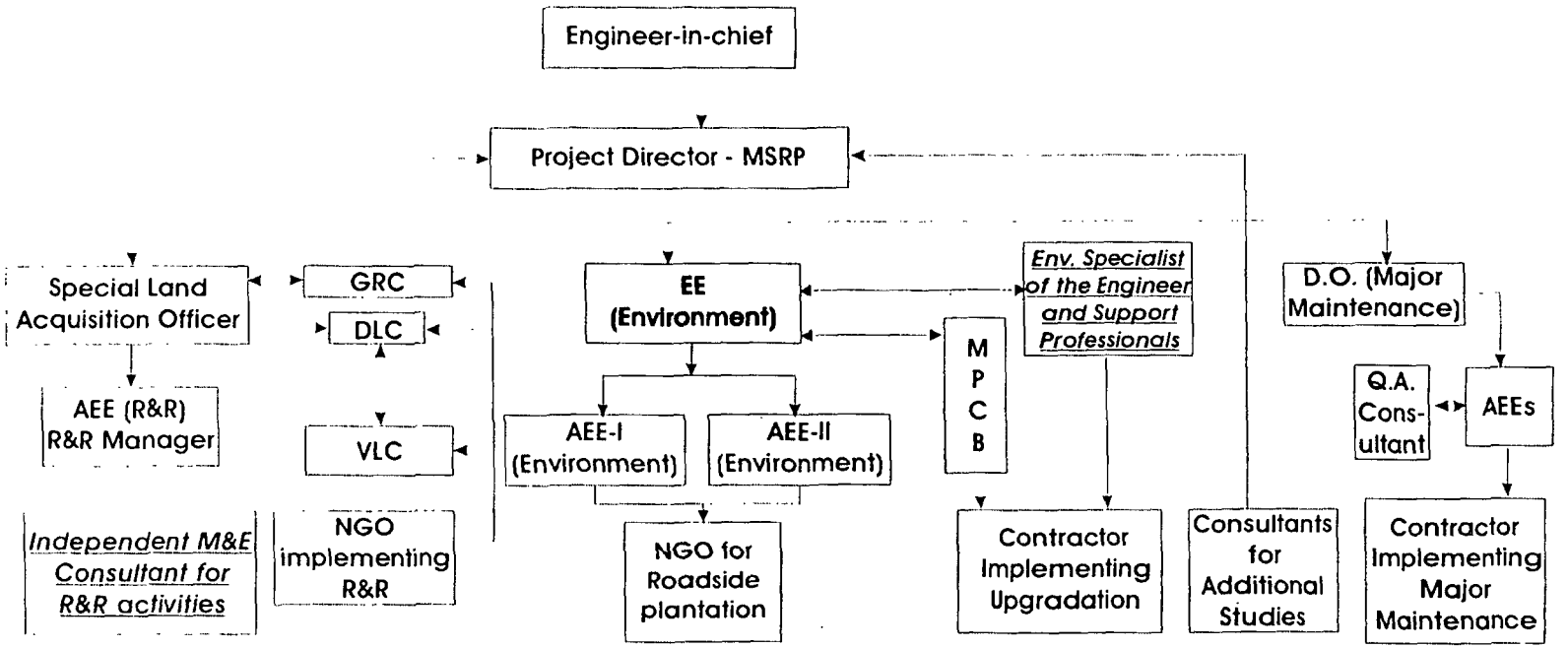
7.1. PROJECT IMPLEMENTATION UNIT, MPWD

The Project Implementation Unit (PIU) is entrusted with the responsibility of the MSRP, from preparation to implementation of both phases. Currently staffed with 7 full-time officials, the Unit is functioning from PWD headquarters in Aizawl. A Project Director (PD), an officer of the Superintending Engineer rank, heads the PIU. The PD is assisted by three officials (two Executive Engineers and a Special Land Acquisition Officer), one each looking after procurement, Environmental and Resettlement and Rehabilitation (R&R) issues. These officers in turn have one assistant engineer each, with an account officer also assisting the Executive Engineer in-charge of procurement. Experience in Phase I shows that the existing environmental staff of PIU is falling short of manpower to undertake field visits to inspect work sites. With the implementation of Phase II, all the works will be running simultaneously. Hence, to ensure adequate supervision and monitoring from the PIU, another A.E (Environment) will be procured for assisting E.E(Environment) for implementation of Phase-II.

7.2. OTHER STAKEHOLDERS

The PIU has availed services of several consultants for the project – for assisting it with preparation, institutional strengthening and supervision of implementation of MSRP Phase-II. In addition, services of a Non-Governmental Organisation (NGO) have also been procured as part of the project for implementation of the R&R activities and plantation on the roadside, where extra land is available and has recently been declared as road reserve. Implementation of the actual construction will be through Contractors procured through International Competitive Bidding (ICB) route. For major maintenance component, field units (divisions) of the PWD will act as supervisors and a consultant is expected to provide quality assurance services. Contractors for maintenance component are to be procured through National Competitive Bidding (NCB). The project will also require monitoring by other government agencies as MPCB, Department of Environment and Forests etc., at various points in the project cycle.

The implementation mechanism of PIU, environmental cell is shown in the flow diagram in **Figure 7-1**.



KEY
MSRP = Mizoram State Road Project
EE = Executive Engineer
AEE Assistant Executive Engineer
Acc. Off = Account Officer
MPCB = Mizoram Pollution Control Board
NGO = Non Governmental Organization
GRC = Grievance Redressal Committee
DLC = District Level Committee
SC = Supervision Consultant
VLC = Village Level Committee
M&E = Monitoring & Evaluation
R&R = Resettlement & Rehabilitation
DO = Divisional Officer
QA = Quality Assurance

Figure 7.1: Implementation Arrangement

7.3. ENVIRONMENTAL CELL, PIU

The Environmental Cell within the PIU, MPWD includes the Executive Engineer and an Assistant Environmental Engineer. They, operating as representatives of the Employer and as a unit are to ensure that the MSRP complies with the environmental covenants of the agreement with the IDA.

The Environmental Cell will continue to:

- Monitor progress of the implementation of the EMP measures in consonance with the timeline for the project within the allotted budget;
- Support Division offices' staff on the implementation of ERMP measures along the routes selected for the major maintenance component;
- Maintain interaction with the various other statutory bodies like Mizoram Pollution Control Board;
- Occasionally inspect the environmental measures being implemented by the Contractor and the NGO responsible for plantation;
- Report progress of works, both in terms of physical progress and quality for transmission to statutory authorities such as the Ministry of Environment and Forests as well as the World Bank Group;
- Facilitate training of appropriate PWD staff on Environmental aspects, either through the Environmental Specialist(s) of the Construction Supervision Consultants and/or External trainers; and
- Document and disseminate good practices, bottlenecks and their resolution during the implementation of environmental measures as part of MSRP.

7.4. PROJECT CO-ORDINATING CONSULTANTS

The role of the PCC, assisting the MPWD in project preparation, gradually reduces as the project moves entirely into the implementation stage. However, their limited presence will remain beyond preparation until the end of the project. A limited input from the Environmental and Social Experts is envisaged when the Supervision Consultant (SC) for Phase II mobilises. This will be for providing the SC with an overview of the environmental issues that are to be addressed during implementation.

7.5. SUPERVISION CONSULTANTS

The Supervision Consultants will be the key to ensure the successful implementation of EMP provisions during Phase II. As the 'Engineer' for the Contract, the SC will certify the Contractors' bills. Since ICB procurement is envisaged, the selected consultants are expected to have the necessary professional(s) to tackle the issues that MSRP Phase II is likely to bring up. The Environmental Specialist of the SC will be a key position that can be leveraged to ensure that the Contractor complies with the various EMP

requirements. The draft Terms of Reference for Environmental Specialist are given below:

The upgradation component of Phase II of MSRP will involve improvement the southern part of Aizawl – Thenzawl – Lunglei Road (P1) between Buangpui (km 100.000) to Lunglei (km 169.400) & construction of Aizawl bypass with World Bank assistance. Environmental Management Plans have been prepared for the same which need to be followed during the implementation of the civil works. The key responsibility of the Environmental Specialist will be the successful implementation of the EMP. In addition, s/he will report to the PIU and the World Bank on the progress of environmental protection and/or enhancement works as envisaged in the EMP. S/he will also ensure that the environmental capacity available to the PIU during implementation of MSRP is successfully transferred to MPWD in general and PIU staff in particular. The desired qualifications of the Environmental Specialist are:

- A degree in Civil and/or Environmental Engineering
- 15 years of experience in Supervision of implementation of Environmental Management Plan including at least one linear project
- Prior practical experience in Hill Roads would be an advantage

His/Her responsibilities will include:

- Supervise and monitor the implementation of EMP by the Contractor
- Review and approve site-specific environmental mitigation/enhancement designs for waterfalls,. locations for biodiversity protection, etc. worked out by the Contractor based on the sketches provided in the EMP prepared during project preparation
- Review and recommend the Contractors' Implementation Plans for approval (with any changes that may be necessary) to ensure compliance with the environmental provisions of the Contract
- Hold regular meetings with the Environmental Cell of the PIU and keep it updated on the progress of site works
- Prepare and submit Environmental progress report to the Environmental Cell
- Develop and organise environmental training programmes to upgrade the skills within the staff of the Environmental Cell, Contractors and other MPWD staff
- Document and develop good practices during project implementation for wider dissemination

MSRP Phase II will require continuous environmental supervision. It is desirable to have field staff with environmental functions to be on site for the duration of construction. Either the field engineers supervising construction can be trained on environmental aspects or one dedicated junior staff may be stationed for the duration of the project.

7.6. NON – GOVERNMENTAL ORGANISATIONS

Phase II of MSRP will utilise the services of a NGO for the implementation of R&R activities as well as for the plantation on the roadside, where extra land is available and has recently been declared as road reserve. The NGO will follow the specifications appended to the Environmental Management Plan for planting of saplings and for the maintenance of the plantation for 3 years. A separate amount is budgeted for this roadside plantation in addition to that for compensatory plantation at the rate of 10 saplings for each tree felled. In addition to this, they will also be entrusted the function of occasionally visiting Important Biodiversity Areas (IBAs) already identified. In these stretches, they can motivate the local people for conservation efforts and supplement the endeavours of the Environmental Specialist. They can also send their representatives for training programmes conducted by the CS and/or PIU so that these grass-roots level workers can go back to the site and train village council representatives of settlements.

7.7. QUALITY ASSURANCE CONSULTANTS

The major maintenance component in Phase II requires more environmental supervision than envisaged for Phase I. Since the Kanhmun – Tuilutkawn (M2) corridor passes through Dampa Tiger Reserve towards its southern end for nearly 10 km, it is suggested that Type III treatment that envisages building the road subgrade upwards be avoided in this section of M2. This is reflected in the ERMP. Moreover, the Zobawk – Haulawng road (M6) is being converted from its current earthen condition to a blacktopped road. Therefore, the levels of impact are anticipated to be higher on this particular stretch. The QA consultants need to be aware of these special requirements. It is expected that like Phase I, there will be provision for Environmental staff as part of the QA consultants' ToR so that these issues are accorded due importance.

7.8. CONTRACTORS

Execution of works will be responsibility of the contractor. The contractor will also implement the nvironmental measures since they are already a part of the BoQ for Phase II. This has been done with a view to ensure that road construction and environmental management go together. As executioners guided by the EMP and/or ERMP, Contractors need to be sensitised to the needs of Hill Roads. Though the individual Contractor's set up will vary, they are expected to have sufficient environmental input to ensure that works entrusted to them are implemented on the ground. Civil Engineers with implementation experience on highways, and an understanding of environmental issues, or better – post-degree qualification in environmental engineering should provide a continuous expertise with the SC's

Environmental Specialist. The responsibilities of Environmental Engineer of the Contractor are:

- Provide key inputs in the development of the Contractors' implementation plan for all construction activities, including haulage of material to site, adhering to the requirements of the EMP and getting approval of SC on the same before start of works.
- Ensure that the regulatory permissions required for the construction equipment, vehicles and machinery (given in the EMP) have been obtained and are valid at all times during the execution of the project.
- Identify locations for siting construction camps and other plants, machinery, vehicles and equipment, as well as locations for storage and disposal of wastes, both from the construction camps and from the site and obtain approval for the same from the Environmental Specialist of the SC.
- Detail out site-specific environmental mitigation and enhancement measures based on sketches provided as part of the EMP and obtain approval of SC for the same.
- Carry out the measurements of environmental mitigation and/or enhancement works and prepare bills for the same for approval and payment through the SC's Environmental Specialist.
- Ensure that the safety of the workers and other site users is not compromised during construction.
- Ensure that adequate monitoring facilities are available for collecting samples of all discharges from the Contractor's plants, equipment and camps.
- Verify the extent of environmental compliance at sites from where the Contractor is procuring the material – quarries, crushers or even sand and suggest appropriate mitigation measures, if required.
- Participate in training programmes and assist the PIU in preparing documentation for good practices in environmental protection as part of MSRP.

7.9. MONITORING ENVIRONMENTAL ACTIVITIES

The monitoring plan prepared for Phase II focuses on activities that can have significant environmental impacts and can be controlled with appropriate mitigation and/or enhancement measures. The results of monitoring will provide important information regarding the effectiveness of the proposed measures and thus influence decision-making process. The monitoring includes the use of:

- Visual observations of activities which (can) cause pollution
- Sampling and analysis of air, water or noise levels close to sensitive receptors at regular specified intervals using methods specified in the EMP.
- Feedback from NGO for IBA's
- Surveying and enumeration of biodiversity

7.10. REPORTING SYSTEM

Reporting system provides the necessary feedback for project management to ensure quality of the works and that the program is on schedule. The rationale for a reporting system is based on accountability to ensure that the measures proposed as part of the Environmental Management Plan get implemented in the project. Reporting system for the suggested monitoring program operates at two levels as:

- Reporting for environmental condition indicators and environmental management indicators
- Reporting for operational performance indicators at the PIU level.

The reporting system will operate linearly with the contractor reporting to the Supervision Consultant, who in turn shall report to the Project Director. All reporting by the Supervision Consultant shall be on a quarterly basis. The MPWD shall be responsible for preparing targets for each of the identified EMP activities. All subsequent reporting by the contractor shall be monitored as per these targets set by the MPWD before the contractors move on to the site. The reporting by the Contractor will be monthly report like report of progress on construction and will form the basis for monitoring by the MPWD, either by its own Environmental cell or the Environmental Specialist hired by the Supervision Consultant.

Along with these reports, NGO shall report progress of plantation and survival rate as per the monitoring plan. **Table 7.1** summarises the monitoring and reporting arrangements. Individual formats are given in **Annexure 7.1**

Table 7-1 : Summary of Reporting of Environmental components in Phase II of MSRP

Format No.	Target Sheet	Timing	Supervision Consultant		PIU, MPWD	
			Supervision	Reporting to PIU, MPWD	Compliance Monitoring	Report to WB
Construction Phase						
C1	Construction camp	Before construction	Quarterly	Quarterly	As required	Quarterly
C2	Disposal locations	Before construction	As required	One time		Quarterly
C3	Borrow areas	Before construction	As required	One time		Quarterly
C4	Protection measures for endangered flora	Before construction	Quarterly	One time	As required	Quarterly
C5	Pollution monitoring	During Construction	As required	After Monitoring		Quarterly
C6	Cleaning culvert openings	Construction	Quarterly	Quarterly	Quarterly	Quarterly
C7	Bio-diversity monitoring	Construction	Quarterly	Quarterly		Quarterly
Operation Phase						
O1	Roadside plantation	Operation			Quarterly	Quarterly
O2	Culvert openings	Operation			Quarterly	Quarterly
O3	Bioengineering	Operation			As required	Quarterly

7.11. ENVIRONMENTAL CAPACITY BUILDING WITHIN MPWD

The preparation of two phases of MSRP and the training programmes that have been organised during this period have sensitised members of the PIU and many key MPWD officials to environmental issues in the project. Targeted training modules and a clear setting of priorities by the PIU have been the key to success of the training so far. This needs to be built upon during the course of remainder of the MSRP so that the MPWD benefits from the expertise acquired by its staff well beyond the completion of MSRP.

The focus of future training programmes has to be on implementation. Since project preparation is drawing to a close, the MPWD officials can concentrate on simultaneous progress of Phase I and II. The proposed training should allow the officials to enhance their skills for effective monitoring of project by understanding the formats developed for reporting. Issues that the training can cover include the stability of slopes, their protection using civil engineering structures as well as bioengineering techniques, biodiversity and its protection, etc. For the former, on-site training such as in Nepal can be considered while for the latter training can be sourced from the biodiversity centre being planned in Imphal for the Northeast region.

In addition, close interaction is required among members of the PIU responsible for the Environmental and R&R activities since it is envisaged that the two aspects will have a considerable overlap. It is envisaged that the training as part of MSRP will include training on several issues important for both teams simultaneously. The following modules (**Table 7-2**) are to be undertaken as part of MSRP Phase II:

Table 7-2: Modules for further training during MSRP II

Session	Particulars	Short Description
I	**Timing:** After finalisation of Contracts for NGO and Civil Works **Target Group:** Members of PIU, representatives of NGO, Environmental Specialist of CS, Environmental staff of the Civil Contractor **No of Trainees:** 20 **Mode of Training:** Lectures, Presentation, Discussions Site visits along Phase I route(s) **Responsibility:** External Agency or PCC, PIU	**Overview of responsibilities in MSRP** • The roles and responsibilities of the CS, NGO and the Contractor • Reporting arrangements • Contractual obligations, Environmental Protection and Social Development **Special Issues in MSRP** • The importance of slope protection • Biodiversity and road construction • Preparation of Micro Plans • Income generation and Economic Rehabilitation
II	**Timing:** During implementation of Phase II of MSRP **Target Group:** Members of the PIU, Senior staff of the MPWD's Planning Cell **No. of Trainees:** 10 **Mode of Training:** Lectures, Discussions, Presentations, Role Play **Responsibility:** External Agency or PCC, CS, PIU	**Inter-Departmental Co-ordination** • Clearance requirements and prescribed procedures • Expectations of other departments – documentation and follow-up • Developing formats for ease of reporting • Improved co-ordination with Village Councils **Long term issues in Road Planning in Mizoram** • Emerging trends in Environmental and Social Assessments • Priority corridors, Protected Areas and conservation needs • Consultation and Public Involvement in Road Planning • Highway Development and diseases

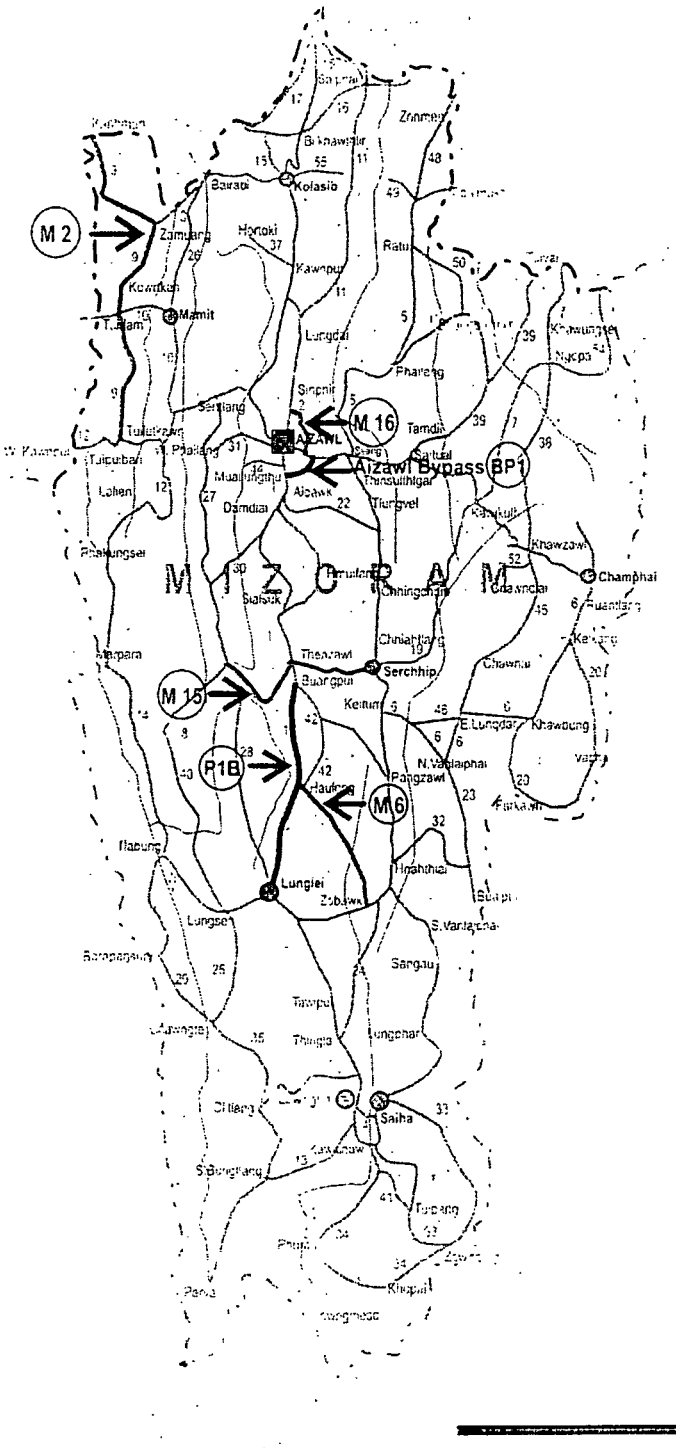
The total expenditure on training, inclusive of site visits; per diems and training fees will be approximately INR 1.0 million.

7.12. ENVIRONMENTAL BUDGET

The environmental budget for P1B covers all the environmental costs for the Buangpui-Lunglei section, details of which are available in Table 6.1 of the EMP submitted separately. The total costs are slightly over INR 7 million. This also includes the administration and logistic expenses for P1B and Aizawl bypass BP1. The detailed budget for the Aizawl bypass is presented Chapter 7 of the EIA and EMP for BP1. The break-up of the costs worked out is present in **Table 7.3**.

Table 7-3: Summary Budget for P1B

Head	Amount (in INR)
Mitigation/Enhancement Costs	4,092,344.00
Monitoring Costs	8,45,000.00
Miscellaneous Cost (Training, Maintenance, etc.)	2,086,600.00
TOTAL BUDGETED COSTS	**7,023,944.00**


M 2
M 16
Aizawl Bypass BP1
M 15
R1B
M 6
AIZAWL
Kolasib
Zamuang
Mamit
Lunglei
Saiha
Champhai
Serchhip
MIZORAM

Annexures

Annexure 3.1

LUNGLEI – BUANGPUI SECTION. PROJECT PROPOSAL P1B

A. General Observations:

This section was inspected on 18/01/03 and the allied stretches on 17/01 & 19/01. The subject stretch represents basically an old PWD alignment to be widened and improved upon under present project proposal. This stretch is an old road bench and appears to be perceptibly in a stabilised state. Some sporadic distress points viz.. road cuts exhibiting mini to macro collapses on both uphill & downhill faces with slope at locations quite steep. However, these do not look to be immediately vulnerable.

It is to be emphasized on the basis of observations & the expert views, that the route alignment in the section of P1B from km 111 km to 165 km do suggest at the various elevations of the present line, existence of hill cover material in a coherent and cohesive matrix and thus in a stable state even considering the minor variations in any natural soil / weathered rock / rock materials.

Thus, the scale of protection works envisaged in the DPR in this stretch may be considered as all that not essentially implemental. While it is admitted, the knowledge of the actual status demanding immediate implementation of protective action in the scale and stretch, can be better known during execution & implementation phase, it is possible to allot the estimated funds to be expended in stages (subject to acceptability of the funding system) say 60/70 p.c. during major implementation and next 30-40 pc in next 2-3 years during the road service is fully open to public.

The project proposal P1B have identified the engineering needs and have identified in a table the needs of Retaining Walls with brief details of heights and lengths. But during inspection the necessities of such elaborate proposal could not apparently be quite appreciated without a specific and detailed road – log of the observations, the existing cuts & slopes of down hill positions with re – entrant locations and culvert inlets outlets.

Further, it is to be borne in mind that during actual implementation with the local re-alignment, local re- curving local re-grading and widening several newer features would be revealed. Effects of these new features at some locations could be favourable and at some other locations unfavourable. Thus the scope of this proposal would desirably elect to provide some specific broad directions for implementation (for the PMC & the authority) as to expend the allotted of quantities of the protection works in a more clever manner, say, 60 pc as planned and 40 pc. Thereafter as the stretch reveals itself and the requirements identified.

In this regard attention is further drawn to one specific item like 8.0 m to 12.0 m high retaining walls (RCC) with presumably wide bases. The modes of its footing excavation, backfilling etc

may be specifically directed for guidance keeping in view to the practicability or the practical limitations in the formation of hill road benches with appropriate level of stability.

B. OBSERVATIONS Specifically Connected to Certain Locations

The Recee Notes on the Route from Lunglei to Buangpui section (P1B) is enclosed. Cut faces on uphill faces generally exhibit light yellow colour exhibiting cohesive character, with often relatively high silt content. Mostly cut depths range between 2m to 3 m with higher depths of cuts occurring infrequently in between. The sights of these old cuts appear to be broadly stable with quite occasional failures with small stretches (3 m to 6m). When the cut occurs in weathered rocks, highly weathered rocks, scree materials, the stability generally is found in order with some failures, when the disposition or orientation of bedding planes and/or joint planes is unfavourable. The failure in scree material depends upon the strength & character of the matrix materials. Mostly the derived products as observed in this stretch being cohesive, exhibit coherent faces and generally stable for the exposed heights, despite high silt content.

In the above general and local scenario, this route length may be considered as it is, in a better status compared to the stretch under P1A. However several specific cases are revealed in Recce Route Logs; some of them are elaborated.

Recee Notes are not to be considered as exhaustive, but provides keynotes for the scale of the problem in this stretch. Observations in the enclosed notes may be read in conjunction with the following.

Km 163 +270

Friable thinly bedded shale is slowly eroded after weakening of the joint planes on exposures. Elaborate protection system could be developed at prohibitive expenses. Instead a dwarf height protection, say 2m high breast wall with mortar & weep holes appears to be an optimum solution.

Similar specific cases are to be decided following detailed guidance from PCC under PMC/Authority for the contractor's implementation.

Km 161 + 100

To the extent the stated weakness is perceptible, the protection work may cover another 1.5 m / 2.0 m in height and 2.0 m / 3.0 m on lateral extend to contain the problem.

Similar cases to be identified and implementation action as mentioned earlier taken say at km 160 + 910.

Km 159 + 100

This specific case has potential problem. Matrix being of incoherent character, stepped cuts (in heights) protected with breast walls (banded with mortar) in filled with inverted filter (when required with Geo-textiles) giving an average slope of 70° or so could be considered.

Km 152 + 860

Widening of the existing culvert with u/s face organized, reset to arrest boulder rolling, but permitting small gravels, pebbles etc running down with water flow during monsoon. The case demands specific observation and guidance using rock fall barrier and / or enlarging size & length of culvert.

Km 151 + 773

The downhill steep faces around culvert outlet are to be protected for long serviceability of the road turning. Uphill boulder arrestor wall, if required, to be strengthened and/or additional energy absorbing arresting blocks at several uphill stream location may be considered, after detailed inspection.

Km 148 + 700

Properly designed breast walls, in 2/3 stage heights in a stepped back pattern may be considered with longitudinal drains at each stage height/stepped back location.

Km 142 + 600

Problematic case: Well planned stepped back cut to be formed and protected with Breast Walls having horizontal face also protected and fitted with longitudinal drains with possibly sealing course to avoid running water ingress behind the breast wall.
Retaining walls as appropriate to protect the down hill faces of Hume pipe outlet. Hume pipe junctions (typically vulnerable for movement and leakages) are to be well detailed out for execution.

Km 138 + 560

Low height breast wall protection with dowel anchors and drainage holes is one option.
Alternatively proper cut of road drains (uphill side) backed with medium height breast wall (3 m – 4 m), adequate weep holes, gaps filled with drainage blanket may be considered.

Km 132

Depending on the condition of the face, breast walls of proper design with heights 2 m – 3 m in massive exposure with joints unfavourable; heights 3 m – 5 m in not so massive exposure with less coherent joints; stepped back walls with intermediate drains etc. in scree materials are to be properly developed, based on local features and geometry.

Km 113 + 680

Careful cleaning of a part of uphill zone to avoid lubricating effect of joint planes during monsoon and provision of cut off drain, followed with breast wall on the down slope with weep holes etc for a stretch of say 15m / 20- m may be considered. If cleaning of bushes exposures higher degree of problematic zone, stepped back geometrics as mentioned earlier may be considered.

LUNGLEI – BUANGPUI – SECTION, RECEE NOTES

Route Km.	Brief Location	Brief Description of Road Bench Started			Photo Mark	Problems/Materials
		Up Hill	Down Hill	Other Observation		
165/344	Just After tourist lodge					
165/344	Zotlang	Cohesive spoil with breast wall		Light yellow cohesive greasy boulder studded		Local small slides on up hill spoils
165/160		Ridge		Ditto		A few local small slides on spoils
165/096	Village with BSF camp	Ridge		No widening		
	Pukpui			Cohesive spoil with some boulder		
163/860		Rock cut exposure partly weathered		Grey massive silt stone	1	Cut slope steep. Dip of bedding <30°
163/270		Thinly bedded silt stone with thin shale capped with thin silt stone holding top over	Right side point of specific concern	Bedding plane O.K. Joint planes unfavourable	2, 3	Friable thinly bedded grey shale – gradually washed away
162/200	Pukpui Village	Thinly bedded grey shale alternate with thin silt stones				Thin clay top cover
161/500		Thinly bedded grey sales	-			Slow disintegration possible
161/100		Mixed expose of shale & silt stones joints no cut face opening up		Joint planes near verti. Strike – N 155 bedding pl strike N225. Dip less than 50°	4, 5	Slow disintegration clay balls/exfoliated siltstone exhibit rounded voids. Failure along joint planes
160/910		Weathered to highly weathered silt stones with thin unconsolidated soil cover		Bedding planes dipping unfavourably. Joint materials weak	6	Locally some problems of sliding. May be tackled with breast walls
159/800	Between two hills	Both sides Down Hill	Down Hill	Width only 5.6 m		To be graded down for formation width
159/100		Highly weathered mixed soil	Height of retaining walls 6.0 m/8.0 m from downhill foot hold	Small slides in clay mixed boulders observed.		Highly weathered mixed soil & rock pieces susceptible to collapse Matrix do not exhibit Well-developed cohesive character.
158/860		Exposure of large blocks of silt stones				
158/480		Thinly bedded bluish grey			7, 8	Structurally the exposure is ok;

Route Km.	Brief Location	Brief Description of Road Bench			Photo Mark	Problems/Materials
		Started				
		Up Hill	Down Hill	Other Observation		
		shale alternating with thin & weathered silt stone with inherent micro fine weakness				small & slow degeneration expected. Low height protect wall feasible.
157/420	Proposed sanctuary	Cut exhibit shallow yellowish grey clayey matrix with local rock pieces			9 Uphill view for general appreciation of terrain character.	
152/860		Cuts comprise of clayey spoils generally O.K.		Perennial stream with culvert. Occasional breast wall 2m/3m height	10	Culvert to be widened as to avoid its blockage as discharge with spoil coming from hills during high precipitation.
151/773	Jhora stream steep fall both UP/DN	Large/massive silt stones/clay stones (bluish grey)		Bedding planes favourable joints widely spaced but dislodged by stream	12, 13, 14, 15	Down hill culvert faces going steeply down.
150/302	Tlawng River					Nothing critical observed
148/700		Dirty silt stone in weathered condition		Bedding planes dipping unfavourably	16	Slide on mixed soil on uphill observed.
		Bedding planes sub-horizontal			17	Failure along joint plane
142/600		Uphill short tongue type failure observed	3 m downhill steep in scree material	Re-culvert location cohesive road curve retaining wall, Hume pipe	19, 20	Narrow head failure. Slide in scree materials (Uphill 50)
141/950	Water Harvesting Proposal			Stream water perennial 2 sub structure	21	
138/560		Thinly bedded weathered shale		Alternate with silt stone	22, 23	Joint plane weak steep & unfavourable
133/480 to 560	Various features marked in project report as potential slide zone.	Mixed spoils (scree) material		Sketch to represent problematic materials.	A	Mini to macro failure spots with large scar about 80 m long in scree materials
132	Prior to Haulawng village	Steep joint planes unfavourable. Weathered, silt stone along joint plane. Mixed spoils.			24, 25, 26, 27	
131/600	Haulawng			Probable location of construction camp	28	Good location on uphill shallow slope
127/130						Site for 10 m high retaining wall could not be found
124/590				Flat Topography on RT.	29, 30	

Route Km.	Brief Location	Brief Description of Road Bench Started			Photo Mark	Problems/Materials
		Up Hill	Down Hill	Other Observation		
				Side.		
123/800						No problem apparently discerned
120/700 to 750	Land slide potential site as reported in DPR	Weathered silt stone failing along joint planes at 120 + 650 to 580		Nothing significant observed as physical evidence	31, 32	Only 20 m stretch (small potential) slides as little ahead of location marked.
113/680		Weathered yellow material highly weathered silt stone		Sliding along joint plane	33, 31	Careful cleaning and breast wall may be considered with bio engineering
111/780		Old scar identified at culvert location (111 + 800		Dislocation of drains/ culvert chokage	35	Formation – muddy due ground water with clayey wash coming on.
111/750 to 730		Sliding along bedding plane, bluish grey silty shale		Tree roots may cause slide	36, 37	

Annexure 3.2

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No. B. 12012/21/02-FST
GOVERNMENT OF MIZORAM
ENVIRONMENT & FORESTS DEPARTMENT

NOTIFICATION

.Dated Aizawl, the 28th Feb. 2002.

Whereas the Govt. of Mizoram considers that the area, situation and limits of which are specified in the schedule below is of adequate ecological, faunal, floral and geomorphological importance.

Therefore, in exercise of the power conferred under sec. - read with sec. 19, 20 and 21 of the wildlife (Protection) Act, 1972, the Govt. of Mizoram hereby intends to declare the said area to a Bird Sanctuary known as "SAZA TLANG BIRD SANCTUARY" for protecting, propagating and developing of wildlife and its environment.

SCHEDULE

Name of the area	:	Saza Tlang.
Location	:	15 kms. away from Lunglei town along Lunglei-Aizawl road via Thenzawl.
Area	:	15 Sq.Kms.

BOUNDARIES

STARTING POINT	:	The junction "Mausep peng." Lunglei – thenzawl PWD Road, Faith Farming Society Pukpui Jeep Road is used as the starting point.
SOUTH	:	The boundary runs along Mausep peng Faith Farming Society road excluding Pu H.P. Lalchhandama's land till it crosses the road at 1177 meters then following the drain downwards till it meets Pialthienglui. Then it follows Pialthienglui downwards and meets Tlawng lui.
EAST & NORTH	:	From the point where Pialthlenglui meets Tlawng lui., the boundary goes along Tlawng lui downwards upto Valkai-Lunglei to Thenzawl PWD to Bailey Bridge.
WEST	:	From the bridge over Tlawng lui, the boundary follows PWD road towards Pukpui direction till it reaches Mausep peng which is the starting point.

Sd/- VANHELA PACHUAU
Secretary to the Govt. of Mizoram,
Environment & Forest Department.

Memo No. B. 12012/21/02-FST : Dated Aizawl, the 28th Feb. 2002.

Copy to:-

1. The P.S. to Governor, Mizoram.
2. The P.S. to Chief Minister, Mizoram.
3. P.S. to Speaker / Dy. Speaker, Mizoram.
4. P.S. to Minister / Minister of State.
5. P.S. to Chief Secretary, Mizoram.
6. All Commissioners / all Secretaries.
7. All Head of Departments.
8. Principal Chief conservator of Forests with reference to his letter no. B.15014/4/200-PCCF/278 dt. 31.1.02.
9. The Chief Wildlife Warden, Mizoram.
10. The Deputy Commissioner (Lunglei). He is requested to take further follow-up action to enquire into and determine the existence, nature and extent of rights of any person in or over the land comprised within the limit of the sanctuary and to settle the claims in the manner as laid down from section 19 t 25 of the Wildlife (Protection) Act, 1972 and to submit his report to this Department.
11. The Controller, Printing & Stationeries with a request to publish the Notification in the Mizoram Gazette. (7 (Seven) spare copies enclosed). 40 (forty) copies of the Notification so published may be supplied to the undersigned.
12. The Director, Land Revenue & Settlement. He is requested to look into the matter and to intimate whether there is any objection.
13. Joint Director (WL), Govt. of India, Ministry of Environment & Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi.
14. All Conservators of Forests.
15. All Divisional Forest Officers.
16. Guard File.

(ROSIANA RALTE)
Under Secretary to the Govt. of Mizoram,
Environment & Forest Department.

Annexure 3.3

Tree Inventory within COI of 15 m for Buangpui-Lunglei Road

Chainage km.	Girth	Both												
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Others	Total
100.00 to 110.00	G1	85	73	76	21	9	31	7	4	18	3	3	218	548
	G2	34	32	21	8	12	12	4	4	3	2	1	53	186
	G3	13	11	12	3	7	5	2	1				48	102
	G4	13	18	2		6	1	8	1			3	22	74
	G5	2	8	1		2		1		1			17	32
	G6	9	13	2		2		1		1		2	18	48
	G7	7	8	3	1		1	2					6	28
	Total	**163**	**163**	**117**	**33**	**38**	**50**	**25**	**10**	**23**	**5**	**9**	**382**	**1018**
110.00 to 120.00	G1	43	22	42	53	9	21	19	4	6	4	2	110	335
	G2	13	22	22	20	6	7	7	3	1		2	43	146
	G3	28	37	7	8	10	16	11	3	1			59	130
	G4	14	21	6	2	5	4	3	2	3			29	89
	G5	10	14		1	2	2	1	1				13	44
	G6	12	26	1	1	3	4	3	2			1	14	67
	G7	9	15	2	1	4			4	1			15	51
	Total	**129**	**157**	**80**	**86**	**39**	**54**	**44**	**19**	**12**	**4**	**5**	**283**	**912**
120.00 to 130.00	G1	116	136	87	41	46	16	57	12	18	4	20	385	938
	G2	36	34	14	17	11	3	17	3	3		7	68	213
	G3	10	11	1	3	3		1	1	2		2	19	53
	G4	5	5							1		1	13	25
	G5	5	2					1					2	10
	G6		2					1					2	5
	G7							1						1
	Total	**172**	**190**	**102**	**61**	**60**	**19**	**78**	**16**	**24**	**4**	**30**	**489**	**1,245**
130.00 to 140.00	G1	148	88	38	79	53	34	23	37	34	1	19	344	898
	G2	64	56	27	62	14	20	13	21	35		12	143	467

Original Document by ICT & CES
Revised and Updated by LASA

Chainage km.	Girth	Both												
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Others	Total
	G3	47	32	9	37	2	9	6	8	16		2	51	219
	G4	3		1	2					1			6	13
	G5	3						1					2	6
	G6	2	1		1								3	7
	G7	1	1			1		1					1	5
	Total	**268**	**178**	**75**	**181**	**70**	**63**	**44**	**66**	**86**	**1**	**33**	**550**	**1,615**
140.00 to 150.00	G1	47	41	88	18	85	25	20	43	10	92	10	246	725
	G2	21	15	10	5	4	11	19	7	3	2	4	50	151
	G3	7	5	4		3		4		1	1		17	42
	G4		1	2		1				1		1	7	13
	G5		1	1									4	6
	G6		4			1		1					1	7
	G7							1					1	2
	Total	**75**	**67**	**105**	**23**	**94**	**36**	**45**	**50**	**15**	**95**	**15**	**326**	**946**
150.00 to 160.00	G1	37	44	72	32	42	66	6	14	22	87	32	266	720
	G2	8	11	10	8	9	18	1	8	12	1	13	110	209
	G4												1	1
	G5				2				1				2	5
	G6					1							1	2
	G7				1	2							3	6
	Total	**48**	**61**	**84**	**48**	**63**	**87**	**7**	**23**	**36**	**88**	**48**	**408**	**1,001**
160.00 to 170.00	G1	35	41	33	54	3	13	8	20	5		11	289	512
	G2	12	12	8	8	1	5	5	6	1		2	93	153
	G3	12	12	1	4		6	2	2	1		2	43	85
	G4	3											1	4
	G5												2	2
	G6	3											7	10
	G7	3	1	1								2	8	15
	Total	**68**	**66**	**43**	**66**	**4**	**24**	**15**	**28**	**7**	**0**	**17**	**443**	**781**

Annexure - 3.4

BUANGPUI-S. KANGHMUN
(Altitude : 707-820 m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq metre size quadrat)

Name of the Species	Total no. of Individuals of each species	No. of quadrats occurrence	Total no. of quadrats studied	Frequency In %	Abundance	Density
1. Ageratum conzoides	52	30	30	100	1.73	1.73
2. Bidens biternata	30	30	30	100	1	1
3. Saccharum longisetosum	110	25	30	83.33	4.4	3.66
4. Clerodendrum colebrookianum	2	10	30	33.33	0.2	0.06
5. Mikania Micrantha	80	30	30	100	2.66	2.66
6. Chromolaena odorata	75	30	30	100	2.5	2.5
7. Cynodon dactylon	25	30	30	100	0.83	0.83
8. Thysanolaena maxima	20	20	30	66.66	1	0.66
9. Melastoma malabathricum	12	20	30	66.66	0.6	0.4
10. Cinnamomum obtusifolium	3	5	30	16.66	0.6	0.1
11. Phyllanthus fraternus	7	10	30	33.33	0.7	0.23
12. Didymochlaena truncatula	8	10	30	33.33	0.8	0.26
13. Diplazium griffithii	5	5	30	16.66	1	0.16
14. Dryopteris ornate	7	10	30	33.33	0.7	0.23
15. Pteridium aquilinum	5	5	30	16.66	1	0.16
16. Tectaria Macrodonta	6	5	30	16.66	1.2	0.2
17. Microlepia strigosa	6	5	30	16.66	1.2	0.2
18. Polystichum aristatum	4	10	30	33.33	0.4	0.13
19.P. Biaristatum	9	5	30	16.66	1.8	0.3
20 Pteris biaurita.	7	5	30	16.66	1.4	0.23
21.P. quadriaurita	5	5	30	16.66	1	0.16

Name of the Species	Total no. of individuals of each species	No. of quadrats occurrence	Total no. of quadrats studied	Frequency in %	Abundance	Density
22.P. subquinata	3	4	30	13.33	0.75	0.1
23.P. vitta	8	5	30	16.66	1.6	0.26
24. Hedyotis scandens	4	2	30	6.66	2	0.13
25.Maesa indica	1	2	30	6.66	0.5	0.03
26.Musa paradisiacal	15	20	30	66.66	0.75	0.5
27.Curuligo crassifolia	5	30	30	100	0.16	0.16
28. Rubus birmanicus	30	30	30	100	1	1
29. Piper betle	3	1	30	3.33	3	0.1
30. Dysoxylum gobara	2	12	30	40	0.16	0.06
31. Cyathea dealbata	3	1	30	3.33	3	0.1
32. Amomum dealbatum	10	20	30	66.66	0.5	0.33
33. Blumea alata	8	30	30	100	0.26	0.26
34. Colocasia sculenta	12	5	30	16.66	2.4	0.4
35. Imperata Cylindrica	22	20	30	66.66	1.1	0.73
36. Spilanthes oleracea	33	30	30	100	1.1	1.1
37. Smilax perfoliata	4	5	30	16.66	0.8	0.13
38. Ficus auriculata	5	4	30	13.33	1.25	0.16
39. Begonia dioica	6	20	30	66.66	0.3	0.2
40. Bridelia monoica	8	10	30	33.33	0.8	0.26
41. Acacia Pruinescens	5	5	30	16.66	1	0.16
42. Costus speciosus	10	4	30	13.33	2.5	0.33
43. Melocanna Baccifera	11	6	30	20	1.83	0.36

Annexure – 3.5

BUANGPUI - S. KANGHMUN
(Altitude : 707 - 820 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Anogeissus acuminata	12	6	10	60	2	1.2
2. Macaranga indica	20	10	10	100	2	2
3. Gmelina arborea	7	4	10	40	1.75	0.7
4. Callicarpa arborea	15	10	10	100	1.5	1.5
5. Castanopsis tribuloides	23	10	10	100	2.3	2.3
6. Parkia timoriana	10	7	10	70	1.42	1
7. Duabanga grandiflora	17	8	10	80	2.12	1.7
8. Tectona grandis	13	2	10	20	6.5	1.3
9. Albizzia chinensis	6	2	10	20	3	0.6
10. Cinnamomum verum	2	1	10	10	2	0.2
11. Securinega virosa	8	4	10	40	2	0.8
12. Artocarpus heterophyllus	5	2	10	20	2.5	0.5
13. Schima khasiana	16	10	10	100	1.6	1.6
14. Rhus semialata	14	6	10	60	2.33	1.4
15. Lithocarpus pachyphylla	10	4	10	40	2.5	1
16. Quercus helpheriana	4	2	10	20	2	0.4
17. Quercus polystachya	12	10	10	100	1.2	1.2
18. Trema orientalis	15	10	10	100	1.5	1.5
19. Schima wallichii	20	10	10	100	2	2
20. Spondias pinnata	4	1	10	10	4	0.4

Annexure –3.6

S.KANGHMUN-RAMLAITUI
(ALTITUDE: 729-761 M)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of the Species	Total no. of individuals of each species	No. of quadrats occurrence	Total no. of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	48	25	30	83.33	1.92	1.6
2. Bidens biternata	35	27	30	90	1.29	1.16
3. Saccharum longisetosum	92	15	30	50	6.13	3.06
4. Mikania micrantha	84	30	30	100	2.8	2.8
5. Chromolaena odorata	60	30	30	100	2	2
6. Cynodon dactylon	44	30	30	100	1.46	1.46
7. Osbeckia chinensis	3	2	30	6.66	1.5	0.1
8.Rrubus birmanicus	38	30	30	100	1.26	1.26
9. Imperata Culindrica	20	10	30	33.33	2	0.66
10. Spilanthes oleracea	30	28	30	93.33	1.07	1
11. Bridelia monoica	5	5	30	16.66	1	0.16
12. Costus speciosus	3	2	30	6.66	1.5	0.1
13. Hedychium coccinum	4	4	30	13.33	1	0.13
14. Melocanna baccifera	13	7	30	23.33	1.85	0.43

Annexure – 3.7

S. KANGHMUN - RAMLAITUI
(Altitude : 729 - 761 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Anogeissus acuminata	10	4	10	40	2.5	1
2. Macaranga indica	23	10	10	100	2.3	2.3
3. Gmelina arborea	9	5	10	50	1.8	0.9
4. Callicarpa arborea	7	3	10	30	2.33	0.7
5. Castanopsis tribuloides	27	10	10	100	2.7	2.7
6. Parkia timoriana	5	2	10	20	2.5	0.5
7. Duabanga grandiflora	15	6	10	60	2.5	1.5
8. Tectona grandis	10	1	10	10	10	1
9. Albizzia chinensis	13	7	10	70	1.85	1.3
10. Securinega virosa	14	5	10	50	2.8	1.4
11. Artocarpus heterophyllus	4	2	10	20	2	0.4
12. Schima khasiana	20	10	10	100	2	2
13. Rhus semialata	14	6	10	60	2.33	1.4
14. Lithocarpus pachyphylla	18	9	10	90	2	1.8
15. Quercus polystachya	8	4	10	40	2	0.8
16. Trema orientalis	20	8	10	80	2.5	2
17. Emblica officinalis	4	2	10	20	2	0.4
18. Toona ciliata	9	5	10	50	1.8	0.9
19. Artocarpus chama	13	7	10	70	1.85	1.3
20. Saurauia napaulensis	28	10	10	100	2.8	2.8
21. Albizzia thomsoni	7	2	10	20	3.5	0.7
22. Castanopsis laceaefolia	8	3	10	30	2.66	0.8

Annexure – 3.8

RAMLAITUI-SEKHUM
(Altitude: 779-850 m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of the Species	Total no. of individuals of each species	No. of quadrats occurrence	Total no. of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	38	30	30	100	1.26	1.26
2. Bidens biternata	32	30	30	100	1.06	1.06
3. Saccharum longisetosum	85	20	30	66.66	4.25	2.83
4. Mikania micrantha	62	30	30	100	2.06	2.06
5. Chromolaena odorata	60	28	30	93.33	2.14	2
6. Cynodon dactylon	32	29	30	96.66	1.10	1.06
7. Thysanolaena maxima	25	30	30	100	0.83	0.83
8. Phyllanthus fraternus	4	4	30	13.33	1	0.13
9. Didymochlaena truncatula	5	4	30	13.33	1.25	0.16
10. Dryopteris ornate	9	7	30	23.33	1.28	0.3
11. Tectaria macrodonta	7	5	30	16.66	1.4	0.23
12. Microlepia strigosa	10	8	30	26.66	1.25	0.33
13. Pteris biaurita	8	6	30	20	1.33	0.26
14. P. Subquinata	4	2	30	6.66	2	0.13
15. P. vitta	5	4	30	13.33	1.25	0.16
16. Passiflora nepalensis	2	1	30	3.33	2	0.06
17. Eryngium foetidum	2	1	30	3.33	2	0.06
18. Musa paradisiacal	18	15	30	50	1.2	0.6
19. Centella asiatica	10	5	30	16.66	2	0.33
20. Rubus birmanicus	32	30	30	100	1.06	1.06
21.Solanuma torvum	10	8	30	3.33	1.25	0.33
22. Polygonum Chinense	8	6	30	20	1.33	0.26

Name of the Species	Total no. of individuals of each species	No. of quadrats occurrence	Total no. of quadrats studied	Frequency in %	Abundance	Density
23.Cyathea Dealbata	4	2	30	6.66	2	0.13
24.Amomum dealbatum	8	6	30	20	1.33	0.26
25.Blumea alata	15	15	30	50	1	0.5
26. Sida acuta	10	4	30	13.33	2.5	0.33
27.Imperata Cylindrica	18	16	30	53.33	1.13	0.6
28.Spilanthes oleracea	45	30	30	100	1.5	1.5
29.Desmodium triquetrum	15	10	30	33.33	1.5	0.5
30.Ficus auriculata	3	1	30	3.33	3	0.1
31.Begonia dioica	10	6	30	20	1.66	0.33
32.Bridelia monoica	5	3	30	10	1.66	0.16
33. Mussaenda glabra	2	1	30	3.33	2	0.06
34. Costus specisosus	5	2	30	6.66	2.5	0.16
35 Melacanna baccifera.	14	8	30	3.33	1.75	0.46

Annexure – 3.9

RAMLAITUI - SEKHUM
(Altitude : 779 - 850 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Anogeissus acuminata	12	4	10	40	3	1.2
2. Macaranga indica	25	10	10	100	2.5	2.5
3. Gmelina arborea	10	5	10	50	2	1
4. Callicarpa arborea	8	2	10	20	4	0.8
5. Castanopsis tribuloides	30	10	10	100	3.0	3.0
6. Parkia timoriana	4	1	10	10	4	0.4
7. Duabanga grandiflora	27	9	10	90	3	2.7
8. Tectona grandis	20	7	10	70	2.85	2
9. Albizzia chinensis	15	6	10	60	2.5	1.5
10. Securinega virosa	13	4	10	40	3.25	1.3
11. Artocarpus heterophyllus	7	2	10	20	3.5	0.7
12. Rhus semialata	5	1	10	10	5	0.5
13. Trema orientalis	20	8	10	80	2.5	2
14. Schima wallichii	27	10	10	100	2.7	2.7
15. Spondias pinnata	2	1	10	10	2	0.2
16. Saurauia napaulensis	12	5	10	50	2.4	1.2
17. Embelia vestita	6	3	10	30	2	0.6
18. Bombax ceiba	13	6	10	60	2.16	1.3
19. Artocarpus chama	8	3	10	30	2.66	0.8
20. Emblica officinalis	5	2	10	20	2.5	0.5
21. Ficus retusa	2	1	10	10	2	0.2
22. Bauhimia variegata	10	7	10	70	1.42	1
23. Lithocarpus xylocarpa	15	5	10	50	3	1.5
24. Litsea cubeba	8	6	10	60	1.33	0.8

Annexure – 3.10

SEKHUM-N. MUALTHUAM
(Altitude: 840-735m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	45	30	30	100	1.5	1.5
2. Bidens biternata	15	28	30	93.33	0.53	0.5
3. Saccharum longisetosum	75	20	30	66.66	3.75	2.5
4. Mikania micrantha	62	28	30	93.33	2.21	2.06
5. Chromolaena odorata	55	30	30	100	1.83	1.83
6. Cynodon dactylon	22	25	30	83.33	0.88	0.73
7. Thysanolaena maxima	32	18	30	60	1.77	1.06
8. Melastoma malabathricum	8	5	30	16.66	1.6	0.26
9. Diplazium griffithii	25	10	30	33.33	2.5	0.83
10. Curculigo crassifolia	15	10	30	33.33	1.5	0.5
11. Rubus birmanicus	67	30	30	100	2.23	2.23
12. Amomum dealbatum	15	10	30	33.33	1.5	0.5
13. Blumea alata	12	8	30	26.66	1.5	0.4
14. Imperata cylindrica	20	18	30	60	1.11	0.66
15. Spilanthes oleracea	38	30	30	100	1.26	1.26
16. Bridelia monoica	5	3	30	10	1.66	0.16
17. Centella asiatica	8	6	30	20	1.33	0.26
18. Desmodium triquetrum	10	7	30	23.33	1.42	0.33
19. Polygonum chinense	6	4	30	13.33	1.5	0.2
20. Cayratia obovata	3	2	30	6.66	1.5	0.1
21. Urena lobata	28	25	30	83.33	1.12	0.93
22. Lygodium flexuosum	5	2	30	6.66	2.5	0.16
23. Melacanna baccifera	12	6	30	20	2	6.4

Annexure – 3.11

SEKHUM - N. MUALTHUAM
(Altitude : 840 - 735 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Derris robusta	7	2	10	20	3.5	0.7
2. Macaranga indica	10	8	10	80	1.25	1
3. Rhus succedania	9	4	10	40	2.22	0.9
4. Anthocephalus chinensis	8	3	10	30	2.66	0.8
5. Ficus hirta	6	5	10	50	1.2	0.6
6. Ficus neligiosa	4	2	10	20	2	0.4
7. Duabanga grandiflora	13	7	10	70	1.85	1.3
8. Tectona grandis	7	3	10	30	2.33	0.7
9. Securinega virosa	6	2	10	20	3	0.6
10. Artocarpus heterophyllus	5	1	10	10	5	0.5
11. Rhus semialata	8	2	10	20	4	0.8
12. Trema orientalis	16	7	10	70	2.28	1.6
13. Schima wallichii	15	8	10	80	1.87	1.5
14. Wenlandia grandis	9	5	10	50	1.8	0.9
15. Saurauia napaulensis	10	4	10	40	2.5	1
16. Ficus benghelensis	1	1	10	10	1	0.1
17. Bombax ceiba	11	6	10	60	1.83	1.1
18. Artocarpus chama	8	3	10	30	2.66	0.8
19. Emblica officinalis	6	2	10	20	3	0.6
20. Terminalia myriocarpa	7	4	10	40	1.75	0.7
21. Bauhimia variegata	5	2	10	20	2.5	0.5
22. Lithocarpus xylocarpa	14	7	10	70	2	1.4
23. Litsea cubeba	8	3	10	30	2.66	0.8
24. Acrocarpus fraxini folius	5	2	10	20	2.5	0.5
25. Quercas helpheriana	9	3	10	30	3	0.9
26. Lithocarpus pachyphylla	13	7	10	70	1.85	1.3
27. Albizzia thomsoni	4	2	10	20	2	0.4
28. Gmelina arborea	7	3	10	30	2.33	0.7
29. Quercas polystachya	6	2	10	20	3	0.6

Annexure – 3.12

N. MUALTHUAM - HAULAWNG
(Altitude : 754 - 952 m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	50	28	30	87.11	1.78	1.66
2. Bidens biternata	10	2	30	6.66	5	0.33
3. Saccharum longisetosum	62	30	30	100	2.06	2.06
4. Mikania micrantha	50	27	30	90	1.85	1.66
5. Chromolaena odorata	22	17	30	56.66	1.29	0.73
6. Cynodon dactylon	28	10	30	33.33	2.8	0.93
7. Melastoma malabathricum	7	2	30	6.66	3.5	0.23
8. Phyllanthus fraternus	5	1	30	3.33	5	0.16
9. Gleichemia linearis	15	10	30	33.33	1.5	0.5
10. Musa paradisiaca	10	4	30	13.33	2.5	0.33
11. Curculigo crassifolia	4	2	30	6.66	2	0.13
12. Rubus birmanicus	12	8	30	26.66	1.5	0.4
13. Amomum dealbatum	7	2	30	6.66	3.5	0.23
14. Blumea alata	8	5	30	16.66	1.6	0.26
15. Colocasia esculenta	6	2	30	6.66	3	0.2
16. Imperata cylindrica	15	4	30	13.33	3.75	0.5
17. Spilanthes oleracea	25	10	30	33.33	2.5	0.83
18. Oxalis corniculata	30	18	30	4.62	1.66	1
19. Urena lobata	18	6	30	20	3	0.6
20. Phryhium capitatum	5	1	30	3.33	5	0.16
21. Polygonum chinense	5	2	30	6.66	2.5	0.16
22. Costus speciosus	8	4	30	13.33	2	0.26
23. Melacanna baccifera	14	7	30	23.33	2	0.46

Annexure – 3.13

N. MUALTHUAM - HAULAWNG
(Altitude : 754 - 952 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Anogeissus acuminata	9	4	10	40	2.25	0.9
2. Macaranga indica	17	8	10	80	2.12	1.7
3. Gmelina arborea	6	3	10	30	2	0.6
4. Callicarpa arborea	8	5	10	50	1.6	0.8
5. Castanopsis lanceaefolia	4	2	10	20	2	0.4
6. Parkia timoriana	7	4	10	40	1.75	0.7
7. Duabanga grandiflora	15	8	10	80	1.87	1.5
8. Tectona grandis	6	2	10	20	3	0.6
9. Securinega virosa	5	2	10	20	2.5	0.5
10. Artocarpus heterophyllus	4	1	10	10	4	0.4
11. Trema orientalis	14	6	10	60	2.33	1.4
12. Saurauia napaulensis	10	6	10	60	1.66	1
13. Bombax ceiba	10	7	10	70	1.42	1
14. Artocarpus chama	6	2	10	20	3	0.6
15. Emblica officinalis	5	1	10	10	5	0.5
16. Ficus retusa	2	1	10	10	2	0.2
17. Lithocarpus xylocarpa	11	7	10	70	1.57	1.1
18. Albizzia thomsoni	8	3	10	30	2.77	0.8
19. Acrocarpus fraxini folius	7	4	10	40	1.75	0.7
20. Schima khasiana	12	5	10	50	2.4	1.2
21. Betula alnoides	5	2	10	20	2.5	0.5
22. Lithocarpus pachyphylla	15	8	10	80	1.87	1.5
23. Anthocephalus chinensis	6	3	10	30	2	0.6

Annexure – 3.14

HAULAWNG - MAUSEN
(Altitude : 1052 - 623 m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	50	28	30	93.33	1.78	1.66
2. Bidens biternata	20	18	30	60	1.11	0.66
3. Saccharum longisetosum	30	23	30	76.66	1.30	1
4. Mikania micrantha	80	30	30	100	2.66	2.66
5. Chromolaena odorata	20	19	30	63.33	1.05	0.66
6. Cynodon dactylon	30	12	30	40	2.5	1
7. Thysanolaena maxima	35	24	30	80	1.45	1.16
8. Melastoma malabathricum	12	4	30	13.33	3	0.4
9. Didymochlaena truncatula	20	12	30	40	1.66	0.66
10. Microlepia strigosa	17	10	30	33.33	1.7	0.56
11. Polystichum aristatum	23	15	30	50	1.53	0.76
12. Musa paradisiaca	30	12	30	40	2.5	1
13. Curculigo crassifolia	8	3	30	0.1	2.66	0.26
14. Rubus birmanicus	25	20	30	66.66	1.25	0.83
15. Cyathea dealbata	19	5	30	16.66	3.8	0.63
16. Amomum dealbatum	18	10	30	33.33	1.8	0.6
17. Colocasia esculenta	13	2	30	6.66	6.5	0.43
18. Imperata cylindrica	50	26	30	86.66	1.92	1.66
19. Spilanthes oleracea	40	28	30	93.33	1.42	1.33
20. Costus speciosus	23	11	30	36.66	2.09	0.76
21. Begonia dioica	4	1	30	3.33	4	0.13

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
22. Urena lobata	25	20	30	66.66	1.25	0.83
23. Centella asiatica	20	12	30	40	1.66	0.66
24. Polygonum chinense	8	2	30	6.66	4	0.26
25. Holigarna longifolia	2	1	30	3.33	2	0.06
26. Securinega virosa	10	3	30	10	3.33	0.33
27. Desmodium triquetrum	3	1	30	3.33	3	0.1
28. Saurauia punduana	4	2	30	6.66	2	0.13
29. Gleichenia linearis	20	5	30	16.66	4	0.66
30. Manihot esculenta	4	1	30	3.33	4	0.13
31. Argyreia mastersii	30	27	30	90	1.11	1
32. Mussaendra glabra	4	2	30	6.66	2	0.13
33. Melacanna baccifera	11	5	30	16.66	2.2	0.36

Annexure – 3.15

HAULAWNG - MAUSEN
(Altitude : 1052 - 623 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Cordia fragrantissima	7	3	10	30	2.33	0.7
2. Macaranga indica	14	6	10	60	2.33	1.4
3. Callicarpa arborea	8	5	10	50	1.6	0.8
4. Castanopsis tribuloides	16	7	10	70	2.28	1.6
5. Parkia timoriana	6	2	10	20	3	0.6
6. Duabanga grandiflora	13	5	10	50	2.6	1.3
7. Tectona grandis	5	2	10	20	2.5	0.5
8. Albizzia chinensis	9	5	10	50	1.8	0.9
9. Securinega virosa	5	3	10	30	1.66	0.5
10. Artocarpus heterophyllus	4	1	10	10	4	0.4
11. Rhus semialata	6	2	10	20	3	0.6
12. Trema orientalis	12	7	10	70	1.71	1.2
13. Schima wallichii	13	6	10	60	2.16	1.3
14. Saurauia napaulensis	11	5	10	50	2.2	1.1
15. Bombax ceiba	12	7	10	70	1.71	1.2
16. Emblica officinalis	5	2	10	20	2.5	0.5
17. Lithocarpus xylocarpa	13	6	10	60	2.16	1.3
18. Rhus succedania	6	3	10	30	2	0.6
19. Ficus hirta	4	1	10	10	4	0.4
20. Ficus neligiosa	2	1	10	10	2	0.2
21. Quercas helpheriana	11	7	10	70	1.57	1.1
22. Terminalia myriocarpa	8	3	10	30	2.66	0.8
23. Quercus polystachya	12	6	10	60	2	1.2
24. Anthocephalus chinensis	7	4	10	40	1.75	0.7
25. Derris robusta	4	3	10	30	1.33	0.4

Annexure – 3.16

MAUSEN - LUNGLEI
(Altitude : 605 - 1010 m)
Frequency, Abundance and Density of Herbs & Shrubs
(of 1 sq. metre size quadrat)

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Ageratum conyzoides	55	28	30	93.33	1.96	1.83
2. Bidens biternata	30	17	30	56.66	1.76	1
3. Saccharum longisetosum	100	26	30	86.66	3.84	3.33
4. Mikania micrantha	90	30	30	100	3	3
5. Chromolaena odorata	50	27	30	90	1.85	1.66
6. Cynodon dactylon	35	14	30	46.66	2.5	1.16
7. Thysanolaena maxima	15	10	30	33.33	1.5	0.5
8. Melastoma malabathricum	6	2	30	6.66	3	0.2
9. Didymochlaena truncatula	12	4	30	13.33	3	0.4
10. Microlepia strigosa	10	4	30	13.33	2.5	0.33
11. Polystichum aristatum	15	4	30	13.33	3.75	0.5
12. Musa paradisiaca	23	12	30	40	1.91	0.76
13. Curculigo crassifolia	10	4	30	13.33	2.5	0.33
14. Cyathea dealbata	1	1	30	3.33	1	0.03
15. Clerodendrum viscosum	2	1	30	3.33	2	0.06
16. Spilanthes oleracea	40	23	30	76.66	1.73	1.33
17. Phyllanthus fraternus	5	2	30	6.66	2.5	0.16
18. Maesa indica	2	1	30	3.33	2	0.06
19. Imperata cylindrica	18	4	30	13.33	4.5	0.6
20. Urena lobata	20	13	30	43.33	1.53	0.66

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
21. Centella asiatica	10	5	30	16.66	2	0.33
22. Polygonum chinense	15	7	30	23.33	2.14	0.5
23. Gleichenia linearis	12	5	30	16.66	2.4	0.4
24. Argyreia mastersii	15	10	30	33.33	1.5	0.5
25. Mussaendra glabra	3	1	30	3.33	3	0.1
26. Diplazium griffithii	10	4	30	13.33	2.5	0.33
27. Cycas pectinata	1	1	30	3.33	1	0.03
28. Coix lacryma-jobi var. puellarum	1	1	30	3.33	1	0.03
29. Cayratia obovata	1	1	30	3.33	1	0.03
30. Impatiens porrecta	2	1	30	3.33	2	0.06
31. Hedyotis scandens	2	1	30	3.33	2	0.06
32. Solanum khasianum	5	2	30	6.66	2.5	0.16
33. Costus speciosus	10	4	30	13.33	2.5	0.33
34. Melaconna baccifera	12	5	30	16.66	2.4	0.4

Annexure – 3.17

MAUSEN - LUNGLEI
(Altitude : 605 - 1010 m)
Frequency, Abundance and Density of Trees

Name of Species	Total number of individuals of each species	Number of quadrats occurrence	Total number of quadrats studied	Frequency in %	Abundance	Density
1. Macaranga indica	10	6	10	60	1.66	1
2. Gmelina arborea	7	4	10	40	1.75	0.7
3. Callicarpa arborea	4	1	10	10	4	0.4
4. Castanopsis tribuloides	15	6	10	60	2.5	1.5
5. Parkia timoriana	3	1	10	10	3	0.3
6. Duabanga grandiflora	14	7	10	70	2	1.4
7. Tectona grandis	8	3	10	30	2.66	0.8
8. Albizzia chinensis	5	2	10	20	2.5	0.5
9. Securinega virosa	8	3	10	30	2.66	0.8
10. Artocarpus heterophyllus	4	1	10	10	4	0.4
11. Rhus semialata	3	1	10	10	3	0.3
12. Trema orientalis	6	2	10	20	3	0.6
13. Schima wallichii	13	5	10	50	2.6	1.3
14. Saurauia napaulensis	8	5	10	50	1.6	0.8
15. Bombax ceiba	12	5	10	50	2.4	1.2
16. Artocarpus chama	7	3	10	30	2.33	0.7
17. Emblica officinalis	5	2	10	20	2.5	0.5
18. Ficus semicordata	6	2	10	20	3	0.6
19. Bauhimia variegata	3	1	10	10	3	0.3
20. Lithocarpus xylocarpa	4	1	10	10	4	0.4
21. Quercus helpheriana	12	4	10	40	3	1.2
22. Albizzia thomsoni	8	3	10	30	2.66	0.8
23. Castanopsis lanceaefolia	7	3	10	30	2.33	0.7
24. Anthocephalus chinensis	4	2	10	20	2	0.4
25. Quercas polystachya	13	5	10	50	2.6	1.3

Annexure – 3.18

List of Herb & Shrub Species found at priority road P1B (Buangpui - Lunglei)

Sl.No.	Name of Species
1.	Ageratum conyzoides
2.	Bidens biternata
3.	Saccharum longisetosum
4.	Clerodendrum colebrookiana
5.	Mikania micrantha
6.	Chromolaena odorata
7.	Cynidon dactylon
8.	Thysanolaena maxima
9.	Melastoma malabathricum
10.	Cinnamomum obtusifolium
11.	Phyllanthus fraternus
12.	Didymochlaena truncatula
13.	Diplazium griffithii
14.	Dryopteris ornata
15.	Pteridium aquilinum
16.	Tectaria macrodonta
17.	Microlepia strigosa
18.	Polystichum aristatum
19.	P.Biaristatum
20.	Pteris biaurita
21.	P. Quadriaurita
22.	P. Subquirata
23.	P. Vitta
24.	Hedyotis scandens
25.	Maesa indica
26.	Musa paradisiaca
27.	Curculigo crassifolia
28.	Rubus birmanicus
29.	Piper betle
30.	Dysoxylum gobara
31.	Cyathea dealbata
32.	Amomum dealbatum
33.	Blumea alata
34.	Colocasia esculanta
35.	Imperata cylindrica
36.	Spilamthes oleracea
37.	Smilax perfoliata
38.	Ficus auriculata
39.	Begonia dioica
40	Bridelia monoica
41.	Acasia pruinescens
42.	Costus speciosus

Sl.No.	Name of Species
43.	Osbeckia chinensis
44.	Hedychium coccinum
45.	Passiflora nepalensis
46.	Eryngium foetidum
47.	Centella asiatica
48.	Solanum torvum
49.	Polygonum chinense
50.	Sida acuta
51.	Desmodium triquetrum
52.	Mussaenda Glabra
53.	Cayratia obovata
54.	Urene lobata
55.	Lygodium flexuosum
56.	Gleichemia linearis
57.	Oxalis corniculata
58.	Phryhium capitatum
59.	Holigarna longifolia
60.	Securinega virosa
61.	Saurauia punduana
62.	Manihot esculenta
63.	Argyreia mastersii
64.	Clerodendrum viscosum
65.	Cycas pectinata
66.	Coix lacryma-jobi var. puellarum
67.	Impatiens porrecta
68.	Solanum khasianum
69.	Melocanna baccifera.

Annexure – 3.19

List of Tree Species found at priority road P1B (Buangpui - Lunglei)

Sl.No.	Name of Species	Local Name
1.	*Anogeissus acuminata*	Zairum
2.	*Macaranga indica*	Hnahkhar
3.	*Gmelina arborea*	Thlanvawng
4.	*Callicarpa arborea*	Hnahkiah
5.	*Castanopsis tribuloides*	Thingsia
6.	*Ficus Semicordata*	Theipui
7.	*Trema Orientalis*	Belphuar
8.	*Parkia timoriana*	Zawngtah
9.	*Duabanga grandiflora*	Zuang
10.	*Saurauia napaulensis*	Tiarpui
11.	*Embelia vestita*	Tling
12.	*Bombax ceiba*	Phunchawng
13.	*Tectona grandis*	Teak
14.	*Toona ciliata*	Teipui
15.	*Spondias pinnata*	Taitaw
16.	*Artocarpus chama*	Tatkawng
17.	*Emblica officinalis*	Sunhlu
18.	*Ficus retusa*	Zaman-hmawng
19.	*Bauhimia variegota*	Vaube
20.	*Albizzia chinensis*	Vang
21.	*Albizzia thomsoni*	Thingri
22.	*Rhus succedanea*	Chhimhruk
23.	*Castanopsis lanceaefolia*	Vawmbuh
24.	*Lithocarpus xylocarpa*	Then
25.	*Cinnamomum verum*	Thakthing
26.	*Cordia fragrantissima*	Mukpui
27.	*Litsea cubeba*	Sernam
28.	*Ficus hirta*	Sazu theipui
29.	*Securinega virosa*	Saisiak
30.	*Acrocarpus fraxini folius*	Nganbawm
31.	*Artocarpus heterophyllus*	Lamkhuang
32.	*Schima wallichii*	Khiang
33.	*Schima khasiama*	Khiangzo
34.	*Rhus semialata*	Khawmhma
35.	*Betula alnoides*	Hriang
36.	*Ficus neligiosa*	Hmawng
37.	*Lithocarpus pachyphylla*	Fah
38.	*Quercus helpheriana*	Hlai
39.	*Terminalia myriocarpa*	Char
40.	*Ficus benghelensis*	Bung
41.	*Wenlandia grandis*	Batling
42.	*Anthocephalus chinensis*	Banphar
43.	*Quercus polystachya*	Thil
44.	*Derris robusta*	Thingkha
45.	*Eurya cerasifolia*	Sihneh

Annexure – 3.20

List of Ethno-medicinal Plant Species found at priority road P1B (Buangpui - Lunglei)

Sl.No.	Name of Species	Local Name	Uses
1.	*Holigarna longifolia*	Kawhtebel	Juice of crushed roots / leaves taken for colic / stomache
2.	*Mikania micrantha*	Japan hlo	Juice of leaves taken externally for fresh wound and internally in malaria, fever, dysentery & diarrhoea. Decoction of leaves taken for stomache also
3.	*Clerodendrum colebrookianum*	Phuihnam	Infusion of leaves is taken as vegetable to cure hypertension
4.	*Alocasia fornicata*	Baibing	Juice of the plant is applied on snakebite
5.	*Chromolaena odorata*	Tlangsam	Juice of crushed leaves taken for fresh wound and cuts
6	*Blumea alata*	Buar	Juice of crushed leaves taken for antipyretic and diuretic
7	*Polygonum chinense*	Taham	Plant taken for general tonic and antiscorbutic
8	*Costus speciosus*	Sumbul	Decoction of roots taken for kidney and urinal problems
9	*Anogeissus acuminata*	Zairum	Juice of bark applied on cuts & wounds.
10	*Hedyotis scandens*	Kelhnamtur	Decoction of leaves & roots taken for pulverized Kidney stone
11	*Mussaenda roxburghii*	Vakep	Leaf chewed raw and paste applied externally for snakebite
12	*Osbeckia chinensis*	Builukhampa	Roots are used for renal disorder and genito-urinary problems
13	*Securinega virosa*	Saisiak	The leaves are boiled in the water and is used for bathing for patients suffering from smallpox, measles & scabies
14	*Solanum khasianum*	Rulpuk	The smoke of burnt fruit is sucked in the mouth to remove tooth-worms
15	*Embelia vestita*	Tling	Leaves taken for tonic
16	*Begonia dioica*	Sekhupthur	Decoction of stem, leaves or roots is used for dysentery
17	*Passiflora nepalensis*	Nauawimu	Juice of roots taken for fever
18	*Bombax ceiba*	Phunchawng	Root & bark used for tonic, diarrhoea & dysentery. Juice of flower & fruit taken for snakebite
19	*Callicarpa arborea*	Hnahkiah	Juice of young leaves is used for stomache while decoction of bark is used as tonic and aromatic
20	*Phyllanthus fraternus*	Mitthi Sunhlu	Fruits taken for stomache
21	*Schima wallichii*	Khiang	Decoction of fruit is used in snake bit and insect bite. Juice of bark is applied in sores.
22	*Centella asiatica*	Lambak	Juice of leaves taken for any stomach trouble and general tonic
23	*Dysoxylum gobara*	Thingthupui	Decoction of leaves taken orally for diarrhoea and stomache
24	*Ficus semicordata*	Theipui	Influsion of bark / leaves for liver ailment in combination with others
25	*Ageratum conyzoides*	Vailenhlo	Juice of leaves applied externally in cuts, wounds & itches
26	*Musa paradisiaca*	Changel	Juice of stem used in snakebite and cholera associated with urinary trouble.

Annexure 6.1

1. Lessons Learnt from Phase – I implementation

Implementation of MSRP – I is under progress of which environmental management plan is an integral part. Feedback from the implementation authorities on the EMP provides valuable inputs into formulation of the EMP for subsequent phases. Various issues have been studied for implementation aspects of the measures suggested. The feedback received is presented in the following sections.

1.1 Issues on implementation of environmental mitigation measures

Environmental mitigation measures suggested in the EMP are being implemented during the construction of Phase – I roads. The aspects that came to light during implementation and which need to be addressed during the course of construction and in preparation of EMP for subsequent phases are presented in the following sections.

1.1.1 Contractor's EMP

Apart from the EMP prepared during project design, contractor prepares an EMP after review of the document and field verification. During this phase, due to lack of enough environmental expertise with the contractor the EMP prepared is not implementable. The supervision consultants had to intervene in its preparation by giving him guidance and prepare a draft on his behalf.

1.1.2 Spoil Disposal

This aspect is given greater emphasis in the EMP and accordingly during construction. The engineer has also formulated a spoil disposal strategy. Locations suitable for reuse of the spoil are identified and accordingly agreements are made for disposal. The spoil is mostly being reused for landscaping.

Due to narrow access at some locations, especially at Sialsuk bypass, spillage of soil is unstoppable. The cut heights being higher than those reachable by excavators, spoil benches are being used to reach the full cut height. Hence the machinery cannot be adopted for stopping the spillage.

1.1.3 Water management

Water harvesting structures are proposed for construction to augment the construction water requirement of the contractor and also not to interfere with the sources of community water supply. The structures are intended for use of the community after construction. However, since the contractor has sourced water from a greater distance where quantity available is higher, there is no interference with the community water sources. The budget for these structures as per estimates of the engineer is limited and hence these have not been implemented. Implementation of these measures would entail issuing a variation order for the works.

1.1.4 Worker's safety

The engineer and the contractor prepared a safety plan. The safety plan included provision of personal protective equipment for the contractor's staff and also erection of safety signage. However, there is non-compliance of the contractor on implementation of the safety plan. The reason for non-compliance as reported by the engineer being, lack of awareness of the labour in complying with the safety plan. There is lack of communication between the contractor and labour on enforcement of the safety obligations.

1.1.5 Bio-Engineering

Bioengineering measures for slope protection works have received considerable attention of the engineer and the contractor. Simple bioengineering techniques as planting of grass, bamboo and other local shrubs are being taken up with the participation of the villagers. A variation order is being issued to carry out the works.

The contractor could not carry out more diverse and site-specific bioengineering techniques, as enough attention to the detail is seldom possible. However, training for implementation staff for bioengineering can give exposure to the techniques available and will need to be applied in the post – construction stage.

1.1.6 Quarrying operations

The contractor has not submitted quarry area redevelopment; operation and closure plan are to the engineer. The contractor has also not produced any licenses for the quarries being used. Apart from these, site preparation for the

crusher plant and haul roads is very poor. Hence more stringent codes of practice are to be formulated for enforcement of environmental safeguards and management of quarry operations.

1.1.7 Air Quality

Air quality management at construction sites as well as crusher sites is poor. There is inadequate sprinkling of water and is causing extreme discomfort to the roadside dwellers as well as travelers. The problem is compounded during dry season and with the falling debris from construction operations. Water sources being at a considerable distance and being expensive, this measure is not being implemented as envisaged. Water being scarce and expensive and also in the dry season dust suppression by water being short lived; alternative dust suppressants are being explored. Engineering budget is to provide higher amount for dust suppression by water or provide for alternative dust suppressants.

1.1.8 Traffic management

A traffic management plan has been prepared by the contractor and is being implemented. The plan includes appropriate signage at construction sites and traffic diversions are also planned.

1.1.9 Bio – diversity

The engineer has prepared a working paper and a briefing indicating need for conservation, measures to be taken and specifications for the same. Implementation of the measures for protection of endangered flora is to be initiated. Provision of additional culverts for Chinese Pangolin is disregarded during implementation due to the concerns: a) extent of utilisation of culverts by Pangolin for crossing the road b) high frequency of culverts already present in the region in question c) existing culverts being large enough for the Pangolin d) Absence of specific design of culvert for Pangolin to cross and e) Unknown crossing locations.

1.1.10 Construction camp

Though a construction camp is set up with the envisaged facilities, these are not maintained. Solid waste management, sanitary arrangement and oil/fuel spillage cleansing mechanisms are not operational. However, disposal of solid waste and hazardous waste through burying is taking place.

1.2 Issues on implementation of environmental enhancement measures

Environmental enhancement measures as enhancement of waterfall locations are not being implemented due to limited budget provided. The engineer is unable to judge the extent of works involved, as the enhancement drawings provided are generic. The engineer expressed concerns on the residual impacts of enhancement measures on slope stability and traffic flows. Proposals are being worked out to work out enhancement measures on a lesser scale than those proposed in EMP. Variation orders are being sought for inclusion in the contract.

1.3 Issues on training of environmental staff

Two training sessions are conducted by the PIU for the implementation staff. In further requirements of training, it is necessary for the PIU to have exposure in institutional arrangements for effective implementation of EMP. An internal seminar with an external trainer is identified to be effective means of undertaking the training. Budgetary provisions for training have been generous and would be utilised partially.

1.4 Issues on implementation of EMP

1.4.1 Integration of EMP

The EMP has not been included in the contract during Phase I. Some of the mitigation measures are included in the contract's BoQ and Specifications but for others as fencing of biodiversity areas and for other amenities are not included in the main contract. Hence for implementation these measures, variation orders are to be issued. However, the contractor being an ISO 9002 registered company has obligations to fulfil towards environmental mitigation.

The EMP being prepared stage wise, including pre-construction and operation stages, it is leading to confusion for integration into the contract documents. Hence the works involved in construction stage are to be clearly specified with the construction drawings and specifications.

1.4.2 Supervision and monitoring

The expertise required for monitoring of air, noise, water, biodiversity and bioengineering measures is expensive in case of Mizoram and in most of the

cases it is not available in the North-east states. Equipment haulage costs are also high. The State Pollution Control Board has a laboratory and few trained staff but lacks air-sampling equipment. Hence it was felt prudent to utilize the EMP funds for procurement of necessary equipment and have a tie up with the SPCB towards monitoring of air, noise and water sampling. An outline of agreement for monitoring works between PIU and SPCB is prepared. No monitoring has been carried out in the construction sites to date.

Biodiversity monitoring is suggested by the EMP to serve as a databank for understanding the impacts the construction may have on the biodiversity. Since the methodology used for pre-project assessment of biodiversity is 'Quadrant' method, construction stage monitoring with the same methodology will yield comparable results. However, with the concerns expressed over validity and use of monitored data, biodiversity monitoring is not undertaken.

1.4.3 Reporting of implementation

Apart from the mechanism suggested in the EMP for implementation, the Supervision consultant has prepared guidelines for the engineer's site staff. The guidelines include purpose of EMP implementation and the role of Supervision consultant. It also includes a checklist of items to be reported, the frequency and necessary formats for reporting. Reporting system provided in the EMP is slightly modified and is elaborated further. However, the reporting system is limited to the communication between site staff and supervision consultant's head office. Reporting to the PIU is only in the form of progress reports and interim reports.

Annexure 6.2

Precautions to be taken while disposing waste material

The contractor shall take the following precautions while disposing off the waste material

- During the site clearance and disposal of debris, the contractor will take full care to ensure that public or private properties are not damaged/affected, there is no dwellings below the dumpsite and that the traffic is not interrupted.
- Contractor will dispose off debris only at the identified places (identified and described in EIA report) or at other places only with prior permission of Engineer.
- Contractor can also dispose off the debris for the improvements in public utilities after the consent of villagers and approval of Engineer.
- In the event of any spoil or debris from the sites being deposited on any adjacent land, the contractor will immediately remove all such spoil debris and restore the affected area to its original state to the satisfaction of the Engineer.
- The contractor will at all times ensure that the entire existing stream courses and drains within and adjacent to the site are kept safe and free from any debris.
- Where possible, the vegetation below should be already disturbed, avoiding mature forest to the extent practicable.
- Contractor will utilize effective water sprays during the delivery and handling of materials when dust is likely to be created and to dampen stored materials during dry and windy weather.
- Materials having the potential to produce dust will not be loaded in a truck to a level higher than the side and tail boards and will be covered with a tarpaulin in good condition.
- During cutting of hills and disposal of debris, proper warning signs are to be installed to the satisfaction of the Engineer.
- Any diversion required for traffic during disposal of debris shall be provided with traffic control signals and barriers after discussion with local people and with the permission of Engineer.
- During the debris disposal, contractor will take care of surrounding features and avoid any damage to it.
- While disposing debris / waste material, the contractor will take into account the wind direction and location of settlements to ensure against any dust problems.

Adequate arrangements will be made to ensure that the debris/waste material is disposed off nearest to the designated dumping site. The report on this activity shall be prepared regularly by NGOs / Village Council Presidents (VCPs)..

Annexure 6.3

Facilities and hygiene at construction camps

- Adequate number of latrines shall be provided at construction camps besides other sanitary arrangements at areas of the site where work is in progress to ensure hygienic conditions. Except in workplaces provided with water-flushed latrines connected with a water borne sewage system, all latrines shall be provided with dry-earth system (receptacles) which shall be cleaned at least four times daily and at least twice during working hours and kept in perfect sanitary condition. Receptacles shall be tarred inside and outside at least once a year.
- Potable water supply systems for labour camps occupants shall be as per the design approved by the Local Public Health Engineering Department and meet the water quality standards as prescribed by the State Pollution Control Board. In addition, the design of water system facilities shall be based on the suppliers Engineer's estimates of water demands.
- At the construction camps as well as other workplace, good and sufficient water supply shall be maintained to eliminate chances of waterborne diseases to ensure the health and hygiene of the workers.
- Prior approval of concerned medical, health or municipal authorities shall be obtained for the site for location of the camps.
- The workers shall be provided preventive medical care at the camps and at other workplaces.
- It will be ensured that construction workers do not cut trees and vegetation for their fuel requirements. Therefore adequate quantity of Kerosene or any other fuel will be provided to the labourers to prevent use of vegetation and trees as fuel.
- Construction workers will be directed not to poach upon fauna and hunting shall be strictly prohibited.
- All construction labourers' camps shall be provided with a sewage system (including septic tanks and soak pits) designed, built and operated such that no pollution to ground or adjacent water bodies/water courses take place.
- Garbage bins shall be provided in the camps and regularly emptied and garbage disposed off in a hygienic manner, to the satisfaction of the relevant norms.
- It will be ensured that the percolating wastewater does not reach the underground water resources.
- Adequate arrangements for disposal of excreta by composting at the site duly approved by the local health/municipal authorities will be made to avoid the pollution of surrounding environment.
- On completion of the works, all such temporary structures shall be cleared away, all rubbish burnt, excreta tank and other disposal pits or trenches filled in and effectively sealed off and the outline site left clean and tidy, at the Contractor's expense to the entire satisfaction of the engineer.

Annexure 6.4

Instructions for rehabilitation of Quarry and Borrow areas

- The objective of rehabilitation programme is to return the quarry /borrow pit sites into a safe and secure area, which the general public should be able to safely enter and enjoy. Securing borrows pits/quarry sites in a stable condition should be a fundamental requirement of the rehabilitation process. This could be achieved by filling the quarry / borrow pit floor to approximately the access road level.
- It is important to plan restoration from the outset and coordinate restoration with quarrying activities. In addition to the bio-diversity issues, land planning considerations are also taken into account when defining a rehabilitation project in order both to preserve the environment and to generate income for the local communities. In this framework, quarry rehabilitation often leads to the creation of wetlands and natural reserves or recreation areas.
- Special quarry/borrow pit rehabilitation plan called 'landscape plan' should be specified according to the location and shaping of the mining slopes after exploitation and overburdened dump, with different subsequent uses e.g. forest, meadow, reserve for special and endangered species of animals and plants, wetlands etc., the re-greening and replanting methods. This rehabilitation plan with focus on bio-diversity should be worked out in co-operation with nature protection experts.

Other criteria, which should be followed for rehabilitation of quarry/borrow pits, are given below:

- Quarries and borrow pits will be backfilled with rejected construction wastes and will be given a vegetative cover. If this is not possible, then the excavation slopes will be smoothed and depression will be filled in such a way that it looks more or less like the original ground surface.
- During works execution, the contractor shall ensure preservation of trees during piling of materials; spreading of stripping material to facilitate water percolation and allow natural vegetation growth; reestablishment of previous natural drainage flows; improvement of site appearance; digging of ditches to collect runoff; and maintenance of roadways where a pit or quarry is declared useable water source for livestock or people nearby. Once the works are completed, the contractor shall restore at his own expense, the environment around the work site to its original splits.
- To create a safe environment under the terms of The Mines and Quarries Act, the faces have to be reduced to a naturally stable slope or be adequately fenced to prevent access to the top and bottom of the faces. Such a fence must be of a height as prescribed under The Mines Act with a barbed wire top strand designed to exclude the public from the quarry area. Depending on the location of the site, presence of a permanent lake is considered to be a satisfactory alternative to a fence.
- Appropriate plant species for the planting programme have to be selected in consultation with ecological consultant and local forest department. Depending on the limitations on the availability of appropriate plant material, harsh growing conditions (lack of irrigation and hot summer) and ongoing quarry rehabilitation operations there may be

substantial loss of plantation and the planting programme may have to be continued for over 3–5 years. As plantings are progressively established, they should be monitored before undertaking the next stage to ensure maximum plant survival rates.

- The quarry or borrow pit immediate surroundings should be developed as a low maintenance reserve, with significant areas of native trees and shrubs and areas of longer grass and tussocks forming the open spaces. Walkways around the borrow site must be constructed. Provision for a future drive-in picnic area and car-parking area may be developed.

Annexure 7.1

Reporting system formats

C1: Construction camp and storage area

Construction Stage Report: Date _____ Month_____ Year_____
(Site Layout of Construction camp and working drawings of dwelling units with allied facilities to be attached with format)

Format to be submitted before target date (decided by PP.) of establishing camps as

Camp no. WC

Location of Camp (km_____ Package_____)

S.No	Item	Unit	Details	Remarks by SC.if any
1.	**Detail of item camp**			
a.	Size of Camp	Mxm		
b.	Area of Camp	sq.m		
c.	Distance from Nearest Settlement			
d.	Distance from Nearest Water Source	Type/Size/Capacity/ present Use/Ownership		
	Date of camp being operational dd/mm/yy			
	Present land use			
	No other trees with girth > 0.3m.			
e.	Details of Storage area(Availability of impervious surface)	mxm		
f.	Availability of separate waste disposal from storage area	Cum		
2.	**Details of toposoil stacking**			
a.	Quantity of top soil removed	sq.m		
b.	Detail of storage of topsoil	Describe stackling arrangement		
3.	**Details of workforce**			
a.	Total No of Labourers	nos		
b	Total no of Male Workers	nos		
c.	No of Male Workers below 18 years of age	nos		
d.	Total No of Female Workers	nos		
e.	No of Female workers below 18 years of age	nos		
f.	No of children	nos		
4.	**Details of dwelling units**			
a.	No of dwellings/huts	nos		
b.	Minimum Size of Dwelling	mxm		
c.	No. of openings per dwelling	nos		
d.	Minimum size of opening	mxm		
e.	Walls	specifications		
f.	Roofing	specifications		
g.	Flooring	specifications		
h.	Drinking Water Tank	specifications		
i.	Capacity of Drinking water Tank	cum		
j.	Total no of WC	nos		
k.	No of Wcs for female workers	Nos		
l.	Total No of Bathrooms for female workers	Nos		
m.	Size of septic tank for WC/Baths	Mxmxm		
n.	Capacity of Water Tank for WCs/ Bathrooms and general purpose			

S.No	Item	Unit	Details	Remarks by SC.if any
o.	Fencing around camp	Y/N		
5	**Details of facilities**			
a	Availability of secunty guard 24 hrs a day	Yes/No		
b	Details of First Aid Facility	Yes/No		
c	Availability of Dav Care Centre	Yes/No		
d	Availability of dust bins (capacity 60 ltr)	nos		

Certified that the furnished information is correct. The quality of work is as per good practice and all relevant information as required is attached

Project Engineer (Contractor)
(Supervision Consultant)

C2: Selection of Dumping site locations

Route _____
Stretch: _____ To _____
(Give chainages and nearest settlements from both ends)

Criteria on which information for each site is to be collected	Site 1	Site 2	Site 3	Site 4
Area covered (m^2)				
Total Material that can be dumped within the site (m^3)				
Depth to which dumping is feasible (m)				
Distance of nearest watercourse (m)				
Nearest Settlement (m)				
Date/s of Community Consultation/s				
Whether the community is agreeable to siting of dumping site (Y/N)				
Date of Permission from Village Council President(VCP)				
Proposed future use of the Site				
Selected Site (tick any one column only)				

Enclosures (Tick as appropriate): Map of each location/Photographs/Each dumping location/Each community consultation/Photocopies of permissions from VCPs

Certified that the above information is correct to the best of my knowledge and belief.
_____ Date: _____
(Contractor)

Name and Designation of Verifier: _____
Date: _____

Recommendation on the suitability of the site _____

_____

Signed _____ Date: _____
Name & Designation:_____
Decision Taken (tick one): Approved/Not Approved

Signed: _____
Date: _____
Name and Designation of Deciding Authority _____

C3: BORROW AREAS

Construction Stage Report: Date ____ Month_____ Year_____

Site Layout of Borrow Area and Proposed Borrow Area Redevelopment Plan to be attached with format

Format to be submitted before target date as (decided by PIU) for establishing Borrow Areas

Borrow Area No. _____ Location of Borrow Area (Km_____ Package _____)

Sl. No	Item	Unit	Details	Remarks by CSC, if any
1	Details of Borrow Area			
a	Date of Borrow Area becoming operational dd/mm/yy			
b	Current Landuse			
c	Distance from Nearest Settlement	Km		
d	No of settlements within 200m of Haul Road	No.		
e	No of settlements within 500m of Borrow Area	No.		
f	Total Capacity	cum		
g	No of Trees with girth more than 0.3 m	No.		
h	Length of Haul Road	km		
i	Width of Haul road	m		
j	Type of Haul Road	metal/dirt		
k	Size of Borrow Area	sqkm		
l	Area of Borrow Area	km x km		
m	Quantity Available	cum		
n	Distance of Nearest Water Source	Type/Size/Capacity/Present Use/Ownership		
o	Quantity of top soil removed	cum		
p	Detail of storage of topsoil			
q	Daily/occasional use of the Borrow Area by the community, if any	-		
r	Probable reuse of Borrow pit-ask community	-		
s	Drainage channels/slope/characteristics of the area	-		
2	Enhancement Elements			
a	Quantity of top soil removed	sq.m		
b	Detail of storage of topsoil	sq.m		
c	Adjoining land use/Natural elements			
d	Near by catchment for storing water			
e	Erosion Control Programme			
f	Preventive measures for			
i	Leaching			
ii	Mosquito Breeding			
iii	Water run-off/contamination			
iv	Any other environmental degradation			
3	Details of workforce			
a	Total No of Labourers	No.		
b	Total no of Male Workers	No.		
c	No of Male Workers below 18 years of age	No.		
d	Total No of Female Workers	No.		

e	No of Female workers below 18 years of age	No.		
4	Details of redevelopment, Plan to be enclosed			

Certified that the furnished information is correct the quality of work is as per good practice and all relevant information as required is attached

Project Engineer
(Supervision Consultant) **(Contractor)**

C4: TARGET SHEET FOR PROTECTION MEASURES AT SPECIFIC LOCATIONS WHERE ENDANGERED FLORA IS FOUND

CHAINAGE: DATE:

Species to be protected 1) _____ No. of plants_____
2) _____ No. of plants_____
3) _____ No. of plants_____

Total Area to be protected_____, (along the road) **x**_____ **m (1 to road)**

No. of Bamboo Poles 1750 mm high _____
No. of Bamboo Poles 750 mm high _____
No. of Bamboo Poles 2000 mm long _____
No. of Bamboo Poles 2100 mm long _____
No. of Bamboo Poles 2400 mm long _____
Length of Barbed wire _____ m
No. of Bamboo mats 2 m x 1 m with _____
1.1.1 Openings <6mm
Description of condition of specific plants being protected:

_____
_____
_____
_____
_____

Attach copy of photograph showing current situation.

_____
_____
(Contractor's representative)

(Engineer's Environmental Specialist)

C5: POLLUTION MONITORING

Construction Stage: Report -Date_____ Month_____ Year_____
(Locations at which monitoring to be conducted as per EMP)

S.No.	Chainage	Details of location	Duration of monitoring	Instruments used	Completion		
					Target Date	Date of completion if task completed	Reason for Delay if any
Air Monitoring							
1							
2.							
3.							
4.							
Water Monitoring							
1							
2							
3							
4							
5							
Soil Monitoring							
1							
2							
3							
4							
5							
Noise Monitoring							
1							
2							
3							
4							
5							

Certified that the Pollution Monitoring has been conducted at all the locations specified In the EMP and as per the directions of the SC

Project

Engineer
Contracto

r
(Supervision Consultant)

C6: CLEANING OF CULVERT OPENINGS

Construction Stage: Report – Date_____ Month_____ Year

S. No.	Location / `Chainage	Completion Target		
		Target Date	Date of Completion if task completed	Reason for Delay if any
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Project Engineer
(Supervision consultant)

C 7: MONITORING SHEET FOR SPECIFIC ENDANGERED FLORA LOCATIONS TO BE PROTECTED

PERIOD OF VERIFICATION _____ TO _____ CHAINAGE _____ KM
Species to be Protected _____
No. of Plants _____
No. of Bamboo Poles in first row _____ of which damaged ____ ____
No. of Bamboo poles damaged in first row _____
Length of Ditch _____ m
Length of Ditch Cleared _____ m (Quantity of material removed from ditch_____m^3)
No. of Bamboo Poles in second row ____ of which damaged ____
No. of Horizontal Poles in second row _____ of which damaged ____
No. of MS angles (50x50x8) ____
No. of Bamboo mats ____ of which damaged ____
Description of Area being protected (include description of condition of specific plants being protected)

_____
_____
_____
_____
_____

Recent Photograph attached Yes ☐ ☐ No
Certified that the above information has been collected from on-site observations.

_____ _____

(Contractor's Representative) (Engineer's Environmental Specialist)

O1: TARGET SHEET FOR ROAD SIDE TREE PLANTATION

Operation Stage: Report – Date_____ Month_____ Year_____

S. No.	Section (km – Km)	Roadside Trees		Turfing on slopes			
				Hill Side		Valley Side	
		Species	Total trees Planted	Species	Total Area turfed (Sq.m)	Species	Total Area Turfed (Sq.m)
			Nos		Nos		Nos

Certified that the furnished information is correct

Project Engineer
(PIU)

O2: CLEANING OF CULVERTS

Operation Stage:

Report – Date_____ Month_____ Year_____

S. No.	Location / Chainage	Completion Target		
		Target Date	Date of Completion if task completed	Reason for Delay if any
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Project Engineer
(Supervision Consultant)