INLAND WATERWAYS AUTHORITY OF INDIA (IWAI)

Consultancy Services for Preparation of Detailed Project Report (DPR) for development of Longmatra to Avakhung stretch of Tizu & Zungki Rivers (NW 101) to facilitate Inland Water Transportation in the State of Nagaland

FINAL DPR - NW 101 (MAIN REPORT)

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VOLUME-I of III

Ministry of Jal Shakti
Government of India

वाप्कोस लिमिटेड
WAPCOS LIMITED

JANUARY 2020

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Acknowledgement

This report gives the present status of water-way (NW-101), Outcomes of past studies, Reconnaissance survey cross structures along with socio-economic information of the waterway & detailed methodology to carry out the work as per TOR.

WAPCOS LTD. expresses their gratitude to **Shmt**. **Dr. Amita Prasad, Chairperson (IAS)**,**Shri Pravir Pandey, (IA&AS), Vice Chairman** for sparing their valuable time and guidance for completing this report. We would also like to thanks **Shri Alok Ranjan, Member (Finance); Shri S.K.Gangwar, Member (Technical); Shashi Bhushan Shukla, Member(Traffic); Shri S.V.K. Reddy, Chief Engineer(Tech).**

We would also like to thank **Hon'ble Member of Parliament K.G.Kenye, Chairman of Nagaland Inland Waterway Board**, officials of Govt. of Nagaland and their team for their invaluable support and suggestions provided throughout the survey period.

WAPCOS LTD. wishes to express their gratitude to **Shri S.R. Maurya, Director (NER)**, **Shri R.K. Singh,Dy. Director,**IWAI and **Shri Thomas Thailu, OSD**, Department of Planning & Co-ordination, Govt. of Nagaland for constant encouragement, technical guidance and for evincing keen interest in the project and in this report. WAPCOS is pleased to place on record their sincere thanks to **Shri R.P.Khare ,Senior consultant,IWAI** for constant scrutiny and consistent quality check to make this report foolproof.

We are pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation throughout the project period.

WAPCOS Team

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THIS DPR CONTAINS THREE VOLUMES

VOLUME-I MAIN REPORT

VOLUME-II DRAWINGS

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FINAL DETAILED PROJECT REPORT- RIVER TIZU & ZUNGKI

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Abbreviation

Abbrreviations	Full Form
APMC	Agriculture Produce Marketing Committee
ASEAN	Association of Southeast Asian Nations
ATMA	Agricultural Technology Management Agency
BVFCL	Brahmaputra Valley Fertilizer Corporation Limited
CAGR	Compound Annual Growth Rate
DAP	Diammonium phosphate
FCI	Food Corporation of India
GoI	Government of India
IBEF	India Brand Equity Foundation
IFFCO	Indian Farmers Fertiliser Cooperative Limited
INR	Indian Rupees
ITC	International Trade Center
IWAI	Inland Waterway Authority of India
IWT	Inland Waterway Transportation
MFMS	Mobile Fertilizer Management System
MT	Metric Tonne
MUV	Multi Utility Vehicle
MW	Megawatt
NH	National Highway
NSMDC	Nagaland State Mineral Development Corporation
NW	National Waterway
PWD (R&B)	Public Works Department (Roads and Buildings)
SH	State Highway
SREP	Strategic Research Extension Plan
TPD	Tonne Per Day
WAPCOS	Water And Power Consultancy Limited Services
IWT	Inland Water Transport
SWOT	Strength, Weaknesses, Opportunities and threats
BM	Bench Mark
CD	Chart Datum
DGPS	Differential Geo Positioning System
GTS	Great Trigonometric Survey
LAD	Least Available Depth
PPK	Post Processing Kinematics
SD	Sounding Datum
RTK	Real Time Kinematics
TBM	Temporary Bench Mark
TS	Total Station
HC	Horizontal Control
Km	Kilometer
Cum	Cubic Meter

RL	Reference Level
HFL	Highest Flood Level
MSL	Mean Sea Level
DGPS	Differential Global positioning system
DWT	Deadweight tonnage
CH	Chainage
NH	National Highway
CWC	Central Water Commission
INTACH	Indian National Trust for Art and Cultural Heritage
CWPRS	Central Water And Power Research Station
G	Gauge
GD	Gauge and Discharge
GQ	Gauge and Water Quality
GDQ	Gauge, Discharge and Water Quality
GDSQ	Gauge, Discharge, Sediment, and Water Quality
DWT	Dead Weight Tonnage
APMC	Agriculture Produce Marketing Committee
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INR	Indian Rupees
ITC	International Trade Center
IWAI	Inland Waterway Authority of India
IWT	Inland Waterway Transportation
MFMS	Mobile Fertilizer Management System
MT	Metric Tonne
MUV	Multi Utility Vehicle
MW	Megawatt
NH	National Highway
NSMDC	Nagaland State Mineral Development Corporation
NW	National Waterway
PWD (R&B)	Public Works Department (Roads and Buildings)
SH	State Highway
SREP	Strategic Research Extension Plan
TPD	Tonne Per Day
WAPCOS	Water And Power Consultancy Limited Services

SALIENT FEATURES

Sr. No.	Particulars	Details			
A.	**GENERAL**				
1.	***Location***	***River Tizu&Zungki***			
a)	State(s)	Nagaland			
b)	Co-ordinates& Name of Place	**Start**	**End**		
	River	**From (Lat/Long)**	**To (Lat/Long)**		
	Tizu-(0-35.410 KM)	*Longmatra* Lat 25°46'12"N, Lon 94°44'35"E	*Avakhung* Lat 25°35'03"N, Lon 94°53'06"E		
	Zungki- (0-4.629 KM)	*Zungki river bridge* Lat 25°48'26"N, Lon 94°46'36"E	*Confluence of Tizu&Zungki* Lat 25°46'58"N, Lon 94°45'21"E		
B.	**TECHNICAL**				
1.	***Waterway***				
a)	National Waterway Number	101			
b)	Class	I and special class(15m bottom wide)			
c)	Type (Tidal/Non-Tidal)	Non-Tidal			
	Length (Km.)	**Total**	**Tidal**		**Non-Tidal**
		40.04	-		40.04
d)	Average Tidal Variation, if applicable	-			
e)	Chart Datum	Chart Datum/ Sounding Datum,Longmatra Guest House TBM -1 value was used for calculating the sounding data for the entire stretch of river TIZU.			
	Description/Basis	**Tidal Stretch** The entire river is Non-Tidal **Non-Tidal Stretch** The non-tidal stretch of River (Tizu River) is from Avakhung to Longmatra about 35.41 Km and from confluence to Zungki River Bridge is about 4.62 Km.			
f)	LAD Status (w.r.t. CD)				

Survey Period – August 2015

Stretch (From……To……) in km	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**0-5 Zungki**	**Total**
Length with LAD < 0.6 m in Km	0.30	0.40	0.65	0.60	0.70	0.70	0.25	0	3.60
Length with LAD 0.6 to 0.8 m in Km	0.30	0.85	1.00	1.05	0.55	0.30	0.20	0	4.25
Length with LAD >0.8 to 1 m in Km	1.40	1.05	0.80	0.60	0.45	0.55	0.30		5.15
Length with LAD > 1.0 to 2 m in Km	2.90	2.10	1.85	2.10	1.70	2.30	1.35	0	14.30
Length with LAD > 2 m in Km	0.10	0.60	0.70	0.65	1.60	1.15	2.90	5.00	12.70
Total (km)	5.00	5.00	5.00	5.00	5.00	5.00	5.00		40.00

g)	Target Depth of Proposed Fairway (m)	0.6m & 1.0 m
h)	Conservancy Works Required	-

Sr. No.	Particulars	Details			
	Type of Work				
	Dredging Required (Cum.) (15m bottom wide channel)	8640 cum (for 0.6 m LAD) phase-I (Immediate)			
		52380 cum (for 1.0 m LAD) Phase-II			
	Bandalling	No			
	Barrages & Locks	Navigational lock of 40x10m at upcoming Lower Tizuhydro electric dam project 28m high concrete dam of Government of Nagaland, department of power is proposed in the river Tizu about 12 km downstream from confluence of Tizu and Zungki rivers.			
i)	Existing Cross Structures	Laruri Bridge			
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal Clearance**	**Range of Vertical Clearance w.r.t. HFL/MHWS**
	Laruri Bridge (Road Bridge) CH-14.5Km	Concrete	1	15.0m	4.0m
2.	***Traffic***				
a)	Present IWT Operations (type of services)	Not Available			
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	A cement Plant and Mineral based Plant in Wazeho. Few micro and small scale industries exist. A cement plant is proposed to be developed at Laruri.			
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Only road connectivity available in the surrounding areas.			
d)	Commodities	**In-bound**		**Out-bound**	
		• Local Movement – Passengers, Tourists and Household commodities • Export to Myanmar- Cement, Minerals • Import from Myanmar- Food Grains			
e)	Future Potential				
	Name of Commodity	**Phase I (Immediate Phase)**		**Phase II**	
	Total Annual Passenger Traffic (No.)	FY 21- 30,060		FY 23-61,632	
		FY 22- 30,961		FY 27-72,087	
	Total Annual Tourist Traffic (No.)	FY 21-8,872		FY 23-9,413	
		FY 22-9,139		FY 27-10,801	
	Total Annual Traffic of household commodities (Tonnes)	FY 21- 0		FY 23-587	
		FY 22- 0		FY 27-686	
	Total Annual Traffic of Indo- Myanmar Cargo, i.e. cement, mineral, food grains (Tonnes)	FY 21- 0		FY 23-0	
		FY 22- 0		FY 27-0	
f)	Development of NW 101 in Phased manner				

Sr. No.	Particulars	Details
	Phase I (Immediate Phase) (Only Passenger & Tourist Traffic)	Deployment of Inflatable Boats with outboard motor; Clearing channel of boulders and gravels, Land filling/ leveling of ground, Creation of platform by filling boulders, Toilet facility, a shed with seating arrangement
	Phase II (Passenger, Tourist Traffic &household commodities)	Fairway Development, Terminal development with additional facilities, Development of Lower Tizu Dam with Navigational lock (Developed by Department of Power, Nagaland)
	Phase III (Passenger, Tourist Traffic, household commodities & Indo-Myanmar Trade)	Operationalization of Indo Myanmar trade using NW-101, Maintenance of fairway & terminals **(Not recommended)**
3.	***Terminals***	
a)	Terminal/wharf - 1	Near Longmatra
	Town/District	Longmatra / Phek
	Type/Services	Passenger / Tourists & Cargo
	Facilities	At present, no facilities available for IWT
	Approach(Nearest NH/SH/Village road)	NH-202; 0.8Km
	Land Ownership	Community Land/forest
b)	Terminal/wharf - 2	Near Laruri Bridge
	Town/District	Laruri village / Phek
	Type/Services	Passenger & Cargo
	Facilities	At present, no facilities available for IWT
	Approach(Nearest NH/SH/Village road)	Laruri road ; 6.3 Km
	Land Ownership	Community Land/ forest
c)	Terminal/wharf - 3	Near Pokhungri
	Town/District	Phonkhuri village / Phek
	Type/Services	Passenger / Tourists & Cargo
	Facilities	At present, no facilities available for IWT
	Approach(Nearest NH/SH/Village road)	Laruri Road; 1 Km
	Land Ownership	Community Land/ forest
d)	Terminal/wharf - 4	Near Avakhung
	Town/District	Avakhung village / Phek
	Type/Services	Passenger / Tourists & Cargo
	Facilities	At present, no facilities available for IWT
	Approach(Nearest NH/SH/Village road)	Village Road; 1.8 Km
	Land Ownership	Community Land/ forest
4.	***Design Vessel***	
a)	Type	Inflatable Motor Boat – Phase I (Immediate Phase) Inflatable Ferry Boat - Phase II
b)	No. & Size (L X B)	Phase I (Immediate Phase)- • No. of vessel- 4 • Size - 4.5 m X 1.9 m Phase II- • No. of vessel- 3

Sr. No.	Particulars	Details
		• Size – 6 m X 2.5 m
c)	Loaded Draft	Phase I (Immediate Phase)- 0.3 m (Ferry Boat) Phase II- 0.5 m (Ferry Boat)
d)	Capacity	Phase I (Immediate Phase)- 6-7 PAX Phase II- 20 PAX
5.	***Navigation Aids***	
a)	Type	Conventional marks are made of bamboo strips set- 50 Nos.(phase-I) and 50 (phase-II); MS pole tower on 1mx1m MS plate with fluorescent paint fixed with concrete grouting.-25Nos.(phase-I) and 25Nos.(phase-II);Painting on boulders/Trees etc
6.	***Cost Estimate***	
	Phase I (Immediate)	**INR 2.24 Crores** Includes I. land cost,-2 acre(0.5 acre per terminal) II. Rest rooms shed-4 nos III. Sitting shed-4 nos IV. Solar light-4 nos V. bio toilets-4 nos VI. channel marking made of bamboo strips VII. Boulder/stone removal and VIII. vessel cost
	Phase II	**INR 23.57 Crores** Includes I. Dredging/ Removal of Boulder II. Wharf - 4 Nos. III. Terminal Building - 4 Nos. IV. Equipment Shed – 4 Nos. V. Fencing - 4 Nos. VI. Gate - 4 Nos. VII. STP - 4 Nos. VIII. Path - 4 Nos. IX. Internal Road X. Solar – 8 Nos. XI. For Retaining Wall/ Drainage etc. XII. Conventional Marks made of bamboo strips XIII. Backhoe Loader - 4 Nos. XIV. Fire Fighting Equipment - 4 Nos.

EXECUTIVE SUMMARY

1. Inland Water Transport (IWT) has the potential to form an economic, reliable, safe and environment friendly mode of transport. When developed for use by modern inland waterway vessels, it can also reduce investment needs in rail and road infrastructure, promote greater complementarities in the riparian states, enhance intra-regional trade and, through increased economies of scale, significantly reduce transport costs for the benefit of the entire economy and India's global trade competitiveness.

2. Inland Waterways Authority of India (IWAI) is a statutory body of the Ministry of Shipping, Government of India (GoI). IWAI was set up in 1986 for regulation and development of Inland Waterways for the purposes of shipping and navigation. IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) on the National Waterways (NWs) in the country. Presently, there are 111 new NWs in the country including the stretch from Longmatra to Avankhu stretch of Tizu & Zungki rivers, which has been declared as NW – 101 by the GoI during April 2016. *[Note: The official nomenclature of Avakhung village as approved and recognized by the Government of Nagaland is spelled as 'Avakhung' instead of 'Avankhu'.]*

3. IWAI intends to explore the potential of NW-101 i.e. Longmatra (Nagaland) to Avankhu (near Indo-Myanmar Border) stretch of Tizu and Zungki Rivers for round the year navigation and development of water transport facilities. The length of this stretch of the river is 40.039 km (Tizu- 35.410 km & Zungki- 4.629 km) and the maximum width in this stretch is approximately 100 m to 150 m. The waterway flow direction of the river is from Longmatra to Avankhu. The site location is shown in fig.1.1

   Stretch of River under study is river Tizu from Longmatra **to Avakhung at Myanmar border (35.41 km)** and Zungki river from bridge to confluence of Zungki and Tizu rivers **(4.629 km). The same is presented in tabular form below**

Table 1.1 Tizu & Zungki River chainages

River	From (Lat/Long)	To (Lat/Long)
Tizu-(0-35.410 KM)	*Longmatra* Lat 25°46'11.98"N, Lon 94°44'35.04"E	*Avakhung* Lat 25°35'2.94"N, Lon 94°53'6.12"E
Zungki-(0-4.629 KM)	*Zungki river bridge* Lat 25°48'26.10"N, Lon 94°46'35.96"E	*Confluence of Tizu & Zungki* Lat 25°46'58.03"N, Lon 94°45'20.51"E

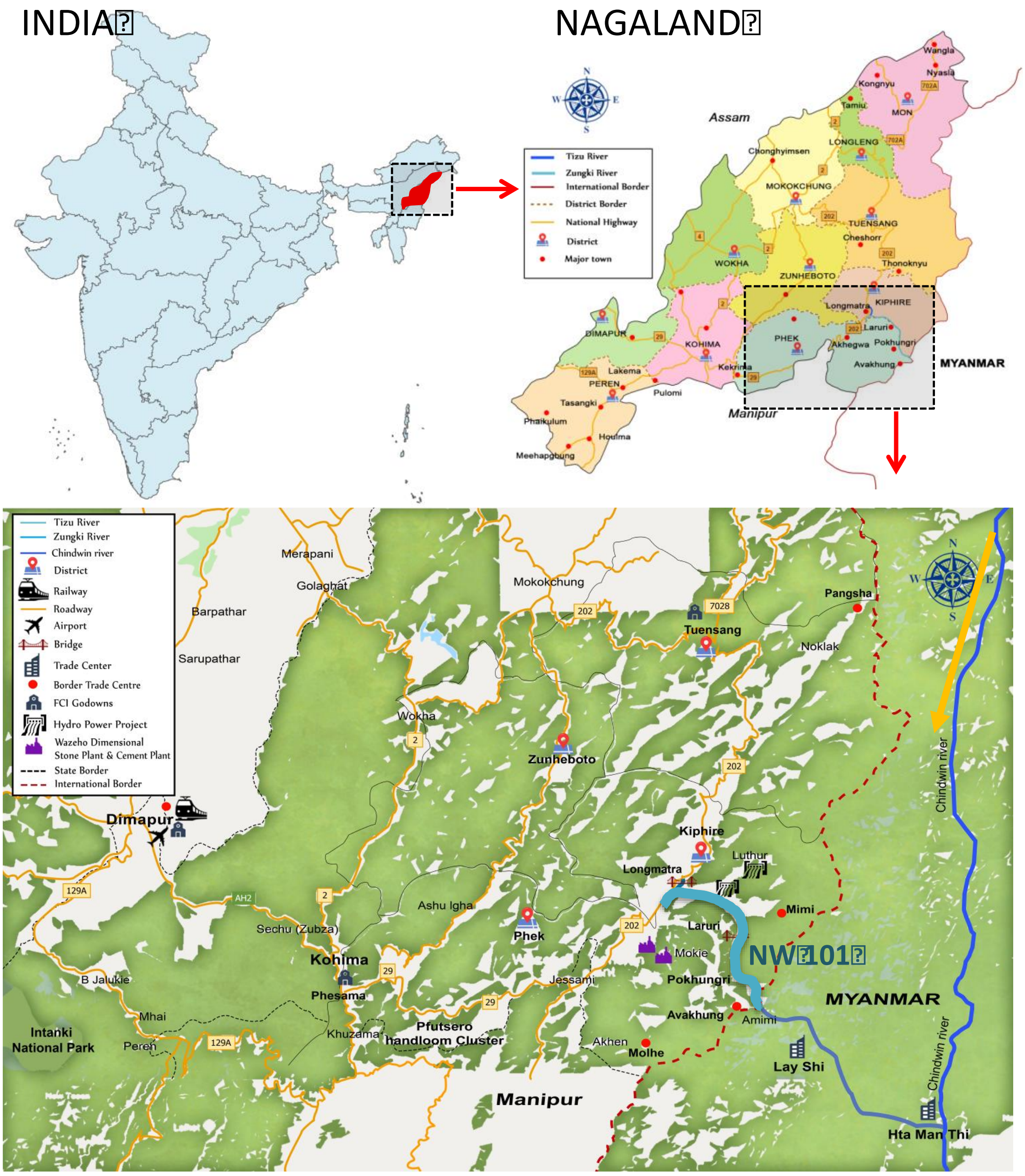


Fig. 1.1 Site Location

4. During 2015, based on requests from the State Government of Nagaland, IWAI had got conduted detailed hydrographic survey of Longmatra to Avakhung stretch of Tizu river through M/s Precision Survey Consultancy. Theteafter, when the process of declaring this waterway as a NW was underway, IWAI planned to conduct DPR study of NW-101 in two stages: Stage 1- Feasibility Study; and Stage 2- DPR Study. IWAI got conducted the Feasibility Study of this NW through M/s DHI (I) Water & Environment Pvt Ltd in September 2016. Subsequently, the consultancy for preparing its DPR was awarded to M/s Wapcos during February 2019.
5. The objective of assignment of preparing a DPR of NW-101 includes to explore the potential of Longmatra- Avakhung/Avankhu stretch for year round navigation and recommending thereafter the specific interventions/ sub-projects for development of IWT infrastructure namely fairway, navigation aids and terminal facilities to have a waterwayfor reliable, safe and cost effective navigation of passengers and cargo. The ToRs of the assignment also include collection & review of available data,

physical reconnaissance survey, assessment of traffic potential, preliminary engineering, designs cost estimate of infrastructure proposed, EIA/ SIA studies, economic & financial analysis suggesting organisation structure for construction and operation and management of the waterway etc. It may be noted that considering remoteness of site and security and safety issues, conducting fresh hydrographic survey of the river was not in the scope of Wapcos and the hydrographic survey conduted by IWAI through M/s Precision Survey Consultancy during 2015 were to be used for preparing this DPR.

6. Nagaland is one of the smallest state in North Eastern India, with an area of 16,579 sq. km. sharing international boundaries with Myanmar in the East and the states of Assam, Manipur and Arunachal Pradesh in the other sides. The capital of the State is Kohima. The State comprises of 11 districts. It is sparsely populated. As per 2011 census, its population was only is 20 lakh. Nagaland is tribal state and its 80 % population lives in villages. The road connectivity of most of the villages is very poor and it is felt that development of IWT infrastructure on NW-101 will ease local transportation needs of the villages situated in its influence areas. There however does not seem to be scope of any substantial cargo movement on the waterway at least in near future.

7. The Tizu river of Nagaland flows into Myanmar, draining an area of about 5500 sq. km. As per Nagaland Water Policy report (2016), the catchment area of Tizu Basin covers 4884 sq.km,The details of individual catchment of Tizu and Zungki rivers are presented in the below table from the length of river measurement point described.

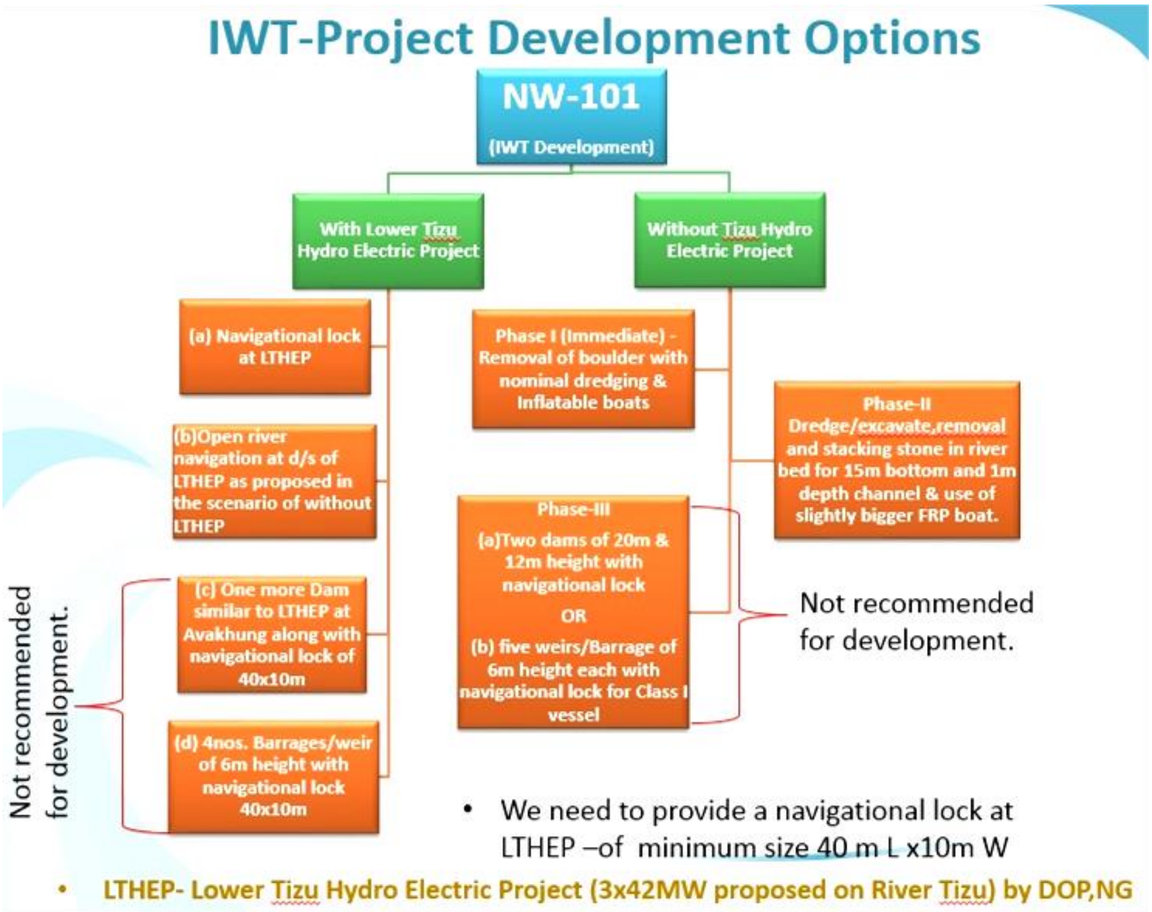
Table 1.2 River and Catchment Area

S. No	Name of the River	Length (KM)	Catchment Area (KM^2)	Length Measurement Points
1	Zungki	80	2060	From Chingmei/ Noklak Area to Tizu Confluence Area
2	Tizu	203	2760	From Helipong area to Avakhung Area

8. A hydro electric dam is proposed to be constructed on river Tizu within the limits of NW-101.. The proposed project is called Lower Tizu Hydroelctric Project (LTHEP). Under this project a 28 m high dam is to be constructed about 12 km downstream from confluence of Tizu and Zungki rivers. The dam site is located below Moya village in Kiphire district. The dam site is about 290 km away from Kohima. This project will be developed and owned by Department of Power, Government of Nagaland. Details of this proposed dam are given in waterway development chapter of this DPR. As per enquiry made by Wapcos officials with the officers of Power Department of Government of Nagaland, the DPR of LTHEP has been prepared and the process of EIA and SIA studies and clearance was underway**.** It has also been gathered that in the current DPR there is no provision of navigation lock in this dam.

9. Since the 28 m high dam of LTHEP is proposed at a 12 km downstream of Longmatra, if it actually gets constructed, it will obviously change the navigability character/ status of NW-101 in a big way. On the one hand, if not provided with a navigation lock, it will disrupt through navigation between Longmatra and Avakhung; on the other hand, due to increase in water level at the dam site by 28 m, it will create a large deep pool of water on its up-stream side making the entire up-stream portion upto Longmatra and beyond navigable even by bigger boats of 2 m and above draft without any fairway development work. However, if a navigation lock is provided, as is being strongly proposed in this DPR of NW-101, the entire length of NW-101 can be made navigable. But if this dam does not eventually come up at all or even if it is delayed abnormally (as happened in many cases) a totally different development strategy will have to be employed for fairway development of NW-101.

10. Hence two alternative fairway development strategies, one with LTEP and the other without LTHEP are proposed in this DPR as shown in a schematic chart below:



10. In the option of **'with LTHEP'** for through navigation between Longmatra and Avakhung, it is necessary that a navigation lock (suggested dimensions- 40m long; 10 m wide) is provided in the dam right from the planning/ DPR stage. While the up-stream portion of the dam will automatically become navigable due to rise in water level. For downstream portion between Longmatra and Avakhung, there again can be three alternatives, namely (i) open river navigation (river conservancy works); or (ii) One more dam similar to LTHEP at Avakhung; or (iii) 4 barrages, each of 6 m height with navigation locks. However considering very low potential for cargo transportation on NW-101 (which is described in detail subsequently), the options of another big dam like LTHEP or that of 4 barrages are not considered viable prima facei. Hence only the option of open river navigation is proposed in this DPR.

11. In the other option of '**without LTHEP'** for navigation between Longmatra and Avakhung, only open river navigation (river conservancy works) has been suggested for fairway development. Considering very low potential for cargo transportation on NW-101, this too has been proposed in three phases, namely; (i) Phase I – removal of boulders with nominal dredging and provision of inflatable boats and landing platforms at four locations; (ii) Phase II – development of navigation channel of 5 m bottom width and 1 m depth by removal of boulders and dredging for use by slightly bigger FRP passenger boats along with terminals at four locations; and (iii) Phase III – either two dams of 20 m and 12 m height with navigation locks at suitable locations; or five barrages/ weirs with navigation locks, each of 6 m height for movement of Class- 1 waterway vessels.

12. As mentioned earlier, IWAI had got conducted deatailed hydrographic survey of the entire NW-101 during 2015 and its results were provided to Wapcos for reference for preparing this DPR. Details of the hydrographic survey are presented in Chapter-2. On analysing the hydrographic survey data, it was found that NW-101 is a typical hilly river with steep gradient (of about 1 m per km on an average (NW-1, the Ganga has an average gradient of 6 cm per km), high current velocities, low depths and presence of several rapids. The river also has presence of boulders, gravels and rocks in the river bed, making navigation by any bigger boats very difficult. Out of the total length of 40 km 3.60 km had average depth of 0.60 m; 4.25 km with depth in the range of 0.60 to 0.80 m; 5.15 km stretch with depth range of 0.80 to 1.00 m; 14.30 km with depth range of 1.00 to 2.00 m; and remaining 12.70 km had depth of more than 2.0 m. In other words, while 27 km (or about 70 %) length of the river had depth of more than 1.0 m the remaining 30 % had less than 1.0 m depth. In fact about 10% of the length had depth of even less than 0.60 m. Such low depths, high currents, presence of rapids and gravels and boulders in the waterway makes it non-navigable by any big boats. However, it can be made navigable for small inflatable boats with out-board motors for movement of local population residing in nearby villages who otherwise have to traverse long and circuitous routes by road and on foot to commute between two villages.
13. With the forgoing, following fairway development strategy has been suggested in this DPR:

Phase-I (immediate) – for passenger movement plus household goods only, with very basic facility and low cost structures. (*for 2 years: FY 21-22*).

Phase-II – for passenger movement plus household goods only, which is done by *Dredging/ excavation, removal and stacking of stones/ boulders in the river bed for 15m bottom width and 1m depth channel. (for 5 years: FY23-27)*

Phase-III – – either two dams of 20 m and 12 m height with navigation locks at suitable locations; or five barrages/ weirs with navigation locks, each of 6 m height for movement of Class- 1 waterway vessels. *(for 22 years: FY28-30)*

It has been assumed that in Phase III, NW 101 would handle Indo- Myanmar international trade, and cargo including cement from Wajeho cemnt plant and Limestone from querries near Laruri terminal. But at the same time, it is realistically felt that Phase III is a remote possibility, as it depends on Myanmar Government to develop the waterway across the border till Hta Man Thi in Chindwin river. (Please refer traffic chapter-3, Section 3.8.2.3 for details on Chindwin River). Whether river route between India and Myanmar is developed or not, potential for NW 101 for any substantial cargo movement is remote, due to the hilly terrain and sparsely populated, underdeveloped region.

WAPCOS therefore, recommends Immediate Phase (Phase-I) followed by Phase-II for development of NW-101.. Phase-III is only viable if the trade with Myanmar through the route opens. It is also important that Government of Nagaland considers provision of a navigation lock of 40 m length and 10 m width at LTHEP right from the planning stage.

14. Traffic Study

14.1 The hinterland of NW 101 is underdeveloped and hilly region. The stretch of the proposed waterway 101 from Longmatra in Kiphire district to Avakhung (Avankhu) in Phek district is considered for study. Two districts, i.e. Phek and Kiphire fall in the primary hinterland of the proposed waterway. Apart from these two districts, Zunheboto and Tuensang districts are also included in the hinterland study.

The hinterland of NW 101 suffers from poor transport facilities. There is no railway connectivity in the primary hinterland. Roadway is the main mode of transportation in the hinterland.

The total length of National Highways within the state of Nagaland is 1546.70 km. The major roadways in the hinterland is listed below.

- NH 202- This national highway connects Kiphire to Kohima and Tuensang districts. It connects Mokokchung- Tuensang- Kiphire- Akash Bridge. It continues up to Akhegwo, which further moves to Longmatra.
- NH 29- The Highway starting from its junction with NH 27 near Dabaka (Assam)- Dimapur-Kohima- Chizami- Jessami NH 202 (Manipur).
- NH 702A- The highway starting from its Junction with NH 2 near Mokokchung connecting Zunheboto, Phek and terminating at its junction with new NH 202 near Meluri.
- SH- It is from Akhegwo to Avakhung.

The road from Kohima to Avakhung passes through 194 km. on the National Highway (upto Akhegwo) and further 96 km on State Highway (between Akhegwo to Phokhungri). To reach Avakhung, the road between Pokhungri and Avakhung, a distance of 18.5 km. is under construction.

NH 29 and NH 202 connect Longmatra to Dimapur/Kohima in Nagaland. Longmatra to Avakhung is connected by 217 km roadways. During fair weather, the distance between Longmatra to Avakhung is covered in 6 hours by roadways, whereas during monsoon season, the travel time increases to minimum 12 hours by road. Development of inland waterway in Tizu river would reduce this distance to 35 km and the waterway would reduce travel time.

Most of the roads in the region are in poor condition, which is a major hurdle for the economic growth of the region. Roads in the hilly areas are serpentine. Local roads are fair weather roads, and not all weather roads. During monsoon, road connectivity in the hilly regions suffer due to occurrence of landslides. This disrupts road connectivity and adversely affect the normal activities of locals, as they are cut off from other regions. Problems due to poor roads in the hinterland could be solved by developing inland waterway in the identified stretch of Tizu and Zungki river.

14.2 Industrial Scenario

There exists no major industry in the hinterland. The only large scale project is Likhimro Hydro Power project in Kiphire district; however this hydro project would not provide any opportunity to the proposed waterway.

The hinterland is rich in mineral reserves and chemical grade limestone is available in abundance. Nagaland State Mineral Development Corporation Ltd. (NSMDC) has implemented several projects for exploiting the mineral reserves of the state for economic development. There are two mineral based industries in the hinterland, Wazeho Cement Plant and Dimensional Stone Plant. Another cement plant is proposed to be developed in Laruri. The distance of the Dimensional Stone Plant from NW 101 is more than 50 km. Also, due to poor road connectivity between Wazeho to nearest terminal on NW 101, it is very unlikely that it would provide opportunity to NW 101.

Wazeho Cement Plant is non operational at present; however there is plan to revive the plant. After both the plants, i.e. Wazeho Cement Plant and upcoming Laruri Plant start production , cement from these plants could be transported to Myanmar using NW 101. However, this is a remote opportunity and depends on development of river in Myanmar till Hta Man Thi for cargo movement.

14.3 Opportunity Identification for NW 101 for Cargo, Passenger & Tourist Movement

The below chart depicts opportunity for cargo and passenger/tourist movement on NW 101 in phases.

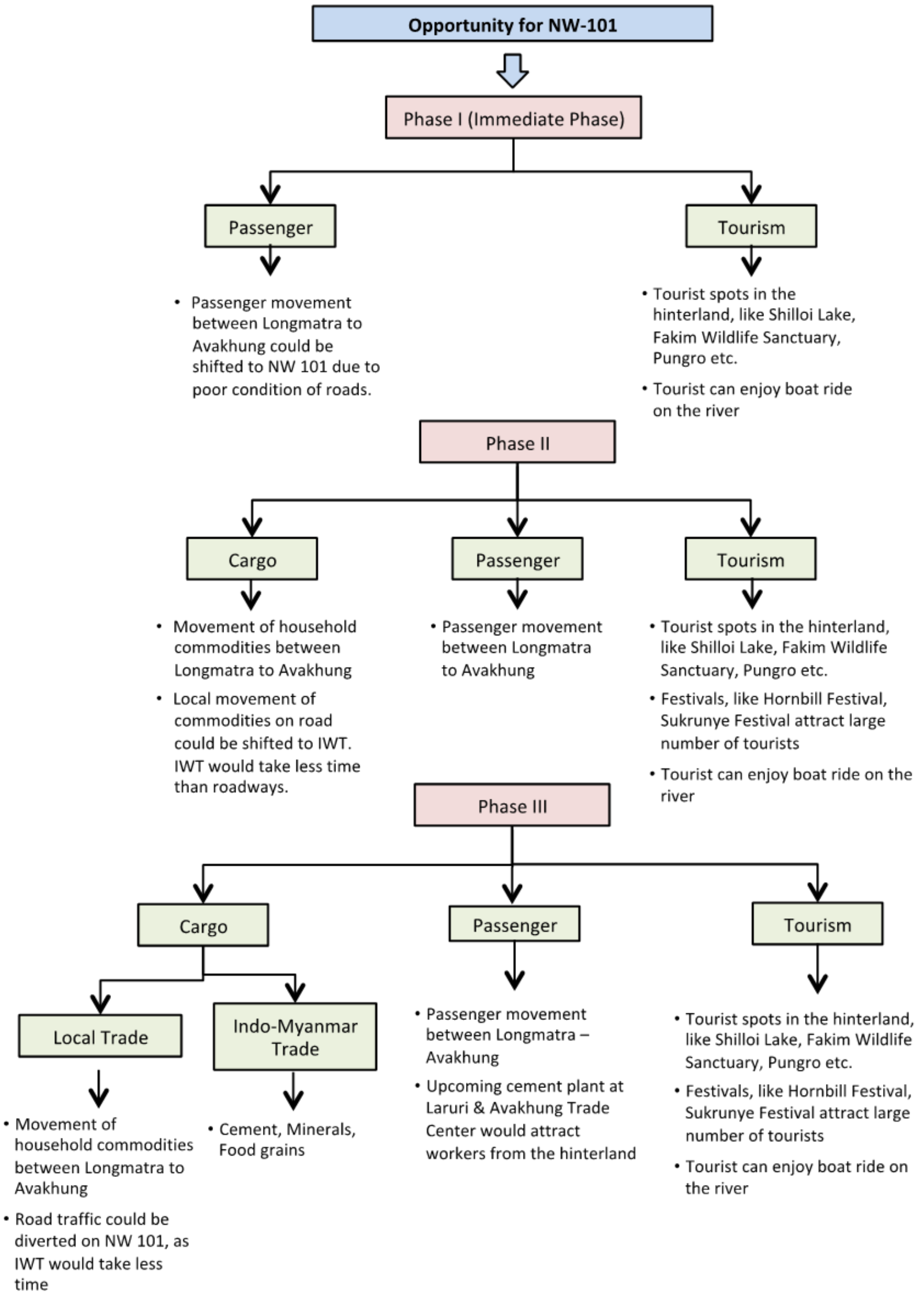


Fig. 1.2 Opportunity for NW 101

Traffic in NW 101 is categorised in three phases, i.e. Immediate Phase-I, Phase-II and Phase-III. Considering the underdeveloped region, it is proposed that in Immediate Phase-I, only passenger traffic would be handled at NW 101. Cargo traffic could be targeted in near future, in Phase -II. Cargo Traffic for NW 101 is categorized in two parts, Phase -II, i.e. local movement of household commodities and Phase -III, i.e. Indo- Myanmar trade and local movement of household commodities. Phase 2 traffic is a remote possibility, provided the river stretch in Myanmar till Hta Man Thi is developed by Mynamar Government along with other infastructure in the region. It is assumed that in all phases, the defined stretch of NW 101 would be navigable throughout the year. The upcoming Lower Tizu Hydro Electric Project would not be an obstacle for NW 101**.**

14.4 Passenger Movement

At present, passenger movement in the hinterland mostly happens by roadway. The road movement which happens near the stretch of Tizu & Zungki river could be shifted to NW 101. Passenger movement on NW 101 could be categorized in two parts:

- ✓ Passenger movement from village to village- Remote villages, like Avakhung, Pokhungri are located on the bank of river Tizu. The movement between these villages could be shifted to NW 101. The purpose of this kind of visits is mostly meeting relatives and friends.

- ✓ Passenger movement from village to towns- There are some towns/hubs near the stretch of NW 101, like Kiphire, Longmatra, Meluri etc. Villagers from other remote areas on the bank of NW 101 could use IWT and reach the nearest terminal from the town. They could travel to these towns from the terminal using roadways. The purpose of movement from villages to towns is going to work, education institutes, buying food and other items from market etc.

14.5 Opportunity from Tourism

Tourism Industry of the hinterland has potential to attract large number of tourists, as the districts, which fall in the hinterland have many tourist spots. As per Directorate of tourism, tourists inflow were observed in some of the tourist villages in the hinterland during Fy 16-17. These villages are Phek village, Leshemi, Chesezu and Matikhru (Phek District), Satoi, Ghukhiye and Aizuto (Zunheboto District). Some of the popular tourist spots in the hinterland, which attracted tourists in Fy 16 & Fy 17 are listed below.

Table 1.4 Famous Tourist Spots in the hinterland (Fy 16 & Fy 17)

District	Tourist Spot	Distance from the River by road (Km)	Arial distance from the River (Km)
Phek	Shilloi Lake	13	6.5
	Dzudu Lake Thuvopsu	182	41
	Zanibu Peak	172	48
	Wazheho	57	14
Zunheboto	Satoi Range	162	23
	Ghoshu Bird Sanctuary	142	40
	Atoizu	135	42
Kiphire	Pungro	10	6
	Fakim Wildlife Sanctuary	-	18
	Mt. Saramati	-	24

Source: Directorate of Tourism

These tourist spots shown in the table are located within 50 km from the river; however due to hilly terrain and serpentine roadways, the distance by roadways is much longer. Development of NW 101 would open opportunity for tourism in the hinterland. Most of the hilly and remote regions in the hinterland of NW 101 are not easily accessible by roadways. The roads in these remote places are in poor condition. Tourists could use boat ride in the proposed waterway to reach the proposed terminals on NW 101, from where they can take local roads to reach the tourist sites. Wild Life Sanctuaries could also be reached using combination of modes, like NW 101 and roadways.

14.7 Movement of Household Commodities

Along with passengers, household commodities would also be moved on NW 101. Passengers, who would be using inland waterway to travel between villages or to towns/hubs for buying household commodities etc. would carry 20 kg. of commodities (each person). This movement of household commodities would provide opportunity for NW 101.

14.8 Movement of Industrial Cargo (Indo- Myanmar Trade)

After development of NW 101 and river stretch in Myanmar across border till Hta Man Thi, Indo-Myanmar trade, which would consist of food grains, mineral and cement (produced in Wazeho cement plant and upcoming Laruri plant) would be transported using NW 101. Food grains from Myanmar would be transported to Nagaland for local consumption. Industrial product, i.e. Cement from Wazeho cement plant and upcoming Laruri plant and minerals from Laruri belt could be transported to Myanmar using NW 101. However, movement of industrial cargo on Indo-Myanmar route is a remote possibility. This trade would happen only if Myanmar Government would develop navigation in the river stretch in Myanmar.

Table 1.5 Projected Traffic for NW 101

Name of Commodity	Phase-I Immediate	Phase -II	Phase -III
Total Annual Passenger Traffic (No.)	FY 21- 30,060	FY 23-61,632	FY 28-154,892
	FY 22- 30,961	FY 27-72,087	FY 50- 300,618
Total Annual Tourist Traffic (No.)	FY 21-8,872	FY 23-9,413	FY 28-11,233
	FY 22-9,139	FY 27-10,801	FY 50-30,730
Total Annual Traffic of household commodities (Tonnes)	FY 21- 0	FY 23-587	FY 28- 721
	FY 22- 0	FY 27-686	FY 50-2,107
Total Annual Traffic of Indo-Myanmar Cargo, i.e. cement, mineral, food grains (Tonnes)	FY 21- 0	FY 23-0	FY 28-481,830
	FY 22- 0	FY 27-0	FY 50-482,001

Despite the obstacles, like technical challenges of the river stretch, under developed hinterland, lack of industries, less traffic volume etc., Government could develop NW 101 for the benefit of the society and development of the region.

15. Terminal Locations and typical wharf design

Total four terminals are proposed to be developed on NW 101. These terminals have been identified based on the market survey and analysis of the needs of local economy and population. The proposed terminal locations have been shown in the map below.The wharf typical layout is shown in fig 8.2 and terminal layout in fig 8.3

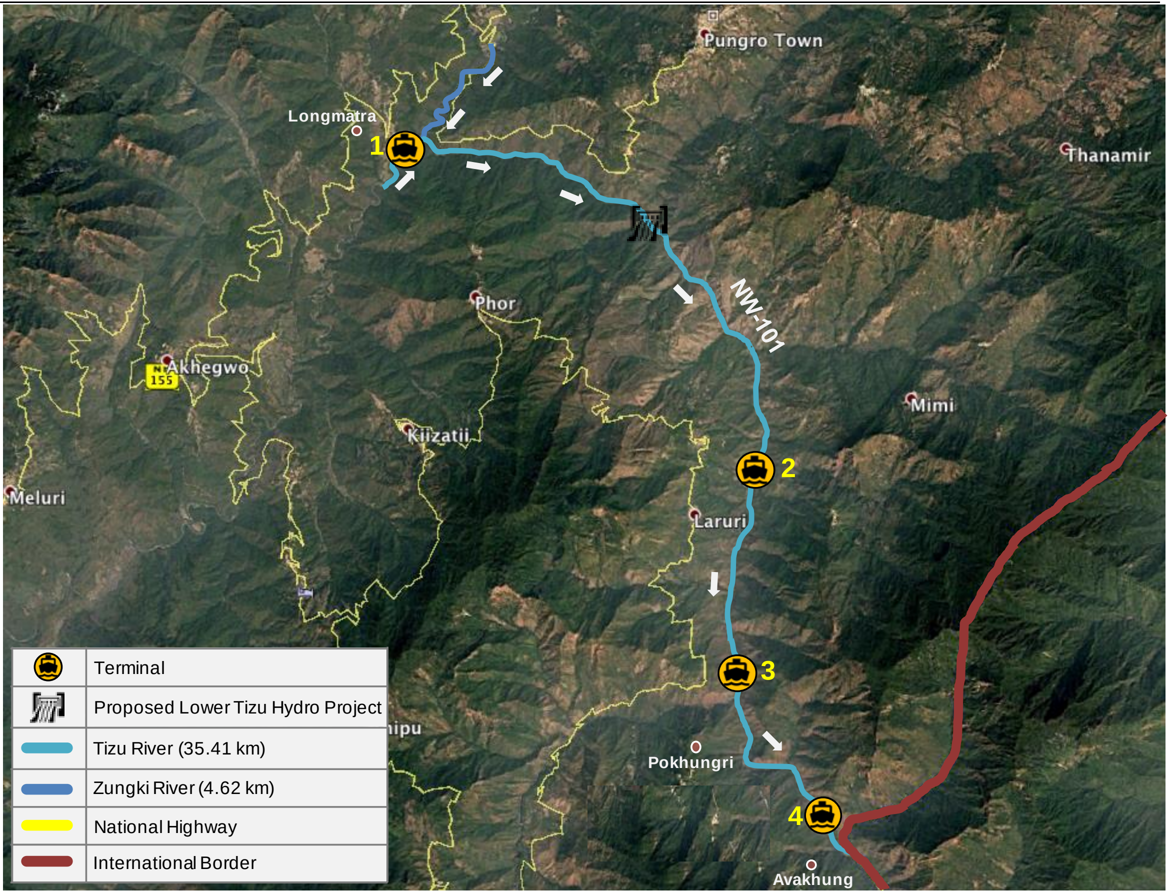


Fig. 1.3 Proposed terminals on NW 101

Table 1.6 Terminal Details on NW 101

Sr. No.	Tentative Location	Size	HFL (m)*	Chainage (km)	Lat-Long
1	Near Longmatra	25x6	459	33.3	Left 1- 25°46'38.46"N, 94°44'54.81"E
					Left 2- 25°46'36.87"N, 94°44'54.66"E
					Right 1- 25°46'38.13"N, 94°44'56.31"E
					Right 2- 25°46'36.54"N, 94°44'56.06"E
2	Near Laruri Bridge	25x6	438	14	Left 1- 25°41'6.52"N, 94°51'12.80"E
					Left 2- 25°41'4.40"N, 94°51'12.62"E
					Right 1- 25°41'6.52"N, 94°51'13.92"E
					Right 2- 25°41'4.29"N, 94°51'13.64"E
3	Phonkhuri	25x6	433	7.5	Left 1- 25°37'48.72"N, 94°50'58.02"E
					Left 2- 25°37'46.86"N, 94°50'57.62"E
					Right 1- 25°37'48.90"N, 94°50'59.34"E
					Right 2- 25°37'46.85"N, 94°50'58.77"E
4	Avakhung	25x6	427.6	1.2	Left 1- 25°35'29.62"N, 94°52'35.57"E
					Left 2- 25°35'27.60"N, 94°52'36.11"E
					Right 1- 25°35'30.09"N, 94°52'36.66"E
					Right 2- 25°35'28.34"N, 94°52'37.20"E

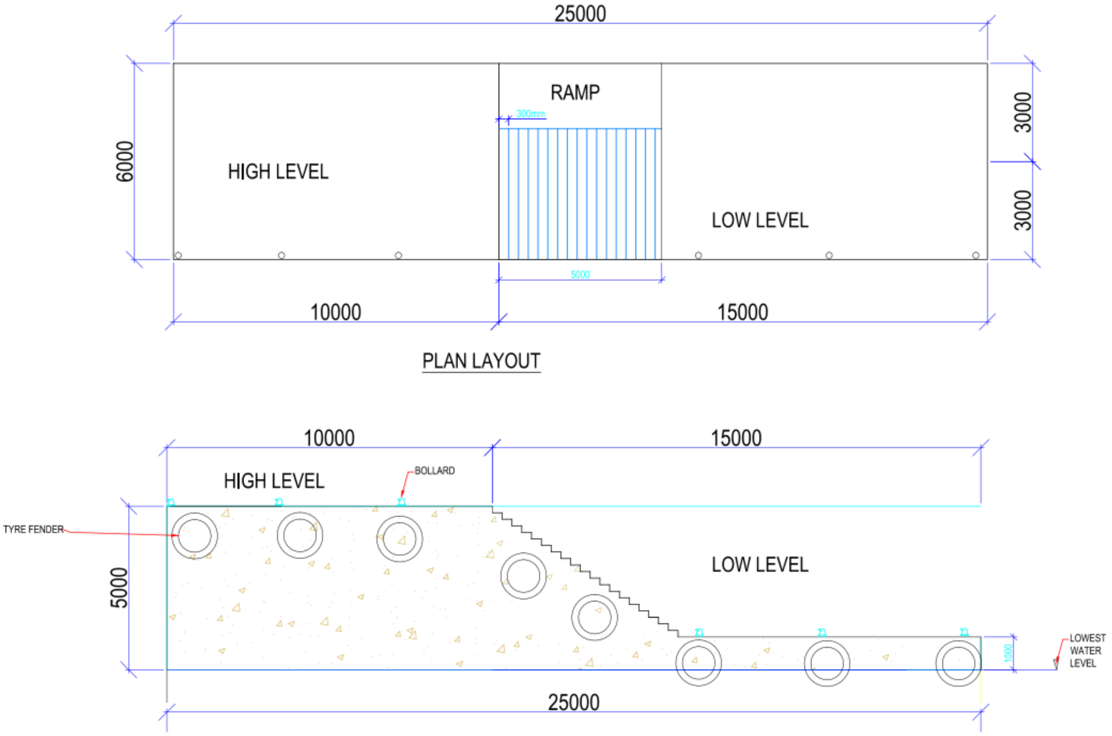


Fig. 1.4 Proposed wharf on NW 101

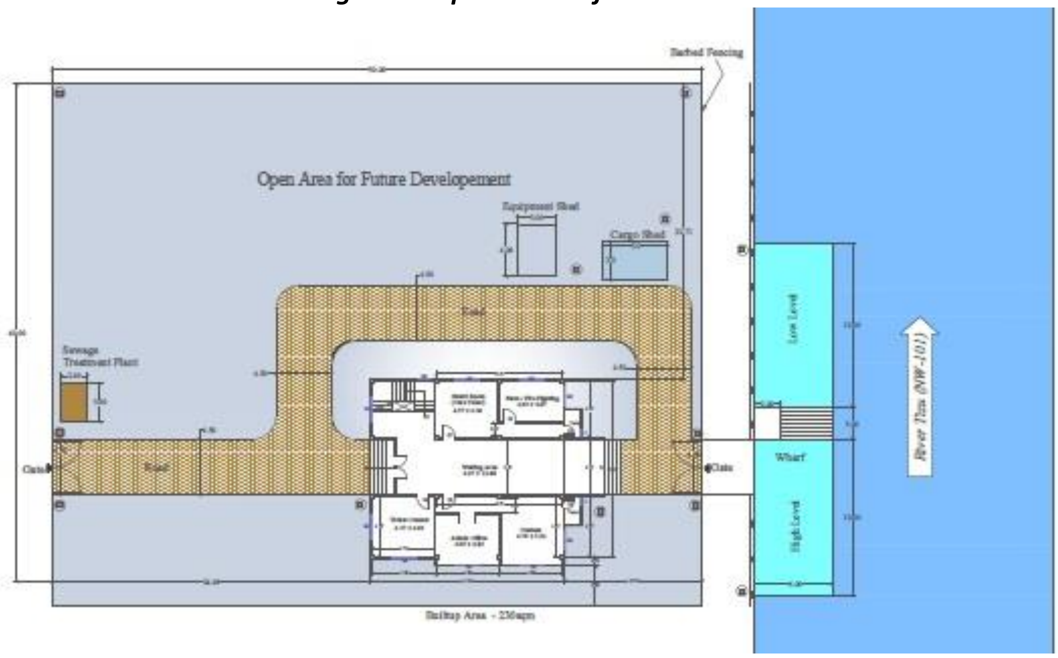


Fig. 1.5 Proposed typical layout on NW 101-Phase-II

The infrastructure present in the terminal is shown in table below

Infrastructure

Sr.	Components	Dimentions
01	Wharf	6.00 x 25.00 (m x m)
02	Store/Fire fighting	4.95 x 3.07 (m x m)
03	Ticket Counter	4.57 x 4.65 (m x m)
04	Admin Office	4.95 x 3.85 (m x m)
05	Canteen	4.76 x 5.22 (m x m)
06	Guard Office(Caretaker)	4.57 x 4.34 (m x m)
07	Cargo Shed	5.0 x 3.0 (m x m)
08	Waiting Area	12.88 x 4.27 (m x m)
09	Sewage Treatment Plant	2.00 x 3.00 (m x m)
10	Toilet	1.22 x 2.13 (m x m)
11	Total Road Area	159.59 SqMt
12	Equipment Shed	3.00 x 4.00 (m x m)
13	Vacant Land (Total Area)	1731.93 SqMt

16. Suggested Types and Size Vessels

16.1 Under the IWAI's Classification of inland waterways Regulations 2006, suggested vessel sizes (length and draft) are also given for all the seven classes of waterways However, due to the waterway characteristics mentioned above the vessels suggested even for the smallest size (i.e. Class I) may not be able to ply smoothly on NW-101. Therefore, in the present DPR, the vessels to ply on NW-101 have been selected based on the local need, market and terrain of the river.

Accordingly, types, size and numbers of vessels are proposed for development of NW-101 during Phase I and Phase II and Phase III. Passenger traffic would be handled in all three phases; household commodities would be handled in Phase II & Phase III; while cargo traffic would be handled only in Phase III. Passenger, Tourist and Household commodities (passenger carrying cargo) can be accommodated in single type of passenger vessel. For cargo (Mineral, Cement & food grains) traffic in Phase III, bigger cargo vessel will be required, depending on the proposed traffic.

16.2 Vessels for Immediate Phase (Phase-I)

Based on the market enquiry for boats available indigenously, following types of inflatable boats with outboard motor (OBM) which are easily available off the shelf within India are proposed to be deployed on NW 101 in the Immediate phase which would handle only passenger traffic.

Table 1.7 Vessel's Specification for Immediate Phase- Inflatable Boats with OBM

Inflatable boat with outboard motor (OBM) has been proposed to be deployed on NW 101 in the Phase I. This phase would handle passenger traffic.

Company / Ferry Name →	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	4.2	4.1	4.5 – 4.7	4.4
Beam (m)	1.8	1.7	1.9	1.8
Passenger Capacity (PAX)	6-7	4-6	8-10	8-10
Engine Power (HP)	25	25	25	25
Make	Indian	Indian	Indian	Indian
Fuel	Diesel	Diesel	Diesel	Diesel
Price (INR)	7,50,000/-	5,83,000/-	1,55,000/-	5,50,000/-

Source: Direct information from the vessel manufactures (as listed below)

Note: Details of vessels described in ANNEXURE XII.

Vessel Type 1 – Safin 420 Inflatable Rescue Boat, Mumbai (https://www.shmgroup.com)

Vessel Type 2 – Gee Pee 4.1 Mt Boat, Delhi(http://www.geepee.in)

Vessel Type 3 – Culcutta Sportsboat, Kolkata(http://www.calcuttaboat.com)

Vessel Type 4 – Gemeni Boat, Mumbai (https://www.shmgroup.com)

16.3 Vessels for Phase II & III

Phase II: Vessels for passengers and household commodities

It has been proposed that vessels with less than 1 m draft, categorised as special class, should be deployed in NW 101 for passenger transportation. Following table lists down sample vessels along with images provided by suppliers that could be deployed on NW 101.

Table 1.8 Vessel's Specification for Immediate Phase- Inflatable Boats with OBM Ph-II

Ferry→	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	5.6	6	11	7
Beam (m)	2.28	2.5	3.84	2
Draft (m)	0.6	0.5	0.6	0.4
Passenger Capacity (No.)	18	20	20	10
Speed (Knots)	10	10	12	12
Fuel Consumption (Ltr/Hr)	4.5	2.6	20	6.8
Type of Fuel	Diesel	Diesel	Petrol	Diesel
Engine Capacity (HP)	25	15	2 X 70	40
Make	Indian	Foreign	Foreign	Indian
Fuel	Diesel	Diesel	Petrol	Diesel

Source: Direct information from the vessel manufactures (as listed below)
No
Note: Details of vessels described in ANNEXURE XII of Volume-III
Vessel Type 1 – India Bungy, Ahmedabad (http://www.indiabungy.com)
Vessel Type 2 –Inflatable Ferryboat, Slovenia, EU (https://www.hovercraft.si)
Vessel Type 3 – Abra 36. UAE (https://www.smartown.ae)
Vessel Type 4 – Model Victory 10 Boat, Kolkata (http://www.calcuttaboat.com)

16.4 *Phase III: Vessels for Cargo (Cement, Minerals & Food Grains)- Indo-Myanmar Trade*

Keeping in view the river parameters (30 m bottom width and 1.2 m draft), traffic type (Minerals, Cement and Food Grains), volume (approx. 0.48 MMTPA) and Ideal Vessel Size (Vessel with 5 m width), Class I type of vessel could be deploy in NW 101, between Laruri and Avakhung, to cater the projected traffic till FY50. The table below shows the recommended vessel specification for cargo handling in Phase 2.

Table 1.9 Vessel's Specification for Class I for cargo handling

Specifications	Cargo Vessel
Length (m)	32
Beam Width (m)	5
Draft (m)	1
Speed (Knots)	6
DWT (T)	110
Block Coefficient	0.85
Cargo Capacity (T)	100
Fuel Used	Diesel
Fuel Consumption (Ltr/Hr)	17
Engine Capacity (BHP)	100

[Note:Details/ budgetary offers collected by Wapcos from the vendors/ manufacturers of the above mentioned boats are also given in Volume- III (Annexures) of this DPR]

Requirement of number of vessels:

Requirement of fleet of vessels to be deployed on NW 101 to cater Passenger, Tourist and cargo traffic has been computed considering the relevant factors such as traffic (type, volume and nature), movement distance, capacity, speed, physical constrains, vessel specifications, operational days/hours, etc.

Table 1.10 Vessels Required for Passenger Movement

Sr. No	FY23	FY30	FY40	FY50
Approx. Daily Passengers (No.)	126	235	338	509
Daily Ship Calls (No.)	7	12	17	26
Vessels Required (No.)	3	5	7	11
Additional Requirement (No.)	-	2	2	4

Table 1.11 Vessels Required for Cargo Movement

Sr. No	FY 28	FY 30	FY 40	FY 50
Daily Cargo Movement (Tons)	1,606	1,606	1,606	1,605
Daily Ship Calls (No.)	18	18	18	18
Total No. of Vessels Required (No.)	9	9	9	9
Additional Requirement (No.)	-	0	0	0

The number of vessels calculated in the above table for various years are sufficient to handle the total projected traffic till FY 50.

17 Hydrological data analysis of nearby Gauge site

There is no Central water commission (CWC) as well as Nagaland water resources Gauge station is present in the stretch defined for NW101.

However, two nearby gauge station of WRD,Nagaland are present; (i) Tizu GD (Gauge and Discharge) station at Phek which is approximately 32 km upstream from nearest point of NW-101; and (ii) Tape GD station at Kiphire which is approximately 10 km upstream of River Zungki. The Tape GD station is present on the tributary of the River Zungki while the Tizu GD station is on the River Tizu. The details of the Gauge station are given in the below table 10.1 and the location of Gauge station is shown in fig 1.12:

Table 1.12 Details of Gauging Station

Site Name	Location	State	Basin	Local River	Zero of the Gauge (m)	Type of Site
Tizu GD at Phek	25°38'25.21"N 94°35'7.34"E	Nagaland	Irrawady Chindwin	Tizu	Local Zero	GD-WRD Nagaland
Tape GD at Kiphire	25°50'32.36"N 94°47'12.71"E	Nagaland	Irrawady Chindwin	Tape (Tributary of Zungki)	Local Zero	GD-WRD Nagaland

Source: WRD, Nagaland

The hydrological inputs play a very vital role in planning, execution and operation of any Navigational project. The hydrological studies are carried out at all the stages of project starting from the pre- feasibility stage and are continued even during the operation of the project. Hydrological studies usually cover the assessment of quantities of available water and its time variation, estimation of design flood usually required for the hydraulic design as well as safety of the structure.

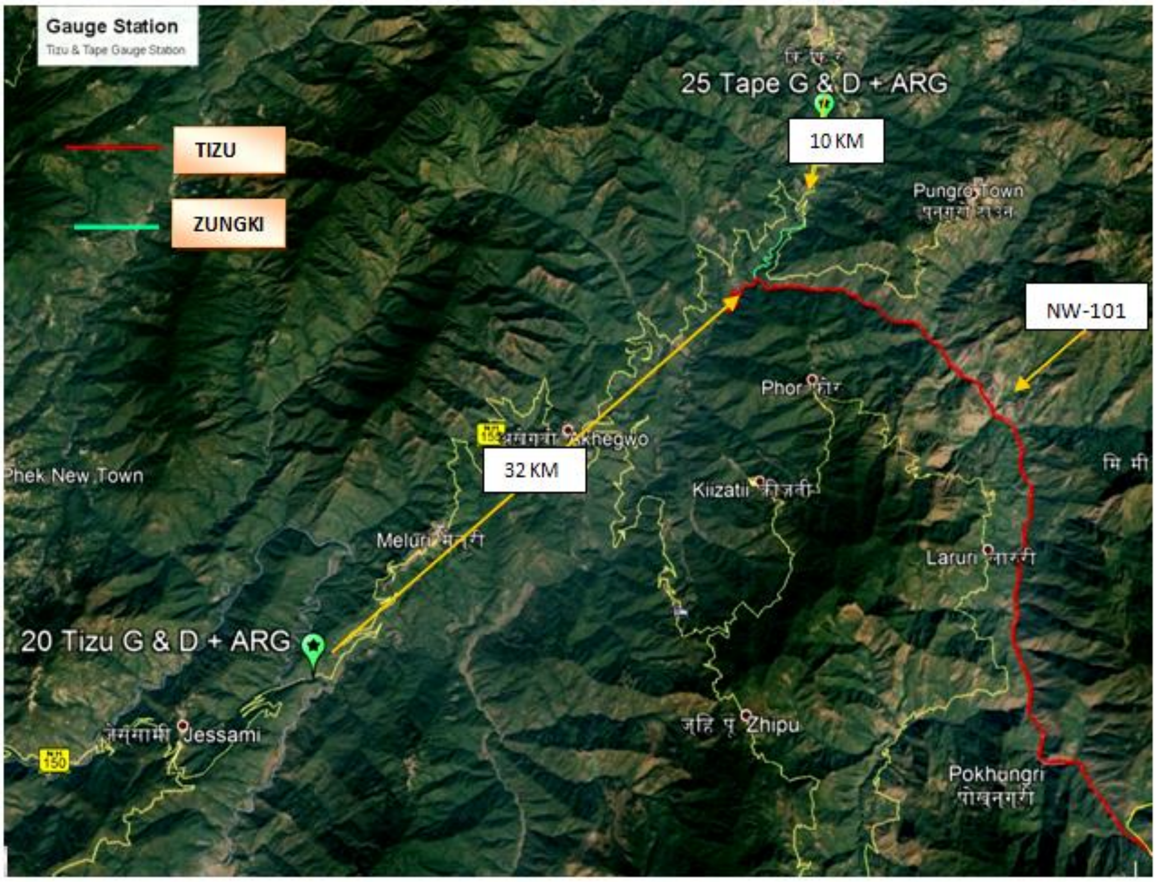


Fig 1.6: location of Gauge station Tape and Tizu

2420 Cum discharge has been taken further for designing of structures like barrage/Weir in the waterway NW101.

it is also recommended that project development authorities should establish one Gauge and Discharge stations on Tizu River near Laruri Bridge site for measuring discharge at least twice daily. These measurements proposed to be utilized for updating the available discharge to incorporate the latest trend of discharge in the studies.

18 Dredging Plan:

Table 1.13 Class of waterways development with dredging quantities

Sr.No	Phase	Stretch	Design Vessel	Qty (Cum)
1	Immediate Phase-I	Longmatra to Avankhung (with inflatable rubber boats)	15m bottom width,0.6 m depth	**8640**
2	Phase-II	Longmatra to Avankhung	15m bottom width,1m depth	**(61020- 8640) = 52380**
3	Phase-III	Longmatra to Avankhung (With Interventions)	Class-I	**NIL** *(due to presence of dam/Barrages)*

19 ENVIRONMENT

19.1 Impact on local economy

The construction phase would lead to generation of temporary employment opportunities such as requirement of manpower/vessels to trans-ship the materials, ground clearing, road laying works etc. These activities would temporarily increase the income levels of the local population. Thus, this will not only improve the economy of the port but also the economy of the entire region as a whole.

Table-1.14: Impoverishment Risk Assessment

S. No.	Risks involved	Description of risks involved	Details
1.	Landlessness	Expropriation of land removes the main foundation on which people build productive systems, commercial activities, and livelihoods. Often land is lost forever, sometimes it is partially replaced, and seldom is it fully replaced or fully compensated. This is the principal form of de-capitalization and pauperization of displaced people, as they lose both natural and man-made capital.	As per our assessment, there are about 5 acre of who are likely to lose their lands in varying proportions due to the process of land acquisition. The villagers depend on their lands for their livelihood. In addition, there are a number of families that are dependent on these lands for their livelihood, who work as agricultural labour work force. Acquisition of lands would invariably affect their means of livelihood and sustenance.
2.	Improper Management of Money (Compensation Amount)	The affected population will get lot of money in form of compensation of their properties and other grants as per applicable R&R Policy.	Some of the Villagers are not wise enough to invest their money in purchase of agriculture land or in other sources of alternative livelihoods. Money becomes a great cause of family rift also so the money should be invested wisely having a foresighted approach of life.
4.	Other Indirect Losses of Displacement (Women Insecurity)	Displaced people often internalize a sense of helplessness and powerlessness because of their encounter with the powerful external world, although there are also several examples of active resistance movements against development-induced displacement. Displacement also leads to deterioration in health and high mortality rates as services in those selected areas are the first to be cut.	

20 ENVIRONMENTAL MONITORING PROGRAMME

20.1 The summary of Environmental Monitoring Programme for implementation during project construction and operation phases is given in Tables 1.15 and 1.16 respectively.

Table 1.15 Summary of Environmental Monitoring Programme for implementation during project construction phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
1.	**Marine water**			
	Physico-chemical parameters	pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.	Once in three months	1 location near each Terminal
	Biological parameters	Light penetration, Chlorophyll, Primary Productivity, Phytoplanktons, Zooplanktons	Once in three months	1 location near each Terminal
2.	**Sediments**			
	Physico-chemical parameters	Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates	Once in three months	1 location near each Terminal
	Biological parameters	Benthic Meio-fauna, Benthic Macro-fauna	Once in three months	1 location near each Terminal
3.	**Ambient air quality**	PM_{10}, $PM_{2.5}$, SO_2 & NOx	- Summer and Winter seasons. - Twice a week for four consecutive weeks per season.	1 location near each Terminal
4.	**Noise**	Equivalent Noise Level	During peak construction activities	1 location near each Terminal

Table 1.16 Summary of Environmental Monitoring Programme for implementation during project operation phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
1.	**Marine water**			
	Physico-chemical parameters	pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.	Once in three months	1 location near each Terminal
	Biological parameters	Light penetration, Chlorophyll, Primary Productivity, Phyto-planktons, Zooplanktons	Once in three months	1 location near each Terminal

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
2.				
	Physico-chemical parameters	Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates	Once in three months	1 location near each Terminal
	Biological parameters	Benthic Meio-fauna, Benthic Macro-fauna	Once in three months	1 location near each Terminal
3.	Ambient air quality	PM_{10}, $PM_{2.5}$, SO_2 & NOx	- Summer, & Winter Seasons. - Twice a week for four consecutive weeks per Season.	1 location near each Terminal
4.	Noise	Equivalent Noise Level	Once per month	1 location near each Terminal
5.	Greenbelt Development	Rate of survival and growth of various species	Once per month	Various plantation sites.

20.2 BUDGET

The cost required for implementation of Environmental Monitoring Program (EMoP) during project construction phase is Rs. 43 lakh. The budget is given in Table 11.5

Table 1.17 Summary of Cost estimation for Implementation of Environmental Monitoring Programme during Construction Phase

S. No.	Parameters	Cost (Rs. lakh)
1	Water and Sediment Quality	21
2	Ambient Air Quality	21
3	Noise	1.0
	Total	**43**

The cost required for implementation of Environmental Monitoring Program (EMoP) during project operation phase is Rs. 27 lakh/year. The detailed budget is given in Table 1.18

Table 1.18 Summary of cost estimation for implementation of Environmental Monitoring Programme during operation phase:

S. No.	Parameters	Cost (Rs. lakh)
1	Water and Sediment Quality	15
2	Ambient Air Quality	12
	Total	**27**

21 Organisation Structure

21.1 Since there is no recent history of any inland water transport facility in the State of Nagaland, it is necessary to suggest a practical approach towards developing an organisation structure system including manpower and resource planning customised to local needs of

Nagaland. Incidentally, Government of Nagaland has constituted Nagaland Inland Water Board (NIWB) recently; it will be obvious that under overall supervision of IWAI this NIWB plays an important role in development, operation and management of IWT infrastructure proposed to be developed on NW-101. This would on one hand help in reduction of overheads of IWAI and at the same time it would l also help in generation of a localised organisation by training and utilising local talent well suited to local customs and process.

During discussion with IWAI officials it was gathered that IWAI has decided that all the National Waterways located in North-Eastern states of India would be developed and operated under the administrative jurisdiction of Guwahati Regional Office of IWAI. Accordingly it is suggested that development, maintenance and management of NW-101 is carried out through NIWB under technical guidance and supervision of Director IWAI, Guwahati, Assam.

It may be recalled that it is proposed to develop NW-101 in three phases, i.e. Immediate Phase-I; Phase –II; and Phase-III. In The immediate phase, development requirement includes deployment of Inflatable Boat with outboard motors (transportation capacity- 5 to 8 person). It is proposed to allocate Boats to nearby villages so that the operation and safety of boats are ensured through responsible person(s) from the village itself.

21.2 In Phase -II, terminals could be developed by IWAI with first line supervision of NIWB. The entire stretch of NW-101 would be made navigable by dredging and deepening the channel. The additional facilities in Terminals would also be developed in this Phase. After Phase -II development, NW-101 would be operational for local movement of passengers and household commodities. It is proposed to deploy three person (as shown in the below chart) on every terminal to facilitate movement of passenger and their belongings on NW 101 in Phase -II.

21.3 In Phase -III, IWT route between India and Myanmar is proposed to be developed and NW-101 would be linked with Chindwin River in Myanmar. In Phase -III, there would be need of maintenance of fairway and terminals. The organisational structure for management and administration of NW – 101 will therefore have to be accordingly strengthened in Phase III.

21.4 The proposed indicative general arrangement of Organisation Structure in three phases of development and management of NW-101 is explained in the following flow charts, separately for each. Some changes here and there can however, be made by IWAI and Government of Nagaland based on actual requirement from time to time.

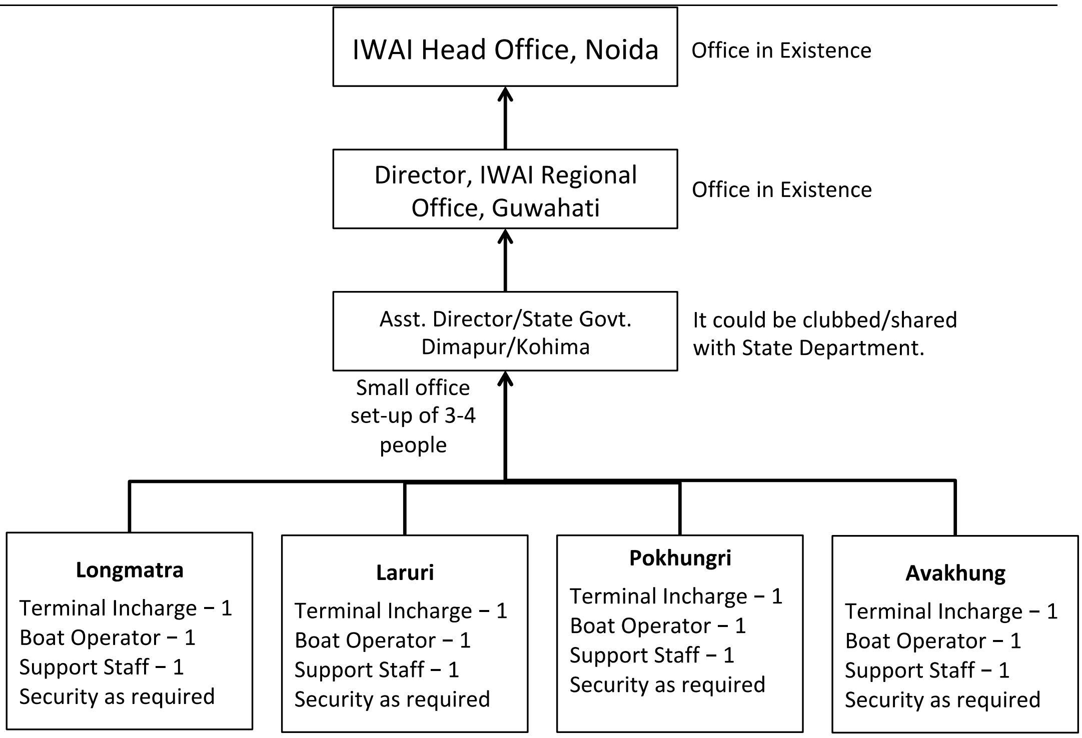


Fig. 1.7 Organisation Structure in Immediate Phase-I

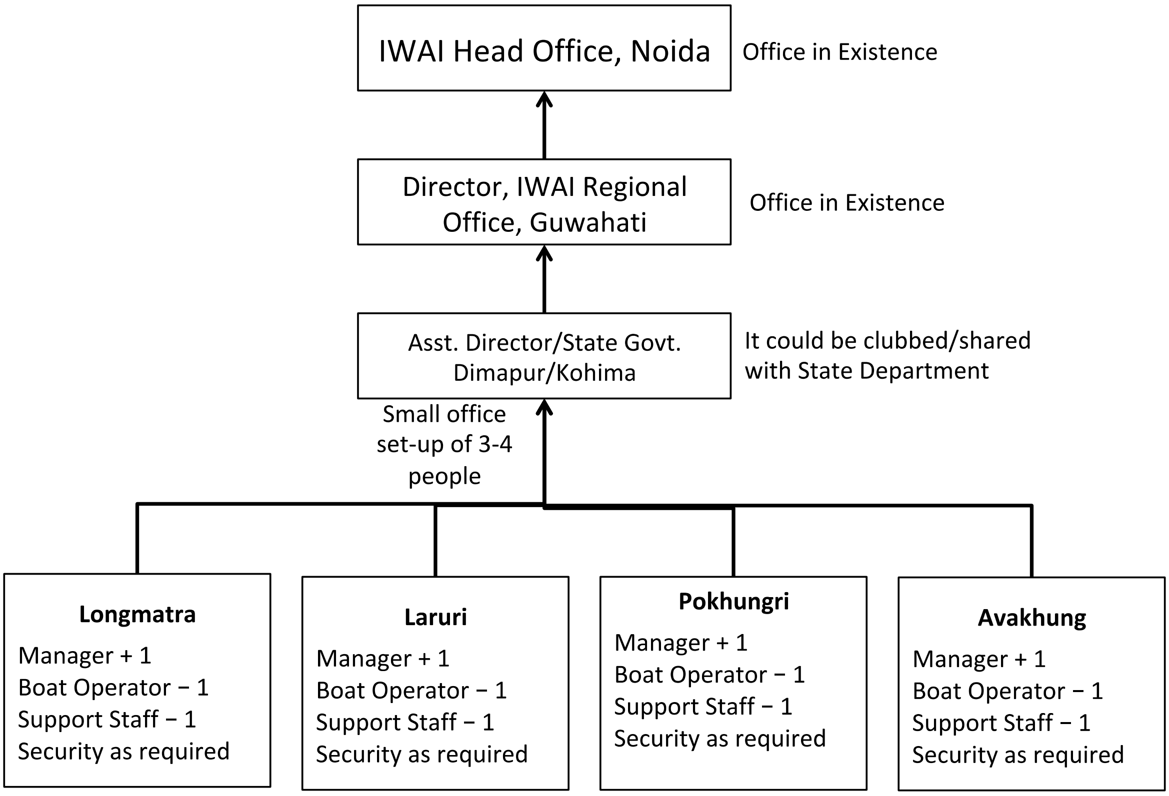


Fig. 1.8 Organisation Structure in Phase –II

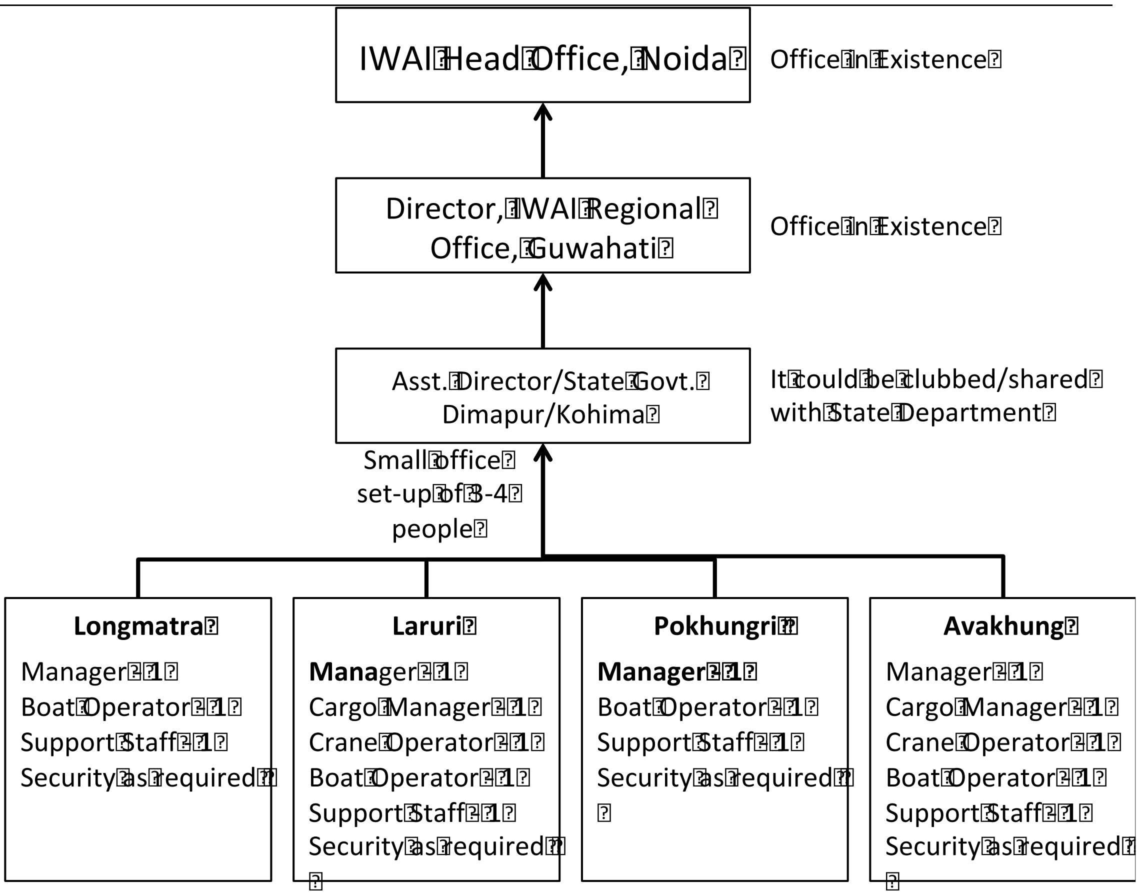


Fig. 1.9 Organization Structure in Phase -III

21.5 Manpower Requirement

Man power requirement for operation of waterway in NW 101 includes terminal operations and Navigation operation. Every terminal will require institutional setup for proper functioning of terminal operations. The following table depicts requirement of manpower at all terminals on NW 101.

Table 1.19 Requirement of Manpower at all Terminals

Sr. No	Manpower	Immediate Phase-I	Phase -II	Phase -III
1	Asstt Director	1	1	1
2	Terminal Manager	4	4	6
3	Boat Operator	4	4	6
4	Support Staff	4	4	4
	Total Manpower	**13**	**13**	**17**

21.6 Cost Implications

Cost implication for establishing institutional requirement will include salaries of employees deployed at terminals and regional office. Institutional setup is required for operation and maintenance of waterway and terminals. Capacity building through education and training to the staff and employees will also have cost implications. Average annual salary of top management like Director and Terminal Managers is taken as INR 12,00,000. Average annual salary of manpower at Regional and Terminal Offices is taken as INR 3,00,000.

Table 1.20 General Annual Salary for Operation of Terminals and Fairway

Phases	Items	Quantity	Annual Salaries (INR)	
			Rate	Amount
Phase I	Top Management	01	12,00,000	12,00,000
	Other Staff	16	3,00,000	48,00,000
Phase II	Top Management	01	12,00,000	12,00,000
	Other Staff	20	3,00,000	60,00,000
Phase III	Top Management	01	12,00,000	12,00,000
	Other Staff	24	3,00,000	72,00,000

22 Project Costing

22.1 Basis of Costing

An estimate of the capital cost of various facilities is made. The cost arrived at are based on the budgetary quotes and the in house data base available on cost estimates. The rates for various items of work have been prepared on the basis of current rates for various items of work prevailing in the region.

The items and costs have been arrived at broadly on the following:

- Rates taken from current works of similar nature
- Updated rates of work of similar nature completed in the recent past.
- Consultant's in house data bank of cost estimates and budgetary quotations.

The rates for preparation of cost estimates for the scheme have been worked out based on Nagaland PWD Schedule of Rates 2016 and Schedule of Rate for NH, MORTH work in Nagaland 2016. The general cost abstract and detailed cost estimates have been prepared as per the general guidelines.

Table 1.21: Capital Cost Estimate phase-I

Capital Cost for Phase- I (Immediate)		
Sl. No.	**Description**	**Amount in Crores.**
(I)	**Fairway Development**	
(i)	Dredging/ Removal of Boulder	1.47
	Add 3% Contingency & 7% Supervision Charges	0.15
	Total Fairway Development Cost	**1.62**
(II)	**Civil Cost**	
A	**Terminals**	
(i)	Rest Rooms - 4 Nos.	0.07
(ii)	Area for Passenger Wharf - 4 Nos.	0.003
(iii)	Sitting Area - 4 Nos.	0.04
(iv)	Solar – 4 Nos.	0.02
	Total Cost (II)	0.13

Capital Cost for Phase- I (Immediate)		
Sl. No.	Description	Amount in Crores.
	Add 3% Contingency & 7% Supervision Charges	0.01
	Total Civil Cost	**0.14**
(III)	**Navigation & Communication Cost**	
(i)	Conventional Marks made of bamboo strips	0.04
	Add 3% Contingency & 7% Supervision Charges	0.004
	Total Navigation & Communication Cost	**0.047**
(IV)	**Vessel Cost**	
(i)	Vessels (Inflatable Boat) - 4 Nos.	0.22
	Total Vessel Cost	**0.22**
(V)	Other cost including financing cost and interest during construction (10% of (II))	**0.01**
(VI)	**Land for terminal development @ 0.5 acre per terminal - 4 Nos**	
	*Considering Rs.10 lacs per acre	**0.20**
	Total Capital Cost	**2.24**

Table 1.22 Capital Cost Estimate phase-II

Capital Cost for Phase II		
Sl. No.	Description	Amount in Crores.
(I)	**Fairway Development**	
(i)	Dredging/ Removal of Boulder	8.90
	Add 3% Contingency & 7% Supervision Charges	0.89
	Total Fairway Development Cost	**9.79**
(II)	**Civil Cost**	
A	**Terminals**	
(i)	Wharf - 4 Nos.	2.86
(ii)	Terminal Building - 4 Nos.	2.28
(iii)	Equipment Shed – 4 Nos.	0.03
(iv)	Fencing - 4 Nos.	0.82
(v)	Gate - 4 Nos.	0.09
(vi)	STP - 4 Nos.	0.20
(vii)	Path - 4 Nos.	0.23
(viii)	Internal Road	0.07
(ix)	Solar – 8 Nos.	0.032
B	**Miscellaneous**	
	For Retaining Wall/ Drainage etc.	3.00
	Total Cost (II)	9.60

Capital Cost for Phase II		
Sl. No.	**Description**	**Amount in Crores.**
	Add 3% Contingency & 7% Supervision Charges	0.96
	Total Civil Cost	**10.56**
(III)	**Navigation & Communication Cost**	
(i)	Conventional Marks made of bamboo strips	0.04
	Add 3% Contingency & 7% Supervision Charges	0.004
	Total Navigation & Communication Cost	**0.05**
(IV)	**Handling Equipment Cost**	
(i)	Backhoe Loader - 4 Nos.	0.80
(ii)	Fire Fighting Equipment - 4 Nos.	0.005
	Total Cost (II)	0.81
	Add 3% Contingency & 7% Supervision Charges	0.08
	Total Handling Equipment Cost	**0.89**
(V)	Other cost including financing cost and interest during construction (10% of (II))	**1.06**
(VI)	**Environment Cost**	
(i)	During Implementing Environmental Management Plan (EMP)	0.96
(ii)	Monitoring Programme (EMoP) during construction phase	0.27
	Total Environment Cost	**1.23**
	Total Capital Cost	**23.57**

Phase-III cost is more than Rs.981 crores due to proving of interventions like barrages .hence not viable considering traffic potential. Hence not recommended for development.

Detailed BOQ for the capital cost estimate is given in Annexure-VIII

23 Financial

23.1 Financial IRR

Revenue generated from Terminal and Fairway operation is based on the projected traffic for next 30 years. Tariff rates considered in the financial analysis, for terminal and fairway usage, is as per the market standards. At terminals, INR 100 per passenger/tourist will be charged for using ferry service, INR 50 for using viewing deck at the terminal and INR 1/Kg for carrying cargo (household products). For Fairway usage, passenger and tourists will be charged INR 3 Pax-Km.

Estimated project cost for development of 35.4kms of fairway and all 4 terminals is INR 2.23 Cr in Phase I & INR 23.58 Cr in Phase II. Due to high development cost (CAPEX & OPEX) and very less revenue in return, there is huge difference between outflow and inflow. Revenue generated from terminals and fairway is not sufficient even to cover day to day operating expenses. In such scenario, this project does not generate any returns. However, considering the remoteness of the site, bad road connectivity, hilly highly underdeveloped region and the thrust/ importance being attached to development of NER, it is proposed that the Government/ IWAI may develop NW 101 for the benefit of the society and development/ growth of the region and the State of Nagaland.

24. SWOT AT GLANCE

Strength	Weakness
• Availability of water and depths • Local People and Govt. Support • Availability of deposits of Mineral belt • Increasing Opportunity and Livelihood of local people • Scope of Mineral Mining • River Tizu is a transboundary International river. It crosses the border of Nagaland state and reaches Myanmar. • International Trade with Myanmar if other side of the water way gets developed it can be connected the Hta-Man-Thi port of Myanmar • will encourage improvements in infrastructure, aiding the safe and smooth operation of cargo movement.	• Availability of Road Network • Sinking Land Slide Zone. Landslides leads to closure of roads. • Very high velocity of water in river and presence of rapids • Very Less population to commute. • Lack of Financial Strength for local vessel operators • Lack of Marketing Strategies • Local Unrest and Agitations for various reasons • Flood uncertainties, fully rocky terrain and boulders throughout the river. • Inadequate credit for agricultural operations. • High cost of infrastructure maintenance due to recurring floods • No assured return on investment. • No Repairing and other ancillary facilities for vessels.
Opportunities	**Threats**
• Potential for Industrial Investment. • Tourism can be developed. • Availability of new technologies and farming practices. • Rising demand for diversified agriculture and horticulture product. • Focused area of central and state Govt. schemes • Commercialization and globalization of agricultures and other market • Socio-Economic development of nearby project areas.	• Risk of Natural calamities • Local and Political Support and Unrest • High cost of Operation • Competition from other Modes • Shortage of skilled labour • Timely implementation of projects • Private Investment cannot be expected

Major Bottlenecks & Suggestive Methods

Bottlenecks

1. River Morphology and geographical condition of Tizu & Zungki river
2. Proposed Hydro Electric Power plant in Lower Tizu
3. Less Available Depth of Tizu river
4. Poor road connectivity & no railway line
5. Under developed hinterland of NW 101 & less population
6. Regulatory constraints & no policy for promoting IWT by law enforcement
7. Political unrest in the region
8. Security & safety in Inland Navigation & high cost of security measures
9. Project is not profitable due to large investment and less traffic

Suggestive Methods

1. Dredge the river to maintain draft, width & easements around bends in the river
2. Install navigation lock for navigability
3. Maintain depth in the river through dredging
4. Develop roads for easy access to terminals
5. State Government should promote trade & commerce & develop rural area
6. Government should promote IWT with policies & incentive programs
7. Government should ensure peace, law & order in the region
8. Develop a Security Plan for inland navigation & terminal operation
9. Government could develop NW 101 for the benefit of society and growth of the region

Figure -1.10 Major Bottlenecks & Suggestive Methods

CHAPTER – 1
INTRODUCTION

1.0 INTRODUCTION

1.1 Inland Waterways Authority of India (IWAI) is a statutory body of the Ministry of Shipping, Government of India (GoI). IWAI was set up in 1986 for regulation and development of Inland Waterways for the purposes of shipping and navigation. IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) on the National Waterways (NWs) in the country. Presently, there are 111 new NWs in the country including the stretch from Longmatra to Avankhu also spelled as Avakhung stretch of Tizu & Zungki rivers which has been declared as NW – 101 by the GoI during April 2016.

1.2 IWT has the potential to provide a cost efficient, economic, reliable, safe and environmental friendly form of transport. When developed for use by modern inland vessels operating on dependable rights of way, it can reduce congestion and investment needs in rail and road infrastructure, promote greater complementarities in the riparian states, enhance intra-regional trade and, through increased economies of scale, significantly reduce overall logistics costs for the benefit of the entire economy and India's global trade competitiveness.

1.3 Inland Waterways are economic multipliers, as they induce factors in development of an area, both through planned development policies and by the unplanned growth of related industries thus providing space for industrial clusters. They also nurture growth of other related industries like ship repairs and dredging activities. The clustering of related activities improves the competitive advantage of players by augmenting their productivity and reducing costs in movement and also paving the way for technological innovation. So, Inland Waterways create a kind of value chain of interrelated activities of the hinterland that are mutually supportive and continuously growing.

1.4 Objective and scope of the Assignment

1.4.1 IWAI had planned to conduct DPR study of Tizu and Zungki rivers declared as NW 101 from Longmatra to Avankhung near Myanmar border. The Study was conducted in two stages

Stage 1- Feasibility Study

Stage 2- DPR Study for feasible river stretches

The feasibility study was made by consultant DHI in September 2016.The stage 2 part DPR was awarded to WAPCOS for further study.
IWAI intends to explore the potential of NW - 101 i.e. Longmatra (Nagaland) to Avakhung (near Indo-Myanmar Border) stretch of Tizu and Zungki Rivers for round the year navigation and development of water transport facilities. The combined length of this stretch of the river under study is 40.039 km and the maximum width in this stretch is approximately 100 m to 150 m. The waterway flow direction of the river is from Longmatra to Avakhung.The site location is shown in fig.1.1

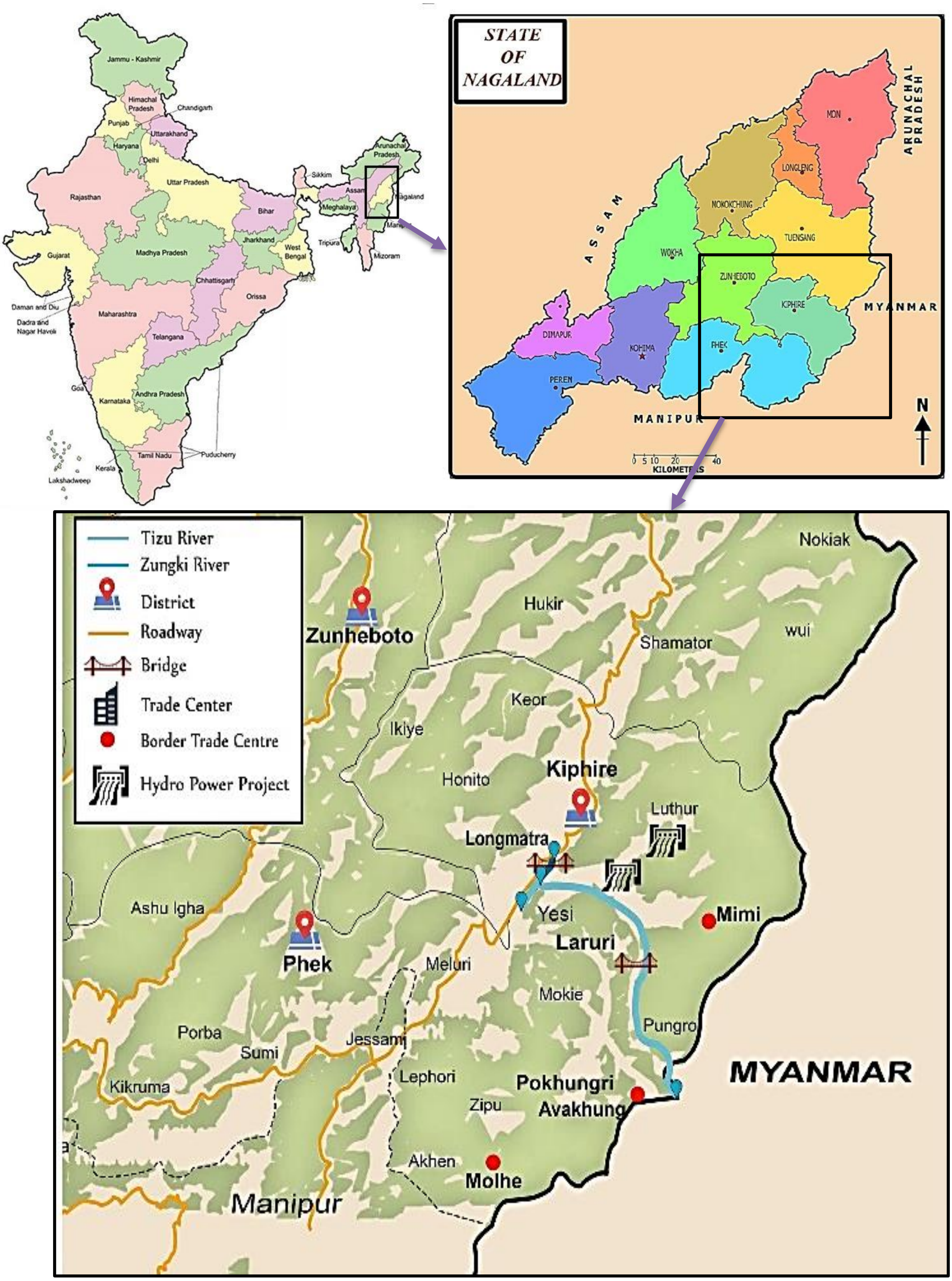


Fig. 1.1 Site Location

Stretch of River under study is **40.039 km** length of the river from Longmatra **to Avakhung at Myanmar border (35.410 km)** and in Zungki river from bridge to confluence of Zungki and Tizu rivers **(4.629 km). The same is presented in tabular form below**

Table 1.1 Tizu & Zungki River chainages

River	From (Lat/Long)	To (Lat/Long)
Tizu-(0-35.410 KM)	*Longmatra* Lat 25°46'12"N, Lon 94°44'35"E	*Avankhung* Lat 25°35'03"N, Lon 94°53'06"E
Zungki- (0-4.629 KM)	*Zungki river bridge* Lat 25°48'26"N, Lon 94°46'36"E	*Confluence of Tizu & Zungki* Lat 25°46'58"N, Lon 94°45'21"E

Source: THE NATIONAL WATERWAYS ACT, 25 Mar 2016 Gazette Notification

*

Fig. 1.2 Marking of Tizu and Zungki River stretch under study

1.4.2 The objective of this consultancy was to prepare a DPR as a part of stage 2 studies to explore the potential of Longmatra – Avakhung/Avankhu stretch of NW - 101 for year round navigation and recommending thereafter the specific interventions / sub-projects for development of IWT Infrastructure to achieve waterway capable of reliable, safe & cost effective navigation by developing infrastructure facilities namely fairway, navigational aids and terminal facilities. DPR includes Technical (together with Preliminary Engineering, Design work & Detailed cost estimate), Economic & Financial Analysis.

1.4.3 WAPCOS has also carried out an assessment of the existing cargo & passenger movements along the river corridor and across the river, identified and analyzed important O-D pairs and identification of all infrastructure, institutional, regulatory and environmental & safety challenges hindering IWT operations.

1.4.4 WAPCOS has engaged a team of suitably-qualified experts with domain experience as per the requirement of the ToR**. (TOR attached as Annexure-IV)**

1.5 **The work Consultancy Services for Preparation Consultancy Services for preparation of Detailed Project Report (DPR) for development of Longmatra to Avakhung stretch of Tizu & Zungki Rivers (NW–101) to facilitate inland water transportation in the state of Nagaland was given by IWAI LOA No. IWAI/PR-101/TIZU/2017 dated 20/02/2019 by IWAI. The scope of work of the study is as given below**:

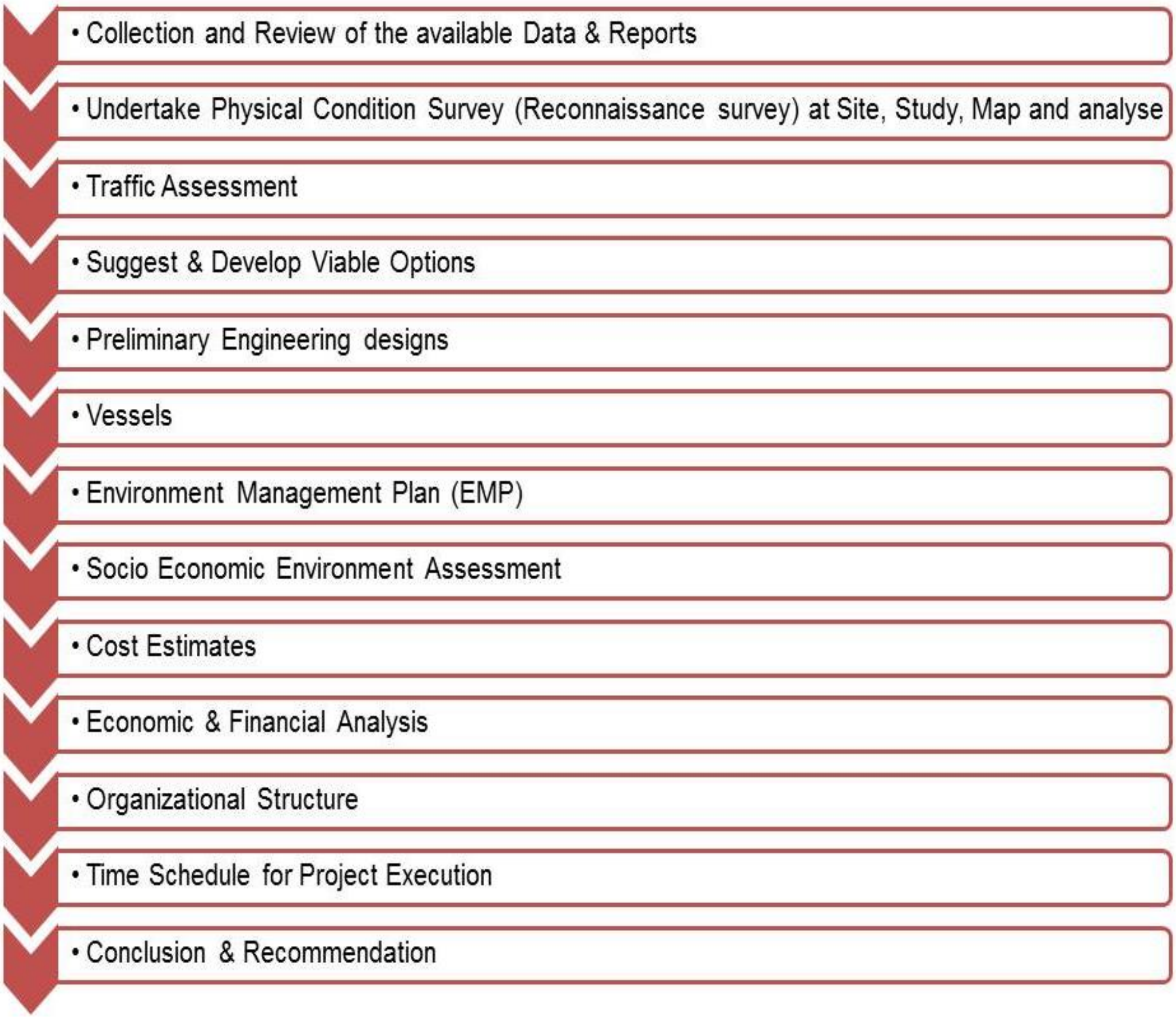


Fig. 1.3 Objectives of Assignment

1.6 GENERAL ABOUT NAGALAND

Nagaland is one of the smallest state in North Eastern India – with an area of 16,579 sq. km. sharing international boundaries with Myanmar in the East the states of Assam, Manipur and Arunachal flank its Western, Southern and Northern borders respectively. The rich diversity of flora and fauna characterize the landscape of Nagaland. The Naga hills run through this small state, which has Saramati as its highest peak at a height of 12,600ft. The main rivers that flow through Nagaland are Dhansiri, Doyang, Dikhu and Jjhanji. The terrain is mountainous, thickly wooded and cutting deep river valleys. There is a wide variety of plant and animal life. Nagaland has a monsoon climate with generally high humidity; rainfall averages between 1800mm and 2500mm a year. Nagaland has a single-chamber legislative assembly with 60 seats. The state sends two members to national parliament; one to upper house and one to lower house. There are 11 local government administrative districts –Mokokchung, Tuensang, Mon, Wokha, Zunheboto, Langleng, Phek, Peren, Dimapur, Kiphire and Kohima. The capital is Kohima. Little is known about the early history of Nagaland, including the origin of several large sand stone pillars at Dimapur. The climate varies from sub-tropical in the south to temperate and alpine in the north with some areas experiencing snowfalls during winter. Nagaland was constituted on 25th January 1950, a day before India became a Republic. On August 21, 1962 the then Hon'ble Prime Minister Shri Pandit Jawahar Lal Nehru introduced a Bill in the Parliament for the formation of Nagaland as an independent State. The Act provided for the formulation of the State of Nagaland as the 16th State in the Indian Union, and on December 1,1963, President Dr. S. Radhakrishnan inaugurated the State of Nagaland.

The State is bounded by Myanmar, Arunachal Pradesh on its eastern side, by Assam in western and northern side and by Manipur in the southern side and runs more or less parallel to the left bank of the Brahmaputra river. The capital of the State is Kohima. The State comprises of 11 districts, 52 blocks, 9 towns and 1317 villages. According to 2011 census, the state population is 2 millions. The average density of population is 119 per Sq. Km as against the national average of 383.Literacy rate of the state is 79.55%. Nagaland is predominantly a tribal state where about 80% its population lives in rural areas. Nagaland is aptly name after its main tribe "Naga" There are many separate tribes and sub tribes among the Naga. The major sun tribes are, Phom, Konyak, Aos, chang, Sema, snagtam, angami and lotha. These tribes have their own district languages, culture and festivals.

1.7 ECONOMY OF THE STATE

Agriculture is the predominant occupation of the people of Nagaland. About 90% of the population is directly depending on agriculture for livelihood even though the availability of agricultural land is very limited due to hilly and mountainous type of geography of the state. The jhum cultivated is extensively practiced. Area under jhum cultivation is about

76512 ha and under terraced cultivation is about 27133 ha. A narrow belt along the foot hills bordering Assam and the lower ranges of westerns and north western flank constitute major agriculture areas of the state. About 62300 ha is under irrigation. The state is heavily dependent on the union government and other state governments to meet its food and agricultural requirement. Rice being a staple food, paddy is grown in the state as the main crop. However, other crops like wheat, Maize other cereals, pulses, oil seeds; sugarcane, tea, potato, fruits and spices are also grown in a limited way.

Development of IWT on potential rivers will ease the transportation of the state. Since the road connectivity is very poor in far flange areas and mostly blocked mainly during monsoon due to landslide. Hence the development of IWT if connected with Myanmar region will also boost the economy of the region.

1.8 RIVER COURSE: BACKGROUND INFORMATION

Tizu River system forms an important drainage system. It drains the south eastern part of Nagaland and north eastern part of Manipur. It originates from the central part of the state and runs through a northeast direction flows through Zunheboto, Phek Districts and empties itself in the Chindwin River of Myanmar. The main tributaries of Tizu are the Zunki, Lanye and Likimro. The Zunki, the biggest tributary of Tizu, starts from the north-eastern part of Changdong forest in the south of Teku and flows in southerly direction towards Noklak, Shamator and Kiphire and finally joins Tizu below Kiphire. In Manipur, the northern part of the Ukhrul District is drained by the Tizu River and its tributaries at an altitude of about 500–2000 m asl. The important tributaries of tizu include the Challou or Chingai or Chammu and Laniye. Both the rivers originate from the Sirohi hills. The Laniye is mainly formed by three brooks of north western side of Sirohi hills viz., Akbong Lok (’Lok’ meaning brook in Manipuri), Masakong Lok and Langdang Turel (’Turel’ Meaning River in Manipuri). Laniye meets the Zerry lok, which comes from the eastern side of Senapati District and flows north eastward meet Tizu near Jessami (116 kms of north east Ukhrul town). Challou River originates from the northern watersheds of Sirohi hills, joins by the Riori River and then flows northward towards Tizu. Some of the important feeder streams are Sirohi lok, Poi, Wanze, Ringnga, Momo and Riori. The Tizu meets the Challou River at Akash-bridge forming a boundary between Manipur and Nagaland.

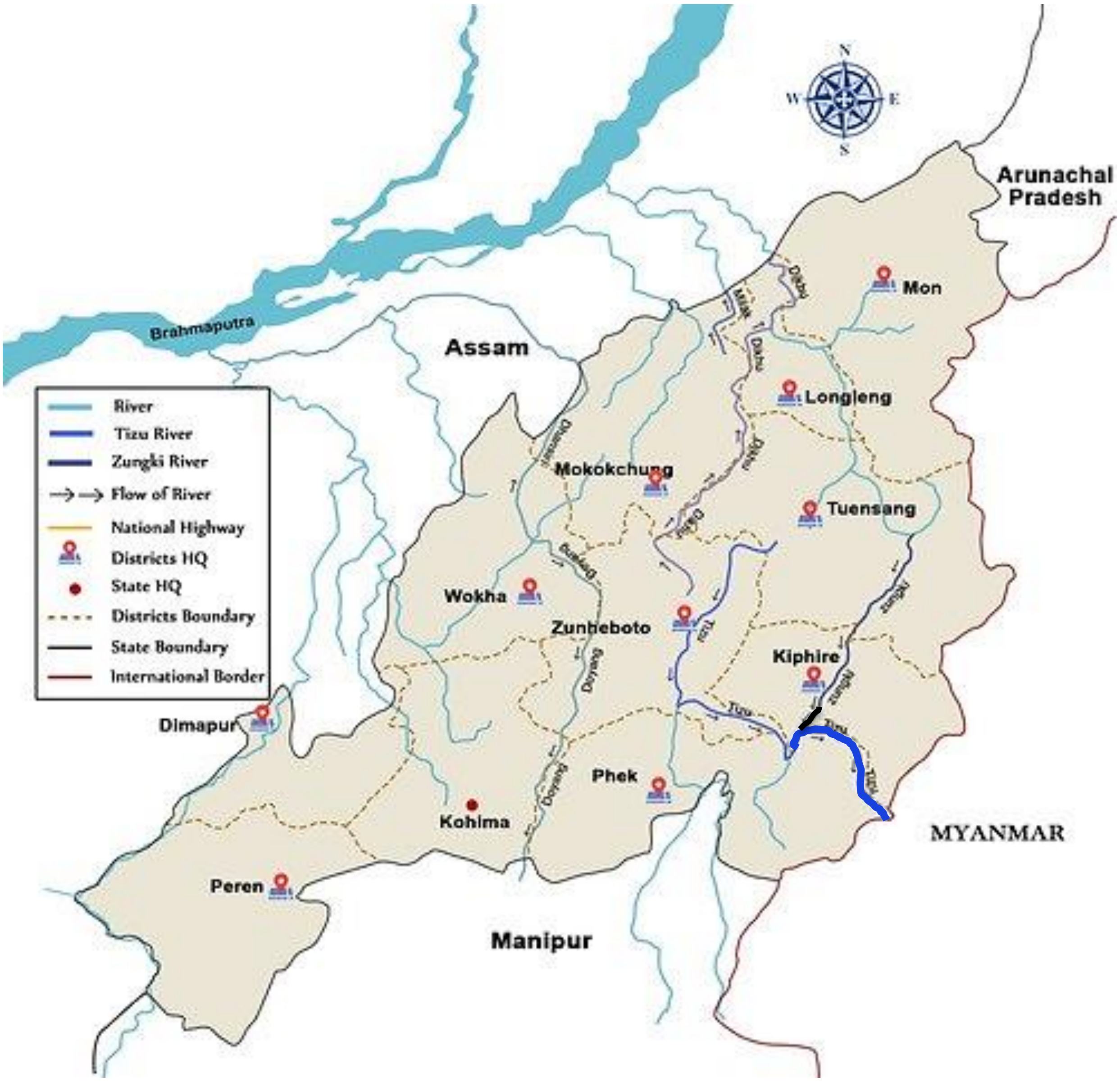


Fig. 1.4 River Maps of Nagaland

1.9 Tributaries / Network of Rivers / Basin

Tizu River forms an important drainage system in the eastern part of Nagaland. It runs through a northeast direction flows through Zunheboto, Phek district and empties itself in the Chindwin River of Myanmar. It is the second largest and longest rivers of Nagaland roughly covers one – third area of the state and is located within the innermost high mountain range bordering Myanmar.

It originates near Longkhim (2253m) Tuensang district, and flows for about 115 km and joins Lanyie – Thetsiru River. It flows for another 35 km north-Easterly up to Longmatra and joins Chindwin River near Myingan Town in Myanmar. The river Tizu after crossing Nagaland border in India enters into Myanmar, where it joins the Chindwin – Airwady river system.River Tizu flows across major section of the state and finally enters Myanmar near International Boundary Pillar (IBP) No. 133 at Avakhung or Avankhu Village and falls into Chindwin River of Myanmar. The Tizu River forms an important drainage system in the eastern part of the state with a total length of 203km (from Helipong rear to Avankhu area). It originates from the central part of the state and runs through northeast direction flowing through Zunheboto, Phek district and empties itself in the Chindwin River of Myanmar. The main tributaries of river Tizu are river Zungki, Lanye and Likimro.

The Zungki River, which is the biggest tributary of Tizu, starts from the northeastern part of Changdong forest in the south of Teku and flows in southerly direction towards Noklak, Shamator and Kiphire and finally joins Tizu below Kiphire. Its total length measures about 80km (from Chingmei/Noklak area to Tizu confluence area).

As per Nagaland Water Policy report (2016), the catchment area of Tizu Basin covers 4884 sq.km, and has water yield of 4463 MCM. The details of individual catchment of Tizu and Zungki rivers are presented in the below table from the length of river measurement point described.

Table 1.2 River and Catchment Area

S.No	Name of the River	Length (KM)	Catchment Area (KM^2)	Length Measurement Points
1	Zungki	80	2060	From Chingmei/ Noklak Area to Tizu Confluence Area
2	Tizu	203	2760	From Helipong area to Avakhung Area

Note: Length of river and catchment calculated in GIS environment
Source: Nagaland GIS and Remote Sensing Centre, Planning and Coordination Department, Government of Nagaland, Nagaland water policy 2016,India rivers week,2016

Gentle to moderate slopes are observed at the downstream of river at Avakhung. Steep slopes and valleys were observed along the length of the river which makes most of the river reach inaccessible.

Table 1.3 Salient Features of Rivers

Tizu River

Chainage (Km)		Deepest Channel (m)			Average width of water portion during survey Aug 2015	Average width of river	River Gradient m / Km
From	To	Min.	Max.	Avg.	(m)	(m)	
0	1	0.50	1.80	0.937	16 - 25	65 – 100	1.37
1	2	0.50	1.80	1.223	18 - 27	65 – 100	0.27
2	3	0.20	2.00	1.166	17 - 25	65 – 100	0.60
3	4	0.00	4.00	1.127	21- 28	65 – 100	0.47

Chainage (Km)		Deepest Channel (m)			Average width of water portion during survey Aug 2015	Average width of river	River Gradient m / Km
From	To	Min.	Max.	Avg.	(m)	(m)	
4	5	0.40	2.70	1.126	22 - 38	65 – 100	1.48
5	6	0.30	3.60	1.458	22 - 53	65 – 100	0.80
6	7	0.60	4.00	1.297	26 - 40	65 – 100	2.16
7	8	0.10	1.80	0.965	18 - 25	65 – 100	0.50
8	9	0.00	1.80	0.967	24 - 35	65 – 100	0.50
9	10	0.00	4.70	1.599	26 - 36	65 – 100	-1.43
10	11	0.30	3.80	1.196	32 - 38	60 – 100	3.83
11	12	0.20	3.80	1.255	27 - 48	60 – 100	-0.69
12	13	0.17	2.70	1.064	27 - 45	60 – 100	1.98
13	14	0.00	2.10	0.773	36 - 47	60 – 100	1.33
14	15	0.20	3.10	1.632	34 - 36	60 – 100	-0.48
15	16	0.10	2.20	0.876	29- 33	60 – 100	1.38
16	17	0.20	3.40	1.406	30 - 33	60 – 100	0.49
17	18	0.20	3.10	1.125	23 - 38	60 – 100	1.93
18	19	0.00	2.90	1.103	23 - 32	60 – 100	1.21
19	20	0.00	3.00	1.588	19 - 29	60 – 100	-0.15
20	21	0.20	3.10	1.652	16 - 25	65 – 90	1.34
21	22	0.00	6.10	1.558	13 - 17	65 – 90	1.05
22	23	0.10	6.10	2.376	16 - 24	65 – 90	2.61
23	24	0.00	2.80	1.166	18 - 34	65 – 90	0.93
24	25	0.20	5.20	1.976	14 - 24	65 – 90	0.86
25	26	0.20	4.90	1.559	15 - 24	65 – 100	0.67
26	27	0.00	4.10	1.375	18 - 32	65 – 100	2.29
27	28	0.00	4.60	1.400	18 - 25	65 – 100	-1.40
28	29	0.00	3.80	1.323	18 - 33	65 – 100	1.75
29	30	0.10	3.50	1.487	18- 21	65 – 100	1.93
30	31	0.10	2.70	1.290	16 - 27	65 – 100	0.88
31	32	0.30	3.20	1.484	14 - 19	65 – 100	0.94
32	33	0.20	4.20	2.324	14 - 31	65 – 100	1.16
33	34	0.40	4.90	3.355	22 - 27	65 – 100	-0.33
34	35	0.90	4.00	2.728	17 - 21	65 – 100	-0.86

Note:- The details of table with every 50m interval is attached in Annexure-III Pg.34 of volume-III

Zungki River

Chainage (Km)		Deepest Channel			Average width of water portion	Average width of water portion during survey Aug 2015	River Gradient m / Km
From	To	Min.	(m)	Avg.	(m)	(m)	
0	1	1.2	5	3.325	14 - 20	60 – 100	0.933
1	2	1.3	5.7	3.783	16 - 22	60 – 100	0.725
2	3	2	7.3	4.260	15 - 21	60 – 100	0.45
3	4	2.9	8.6	5.194	14 - 23	60 – 100	0.142
4	4.65	3.3	7.9	5.803	16 - 36	60 – 100	0.208

Note:- The details of table with every 50m interval is attached in Annexure-III Pg.53 of volume-III
Negative values of the slope indicates the reverse slope.

Source: Analysis done by hydrographic survey report

1.10 Topography and Geology of the State

The topography of the state is very rugged and is full of hill ranges and deep gorges with steep terrains which break into a wide chaos of spurs and ridges. The topography and landscape can be grouped into three groups viz.

i) Foot hills with undulating to rolling topography having warm sub-tropical climate

ii) The lower ranges and the mid slopes with varying degrees of slopes having submountain climate

iii) High hills and mountainous regions having cold climate. The altitude of the state varies from 194 m to 3048 m. The highest peak “Saramati” is an elevation of 3340 m and lies on Borali hill ranges in Tuensang district. Most of the thousand and odd villages stand at 1 to 2000 meter high as it is very typical of the Nagas to build their houses on the hill top and at higher elevations. The general topography of the study area is shown in fig.1.5 to 1.7

1.11 Location of `the Project

The project is located in Phek and kiphire district of Nagaland from Longmatra to Avakhung. The human settlements in the project area are scattered. There are no monuments of archaeological or national importance, which would be affected by project activities directly or indirectly.

Access to Project

The terminal 1 at Longmatra site is approachable from nearest airport and rail head at Dimapur (407 km) via Kohima (337 km), Kiphire (78 km). The road to Avakhung is jeepable track. The time taken from kohima and dimapur to reach the site is shown below in images.

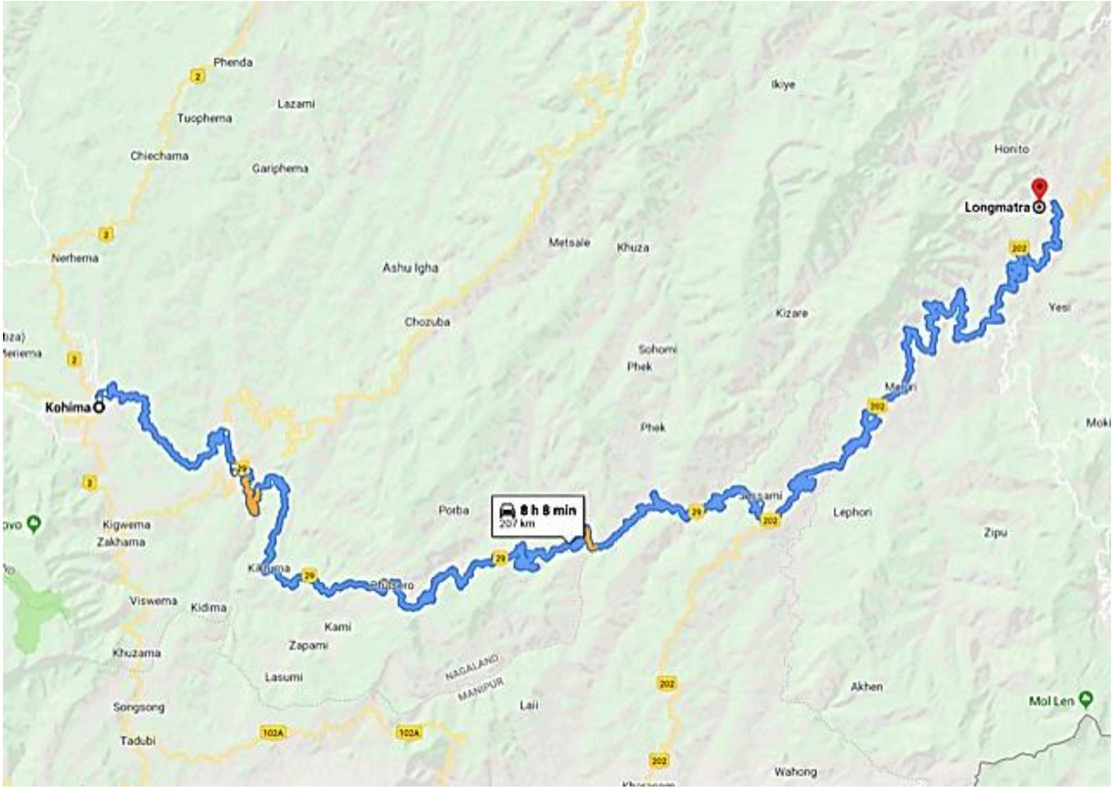


Fig. 1.5 Kohima to longmatra 207km time required 8hrs

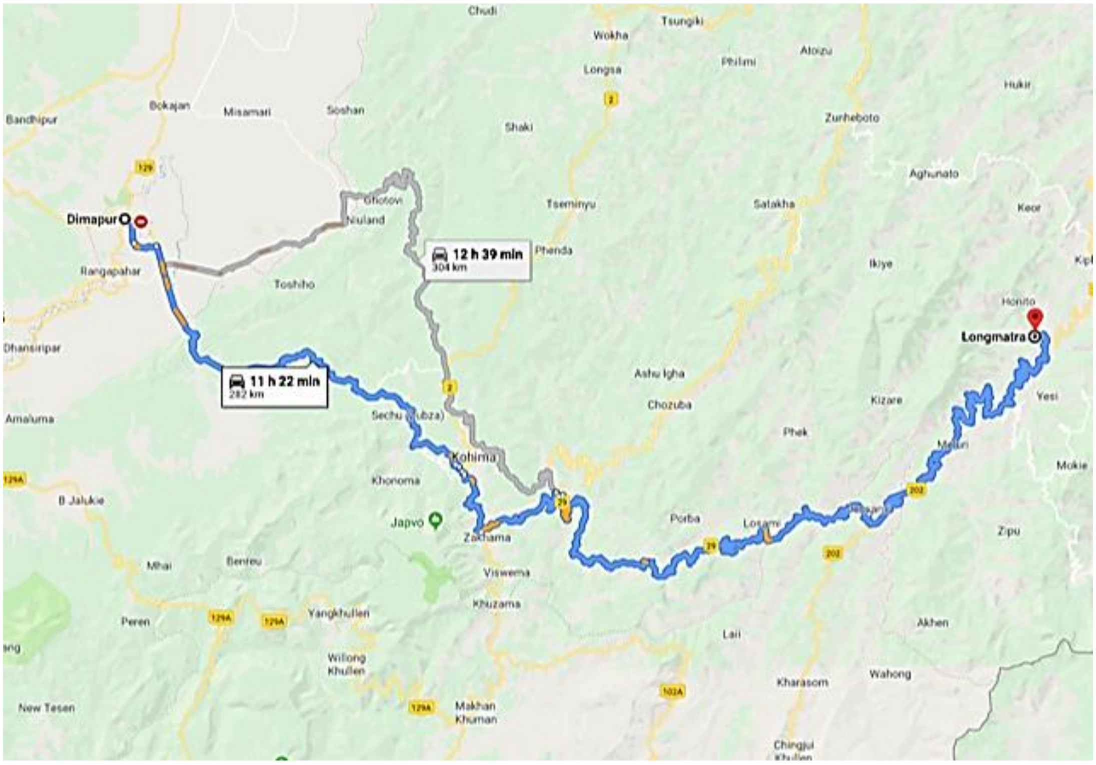


Fig. 1.6 Dimapur to longmatra 282 km time required 12hrs

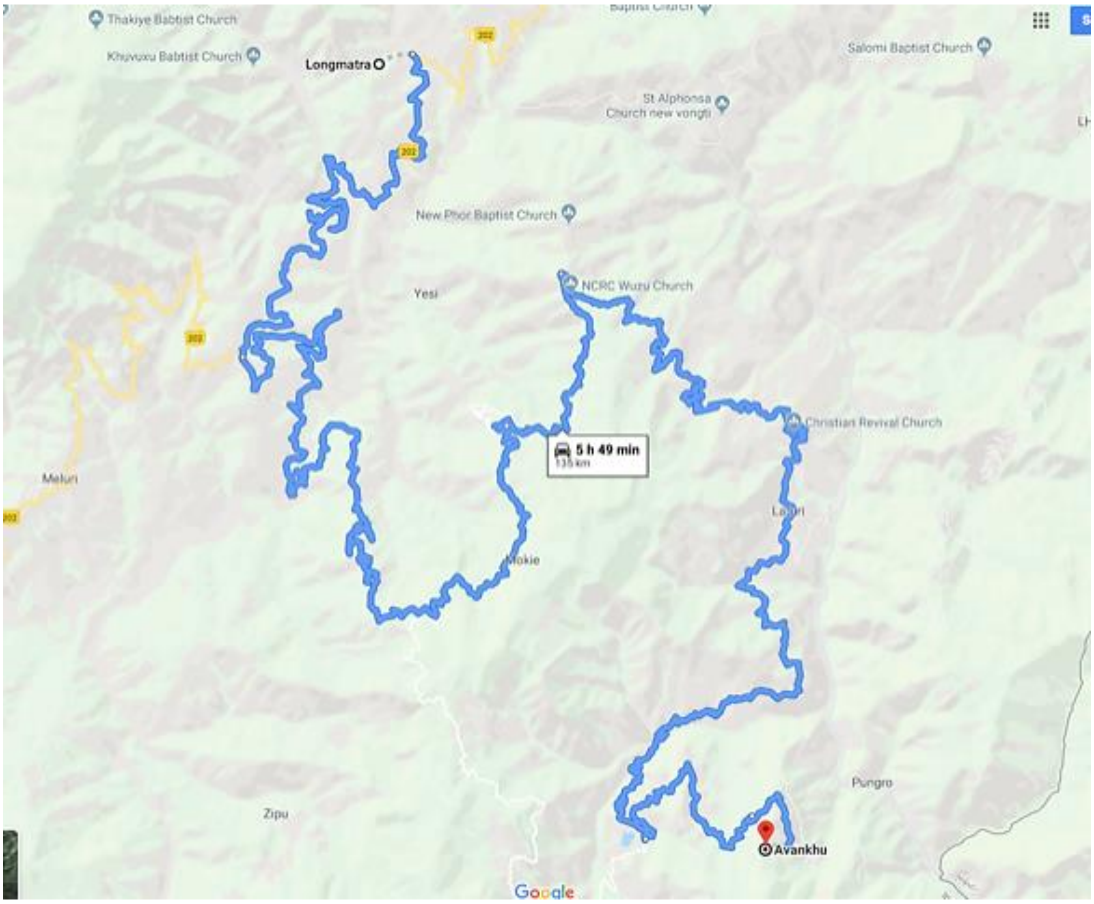


Fig. 1.7 Longmatra to Avakhung 135km time required 6hrs

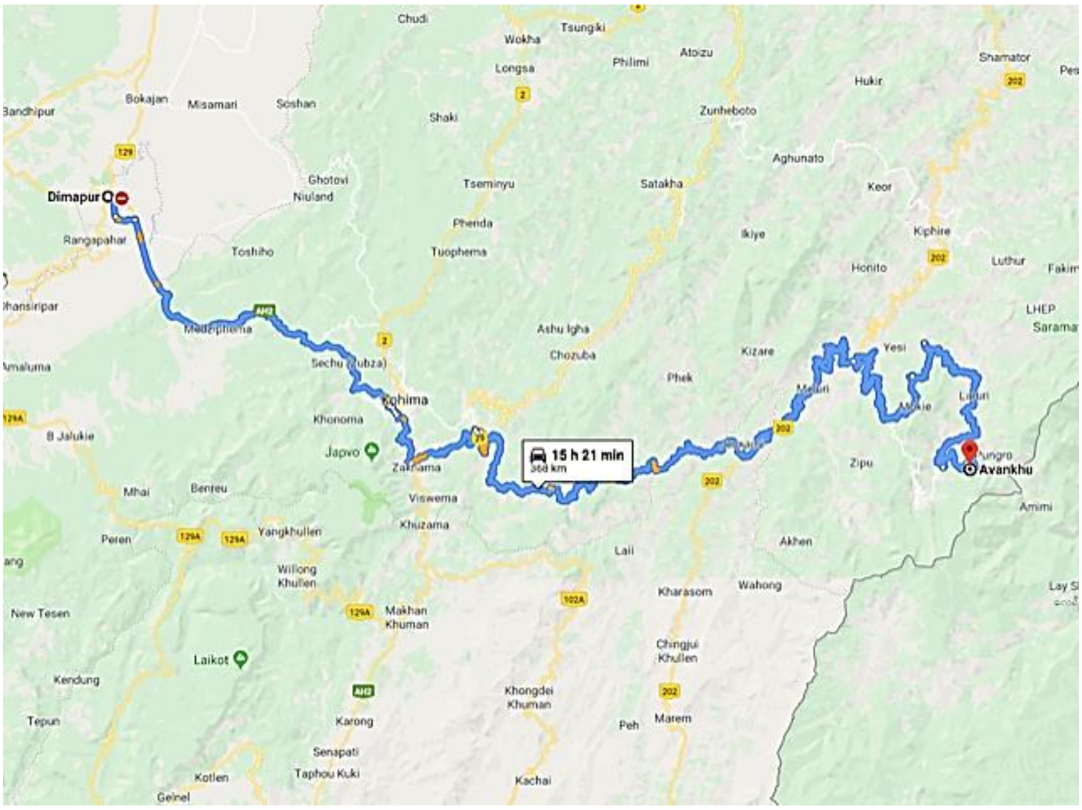


Fig. 1.8 Dimapur to Avankhung 368km time required 16hrs

1.12 General Climatic Conditions in the Project Area

The altitude varies from 194 m to 3048 m. The average annual rainfall varies from 2000 mm to 2700 mm. The area experiences heavy precipitation during the monsoon months between May-October. The climate is cool during winter and occurrence of frost over large tracts is observed in the high hill ranges. The climate over the foot hill is warm and sub-tropical. Temperature varies from 5 °C to 25 °C on the hills and from 12° C to 32° C on the foot hills.

1.13 Seismicity & Land Required for the Project

The major tectonic domain in the area is the Tertiary fold-thrust belt of the Indo-Burma Arc (Plate.2). The Burmese Arc is considered highly seismic which is mostly related to Indo-Burmese convergent margin tectonics. About 200 earthquake episodes of magnitude >4.5M are plotted of which 95% plot are located in areas east of the Belt of Schuppen. The 6.6 magnitude earthquake of 1988 in the Burmese Arc cost considerable damage in India and Myanmar. The damage incidents due to this earthquake were evidenced in the form of house collapses or houses rendered unsafe for dwelling, and development of ground fissures causing the disruption of train and road services. The maximum intensity of the shock was experienced in Silchar, Jorhat and Diphu in Assam, and Tuli in Nagaland.

The project area falls between Iso-seismals VIII and IX of the devastating Assam Earthquake of 15 August 1950 (Fig.1). This M8 earthquake caused widespread devastation throughout Upper Assam, Mishmi and Abhor Hills. Several tributaries of the Brahmaputra River were blocked by landslips. Railway communication was disrupted because of damage to tracks and bridges. The worst affected areas were Dibrugarh and Saikhoaghat.

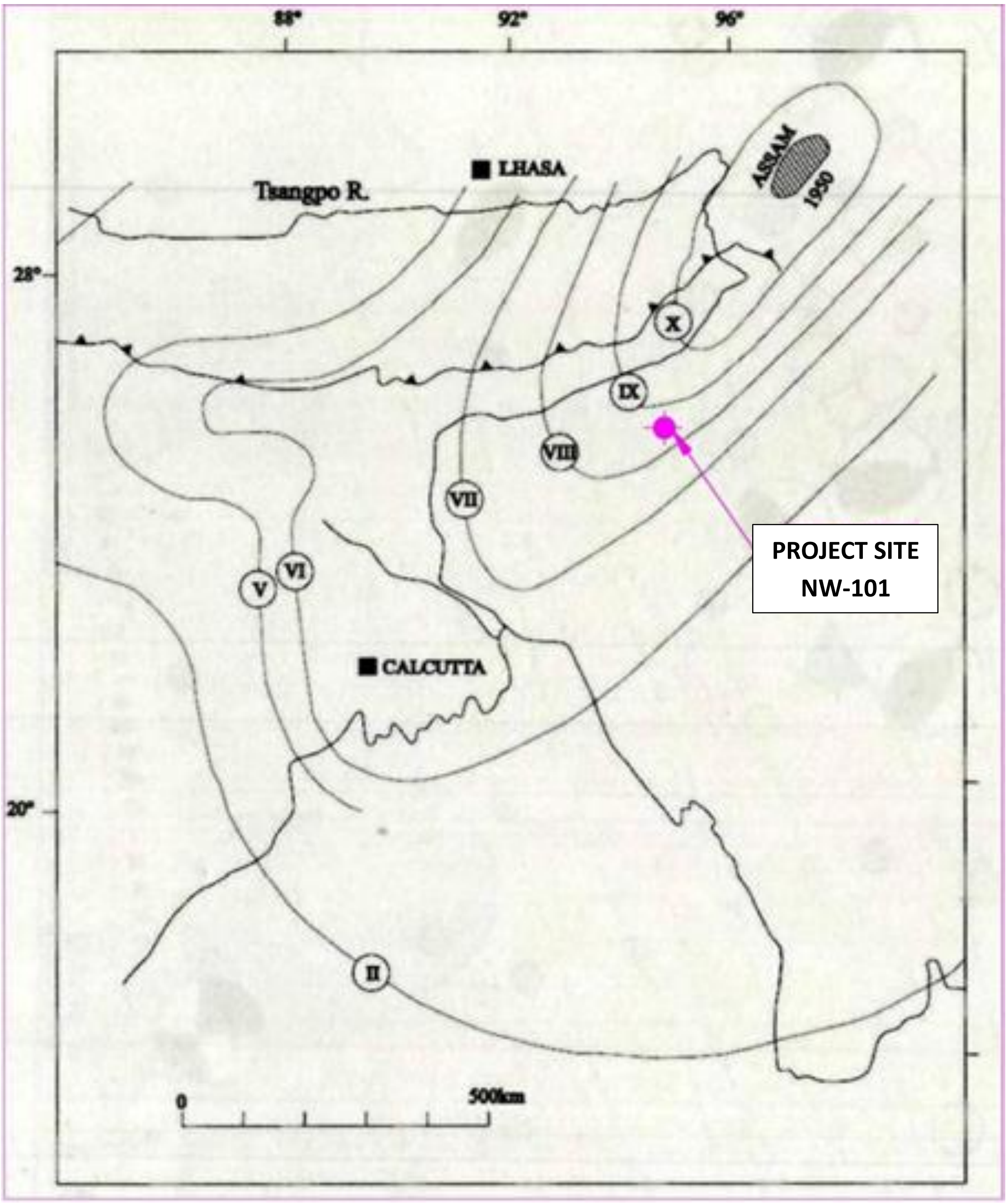


Fig. 1.9 Isoseismal map of Assam Earthquake of 15 August 1950

The project area lies immediately east of the Eastern Boundary Thrust Zone and is located about 75 km east of the Disang Thrust. As per the Seismic Zoning Map of India, the project is located in Zone-V (Fig.1.10).

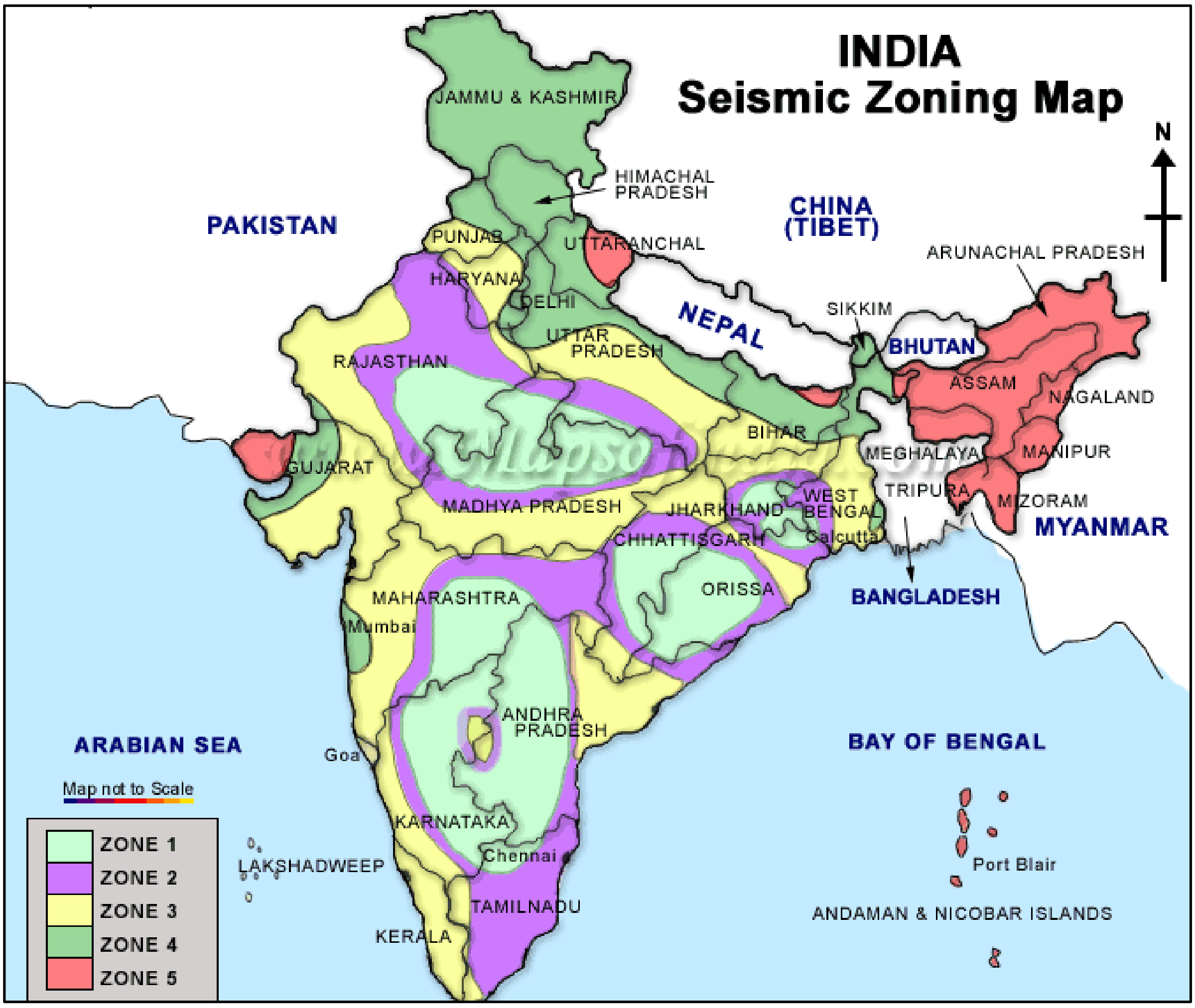


Fig. 1.10 Seismic Zone Map of India

It is to be noted complete Nagaland state falls in Zone V.

Land requirement for each Terminal

0.5 acre of land is required for each terminals hence total of 0.5x 4(terminals) = 2 acres of land will be required for five terminals.

1.14 Natural Resources

Nagaland is rich in mineral resources. Explorations carried by the state Geology & Mining Department, Geological Survey of India, ONGC Ltd., Atomic Minerals Division and Central Ground Water Board have established the following mineral reserves which can be exploited for commercially purposes:

- Petroleum & Natural Gas
- High grade limestone
- Marble and dimensional/decorative stones
- Coal
- Nickel-Cobalt-Chromium bearing ore

1.15 Environmental Aspects

The forest cover in the State of Nagaland is more than 41 % out of which dense forest constitute about 25 % and the remaining area (16%) is covered by open forests. Shifting cultivation has severely degraded the forest cover and forests mainly secondary in nature. Therefore, degraded forest/ scrub account for more than 27 % of the area whereas as under jhum cultivation is more than 20%   River and flood plains also constitute a sizable percent of this area (2%).

1.16 Population affected by the project

The human settlements in the project area are scattered and habituated on hills much above the submergence area. There are no monuments of archaeological or national importance which would be affected by project activities directly or indirectly. However the construction of Dam and barrages at the proposed location submergence need to be studied.

1.17 Reconnaissance Survey & Investigations

Physical Reconnaissance survey of the entire stretch of river under study from Longmatra to Avakhung and information on the waterway characteristics was collected. Fresh information were gathered and presented in comparison with the available data through earlier hydrographic survey of IWAI duly presenting any major changes observed during the intervening period.

Physical Survey were conducted to verify the vertical and horizontal clearance of all man-made structures on the river system (barrages, locks, bridges, HT / LT lines, underwater pipes, power cables, river re – direction or river resistive or bank – protection works) and suggestions for improvements required thereon for smooth round the year and round the clock uninterrupted navigation by design size of inland vessels was analyzed.

WAPCOS has carried out the Reconnaissance Survey by mobilizing its team of expert, who has visited the site from 10th March 2019 to 16th March 2019. The team held a meeting with various officials of Govt. of Nagaland, Member of Parliament, and Local Stake holder, regarding the scope, work plan to carry out the studies and opportunities for socio economic growth of the region, via development of NW-101.WAPCOS has also visited the site during from 13th to 18th May 2019 for further studies at the site. The multiple visit to government offices and meeting with local villagers were also conducted for the project utility.

The experts visited several State Government agencies/ department for data collection. After data collection the team visited the site for physical survey. The team visited the terminal locations proposed during Feasibility Studies i.e. Longmatra, Laruri and Avakhung.

Stakeholder Meeting was held at the Conference Hall of Chief Secretary Nagaland at Kohima on 25th November 2019.The details of the meeting is attached in the volume -III annexure-X Pg.183.

Site visit of was also done by IWAI team and consultant during 26th to 29th Nov 2019

1.18 Data Collection

Following data shown at Table 1.4 were collected during the Reconnaissance survey :

Table 1.4 Data Collected during Reconnaissance Survey

S.No.	Data Collected	Source
1	Flood Data/ Rainfall Data	Water Resource Department, Govt. of Nagaland, WAPCOS team held discussions with Chief Engineer, WRD, Public Literature
2	Agricultural Data	Agriculture Department, Govt. of Nagaland, WAPCOS team held discussions with Additional Director, Agriculture Dept., Public Literature
3	Forest and Environment Data	Department of Environment, Forest and Climate Change, Govt. of Nagaland, WAPCOS team held discussions with Member Secretary, Forest Dept., Public Literature
4	Development of Proposed Hydropower projects in the Tizu river	Power Department, Govt. of Nagaland, WAPCOS team held discussions with Chief Engineer, Power Department
5	Mineral Resources Data	Nagaland State Mineral Development Corporation Ltd (NSMDC), Govt. of Nagaland, WAPCOS team held discussions with Director, NSMDC, Public Literature
6	Discharge Data	Power Department, Govt. of Nagaland, WAPCOS team held discussions with Chief Engineer, Power Dept., Public Literature
7	Data pertaining to demographic particulars and local developments in study area	Department of Economic & Statistics, Govt. of Nagaland, WAPCOS team held discussions with officials from Govt. of Nagaland, Member of Parliament etc.., Public Literature
8	Industrial Growth in Phek & Kiphire District	Department of Industries & Commerce, Govt. of Nagaland, WAPCOS team held discussions with Additional Director, Industries Department, Public Literature
9	Goods Traffic flows by various	Department of Economic & Statistics,

S.No.	Data Collected	Source
	transportation modes such as rail, road and IWT	Transport Department, Govt. of Nagaland, WAPCOS team held discussions with officials from Department, Public Literature, Inquiry with local people
10	Fisheries Data	Department of Fisheries & Aquatic Resource, Govt. of Nagaland, WAPCOS team held discussions with Additional Director, Fisheries Department, Public Literature
11	Soil & Land Use Data	Department of Soil & Water Conservation, GIS & Remote Sensing Department, Govt. of Nagaland, WAPCOS team held discussions with Additional Director, Public Literature
12	Soil and water Sample	Soil and water samples collected from the site for lab studies.
13	Food grain supply data in Nagaland	Food corporation of India, Dimapur

1.19 OBSERVATIONS

As a part of studies, data was provided to WAPCOS from IWAI (Hydrographic and Feasibility report). Thereafter, WAPCOS has done desk studies for NW-101 & detailed analysis of the same is discussed in the DPR.

*****

CHAPTER – 2
WATERWAY/DETAILED HYDROGRAPHIC SURVEY

2.0 Hydrographic Survey

This chapter is exclusively based on the survey report provided by IWAI. The Primary Survey was conducted by IWAI during 2015. Stretch of about 40.039 km from Longmatra to Avakhung. The survey was commenced on 25th April and completed on 30th April 2015 by "Precision Survey Consultancy". The survey was undertaken on a scale of 1:1000, with sounding line spacing kept at 50 m and plotted on UTM Projection (Zone 46) as specified in the contract specifications. All the data, figures, tables etc. are based on the final Report submitted by Precision Survey Consultancy to M/s IWAI.

The purpose of detailed hydrographic survey was to determine the hydraulic features and existing conditions of the Tizu River and Zungki from **Longmatra** to ***Avankhung 40.039 km stretch***.

2.1 Waterway in General and Hydro-morphological Characteristics

Stretch of River under study is **40.039** km length of the river from **Longmatra** to ***Avakhung*** at Myanmar border and in Zungki river from bridge to confluence of Zungki and Tizu rivers

Table 2.1 River Tizu and Zungki Coordinate

River	From (Lat/Long)	To (Lat/Long)
Tizu-(0-35.410 KM)	*Longmatra* Lat 25°46'12"N, Lon 94°44'35"E	*Avankhung* Lat 25°35'03"N, Lon 94°53'06"E
Zungki- (0-4.629 KM)	*Zungki river bridge* Lat 25°48'26"N, Lon 94°46'36"E	*Confluence of Tizu & Zungki* Lat 25°46'58"N, Lon 94°45'21"E

Source: THE NATIONAL WATERWAYS ACT, 25 Mar 2016 Gazette Notification

Tizu River forms an important drainage system in the eastern part of Nagaland. It runs through a northeast direction flows through Zunheboto, Phek district and empties itself in the Chindwin River of Myanmar.

The River Tizu originated in the hills of Nagaland and flows across major section of the state and finally enters Myanmar near International Boundary Pillar (IBP) No. 133 at Avankhu Village and falls into Chindwin River of Myanmar. The Tizu River forms an important drainage system in the eastern part of the state with a total length of 203km (from Helipong rear to Avankhu area). It originates from the central part of the state and runs through northeast direction flowing through Zunheboto, Phek district and empties itself in the Chindwin River of Myanmar. The main tributaries of river Tizu are river Zungki, Lanye and Likimro.

The Tizu river of Nagaland flows into Myanmar, It originates near Longkhim (2253m) Tuensang district, and flows for about 115 km and joins Lanyie – Thetsiru River. It flows for another 35 km north-Easterly up to Longmatra Tizu River and joins Chindwin River near Myingan Town in Myanmar. The river Tizu after crossing Nagaland border in India enters into Myanmar, where it joins the Chindwin – Airwady river system. The river serves as international waterway since the waterway link in Myanmar has lot of IWT potential. The catchment area of river Tizu is of about 4884 sq. km and falls within Kiphire, Phek and Zunheboto districts of Nagaland and Ukhrul district of Manipur. It is the second largest and longest rivers of Nagaland roughly covers one – third area of the state and is located within the innermost high mountain range bordering Myanmar.

2.2 Catchment Area of the river

The Zungki River, which is the biggest tributary of Tizu, starts from the northeastern part of Changdong forest in the south of Teku and flows in southerly direction towards Noklak, Shamator and Kiphire and finally joins Tizu below Kiphire. Its total length measures about 80km (from Chingmei/Noklak area to Tizu confluence area).

Fig. 2.1 Detailed View of the confluence of Tizu and Zungki Rivers

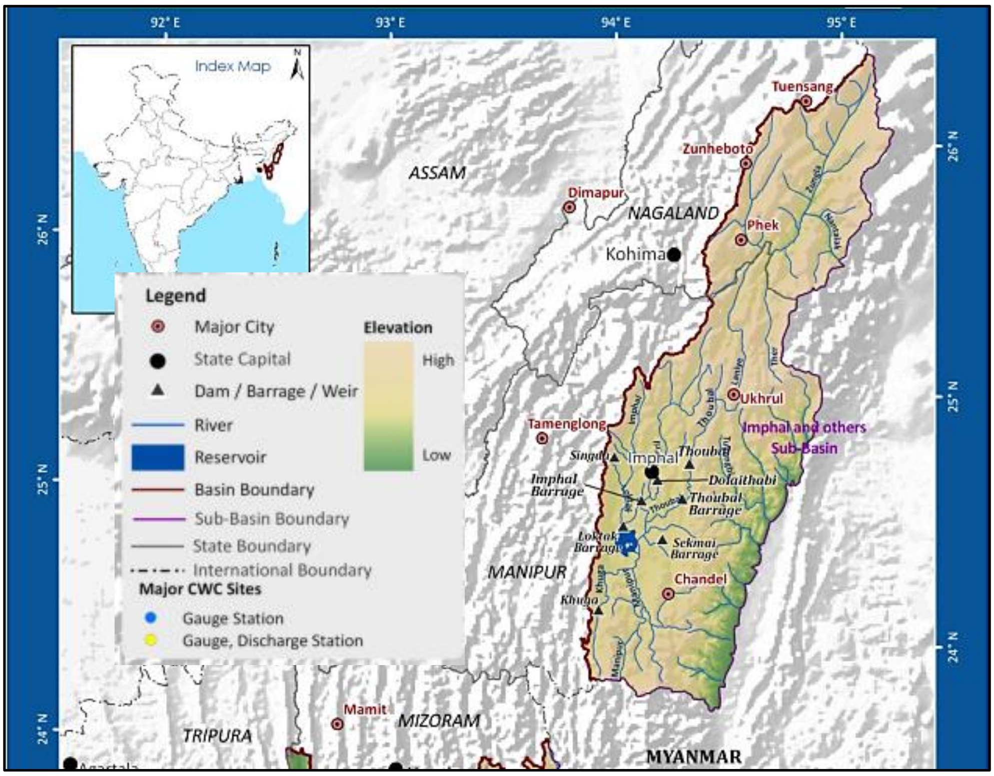


Fig. 2.2 Catchment of Rivers and major tributaries

The Tizu River forms an important watershed system in the eastern part of Nagaland and finally leaves Nagaland and drain itself into the Chindwin River in Myanmar. Rivers of the Chindwin Watershed in Nagaland include Tizu, Zungki, Likimro and Hanye. Fig. 2.2 showing Catchment of River and major tributaries

The hydrographic survey was commenced on 25th April and completed on 30th April 2015 by precision survey. The survey was undertaken on a scale of 1:1000, with sounding line spacing kept at 50 m and plotted on UTM Projection (Zone 46) as specified in the contract specifications.

2.3 Weather

The weather was conducive for most of the survey period. It was very pleasant as the winter was about to end and temperature was increasing day by day. However the topography and Hydrographic survey work was not hampered due to the prevailing weather conditions. Due to severe stones accumulating underneath along the river stretch which adversely affected the progress of boat sounding. At some locations, the boats had to be physically controlled& moved toward the deeper area for containing the survey work.

2.4 Bathymetric

The detailed bathymetric survey is to be carried out by using Automated Hydrographic Survey System (using digital Echo sounder for depth measurement, DRTK Beacons Receivers for position fixing and Hypackmax or equivalent software for data logging). The survey is to be conducted in WGS’84 datum.

The horizontal control is to be made from either one of the following methods:-

- Transfer of positions from GTS Bench Marks or position established at permanent BM etc.
- Using RTK with minimum 24 hours observations at some permanent platform/base.
- DRTK receiving direct Satellite corrections.
- IWAI, Guwahati / State Government of Nagaland will arrange to provide the Bench marks details if any available.

2.4.1 Horizontal Control

The survey boat used for the survey operations throughout the project was positioned by the Differential Global Positioning System (DGPS). DGPS Reference stations was established at Longmatra Guest House (front gate stair). The Trimble DGPS Receiver was used for receiving the correction from DGPS reference stations. The position correction details were received from the high precision RTK DGPS and position data were found to be in differential mode, during the entire survey period.For topographic survey, horizontal control was carried out from the Bench marks no. TMB -1. The BM position of Longmatra was established by using the DGPS receiver in different mode. The value of the B.M at Longmatra is:-

Latitude(N)	25° 47' 03.08"
Longitude:(E)	94° 44' 48.44"
Elevation:(m)	796.546

2.4.2 Vertical Control

Vertical control from TMB -1 is used for the entire survey work; its value is 796.546 m w.r.t. MSL has been considered for calculating the vertical levels. Water level at every 500 m interval was collected during the survey period. Total 6 nos. of BM was established along the

35 Km. stretch of the Tizu River with the reference of TBM-1, which was fixed at Longmatra Guest House.

The details of Bench Marks established along the river TIZU with elevation are mentioned below:

Table 2.2 TBM benchmark coordinates & level

Sr. No.	Point	Easting(m)	Northing(m)	Elevation(m)	Location
1	TBM.-1	675149.813	2852945.955	796.546	Longmatra Guest House
2	TBM.-2	675135.868	2852946.881	795.195	Longmatra Guest House
3	TBM.-3	686048.613	2842210.669	431.154	Laruri Bridge
4	TBM.-4	689881.357	2830379.114	361.557	End of site Avankhu, top of hard rock
5	TBM.-5	689855.618	2830396.360	359.158	End of site Avankhu, top of hard rock
6	TBM.-6	688371.180	2829898.218	1232.082	Avankhu Village road side

The description of all temporary bench marks stations is placed at Annexure – III at Para 2.1 Pg.19 of Volume –III .TBM Benchmarks Levels are w.r.t. MSL.

All Bench mark potion in Google map view is shown in fig 2.2 to 2.5 below

Fig. 2.3 location of TBM 1 & 2 in google map view

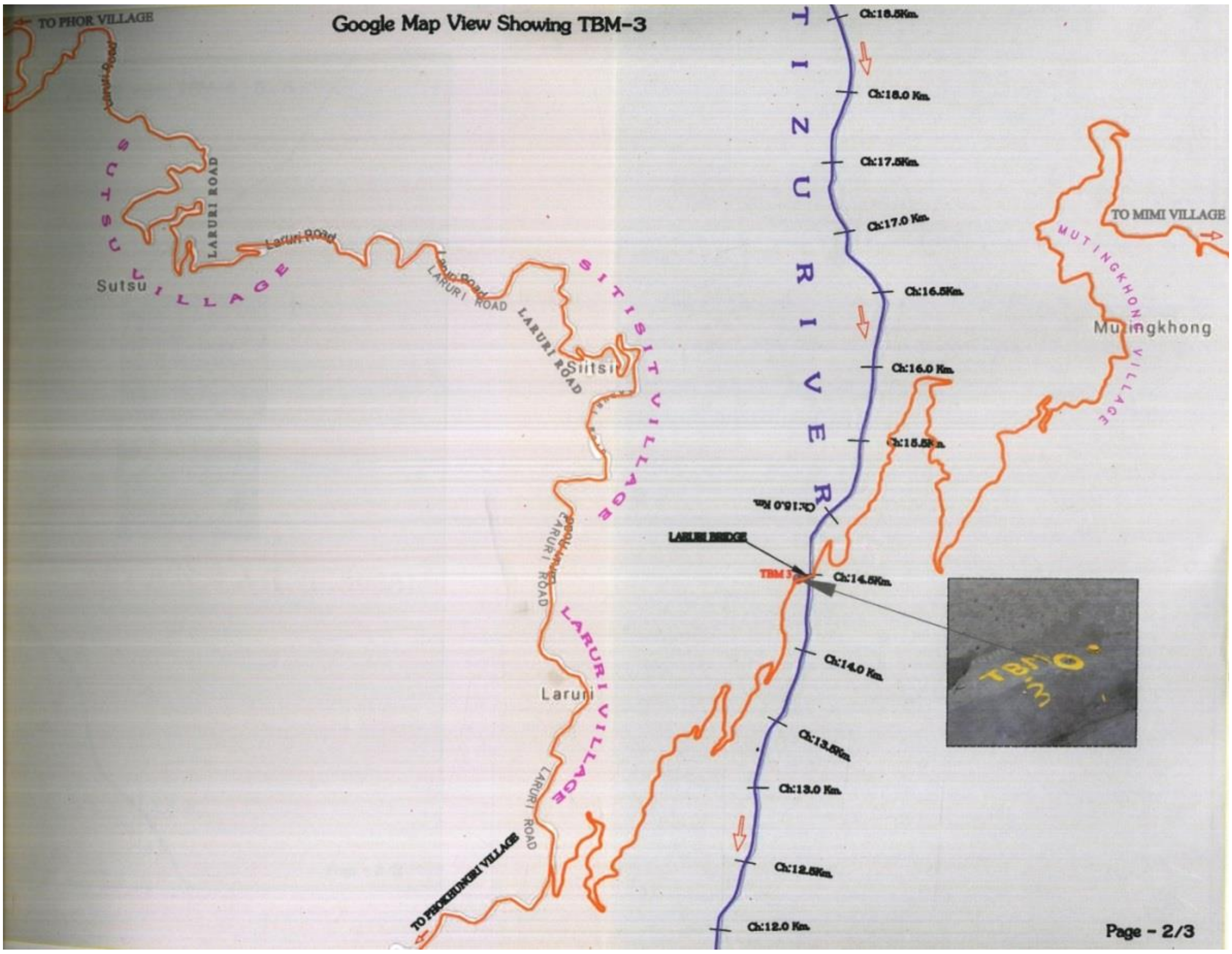


Fig. 2.4 Location of TBM 3 in google map view

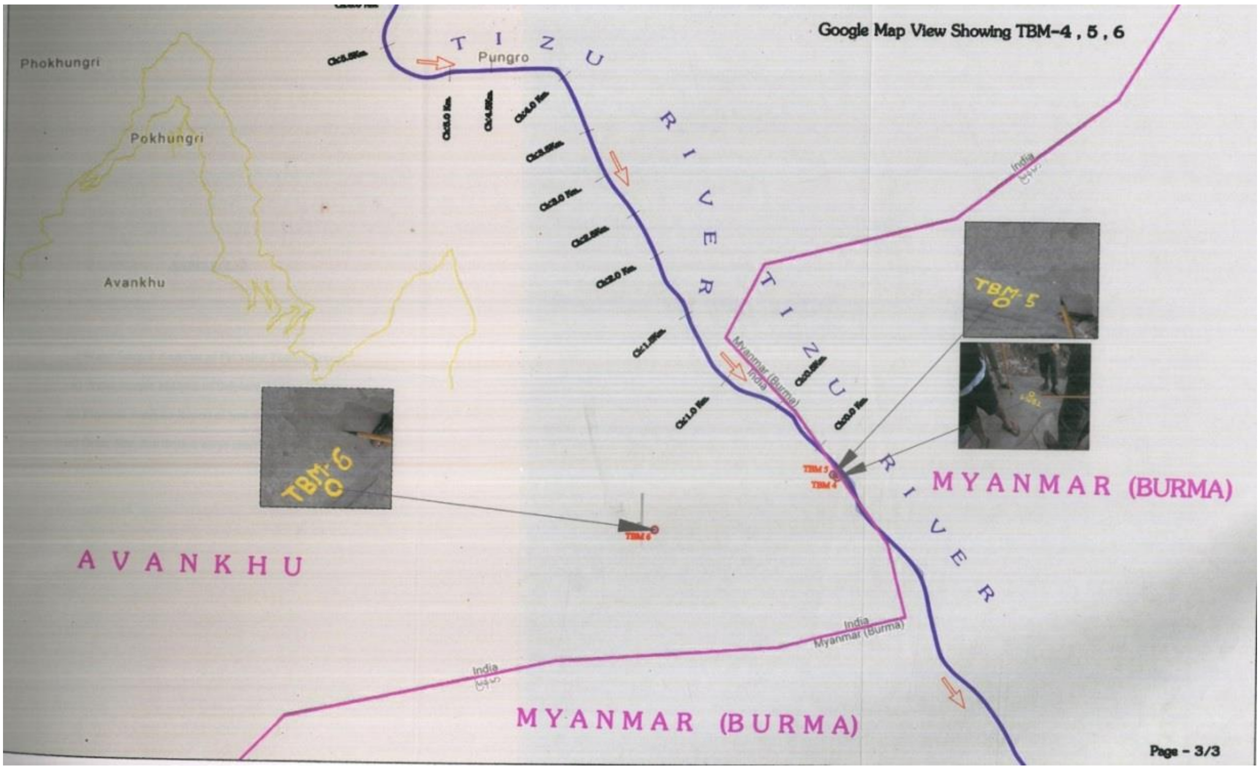


Fig. 2.5 Location of TBM 5 & 6 in google map view

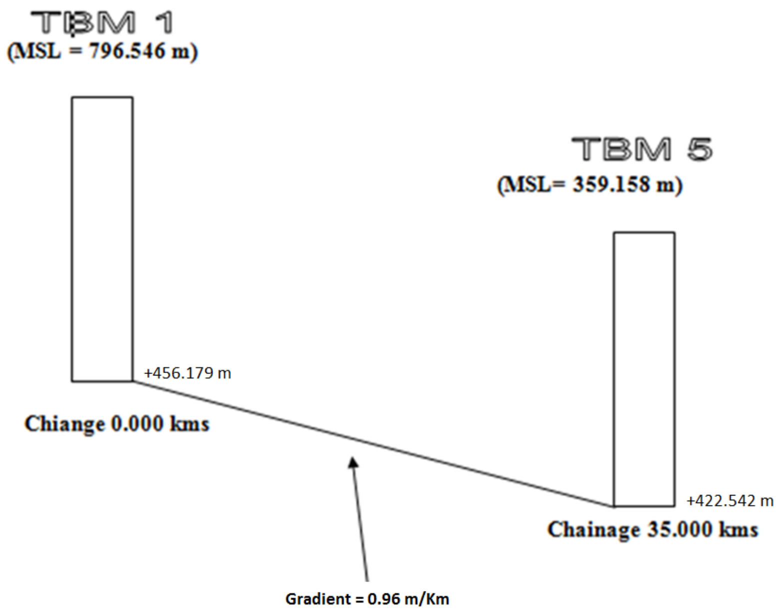
Sounding Datum/Reduction factor

For establishing sounding datum, Longmatra Guest House TBM -1 value was used for calculating the sounding data for the entire stretch of river TIZU.

Establishment of chart datum/sounding datum

a) Vertical control was started from **Longmatra Guest House Stair TBM -1** situated at Chainage 0.000 kms, TBM level 796.546m + w.r.t. MSL.

Low water line observed during the survey period has been considered as sounding datum (SD) and details are placed at Annexure III at Para– 2.5



2.4.3 Average Bed Slope

The slope in meter per km of stretch has been calculated and shown in Table 2.5. Steep slopes and valleys were observed along the length of the river which makes most of the river accessibility very difficult. Fig. 2.3 shows the general topography of the area. The Bed Slope of River Stretch i.e. chainage v/s fall in m/km is shown in fig. 2.4 and fig.2.5

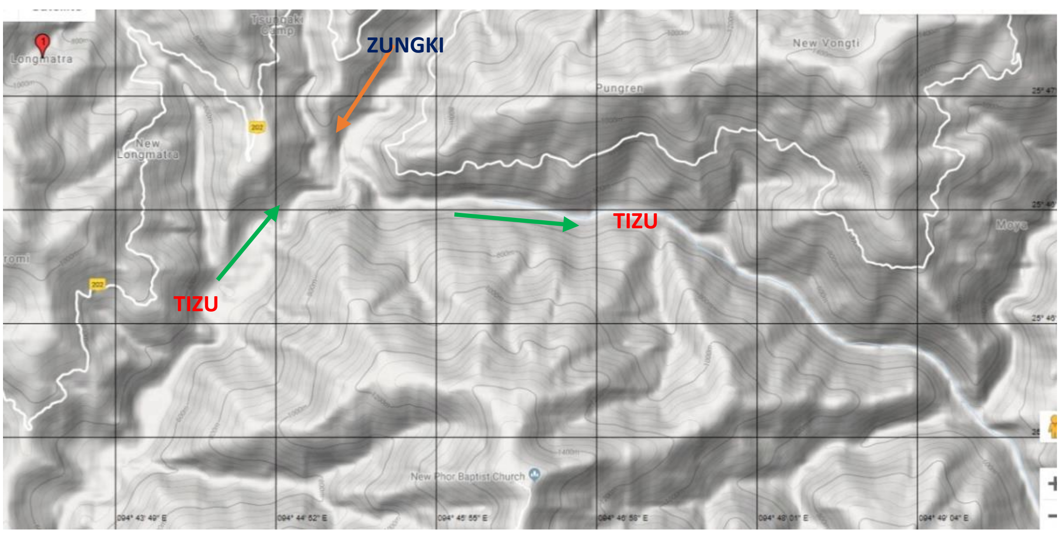


Fig. 2.6 Topography of Tizu and Zungki Rivers

Table 2.3 Average Bed Slope of Tizu and Zungki Rivers

Tizu River

Chainage (Km)		Deepest Channel (m)			Average width of water portion during survey Aug 2015	Average width of river	River Gradient m / Km
From	To	Min.	Max.	Avg.	(m)	(m)	
0	1	0.50	1.80	0.937	16 - 25	65 – 100	1.37
1	2	0.50	1.80	1.223	18 - 27	65 – 100	0.27
2	3	0.20	2.00	1.166	17 - 25	65 – 100	0.60
3	4	0.00	4.00	1.127	21- 28	65 – 100	0.47
4	5	0.40	2.70	1.126	22 - 38	65 – 100	1.48
5	6	0.30	3.60	1.458	22 - 53	65 – 100	0.80
6	7	0.60	4.00	1.297	26 - 40	65 – 100	2.16
7	8	0.10	1.80	0.965	18 - 25	65 – 100	0.50
8	9	0.00	1.80	0.967	24 - 35	65 – 100	0.50
9	10	0.00	4.70	1.599	26 - 36	65 – 100	-1.43
10	11	0.30	3.80	1.196	32 - 38	60 – 100	3.83
11	12	0.20	3.80	1.255	27 - 48	60 – 100	-0.69
12	13	0.17	2.70	1.064	27 - 45	60 – 100	1.98
13	14	0.00	2.10	0.773	36 - 47	60 – 100	1.33
14	15	0.20	3.10	1.632	34 - 36	60 – 100	-0.48
15	16	0.10	2.20	0.876	29- 33	60 – 100	1.38
16	17	0.20	3.40	1.406	30 - 33	60 – 100	0.49
17	18	0.20	3.10	1.125	23 - 38	60 – 100	1.93
18	19	0.00	2.90	1.103	23 - 32	60 – 100	1.21
19	20	0.00	3.00	1.588	19 - 29	60 – 100	-0.15
20	21	0.20	3.10	1.652	16 - 25	65 – 90	1.34
21	22	0.00	6.10	1.558	13 - 17	65 – 90	1.05
22	23	0.10	6.10	2.376	16 - 24	65 – 90	2.61
23	24	0.00	2.80	1.166	18 - 34	65 – 90	0.93
24	25	0.20	5.20	1.976	14 - 24	65 – 90	0.86
25	26	0.20	4.90	1.559	15 - 24	65 – 100	0.67
26	27	0.00	4.10	1.375	18 - 32	65 – 100	2.29
27	28	0.00	4.60	1.400	18 - 25	65 – 100	-1.40
28	29	0.00	3.80	1.323	18 - 33	65 – 100	1.75
29	30	0.10	3.50	1.487	18- 21	65 – 100	1.93
30	31	0.10	2.70	1.290	16 - 27	65 – 100	0.88
31	32	0.30	3.20	1.484	14 - 19	65 – 100	0.94
32	33	0.20	4.20	2.324	14 - 31	65 – 100	1.16
33	34	0.40	4.90	3.355	22 - 27	65 – 100	-0.33
34	35	0.90	4.00	2.728	17 - 21	65 – 100	-0.86

Note:- The details of table with every 50m interval is attached in Annexure-III Pg.34 of volume-III

Zungki River

Chainage (Km)		Deepest Channel in m			Average width of water portion	Average width of water portion during survey Aug 2015	River Gradient m / Km
From	To	Min.	Max.	Avg.	(m)	(m)	
0	1	1.2	5	3.325	14 - 20	60 – 100	0.933
1	2	1.3	5.7	3.783	16 - 22	60 – 100	0.725
2	3	2	7.3	4.260	15 - 21	60 – 100	0.45
3	4	2.9	8.6	5.194	14 - 23	60 – 100	0.142
4	4.65	3.3	7.9	5.803	16 - 36	60 – 100	0.208

Note:- The details of table with every 50m interval is attached in Annexure-III Pg.53 of volume-III
Negative values of the slope indicates the reverse slope.

Table 2.5 it can be seen that the average slope of river bed in meter/Km for Tizu river from chainage 0-10km is 0.94m/km or 0.0009, similarly for chainage 10-20km is 1.69m/km or 0.00169 and from chainage 20-34km is 1.37m/km or 0.00137.

For Zungki river is Ch 0-4.65 km is 0.491 m/km or 0.00049.

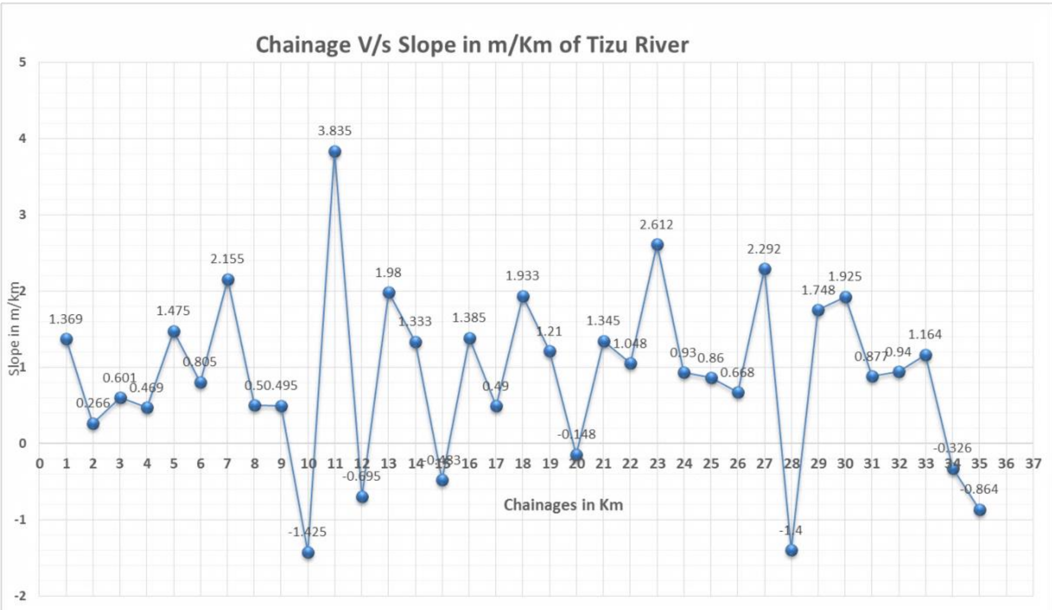


Fig. 2.7 Average Bed Slope of River Tizu Stretch

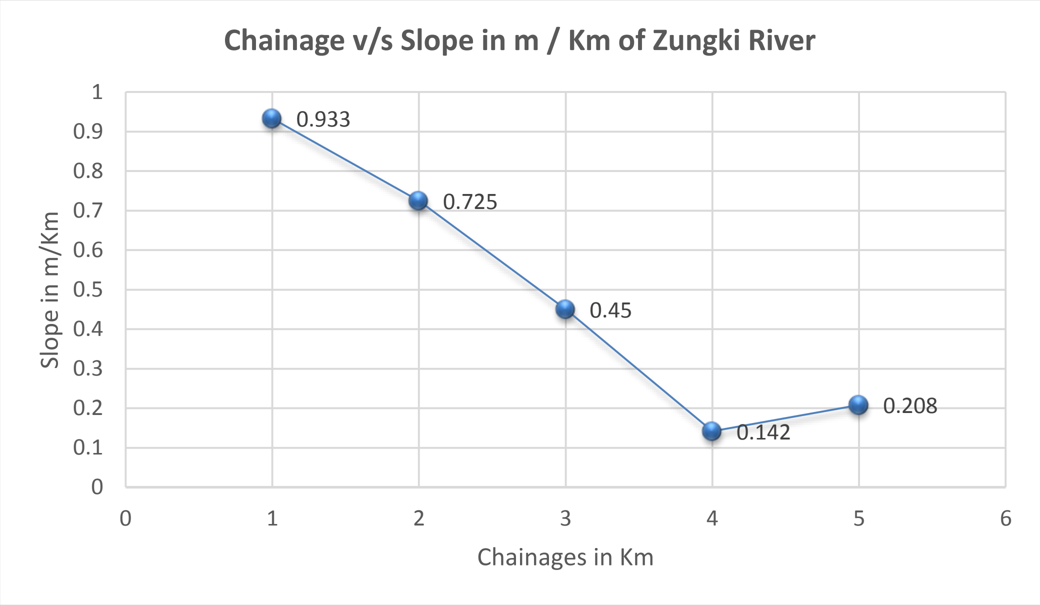


Fig. 2.8 Average Bed Slope of River Zungki Stretch

2.5 Equipment

2.5.1 Vessels

The bathymetric survey was conducted using a small inflatable boat for collecting bathymetry data at every 50 m. cross section interval along the river stretch during the entire survey work.

Fig. 2.9 Bathymetry Survey at Site

2.5.2 Survey equipment

Following survey equipments were deployed for the bathymetric and topographic survey:-

Table 2.4 Equipment used

Sl.No.	Equipment	Make	Eqpt. Serial No.	Qty Employed
1	Echo sounder	Sonarmite, Ohmex, UK	20114	1
2	Direct-Reading EM Current Meter	JFE Advantech Co. Ltd., Japan	AEM 213-D	1
3	Water Sampler	-	-	1
4	Grab Sampler	Vanveen	-	1
5	Inflatable Boat with 4 stoke Yahama engine	-	-	1
6	RTK	Trimble SPS855	5340K46115 5431R03128	2
7	RTK Sets	Trimble SPS361 (Beacon Activated)	5308K59587	1
8	Software	Hydaspro i	Version 12	1
9	Software	AUTOCAD Civil 3D	2013	1
10	Software	Hypack	Version 14	1
11	Software	Microsoft Office	2013	1

2.5.3 Calibration

The equipment's used for the survey work were calibrated by the equipment supplier. The equipment calibration certificates are placed at (Annexure – 2.4) to this report. In addition day to day calibration during the survey work was performed on the survey equipment and found to be satisfactory.

2.6 Survey Work

2.6.1 Topographic Survey

The topographic survey was conducted to ascertain following in the survey area:-

- Spot levels
- High bank Line
- Vegetation covered
- Bridges and permanent structures
- Road, culvert and other communication network

The spot levels along the canal were obtained by using RTK leveling technique. The RTK control was extended using the co-ordinates and height of the recovered geodetic station of TMB-1. The elevation of RTK-1 with respect to MSL was considered. These BMs and Points were then used as reference stations for deriving the spot levels of the rover locations in the Stop-Go method. The data was post processed to get the correct position and height values of the rover locations surveyed the day.

2.6.2 Bathymetric Survey

2.6.2.1 Sounding operations

Sonar Mite (Ohmex, UK) was used to obtain depths in river TIZU. A working frequency of 210 KHz was used for sounding operations. The digital output from the echo sounder was interfaced to the Hydaspro i data logging software for acquisition of survey data in real time.

The performance of the echo sounder was found to be satisfactory during the entire duration of the survey.

Sound velocity was observed daily before commencement of survey work. The sound velocity thus obtained was set on the echo sounder. The sounding lines were run as per the cross section lines provided by Inland Waterways Authority of India. The raw data collected during the Survey period is submitted to IWAI as deliverable data along with this report.

2.6.2.2 Current Meter Observations

The current meter observation was carried out as per the scope of work at 7 Locations along the stretch of Tizu River. The current velocity recorded was at the deepest part of every 10 km stretch of the river terrain, during the survey period. The current velocity and water discharge have been calculated. The details of the current meter locations are as follows:

Table 2.5 Current meter deployment locations

Chainage (km)	Latitude(N)	Longitude(E)	Easting(m)	Northing(m)	Current Velocity (m/s)		
					Surface 0.3d	Mid Depth 0.5d	Bottom d
0.44	25°34'50.795"	94°53'17.387"	689650.264	2830608.425	3.02	2.8	2.66
9.968	25°38'50.536"	94°50'48.970"	685405.625	2837927.094	2.9	2.7	2.55
19.99	5°43'45.275"	94°50'49.973"	685306.79	2846996.847	2.92	2.6	2.45
30.014	25°46'42.003"	94°46'39.182"	678243.534	2852338.835	3.02	2.8	2.52
32.498	25°46'57.434"	94°45'20.700"	676050.734	2852784.309	3.25	2.92	2.63
35.285	25°46'12.502"	94°44'37.620"	674868.904	2851385.797	3.1	2.78	2.52
0.400	25°48'25.230"	94°46'35.657"	678102.479	2855513.840	2.89	2.65	2.48

The collected data is submitted as deliverable data to IWAI along with this report.

2.6.2.3 Sampling

River bed soil and water sampling was collected using Vanveen Grab and sampling bottles at respective locations. The samples were collected at five locations along the river stretches. The details of sampling locations are as follows:

Table 2.6 Soil and Water sampling locations

Chainage	Latitude(N)	Longitude(E)	Easting(m)	Northing(m)
0.44	25°34'50.795"	94°53'17.387"	689650.264	2830608.425
9.968	25°38'50.536"	94°50'48.970"	685405.625	2837927.094
19.99	25°43'45.275"	94°50'49.973"	685306.79	2846996.847
30.014	25°46'42.003"	94°46'39.182"	678243.534	2852338.835
35.285	25°46'12.502"	94°44'37.620"	674868.904	2851385.797

2.6.2.4 Analysis

The collected samples were analyzed for following properties:-

a) Soil Samples

- Gravel

- Sand
- Specific gravity
- PH Value
- Cu, Cc
- Clay Silt percentage

b) Water samples

- Sediment Concentration

A detailed report on water sample analysis is placed at (Annexure – 3) to this report.

2.6.3 Data Processing

The topographic and hydrographic data collected during the field work was processed and analyzed using the proprietary data collecting &processing software by Hydaspro i & all data in X, Y, Z format have been processed by software Hypack and AutoCAD. The following flowchart explains the sequence and process of digital data processing:

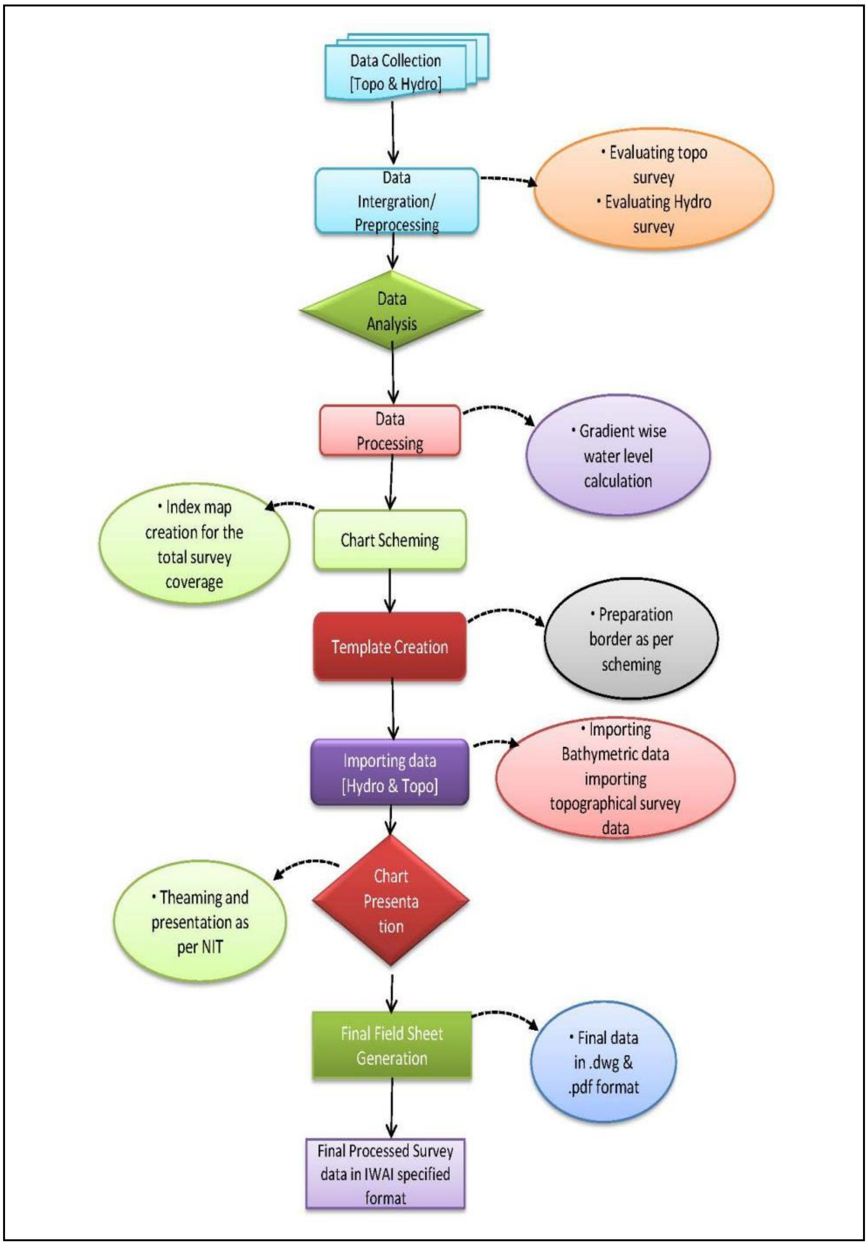


Fig. 2.10 Data processing flow chart

2.7 DESCRIPTION OF WATERWAY

2.7.1 The stretch of river under area of study is along the river from Longmatra in Kiphire District to Avankhu in Phek district, near international border of India and Myanmar. The average width of Tizu river from Ch. 0.00 Km to 5 Km is 65m to 100m approximately. Average depth of water in this stretch is 0.9 m to 1.2m ,Maximum depth of 4m was observed in this stretch .Average water portion of the river is 40 – 45 m. The stretch of the river passes through the Phek District Nagaland. Avankhu village is situated at the western side of the river stretch. River gradient along this stretch is 0.9m/km approx. High hills are situated both sides of the river. Several submerged rocks laid underneath of the river. The main flow of water can be seen along the bank and it was observed to be having out crop rocks and rapids.

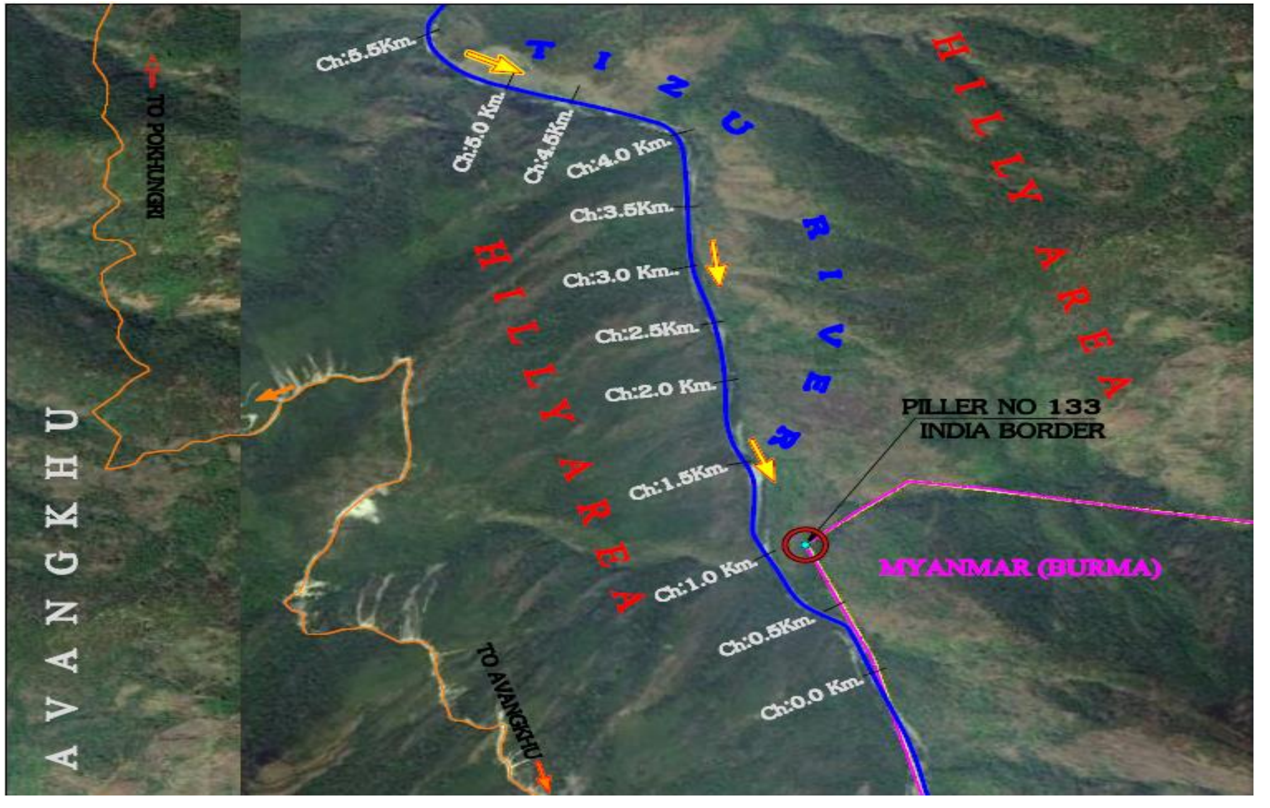


Fig. 2.11 Ch. 0 to 5 KM

2.7.2 Average width of river bank from Ch. 5 Km to 10 Km is 65m to 100m approximately. Average water portion of the river is 40 – 45 m. The stretch of the river passes nearby village of Pokhungri. River gradient along this stretch is 0.91 m/km approx.. Average depth of water in this stretch is 1.0 m to 1.6m ,Maximum depth of 4.7 m was observed in this stretch High hills are situated both sides of the river.

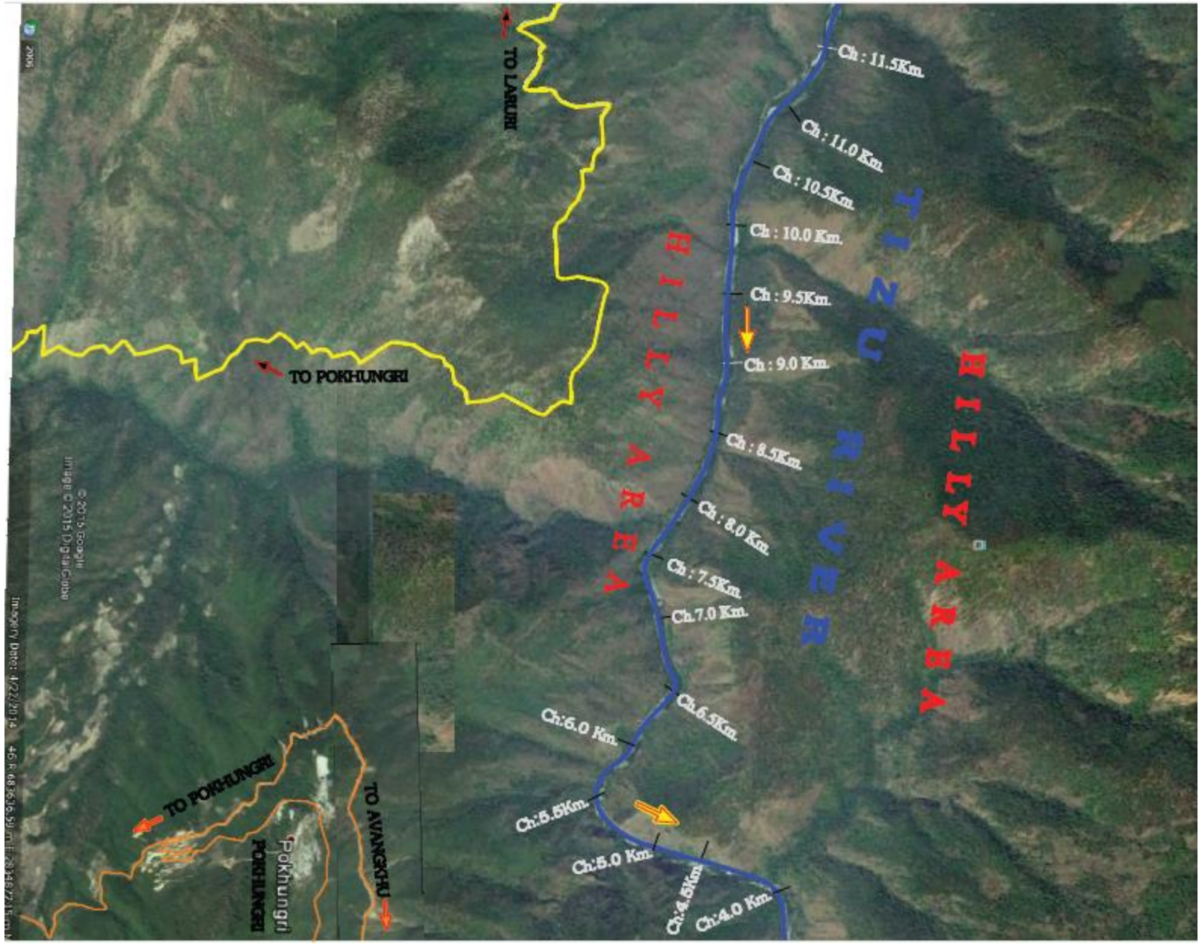


Fig. 2.12 Ch. 5 to 10 KM

2.7.3 Average width of river bank from Ch. 10 Km to 15 Km is 60m to 100m approximately. Average water portion of the river is 35 – 40 m. Average depth of water in this stretch is 0.8 m to 1.6m ,Maximum depth of 3.8m was observed in this stretch The stretch of the river passes nearby village of Laruri which is nearly 6 KM away by Link road. River gradient along this stretch is 0.92 m/km approx. High hills are situated both sides of the river. Several submerged rocks laid underneath of the river. The main flow of water can be seen along the bank and it was observed to be having out crop rocks and rapids. During this stretch, river passes through Laruri Bridge, which falls on the Mimi- Laruri mineral link road.

Fig. 2.13 Ch. 10 to 15 KM

2.7.4 Average width of river bank from Ch. 15 Km to 20 Km is 60m to 100m approximately. Average water portion of the river is 35 – 40 m. Average depth of water in this stretch is 0.9 m to 1.6m ,Maximum depth of 3.4m was observed in this stretch. River gradient along this stretch is 0.93m/km approx. High hills are situated both sides of the river. The river has meandering and braiding behavior. River velocity in this stretch is very high and it was observed to be having out crop rocks and rapids.

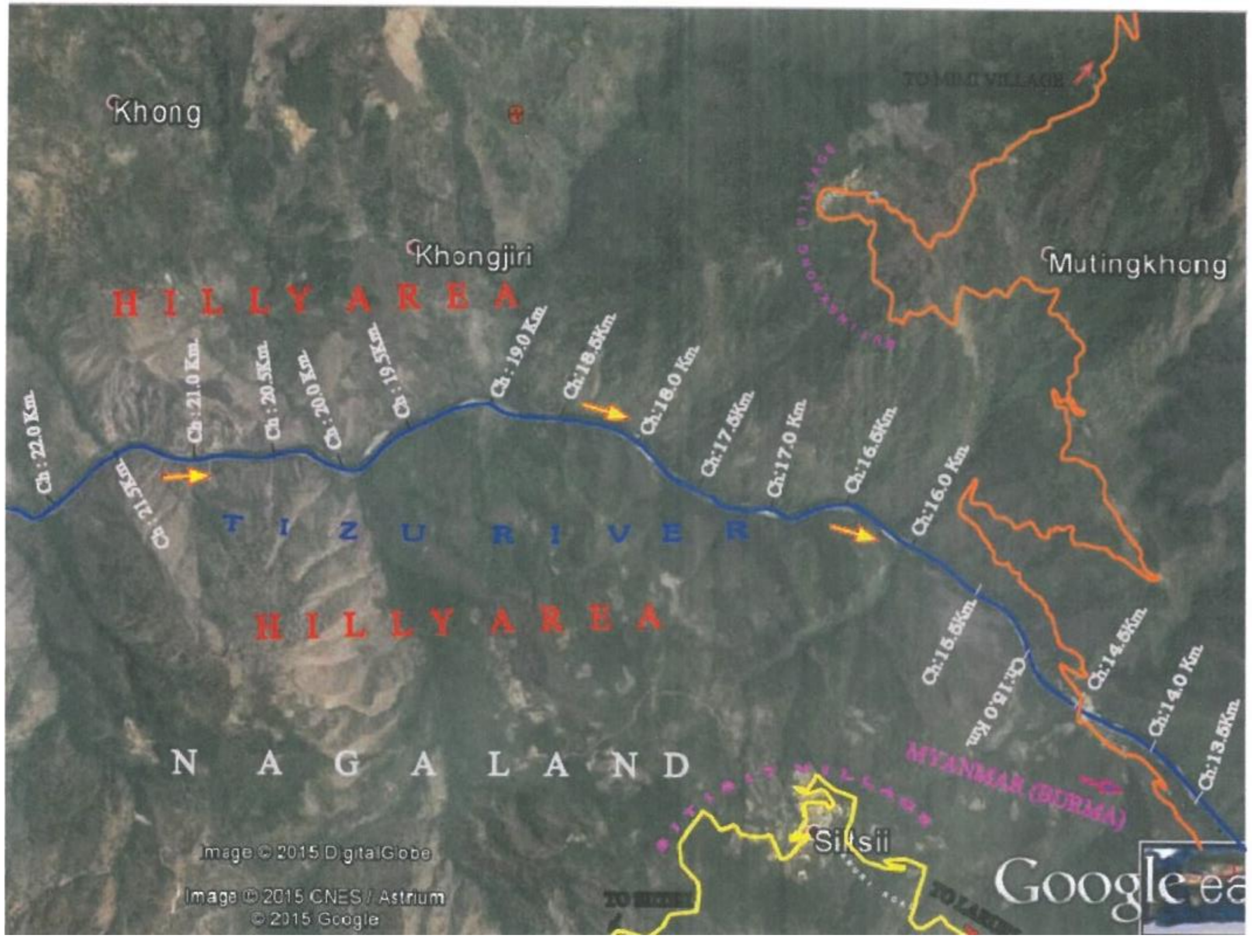


Fig. 2.14 Ch. 15 to 20 KM

2.7.5 Average width of river bank from Ch. 20 Km to 25 Km is 65m to 90m approximately. Average water portion of the river is 35 – 40 m. River gradient along this stretch is 0.94 m/km approx. Average depth of water in this stretch is 1.6 m to 2.3m ,Maximum depth of 6.1m was observed in this stretch This stretch passes through a gorge surrounded by hills and is very narrow with steep banks. The river bed material consists of coarse sand with rocky shores on either bank with dense forest. River velocity in this stretch is very high and it was observed to be having out crop rocks and rapids.

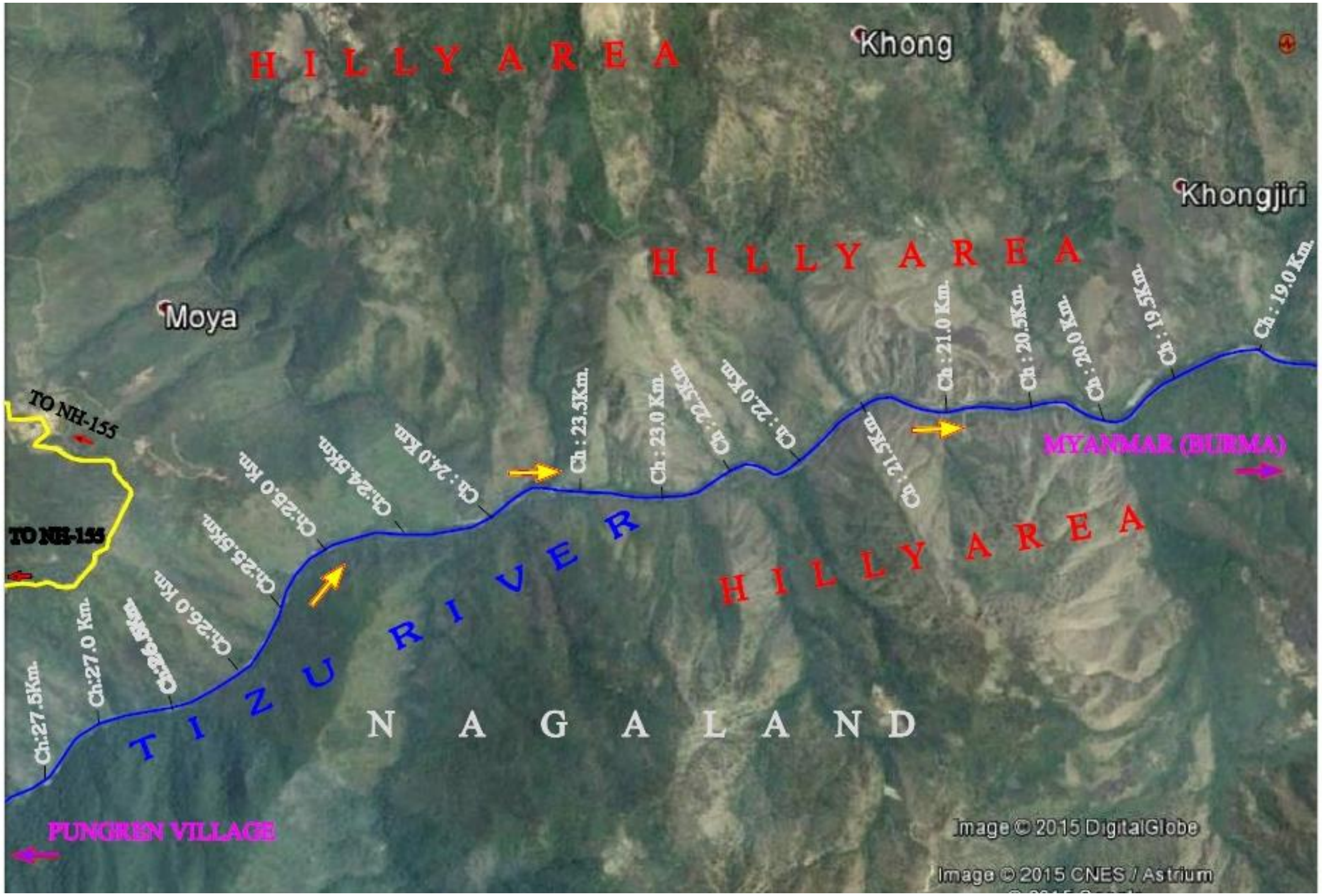


Fig. 2.15 Ch. 20 to 25 KM

2.7.6 Average width of river bank from Ch. 25 Km to 30 Km is 65m to 100m approximately. Average water portion of the river is 30 – 35 m. River gradient along this stretch is 0.95 m/km approx. Average depth of water in this stretch is 1.3 m to 1.6m ,Maximum depth of 4.9m was observed in this stretch This stretch is full of rocks and boulders with a surface of coarse sand along the watered part. River velocity in this stretch is very high and it was observed to be having out crop rocks and rapids.

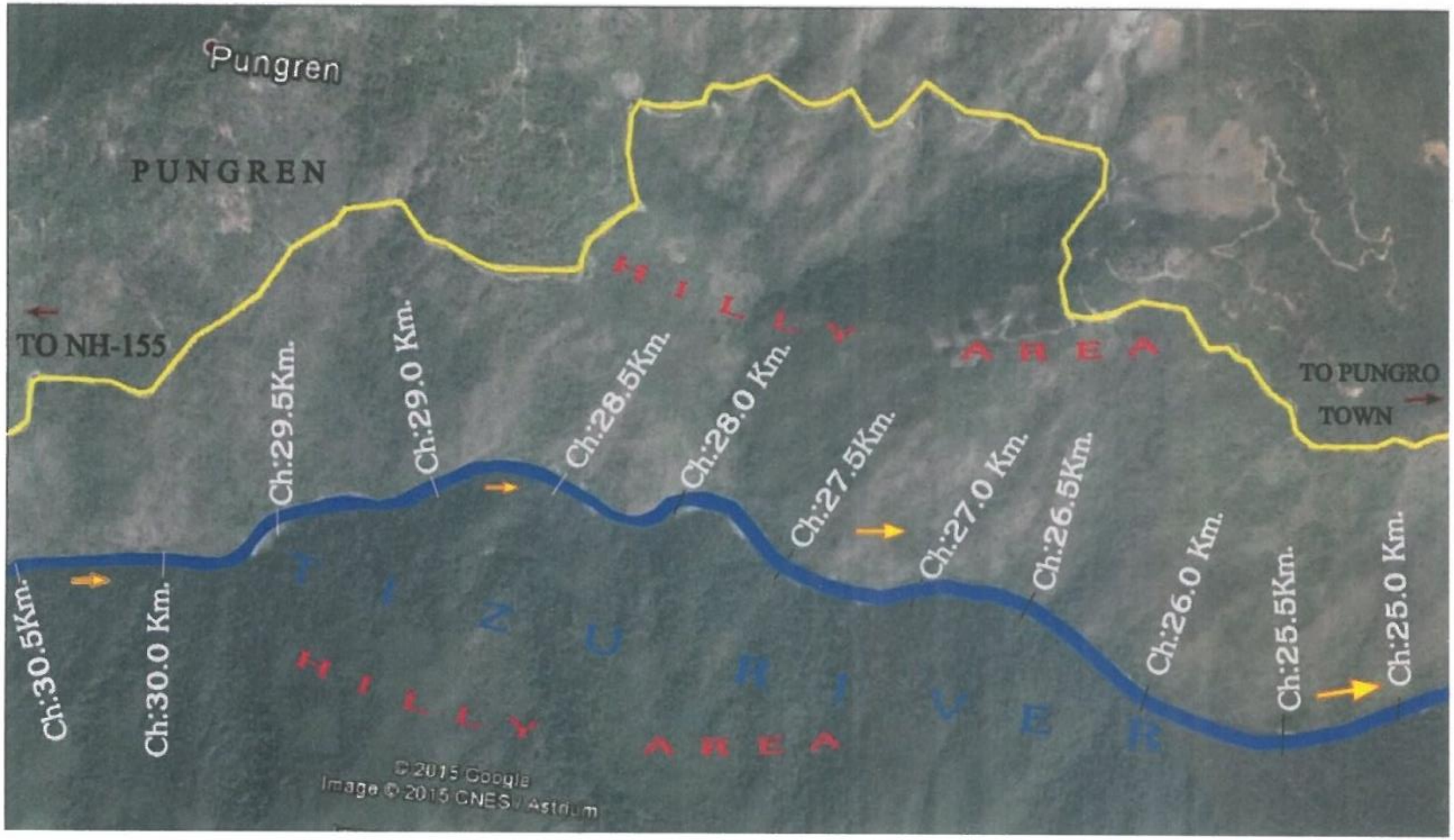


Fig. 2.16 Ch. 25 to 30 KM

2.7.7 Average width of river bank from Ch. 30 Km to 35 Km is 65m to 100m approximately. Average water portion of the river is 30 – 35 m. River gradient along this stretch is 0.96 m approx. Average depth of water in this stretch is 1.29 m to 3.3 m ,Maximum depth of 4.9m was observed in this stretch This stretch passes through a gorge surrounded by hills and full of rock outcrops and dense bush. River Zungki confluences in Tizu river at Ch. 32.5 Km. Nearby village Longmatra is situated at the left bank of Tizu River. Land is being used for cultivation purpose at the left bank of Tizu River at Ch. 34.5 Km – Ch. 35 Km.

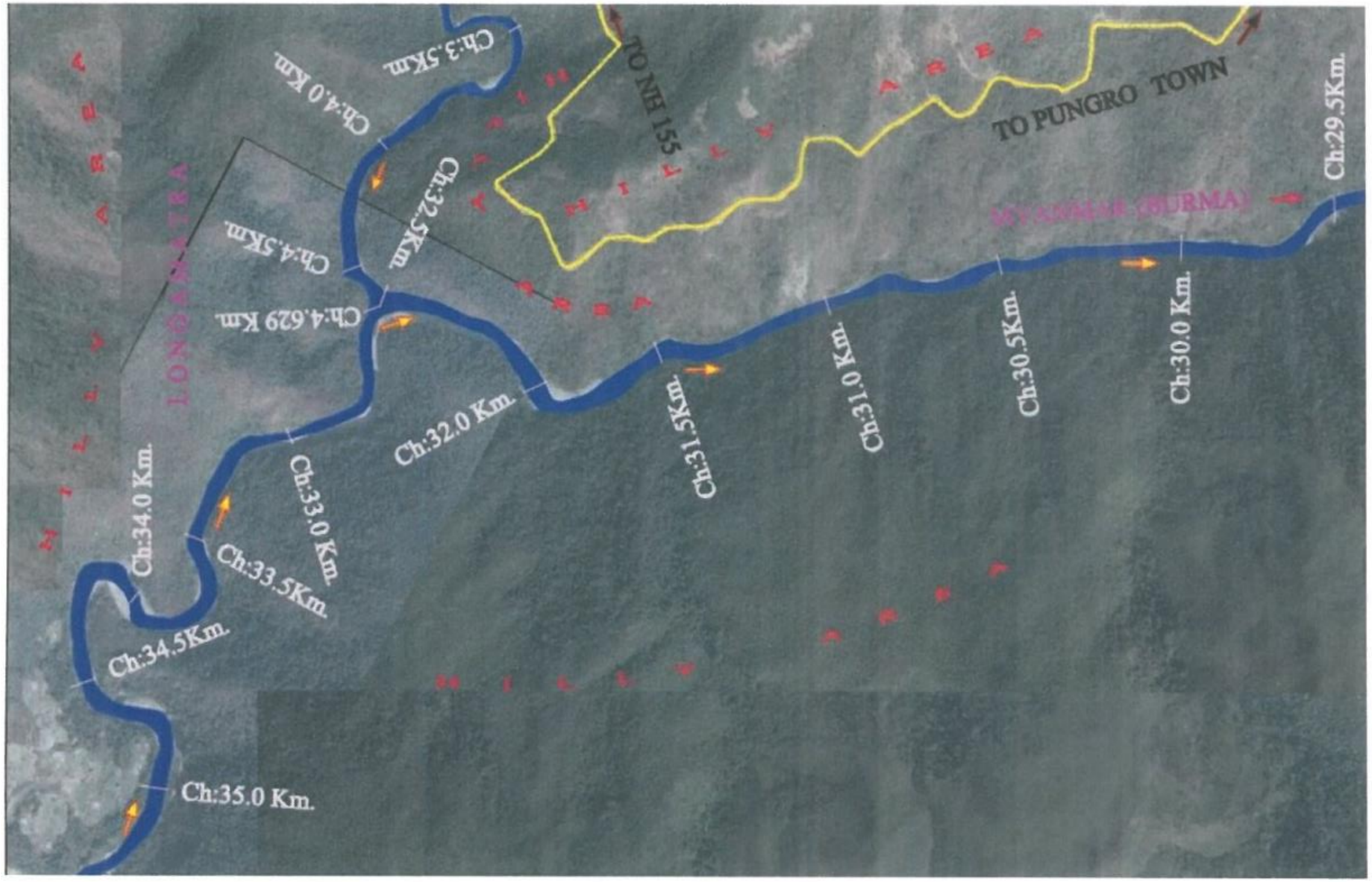


Fig. 2.17 Ch. 30 to 35 KM

2.7.8 Zungki River

Average width of river bank from Ch. 0 Km to 4.62 Km is 60m to 100m approximately. Average water portion of the river is 15 – 35 m. River gradient along this stretch is 0.49 m approx. Average depth of water in this stretch is 3.30 m to 5.8 m ,Maximum depth of 8.6m was observed in this stretch. River Zungki confluences in Tizu river at Ch. 32.5 Km. Nearby village Longmatra is situated at the left bank of Tizu River.Land is being used for cultivation purpose.

Fig. 2.18_Zungki River Ch- 0 - 4.62 Km

2.8 River Side Information

2.8.1 Details of Irrigation canals and outlets

During the survey work no irrigation canals and outlets were noticed except Zungki river confluences in Longmatra, Tizu River about 4.5 km upstream of Zungki river was surveyed and details are submitted along with stretch of Tizu River. The details of Zungki river recorded during the survey are as follows:-

Stretch No.	Geographic Location	Chainage (km)	Remarks
1	25-46-57.427 N , 94-45-20.490 E	32.5	Meeting point of Tizu & Zungki River

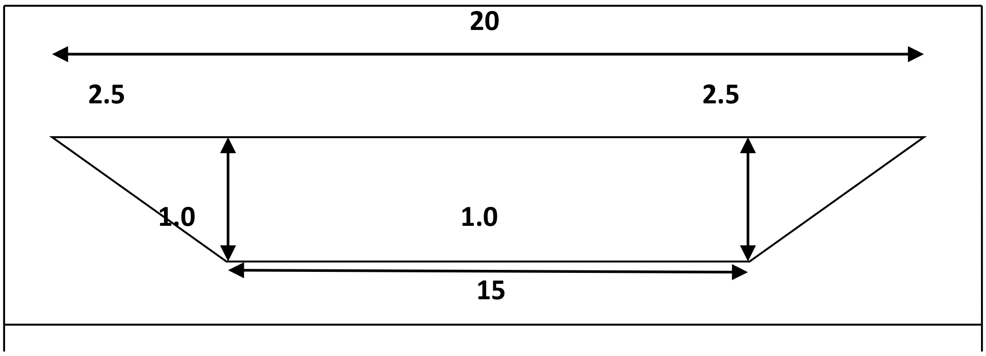
2.8.2 Condition of River Bank and Bank Protection

During the course of survey, it was observed that both side of the river is rocky outcrop and the complete bank is fully covered with rocks.

2.9 Waterway Development

2.9.1 Fairway Dimensions

As per the specification of the survey, dredging quantity was required to be estimated for a channel dimension of 15m x 1.0m with Side slope of 1:2.5 along the deepest route.



2.9.2 Calculation of Dredging Quantity (1.0m)

The total length of waterway from Longmatra to Avanku Indo – Myanmar Border approx. 35 Kms. Volume summary at 1 km. interval of 1:2.5 slope wise is given below list:

Table 2.7 Calculation of dredging quantity (1m depth) 15m bottom width

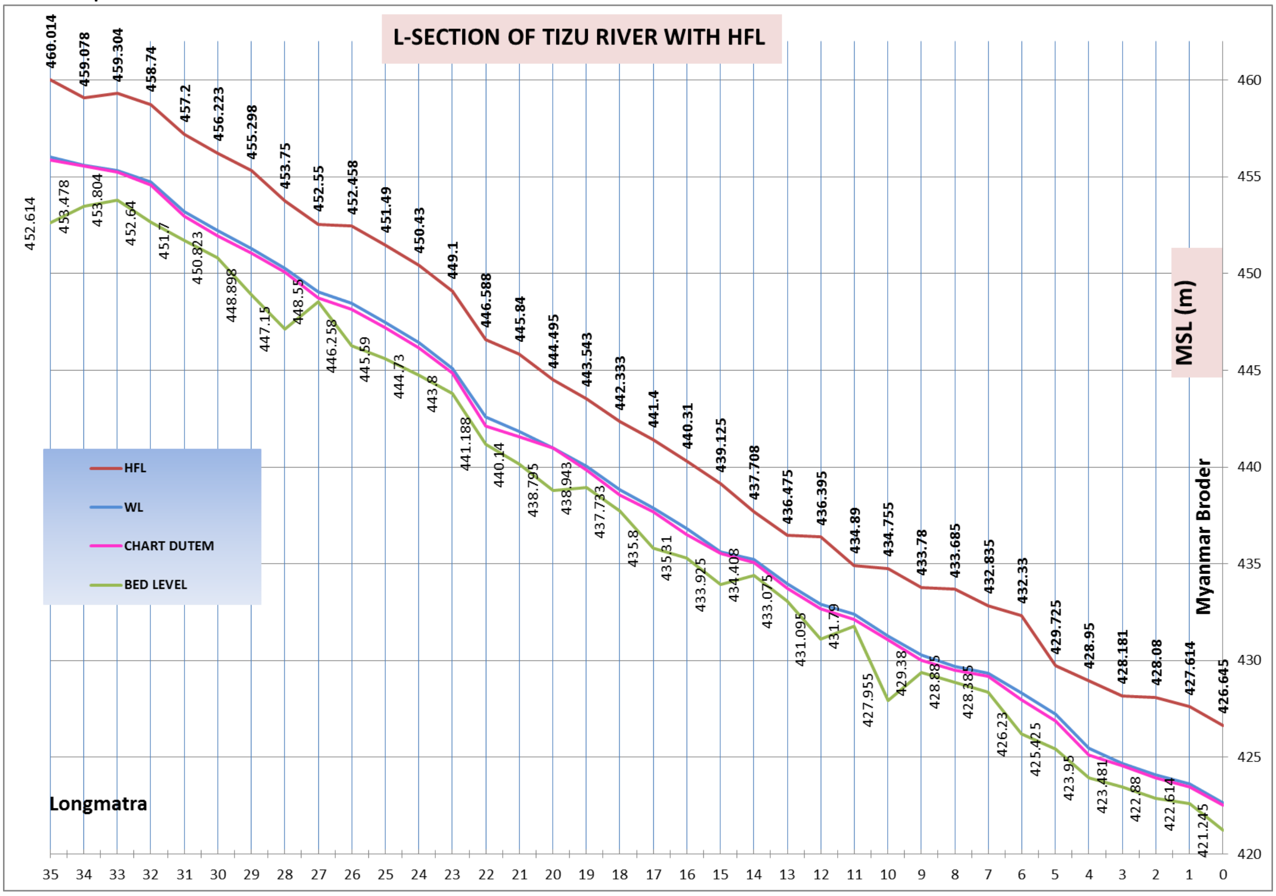
Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg Depth of Cut (m)	Dredging Volume Per KM (Cum)	Cumulative Volume Per KM (Cum)
		MIN	MAX	AVG					
1	1	0.8	1.3	1.03	600	39.22	0.125	1961.18	
2	2	1.5	1.7	1.6	350	8.56	0.028	428.17	2389.35
3	3	0.8	1.4	1.1	250	21.48	0.068	1073.92	3463.27
4	4	1.6	1.6	1.6	300	20.06	0.064	1003.00	4466.26
5	5	1.7	2.2	1.94	400	28.96	0.092	1447.84	5914.10
6	6	0.5	1.9	1.13	200	13.29	0.041	664.43	6578.53
7	7	0.9	1	0.94	400	14.85	0.048	742.62	7321.15

Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg Depth of Cut (m)	Dredging Volume Per KM (Cum)	Cumulative Volume Per KM (Cum)
		MIN	MAX	AVG					
8	8	0.6	1.4	1	650	77.60	0.237	3880.07	11201.22
9	9	0	0.9	0.48	550	40.07	0.125	2003.65	13204.86
10	10	1.6	2.7	2.12	400	29.34	0.093	1467.04	14671.91
11	11	0.6	1.2	0.95	450	25.48	0.082	1273.81	15945.72
12	12	0.8	1	0.85	400	31.65	0.100	1582.27	17527.99
13	13	0.6	1.2	0.92	550	45.03	0.142	2251.52	19779.51
14	14	0.4	1	0.64	800	101.51	0.315	5075.72	24855.24
15	15	0.3	0.5	0.375	250	31.15	0.097	1557.59	26412.82
16	16	0.6	1.6	1.22	750	72.41	0.228	3620.43	30033.25
17	17	0.3	1.3	0.63	250	22.83	0.072	1141.53	31174.78
18	18	0.2	1.1	0.65	450	42.67	0.133	2133.66	33308.44
19	19	0.7	0.9	0.8	500	37.25	0.118	1862.37	35170.81
20	20	0.2	0.2	0.2	350	49.41	0.152	2470.36	37641.17
21	21	0.2	1.2	0.68	300	49.53	0.152	2476.61	40117.78
22	22	0.3	0.6	0.5	300	37.21	0.115	1860.69	41978.47
23	23	0.1	0.4	0.25	250	26.27	0.081	1313.63	43292.10
24	24	1	2.8	2	550	60.99	0.189	3049.51	46341.62
25	25	5.1	5.2	5.15	250	19.70	0.063	984.76	47326.37
26	26	0.8	1.1	1	200	21.78	0.068	1089.06	48415.44
27	27	1.6	1.9	1.8	350	38.71	0.120	1935.74	50351.17
28	28	1.2	4.6	3.23	400	38.63	0.120	1931.68	52282.85
29	29	0.8	1.2	1	400	72.77	0.218	3638.65	55921.49
30	30	0.2	0.4	0.3	250	24.86	0.077	1242.80	57164.29
31	31	0.6	0.9	0.73	350	39.42	0.122	1970.84	59135.13
32	32	1.2	2.1	1.77	350	37.71	0.117	1885.63	61020.76
33	33	0.5	3.2	1.7	0	0	0.000	0	61020.76
34	34	2.6	4.9	4.1	0	0	0.000	0	61020.76
35	35.1	1.9	3	2.6	0	0	0.000	0	61020.76
				Total Dredging Volume Tizu river					**61020.76**

ZUNGKI RIVER									
Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Volume Per KM (cum)
		MIN	MAX	AVG					
1	1	3.1	4.6	3.53	0	0	0	0	61020.76
2	2	1.3	3.9	2.6	0	0	0	0	61020.76
3	3	4.1	6.4	5.25	0	0	0	0	61020.76
4	4	4.7	6	5.26	0	0	0	0	61020.76

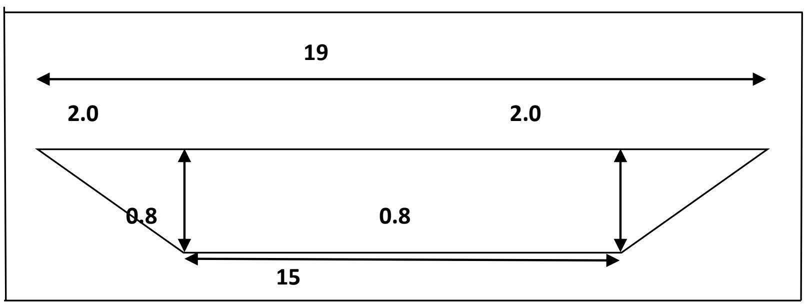
ZUNGKI RIVER									
Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Volume Per KM (cum)
		MIN	MAX	AVG					
5	4.65	5.5	6.8	6.1	0	0	0	0	61020.76
					Total Dredging Volume Tizu+ Zungki river				61020.76

Hence, it can be seen from the above table that no dredging is required in Zungki river for 1 m depth. L section of tizu river is shown below.



2.9.3 Fairway Dimensions

As per the specification of the survey, dredging quantity was required to be estimated for a channel dimension of 15m x 0.8m with Side slope of 1:2.5 along the deepest route.



2.9.4 Calculation of Dredging Quantity (0.8m)

The total length of waterway from Longmatra to Avanku Indo – Myanmar Border approx. 35 Kms. Volume summary at 1 km. interval of 1:2.5 slope wise is given below list:-

Table 2.8 Calculation of dredging quantity (0.8m depth)

TIZU RIVER

Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Dredging Volume (cum)
		MIN	MAX	AVG					
1	1	0.8	1.3	1.03	200	9.06	0.029	452.81	
2	2	1.5	1.7	1.6	0	0	0	0.00	452.81
3	3	0.8	1.4	1.1	150	6.36	0.021	318.11	770.92
4	4	1.6	1.6	1.6	100	4.33	0.014	216.50	987.42
5	5	1.7	2.2	1.94	200	9.16	0.029	458.22	1445.64
6	6	0.5	1.9	1.13	100	6.25	0.02	312.50	1758.14
7	7	0.9	1	0.94	100	0.75	0.002	37.66	1795.80
8	8	0.6	1.4	1	450	39.99	0.124	1999.36	3795.16
9	9	0	0.9	0.48	250	17.52	0.056	876.08	4671.24
10	10	1.6	2.7	2.12	300	7.75	0.025	387.51	5058.75
11	11	0.6	1.2	0.95	150	4.28	0.014	213.93	5272.67
12	12	0.8	1	0.85	200	9.40	0.03	469.84	5742.52
13	13	0.6	1.2	0.92	350	15.21	0.049	760.48	6503.00
14	14	0.4	1	0.64	700	49.68	0.158	2484.06	8987.06
15	15	0.3	0.5	0.38	250	14.72	0.047	735.92	9722.98
16	16	0.6	1.6	1.22	600	27.30	0.088	1365.22	11088.20
17	17	0.3	1.3	0.63	150	9.22	0.029	461.11	11549.31
18	18	0.2	1.1	0.65	300	20.92	0.067	1045.80	12595.10
19	19	0.7	0.9	0.8	200	12.16	0.039	608.20	13203.31
20	20	0.2	0.2	0.2	300	26.82	0.084	1341.02	14544.33
21	21	0.2	1.2	0.68	300	29.10	0.092	1455.11	15999.44

Sr. No.	Chainage in Km	Water Depth			Shoal Length (m)	Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Dredging Volume (cum)
		MIN	MAX	AVG					
22	22	0.3	0.6	0.5	250	19.47	0.062	973.47	16972.91
23	23	0.1	0.4	0.25	100	12.51	0.039	625.39	17598.30
24	24	1	2.8	2	400	27.17	0.085	1358.32	18956.62
25	25	5.1	5.2	5.15	150	5.92	0.019	295.87	19252.49
26	26	0.8	1.1	1	150	11.03	0.035	551.25	19803.74
27	27	1.6	1.9	1.8	200	19.72	0.062	985.84	20789.58
28	28	1.2	4.6	3.23	250	17.68	0.056	884.14	21673.72
29	29	0.8	1.2	1	300	47.44	0.145	2372.08	24045.81
30	30	0.2	0.4	0.3	100	11.63	0.036	581.33	24627.14
31	31	0.6	0.9	0.73	250	18.52	0.058	926.18	25553.32
32	32	1.2	2.1	1.77	200	18.04	0.057	902.01	26455.33
33	33	0.5	3.2	1.7	0	0	0	0.00	26455.33
34	34	2.6	4.9	4.1	0	0	0	0.00	26455.33
35	35.1	1.9	3	2.6	0	0	0	0.00	26455.33
				Total Dredging Volume Tizu river					**26455.33**
				ZUNGKI RIVER					
Sr. No.	**Chainage in Km**	**Water Depth**			**Shoal Length (m)**	**Total Area to be Cut per km (m^2)**	**Avg. Depth of Cut (m)**	**Dredging Volume Per KM**	**Cumulative Dredging Volume**
		MIN	**MAX**	**AVG**					
1	1	3.1	4.6	3.525	0	0	0	0.00	26455.33
2	2	1.3	3.9	2.6	0	0	0	0.00	26455.33
3	3	4.1	6.4	5.25	0	0	0	0.00	26455.33
4	4	4.7	6	5.26	0	0	0	0.00	26455.33
5	4.65	5.5	6.8	6.1	0	0	0	0.00	26455.33
					Total Dredging Volume Tizu + Zungki river				**26455.33**

2.9.5 Fairway Dimensions

As per the specification of the survey, dredging quantity was required to be estimated for a channel dimension of 15m x 0.6m with Side slope of 1:2.5 along the deepest route.

2.9.6 Calculation of Dredging Quantity (0.6m)

The total length of waterway from Longmatra to Avanku Indo –Myanmar Border approx. 35 Kms. Volume summary at 1 km. interval of 1:2.5 slope wise is given below list:-

Table 2.9 Calculation of dredging quantity (0.6m depth)

TIZU RIVER

Sr. No.	Chainage in Km	Water Depth			Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Dredging Volume (m^3)
		MIN	MAX	AVG				
1	1	0.8	1.3	1.03	1.26	0.004	62.95	
2	2	1.5	1.7	1.60	0.00	0.000	0.00	62.95
3	3	0.8	1.4	1.10	1.14	0.004	56.95	119.90
4	4	1.6	1.6	1.60	0.30	0.001	15.05	134.95
5	5	1.7	2.2	1.94	1.71	0.006	85.64	220.60
6	6	0.5	1.9	1.13	1.53	0.005	76.25	296.85
7	7	0.9	1	0.94	0.00	0.000	0.00	296.85
8	8	0.6	1.4	1.00	19.38	0.061	968.82	1265.67
9	9	0	0.9	0.48	6.02	0.020	301.15	1566.82
10	10	1.6	2.7	2.12	0.00	0.000	0.00	1566.82
11	11	0.6	1.2	0.95	0.00	0.000	0.00	1566.82
12	12	0.8	1	0.85	0.25	0.001	12.53	1579.36
13	13	0.6	1.2	0.92	0.85	0.003	42.73	1622.09
14	14	0.4	1	0.64	13.18	0.043	659.05	2281.14
15	15	0.3	0.5	0.38	5.03	0.016	251.33	2532.47
16	16	0.6	1.6	1.22	5.00	0.016	250.08	2782.55
17	17	0.3	1.3	0.63	2.19	0.007	109.69	2892.24
18	18	0.2	1.1	0.65	4.97	0.016	248.52	3140.76
19	19	0.7	0.9	0.80	3.10	0.010	155.00	3295.76
20	20	0.2	0.2	0.20	10.17	0.032	508.53	3804.28
21	21	0.2	1.2	0.68	11.28	0.036	564.11	4368.39
22	22	0.3	0.6	0.50	6.69	0.022	334.31	4702.70
23	23	0.1	0.4	0.25	5.93	0.019	296.64	4999.34
24	24	1	2.8	2.00	10.68	0.034	534.01	5533.34
25	25	5.1	5.2	5.15	0.50	0.002	25.14	5558.48
26	26	0.8	1.1	1.00	3.10	0.010	155.00	5713.48
27	27	1.6	1.9	1.80	7.62	0.025	380.95	6094.43

Sr. No.	Chainage in Km	Water Depth			Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (cum)	Cumulative Dredging Volume (m^3)
		MIN	MAX	AVG				
28	28	1.2	4.6	3.23	3.91	0.013	195.31	6289.74
29	29	0.8	1.2	1.00	27.14	0.085	1357.08	7646.82
30	30	0.2	0.4	0.30	5.10	0.016	255.08	7901.90
31	31	0.6	0.9	0.73	7.03	0.023	351.56	8253.46
32	32	1.2	2.1	1.77	7.74	0.025	386.88	8640.34
33	33	0.5	3.2	1.70	0.00	0.000	0.00	8640.34
34	34	2.6	4.9	4.10	0.00	0.000	0.00	8640.34
35	35.1	1.9	3	2.6	0.00	0.004	0.00	8640.34
Total Dredging Volume Tizu river - 8640.34								
ZUNGKI RIVER								
Sr. No.	**Chainage in Km**	**Water Depth**			**Total Area to be Cut per km (m^2)**	**Avg. Depth of Cut (m)**	**Dredging Volume Per KM (cum)**	**Cumulative Dredging Volume (m^3)**
		MIN	**MAX**	**AVG**				
1	1	3.1	4.6	3.53	0.000	0.00	0.00	8640.34
2	2	1.3	3.9	2.60	0.000	0.00	0.00	8640.34
3	3	4.1	6.4	5.25	0.000	0.00	0.00	8640.34
4	4	4.7	6	5.26	0.000	0.00	0.00	8640.34
5	4.65	5.5	6.8	6.10	0.000	0.00	0.00	8640.34
			Total Dredging Volume Tizu + Zungki river					**8640.34**

2.9.7 Fairway Calculation of Dredging Quantity Class I (1.2m),Bottom width 30m, side slope 1: 2.5

Based on the data provided by IWAI. The dredging quantities were calculated for class I vessel also.

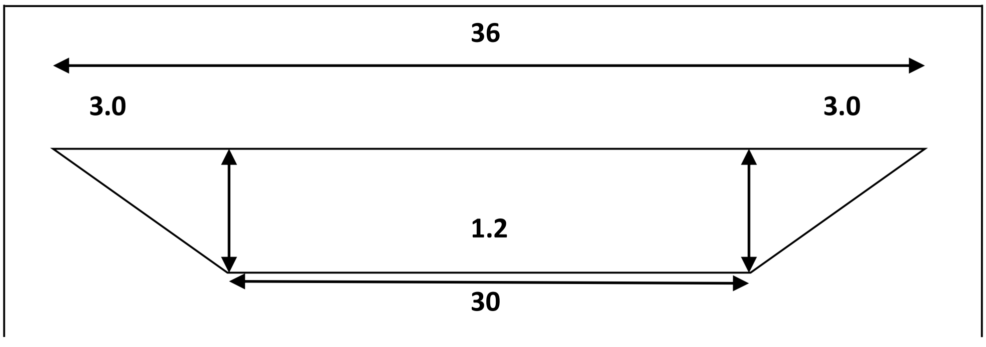


Table 2.10 Tizu River Dredging-Class I

Chainage in KM	Water Depth			Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (m^3)	Cumulative Dredging Volume (m^3)
	MIN	MAX	AVG				
1	0.8	1.3	1.03	175.23	0.283	8761.49	
2	1.5	1.7	1.60	78.05	0.127	3902.41	12663.90
3	0.8	1.4	1.10	85.89	0.138	4294.42	16958.32
4	1.6	1.6	1.60	92.77	0.150	4638.55	21596.88
5	1.7	2.2	1.94	125.90	0.203	6295.07	27891.94
6	0.5	1.9	1.13	54.90	0.088	2745.08	30637.03
7	0.9	1	0.94	91.35	0.148	4567.60	35204.63
8	0.6	1.4	1.00	244.04	0.386	12202.21	47406.84
9	0	0.9	0.48	159.23	0.255	7961.72	55368.56
10	1.6	2.7	2.12	113.63	0.183	5681.74	61050.29
11	0.6	1.2	0.95	120.11	0.194	6005.46	67055.75
12	0.8	1	0.85	122.59	0.197	6129.36	73185.12
13	0.6	1.2	0.92	169.03	0.271	8451.58	81636.69
14	0.4	1	0.64	301.48	0.478	15074.19	96710.88
15	0.3	0.5	0.38	93.19	0.148	4659.30	101370.18
16	0.6	1.6	1.22	239.19	0.382	11959.66	113329.84
17	0.3	1.3	0.63	80.17	0.128	4008.55	117338.39
18	0.2	1.1	0.65	152.41	0.243	7620.38	124958.77
19	0.7	0.9	0.80	162.75	0.262	8137.32	133096.09
20	0.2	0.2	0.20	140.59	0.222	7029.74	140125.83
21	0.2	1.2	0.68	134.61	0.212	6730.61	146856.44
22	0.3	0.6	0.50	113.64	0.180	5681.94	152538.39
23	0.1	0.4	0.25	85.66	0.136	4283.21	156821.60
24	1	2.8	2.00	193.00	0.306	9650.13	166471.72
25	5.1	5.2	5.15	73.22	0.118	3661.01	170132.73
26	0.8	1.1	1.00	80.45	0.128	4022.43	174155.16
27	1.6	1.9	1.80	123.73	0.196	6186.29	180341.45
28	1.2	4.6	3.23	128.38	0.204	6419.14	186760.59
29	0.8	1.2	1.00	202.30	0.316	10114.83	196875.42
30	0.2	0.4	0.30	92.54	0.148	4627.00	201502.42
31	0.6	0.9	0.73	129.28	0.205	6463.90	207966.32
32	1.2	2.1	1.77	123.85	0.197	6192.29	214158.61
33	0.5	3.2	1.70	0.00	0.000	0.00	214158.61
34	2.6	4.9	4.10	0.00	0.000	0.00	214158.61
35.1	1.9	3	2.6	6.10	0.283	305.00	214463.61
				Total Dredging Volume Tizu river			**214463.61**

Table 2.11 Zungki River-Class I ,30m bottom,1:2.5							
Chainage IN KM	Water Depth			Total Area to be Cut per km (m^2)	Avg. Depth of Cut (m)	Dredging Volume Per KM (m^3)	Cumulative Dredging Volume (m^3)
	MIN	MAX	AVG				
1	3.1	4.6	3.53	0.000	0.00	0.00	214463.61
2	1.3	3.9	2.60	0.000	0.00	0.00	214463.61
3	4.1	6.4	5.25	0.000	0.00	0.00	214463.61
4	4.7	6	5.26	0.000	0.00	0.00	214463.61
4.65	5.5	6.8	6.10	0.000	0.00	0.00	214463.61
		Total Dredging Volume Tizu + Zungki river					**214463.61**

The high value of dredging is due to increase in bottom width and depth

2.10 Survey Chart details

Based on the scale requirement and area surveyed, the survey chart key map was made. The survey sample chart was prepared using Hypack version 2014 software, scale 1:1,000 to cater for the projection and scale requirements of the deliverable sheets. A total of 36 sheets of scale 1:1,000 in portrait and landscape are planned &submitted by the survey party to IWAI in 2015.

2.11 Conclusion

The aim of the study of existing hydrographic survey data was to analyse the possibility of IWT transport in Tizu and Zungki River.

WAPCOS has also analysed the data for development of class I channel as suggested in pre feasibility study. As per survey data the dredging quantities obtained for Class I with 1.2m depth and 30 m bottom depth is high i.e. 2.14 lac Cum which is very high for small river stretch. If bottom depth of 1m with channel width at bottom of 15m is considered then In the present form, the river is navigable between Longmatra to Avankhu without much dredging requirement but removal of stones underneath the water are required with minimum dredging.

It is observed that the river had very limited potential for its development for Inland Water Transport (IWT) operation.In the future the waterway could also provide connectivity through IWT mode between India & Myanmar upto Tha man thi location in Myanmar.

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CHAPTER – 3
TRAFFIC STUDY

3.1 Background

Tizu River is one of the main four rivers of Nagaland. It originates in district Zunheboto in Nagaland and runs along the districts of Kiphire and Phek. Tizu river system flows towards the east and southeast and confluences with Chindwin River in Myanmar. The main tributaries of Tizu river are Zungki, Lanye and Likimro. Zungki river is the biggest tributary of Tizu river. It starts from the north-eastern part of Chandong forest in the south of Teku and flows in southern direction towards Noklal, Shamator and Kiphire and finally joins Tizu below Kiphire.

The flow direction of Tizu river is from Longmatra (District Kiphire) to Avankhu (Avakhung) in District Phek, near Indo- Myanmar border. The offical nomenclature of Avakhung village as approved and recognized by the Government of Nagaland is spelled as 'Avakhung' instead of 'Avankhu'.

The defined stretch of Zungki river is from bridge to confluence of Zungki and Tizu rivers. IWAI intends to explore the potential of NW 101, i.e. Longmatra to Avakhung (Avankhu) stretch of Tizu and Zungki Rivers for round the year navigation and development of water transport facilities. The length of this defined stretch of the river is 40.03 km (Tizu- 35.41 km & Zungki- 4.62 km) and the maximum width in this stretch is between 100 m- 150 m.

The distance between Longmatra to Avakhung (Avankhu) by roadways is 217 Km. This distance could be reduced to 35 Km, if the proposed waterway in Tizu river is used for transportation. The below image shows Tizu river in Nagaland.

Fig. 3.1 Tizu River

The river crosses through valleys and high hills. The riverbank has steep terrain. There are agricultural lands, forest and other plantations in the vicinity. Some parts have barren land. The riverbed consists of rock outcrops. Tizu river's velocity is very high and rapids would be hurdle for navigation.

Fig. 3.2 Rapids in Tizu River

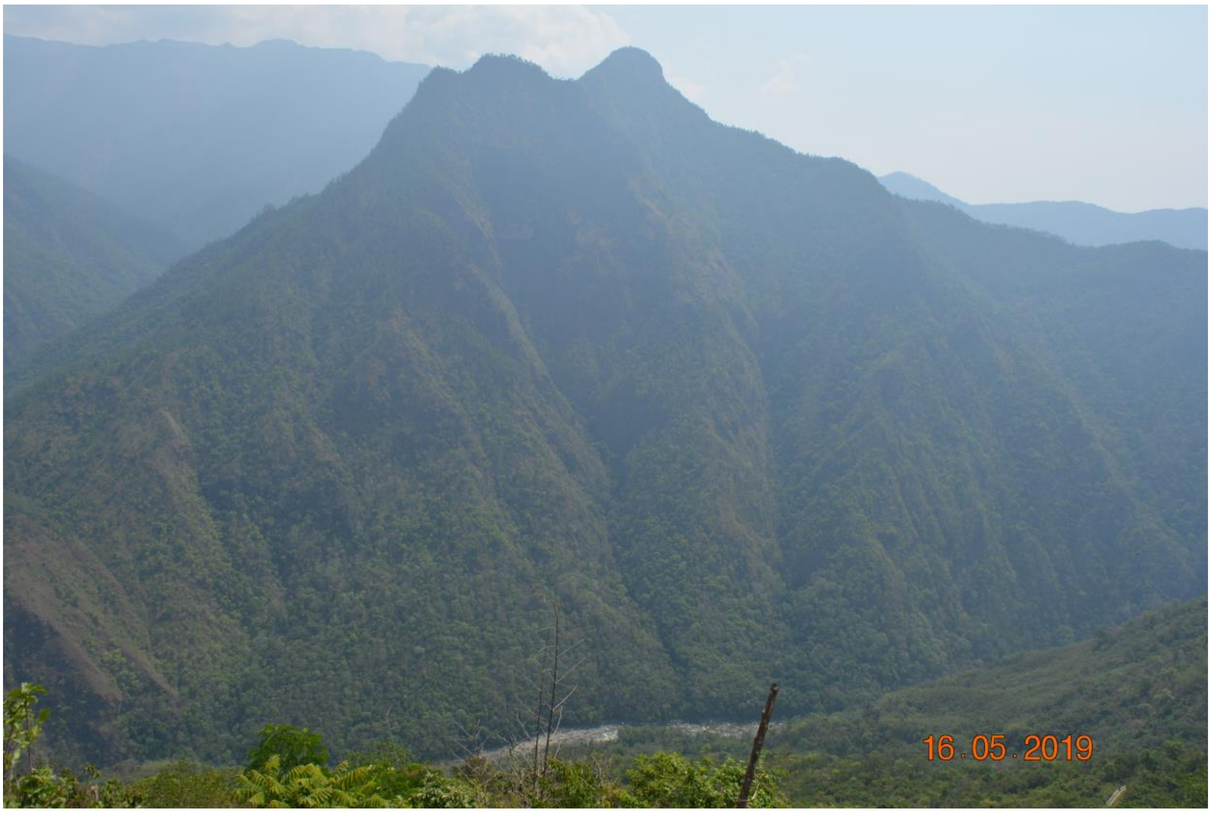


Fig. 3.3 Steep hills on the bank of Tizu River

Fig. 3.4 V Shape valley surrounding Tizu River

3.2 Hinterland Analysis

The stretch of the proposed waterway 101 from Longmatra in Kiphire district to Avakhung (Avankhu) in Phek district is considered for study. Two districts, i.e. Phek and Kiphire fall in the primary hinterland of the proposed waterway. Apart from these two districts, Zunheboto and Tuensang districtsare also included in the hinterland study.

District Phek, located in the southeastern part of Nagaland is a mountainous region. The district is bounded by Myanmar in the east. Important towns in the district are Phek, Pfutsero, Meluri, Chozuba, Chizami, Khezhakeno, Sakraba and Waziho.

District Kiphire is located in northeastern part of Phek district. Kiphire district is located on hilly terrain and is a land locked area. The main towns of this district are Seyochung, Sitimi, Pungro and Kiphire.

Zunheboto district is geographically located at the centre of Nagaland. The northern part of the district occupies the lower ranges of the middle Nagaland and the southern part falls under the high hills and mountainous region of the state.The entire Zunheboto district is characterized by presence of two vertical ranges, which run parallel to each other and divided by Tizu River. Satoi taluka falls in the primary hinterland. It is an underdeveloped area. Natural beauty of this taluka made it a popular tourist destination.

Tuensang district shares a long international border with Myanmar on its eastern side. Nagaland's highest peak, Mount Saramati is located in this district.

The hinterland is a hilly region. The two districts of the hinterland are located in higher altitude; Zunheboto at 1,874 m and Phek at 1,524 m. Tuensang is located at an altitude of 1,371 m. and Kiphire at an altitude of 896 m. The district headquarter is situated in

Tuensang town. The majority of the villages are located at the hill tops, mostly secludedfrom one another.

The below map shows identified stretch of the proposed waterway NW 101, districts in the hinterland and connectivity around the river.

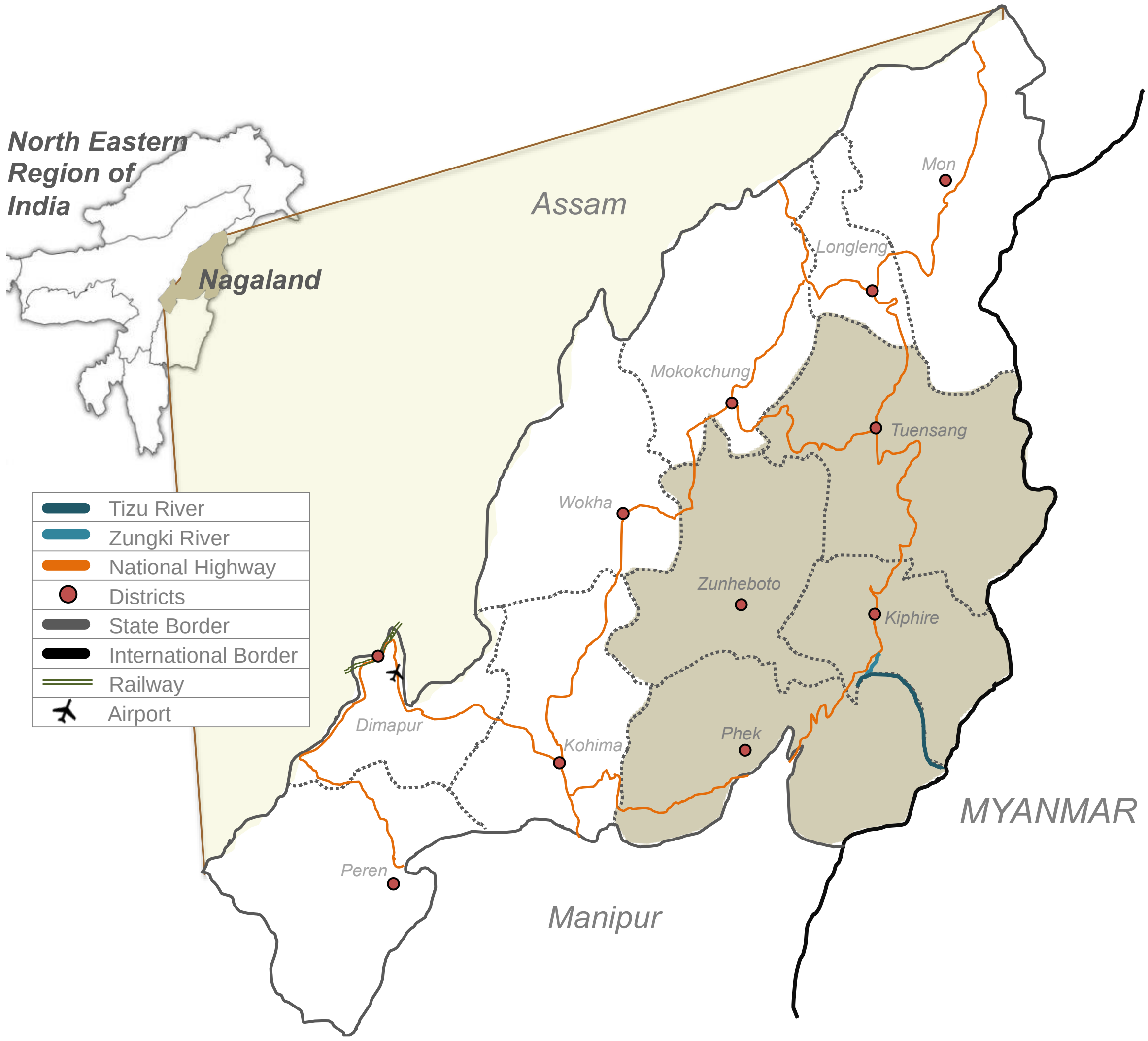


Fig. 3.5 Macro Map of NW 101

3.2.1 Population of the Hinterland

The hinterland is underdeveloped region in the state. A small urban built up region is observed at the bank of Zungki river. The districts of the hinterland, i.e. Kiphire, Phek, Tuensang and Zunheboto are rural districts. The below tables show district wise population and number of villages in the hinterland.

Table 3.1 Population and number of villages in Phek District

Phek District					
Rural Development (R.D.) Block	No. of households	Total Population	Total no. of villages	Circle wise no. of villages	Name of circles falling within each R.D. Block
Sekruzu	6,047	26,202	17	9	Sekruzu
				8	Chozuba

Phek District					
Rural Development (R.D.) Block	No. of households	Total Population	Total no. of villages	Circle wise no. of villages	Name of circles falling within each R.D. Block
Phek	4,653	19,382	25	15	Phek Sadar
				3	Sakraba
				7	Khuza
Meluri	5,101	22,618	34	13	Meluri
				11	Phokhungri
				10	Phor
Kikruma	7,531	32,025	12	3	Pfutsero
				9	Chetheba
Pfutsero	8,250	38,616	29	7	Sakraba
				4	Pfutsero
				2	Khezhakeno
				6	Chizami
				5	Zuketsa
				5	Razieba
Total	31,582	1,38,843	117		

Source: Census 2011

As per Census 2011, population of Phek district is 163,294. Phek district is the 2nd largest district in the State accounting for 12.22% of the total geographical area of the State. In 2011, Phek had population of 163,294 of which male and female were 83,684 and 79,610 respectively. Out of the total population of Phek, 15.07% lives in urban regions and 84.93% population lives in rural areas of Phek district. Kikruma village has the highest population in Phek district.

Table 3.2 Population and number of villages in Kiphire District

Kiphire District					
Rural Development (R.D.) Block	No. of households	Total Population	Total no. of villages	Circle wise no. of villages	Name of circles falling within each R.D. Block
Sitimi	3,534	18,153	40	13	Sitimi
				15	Seyochung
				12	Longmatra
Kiphire	3,351	14,527	29	12	Amahator
				9	Kiphire
				8	Kiusam
Pungro	4,777	24,837	27	19	Pungro
				8	Khonsa
Total	11,662	57,517	96		

Source: Census 2011

In 2011, Kiphire had population of 74,004 of which male and female were 37,830 and 36,174 respectively. Out of the total Kiphire population as per 2011 census, 22.28% population lives in urban regions of district and 77.72% population lives in rural areas of the district. Per capita income of individuals in the district is low. In Kiphire district, there are 6 uninhibited villages.

Table 3.3 Population and number of villages in Zunheboto District

Zunheboto District					
Rural Development (R.D.) Block	**No. of households**	**Total Population**	**Total no. of villages**	**Circle wise no. of villages**	**Name of circles falling within each R.D. Block**
Zunheboto	2,197	10,592	18	18	Zunheboto Sadar
Suruhuto	3,745	18,550	35	14	Suruhuto
				21	Asuto
Satakha	4,664	22,594	41	5	Zunheboto Sadar
				20	Satakha
				5	Saptiqa
				11	Satoi
Tokiye	4,079	21,355	34	6	Asuto
				28	Aghunato
Akuluto	4,740	23,159	41	9	V.K
				10	Akuluto
				17	Atoizu
				5	Akuhaito
Ghathashi	3,589	16,910	23	10	Poghuboto
				13	Ghathashi
Total	23,014	1,13,160	192		

Source: Census 2011

Zunheboto district has total 191 villages, excluding Satakha census town. Aghunato Circle has the highest number of villages, i.e. 28 villages. Out of total population of the district in 2011, i.e. 141,014, male and female population was 71,169 and 69,845 respectively.In 2011, urban population of the district was 27,597 and rural population was 113,160. There are 13 sub districts in the district; among them Zunheboto Sadar is the most populous sub district.

Table 3.4 Population and number of villages in Tuensang District

Tuensang District					
Rural Development (R.D.) Block	**No. of households**	**Total Population**	**Total no. of villages**	**Circle wise no. of villages**	**Name of circles falling within each R.D. Block**
Noksen	2,768	16,160	12	10	Noksen
				2	Ngoungchung
Chare	2,039	11,156	15	15	Chare
Longkhim	3,272	17,306	12	12	Longkhim
Sangsangyu	4,419	25,063	25	8	Sangsangyu
				6	Tuensang Sadar
				8	Ngoungchung
				3	Sotokur
Noklak	7,969	40,700	32	9	Noklak

Tuensang District					
Rural Development (R.D.) Block	**No. of households**	**Total Population**	**Total no. of villages**	**Circle wise no. of villages**	**Name of circles falling within each R.D. Block**
				6	Chingmei
				7	Nokhu
				10	Panso
Shamator	2,915	14,858	14	11	Shamator
				3	Tsurungto
Chessore	3,190	15,979	17	6	Chessore
				7	Mangko
				4	Sotokur
Thonoknyu	3,210	18,600	17	17	Thonoknyu
Total	29,782	1,59,822	144		

Source: Census 2011

In 2011, Tuensang had population of 196,596 of which male and female were 101,933 and 94,663 respectively. Out of the total population of Tuensang in 2011, around 18.71%, i.e. 36,774 people live in urban regions and 81.29%, i.e. 159,822 live in rural regions of the district. In the district, there are 6 uninhibited villages.

Following maps depict block/town wise and village population distribution in the hinterland of Tizu & Zungki river (NW 101).

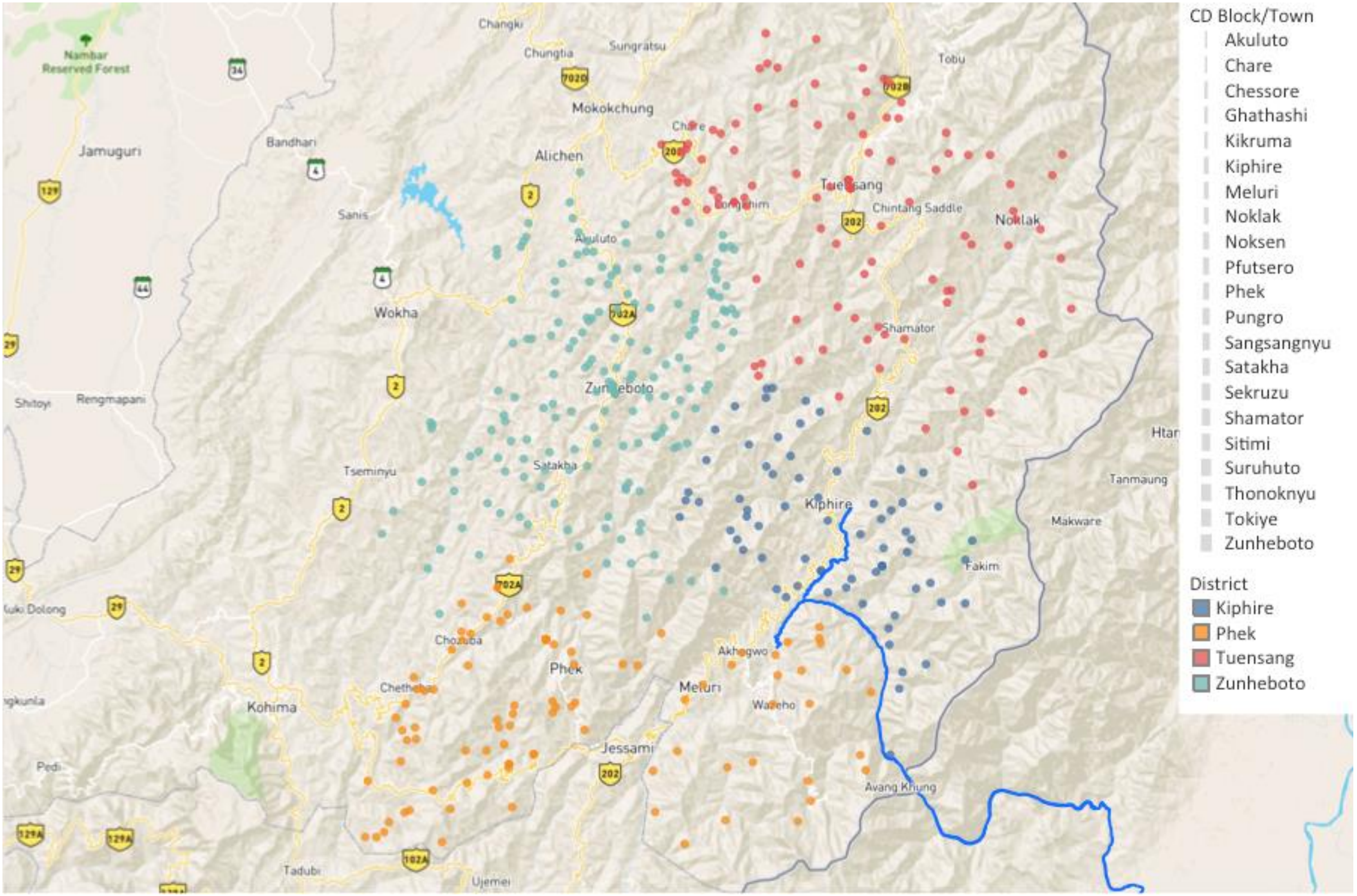


Fig. 3.6 Village wise Population distribution in the hinterland

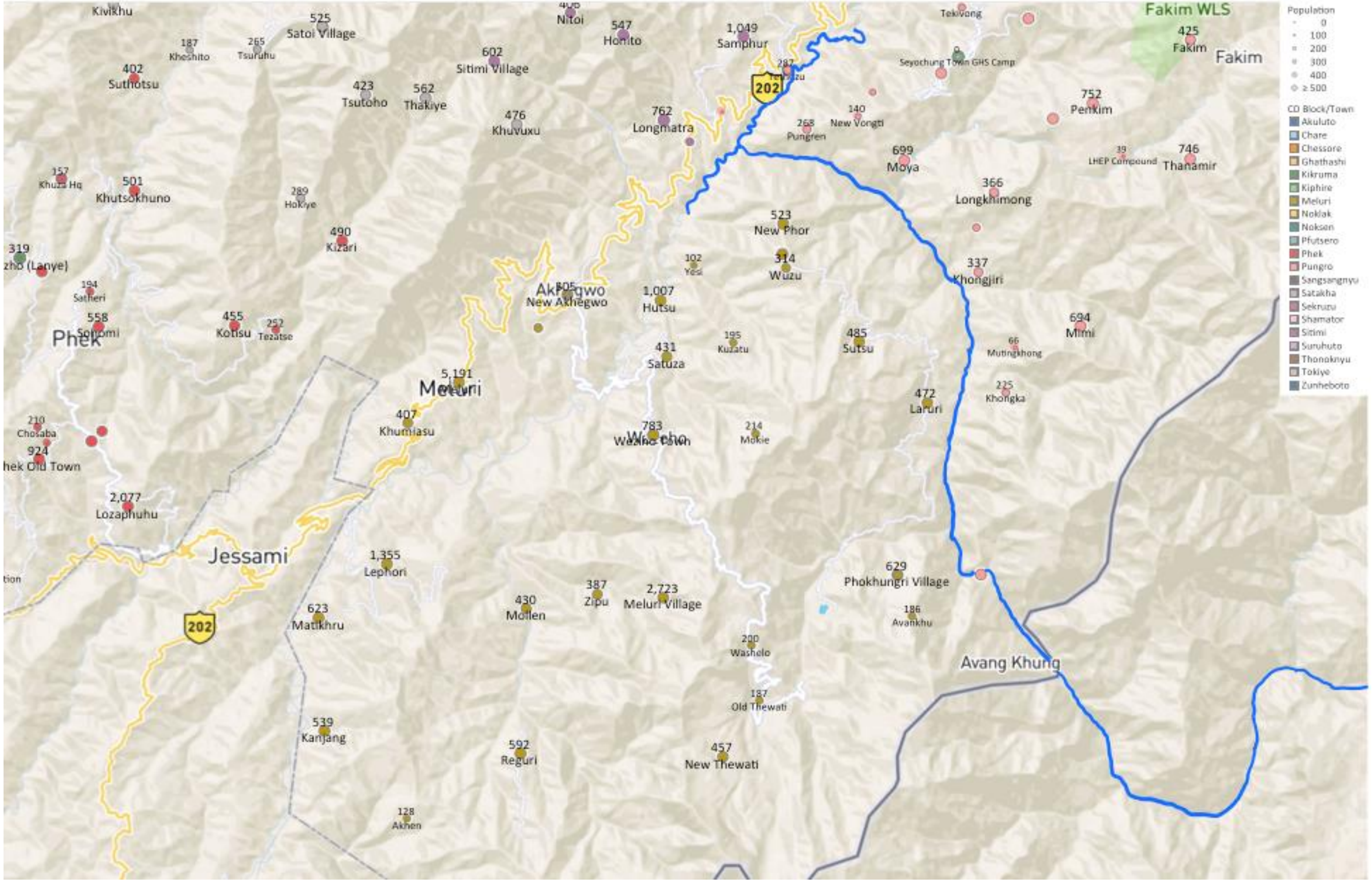


Fig. 3.7 Block/Town wise Population in the hinterland

3.2.2 Economic Profile of the Hinterland

Economy Sectors of Nagaland

Primary

- Agriculture
- Horticulture
- Floriculture
- Forestry
- Fishing
- Mining & Quarrying

Secondary

All types of manufacturing industries come under secondary sector. The districts which fall in the hinterland of NW 101 does not have large industrial units. There is a cement plant and mineral based plant in Wazeho. Few micro and small scale industries exist, which are engaged in bamboo, handicraft, food processing, pottery, rubber etc.

Tertiary

Service based industries like banking & insurance, Hotels and restaurants, Communications etc. come under Tertiary sector. Tourism industry has potential to grow in Nagaland.

Fig. 3.8 Economy Sectors of Nagaland

3.2.2.1 Primary Sector

Primary sector consists of Agriculture, Forestry & Logging, Fishing, Animal husbandry and Mining & Quarrying. With majority of people living in rural areas, agriculture is the main occupation. Fishing is another major activity of the region. Agro processing and fish processing activities also take place in the hinterland.

- Agriculture

About 70% of the population of Nagaland depends on agriculture. 70% of the total cultivated area is occupied by Rice, consisting about 75% of the total food grain production. Maize, beans, pea, cowpea and pulses, like arhar and nagadal are the common crops. Other important crops are corn, millets, tobacco, oil seeds, sugarcane, potatoes and fibers.

Table 3.5 Agriculture Production in the hinterland (Fy 18)

(Unit- '000 MT)

	Phek	Kiphire	Zunheboto	Tuensang
Rice	45.79	26.88	33.73	40.22
Maize	17.53	14.97	20	20.12
Jowar	0.05	0.05	-	-
Other Cereals	2.6	0.31	1.77	1.89
Pulses	3.96	5.34	3.26	10.02
Oil Seeds	6.84	3.05	12.59	5.63
Commercial Crops	43.91	20.52	27.05	48.95
Total	120.68	71.12	98.4	126.83

Source: Director of Agriculture, Nagaland, Kohima

- ✓ Kiphire District- The primary mode of agricultural practice is jhum cultivation (dry farming, burn method of cultivation). Rice is the major crop of the district. Other main crops grown in the district are maize, millet, barley and varieties of beans, called 'Kholar'. Cash crops like potato, soybean and groundnut are also grown in the district.

- ✓ Phek District- Agriculture is the main occupation of the district. Around 80.84% of population is engaged in agriculture. Terrace rice cultivation is predominant.

- ✓ Zunheboto District- The main occupation of people of the district is agriculture. Majority of people, living on the bank of Tizu river, practice terrace cultivation.

- ✓ Tuensang District- The most common practice of agriculture in the district is Jhum-cultivation. The main crops are Rice Maize, Millet, Kholar bean etc.

- Horticulture

Banana, orange, passion fruit, guava, are the common fruits grown in the hinterland. Among vegetables, cabbage, garlic, potato, ginger and cardamom are commonly grown.

- ✓ Kiphire District- The general climatic condition of the district is favorable for horticultural farming. In colder regions such as the foothills of Saramati Mountain, apples are grown in abundance. Thanamir village is famous for its exquisite apple produce. Other fruits like orange, mango, guava, and banana are also grown abundantly.

- ✓ Phek District- Horticultural crops occupy nearly 2,337 ha. area in Phek district. Geographical conditions of the district are well suited for the production of horticulture crops. The main fruits grown in the district are orange, passion fruit, pear, peach, plum, kiwi, guava, lemon, papaya and banana etc. In Pfutsero, apple is grown.

  Cabbage, tomato, potato, tapioca, colacassia, leafy vegetable etc. are the main vegetable crops grown in the district. These crops have good market potential, but due to their perishable nature they cannot be kept for longer time.

  The below tables depict production of fruits and vegetables in the districts, which fall in the hinterland (Phek, Kiphire, Zunheboto and Tuensang).

Table 3.6 Production of major Horticulture Crops in the hinterland (Fy 17)

(Unit- MT)

Sr. No.	Fruit	District			
		Phek	Kiphire	Zunheboto	Tuensang
1	Apple	528	1,035	79	-
2	Pear	322	381	252	343
3	Plum	498	211	204	431

Sr. No.	Fruit	District			
		Phek	Kiphire	Zunheboto	Tuensang
4	Peach	270	-	273	255
5	Orange	4,734	4,298	4,270	4,068
6	Pomegranate	82	-	-	58
7	Papaya	1,723	1,360	1,605	1,232
8	Banana	10,300	9,204	8,865	9,685
9	Guava	361	414	429	362
10	Mango	235	313	139	130
11	Litchi	136	159	165	112
12	Jackfruit	210	186	150	171
13	Pineapple	9,493	9,360	8,448	8,848
14	Grapes	114	-	-	118
15	Mosambi	105	128	42	82
16	Passion Fruit	1,824	2,655	1,526	2,205
17	Kiwi	882	-	862	-
18	Goose Berry	392	289	303	280
	Total	32,209	29,993	27,612	28,380

Source: Directorate of Horticulture

Table 3.7 Production of major Vegetable Crops in the hinterland (Fy 17)

(Unit- MT)

Sr. No.	Vegetable	District			
		Phek	Kiphire	Zunheboto	Tuensang
1	Sweet Potato	1,980	-	-	2,155
2	Cabbage	20,640	10,761	1,259	14,204
3	Cauliflower	472	423	332	393
4	Brinjal	302	161	303	265
5	Chilly	4,164	3,704	2,414	4,812
6	Peas	790	748	658	535
7	Beans	1,654	2,464	1,184	4,122
8	Tomato	1,469	1,908	1,792	1,695
9	Ginger	538	392	4,896	5,203
10	Garlic	386	298	202	185
11	Radish	854	267	380	484
12	Colacasia	3,374	-	5,041	2,480
13	Taioca	10,150	-	9,336	7,106
14	Carrot	596	451	549	523
15	Onion	424	341	514	655
16	Naga Cucumber	293	272	252	245
17	Mushroom	263	-	198	239
18	Leafy Vegetables	4,246	-	4,280	4,127
19	Pumpkin	576	208	763	443
20	Watermelon	230	186	121	101
21	Others	91	2,765	81	3,854
	Total	53,492	25,349	34,555	53,826

Source: Directorate of Horticulture

Most of the horiculture produce is marketed in the local markets leading to huge volume of surplus and wastage. The Government has introduced several schemes of assistance for fruits and vegetable processing. Potential from Agriculture products for NW 101 is discussed in the Section 'Commodity Composition'.

- Floriculture

There is good potential for floriculture industry in Nagaland. Many species of orchids are available in the state, which has tremendous commercial potential. These can be exported. The standard of cut flowers produced in the state is of superior quality and in high demand both within and outside the state. However, these are perishable commodities and due to their time sensitive nature, they could not be transported using waterways.

- Forestry

The hilly region of the hinterland comprises of green vegetation, whereas lower region is comprised of deciduous forest. Out of 202,600 ha. of total land area of Phek district, forests occupy an area of approximately 56,593.36 ha. The hinterland of NW 101 is rich in forest products like timber, bamboo and cane. Medicinal herbs and aromatic plants also grow abundantly in the hinterland.

- Fisheries

In Phek district, very less number of farmers involve in pure fish farming. Paddy cum fish culture is the common fish farming scenario in the region. Demand for fish rearing in Kiphire district is met through supply from other states. Farmers have started fish farming as an activity for earning income.

Table 3.8 Production of Fish (Culture & Capture) in the hinterland

(Unit- MT)

Year	Hinterland				Entire State
	Kiphire	Phek	Zunheboto	Tuensang	
Fy 13	194	337	239	275	7,130
Fy 14	227	363	267	288	7,465
Fy 15	251	381	310	306	7,835
Fy 16	260	390	345	349	8,220
Fy 17	270	399	380	438	8,605
Fy 18	290	412	380	412	8,990
Fy 19	310	412	382	412	9,058

Source: Directorate of Fisheries

As depicted in the above table, production of fish in the hinterland is not high enough to provide an opportunity for NW 101. Moreover, this fish volume is mostly consumed in the district and nearby region. The perishable nature of fish would also deter any potential for its movement using waterway.

- Mining & Quarrying

Nagaland is rich in mineral reserves, which are mostly unexploited. The main mineral reserves of Nagaland comprise of coal, limestone, marble, nickel, cobalt, chromium, magnetite, copper, zinc and recently discovered platinum, petroleum and natural gas. There are deposits of decorative and dimensional stones also in the hinterland.

The State Government is trying to develop Mineral based industries by providing basic infrastructure requirements such as roads, water supply, power etc. to facilitate production and transportation of input and output. Development of mineral based industries is still in nascent stage.

Kiphire district is rich in natural resources. Other metals like Zinc, Molybdenum and other precious metals, like gold and platinum are found in the eastern parts of Phek, Kiphire and Tuensang districts. Production of Minerals in the hinterland is discussed in Commodity Section. Development of more mineral based industries in the hinterland would contribute in economic growth of the region.

3.2.2.2 Secondary Sector

The Secondary Sector includes Manufacturing, Construction, Electricity, Gas & Water Supply.The secondary sector grew at a CAGR of 6.20% from Fy 11- 12 to Fy 16-17 (Source-IBEF). The districtsin the hinterland, i.e. Phek, Kiphire, Zunheboto and Tuensang are mostly underdeveloped regions and do not have large scale industries. There exist micro and small enterprises in the hinterland. There exists a cement plant, Wazeho Cement plant in Phek district. There is also a plant for decorative and dimensional stones in Wazeho. Due to the abundance of minerals in the hinterland, there is potential to develop mineral based industries, which would eventually provide opportunity for NW 101.

3.2.2.3 Tertiary Sector

The tertiary sector consists of Tourism, Infrastructure, Hotels& Restaurants, Real estate, Service sector, Transport, Education, Storage, Communication, Banking & insurance, Business Services, Public administration & other services etc. The tertiary sector is one of the fastest growing segments in Nagaland. The tertiary sector grew at a CAGR of 10.91% between Fy 11-12 and Fy 16-17. (Source- IBEF)

Tertiary sector consists of mostly service-based industry, so it would provide opportunity for passenger and tourism traffic through waterway in Tizu and Zungki river. At present, tourism is limited in the state due to its geographic isolation and political instability. However, there is potential to boost tourism sector in the state, which would eventually contribute to tourist traffic on the proposed waterway. The rich culture and art of the tribesin the state is a major tourist attraction.Tourist Traffic section shows the famous tourist places in the catchment area, which would provide opportunity for tourist traffic in NW 101.

3.3 Infrastructure Assessment

Infrastructure plays a vital role in the economy of any region, as it boosts industrial, tourism and other sectors. This section would study the existing and upcoming infrastructure in the catchment area.

Prospects for handling cargo, passenger and tourist traffic would receive a tremendous boost by good connectivity. Connectivity like approach road, proximity to national and state highway and railway station can enhance the terminal's prospect for water transportation. Collectively, these features become a deciding factor in choosing one evacuation mode over the other.

Nagaland is a land locked state with hilly and mountainous terrain.Airway and railway is very limited in the state; hence roadway is the only means of transport, which provides accessibility even to the remotest regions of the state. The hinterland of NW 101 suffers from poor transport facilities. The condition of roadways is not good. All the areas are not connected with railways. At present, there exist no ferry ghats in the entire identified stretch.

3.3.1 Roadway

The total length of National Highways within the state of Nagaland is 1546.70 km. The major roadways in the hinterland is listed below.

- NH 202- This national highway connects Kiphire to Kohima and Tuensang districts. It connects Mokokchung- Tuensang- Kiphire- Akash Bridge. It continues up to Akhegwo, which further moves to Longmatra.
- NH 29- The Highway starting from its junction with NH 27 near Dabaka (Assam)-Dimapur-Kohima- Chizami- Jessami NH 202 (Manipur).
- NH 702A- The highway starting from its Junction with NH 2 near Mokokchung connecting Zunheboto, Phek and terminating at its junction with new NH 202 near Meluri.
- SH- It is from Akhegwo to Avakhung.

Table 3.9 Total Length of Roads in the hinterland under PWD (Fy 15)

(Unit-km)

	Surface				Unsurface			
	Phek	Kiphire	Zunheboto	Tuensang	Phek	Kiphire	Zunheboto	Tuensang
National Highways	152.0	93.0	33.0	150.0	-	-	-	-
State Highways	165.0	40.0	212.0	68.0	-	-	-	-
M.D.R.	226.0	112.0	79.0	28.0	22.0	-	49.0	96.0
O.D.R.	223.2	12.0	290.0	40.5	127.8	89.5	515.0	660.6
Rural Road	26.1	14.7	117.5	69.0	325.7	303.9	503.4	529.0

Source: Statistical Handbook of Nagaland 2017

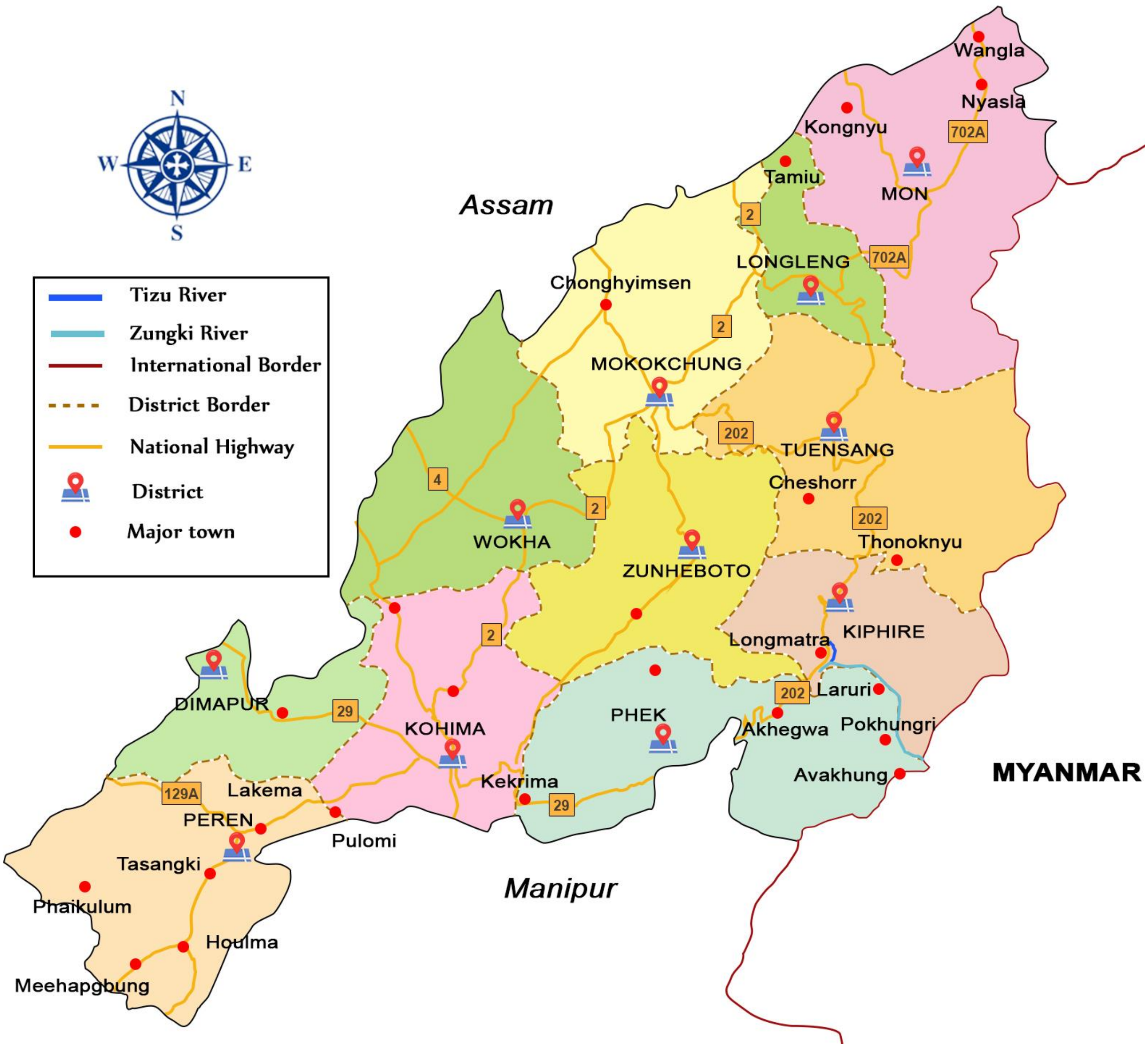


Fig. 3.9 Major Roads in Nagaland

- ✓ **Kiphire –**Inadequacy of the infrastructure and lack of proper connectivity of the district with the rest of the state is a major bottleneck. The total road network within the district is only 626.9 km. Out of this, a total of 403.9 km is concrete and 223 Km is kaccha. In the district, there are few villages, namely Shishimi, Vongtsüvong, Khong and Lopfukhong, which are yet to be connected. All roads are under the PWD R&B except for 78.5 km of NH 202, which passes through the district. Vehicular movement is relatively low even in the district headquarter.

- ✓ **Phek –**Phek district is largely connected with roadways.

- ✓ **Zunheboto –**Zunheboto town has good road connectivity. However, many villages of the district lack road network. Underdeveloped villages like Hokiye, Ikiye, Itovi and Shishimi are not yet connected even by road.

- ✓ **Tuensang –**The stretch of NH 202, which passes through Tuensang to Longleng is lebelled as NH 702B.

Roadway is the main mode of transportation in the hinterland. However, most of the roads in the region are in poor condition, which is a major hurdle for the economic growth of the region. The hinterland of Tizu & Zungki river is mostly hilly and covered in thick vegetation. Roads in the hills are serpentine as shown in the below image.

Fig. 3.10 Serpentine roads on hills

Local roads are fair weather roads, and not all weather roads. During monsoon, road connectivity in the hilly regions suffer due to occurrence of landslides. The hills are prone to landslides. During monsoon, occurrence of landslides is common in Nagaland, which damages roads and vehicles. This disrupts road connectivity and adversely affect the normal activities of locals, as they are cut off from other regions. The below image shows narrow roads in steep hills, which are prone to landslides.

Fig. 3.11 Narrow roads on landslide prone hills

The below image shows poor condition of roads in the hinterland. These kaccha roads become muddy and deplorable during monsoon, which makes connectivity more difficult. Sometimes, local roads are completely washed away during monsoon. Development of inland waterway would solve all these problems.

Fig. 3.12 Poor condition of roads in the hinterland

3.3.1.1 Link Road to Avakhung

Avakhung is crucial for trade movement to/from Nagaland. It is located at Indo-Myanmar border and there exists a border trade center here. It is necessary that Avakhung has good road connectivity. Avakhung is 306 km from Kohima and 378 km from Dimapur airport and railway station. The road from Kohima to Avakhung passes through 194 km. on the National Highway (upto Akhegwo) and further 96 km on State Highway (between Akhegwo to Phokhungri). To reach Avakhung, the road between Pokhungri and Avakhung, a distance of 18.5 km. needs to be developed and INR 8.28 crores has been sanctioned by the North East Council (NEC). The construction of this road is in progress.The major challenge of this road development is steep rocky terrain. This road would be crucial for any kind of trading activity in Avakhung. This road would be a major competitor for NW 101.

The below image depicts under construction road near Border Trade Center at Avakhung.

Fig. 3.13 Under construction road near Border Trade Center, Avakhung

Meluri area in Phek district is designated as mineral belt; hence it is crucial that this area is well connected. The road from Kohima to Meluri is already declared as national highway. The 64 km stretch of road from Meluri to Phokhungri (EAC) post passing through Wazeho (houses cement factory and dimesntional stone plant) is state highway.

NH 29 and NH 202 connect Longmatra to Dimapur/Kohima in Nagaland. Longmatra to Avakhung is connected by 217 km roadways. During fair weather, the distance between Longmatra to Avakhung is covered in 6 hours by roadways, whereas during monsoon season, the travel time increases to minimum 12 hours by road. Development of inland waterway in Tizu river would reduce this distance to 35 km and the waterway would reduce travel time throughout the year.

Problems due to poor roads in the hinterland could be solved by developing inland waterway in the identified stretch of Tizu and Zungki river. Inland waterway would be navigable throughout the year and would ease the movement between villages, located near the river.

3.3.2 Railway

Nagaland is one of the least connected state in India through Railway network. At present, there is no railway line in the vicinity of the study area. Intensive expansions have been taken up by the northeast frontier railway in this region as in the case of the rest of the north east states.

The nearest and only railway station of the state is in Dimapur. The railway station at Dimapur connects Nagaland with the rest of the country via Assam. Dimapur is more than 250 km away from Longmatra by road. A new railway line is coming up, which would connect Dimapur with Kohima. Dimapur also houses freight station and goods yards of Lumding division.

Following are freight stations in Nagaland, used for cargo loading and unloading purpose. All these freight stations have half rake facility. Full rake facility is available in all the stations, except FCI Siding, Dimapur. Train-loading facility is available in Dimapur and Tuli. Wagon loading facility is available only in FCI Siding at Dimapur. However, these FCI are located very far from NW 101; hence they would not provide any opportunity to the waterway.

Table 3.10 Freight Stations in Nagaland

Station Name	Division	Commodity
FCI Siding (BG) Dimapur	LMG-Lumding	**Inward Only-** Food Grains (Rice, Wheat, Maize, Barley, Bajra, Gram, Pulses), Atta (Flour), Rawa, Ballast Balt, Railway Material Consignment, Sleeper (Concrete)
Dimapur		**Inward/Outward Except-** POL & POL Products, LPG, Coal, Automobiles
IOC Siding/Dimapur (P)(BG)		**Inward Only-** POL & POL Products, LPG, Ballast Balt, Railway Material Consignment, Sleeper (Concrete)

Station Name	Division	Commodity
Tuli	TSK-Tinsukia	**Inward-** Ballast Balt, Coal, Sand other than Silica sand, Railway Material Consignment **Outward Only-** Ballast Balt, Coal, Sand other than Silica sand, Stone, Railway Material Consignment

Source: FOIS

3.3.3 Airway

Dimapur Airport is the only airport in the state. It is 184 km from Phek. Direct flights connect the airport to Guwahati and Kolkata. Besides, State Helicopter Service is operated on weekly basis connecting all the major district headquarters. Chartered sorties are also undertaken for lifting VVIP/VIP and patients from remote and rural areas.

3.3.4 Bridges

A new road bridge, i.e. Laruri Bridge (Mineral Bridge) is constructed at Laruri. It has double lane capacity. This Bridge across Tizu river connects the limestone deposit areas between Laruri village in Phek district and Mimi village in Kiphire district. This bridge is constructed in the Nimi – Laruri Mineral Link Road. The bridge and the road facilitates exploration of minerals, like limestone and magnetite. The below table depicts the horizontal and vertical clearance data of the bridge.

Table 3.11 Details of Laruri Bridge

Location	Latitude (N)	Longitude (E)	Horizontal Clearance (m)	Vertical Clearance (m)
Laruri Bridge	25°41'9.58"	94°51'14.90"	15.0	4.0

Fig. 3.14 Laruri Bridge on Tizu River

Fig. 3.15 Tizu River near Laruri Bridge

3.3.5 Upcoming Infrastructure

3.3.5.1 Lower Tizu Hydro Electric Project

A hydro electric project would be developed in Kiphire district. The proposed project site is located in river Tizu about 12 km downstream from confluence of Tizu and Zungki rivers. The dam site is located below Moya village in Kiphire district. The dam site is about 290 km away from Kohima. The catchment area at proposed dam site is 6,573 km2. The catchment area is sparsely populated and covered with forests.The proposed reservoir would lead to submergence of around 72 hectares land.This project will be developed and owned by Department of Power, Government of Nagaland. Location of the proposed Lower Tizu hydro electric project are listed in below table.

Table 3.12 Location of Lower Tizu Hydro Project

1.	Location	Facilities
(i)	State	Nagaland
(ii)	District	Kiphire
(iii)	Village	Moya
(iv)	Accessibility (Nearest airport and railhead at Dimapur)	Dimapur to Kohima (Capital of Nagaland)- 70 km
		Kohima to Kiphire - 259 km
		Kiphire to Moya- 69 km
		Moya to Project site- 9 km
(v)	Geographical Coordinates of Dam Site	Longitude- 94°50’2.68”E
		Latitude- 25°44’50.49”N
(vi)	No. of Units	3
(vii)	Installed Capacity (each unit)	42 MW

Source: Department of Power, Nagaland

The below image shows proposed site for Lower Tizu Hydro Electric Project.

Fig. 3.16 Proposed Lower Tizu Hydro Electric Project site

The proposed dam site is accessible by road from NH 150 at Longmatra via Moya Village. The site is approachable from nearest airport and railway head at Dimapur (407 km) via Kohima (337 km), Kiphire (78 km) and Moya (9 km).

Development of this upcoming hydro power project would be beneficial for NW 101, as due to the development of dam, the river will be navigable in that stretch from the dam till Avakhung. This will solve the problem of dredging and result in saving cost. Due to the upcoming dam, the water level in the stretch from the dam till Avakhung will be high; hence vessels could be easily moved. However, due to the elevation near this project, vessel navigation on upstream of NW 101 (from dam towards Longmatra) would be a challenge. Installation of navigation lock in the dam would make the entire stretch of NW 101 navigable and vessels would be able to cross the dam.

3.3.5.2 Connectivity development

- Road Connectivity to Pangsha (ITC), Lungwa (ITC) and Avakhung (ITC)
- Indo - Myanmar Border Trade Routes:
  - i) Akhewgo (NH 202) to Avakhung -104 km
  - ii) Chendang Saddle (NH 202) to Pangsha - 62 km
  - iii) Tizit- Mon - Lungwa - 90 km
- Construction of 2-Lane Trans Eastern Nagaland Road from Mon to Avakhung (280 km).

3.4 Industrial Scenario

3.4.1 Existing Industries

There exists no major industry in the hinterland. There are two mineral based industries in the hinterland. The only large scale project is Likhimro Hydro Power project in Kiphire district; however this hydro project would not provide any opportunity to the proposed waterway.

The districts that fall in the hinterland are underdeveloped and industrial growth trend in these districts is low. Traditionally, people in these districts work on metal with simple technology and most of the production is meant for household needs and requirement. Basketry, weaving, Stone crushing, Wood based units, Saw mill, Cement craft, Steel Fabrication, wood carving, pottery, Handloom products, Cane & Bamboo products, Stone Tiles, Spinning and Blacksmithy, Food processing units, Carpentry are traditional activities.

There exist Cement plants in the hinterland due to availability of chemical grade limestone in abundance. Nimi Limestone belt is the major limestone reserve in the state with more than 1,000 million tonnes of chemical grade limestone. The major cement plant in the hinterland is Wazheo Cement plant in Phek district. NSMDC has implemented several projects for exploiting the mineral reserves of the state for economic development. One project is construction of Mineral Link Roads, namely Laluri-Nimi (20 km), Ziphu-Moke (9 km) and Wazeho-Satuza (8 km).

The Map below depicts existing cement and dimensional stone plants at Mineral rich region. It also depicts border trade centers in the hinterland.

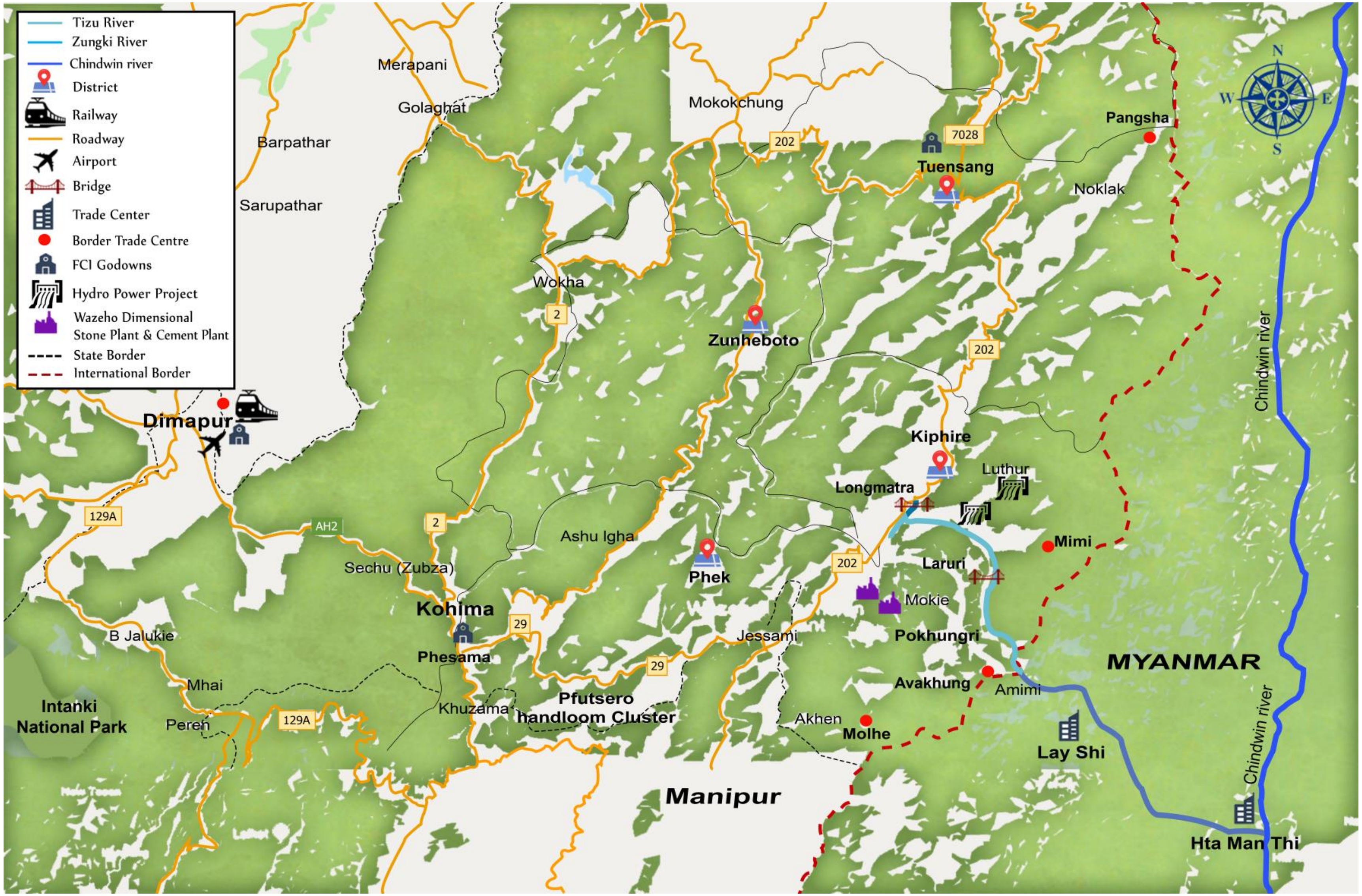


Fig. 3.17 Industrial Areas in the Hinterland of NW 101

3.4.1.1 Phek District

Phek District is underdeveloped. Major exportable items of the district are limestone, marble, talc, chromite and granite, ginger, kholari, maize, chillies, bumboo items, honey based products and other micro agro based products.

There do not exist well developed Industrial areas in the district. Most of industries are micro and small scale industries such as small number of agro based, furniture based and other small production units. There are micro and small industries for handicraft (mostly bamboo, cane and wood based). There is a handloom cluster at Pfutsero. There exist medium to small scale handloom units, handicraft items units etc. Wazeho tile plant is located in Phek. Wazheo Cement plant is the only large industry in the district. Wazeho Dimension Stone Plant under NSMDC is also located in Phek.

- Wazeho Cement plant

Wazeho Cement plant is a State Govt. Enterprise under NSMDC. This 150 TPD Mini Cement Plant in Wazeho is upgraded from 50 TPD. The expansion and modernization of the Plant was completed in May 2008. At present, NSMDC's Wazeho Cement Plant is non operational. State Government is looking for various alternatives to operationalise this cement plant. During discussion with NSMDC, they expressed willingness to use proposed inland waterway in Tizu & Zungki river. This Plant is in the process for privatization as per the Government decision and Operation of the plant would be managed by the Corporation.

Wazeho village is located at a distance of 37 km from Akhewgo, which lies on the State highway (Dimapur – Kiphire Road) and is connected by an all weather road. Dimapur is the nearest rail and air head for Wazeho lying at a distance of 310 km. Limestone quarry and clay quarry are located within a distance of 4-6 km from the plant and connected with an all weather road.

- Decorative and dimensional stone plant (Wazeho)

This plant is located at Wazeho in Phek district. The plant produces marble products and has a production capacity of 200 sq. ft. of stone slabs in a day. The products are in the form of slabs, block, cladding, artifacts and monoliths.

3.4.1.2 Kiphire District

There is a Hydropower project, i.e. Likhimro Hydro Project in Kiphire district. This Hydro Project is located at Pungro in Kiphire. It generates 24 MW power, which is distributed in the state and outside. It is used for irrigation, hydropower and drinking water requirements.

3.4.1.3 Zunheboto District

Zunheboto is an underdeveloped district and there is no large or medium size industry in the district. There are around 48 micro and small enterprises and artisan units. Major exportable items are ginger, soya bean, maize, banana etc.

3.4.1.4 Tuensang District

The district is also underdeveloped and has no large and medium scale industries. There are around 37 micro and small enterprises and artisan units. There exist Border Trade Centre at Pangsha (Pasha). Major exportable items are Soya bean, Maize and minerals, like Cobalt, Limestone, Granite and Coal.

Table 3.13 Opportunity Identification from Industries in Hinterland

Sr. No	District	Industries	Products	Opportunity	Reasoning
1	Phek	Wazeho Cement Plant	Cement	Yes	The plant is non operational at present; however there is plan to revive the plant. When the plant would start production, around 70% of cement could be transported to Myanmar using NW 101. However, this is a remote opportunity and depends on development of river in Myanmar till Hta Man Thi for cargo movement.
2		Proposed Laruri Cement Plant		Yes	After this proposed cement plant becomes operational, its finished product, i.e. cement could be transported to Myanmar using NW 101. However, this is a remote opportunity and depends on development of river in Myanmar till Hta Man Thi for cargo movement.
3		Dimensional Stone Plant	Stone Products	No	The distance of the plant from NW 101 is more than 50 km. Also, due to poor road connectivity between Wazeho to nearest terminal on NW 101, it is very unlikely that it would provide opportunity to NW 101.

Source: Consultant's Analysis

3.4.2 Proposed Industries or Related Infrastructure

To facilitate the industrial growth in the state, the State Government and the Industries & Commerce Department intend to develop infrastructure related to industries. One Industrial Infrastructure Development Center (IIDC) is proposed at Pfutsero.

A cement plant near Laruri is also proposed, which would boost cement production in the hinterland. Once Wazeho Cement plant and proposed cement plant near Laruri become operational and start producing cement, Nagaland's dependence on other states for procuring cement would seize. There is high demand of cement in Myanmar. After development of NW 101 and river stretch in Myanmar till Hta Man Thi, cement from Laruri plant could be transported to Myanmar by NW 101. Please refer Section 3.8.2.3 for details of Chindwin River.

3.5 Commodity Composition

This section would discuss potential commodities, which could provide opportunity to the proposed waterway in River Tizu and Zungki.

3.5.1 Minerals & Mining

The hinterland of NW 101 is rich in mineral reserves. There are limestone, granite and other mineral deposits in the hinterland of NW 101. There also exist rich deposits of varieties of decorative and dimensional stones and other associated metals like Zinc, Molybdenum and other possible precious metals such as gold, and platinum groups of elements in Phek, Kiphire and Tuensang districts of south east Nagaland. The below table depicts mineral reserves available in the hinterland of NW 101.

Table 3.14 Availability of Minerals in District Phek (Fy 10-11)

Minerals	Availability	Units	Reserves
Limestone, Iron Chromium, Nickle, Cobalt	Wazeho	Million Tonnes	4
Stone, Copper, Molybdenum, Chromite, Magnetite, asbestos	-	Million Tonnes	6
Talc	-	Million Tonnes	1
Coal	Akhegwo, Yesi and Molen	-	-

Source: Department of Mines & Geology, Govt. of Nagaland

Table 3.15 Availability of Minerals in District Kiphire (Fy 10-11)

Minerals	Availability
Limestone	Mimi, Salumi, Kamkur
Magnetite	Pokphur, Thongsnyu
Granite	Mini & Luthur
Sandstone	Seyochung, Rishisu, Chanchore, Old Monger, Kisetong and other areas
Green Spiliite	Moya, Likhimro
Boulders, Silty Sand, Sheared Serpentinite	Zungki and Thankaki river side and Mimi-Pungro-Salumi Road

Source: Department of Mines & Geology, Govt. of Nagaland
(* Due to non availability of data, volume of mineral reserves in Kiphire district is not presented.)

Apart from the above mentioned minerals, Crystalline limestone is also found in Moke and Satuza. Limestone resources exist at Satuza, Wazeho, Molen, Mimi, Ziphu, Salumi and Kamku (Kamkhaong) villages. Chromium bearing magnetite ultramaftte, Haematite at Reguri and Chalcedony deposit at Akhen Village are recorded.

- Phek- Limestone deposits are found in Ziphu and Wazeho in Phek district. Malachite mineralization is found at Thewati in Phek.

- Kiphire- Mimi in Kiphire is also rich in mineral reserves, like granite.

- Tuensang-Chemical grade limestone reserve exists in the Nimi limestone belt in Tuensang district. The Geology and Mining Department of Nagaland has established a reserve of 111.07 million tonnes here. There are deposits of Coal, Marble, Limestone and Magnetic in some areas of Tuensang district. Large deposit of magnetite is found near Pokphur village in Tuensang.

The below map shows mineral reserves in Nagaland.

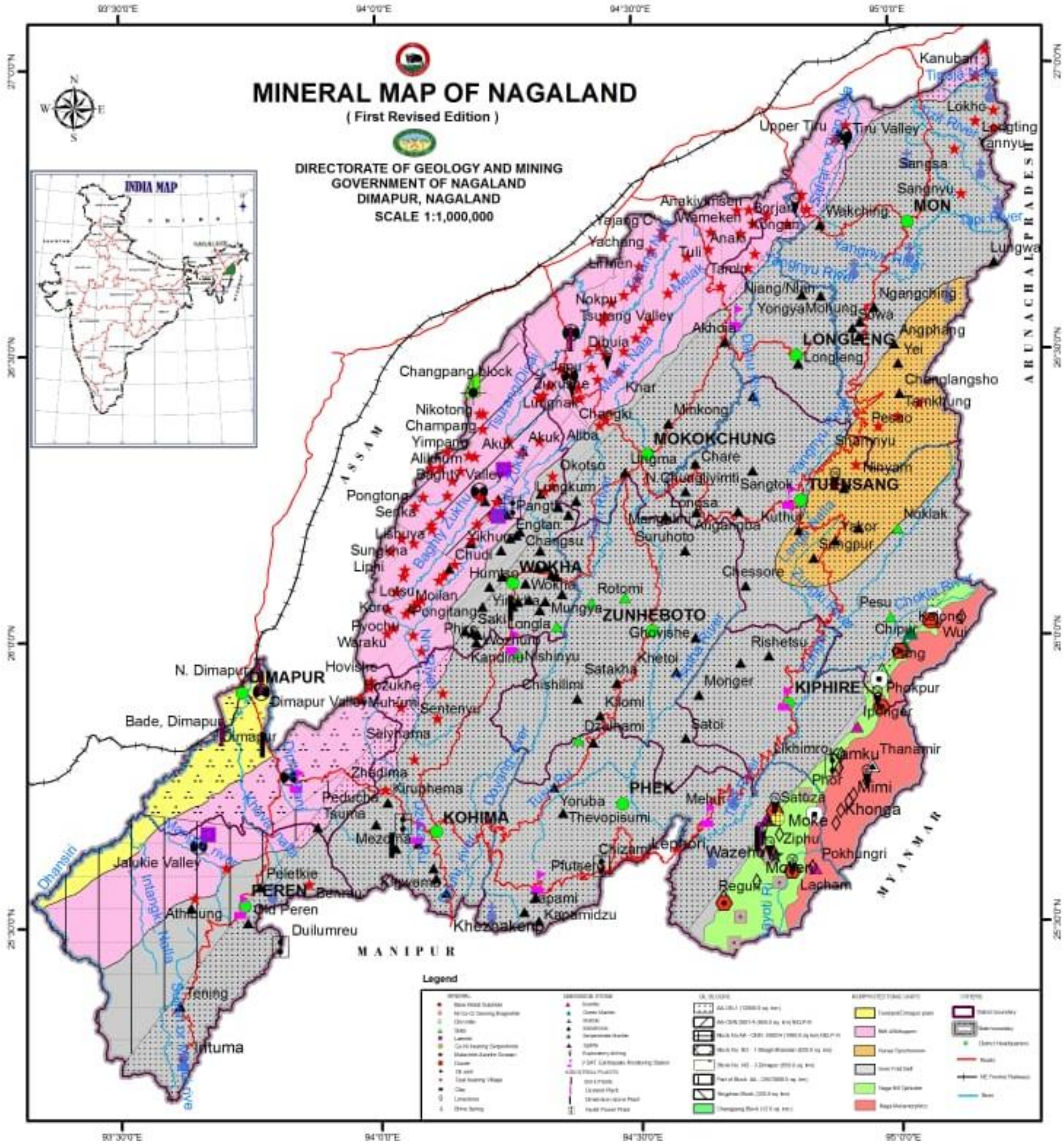


Fig. 3.18 Mineral Map of Nagaland

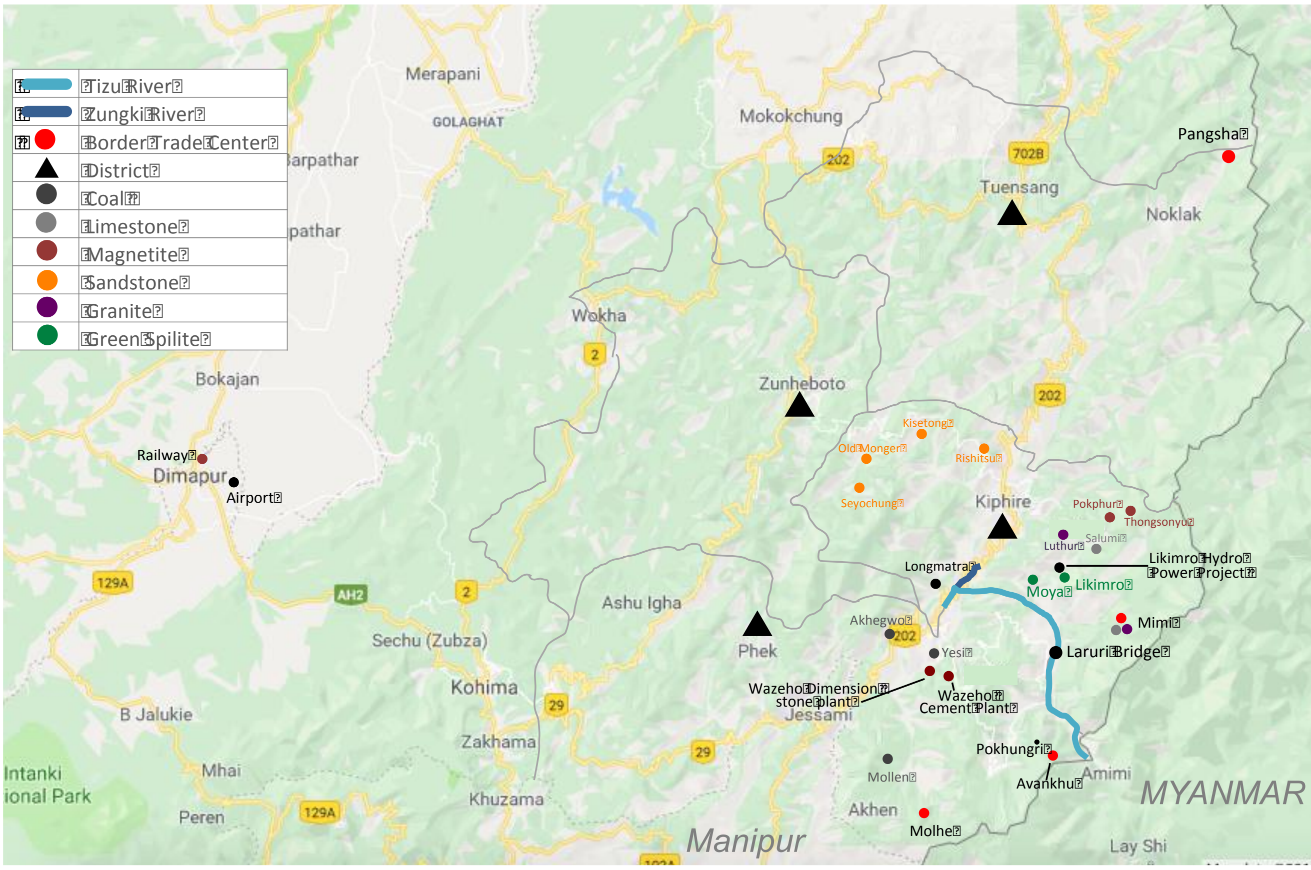


Fig. 3.19 Mineral Reserves in the hinterland

Fig. 3.20 Limestone Reserves in the hinterland

Fig. 3.21 Granite Reserves in the hinterland

Table 3.16 Opportunity Identification for NW 101 from Minerals

Sr. No	District	Mineral Belts	Minerals	Opportunity	Reasoning
1	Phek	Meluri	Coal	No	Meluri is located at a distance of 50 km. from Terminal.Coal is used for local consumption; hence no opportunity for NW 101.
2		Laruri	Limestone	No	Limestone would be consumed by proposed Laruri Cement plant; hence it would not be transported using NW 101.
3		Wazeho	Limestone, Chromium, Nickle, Cobalt	No	Wazeho houses two plants, i.e. Wazeho cement plant and a dimensional stone plant. Both the plants would consume limestone and other minerals, like marble; hence no opportunity for NW 101.
4	Kiphire	Mimi	Limestone, Granite (Marble)	Yes	Granite (marble) from the region, could be transportedto Myanmar using NW 101. This is a remote opportunity and depends on development of NW 101 and river stretch in Myanmar till Hta Man Thi.

Source: Consultant's Analysis

The limestone belt in the hinterland could be exploited, which would eventually help in industrial growth in the region. It is planned that Government would revive Wazeho Cement plant. After operations are resumed in the plant, NSMDC has plans to export around 5 million tonnes of finished product (cement) from the plant.There is also a plan to open another cement factory near Laruri. Capacity of cement production in the region could be increased by setting up more cement factories.

3.5.2 Food Grains & Agro Products

Under various Government schemes, like National Food Security Act and Other Welfare Schemes, food grains is allocated to districts of Nagaland. The below table depicts monthly allocation of food grains in the four districts, which fall in the hinterland of NW 101.

Table 3.17 District wise monthly allocation of food grains under Government Schemes (Fy 19-20) (Unit- MT)

District	Allocation of foodgrains (Monthly)
Phek	1,136.35
Kiphire	681.50
Zunheboto	1,069.40
Tuensang	1,338.41
Total	4,225.66

Source: FCI, Dimapur

Volume of Food grains movement by Railway to Dimapur in the last six months, i.e. Nov 18- Apr 19 is shown in the below table. This food grain is procured from other states.

Table 3.18 Receipt of food grains via Railway at Dimapur (Nov 18-Apr 19)

Sl. No.	Month	Quantity (MT)
1	Nov-18	10,364.02
2	Dec-18	15,569.8
3	Jan-19	23,451.82
4	Feb-19	21,806.47
5	Mar-19	20,930.22
6	Apr-19	20,855.19

Source: FCI, Dimapur

The availability of markets for agro and horticulture products, like fruits and vegetables is scanty in Nagaland. This low density of market directly hampers the production of agro and horticultural crops in the State. Processing facilities are also inadequate for fruits, vegetables and spices. The only functioning processing centre is located at Dimapur, which is far from the identified stretch of NW 101.

Phek District- Marketing of agriculture produce of some of the villages is done by APMC. But due to remoteness and poor connectivity of roads to urban areas the department is unable to market the produce of majority of the villages. Marketing of village produce is mostly done by farmers themselves.

Table 3.19 Markets for agro products in Phek District

Sl. No.	Name of the market centre	Periodicity (Weekly/ Daily)	Important commodities handled	Area covered
1	Phek Town	Daily	Groceries, Vegetables, Fish, Meats etc.	Phek district

Sl. No.	Name of the market centre	Periodicity (Weekly/ Daily)	Important commodities handled	Area covered
2	Kikruma Town	Weekly	Groceries, Vegetables, Fish, Meats etc.	Kikruma Block
3	Pfütsero market	Seasonal/ Daily	Vegetables & fruits	Pfütsero Block
4	Meluri Town	Roadside daily market	Groceries, Vegetables, Fish, Meats etc.	Meluri Block
5	Sukrezu Town	-	-	Sukrezu Block

Source: SREP, ATMA, Phek (kvkphek.nic.in)

The food grains allocated to districts in the hinterland would not provide opportunity to NW 101 as these food grains are locally consumed. Commodities, like fruits, vegetables, fish and meat which are sold in local markets would not provide opportunity to NW 101 due to the perishable nature of these commodities.

Food grains (pulses, beans etc.), which are informally procured from Myanmar near Indo - Myanmar border could provide opportunity for NW 101. At present, these food grains are transported from Myanmar using roadways across the border. After the development of NW 101 and river stretch in Myanmar till Hta Man Thi, this food grain movement could be shifted to waterway.

3.5.3 Fertilizer

Nagaland is an agrarian state; hence it is crucial to understand whether fertilizer consumption in the state would provide opportunity to the proposed waterway, i.e. NW 101.

Annual fertilizer consumption in Nagaland has varied between 324 tons to 437 tons in last three years. Urea has maximum share in the total consumption of fertilizer in Nagaland. There does not exist fertilizer plant in the state; hence it procures fertilizer from other states. It is supplied by fertilizer plants located in Assam. A substantial share of fertilizer is procured from Orissa also.

Table 3.20 Origin- Destination of fertilizer movement in Nagaland

(Unit-Tons)

Company	Plant (Origin)	Consumption (Destination)	Fy 17	Fy 18	Fy 19
BVFCL Namrup-III	Assam	Dimapur	324	-	-
BVFCL Namrup-II			-	99	99
BVFCL Namrup-III			-	198	288
IFFCO Paradeep	Orissa		-	-	50
Total			**324**	**297**	**437**

Source: Department of Fertilizers (Govt. of India) (mFMS)

The below table shows fertilizer sale in Dimapur. From Dimapur, fertilizer gets distributed in Nagaland. As per Department of Fertilizers, There are total 2 wholesalers and 4 retailers of fertilizer in Nagaland. These wholesalers and retailers distribute fertilizer in the state.

Table 3.21 Fertilizer Sale in Dimapur

(Unit Tons)

Product	Fy 17	Fy 18	Fy 19
Urea	324	297	387
DAP	-	-	50
Total	**324**	**297**	**437**

Source: Department of Fertilizers (Govt. of India) (mFMS)

The below image shows Fertilizer Consumption Per Unit of Gross Cropped Area (Kg/Ha) in Nagaland during Fy 17-18.

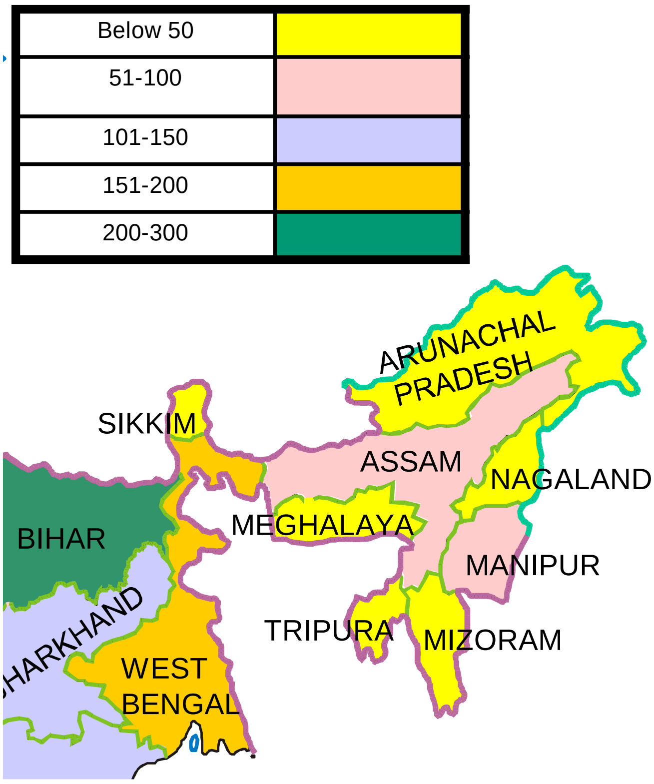


Fig. 3.22 Fertilizer Consumption in Nagaland (Fy 17-18) (Unit Kg/Ha)

Source: Department of Fertilizers (Govt. of India) (mFMS)

In Nagaland, Fertilizer consumption is below 50 (Kg/Ha), which is very less compared to other states. Due to the less volume, it is very unlikely that fertilizer would provide opportunity to the proposed waterway in Tizu & Zungki river.

3.6 Tourism Sector

Nagaland is rich in natural beauty and culture. Picturesque land, green hills, valleys, criss-crossing rivers, lakes, vibrant culture, handicrafts and handlooms, and various festivals make Nagaland a favourite tourist destination. Different tribes in the state have different customs and practices. Tribal festivals provide tourists an opportunity to get a glimpse of the rich culture of these tribes. Hornbill Festival in December is a mega tourism event in the State.

Ministry of Tourism, Government of India, has included 12 villages in Nagaland under the rural tourism scheme in order to promote traditional rural art, craft, textile and culture. The vast Bamboo plantation across the state has added aesthetic value to the hinterland of NW 101. Bamboo plantation is a prospective avenue to boost the tourism industry. Presently, about 46 bamboo species are known to exist in Nagaland. There is potential to promote bamboo tourism as a part of eco-tourism in the hinterland. Handicrafts made of bamboo in the state are popular among tourists.

Tourism Industry of the hinterland has potential to attract large number of tourists, as the districts, which fall in the hinterland have many tourist spots. The below table depicts historic tourist traffic of the state.

Table 3.22 Tourism Inflow Trend of Nagaland

Sr. No.	Year	Domestic	Foreign	Total
1	2010	21,004	1,495	22,499
2	2011	25,216	1,941	27,157
3	2012	28,945	2,173	31,118
4	2013	52,350	2,305	54,655
5	2014	59,507	2,585	62,092
6	2015	64,616	2,769	67,385
7	2016	58,178	3,260	61,438
8	2017	28,503	796	29,299
9	2018*	86,127	4,811 (approx)	90,938

Source: Directorate of Tourism (Statistical Handbook 2017)
(* Tourist inflow statistics 2018; Source- Department of Tourism)

As per Directorate of tourism, tourists inflow were observed in some of the tourist villages in the hinterland during Fy 16-17. These villages are Phek village, Leshemi, Chesezu and Matikhru (Phek District), Satoi, Ghukhiye and Aizuto (Zunheboto District).

3.6.1 Major Tourist Destinations

Some of the popular tourist spots in the hinterland, which attracted tourists in Fy 16 & Fy 17 are listed below. These tourist spots shown in the below table are located within 50 km from the river; however due to hilly terrain and serpentine roadways, the distance by roadways is much longer.

Table 3.23 Famous Tourist Spots in the hinterland (Fy 16 & Fy 17)

District	Tourist Spot	Distance from the River by road (Km)	Arial distance from the River (Km)
Phek	Shilloi Lake	13	6.5
	Dzudu Lake Thuvopsu	182	41
	Zanibu Peak	172	48
	Wazheho	57	14
Zunheboto	Satoi Range	162	23
	Ghoshu Bird Sanctuary	142	40
	Atoizu	135	42
Kiphire	Pungro	10	6
	Fakim Wildlife Sanctuary	-	18
	Mt. Saramati	-	24

Source: Directorate of Tourism

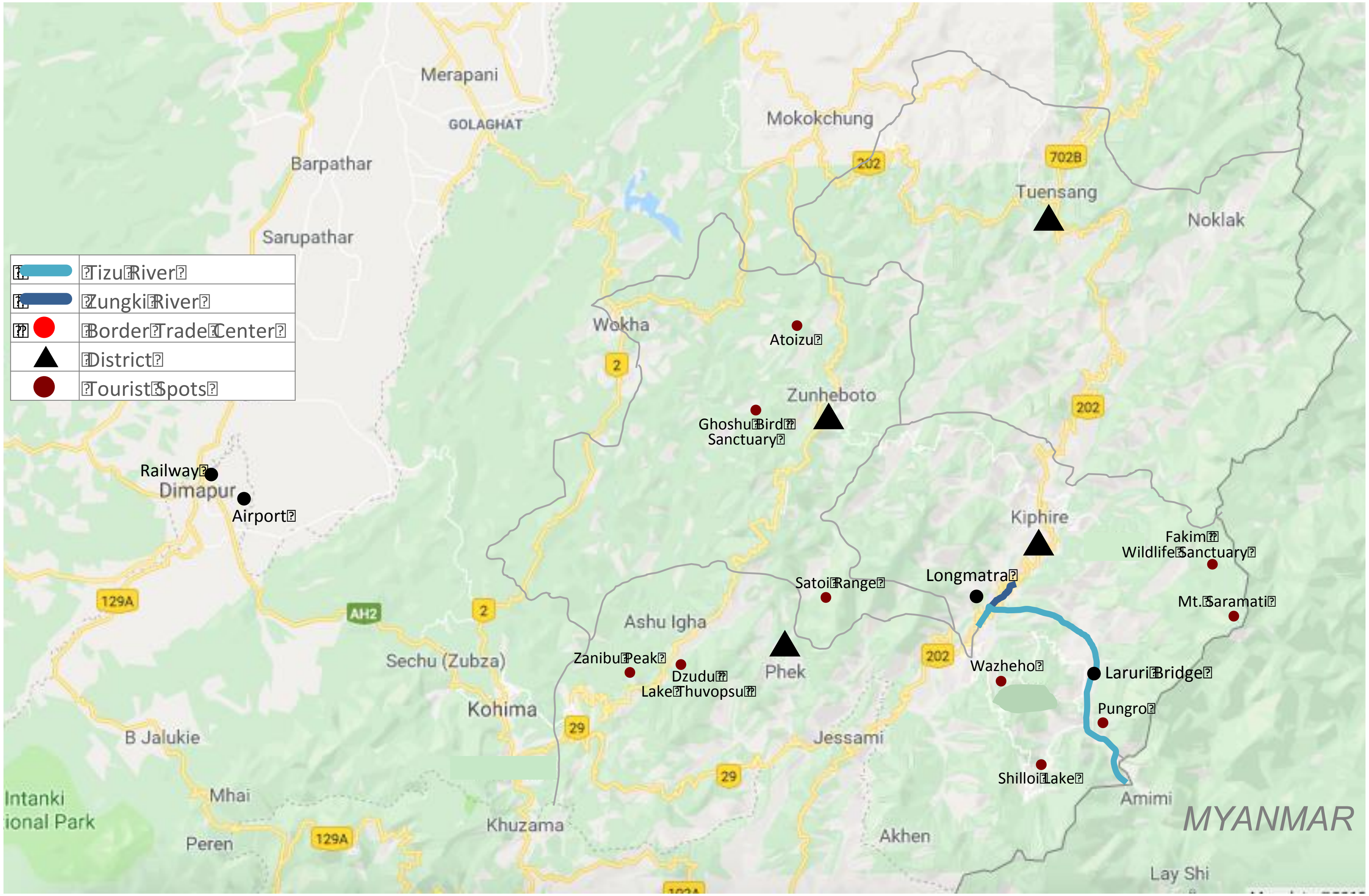


Fig. 3.23 Tourist Spots in the Hinterland

_3.6.1.1_ Phek District

- Shilloi Lake - Shilloi Lake spreads over an area of 0.25-0.30 sq. km. in Phek district. The shape of the lake from the top resembles a giant human footprint and is about 4 mtr. deep. Shilloi Lake is a very picturesque destination with surrounding valleys from all sides. The lake is considered very important by the folks of Latsum village as it is believed that the spirit of a holy child rests in the bottom of the lake.

Fig. 3.24 Shilloi Lake

- Dzudu Lake Thuvopsu- On the top of Mt. Zanibu near Thuvopisumi village, this lake is surrounded by lush greenery. The sparkling water lies in the middle of dense jungles around it. This narrow strip of water is also called the Zanibu Lake. It is a paradise for bird watchers. The lake is considered to be sacred and well-protected by the spiritual guardians.

- Zanibu Peak- Zanibu is a mountain range, which is an extension of Patkai range, the longest mountain range in Nagaland. Around 10 Chakhesang villages encircle this mountain range. The mountain is ever green and full of flora and fauna. Many species are yet to be identified. There is one big lake which stretches nearly 1 km on the mountain range and is called Dzudu Lake.

_3.6.1.2_ Zunheboto District

In the district, Satoi Taluka is a popular tourist destination, which attracts tourists for its natural beauty. There exist two wildlife reserves in the form of Aizuto Forests and the Ghosu Bird Sanctuary.

- Satoi Range- Satoi Range is one of the only remaining virgin forests in Zunheboto district. This range is surrounded by lush green trees and vegetation. Tourists can enjoy sightings of Blyth's Tragopan, a rare bird species in this range. Rare rhododendrons can be spotted in this range during the months of April and May. This range offers facility for camping and trekking.

- Ghoshu Bird Sanctuary- It is located about 9 Km. from the district headquarter of Zunheboto. The Sanctuary houses a wide range of avifauna. It is a home to many species and hosts more than 20 endangered bird species within the sanctuary's boundaries. Few of the commonly spotted birds in the Sanctuary are little Bunting, Cuckoo, Himalayan Black Bulbul, Grey-Hooded Warbler, Oriental Magpie Robin, Great-Eared Nightjar etc.

3.6.1.3 Kiphire District

- Mount Saramati - With 3,840 mtr., it is the highest peak in Nagaland is located in Kiphire district. The mountain range is covered with rich, natural and diverse forests, ranging from sub-tropical ever green and semi ever green to temperate broad leaved and Alpine vegetation. It also has good bio-diversity with natural flora and fauna and various kinds of orchids. Offering a beautiful climb with views of the Rhododendron in its path, Saramati can be reached by taking a three day trek from either Pungro or Salumi towns.

- Fakim Wild Life Sanctuary- It is situated close to the India Myanmar border in the Pungro circle headquarter in Kiphire district. Fakim Sanctuary with an area of 642 hectares is a must visit attraction on a wildlife tour to Nagaland. With hills, high ridges, deep gorges and narrow valleys, here one can see good variation in landscapes.

- Pungro- Pungro is a town in Kiphire district. It is located 36 km. towards South from district head quarter of Kiphire. This place is located in the border of Kiphire and Tuensang District. The Catholic Church is a major place of worship in Pungro. St. Paul's Church is a famous pilgrim center.

The above mentioned places of tourism interest in the hinterland would attract tourists to NW 101. Development of NW 101 would open opportunity for tourism in the hinterland. Most of the hilly and remote regions in the hinterland of NW 101 are not easily accessible by roadways. The roads in these remote places are in poor condition. Tourists could use boat ride in the proposed waterway to reach the proposed terminals on NW 101, from where they can take local roads to reach the tourist sites. Adventure seekers could trek or hike the hills to reach some of the tourist places, like Mt. Saramati, Zanibu Peak, Satoi Range etc. Wild Life Sanctuaries could also be reached using combination of modes, like NW 101 and roadways.

3.7 Passenger Movement

3.7.1 Exisitng Passenger Movement by Road

Nagaland's transportation system for goods and passenger movement is managed by Nagaland State Transport (NST). The below table depicts transport service provided by NST in Nagaland.

Table 3.24 State Transport Service in Nagaland

Items	Fy 14	Fy 15	Fy 16
Length of routes covered by NST (Km)	12,455	12,958	11,181
Average number of passengers handled daily	4,912	4,615	3,686
Average quantity of luggage handled daily (Qtls)	12.15	16.73	19
Number of vehicles	212	215	214

Source: General Manager Nagaland State Transport (Statistical Handbook 2017)

At present, passenger movement in the hinterland mostly happens by roadway. The road movement which happens near the stretch of Tizu & Zungki river could be shifted to NW 101. District wise mode of transportation on roadway is discussed in the below sub sections.

3.7.1.1 Kiphire

Kiphire district's transportation system for goods and passenger movement is managed by Nagaland State Transport (NST). The public transport network has further increased by introducing new bus service from Kiusam town to Kiphire Head Quarter. The district has been allotted with 7 scheduled services. Out of these scheduled services, only four services are run on a regular basis. The remaining three services, which run on alternate days due to less flow of passengers are presently suspended due to poor road conditions. The daily utilization of public transport in the district based on the flow of passengers on average shows that the service between Kiphire to Dimapur has the highest usage.

The district being located in the remote part of the state, public movement especially in times of medical emergencies is greatly hampered. Helicopter service started in 2012 to provide easy and quicker means of transport in the district.

Private players are also involved in the district to provide public transportation facilities. However, the existing transportation facilities are not adequate to handle the growing number of users in the district. The number of registered local taxis in Kiphire town is only 34. Altogether three Inter-district bus services from Kiphire to Kohima and Dimapur is provided by the private operators, which is an addition to the Government run bus services. Other than the inter-district services, the private operators' run taxi services from Kiphire headquarter to six administrative centres and fifteen villages. None of the villages under Kiphire district have scheduled bus services under NST or the private service providers connecting with the district headquarter.

3.7.1.2 Phek

Nagaland State Transport (NST) runs regular buses from Dimapur to Phek. There is regular buses to connect Phek with other parts of the state. Apart from the state transport buses, there are several private buses too.

3.7.1.3 Tuensang

NST operates bus service daily to/from Kohima and Dimapur. Private owned buses also operate daily to/from Dimapur. Shared taxis (10 seater MUV) run daily to/from Kohima, Mokokchung and Dimapur.

3.7.1.4 Zunheboto

Bus and taxi service are available to/from major places, like Kohima, Mokokchung, Akuluto, Aghunato, Satakha, Suruhuto and Dimapur.

3.7.2 Potential for Passenger Movement by NW 101

The above mentioned NST bus services are not available in most of the villages and towns near the stretch of NW 101. The villages are mostly connected by jeepable roads. NH 202 is the major roadways. The local roads in the remote areas are narrow and kaccha roads; hence there is no NST bus service. Most of movement on roads near river stretch is done by jeeps and other small vehicles and two wheelers.

The existing passenger movement on roadways in the region near NW 101 stretch could be shifted to the waterway. There are many remote villages, like Avakhung and other villages near Indo-Myanmar border which do not have proper connectivity. Villagers from these villages could use inland waterways and move from one village to another, which are located on the bank of NW 101. Passenger movement on NW 101 could be categorized in two parts:

- Passenger movement from village to village- Many remote villages, like Avakhung, Pokhungri are located on the bank of river Tizu. The movement between these villages could be shifted to NW 101. The purpose of this kind of visits is mostly meeting relatives and friends.

- Passenger movement from village to towns- There are some towns/hubs near the stretch of NW 101, like Kiphire, Longmatra, Meluri etc. Villagers from other remote areas on the bank of NW 101 could use IWT and reach the nearest terminal from the town. They could travel to these towns from the terminal using roadways. The purpose of movement from villages to towns is going to work, education institutes, buying food and other items from market etc.

Poor road connectivity in the hinterland is a major driving force for locals to opt for inland waterways. Inland waterway would provide an alternate mode of transportation. During monsoon season, when roadways suffer major hurdles, inland waterway would provide seamless passenger movement throughout the year.

3.8 Opportunity Identification

This chapter summarizes and quantifies market opportunity in river transportation. It contains future projection of traffic for transportation of passengers, tourists and commodities/cargo for year 2020, 2025, 2030, 2035, 2040 and 2045.

The opportunity for NW 101 for commodities/cargo and passenger movement are shown in the below graph. These opportunities could be targeted by NW 101, provided the Government develops the region along with proper connectivity with waterways.

Opportunity identification of NW 101 is done for three Phases, (i) Phase I (Immediate Phase), (ii) Phase II- local movement between Longmatra and Avakhung and (iii) Phase III-Indo-Myanmar trade using IWT. Considering the underdeveloped region, it is proposed that in Phase I (Immediate Phase), only passenger traffic would be handled at NW 101. Cargo traffic could be targeted in near future, in Phase II.

In Phase II, NW 101 would handle local movement of passengers and household commodities between Longmatra and Avakhung (Avankhu). NW 101 would be developed by IWAI. After development, NW 101 would be operational for local movement of passengers and household commodities.

In Phase III, NW 101 would handle Indo- Myanmar trade. Phase III is a remote opportunity, as it depends on Myanmar Government to develop the waterway across the border till Hta Man Thi in Chindwain river. (Please refer Section 3.8.2.3 for details on Chindwin River). Whether river route between India and Myanmar is developed or not, potential for NW 101 is remote, due to the hilly terrain and underdeveloped region.

It is projected that minerals and cement produced in Laruri region would be transported to Myanmar using waterway. Other commodities, like food grains, which are transported from Myanmar to Avakhung and nearby villages crossing the border, could also be shifted to NW 101. Passenger movement from villages for across the border movement could also be shifted to NW 101.

The below chart depicts opportunity for cargo and passenger/tourist movement on NW 101 in Phase I (Immediate Phase), Phase II & III.

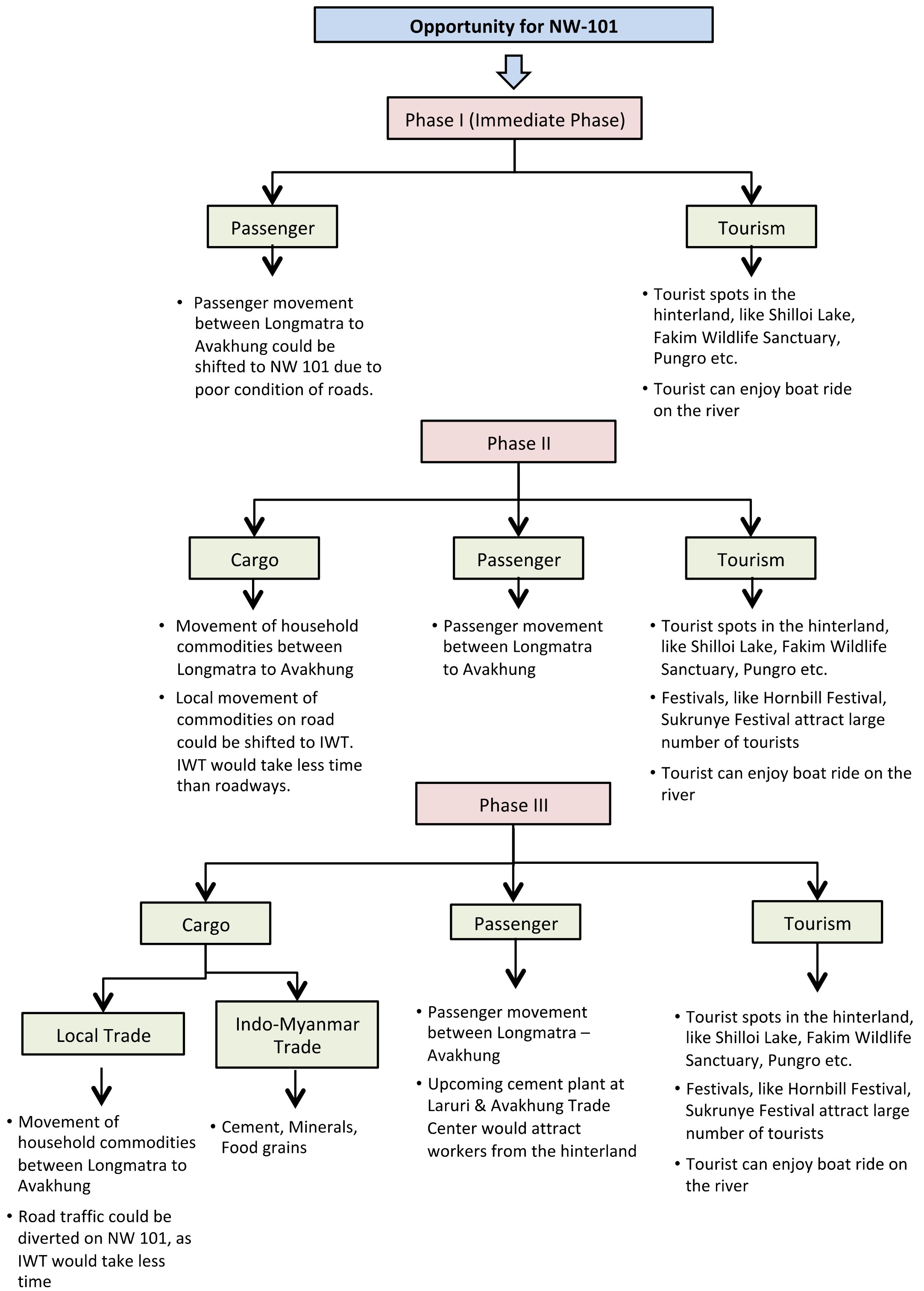


Fig. 3.25 Opportunity for NW 101

3.8.1 Local movement between Longmatra to Avakhung (Avankhu)

Local movement of household commodities between Longmatra and Avakhung could be shifted to the proposed waterway NW 101. Distance between Longmatra to Avakhung is covered in 6 hours by road in fair weather. During monsoon, travel time increases to minimum 12 hours due to poor condition of roadway. This problem could be solved by developing inland waterway in Tizu and Zungki river stretch. At present, locals do not use waterway in Tizu and Zungki river because the waterway is not developed and the river is not navigable due to rock outcrops in river. The river is surrounded by steep hills and rough terrain. At present, the river is not used for transportation and there is no facilities in the form of terminals, jetties or ghats in the defined stretch of the river.

Cargo trucks, which move between Longmatra and Avakhung charge around INR 8,000 for 1-1.5 tonnes of cargo. Travel Charge for each passenger in this route is around INR 600. The cost is high due to the rough terrain and poor condition of roadways. Development of Inland waterway in Tizu & Zungki river would reduce the cost for cargo/passenger movement in the stretch.

Villagers from the remote region near Avakhung (Avankhu) and Indo - Myanmar border could use NW 101 and travel to Longmatra and further to Meluri, Kiphire, Kohima and Dimapur by roadways. Villagers would buy essential commodities from these towns/hubs and would return to villages using IWT. These commodities would contribute to local trade between Longmatra to Avakhung.

3.8.2 International Trade with Myanmar

India is Myanmar’s 4th largest trading partner. India-Myanmar ties are very crucial for trade, considering India's second longest border, both land and maritime, is with Myanmar. Under the bilateral Border Trade Agreement of 1994, trade between India and Myanmar is currently carried out through three designated border trade posts (land custom stations) one each in Manipur, Mizoram and Nagaland.

Besides these three trade posts, there are some other land and river routes, which are vital for Indo - Myanmar Trade. For trade purpose, five Border Trade Centers (BTC) have been identified along the Indo - Myanmar border to promote trade and commerce between the two countries and other ASEAN countries. These Border Trade Centers are listed below

i) Longwa (Lungwa) in Mon district
ii) Pangsha (Pasha) in Tuensang district
iii) Avakhungin Phek district
iv) Molhe in Phek district
v) Mim in Kiphire district

Out of these five trade centers, infrastructural development for 3 have been taken up at Pangsha, Longwa and Avakhung (Avankhu). Among all these trade centers, only Avakhung falls in the primary hinterland of NW 101. The below image depicts border trade center in Avakhung. Avakhung is situated in Phek district, near the international border of India and Myanmar.

Fig. 3.26 Border Trade Center at Avakhung (Avankhu)

Following are the commodities, which are majorly traded between India and Myanmar.

- **Export from India-** Pharmaceuticals and chemical products, machinery, mechanical parts, electrical appliances, articles of iron & steel, cosmetics and transport equipment

- **Import from Myanmar-** Agricultural products like beans, pulses and maize, betel nuts, cotton yarn and forest products such as timber, bamboo products etc.

3.8.2.1 Trade among villages near Indo-Myanmar border

Tizu river would serve as an international waterway since waterway in Tizu would be linked with Chindwin river in Myanmar. At present, some villages located near the border, trade commodities across the border. Villagers, mostly Yimchunger Naga tribe from Kiphire district use a system of bartering with their counterparts in Myanmar. The villagers basically trade salt, medicines, tea, honey and wax in exchange for Myanmarese rum, food items, precious stones, clothes, utensils etc. There is free movement between villagers from across the border. As per present arrangement between the two countries, the villagers from either side can go up to 16 km from the demarcated international border for informal trade and maintaining family relationship. There is no well developed transportation system in these remote villages for cross border movement.

Informal trade that happen between villages of India and Myanmar through Nagaland are not documented. Hence, data of the volume of this trade is not available. Development of inter country inland water transport routes on NW 101 could stimulate trade and commerce between India and Myanmar.

The villagers in the border area prefer cultivation of maize, millet and beans in large scale rather than rice, but marketing of their produces has been a problem due to poor connectivity. Although, they have to depend for rice from outside, the transport cost of carrying the same from Dimapur was exorbitant. A mini truck laden with goods from district headquarters Kiphire to Mimi (just 120 km) costs INR 6,000. Development of NW 101 would facilitate movement of rice and other food grains from Myanmar to these villages located near the border. The transportation cost using IWT would be cheaper than road transportation from Dimapur.

Fig. 3.27 Vehicle carrying goods from Nagaland to Myanmar

3.8.2.2 Trade between Nagaland and Myanmar through Hta Man Thi (Tamanthi)

At present, Lay Shi (Leshi, Layshi) in Myanmar is used as the corresponding point in Myanmar for trade movement between Nagaland and Myanmar. Lay Shi village falls under Sagaing Division. Lay Shi is located in Naga Hills in Myanmar, across the Indo - Myanmar border. Lay Shi is 16 km from the border point. From Lay Shi, the road goes to Hta Man Thi. Hta Man Thi (Htamanthi, Tamanthior Tamanthe) is another major town, which is about 70 km from Lay Shi. Lay Shi can also be reached via Hta Man Thi across the Chindwin River by boat. Hta Man Thi is located on bank of Chindwin River in Hkamti district of Myanmar. Currently, Myanmar operates passenger and cargo vessels along the Chindwin River. Please refer Section 3.8.2.3 for details of Chindwin river and Section 3.8.2.4 for details of Agreement between Government of India and Myanmar for construction and operation of a multi modal transit transport facility on Kaladan river.

Both India and Myanmar want to revive the trade route between Lay Shi and Avakhung (Nagaland), which is used for traditional trade. At present, informal trade takes place in Avakhung and Lay Shi. People living along the international border walk for hours to reach Lay Shi, to buy essential items rather than travel to Meluri (Nagaland) on the Indian side, which is more than 120 km away. With the development of NW 101, trading between Myanmar and Nagaland would be easy. From Hta Man Thi (Myanmar), commodities could be transported to Avakhung (Nagaland) and further to Laruri (Nagaland) using Tizu river. From Avakhung and Laruri, these imported commodities could be distributed locally in the hinterland. Connectivity with NW 101 and Chindwin river would also facilitate inter connectivity between Nagaland and Myanmar to the port of Yangon.

Most of the trade from Myanmar to Nagaland would be consumed by villages which are located near the Indo- Myanmar border. The imported commodities from Myanmar using IWT could not be destined to far off villages and towns in Nagaland due to poor road connectivity. Food grains and other commodities from Hta Man Thi could be transported to Avakhung and Laruri in Nagaland. However, it is time consuming to move these commodities from Avakhung and Laruri to other far off villages using roadways. Hence, it is very unlikely that cargo, which originate in Myanmar could be destined to villages located far from Avakhung and Laruri. These commodities would be distributed in villages near Avakhung, Laruri and nearby region.

Export of minerals and products, like cement could be transported from Laruri and Wazeho to Myanmar by using waterways. It will provide a big boost to the economy of this rich mineral belt in the hinterland. Usually, transportation cost is higher for bringing cement from other parts of Myanmar. Transportation cost for movement of cement from Wazeho to Myanmar (Hta Man Thi) through IWT would be less.

Movement of minerals, cement, food grains and other commodities between Myanmar and Nagaland is possible, provided the river stretch in Myanmar till Hta Man Thi is navigable and developed with connectivity and other infrastructures around the river. The role of NW 101 would be crucial to ease the trade movement between Nagaland and Myanmar to boost economic ties between the two countries.

3.8.2.3 Chindwin River in Myanmar

Chindwin river is the largest tributary of Irrawaddy river in Myanmar. The total length of Chindwin River is 1,200 km. It originates in the Patkai ranges in Indo-Myanmar Border and flows southwards through the Hukawng valley and past the towns of Hkamti, Homalin, Mawlaik, Kalewa and Monywa. It joins the Irrawaddy River near Myingyan in Magway region. Hlaing River connects Irrawaddy River to Yangon port. The below map shows Chindwin and Irrawaddy rivers in Myanmar.

Fig. 3.28 Chindwin & Irrawaddy Rivers in Myanmar

Hta Man Thi is located on the bank of Chindwin River, downstream of Hkamti. Tizu River in Nagaland State of India flows past Lay Shi town in Myanmar and joins Chindwin at Hta Man Thi.

At present, Chindwin river is used for passenger and cargo movement. Inland Water Transport is the authority under Government of Myanmar that operates transportation services for passenger and cargo in the navigable part of Chindwin river (Monywa to Hkamti). River navigation in Chindwin river is possible throughout the year, depending on water level of the river. There are few private companies, promoting river cruises in

Chindwin River. The below flowchart shows existing movement of passengers and cargo in Chindwin river, along with their origin- destination routes.

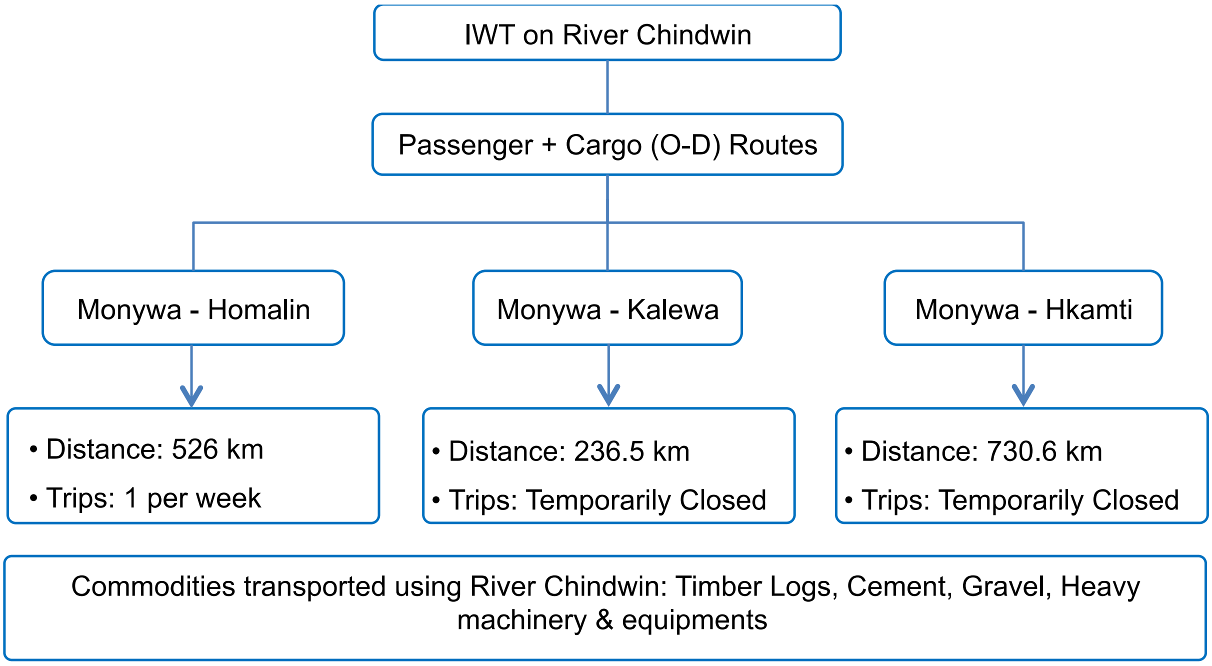


Fig. 3.29 Existing movement on IWT at Chindwin River in Myanmar

*Note: All the trips are updated on July 2019

Source: Inland Water Transport, Ministry of Transport and Communications Myanmar

3.8.2.4 A multi modal transit transport facility on Kaladan river– A Case Study

India and Myanmar signed a bilateral Memorandum of Understanding (MoU) on 22nd October, 2018 for operationalisation of Sittwe Port and Inland Water Transport Terminals at Sittwe and Kaletwa. There is an agreement between Government of India and Myanmar for the construction and operation of a multi modal transit transport facility on Kaladan river, connecting the Sittwe Port (Myanmar) with the state of Mizoram (India). Once fully operational, the project would encourage investment and trade and also open up alternate routes for connectivity to North-East region of India.

The construction of Sittwe Port in Rakhine State of Myanmar is part of the Kaladan multi-modal transport project. The objective of this project is to create a multi-modal (sea, river and road) transport corridor for shipment of cargo from the Indian eastern ports, especially Kolkata Port to Myanmar through Sittwe port. This would also ease movement of cargo from north-eastern part of India via Myanmar. Commodities, which are destined and consumed in North Eastern India, could be transported using Kolkata Port and Sittwe Port and using inland waterway could be further moved towards Nagaland and Manipur. This proposed route would be shorter than the existing route.

As per the Agreement, the cost of the construction of the project shall be borne by the Government of India. On completion, the project will be handed over to the Government of Myanmar. Government of Myanmar would be responsible for operation and maintenance of the project in accordance with the provisions in the Protocol.

The above mentioned Agreement between Government of India and Government of Myanmar for Kaladan multi-modal transport project could be followed as a model for development of Inland waterways between India and Myanmar, connecting NW 101 (Tizu & Zungki river) with Chindwin river in Myanmar by developing Tizu stretch in Myanmar till Hta Man Thi. Similar to the Agreement between Government of both the countries for Kaladan multi-modal transport project, an agreement needs to be signed between both the countries for development and connecting NW 101 with Chindwin river for inland waterway transportation. Some of the suggestions for the Indo- Myanmar Agreement, regarding development of inland waterway between Nagaland (Avakhung) to Myanmar (Hta Man Thi) are listed below.

- Government of India would be responsible for the development of NW 101 (River Tizu) till Avakhung near the Indo- Myanmar border. The river stretch across the border near Avakhung till Hta Man Thi where the river merges with Chindwin river would be developed by Government of Myanmar.
- Government of both the countries would be responsible for the operation and maintenance of their stretch of the inland waterway. For instance, Government of India would operate and maintain NW 101, whereas Government of Myanmar would operate and maintain river stretch across border till Hta Man Thi, where the river merges with Chindwin river.
- Government of both the countries would ensure smooth navigation of vessels in the proposed inland waterway. There should not be any hurdle in vessel movement.
- The international laws for trade between both the countries, using IWT should be flexible and favorable for Indo-Myanmar trade.
- Government body of India (IWAI) would bear the salary for manpower, hired for operation and maintenance of IWT in Indian side of river stretch. Similarly, Myanmar Government would bear the salary for manpower, employed for operation and maintenance of IWT in Myanmar side of river stretch.

Benefits of Inter connectivity (through NW 101) between India and Myanmar

- Increased economic activity, including trade and commerce, will occur in the hinterland through development of inland water transport in Tizu & Zungki river.
- Considering the difficult terrain of the region,development of inland water transport on River Tizu & Zungki could greatly boost Indo- Myanmar trade.
- The development of inland water transport will encourage improvements in infrastructure, aiding the safe and smooth operation of cargo and passenger movement on NW 101.
- During the flood season, when other modes of transport are severely hindered or not in operation, inland water transport continues to link the North-eastern Region to the rest of the country, enabling transport of food grains and other basic commodities to the region during the flood season.
- Considerable natural resources are found in Nagaland in the catchment area of Tizu River, including high-grade limestone, magnetite, decorative stones, coal, chromite etc. Development of this inland water transport route will help boost trade of these products and open up a potential international market.

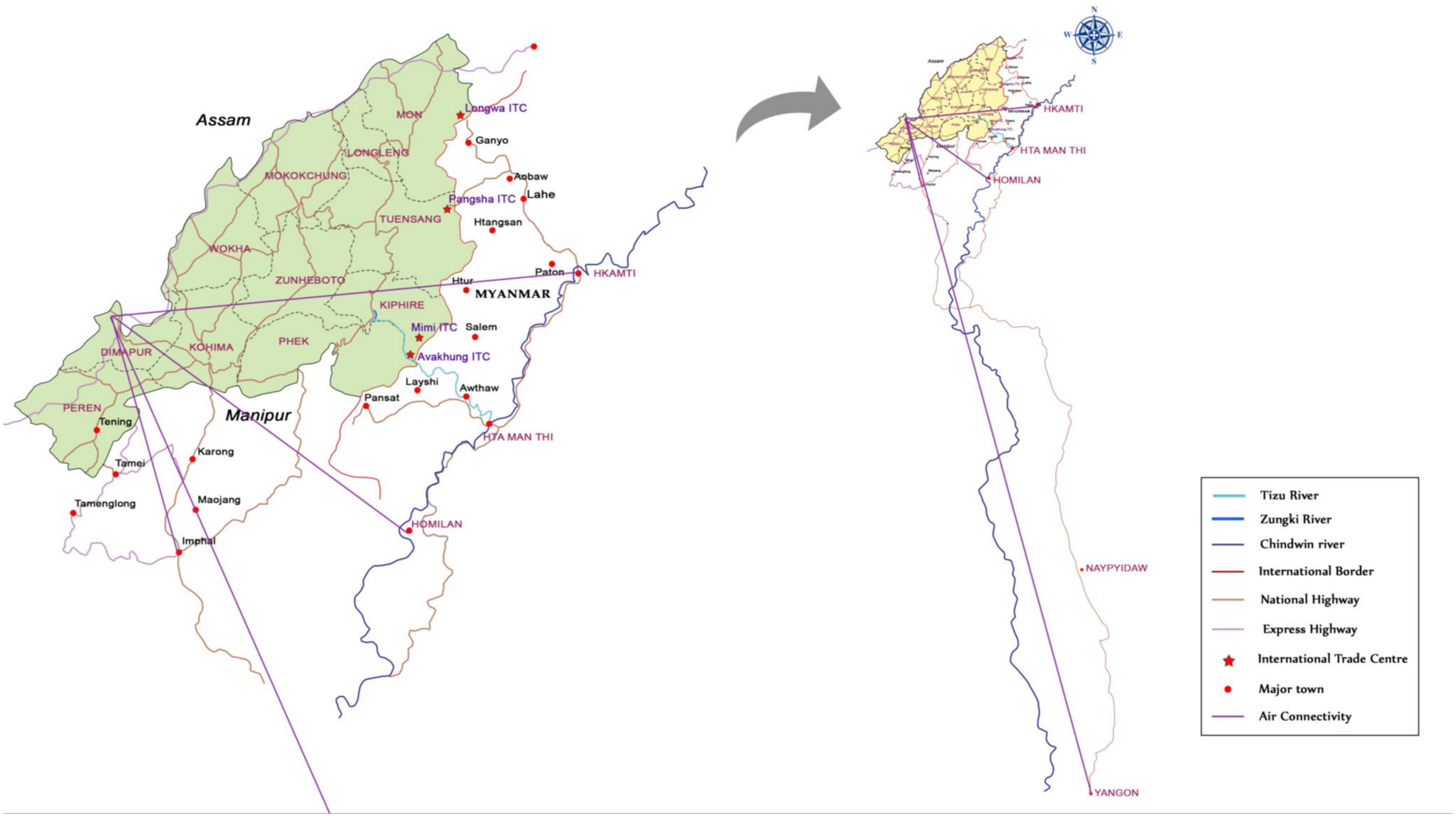


Fig. 3.30 Nagaland and South Asia Connectivity

Source: Nagaland Vision 2030

3.9 Terminal Locations

Inland waterway on Tizu & Zungki river would be developed in three phases, i.e. Phase I (Immediate Phase), Phase II and Phase III. In Phase I (Immediate Phase), there would not be any terminal development. However, landing points would be earmarked. There is no requirement of well developed terminals for embarking and disembarking of passengers in this phase. Terminal development would be done in Phase II.

Efforts have been made to select location of terminals that require minimum investment for development. The locations have been proposed based on factors, like availability of land for construction of terminal, origin- destination of proposed traffic and possibility of future expansion. One type of terminal has been proposed for handling both cargo, passenger and tourist transportation. These terminals would be equipped to handle cargo, like minerals, food grains, cement etc. Currently, minerals are not extracted from the hinterland; hence it is proposed that in long term, minerals would be handled in the terminals on NW 101. Mineral and cement would be moved to Myanmar using IWT after the development of river stretch in Myanmar till Hta Man Thi. Minerals, like limestone, granite, which are in large volume would be transported using IWT. Other categories of minerals, which arelow in volume would not be shifted to the waterways.

These terminals would also cater to passengers for movement between Longmatra to Avakhung and local travel. The residents of the villages, which are located on the bank of river Tizu & Zungki would use the waterway for transportation. Villagers could travel between Avakhung to Longmatra and further from Longmatra to important towns, like Meluri, Kohima and Dimapur, using NH 101. The same identified terminals would be used for tourists visiting various tourist sites on the bank of NW 101.

The terminal locations have been described in the map below. These terminals have been identified based on the market survey and analysis of the needs of local economy and population. All the four terminals are proposed on Tizu river. There is no terminal proposed on Zungki river due to existing parallel roads and less traffic from nearby villages. National Highway, i.e. NH 202 runs parallel to the defined stretch of Zungki. Another local road runs parallel to the stretch of Zungki river till Moya, near the confluence of Tizu & Zungki river. The distance between Zungki bridge to proposed terminal on Longmatra (Terminal 1) by roadway is around 14 km. It takes around 30 minutes to travel from Zungki Bridge to Terminal 1 on Longmatra by roadways. For such short distance, villagers would prefer roadways rather than waterways, as waterway is slower and time consuming due to loading and unloading on terminals. Considering these factors, it is advisable that there is no need to develop any terminal on the defined stretch on Zungki river, which is 4.62 km. For such short distance, IWT terminal would not be viable. Hence, Zungki river stretch could be discarded for development as part of NW 101.

Table 3.25 Details of Proposed Terminals on NW 101

Terminals	Location	Chainage (km)
T1	Near Longmatra	33.3
T2	Near Laruri Bridge	14
T3	Pokhungri	7.5
T4	Avakhung	1.2

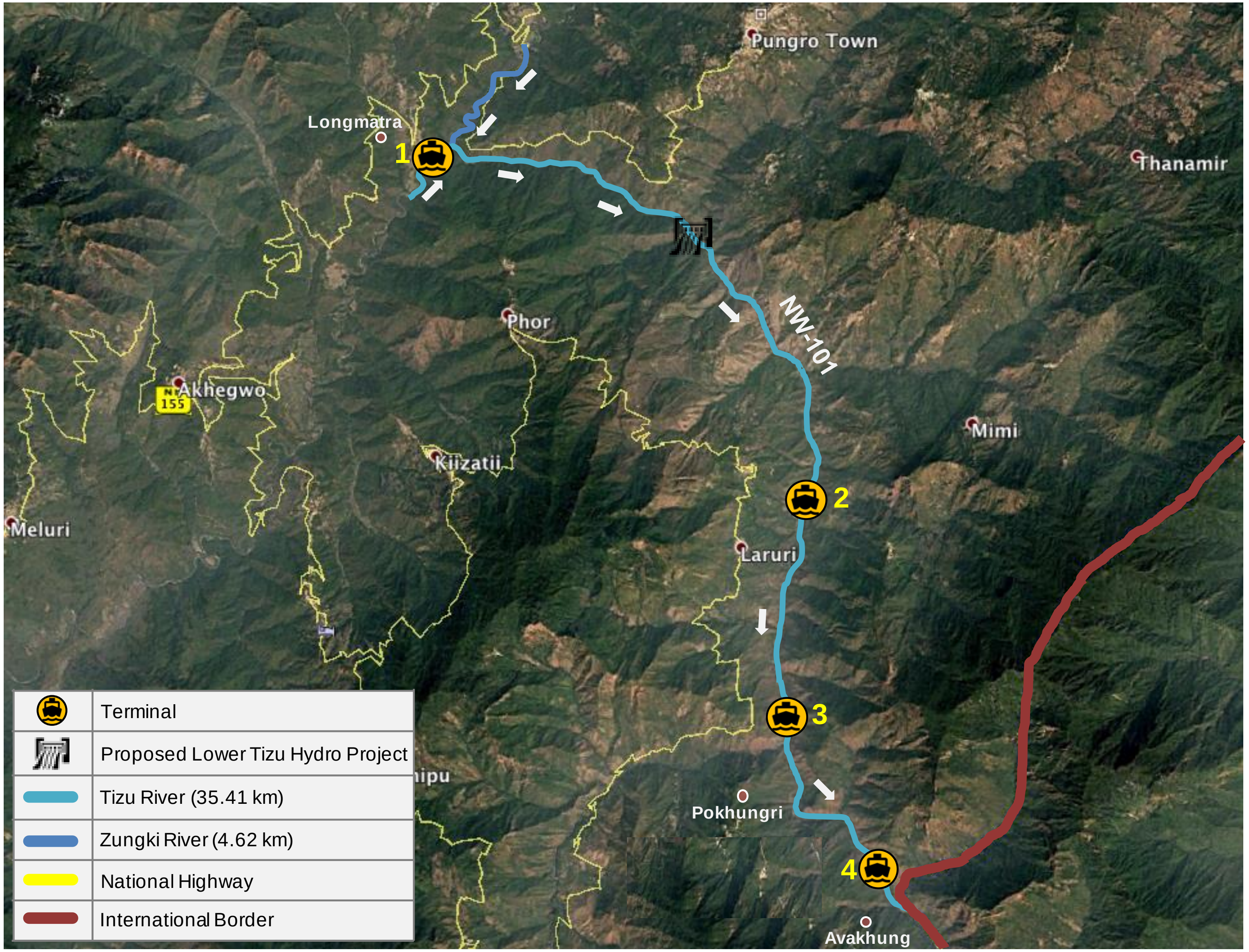


Fig. 3.31 Terminal Locations on NW 101

3.10 Traffic Assumptions & Projections

This chapter would discuss in detail proposed cargo, passenger and tourist traffic, which could be attracted to NW 101. Inland waterway on Tizu & Zungki river would be developed in three phases, i.e. Phase I (Immediate Phase), Phase II and Phase III. Considering the underdeveloped region, it is proposed that in Phase I (Immediate Phase), only passenger traffic would be handled at NW 101. Traffic consisting of household commodities could be targeted in near future, in Phase II and Cargo traffic, consisting of Indo - Myanmar trade would be targeted in Phase III.
The figure below depicts phase wise development of NW 101 for IWT movement.

Phase Wise Development of NW 101

	Phase I (Immediate Phase)	Phase II	Phase III
Operational Years	FY21 – FY22 (2 Years)	FY23 – FY27 (5 Years)	FY28 – FY30 (22 Years)
Trade	Local	Local	• Local • International (Indo-Myanmar)
Type of Traffic	• Passenger • Tourist	• Passenger • Tourist • Household Commodities	• Local: Passenger, Tourist & Household Commodities • International: Cement, Minerals & Food Grains

Fig. 3.32 Phase wise Development Plan of NW 101

Cargo Traffic for NW 101 is categorized in two parts, Phase II, i.e. local movement of household commodities between Longmatra to Avakhung and Phase III, i.e. Indo - Myanmar trade. Phase III traffic could be attracted to NW 101 in future, provided the river stretch in Myanmar (across the border) is developed along with other infrastructure and connectivity development in the region. Phase III development is a remote possibility. For Traffic projection, it is assumed that despite the upcoming Lower Tizu Hydro Electric Project, the entire defined stretch of NW 101 would be navigable throughout the year.

3.10.1 Passenger Movement between Longmatra to Avakhung

Existing passenger movement (i) within the hinterland and (ii) to/from other distant locations (like Dimapur, Kohima) to/from the hinterland are studied in detail to understand the traffic flow and need of IWT in the region. For hinterland connectivity with other distant locations, roads and Helicopter services are available; however Helicopter ride is not included in this analysis because none of the landing points of helicopters fall in the hinterland of NW 101. Hence, Helicopter service for passenger movement has been evaluated and discarded.

For transportation within the hinterland, roads are the only available mode. Traffic moving on roads and travel pattern of passengers are analyzed to identify traffic for NW 101 and project it for next 30 years.

3.10.1.1 Phase I (Immediate Phase)

In Phase I (Immediate Phase), IWT operation on NW 101 would start for passenger movement. In this phase, the waterway movement would be developed without any huge investment or development of concrete infrastructure. Basic facilities would be developed in this phase.

In this phase, IWT operation would start just by deploying inflatable boats with outboard motor in NW 101. The river stretch of Tizu & Zungki river would be navigable by clearing channel of boulders and gravels and Terminal location would be earmarked. Phase I (Immediate Phase) will last for 2 years, i.e. Fy 21- Fy 22. After this phase, Phase II would start when construction of terminals and fairway development would take place.

- **Assumptions**

Detailed analysis of hinterland, population profiling, transportation pattern of localities, need for infrastructure, problems faced in present mode of transportation, safety issues, etc. are some of the major factors considered while generating traffic for NW 101 in base year and future projection. Population around each terminal and their growing consumption, various initiatives taken by State and Central government, increase in demand for IWT due to poor road connectivity are the major growth drivers that are considered for forecasting traffic. The figure below depicts detailed methodology used for Passenger Traffic identification for each terminal on NW 101.

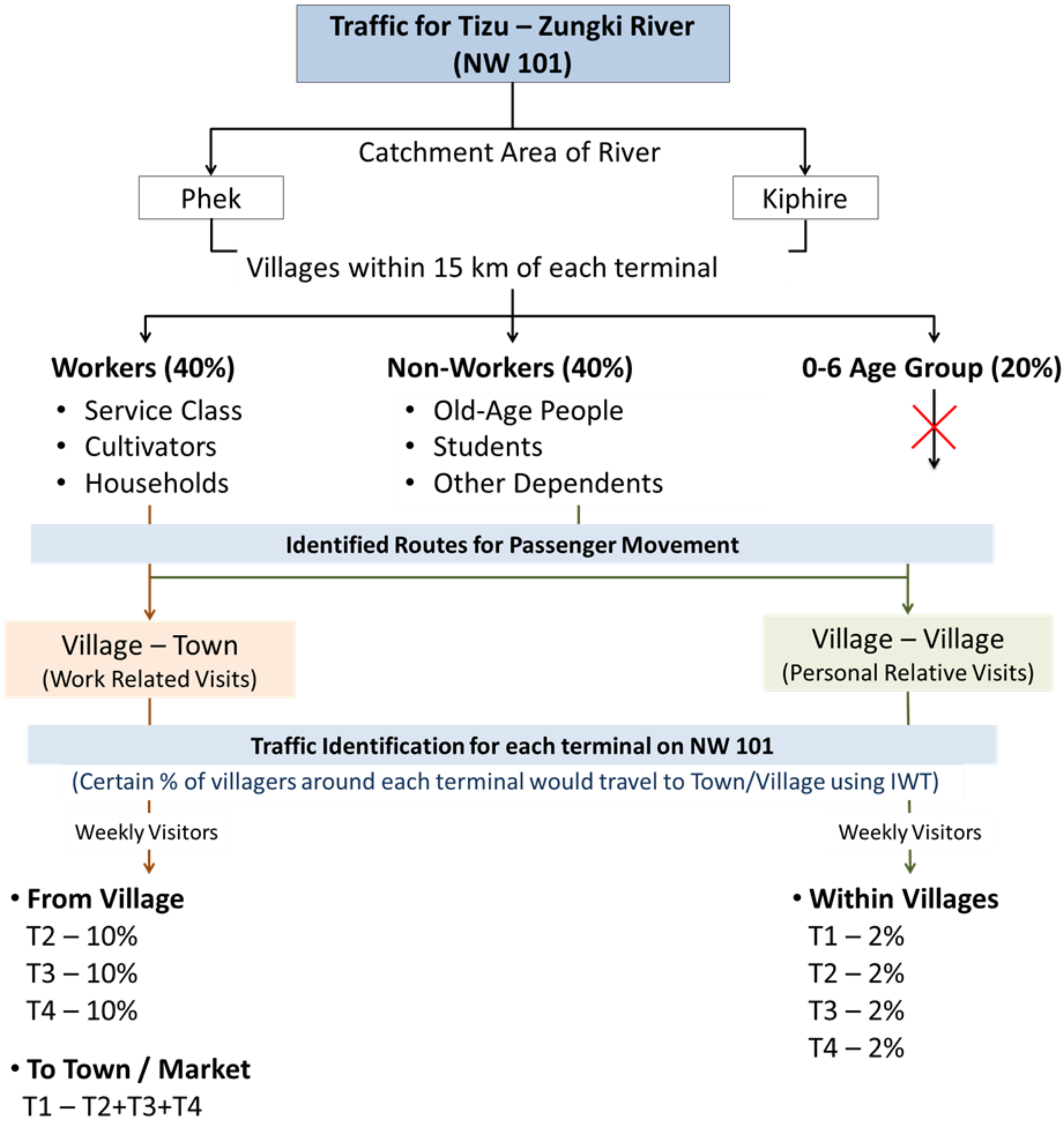


Fig. 3.33 Methodology for Passenger Traffic Identification for NW 101 in Phase I

Considering the underdeveloped region, it is proposed that in Phase I (Immediate Phase), only passenger traffic would be handled at NW 101 and traffic would be less initially. Some percentage of passenger traffic currently moving on roads are diverted to NW 101 for IWT movement. Type of population considered for traffic projection in Phase I (Immediate Phase) is described below.

- Working Class – This category involves all those people who travel to towns like Meluri, Longmatra or Kohima on a daily basis. These are the towns with schools, hospitals, markets, where villagers are employed. Apart from service class people, this category also includes cultivators of the villages, who travel to towns to sell their agro produce in the market.

- Non-Working Class – Old people, students, and other dependents are not involved in daily traveling. People in this category along with working class would travel within villages towards town side for shopping purpose or meeting friends and relatives.

- 0-6 Age Group – Population below 6 years of age is totally excluded from traffic identification for proposed terminals.

All the villages located within 15 km of the proposed terminals on NW 101 have been considered for passenger traffic estimation and projection. The population of villages is based on database of Census 2011. Projection for each terminal is done based on the following assumptions.

- Population around each terminal – Villages within 15 km
- Type of Total Population in the hinterland – Cultivators (25%), Service class (15%), Non-Worker (40%), 0-6 age (20%)
- Village-to-Village travelers (Weekly) – People visiting friends and relatives with family
  - ✓ 2% of Workers, Cultivators and Non-Workers around each terminal (both way)
- Villages to Town for Trade and Job (Weekly) – Service class people traveling to towns for job and cultivators travel to towns to sell their agro produce and return back to their villages.
  - ✓ 10% of Cultivators & Service class people around T2 (Near Laruri Bridge), T3 (Pokhungri) & T4 (Avakhung) each will disembark and embark at T1 (Near Longmatra) (both way).

➢ Growth Rate Considered for 2 years Projection

The table below shows the growth rates assumed for projecting traffic for next 2 years, i.e. Fy 21- Fy 22. These assumed growth rates are based on the average growth in population of the hinterland in last decade (Census 2011). In this phase, 3% growth rate is considered and same rate is considered for all scenarios (Base, Optimistic & Pessimistic), as it has been assumed that there will be no change in market and other related factors in all scenarios. Hence, no sensitivity analysis has been undertaken.

➢ Traffic Projections

Based on the above methodology and assumptions, following projections have been made for Phase I (Immediate Phase).

Table 3.26 Terminal wise Annual Passenger Traffic Projections in Phase I

(Annual- Passenger)

Terminals	FY 20	FY 21	FY 22
T1 (Near Longmatra)	13,632	14,041	14,462
T2 (Near Laruri Bridge)	7,680	7,910	8,148
T3 (Pokhungri)	4,704	4,845	4,990
T4 (Avakhung)	3,168	3,263	3,361

3.10.1.2 Phase II

In Phase II (Fy 23- Fy 27), the entire fairway from Longmatra to Avakhung and proposed four terminals would be developed along with supporting infrastructure and facilities. It has also been assumed that Lower Tizu Hydro Power Project would be developed in Phase II and navigational lock would be installed. It is taken into consideration that despite the upcoming dam in Lower Tizu, the entire defined stretch of NW 101 would be navigable for IWT movement.

Projection of Passenger traffic for all terminals is done for Phase II under 3 different scenarios. Various factors have been considered for identifying traffic for each terminal and projecting future traffic. After Phase II development, NW 101 would be operational for local movement of passengers and household commodities.

- **Assumptions**

Factors like, hinterland analysis, population profiling, connectivity, traveling pattern of passengers, need for infrastructure, bottlenecks in present transportation mode, need for safe mechanism for connecting villages and towns located along the river, are taken into consideration for undertaking traffic identification and projection for each terminal. Population around each terminal and their growing consumption, various initiatives taken by State and Central government, increase in demand for IWT due to poor road connectivity are the major growth drivers that are considered for forecasting traffic. The figure below depicts detailed methodology used for Traffic identification for each terminal in Phase II.

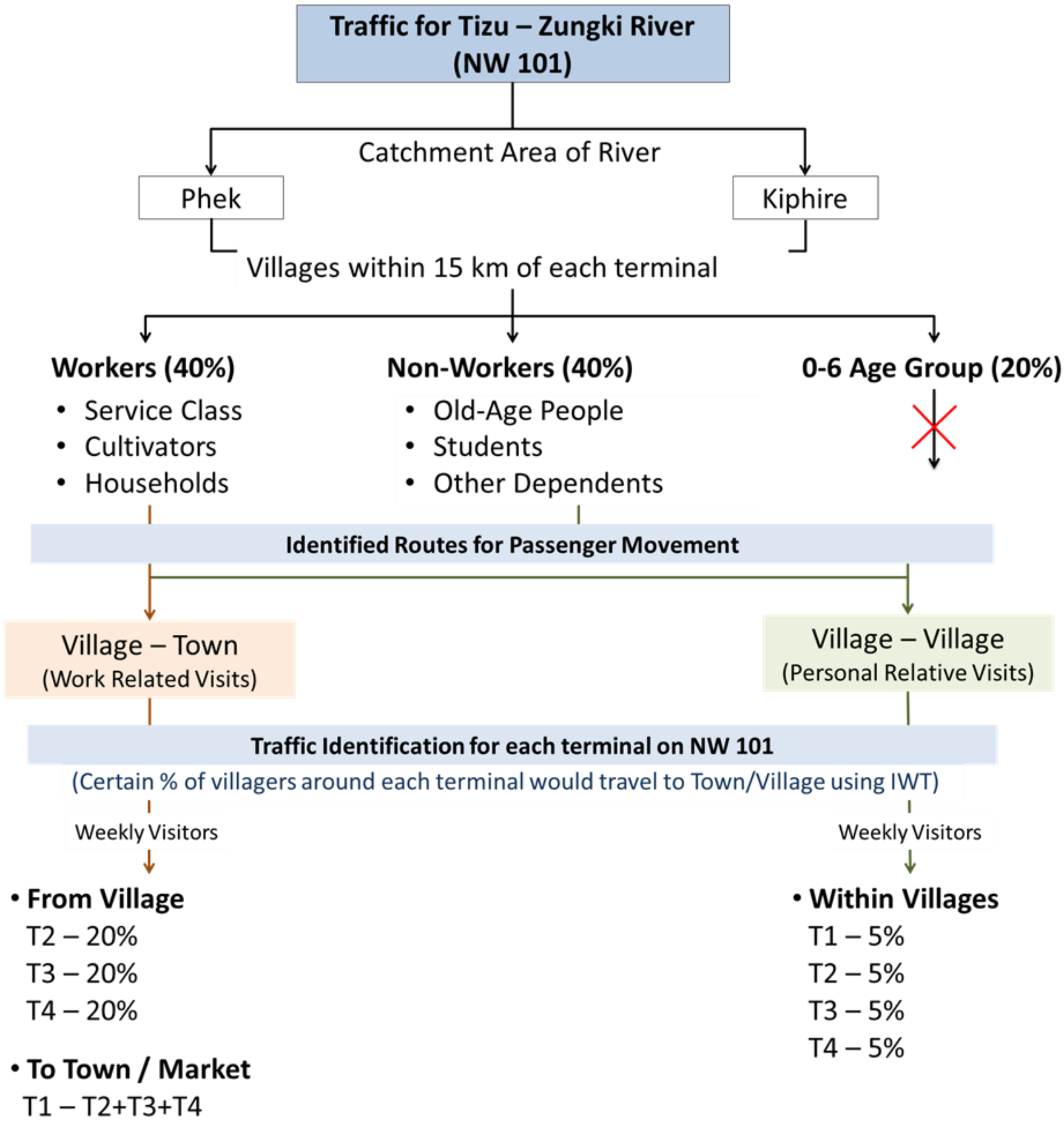


Fig. 3.34 Methodology for Passenger Traffic Identification for NW 101 in Phase II

Passenger traffic likely to come on proposed terminals in Phase II is identified using above methodology. At present, roads are the only mode of transportation in the hinterland. Roadways is in poor condition, which worsens during monsoon season. Certain % share of existing road movement could be diverted to NW 101. IWT would be an alternate mode of transportation in the hinterland and would provide fast and safe movement. All the terminals are proposed for along the river movement, as there is no need for across the river movement. Type of population considered for traffic count in Phase II are as follows

- Working Class – This category involves all those people who travel to towns, like Meluri, Longmatra or Kohima on a daily basis. These towns have schools, hospitals, markets, where villagers are employed. Apart from service class people, this category also includes cultivators of the villages who travel to towns to sell their agro produce in the market.

- Non-Working Class – Old people, students, and other dependents are not involved in daily traveling. People in this category along with working class travel within villages towards towns for shopping purpose or meeting friends and relatives.

- 0-6 Age – Population below 6 years of age are totally excluded from traffic identification for proposed terminals.

All the villages located within 15 km of the terminals proposed on NW 101 have been considered for passenger traffic estimation and projection. The population of respective villages is based on database of Census 2011. Projections for each terminal is based on following assumptions

- Population around each terminal – Villages within 15 km
- Type of Total Population in the hinterland– Cultivators (25%), Service class (15%), Non-Worker (40%), 0-6 age (20%)
- Village-to-Village travelers (Weekly) – People visiting friends and relatives with family
  - ✓ 5% of Workers, Cultivators and Non-Workers around each terminal (both way)
- Villages to Town for Trade and Job (Weekly) – Service class people traveling to towns for job and cultivators to sell their produce and and return back to their villages.
  - ✓ 20% of Cultivators & Service class people around T2, T3 & T4 will disembark and embark at T1 (both way)

- **Growth Rate Considered for 5 years projection**

The table below shows the growth rates assumed for projecting traffic for next 5 years, i.e. from Fy 23 to Fy 27. These assumed growth rates are based on the average growth in population of the hinterland in last decade. Initially for 3 years, growth rate is taken same for all scenarios, as it is assumed that there will be no market or any other related factor change in scenarios. Sensitivity analysis for each terminal is done from Fy 26 to Fy 50. It is assumed that growth rate will remain same in next 25 years under each scenario.

Table 3.27 Assumed Growth Rates for Passenger Traffic in Phase II

Scenarios	FY23	FY24	FY25	FY26	FY27
Pessimistic	3%	3%	3%	3%	3%
Realistic	3%	3%	3%	5%	5%
Optimistic	3%	3%	3%	6%	6%

In pessimistic scenario, growth rate is kept on lower side by considering the declining growth rate of population and lack of immediate development plans. In realistic scenario, growth rate is influenced by rising population, infrastructure development and better connectivity. However, rate is kept moderate due to the demography pattern causing difficulties in development. While in optimistic scenario, it is assumed that the entire hinterland will be developed. Industrial development, availability of services and facilities required by local residents, infrastructure development like schools, hospitals, markets in the region, etc. would generate the additional need for IWT movement.

- **Traffic Projections**

Based on the above methodology and listed assumptions, following prominent projections have been made while differentiating situations of Pessimistic, Base & Optimistic scenarios.

Table 3.28 Terminal wise Annual Passenger Traffic Projections in Phase II

(Annual-Passenger)

Terminals	FY 23	FY 24	FY 25	FY 26	FY 27
Pessimistic Scenario					
T1 (Near Longmatra)	28,416	29,268	30,147	31,051	31,982
T2 (Near Laruri Bridge)	16,416	16,908	17,416	17,938	18,476
T3 (Pokhungri)	10,080	10,382	10,694	11,015	11,345
T4 (Avakhung)	6,720	6,922	7,129	7,343	7,563
Base Scenario					
T1 (Near Longmatra)	28,416	29,268	30,147	31,654	33,237
T2 (Near Laruri Bridge)	16,416	16,908	17,416	18,287	19,201
T3 (Pokhungri)	10,080	10,382	10,694	11,229	11,790
T4 (Avakhung)	6,720	6,922	7,129	7,486	7,860
Optimistic Scenario					
T1 (Near Longmatra)	28,416	29,268	30,147	31,955	33,873
T2 (Near Laruri Bridge)	16,416	16,908	17,416	18,461	19,568
T3 (Pokhungri)	10,080	10,382	10,694	11,336	12,016
T4 (Avakhung)	6,720	6,922	7,129	7,557	8,010

3.10.1.3 Phase III

Passenger traffic in Phase III would consist of traffic of Phase II along with some additional traffic generated due to commencement of Cement Plant near Laruri and existing International Trade center (ITC) at Avankhung near Indo-Myanmar Border.

- **Assumptions**

Development of Laruri Cement Plant and Avakhung ITC are the factors considered in Optimistic scenario, hence no sensitivity is undertaken for Passenger traffic projection in Phase III. Traffic projection is done for next 30 years. Social impact of upcoming project (Laruri cement plant) and Avakhung Trade center, employment generation, trade expansion, economy growth, etc. are various factors considered while identifying the additional traffic for proposed terminals in Phase III. The figure below depicts detailed methodology used for Traffic identification for each terminal.

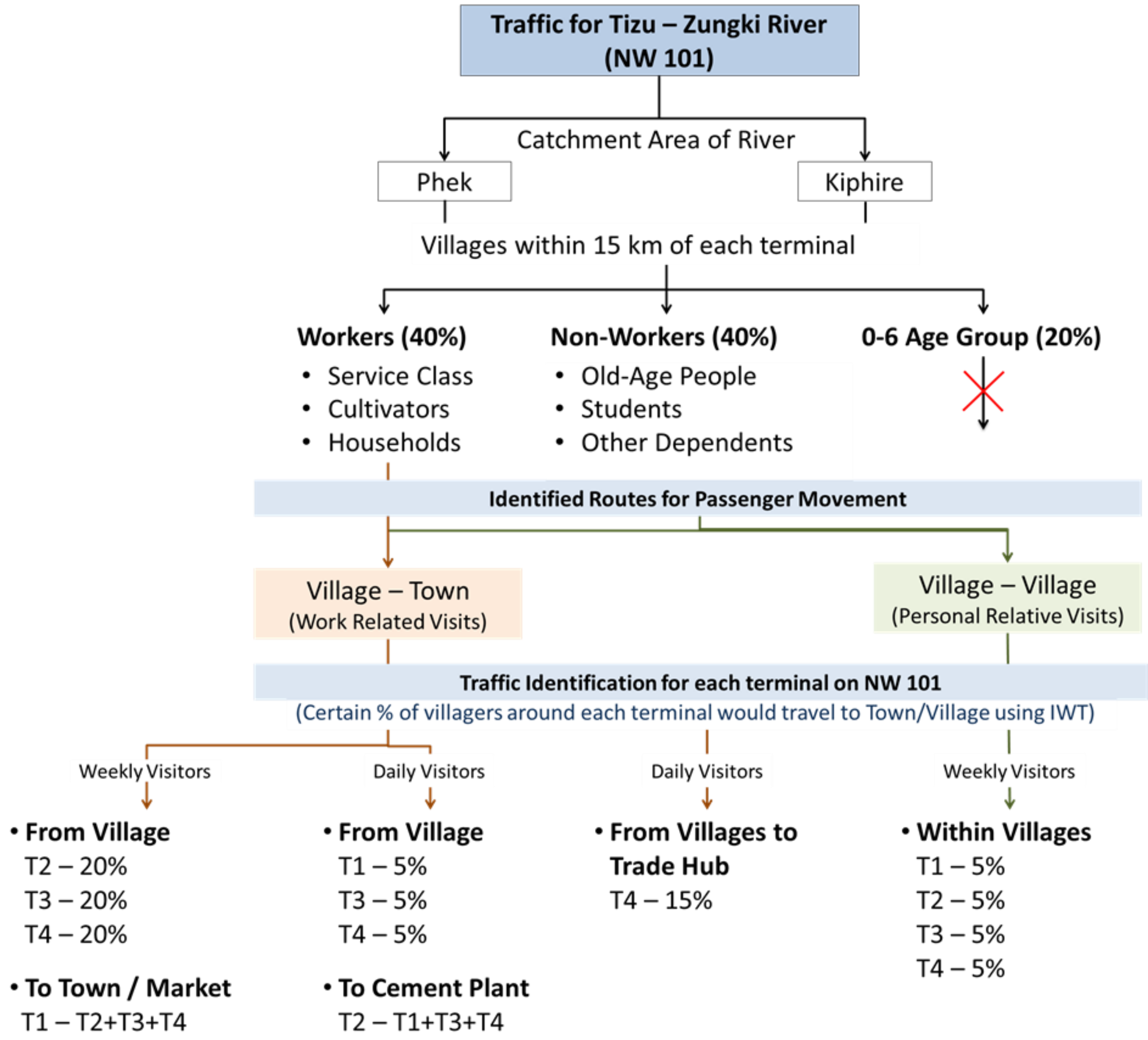


Fig. 3.35 Methodology for Passenger Traffic Identification for NW 101 in Phase III

Phase III development of NW 101 is entirely based on the proposed infrastructure plans and development of Indo-Myanmar IWT route. It is assumed that Laruri Cement plant would start operating from Fy 28. Also, Avakhung ITC (International Trade Center) would be handling more trade from Fy 28. Both these units, i.e. Laruri plant and Avakhung ITC would create employment opportunity in the region, leading to increase in IWT traffic. In Phase III, NW 101 would continue to handle Phase II passenger traffic along with some additional passenger movement towards Laruri cement plant and trade hub. Following is the profiling of hinterland's population that is used for identifying traffic for base year in each terminal.

- Working Class – This category involves all those people who travel to towns, like Meluri, Longmatra or Kohima and also towards Laruri Cement Plant and Avakhung ITC on a daily basis. Apart from service class people, this category also includes cultivators who travel to towns to sell their agro produce in the market and labour class people, who would work in Laruri cement plant and Avakhung trade hub.

- Non-Working Class – Kids and old people are not involved in daily traveling. People in this category along with working class travel within villages and towards town side either for shopping or meeting friends and relatives.

- 0 – 6 Age – Population below 6 years of age are totally excluded from traffic identification for terminals.

All the villages located within 15 km of the terminals on NW 101 have been considered for passenger traffic estimation and projection. The population of villages is entirely based on database of Census 2011. Projections for each terminal is done based on the following assumptions

- Village-to-Village travelers (Weekly) – People visiting friends and relatives with family
    - ✓ 5% of Workers, Cultivators and Non-Workers (both way)
- Villages to Town for Trade and Job (Weekly) - Service class people traveling to towns for job and cultivators to sell their produce and then again back to villages.
    - ✓ 20% of Cultivators & Service class people around T2, T3 & T4 would disembark and embark at T1 (both way)
- Additional Traffic generated by Laruri Cement Plant - Laruri Cement Plant, near T3, is likely to get operational from Fy 28. Once it gets operational, it would start attracting working class people from the hinterland. (Daily)
    - ✓ 1 MMTPA Cement Plant requires 400 skilled manpower for its day-to-day operation, out of which 150 manpower are at managerial role and other staffs. It is assumed that, out of remaining 250 manpower, 40% will be from nearby villages, while 60% stationed from other states.
    - ✓ 5% of working class people from the hinterland of T1, T3 and T4, each will make upto above mentioned 40% of workers in Laruri cement plant.
    - ✓ Traffic from T1, T3 and T4 will disembark at T3. T3 will handle combined traffic of other terminals. (one way)
- Additional Traffic generated by Avakhung ITC – Avakhung ITC, near T4, is likely to handle more Indo-Myanmar trade in coming years. This will provide employment in the hinterland.
    - ✓ As per the food grain traffic projections in Phase III that Avakhung ITC would handle in future, it is assumed that the activities for cargo handling in future would require maximum 10 – 15 number of manpower.
    - ✓ Manpower requirement at Avakhung ITC would be fulfilled by nearby villages, i.e 2% of population around the hinterland of T3 & T4 each would travel to ITC on a daily basis.

- ✓ Among the workers traveling from hinterland of T3 & T4, only T3 is taken into consideration for IWT movement. Because, workers around T4 would come directly using roadways, as IWT would not fall on their way to ITC.

➢ Growth Rate considered for 30 years projections

Phase III is the most optimistic scenario with all the development plans in the region, hence no sensitivity analysis is undertaken for this phase. Growth rates assumed are based on the average growth in population of the hinterland in last decade.

- Phase II Traffic – The growth rate is assumed at higher side, i.e. 6% till Fy 50. This 6% is based on the development in the entire region. It is assumed that all the required facilities and services would be available at this stage for passenger movement. Development of infrastructure in the region would demand for a faster mode of transportation, i.e. IWT. (Due to rough hilly terrain, roadway is in poor condition and takes longer time.)

- Additional Traffic – Additional Traffic generated by Laruri Cement Plant and Avakhung ITC will remain constant till Fy 50, as there is no expansion plans as of now.

➢ Traffic Projections

Based on the above methodology and assumptions, following prominent projections have been made in optimistic scenario in Phase III.

Table 3.29 Terminal wise Annual Passenger Traffic Projections in Phase III

(Annual- Passengers)

Terminals	FY 28	FY 30	FY 35	FY 40	FY 45	FY 50
T1 (Near Longmatra)	54,698	58,275	68,906	82,472	99,788	121,887
T2 (Near Laruri Bridge)	57,661	59,727	65,868	73,706	83,709	96,476
T3 (Pokhungri)	27,079	28,348	32,119	36,932	43,074	50,913
T4 (Avakhung)	15,453	16,299	18,813	22,021	26,116	31,342

3.10.2 Tourist Movement between Longmatra to Avakhung

All the tourist spots located within the hinterland of NW 101 have been considered for attracting tourist traffic for NW 101. Tourist traffic estimation and projection is based on the historic tourist data of the state. Tourism Department of Nagaland could promote NW 101 for tourism for leisure boat ride or cruise ride in the river. Following are the assumptions used for traffic identification for each terminal proposed on NW 101 and forecasting the same for next 30 years.

- 10% of total Domestic Tourist Traffic of Nagaland is assumed to be diverted on NW101
  - ✓ T1 would attract 60% of total diverted traffic, as area around T1 is most developed in the region.
  - ✓ T2 would not handle any tourists, as it is a mineral rich area.

- ✓ T3 would handle around 25% of total diverted traffic. The prominent tourist locations, such as Pungro, Shilloi Lake, etc. are located near the river.
- ✓ T4 will handle very less traffic, i.e. 15% of total diverted traffic.

➢ **Growth Rate considered for 30 years projections**

The following table depicts assumed growth rates assumed for projecting tourist traffic for next 30 years on NW 101.

Table 3.30 Assumed Growth Rates for Tourism Traffic

Scenarios	FY21 – FY25	FY26 – FY30	FY31 – FY35	FY36 – FY40	FY41 – FY50
Pessimistic	3%	3%	3%	4%	4%
Realistic	3%	4%	5%	5%	5%
Optimistic	3%	5%	6%	6%	6%

These assumed growth rates are based on the average growth in hinterland's population. Initially for 5 years, growth rate would be same, i.e. 3% for all scenarios, as it is assumed that there will be no market or any other related factor change in scenarios. Sensitivity analysis for each terminal is done from Fy 26 to Fy 50. It is assumed that growth rate will remain same in Fy 26 – Fy 35 and Fy 36 – Fy 50 under each scenario.

In pessimistic scenario, growth rate is kept on lower side by considering factors, like poor connectivity, demography pattern etc. In realistic scenario, growth rate is influenced by rising tourist footfalls, infrastructure development and better connectivity to the tourist spots with NW 101. However, growth rate has been kept moderate due to the demography pattern causing difficulties in development. While in optimistic scenario, it is assumed that the entire hinterland will be developed. Developing NW 101 for tourism would definitely increase the state's economy.

➢ **Traffic Projections**

Based on the above listed assumptions, following are the projections made in different scenarios, i.e. Pessimistic, Base & Optimistic.

Table 3.31 Phase wise Annual Tourist Traffic Projections for each Terminal

(Annual- Passengers)

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
Pessimistic Scenario									
T1 (Near Longmatra)	5,323	5,483	5,647	6,356	6,547	8,052	9,796	11,918	14,500
T3 (Pokhungri)	2,219	2,285	2,354	2,649	2,729	3,356	4,083	4,967	6,044
T4 (Avakhung)	1,331	1,371	1,412	1,589	1,637	2,013	2,449	2,980	3,625
Base Scenario									
T1 (Near Longmatra)	5,323	5,483	5,647	6,480	6,739	8,868	11,318	14,446	18,437
T3 (Pokhungri)	2,219	2,285	2,354	2,701	2,809	3,696	4,717	6,021	7,684
T4 (Avakhung)	1,331	1,371	1,412	1,620	1,685	2,217	2,830	3,611	4,609

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
Optimistic Scenario									
T1 (Near Longmatra)	5,323	5,483	5,647	6,605	6,935	9,759	13,060	17,477	23,388
T3 (Pokhungri)	2,219	2,285	2,354	2,753	2,891	4,067	5,443	7,284	9,748
T4 (Avakhung)	1,331	1,371	1,412	1,651	1,734	2,440	3,265	4,369	5,847

3.10.3 Movement of Household Commodities between Longmatra & Avakhung

Household commodities traded locally within the hinterland are studied in detail to understand the traffic flow and requirement of development of IWT in the region. The upcoming infrastructures are also studied for projecting future cargo traffic.

3.10.3.1 Phase I (Immediate Phase)

There would be no cargo movement in Phase I (Immediate Phase) development of NW 101. Phase I (Immediate Phase) would be for Fy 21 & Fy 22. After Phase I (Immediate Phase), development of terminals and fairway would start. Hence, from Phase II, NW 101 would start handling movement of local household commodities.

3.10.3.2 Movement of household commodities in Phase II & Phase III

In Phase II, entire fairway from Longmatra to Avakhung and terminals proposed would be developed along with all the required supporting infrastructure. Cargo Projection for all terminals is done for next 30 years, under 3 different scenarios.

It is taken into consideration that proposed Lower Tizu Hydro Electric Project would not cause any hinderance in navigation in NW 101 and movement of vessels between Terminal 1 to Terminal 4.

- **Assumptions**

Cargo Traffic projection for NW 101 in Phase II would be based on local movement of household commodities between Longmatra to Avakhung. After the development of NW 101, the existing road traffic between Longmatra to Avakhung could be shifted to waterway. The poor condition of roads in the hinterland is a major problem for local transportation and IWT would solve this problem to a great extent. The cost of transportation through roadways is higher at present, which is also a major factor that people in the hinterland would prefer IWT for transportation. However, due to the under developed condition of the hinterland, the volume of household commodity movement in this stretch is low. For traffic of local movement of household commodities, it has been assumed that 80% of projected passenger moving from Terminal 1, 2, 3 and 4 (as mentioned in Passenger Traffic Section 3.10.1) would carry 20 kg. Weight (each passenger). This weight would consist of various household commodities. The figure below depicts detailed methodology used for traffic projection for local movement of household commodities in each terminal on NW 101.

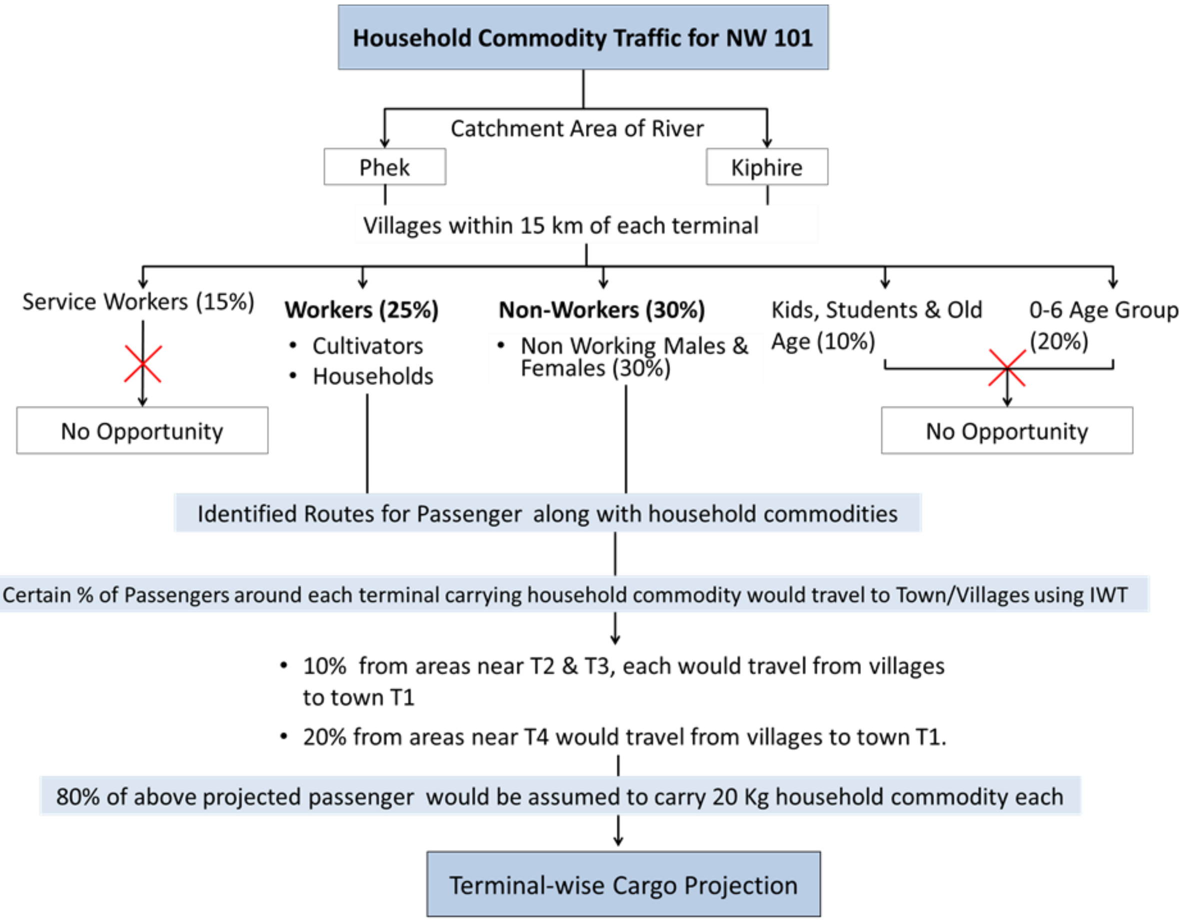


Fig. 3.36 Methodology for local household commodity Traffic for NW 101 in Phase II & III

All the proposed terminals on NW 101 would be used only for along the river movement. There does not exist any requirement for across the river movement.

For traffic estimation and projection of household commodities, villages located within 15 km from terminals are considered. The population of these villages, which is considered for local household commodities traffic count are categorized as follows

- Working Class – Working class includes service class, cultivators and household. It is assumed that service class people would not carry any household commodities; hence 15% of population, which fall in Service class would not provide any opportunity for household commodity movement to NW 101.

- Non-Working Class – Non- working class passengers (30% of population) would carry household commodities. It has been assumed that each passenger from non-working class would carry 20 kg of household commodities during travel. People in this category travel to other villages and towns for shopping or meeting friends and relatives.

- Kids, Students & Old Age – 10% of Population which falling in this category would not provide any opportunity for household commodity traffic to IWT.

- 0-6 Age– Population below 6 years of age are completely excluded from traffic identification for terminals. Thus, they would not provide any opportunity for movement of household commodity on NW 101.

It is assumed that each passenger would carry 20 Kg., except the working class (15% of population) & Kids, students, old age (10% of population).

Projections for household commodities in each terminal is based on following assumptions.

- Household commodities carried by population around each terminal for household commodity Projection – Villages within 15 km
- Included type of Population for opportunity from household commodities – Cultivators (25%), Non-Worker (30%)
- Discarded Population for opportunity from household commodities – Service Class (15%) , 0-6 Age Group (20%) & Kids, Students & Old Age (10%)
- Village-to-Town travelers to T1 (Weekly) – People visiting markets near Longmatra to buy household commodities.
  - ✓ 10% population from areas near T2 & 10 % from T3 would travel from villages to town T1 and carry 20 kg household commodities (each passenger)
  - ✓ 20% of population from areas near T4 would travel from villages to town (Longmatra) T1 and carry 20 kg household commodities (each passenger)

As the household commodities would be carried by passengers on NW 101; hence growth rate of household commodity traffic depends on the growth rate of the passenger traffic for NW 101. Passenger traffic would grow as per the growth rate of population of identified villages in the hinterland.

The below table depicts the growth rates assumed for projecting household commodities traffic for next 30 years. These assumed growth rates are based on the average growth in population of the hinterland in last 10 years.

Table 3.32 Assumed Growth Rates for household commodities

Scenarios	FY23 – FY25	FY26 – FY30	FY31 – FY35	FY36 – FY40	FY41 – FY50
Pessimistic	3%	3%	3%	3%	3%
Realistic	3%	5%	5%	5%	5%
Optimistic	3%	6%	6%	6%	6%

➢ **Traffic Projections**

Based on the above listed assumptions, following are the projections made in different scenarios, i.e. Pessimistic, Base & Optimistic scenarios for traffic projection for household commodities in Phase II & III. The below table depicts projection for each terminal for annual household commodities traffic.

Table 3.33 Phase wise Annual Household Commodity Projections for each Terminal (Tonnes)

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
Pessimistic Scenario									
T1 (Near Longmatra)	0	0	293	330	339	417	484	561	650
T2 (Near Laruri)	0	0	121	136	140	172	200	232	269
T3 (Pokhungri)	0	0	74	83	86	105	122	142	164
T4 (Avakhung)	0	0	99	111	115	141	163	189	220
Base Scenario									
T1 (Near Longmatra)	0	0	293	342	360	506	646	824	1,052
T2 (Near Laruri Bridge)	0	0	121	141	149	209	267	340	435
T3 (Pokhungri)	0	0	74	86	91	128	163	208	266
T4 (Avakhung)	0	0	99	116	121	171	218	278	355
Optimistic Scenario									
T1 (Near Longmatra)	0	0	293	349	370	556	744	996	1,333
T2 (Near Laruri Bridge)	0	0	121	144	153	230	308	412	551
T3 (Pokhungri)	0	0	74	88	93	140	188	252	337
T4 (Avakhung)	0	0	99	118	125	188	251	336	450

3.10.3.3 Movement of Industrial Cargo from India to Myanmar in Phase III

Cargo Traffic projection for Indo-Myanmar trade using NW 101 in Phase III is based on the premise that Myanmar Government would develop navigation in the river stretch from the border till Hta Man Thi. Development of waterway in Mynamar would facilitate border trade movement from Avakhung to Hta Man Thi. There is an agreement between Government of India and Myanmar for Kaladan project. Please refer to Section 3.8.2.4- Agreement between India and Myanmar for the construction & operation of a multi modal transit transport facility on Kaladan river– A Case Study. Similar to this Agreement, inland waterway movement between India and Myanmar using NW 101 could be facilitated with bilateral ties of India and Myanmar.

The movement of industrial cargo on Indo-Myanmar route is a remote possibility. This trade would happen only if Myanmar Government would develop navigation in the river stretch from the Indo- Myanmar border till Hta Man Thi. Industrial cargo for this route would consist of minerals from Laruri region and cement produced in the proposed cement plant at Laruri and existing Wazeho cement plant. At present, it is not recommended to develop Phase III, as currently, there is no industrial cargo traffic which could be shifted to the waterway. The development of this Phase would depend on the development of upcoming industries in the region and development of waterway in the river stretch in Myanmar from the Indo- Myanmar border till Hta Man Thi.

- **Assumptions**

The current capacity of Wazeho Cement Plant is 150 TPD. It was concluded during stakeholders interaction that Wazeho plant would become commercially viable once export of cement happens. Hence, It has been assumed that Wazeho plant would be revived by Fy 28 and it would start exporting 70% of cement from India to Myanmar from Fy 28. Rest 30% cement would be consumed locally in in the hinterland (Nagaland).

During interaction with the local government authorities, it was conveyed to consultants that the capacity of proposed Laruri Cement Plant would be 3,500 TPD. 100% of the produce would be exported to Myanmar using water transport. However, no study has been conducted to establish the demand/market for 3,500 TPD cement plant. Hence, in the absence credible statistics as well as market for cement on a large scale in Myanmar or local hinterland, capacity of proposed cement plant for future projection would be assumed as 300 TPD. The finished product, i.e. cement from this plant would be used for 100% export to Myanmar. Same situation is for marbles, as per discussion with concerned officials, export of 1,000 TPD has been conveyed. But consultant has assumed 200 TPD of marble for export to Myanmar.

Table 3.34 Assumed Capacity of Plants with share of export

Particulars	Tonnes Per Day	Annual Capacity (Tonnes)	% Export
Wazeho Cement Plant	150	45,000	70%
Laruri Cement Plant	300	90,000	100%
Marbles	200	60,000	100%

It has been assumed that total operational days in a year for cargo movement would be 300. At present, there is no future expansion plan for Wazeho Plant and Laruri Plant. Thus, no growth rate has been considered for future cargo projection in Phase III.

- **Traffic Projections**

Based on the above listed assumptions, following are the projections made for industrial cargo movement from India to Myanmar. As it has been considered that Wazeho Plant & new Laruri Cement Plant would be developed by Fy 28. Therefore, industrial cargo projection has been performed after Fy 28 onwards. The below table depicts industrial cargo movement from India to Myanmar in Phase III.

Table 3.35 Annual Industrial Cargo Projections in Phase III

(Tonnes)

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
T2 (Near Laruri Bridge)	0	0	0	0	181,500	181,500	181,500	181,500	181,500

3.10.3.4 Movement of Food Grains from Myanmar to India in Phase III

Food grains would move from Myanmar to India via NW 101 waterway. Projection of household commodities would be based on population of hinterland of NW 101.

- **Assumptions**

For food grain traffic assumption, population in nearby villages (within 15 km) from each proposed terminal has been taken into consideration. Based on the demographic study of the hinterland, it has been assumed that each person in the nearby villages in the hinterland would consume 10 kg food grain every month. Most of food grains consumed in the hinterland would be domestically procured and some would be procured from Myanmar. The department of Food and Civil supplies has a wide network for transportation and distribution of Food grain from FCI godowns, Dimapur. Food grain would also be imported from Myanmar. Hence, it has been assumed that 20% of annual consumption of food grains in the hinterland would be imported from Myanmar.

Table 3.36 Annual Food Grain Consumption & Import of Food Grain from Myanmar

Terminals	Population	Annual Consumption (Kg)	Indo-Myanmar (kg)
T1 (Near Longmatra)	3,273	392,760	78,552
T2 (Near Laruri Bridge)	2,847	341,640	68,328
T3 (Pokhungri)	1,743	209,160	41,832
T4 (Avakhung)	1,158	138,960	27,792
Total			**216,504**

Annual growth rate of food grains consumption has been considered as 1% for initial 10 years and 2% for further years. The consumption of food grains has grown at 1% annually in past 5 years.

- **Traffic Projections**

Based on the above listed assumptions, following are the projections made for food grains traffic (movement from Myanmar). The movement of food grain from Myanmar to India would be unloaded at proposed terminal T2 (Near Laruri Bridge) & T4 (Avakhung) on NW 101. Proposed Terminal 4 would be developed near Avakhung ITC; hence imported food grains from Myanmar would be stored in the ITC and then distributed in the hinterland. A portion of imported food grains from Myanmar would also be unloaded at Terminal 2 (Near Laruri Bridge) and distributed in the surrounding villages.

Table 3.37 Terminal wise Annual imported Food Grain distribution

(Tonnes)

Terminals	**FY 28**	**FY 30**	**FY 35**	**FY 40**	**FY 45**	**FY 50**
Myanmar to India (T2)	130	133	146	162	178	197
Myanmar to India (T4)	87	88	98	108	119	131

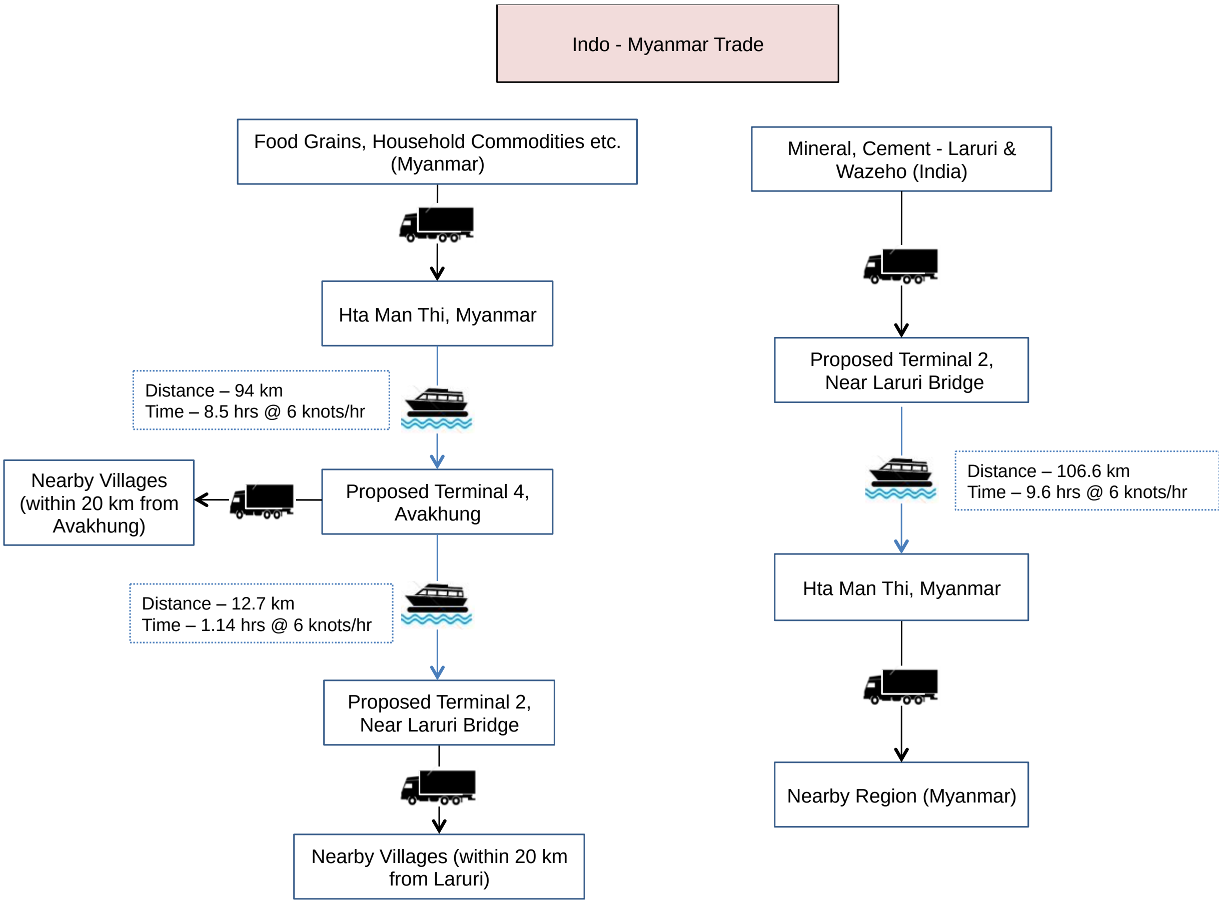


Fig. 3.37 Time- Distance Comparison of Indo-Myanmar Trade Movement

3.11 Conclusion

The hinterland of NW 101 is under developed and hilly region. There exists no major industry in the region. Inland waterway on Tizu & Zungki river would be developed in three phases, i.e. Phase I (Immediate Phase), Phase II and Phase III. Considering the underdeveloped region, it is proposed that in Phase I (Immediate Phase), only passenger traffic would be handled at NW 101. Cargo traffic could be targeted in near future, in Phase II. Cargo Traffic for NW 101 is categorized in two parts, Phase II, i.e. local movement of household commodities and Phase III, i.e. Indo- Myanmar trade and local movement of household commodities. Phase III traffic is a remote possibility, provided the river stretch in Myanmar till Hta Man Thi is developed by Mynamar Government along with other infrastructure in the region. It is assumed that in both phases, the defined stretch of NW 101 would be navigable throughout the year. The upcoming Lower Tizu Hydro Electric Project would not be an obstacle for NW 101.

In Phase II, there is no industrial cargo due to lack of industries in the region. Traffic would consist of only household commodities, which are transported along with passengers between Longmatra to Avakhung (Avankhu). However, the volume of cargo in this stretch is low due to the under developed condition of the hinterland. Passenger traffic in Phase II would consist of local movement of villagers between Longmatra to Avakhung. Tourist traffic would consist of tourists, who would be visiting the tourist sites located in the hinterland. Among all the four proposed terminals, only Terminal 2 (Near Laruri Bridge) would not handle tourist traffic. The terminal would handle commodities, like cement and mineral from the region; hence the surrounding area of the terminal would be dusty and polluted. This would discourage tourists to visit the terminal and surrounding places. Another reason for no tourism opportunity in this terminal is lack of tourist sites in the hinterland of Terminal 2.

In Phase III, Indo- Myanmar trade using IWT is considered. Phase III traffic would consist of local movement as well as Indo- Myanmar trade. Industrial cargo for this route would consist of minerals from Laruri region and cement produced in the proposed cement plant at Laruri and existing Wazeho cement plant. Cargo traffic would also include food grains, which would be transported from Myanmar to Nagaland using NW 101. These commodities would be destined to villages near Avakhung and Laruri. Passenger traffic in Phase III would consist of villagers from the region as well as workers from the proposed cement plant at Laruri and Avakhung Trade Center (ITC). However, at present, Phase III is not recommended to be developed, as currently there is no industrial cargo traffic, which could be shifted to the waterway. The development of this Phase would depend on the development of upcoming industries in the region and development of waterway in the river stretch in Myanmar from the Indo- Myanmar border till Hta Man Thi.

Despite the obstacles, like technical challenges of the river stretch, under developed hinterland, lack of industries, less traffic volume etc., Government could develop NW 101 for the benefit of the society and development of the region. NW 101 could be developed for social cause, like other developments, for instance, hospitals, rural roads, schools etc. The development of NW 101 would solve the existing problem of poor roadways in the hinterland. Due to the problem of landslides and washed away roadways during monsoon, the villagers in remote areas of the hinterland suffer immensely. Villagers could use NW 101 for traveling within villages and to/from Longmatra. From Longmatra, they could use roadways to reach other towns, like Kohima and Dimapur. Development of NW 101 would ease daily travelling of villagers in the hinterland. The following tables depict Passenger and Cargo traffic projection on NW 101.

Table 3.38 Terminal wise Annual Passenger Traffic Projection

(Number)

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	2021	2022	2023	2027	2028	2035	2040	2045	2050
Annual Local Passenger Traffic (Longmatra to Avakhung)									
T1 (Near Longmatra)	14,041	14,462	28,416	33,237	54,698	68,906	82,472	99,788	121,887
T2 (Near Laruri Bridge)	7,910	8,148	16,416	19,201	57,661	65,868	73,706	83,709	96,476
T3 (Pokhungri)	4,845	4,990	10,080	11,790	27,079	32,119	36,932	43,074	50,913
T4 (Avakhung)	3,263	3,361	6,720	7,860	15,453	18,813	22,021	26,116	31,342
Total	30,060	30,961	61,632	72,087	154,892	185,706	215,132	252,687	300,618
Annual Tourist Traffic (Longmatra to Avakhung)									
T1 (Near Longmatra)	5,323	5,483	5,647	6,480	6,739	8,868	11,318	14,446	18,437
T3 (Pokhungri)	2,219	2,285	2,354	2,701	2,809	3,696	4,717	6,021	7,684
T4 (Avakhung)	1,331	1,371	1,412	1,620	1,685	2,217	2,830	3,611	4,609
Total	8,872	9,139	9,413	10,801	11,233	14,782	18,866	24,078	30,730

Table 3.39 Terminal wise Annual Cargo Traffic Projection

(Tonnes)

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	2021	2022	2023	2027	2028	2035	2040	2045	2050
Annual Local Household Commodities Traffic (Longmatra to Avakhung)									
T1 (Near Longmatra)	0	0	293	342	360	506	646	824	1,052
T2 (Near Laruri Bridge)	0	0	121	141	149	209	267	340	435
T3 (Pokhungri)	0	0	74	86	91	128	163	208	266
T4 (Avakhung)	0	0	99	116	121	171	218	278	355
Total (Local household commodities)	0	0	587	686	721	1,014	1,294	1,651	2,107
Annual India to Myanmar Industrial Traffic (Cement, Minerals)									
T2 (Near Laruri Bridge)	0	0	0	0	181,500	181,500	181,500	181,500	181,500
Annual Myanmar to India Food grain Traffic									

Terminals	Phase I (Immediate Phase)		Phase II		Phase III				
	2021	2022	2023	2027	2028	2035	2040	2045	2050
T2 (Near Laruri Bridge)	0	0	0	0	130	146	162	178	197
T4 (Avakhung)	0	0	0	0	87	98	108	119	131
Total (Cements, Minerals & Foodgrains)	0	0	0	0	181,717	181,744	181,769	181,797	181,828

CHAPTER – 4
VESSEL DESIGN

4.0 VESSEL DESIGN

IWAI has defined classifications for development of rivers and canals. NW-101 (River Tizu and River Zungki) faces several difficulty due to lower commercial potential and poor terrain in the region. This restricts development of NW-101 in the pre-defined standard classification of river. Hence, NW-101 would have to conceptualized and developed outside the regular definition and classification of waterways. The dimention of vessels and channel would be lower than the minimum dimension prescribed by IWAI. These vessels could be categorized as special class.

NW101 would be developed under special class waterways. Out of total 40.03km (Tizu-35.41km + Zungki-4.62km), stretch of Tizu river (35.41 km) is considered for development and traffic movement. The traffic study for the project has proposed 4 terminals on River Tizu for passenger, tourism and cargo movement. Domestic traffic (Passengers, Tourism and Household commodities) will be handled at all 4 terminals, while international i.e Indo-Mynamar traffic (Minerals, Cement & Food Grains) will be handled only at Terminal 3 & 4. NW101 is planned to be developed in 3 Phases,i.e Phase I (Immediate implementation), Phase II& Phase III. However, Phase III is very unlikely to come-up because of high development cost and very less volume of traffic, also this phase is depended on operationalisation of Indo-Myanmar Trade that again is less likely to start soon. As mentioned in Traffic Study, at this stage only Phase I & II would be developed and Phase III is discarded. However, vessel designing for all three phases has been done assuming the most optimistic scenario in Phase III.Vessel designing and fleet requirement is calculated for each terminal under each phase.

4.1 Suggested Vessel Specifications

The vessels proposed to be deployed on River Tizu would be selected based on the local need, market and terrain of the river. There are certain parameters that influence the specific class of vessel that should be deployed in the river to handle proposed traffic. The chart below depicts the steps involved in decision making while selecting and recommending type of vessel to be deployed in NW101. The combination of parameters evaluated holistically to devise vessel that are optimum is size, cost effective and safe to use on the NW-101 waterway.

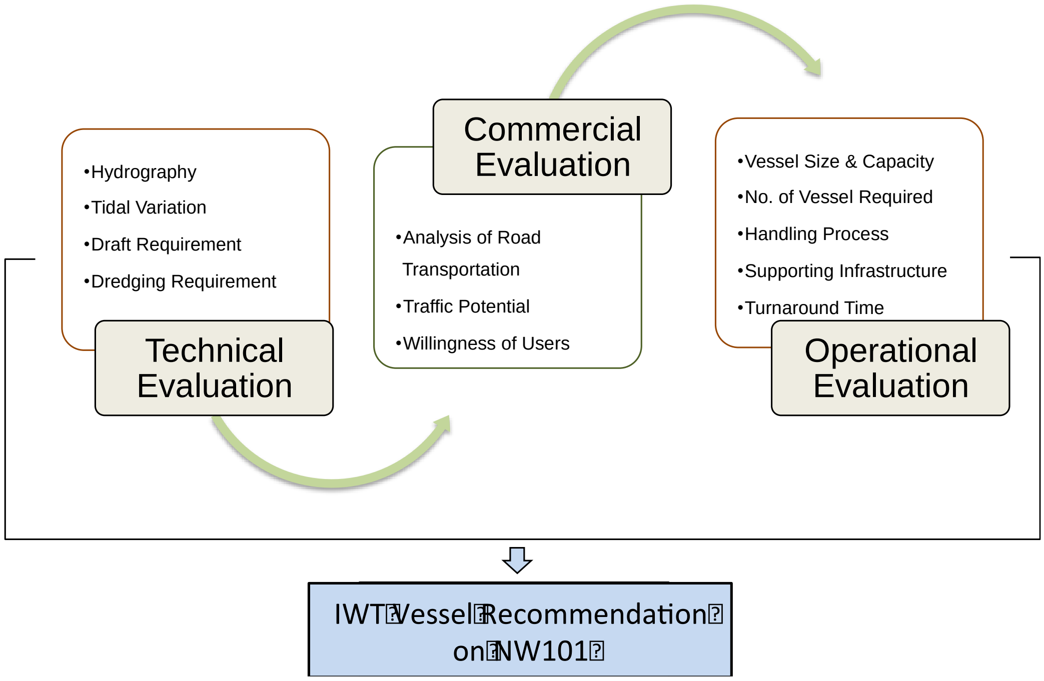


Fig. 4.1 Decision Making Process in Vessel Design

Technical evaluation: Primarily, hydrographic study, tidal study, draft available and waterway characteristics like river course, water depth, radius of bends, current/velocities of water, etc. help to evaluate the technical conditions, which the vessel needs to meet for plying on NW101. This evaluation is an ultimate structure, within which the vessel design selection has to be made.

Commercial evaluation: Evaluation involves type of cargo, volume of cargo, time-distance-speed of transportation and readiness of users to shift to waterways from existing mode of transportation, i.e roadways (there is no rail connectivity in the hinterland). This further helps to narrow down the type of vessels to be recommended based on the capacity requirement.

Operational evaluation: It makes way for the probable operational conditions under which vessel will be operating. This requires knowledge of sailing duration, speed, distance and loading/unloading time, which will further dictate the turnaround time for vessels. It also involves cost incurred in vessel operation (capital, operating and maintenance) and study of physical constraints in the river like clearance under bridge, navigational lock size (existing or recommended), or any other cross structure infrastructure on river.

4.1.1 Factors influencing Design Parameters of Vessels

Inland waterway requires several factors to make it operational for traffic movement. Existence of path of river with sufficient depth, width, and all-round the year water availability are some of the most important factors that determine size of vessel that can safely carrying the proposed traffic on the identified route. Following are the factors that influence the design parameter of vessel that to be deployed in NW101.

- Type of Traffic

  NW101 is proposed to be developed in 3 phases, i.e. Phase I, II & III, for Passenger & Cargo traffic. Passenger traffic would be handled in all three phases; household commodities would be handled in Phase II & III; while cargo traffic would be handled only in Phase III. Passenger, Tourist and Household commodities (passenger carrying cargo) can be accommodated in single type of passenger vessel. For cargo (Mineral, Cement & food grains) traffic in Phase III, bigger cargo vessel will be required, depending on the proposed traffic. Total Traffic volume at each terminal along with origin and destination is shown in Chapter 3.

- Physical Constraints

  Existing and proposed cross-over structures on NW 101, between Longmatra and Avakhung, are to be studied in detail for horizontal and vertical clearance for water transportation. This will help to recommend the size of vessel to be deployed for traffic movement.

- Operational Factors

  Speed of vessel, relation between speed, power and energy consumption, cargo handling rates (Phase 2), Time taken to embark/disembark of passengers, number of non-working days, susceptibility of vessel to damage and crew inefficiency etc. are some of the factors that influence the vessel operation on NW101.

- Type of Vessels

  In Phase I (immediate) of NW101, looking at the traffic and quick commencement of service, motorized inflatable boats is the best option for passenger movement, as no development of any infrastructure or services is proposed in this phase. In Phase II & III, proper terminal construction would be undertaken along with all supporting infrastructure.

4.2 Ideal Vessel Size - Passengers

In Phase I (immediate) of NW101, looking at the traffic and quick commencement of service, motorized inflatable boats is the best option for passenger movement. This limits time taken on development of any infrastructure. The passenger transportation services could commence immediately in this phase. In Phase II & III proper terminal construction would be undertaken along with all supporting infrastructure, to cater the proposed traffic. Size of vessel that can ply on the river depends on whether 1-way or 2-way navigation is to be done, the river bed width, depth and other dimensions. Several guidelines have been evolved from various authorities about relationship between dimension of river and vessels plying on it. NW101 holds minimum 15m bottom width and 20m top width. Along with width of the river and vessel, draft is also considered while suggesting the vessel size. Two types of vessels will be deployed in NW101 i.e. for Passenger and Cargo handling. In Phase II for passenger movement, minimum width of river, i.e. 15 m bottom, is considered for vessel size calculation and same vessel can be used to handle passengers in Phase III as well. While in Phase III for cargo handling, 30 m bottom width is considered for vessel size calculation.

Waterway Width = (Maneuvering Lanes' Width X 2) + (Passing Distance Width) + (Bank Clearance Width X 2)

According to 'The World Association for Waterborne Transport Infrastructure' (PIANC) guidelines, the normal width of waterway for 2-way navigation of barge should be at least around combined width of maneuvering lanes, width of passing distance and width of bank clearance. Width of lanes and passing distance both are same as width of assumed vessel, whereas bank clearance width is taken as half of width of assumed vessel.

Passenger Movement – Phase II & III

Passenger handling Capacity – 20 Nos.
Length – 6 m
Beam Width–2.5 m
Waterway Width - 15 m bottom

→ (2.5X2)+(2.5)+((2.5/2)X2) = 10

Cargo Movement – Phase III

Cargo handling Capacity - 100 Tonnes
Beam Width - 5 m
Draft - 1 m
Waterway Width - 20 m bottom

→ (5X2)+(5)+((5/2)X2) = 20

As per the above calculation, it is established that vessel with 2.5 m width for passenger transportation and 5 m width for cargo transportation for two-way navigation can easily navigation the defined stretch of NW101.

4.2.1 Phase I (Immediate)

Inflatable boat with outboard motor (OBM) has been proposed to be deployed on NW 101 in the Phase I. This phase would handle passenger traffic.

Table 4.1 Suggested Vessel's Specification for Phase I – Inflatable Boats with OBM

Company / Ferry Name →	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	4.2	4.1	4.5 – 4.7	4.4
Beam (m)	1.8	1.7	1.9	1.8
Passenger Capacity (PAX)	6-7	4-6	8-10	8-10
Engine Power (HP)	25	25	25	25
Make	Indian	Indian	Indian	Indian
Fuel	Diesel	Diesel	Diesel	Diesel
Price (INR)	7,50,000/-	5,83,000/-	1,55,000/-	5,50,000/-

Source: Direct information from the vessel manufactures (as listed below)

Note: Details of vessels described in ANNEXURE XII of Volume-III.
Vessel Type 1 – Safin 420 Inflatable Rescue Boat, Mumbai (https://www.shmgroup.com)
Vessel Type 2 – Gee Pee 4.1 Mt Boat, Delhi(http://www.geepee.in)
Vessel Type 3 – Culcutta Sportsboat, Kolkata(http://www.calcuttaboat.com)
Vessel Type 4 – Gemeni Boat, Mumbai (https://www.shmgroup.com)

Fig. 4.2 Inflatable Boat Samples

Inflatable boats have been selected for deployment in the Phase I for the following reasons.

- The lead time for starting operation on NW-101 would be very short
- This would not require lengthy approvals from various government departments
- There would be minimum investment on the shore based infrastructure. The inflatable boats could be berthed along side at all the locations on the river beds. However, there is a proposal to mark the terminal locations and creation of basic facilities even in the Phase I
- They are lightweight and could be carried from one location to another location in deflated condition without much difficulty
- They could be deployed for service after inflating in matter of minutes
- Additional facility for storage and berthing of boats would not be required to be created. The boats, in Phase I, could be stored at any the village located adjacent to the terminal location. It could be left in the custody of boat operator. This eradicates expenses associated with storage, upkeep and maintenance of the boat
- The cost of acquiring inflatable boats with outboard motors is less than 40% of other alternatives. This makes it the cheapest option for water transportation in rivers or disaster management on a smaller scale.

- The terrain of River Tizu has large boulders. A hard hull conventional boat has the risk of getting ruptured on collision with them. This risk is absent to a large scale with inflatable boat.
- The inflatable boat with OBM would have the versatility of operating in extremely low water depth. The operator could lift the OBM and row the boat in areas with less than 0.3 m water depth.
- Tie-up with OEM (Original Equipment Manufacturer) would be made for repair and maintenance of vessels. Other small break-downs could be done locally.

4.2.2 Phase II & III - Passenger, Tourist & Household Commodities

Vessels with less than 1 m draft, categorized as special class, has been proposed to be deployed in NW 101 for passenger transportation. Following table lists down sample vessels along with images provided by suppliers that could be deployed on NW 101.

Table 4.2 Vessel's Specification in Special Class

Ferry→	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	5.6	6	11	7
Beam (m)	2.28	2.5	3.84	2
Draft (m)	0.6	0.5	0.6	0.4
Passenger Capacity (No.)	18	20	20	10
Speed (Knots)	10	10	12	12
Fuel Consumption (Ltr/Hr)	4.5	2.6	20	6.8
Type of Fuel	Diesel	Diesel	Petrol	Diesel
Engine Capacity (HP)	25	15	2 X 70	40
Make	Indian	Foreign	Foreign	Indian
Fuel	Diesel	Diesel	Diesel	Diesel

Source: Direct information from the vessel manufactures (as listed below)

Note: Details of vessels described in ANNEXURE XII of Volume-III
Vessel Type 1 – India Bungy, Ahmedabad (http://www.indiabungy.com)
Vessel Type 2 –Inflatable Ferryboat, Slovenia, EU (https://www.hovercraft.si)
Vessel Type 3 – Abra 36. UAE (https://www.smartown.ae)
Vessel Type 4 – Model Victory 10 Boat, Kolkata (http://www.calcuttaboat.com)

Source: (http://www.indiabungy.com)

Fig. 4.3 India Bungy

Source: (https://www.hovercraft.si)

Fig. 4.4 Inflatable Ferryboat

Source: (https://www.smartown.ae)

Fig. 4.5 Abra-36

Source: (http://www.calcuttaboat.com)

Fig. 4.6 Model Victory 10 Boat

Vessels selected for deployment in the Phase II & III for passenger handling are small ferry boats. These vessels are equipped to carry passengers and the luggage passenger carry with them along while travelling. The carrying capacity of the boats have been selected based the need of local people and their travel needs. The ferry boats would have provision for accommodating passengers and their luggage. Every adult (exclude kids and elderly) passenger has been assumed to carry about 20 kg of weight during their travel. They would be carrying them as part of their hand luggage. The boats selected for deployment are GRP boats.

4.2.3 Phase III–Cargo (Cement, Minerals & Food Grains)

Keeping in view the river parameters (30 m bottom width and 1.2 m draft), traffic type (Minerals, Cement and Food Grains), volume (approx. 0.18 MMTPA) and Ideal Vessel Size (Vessel with 5 m width), Class I type of vessel could be deploy in NW101, between Laruri and Avakhung, to cater the projected traffic till FY50. The table below shows the recommended vessel specification for cargo handling in Phase 2.

Table 4.3 Vessel's Specification in Class I for cargo handling

Specifications	Cargo Vessel
Length (m)	32
Beam Width (m)	5
Draft (m)	1
Speed (Knots)	6
DWT (T)	110
Block Coefficient	0.85
Cargo Capacity (T)	100
Fuel Used	Diesel
Fuel Consumption (Ltr/Hr)	17
Engine Capacity (BHP)	100

In all phases, any similar kind of vessels that are listed above, i.e with 0.5 m or less draft for passengers, 1.0 m draft from cargo and capable of carrying projected traffic could be deploy in NW101 to handle and transport projected traffic. Based on these specifications, total turnaround time and number of vessels required till FY50 are calculated in following section.

4.3 Turnaround Time

Turn around time required by per boat for recommended Special class vessel for passenger handling and Class 1 vessel for cargo handling is computed in the table below. The entire analysis is based on assumption that only daytime navigation will be taken, no night navigation is allowed.

Table 4.4 Calculation of Total Turnaround Time

Route →	Unit	Longmatra to Avakhung	Laruri to Avakhung
Type of Cargo	-	Passengers & Tourists	Cargo
Loading/Unloading at Each Terminal	Hrs:Mins	0:15	2:00
Traffic handling Terminals in route	No.	4	1
Misc. Waiting	Hrs:Mins	-	1:00
Total Handling Time	Hrs:Mins	1:00	3:00
Sailing Speed	Knots	6.0	4.0
Sailing Time	Hrs:Mins	3:10	1:15
Total Time (Hours)	Hrs:Mins	4:10	4:15

4.4 Fleet Requirement

Estimation of fleet required to deploy on above defined routes to cater Passenger, Tourist and cargo traffic is discussed in this section.Requirement of number of vessel is calculated based on the the traffic proposed on NW101 i.e approx. 250 passengers carrying total 2 tons of cargo daily initially (FY24), other relevant factors are also considered such as movement distance, capacity, speed, physical constrains, vessel specifications, operational days/hours, etc. Following are the assumptions considered for calculating ship calls and no. of vessels requirement.

- Vessel Calculation is done for 2 routes.
  - ✓ Route 1 - Longmatra to Avakhung for Passengers
  - ✓ Route 2 - Laruri to Avakhung for cargo.
- It is assumed that the terminal would be operational for 10 hours in a day, 300 days in a year.
- Vessel Capacity
  - ✓ Route 1 for Passenger Movement - 20 passengers + 600kgs household commodities
  - ✓ Route 2 Cargo Movement - 90 Tonnes Cargo
- Loading/Unloading Time & Misc. Waiting Time
  - ✓ Route 1 for Passenger handling – 1.5 Hrs
  - ✓ Route 2 for Cargo Handling – 3 Hrs
- Vessel speed - 6 Knots for passenger &4 Knots for Cargo carrying vessels

Table 4.5 Vessels Required for Passenger Movement (Numbers)

Sr. No	FY23	FY30	FY40	FY50
Approx. Daily Passengers (No.)	126	235	338	509
Daily Ship Calls (No.)	7	12	17	26
Vessels Required (No.)	3	5	7	11
Additional Requirement (No.)		2	2	4

Table 4.6 Vessels Required for cargo Movement (Numbers)

Sr. No	FY28	FY30	FY40	FY50
Daily Cargo Movement (Tons)	606	606	606	606
Daily Ship Calls (No.)	7	7	7	7
Total No. of Vessels Required	4	4	4	4
Additional Requirement		0	0	0

It is recommended to deploy inflatable boats in Phase I to handle only passengers, Special Class vessel in Phase II for passengers along with household commodities and Class I for handling cargo in Phase III.The number of vessels calculated in the above table for each route are sufficient enough to handle the total projected traffic till FY50.

CHAPTER – 5
DATA ANALYSIS

5.1 Data Collection

All relating data of bathymetric, topographic, longitudinal and cross section (survey conducted in year 2015) of Tizu and Zungki river from longmatra to Avakhung were collected from IWAI.

The Gauge discharge data of the nearby region of the rivers were collected from Department of water resources, Govt.of Nagaland. The other secondary sources data were also collected from various departments and the same were analyzed in this chapter.

5.2 Hydrological data analysis of nearby Gauge site

There is no Central water commission (CWC) as well as Nagaland water resources Gauge station is present in the stretch defined for NW101.

However, two nearby gauge station of WRD,Nagaland is present as Tizu GD station at Phek which is approximately 32 km upstream from nearest point of NW-101. and another at Tape GD station at Kiphire which is approximately 10 km upstream of River Zungki. The Tape GD station is present on the tributary of the River Zungki while the Tizu GD station is on the River Tizu. The details of the Gauge station are given in the below table 5.1 and the location of Gauge station is shown in fig 5.1:

Table 5.1 Details of Gauging Station

Site Name	Location	State	Basin	Local River	Zero of the Gauge (m)	Type of Site
Tizu GD at Phek	25°38'25.21"N 94°35'7.34"E	Nagaland	Irrawady Chindwin	Tizu	Local Zero	GD-WRD Nagaland
Tape GD at Kiphire	25°50'32.36"N 94°47'12.71"E	Nagaland	Irrawady Chindwin	Tape (Tributary of Zungki)	Local Zero	GD-WRD Nagaland

Source: WRD, Nagaland

The hydrological inputs play a very vital role in planning, execution and operation of any Navigational project. The hydrological studies are carried out at all the stages of project starting from the pre- feasibility stage and are continued even during the operation of the project. Hydrological studies usually cover the assessment of quantities of available water and its time variation, estimation of design flood usually required for the hydraulic design as well as safety of the structure.

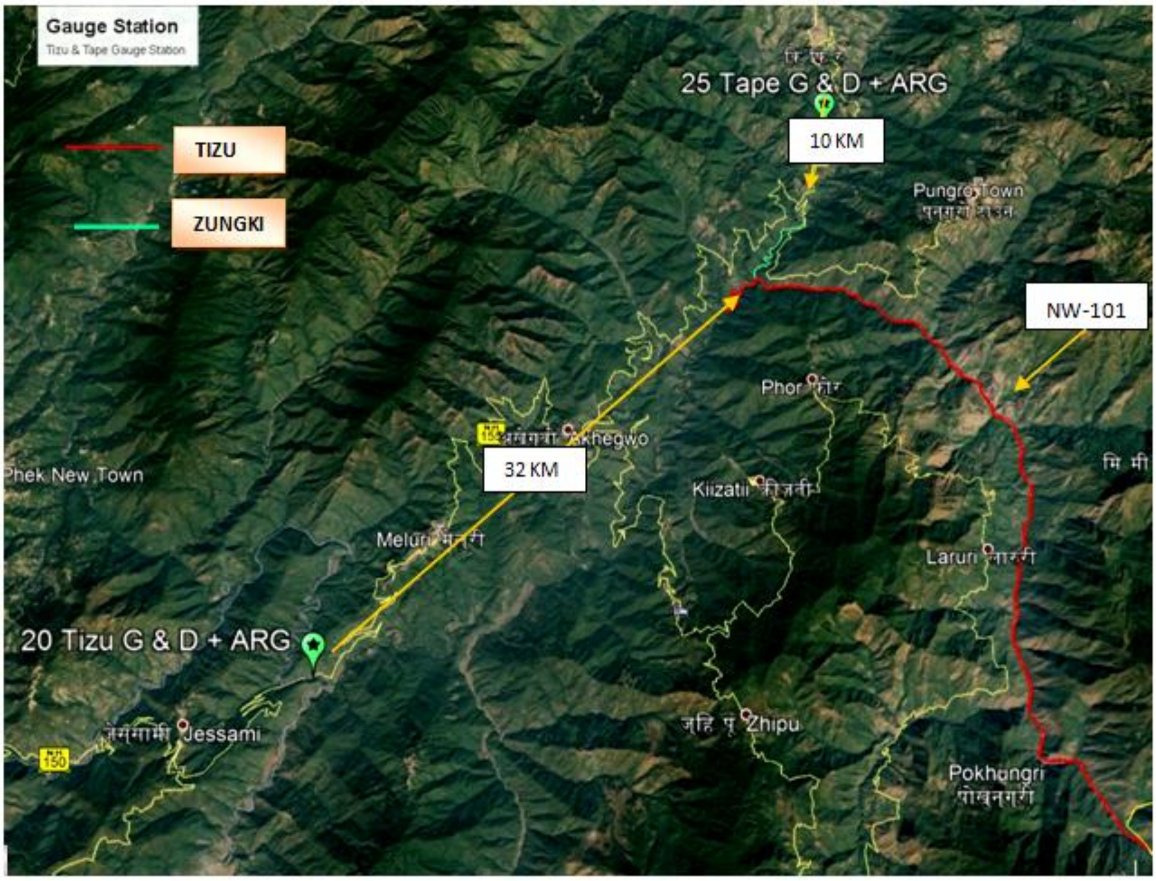


Fig. 5.1 Location of Gauge station Tape and Tizu

5.2.1 Minimum and Maximum Water level and Discharge

The gauge discharge data for above two gauge stations has been analyzed to know the minimum and maximum water level as well as minimum and maximum discharge over a period of time 2012-2018. This analysis has been summarized in the following table:

Table 5.2 Min and Max Water Depth (RL Local Zero) and Discharge at Gauge Stations

Station Name	Period	MIN Water Depth (m)	MIN Q (m3/s)	MAX Water Depth (m)	MAX Q(m3/s)
Tizu GD at Phek	2012-2018	0.01	1.26	6.92	1230.77
Tape GD at Kiphire	2012-2018	0.12	0.17	5.52	202.65

Source: WRD, Nagaland (Depth are w.r.t to local zero of the site)

From the above table it can be seen that the variation of minimum and maximum water level is in the tune of 6.9 m at Tizu GD and 5.4 m at Tape GD. The discharge data collected from Nagaland WRD is attached in **Annexure-IX**

5.2.2 Monthly Minimum and Maximum Water level and Discharge

Further the detailed study of hydrological data has been carried out. The analysis of the data in the form of monthly minimum and maximum water level and discharge observed at each Gauge stations has been analyzed. This will give us the basic idea about the monthly variation of water level as well as discharge, viz, range of variation between monthly minimum and maximum water level and range of variation between monthly minimum and maximum discharge. This is summarized and given in below table:

Table 5.3 Monthly Min and Max Water Depth at Tizu Gauge Stations

Year	Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual
2012-2013	**Min.**	1.70	2.01	2.20	1.95	1.64	1.37	1.21	0.02	0.02	0.01	0.14	1.11	**0.01**
	Max.	3.75	5.59	6.05	2.20	4.17	2.31	1.37	1.25	0.27	0.90	1.11	2.15	**6.05**
2013-2014	**Min.**	2.04	3.09	3.05	2.37	1.85	1.54	1.38	1.06	0.91	0.74	0.79	0.89	**0.74**
	Max.	4.40	6.11	6.00	3.59	2.50	1.83	1.55	1.37	1.42	1.47	1.27	1.69	**6.11**
2014-2015	**Min.**	1.44	2.33	2.50	2.40	2.05	1.48	1.28	1.09	1.03	0.83	1.86	1.75	**0.83**
	Max.	2.29	3.90	4.30	2.78	2.45	2.03	1.46	1.28	1.19	1.90	2.02	1.93	**4.30**
2015-2016	**Min.**	1.88	1.86	2.78	2.27	1.45	1.00	1.08	0.95	0.77	0.79	0.92	0.99	**0.77**
	Max.	2.15	6.92	4.90	3.05	2.38	1.48	1.25	1.07	0.94	1.01	1.07	1.17	**6.92**
2016-2017	**Min.**	1.80	4.10	4.20	4.60	3.50	2.10	1.50	1.24	1.04	1.00	1.14	1.08	**1.00**
	Max.	4.80	5.30	5.10	5.30	5.00	4.10	2.10	1.55	1.25	1.10	1.40	6.06	**6.06**
2017-2018	**Min.**	1.57	4.80	4.70	4.60	4.10	2.20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**1.57**
	Max.	6.60	6.10	5.80	5.50	5.50	5.30	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**6.60**
TOTAL	**Min.**	**1.44**	**1.86**	**2.20**	**1.95**	**1.45**	**1.00**	**1.08**	**0.02**	**0.02**	**0.01**	**0.14**	**0.89**	**0.01**
	Max.	**6.60**	**6.92**	**6.05**	**5.50**	**5.50**	**5.30**	**2.10**	**1.55**	**1.42**	**1.90**	**2.02**	**6.06**	**6.92**

Table 5.4 Monthly Min and Max Discharge (Cumecs) at Tizu Gauge Stations

Year	Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual
2012-2013	**Min.**	37.96	60.34	76.63	44.98	30.33	24.01	21.14	1.33	1.33	1.26	2.39	13.92	**1.26**
	Max.	154.31	359.07	778.76	63.45	323.62	81.45	24.01	21.92	3.82	12.27	18.84	63.74	**778.76**
2013-2014	**Min.**	63.47	163.37	144.73	84.44	53.89	23.59	17.82	8.92	7.48	5.92	5.92	7.66	**5.92**
	Max.	371.56	758.52	724.48	216.74	219.75	47.20	24.39	17.58	19.47	20.75	16.05	30.61	**758.52**
2014-2015	**Min.**	20.21	50.07	61.33	52.74	36.91	26.50	23.50	18.40	16.87	12.12	31.41	29.04	**12.12**
	Max.	42.14	199.19	277.23	72.54	55.43	39.39	29.58	24.04	20.85	33.01	37.80	41.31	**277.23**
2015-2016	**Min.**	31.84	30.84	90.97	63.40	30.03	16.06	18.11	14.36	11.19	11.43	14.12	15.71	**11.19**
	Max.	42.22	1230.77	689.05	107.46	69.46	31.14	23.16	17.93	14.66	16.39	17.75	20.67	**1230.77**
2016-2017	**Min.**	49.94	336.81	349.48	457.96	218.18	57.29	33.58	22.07	17.11	16.07	19.76	12.52	**12.52**
	Max.	512.22	670.33	581.21	670.33	564.29	315.80	57.29	32.88	23.42	18.60	28.15	816.26	**816.26**
2017-2018	**Min.**	122.16	507.12	491.65	476.28	361.61	64.66	51.87	N.A.	N.A.	N.A.	N.A.	N.A.	**51.87**
	Max.	1029.25	954.55	801.00	728.11	-	670.41	68.52	N.A.	N.A.	N.A.	N.A.	N.A.	**1029.25**
TOTAL	**Min.**	**20.21**	**30.84**	**61.33**	**44.98**	**30.03**	**16.06**	**17.82**	**1.33**	**1.33**	**1.26**	**2.39**	**7.66**	**1.26**
	Max.	**1029.25**	**1230.77**	**801.00**	**728.11**	**564.29**	**670.41**	**68.52**	**32.88**	**23.42**	**33.01**	**37.80**	**816.26**	**1230.77**

Table 5.5 Monthly Min and Max Water Depth at Tape Gauge Stations

Year	Month	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual
2012-2013	**Min.**	0.36	0.60	0.55	0.42	0.39	0.25	0.25	0.22	0.25	0.23	0.32	0.65	**0.22**
	Max.	0.80	2.50	3.62	2.88	3.55	0.48	0.46	0.48	0.46	0.42	1.89	2.15	**3.62**
2013-2014	**Min.**	1.32	0.65	0.58	0.53	0.31	0.33	0.24	0.27	0.23	0.26	0.22	0.23	**0.22**
	Max.	1.85	3.52	1.89	1.95	0.75	0.58	0.51	0.50	0.45	0.48	0.53	0.48	**3.52**
2014-2015	**Min.**	0.41	0.54	0.71	1.37	0.44	0.41	0.46	0.26	0.22	1.24	1.27	1.34	**0.22**
	Max.	0.63	2.62	2.77	2.77	1.79	1.79	1.69	1.56	0.68	1.59	1.60	2.65	**2.77**
2015-2016	**Min.**	1.37	1.09	1.34	1.34	0.34	0.12	0.22	0.17	0.24	1.17	1.32	0.48	**0.12**
	Max.	3.57	5.52	3.37	2.59	1.57	1.57	1.37	0.55	1.54	1.57	1.58	2.32	**5.52**
2016-2017	**Min.**	1.32	1.32	0.32	0.32	1.26	1.07	0.34	1.34	1.16	1.00	1.32	1.34	**0.32**
	Max.	2.62	2.64	1.67	1.56	3.47	2.52	1.64	1.66	1.89	2.06	2.57	2.57	**3.47**
2017-2018	**Min.**	1.45	1.15	1.37	1.34	1.08	0.23	0.32	N.A.	N.A.	N.A.	N.A.	N.A.	**0.23**
	Max.	3.65	2.64	2.58	2.64	2.52	2.55	1.56	N.A.	N.A.	N.A.	N.A.	N.A.	**3.65**
TOTAL	**Min.**	**0.36**	**0.54**	**0.32**	**0.32**	**0.31**	**0.12**	**0.22**	**0.17**	**0.22**	**0.23**	**0.22**	**0.23**	**0.12**
	Max.	**3.65**	**5.52**	**3.62**	**2.88**	**3.55**	**2.55**	**1.69**	**1.66**	**1.90**	**2.06**	**2.57**	**2.65**	**5.52**

Table 5.6 Monthly Min and Max Discharge (Cumecs) at Tape Gauge Stations

Year	Month	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual
2012-2013	**Min.**	1.26	3.77	2.55	1.769	2.29	0.83	0.76	0.72	0.64	0.73	1.17	4.31	**0.64**
	Max.	8.38	63.70	126.73	80.73	88.77	2.71	2.98	3.42	2.96	3.10	18.64	37.57	**126.73**
2013-2014	**Min.**	18.35	3.08	2.41	2.84	0.97	1.31	0.86	0.90	0.17	1.01	0.89	0.73	**0.17**
	Max.	33.15	81.75	27.62	36.71	7.72	4.30	2.90	3.14	2.87	2.99	21.80	3.25	**81.75**
2014-2015	**Min.**	1.41	2.47	6.13	11.35	1.61	2.54	2.12	1.05	0.72	10.13	12.42	11.76	**0.72**
	Max.	4.78	38.75	57.14	55.39	28.47	25.55	25.79	24.82	4.62	25.82	25.15	52.67	**57.14**
2015-2016	**Min.**	16.15	11.93	14.61	16.34	1.36	0.42	0.85	0.72	0.77	12.65	16.37	2.84	**0.42**
	Max.	76.24	197.63	59.55	84.36	24.28	20.92	19.32	3.54	22.95	27.58	29.13	41.15	**197.63**
2016-2017	**Min.**	13.88	12.91	1.40	1.32	13.32	8.94	1.43	20.23	1.04	9.84	19.31	23.60	**1.04**
	Max.	63.17	53.54	32.02	24.74	84.98	49.57	26.92	43.38	21.89	15.45	98.72	114.15	**114.15**
2017-2018	**Min.**	27.89	15.97	6.23	15.51	12.89	1.09	1.45	N.A.	N.A.	N.A.	N.A.	N.A.	**1.09**
	Max.	202.65	57.85	62.35	61.98	56.17	54.16	24.71	N.A.	N.A.	N.A.	N.A.	N.A.	**202.65**
TOTAL	**Min.**	**1.26**	**2.47**	**1.40**	**1.32**	**0.97**	**0.42**	**0.76**	**0.72**	**0.17**	**0.73**	**0.89**	**0.73**	**0.17**
	Max.	**202.65**	**197.63**	**126.73**	**84.36**	**88.77**	**54.16**	**26.92**	**43.38**	**22.95**	**27.58**	**98.72**	**114.15**	**202.65**

5.2.3 Ten daily flow Analysis

Monthly Minimum and Maximum water level and discharge gives idea about the variation between minimum and maximum water level and discharge in a particular month. In a month day to day variation of water level and discharge may vary significantly that's why to get insight average of ten daily flow and water level has been computed. This will give us more reliable result about the water level variation and discharge.

The daily gauge discharge data for nearby gauge stations namely **Tizu GD at Phek** and **Tape GD at Kiphire** has been analyzed for computation of ten daily average flows. Details of the analysis is shown in the Annexure 4.1. This analysis indicates rise in ten daily flows from the month April to August then reduction from August to December and from January onwards further reduction in flow till march. Gauge station wise analysis and result are summarized as below:

Tizu GD at Phek

The results of analysis for the station indicate range of average 10 daily discharges in different period of year as following

- June to August - Begins at 187 m^3/s and increases to 415 m^3/s
- September to December - Begins at 265 m^3/s and decreases to 30 m^3/s
- January to March - Begins at 30 m^3/s and decreases to 15 m^3/s
- March to June - Begins at 15 m^3/s and increases to 187 m^3/s

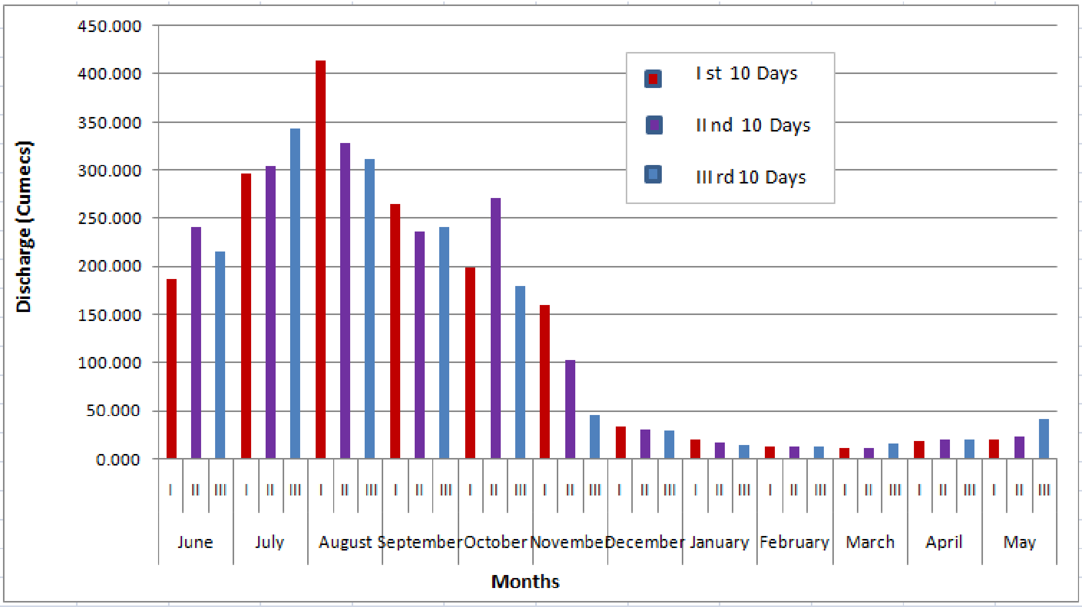


Fig. 5.2 Average 10 daily discharges at Tizu GD at Phek

Tape GD at Kiphire

The results of analysis for the station indicate range of average 10 daily discharges in different period of year as following. For this gauge station variation in uneven as shown in the figure.

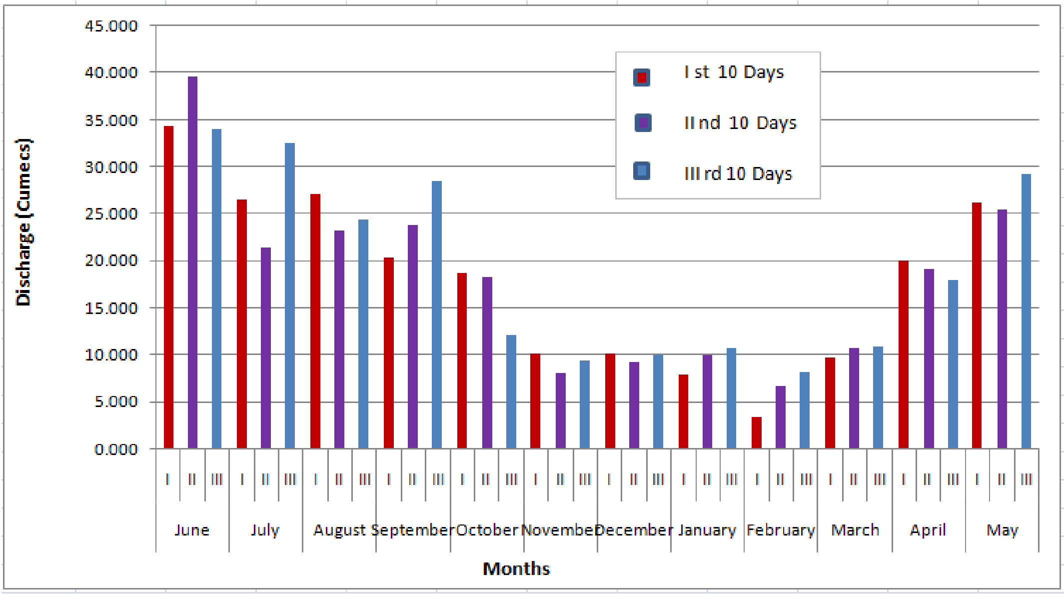


Fig. 5.3 Average 10 daily discharges at Tape GD at Kiphire

5.2.4 Assessment of Water availability/Flow Depth

A water availability study is the most important aspect for success of any navigational project and forms the basis for development of water resources of a river to its maximum potential. The feasibility of a project very much depends on the outcome of studies on water availability at various levels of dependability and on the variations of the flow over considerably long period. For that statistical analysis has been carried out by computing average monthly water level value from the available hydrological data over the data period of the nearer gauge stations to assess the water availability round the year in the River Tizu NW 101. The duration curves of cumulative monthly elevation has been plotted to find out the duration of availability of water depth throughout the year. Also, the minimum water depth available for 330 days has been shown:

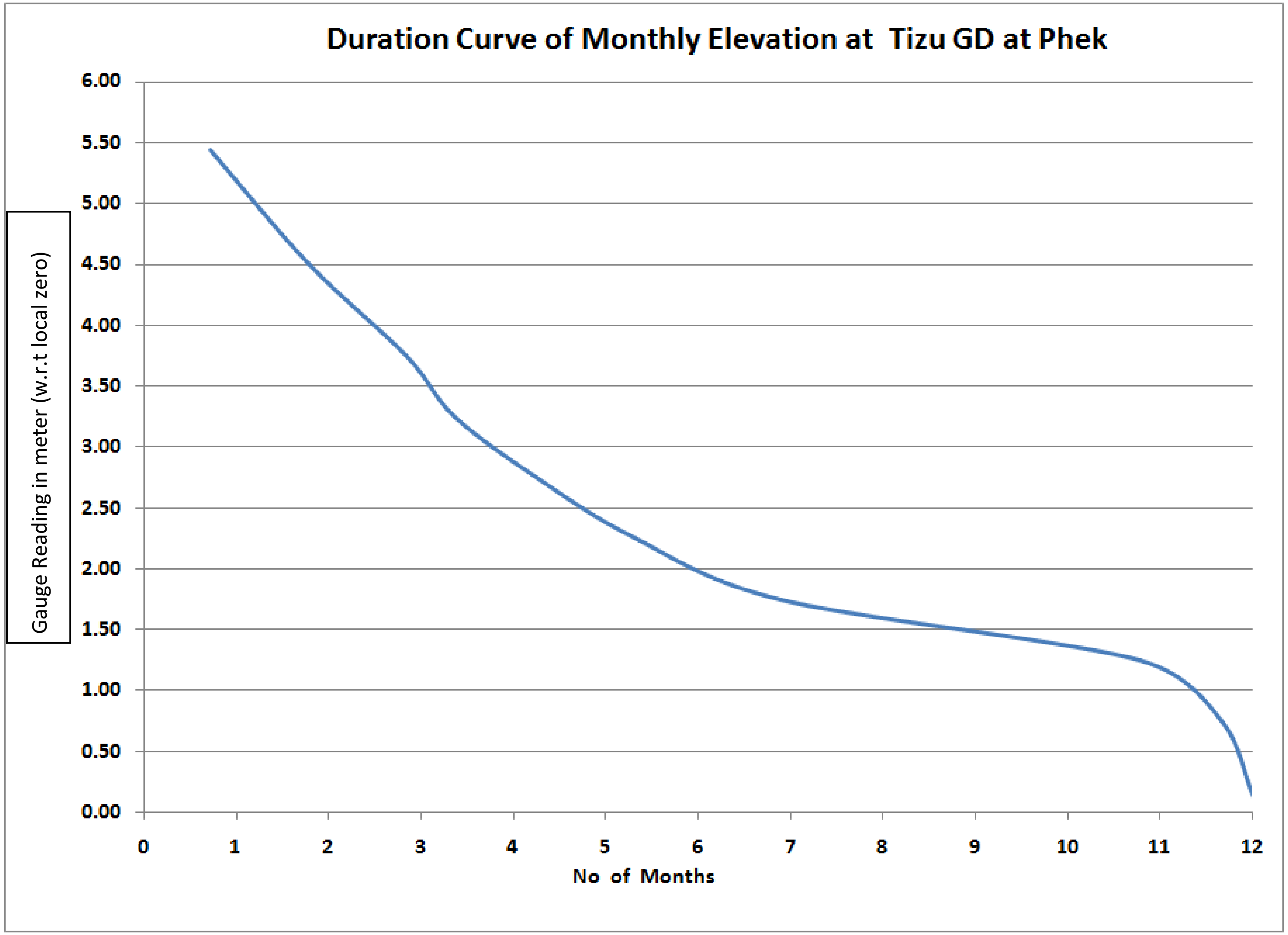


Fig. 5.4 Duration Curve of Monthly Elevation at Tizu GD at Phek

It is quite clear from the above graph that for 330 days min water depth (wrt Bed Level) available is approximately 1.2m.

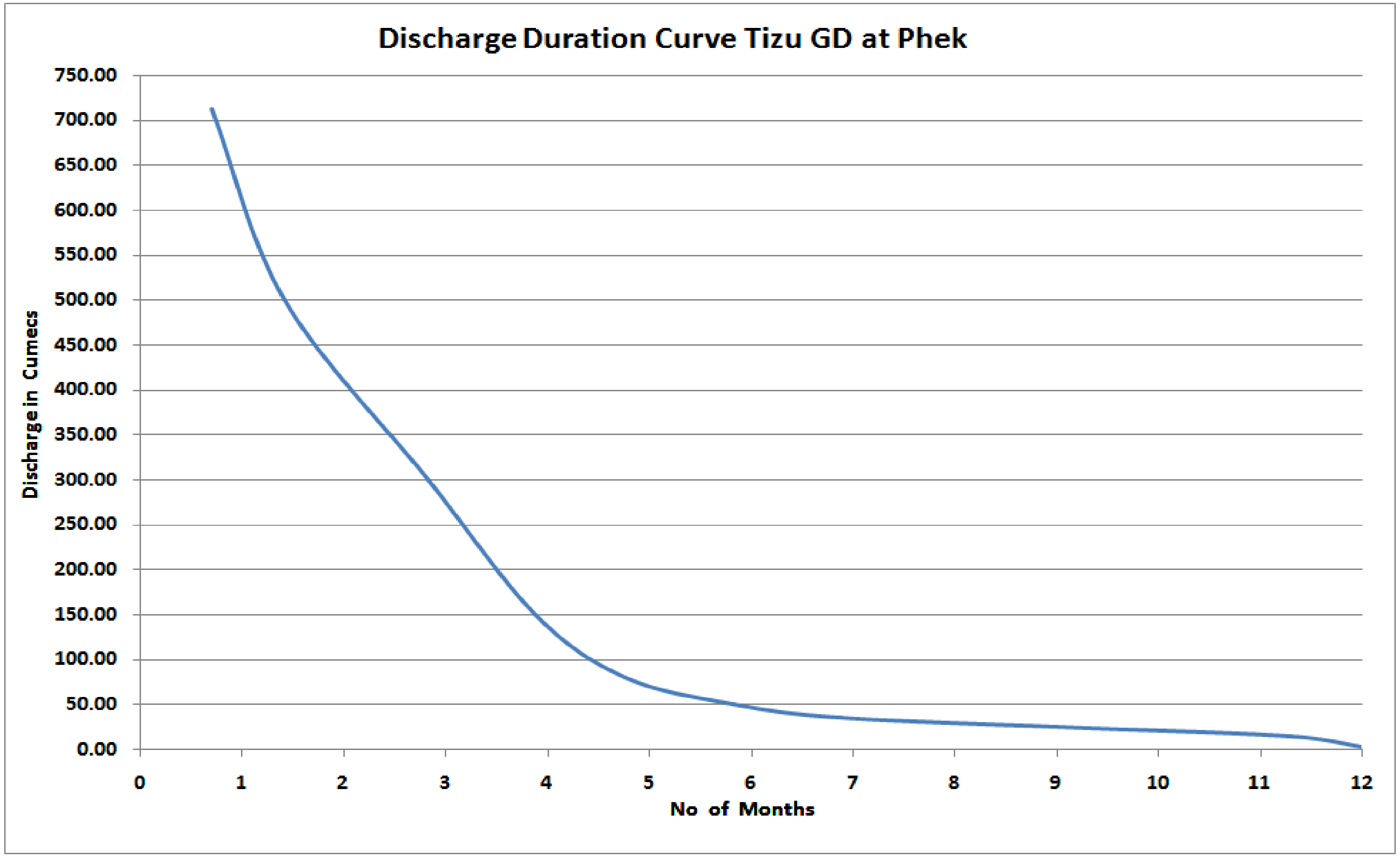


Fig. 5.5 Discharge Duration Curve at Tizu GD at Phek

It is quite clear from the above graph that for 330 days min discharge available is approximately 22 cumecs & 50 cumecs and above discharge is available for 180 days.

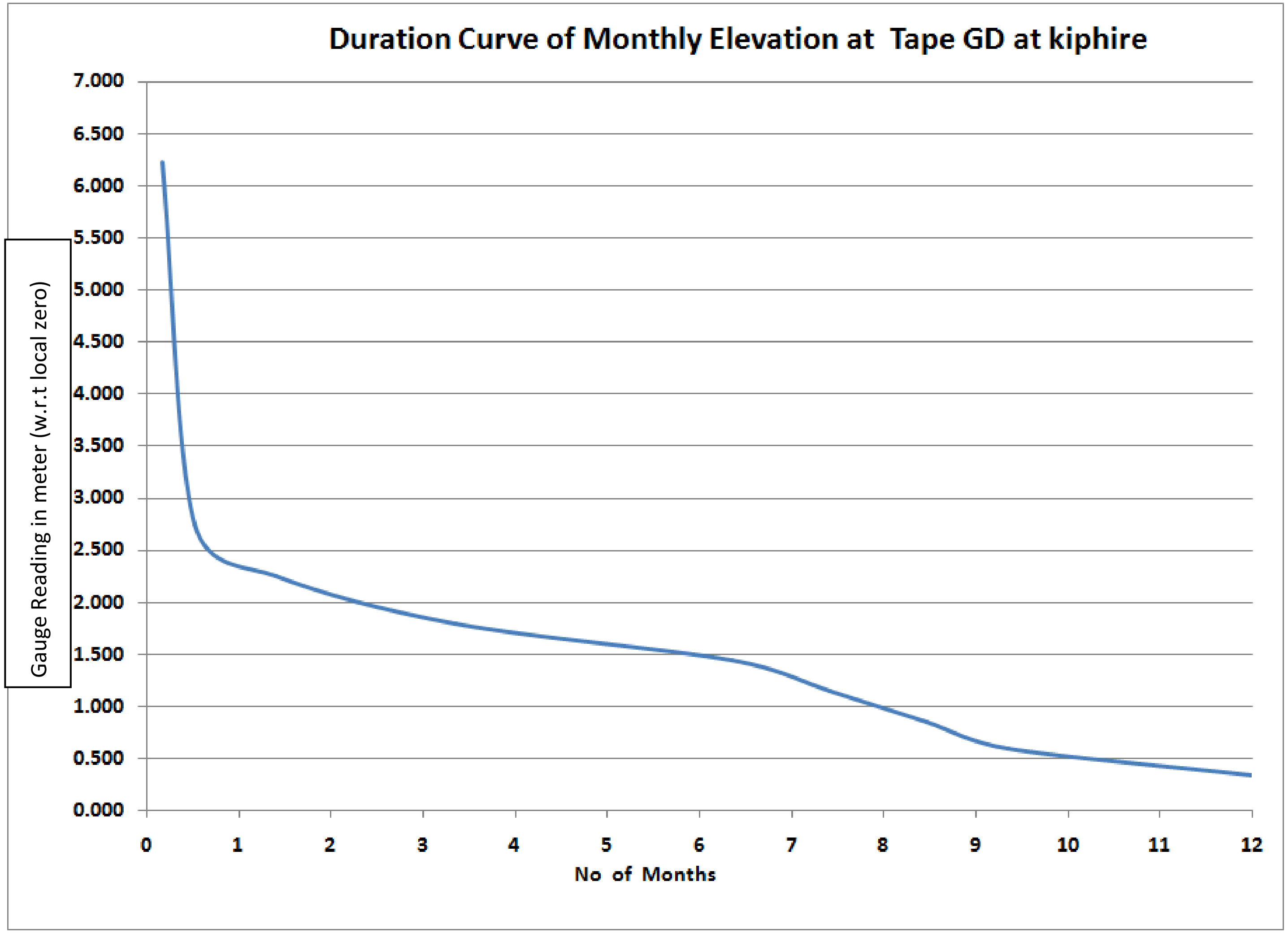


Fig. 5.6 Duration Curve of Monthly Elevation at Tape GD Kiphire

It is quite clear from the above graph that the 1.2 m water depth at Tape GD Kiphire is Available for approximately 215 days and for 330 days min water depth (wrt Bed Level) available is just is 0.4 m.

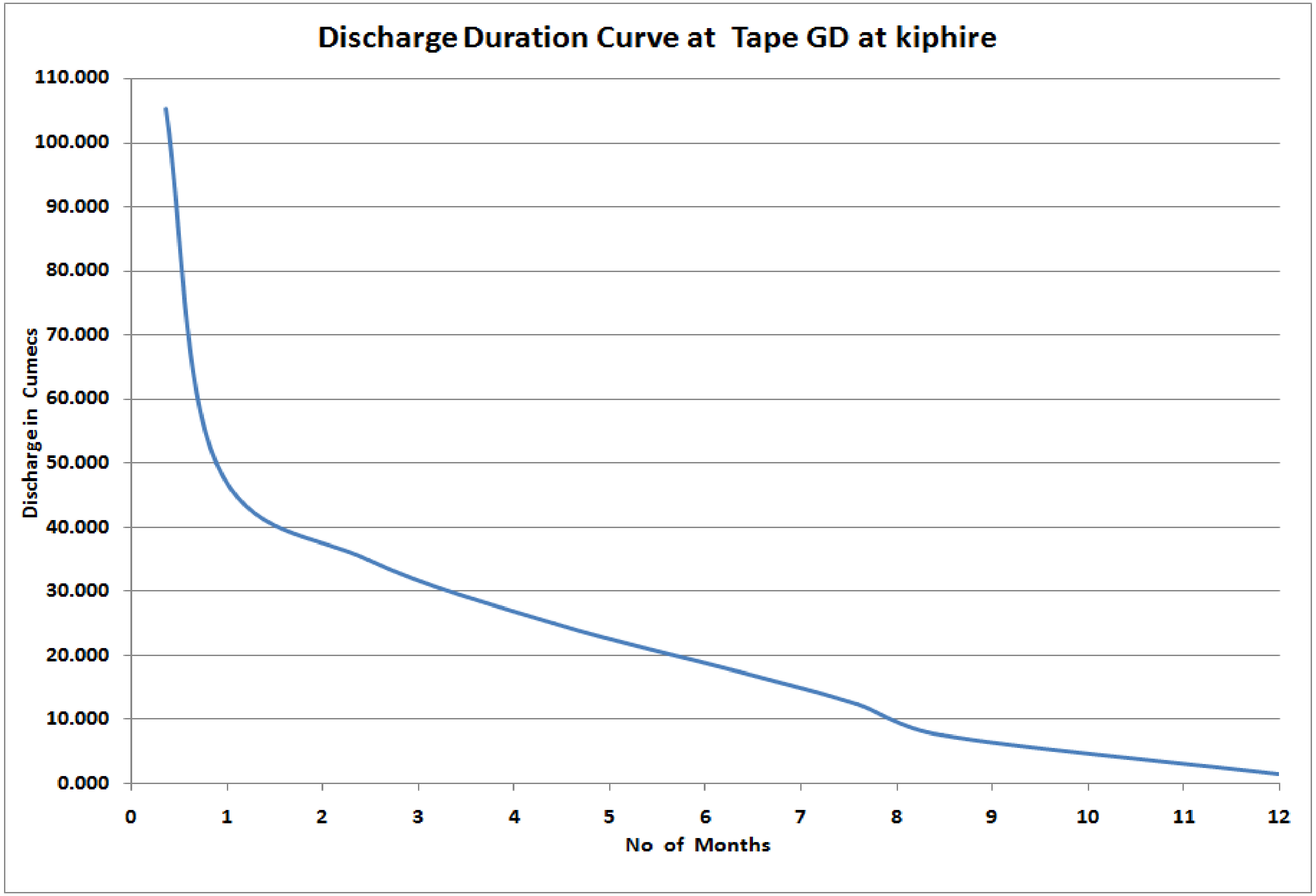


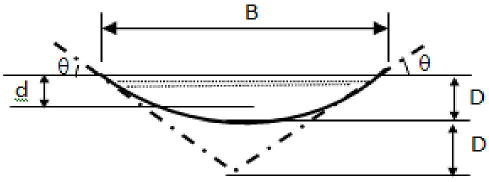
Fig. 5.7 Discharge Duration Curve at Tape GD at Kiphire

It is quite clear from the above graph that for 330 days min discharge available is approximately 4 cumecs & 10 cumecs and above discharge is available for 240 days.

5.3 Flow Requirement for Navigation

For development of an authorized depth in a river it is essential that a minimum required discharge is available. In order to calculate the min discharge required to maintain required depth 1m, 1.5 m and 2m, CBIP formula is used and it is given as under:

$$d = \left\{ \frac{Q}{204\, m\, (S)^{1/2}} \right\}^{4/11}$$



Where d = Depth available (m)
S = Energy / Water slope
θ = Natural angle of repose of a shore or a stabilized bank
m = cot θ = B/6d
d = 2/3 D
Q = Discharge (m^3/s)

The discharges has been calculated by the CBIP formula for maintaining depth for 0.6m,1m,1.5m and 2m has been shown below

Table 5.7 Tizu River Discharge requirement for Development of LAD 0.6m

Discharge requirement for Development of LAD 0.6m								
Chainage		**Width of river during lean season(m)**	**Target LAD (m)**	**Water / Energy Slope**	**m = B/6d**	**$(S)^{1/2}$**	**$(d)^{11/4}$**	**Discharge (cum/s)**
0	**1**	20.5	0.6	0.0014	5.69	0.0370	0.245	10.5
1	**2**	22.5	0.6	0.0003	6.25	0.0163	0.245	5.1
2	**3**	21	0.6	0.0006	5.83	0.0245	0.245	7.2
3	**4**	24.5	0.6	0.0005	6.81	0.0217	0.245	7.4
4	**5**	30	0.6	0.0015	8.33	0.0384	0.245	16.0
5	**6**	37.5	0.6	0.0008	10.42	0.0284	0.245	14.8
6	**7**	33	0.6	0.0022	9.17	0.0464	0.245	21.3
7	**8**	21.5	0.6	0.0005	5.97	0.0224	0.245	6.7
8	**9**	39.5	0.6	0.0005	10.97	0.0222	0.245	12.2
9	**10**	45.5	0.6	-0.0014	12.64	-	0.245	-
10	**11**	35	0.6	0.0038	9.72	0.0619	0.245	30.1
11	**12**	37.5	0.6	-0.0007	10.42	-	0.245	-
12	**13**	36	0.6	0.0020	10.00	0.0445	0.245	22.3
13	**14**	41.5	0.6	0.0013	11.53	0.0365	0.245	21.1
14	**15**	35	0.6	-0.0005	9.72	-	0.245	-
15	**16**	31	0.6	0.0014	8.61	0.0372	0.245	16.0
16	**17**	31.5	0.6	0.0005	8.75	0.0221	0.245	9.7
17	**18**	30.5	0.6	0.0019	8.47	0.0440	0.245	18.6
18	**19**	27.5	0.6	0.0012	7.64	0.0348	0.245	13.3
19	**20**	24	0.6	-0.0001	6.67	-	0.245	-
20	**21**	20.5	0.6	0.0013	5.69	0.0367	0.245	10.5

Discharge requirement for Development of LAD 0.6m								
Chainage		Width of river during lean season(m)	Target LAD (m)	Water / Energy Slope	m = B/6d	$(S)^{1/2}$	$(d)^{11/4}$	Discharge (cum/s)
21	**22**	15	0.6	0.0010	4.17	0.0324	0.245	6.8
22	**23**	20	0.6	0.0026	5.56	0.0511	0.245	14.2
23	**24**	26	0.6	0.0009	7.22	0.0305	0.245	11.0
24	**25**	19	0.6	0.0009	5.28	0.0293	0.245	7.7
25	**26**	19.5	0.6	0.0007	5.42	0.0258	0.245	7.0
26	**27**	25	0.6	0.0023	6.94	0.0479	0.245	16.6
27	**28**	21.5	0.6	-0.0014	5.97	-	0.245	-
28	**29**	25.5	0.6	0.0017	7.08	0.0418	0.245	14.8
29	**30**	19.5	0.6	0.0019	5.42	0.0439	0.245	11.9
30	**31**	21.5	0.6	0.0009	5.97	0.0296	0.245	8.9
31	**32**	16.5	0.6	0.0009	4.58	0.0307	0.245	7.0
32	**33**	22.5	0.6	0.0012	6.25	0.0341	0.245	10.7
33	**34**	24.5	0.6	-	6.81	-	0.245	-
34	**35**	19	0.6	-	5.28	-	0.245	-

Hence, from the above table we can ascertain that average discharge of 12.8 cumecs, minimum discharge of 5.1 cumecs and Max discharge of 30.1 cumecs is required for maintaining LAD of 0.6 m in river Tizu from chainage 0-35km

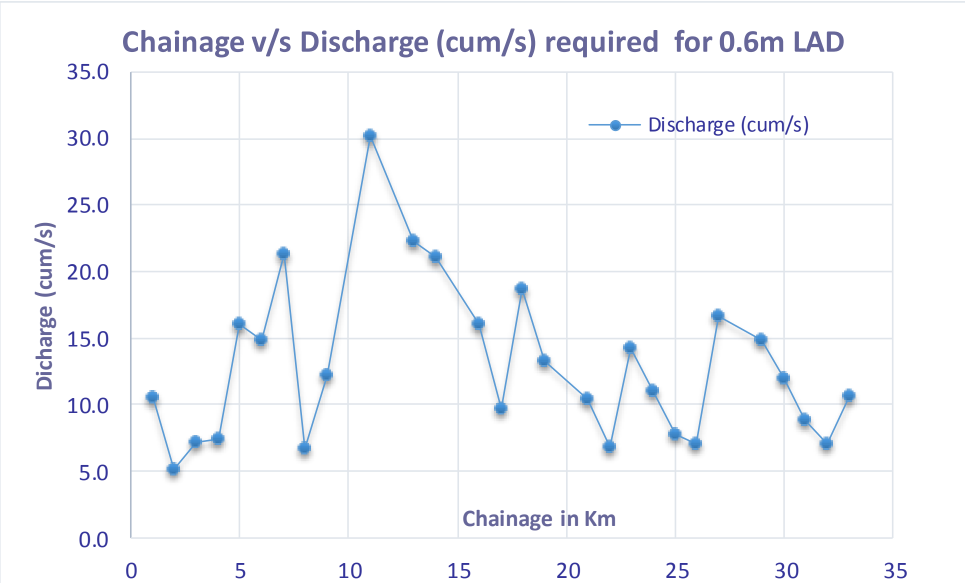


Fig. 5.8 Chainage v/s Discharge for LAD 0.6m

Table 5.8 Tizu River Discharge requirement for Development of LAD 1m

Chainage		Width of river during Survey(m)	Target LAD (m)	Water / Energy Slope	m = B/6d	$(S)^{1/2}$	$(d)^{11/4}$	Discharge (cum/s)
0	1	20.5	1	0.001369	3.42	0.037	1	25.78900
1	2	22.5	1	0.000266	3.75	0.01630951	1	12.47677
2	3	21	1	0.000601	3.50	0.0245153	1	17.50393
3	4	24.5	1	0.000469	4.08	0.02165641	1	18.03979
4	5	30	1	0.001475	5.00	0.03840573	1	39.17384
5	6	37.5	1	0.000805	6.25	0.02837252	1	36.17497
6	7	33	1	0.002155	5.50	0.04642198	1	52.08546
7	8	21.5	1	0.0005	3.58	0.02236068	1	16.34566
8	9	39.5	1	0.000495	6.58	0.0222486	1	29.87986
9	10	45.5	1	-0.001425	7.58	-	1	-
10	11	35	1	0.003835	5.83	0.06192738	1	73.69358
11	12	37.5	1	-0.000695	6.25	-	1	-
12	13	36	1	0.00198	6.00	0.04449719	1	54.46456
13	14	41.5	1	0.001333	6.92	0.03651027	1	51.51599
14	15	35	1	-0.000483	5.83	-	1	-
15	16	31	1	0.001385	5.17	0.03721559	1	39.22523
16	17	31.5	1	0.00049	5.25	0.02213594	1	23.70760
17	18	30.5	1	0.001933	5.08	0.0439659	1	45.59263
18	19	27.5	1	0.00121	4.58	0.03478505	1	32.52403
19	20	24	1	-0.000148	4.00	-	1	-
20	21	20.5	1	0.001345	3.42	0.03667424	1	25.56195
21	22	15	1	0.001048	2.50	0.03237283	1	16.51014
22	23	20	1	0.002612	3.33	0.05110773	1	34.75326
23	24	26	1	0.00093	4.33	0.0304959	1	26.95838
24	25	19	1	0.00086	3.17	0.02932576	1	18.94444
25	26	19.5	1	0.000668	3.25	0.0258457	1	17.13570
26	27	25	1	0.002292	4.17	0.04787484	1	40.69361
27	28	21.5	1	-0.0014	3.58	-	1	-
28	29	25.5	1	0.001748	4.25	0.04180909	1	36.24848
29	30	19.5	1	0.001925	3.25	0.04387482	1	29.08901
30	31	21.5	1	0.000877	3.58	0.02961419	1	21.64797
31	32	16.5	1	0.00094	2.75	0.03065942	1	17.19993
32	33	22.5	1	0.001164	3.75	0.03411744	1	26.09984
33	34	24.5	1	-0.000326	4.08	-	1	-
34	35	19	1	-0.000864	3.17	-	1	-

Hence, from the above table we can ascertain that average discharge of 31.4 cumecs, minimum discharge of 12.5 cumecs and Max discharge of 73.6 cumecs is required for maintaining LAD of 1m in river Tizu from chainage 0-35km

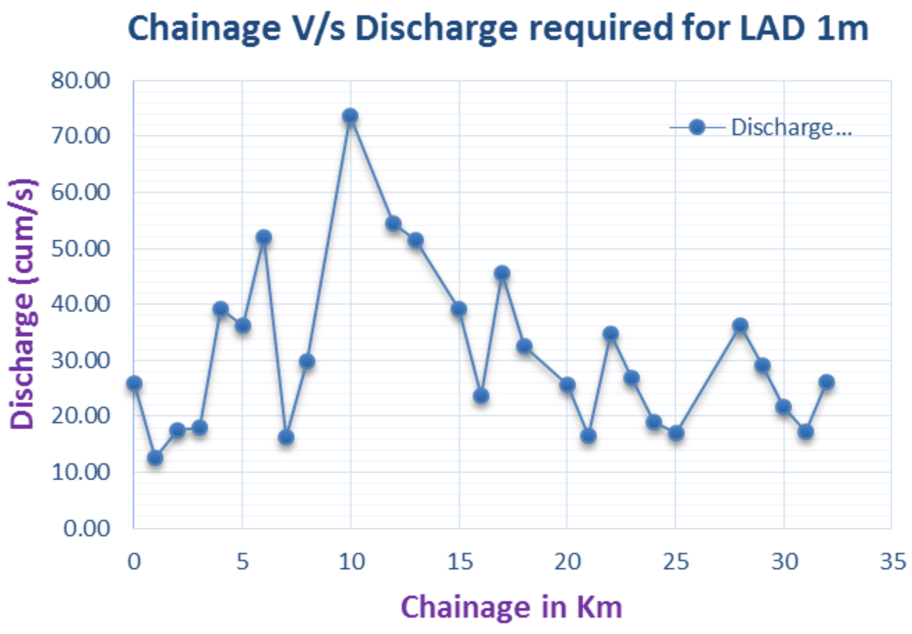


Fig. 5.9 Chainage v/s Discharge for LAD 1m

Similarly discharges for 1.5m LAD and 2 m LAD has been calculated from the CBIP formula

Table 5.9 Tizu River Discharge requirement for Development of LAD 1.5m

Chainage		Width of river during survey(m)	Target LAD (m)	Water / Energy Slope	m = B/6d	$(S)^{1/2}$	$(d)^{11/4}$	Discharge (cum/s)
0	1	20.5	1.5	0.001369	2.28	0.037	3.049657	52.43173
1	2	22.5	1.5	0.000266	2.50	0.01630951	3.049657	25.36658
2	3	21	1.5	0.000601	2.33	0.0245153	3.049657	35.58731
3	4	24.5	1.5	0.000469	2.72	0.02165641	3.049657	36.67677
4	5	30	1.5	0.001475	3.33	0.03840573	3.049657	79.64452
5	6	37.5	1.5	0.000805	4.17	0.02837252	3.049657	73.54749
6	7	33	1.5	0.002155	3.67	0.04642198	3.049657	105.89518
7	8	21.5	1.5	0.0005	2.39	0.02236068	3.049657	33.23243
8	9	39.5	1.5	0.000495	4.39	0.0222486	3.049657	60.74889
9	10	45.5	1.5	-0.001425	5.06	-	3.049657	-
10	11	35	1.5	0.003835	3.89	0.06192738	3.049657	149.82675
11	12	37.5	1.5	-0.000695	4.17	-	3.049657	-
12	13	36	1.5	0.00198	4.00	0.04449719	3.049657	110.73215
13	14	41.5	1.5	0.001333	4.61	0.03651027	3.049657	104.73740
14	15	35	1.5	-0.000483	3.89	-	3.049657	-
15	16	31	1.5	0.001385	3.44	0.03721559	3.049657	79.74899
16	17	31.5	1.5	0.00049	3.50	0.02213594	3.049657	48.20002
17	18	30.5	1.5	0.001933	3.39	0.0439659	3.049657	92.69459

Table 5.9 Tizu River Discharge requirement for Development of LAD 1.5m

Chainage		Width of river during survey(m)	Target LAD (m)	Water / Energy Slope	m = B/6d	$(S)^{1/2}$	$(d)^{11/4}$	Discharge (cum/s)
18	19	27.5	1.5	0.00121	3.06	0.03478505	3.049657	66.12474
19	20	24	1.5	-0.000148	2.67	-	3.049657	-
20	21	20.5	1.5	0.001345	2.28	0.03667424	3.049657	51.97011
21	22	15	1.5	0.001048	1.67	0.03237283	3.049657	33.56684
22	23	20	1.5	0.002612	2.22	0.05110773	3.049657	70.65700
23	24	26	1.5	0.00093	2.89	0.0304959	3.049657	54.80920
24	25	19	1.5	0.00086	2.11	0.02932576	3.049657	38.51602
25	26	19.5	1.5	0.000668	2.17	0.0258457	3.049657	34.83866
26	27	25	1.5	0.002292	2.78	0.04787484	3.049657	82.73436
27	28	21.5	1.5	-0.0014	2.39	-	3.049657	-
28	29	25.5	1.5	0.001748	2.83	0.04180909	3.049657	73.69695
29	30	19.5	1.5	0.001925	2.17	0.04387482	3.049657	59.14099
30	31	21.5	1.5	0.000877	2.39	0.02961419	3.049657	44.01259
31	32	16.5	1.5	0.00094	1.83	0.03065942	3.049657	34.96926
32	33	22.5	1.5	0.001164	2.50	0.03411744	3.049657	53.06371
33	34	24.5	1.5	-0.000326	2.72	-	3.049657	-
34	35	19	1.5	-0.000864	2.11	-	3.049657	-

Hence, from the above table we can ascertain that average discharge of 63.82 cumecs, minimum discharge of 25.36 cumecs and maximum discharge of 149.82 cumecs is required for maintaining LAD of 1.5m in river Tizu.

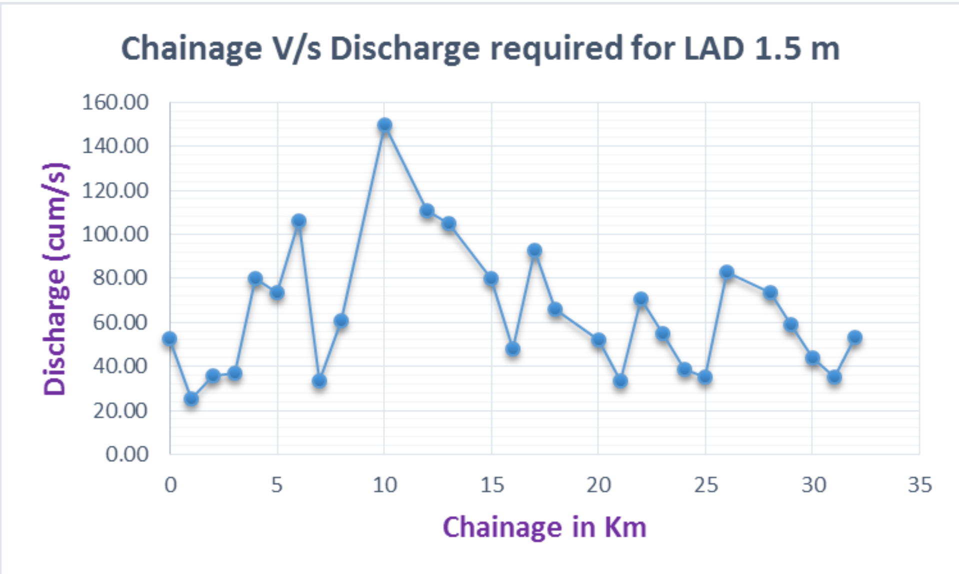


Fig. 5.10 Chainage v/s Discharge for LAD 1.5 m

Table 5.10 Tizu River Discharge requirement for Development of LAD 2m

Chainage		Width of river during Survey (m)	Target LAD (m)	Water / Energy Slope	m = B/6d	$(S)^{1/2}$	$(d)^{11/4}$	Discharge (cum/s)
0	1	20.50	2	0.00137	1.71	0.0370	6.72717	86.74
1	2	22.50	2	0.00027	1.88	0.0163	6.72717	41.97
2	3	21.00	2	0.00060	1.75	0.0245	6.72717	58.88
3	4	24.50	2	0.00047	2.04	0.0217	6.72717	60.68
4	5	30.00	2	0.00148	2.50	0.0384	6.72717	131.76
5	6	37.50	2	0.00080	3.13	0.0284	6.72717	121.68
6	7	33.00	2	0.00216	2.75	0.0464	6.72717	175.19
7	8	21.50	2	0.00050	1.79	0.0224	6.72717	54.98
8	9	39.50	2	0.00050	3.29	0.0222	6.72717	100.50
9	10	45.50	2	-0.00143	3.79	-	6.72717	-
10	11	35.00	2	0.00383	2.92	0.0619	6.72717	247.87
11	12	37.50	2	-0.00069	3.13	-	6.72717	-
12	13	36.00	2	0.00198	3.00	0.0445	6.72717	183.20
13	14	41.50	2	0.00133	3.46	0.0365	6.72717	173.28
14	15	35.00	2	-0.00048	2.92	-	6.72717	-
15	16	31.00	2	0.00138	2.58	0.0372	6.72717	131.94
16	17	31.50	2	0.00049	2.63	0.0221	6.72717	79.74
17	18	30.50	2	0.00193	2.54	0.0440	6.72717	153.35
18	19	27.50	2	0.00121	2.29	0.0348	6.72717	109.40
19	20	24.00	2	-0.00015	2.00	-	6.72717	-
20	21	20.50	2	0.00134	1.71	0.0367	6.72717	85.98
21	22	15.00	2	0.00105	1.25	0.0324	6.72717	55.53
22	23	20.00	2	0.00261	1.67	0.0511	6.72717	116.90
23	24	26.00	2	0.00093	2.17	0.0305	6.72717	90.68
24	25	19.00	2	0.00086	1.58	0.0293	6.72717	63.72
25	26	19.50	2	0.00067	1.63	0.0258	6.72717	57.64
26	27	25.00	2	0.00229	2.08	0.0479	6.72717	136.88
27	28	21.50	2	-0.00140	1.79	-	6.72717	-
28	29	25.50	2	0.00175	2.13	0.0418	6.72717	121.92
29	30	19.50	2	0.00193	1.63	0.0439	6.72717	97.84
30	31	21.50	2	0.00088	1.79	0.0296	6.72717	72.81
31	32	16.50	2	0.00094	1.38	0.0307	6.72717	57.85
32	33	22.50	2	0.00116	1.88	0.0341	6.72717	87.79
33	34	24.50	2	-0.00033	2.04	-	6.72717	-
34	35	19.00	2	-0.00086	1.58	-	6.72717	-

Hence, from the above table we can ascertain that average discharge of 105.59 cumecs, minimum discharge of 41.97 cumecs and Max discharge of 247.87 cumecs is required for maintaining LAD of 2m in river Tizu.

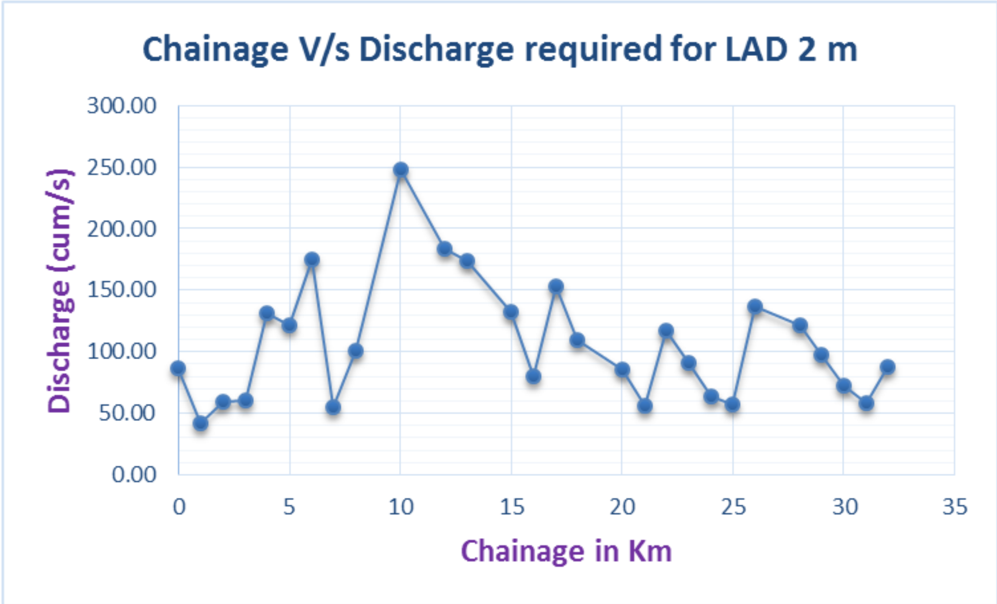
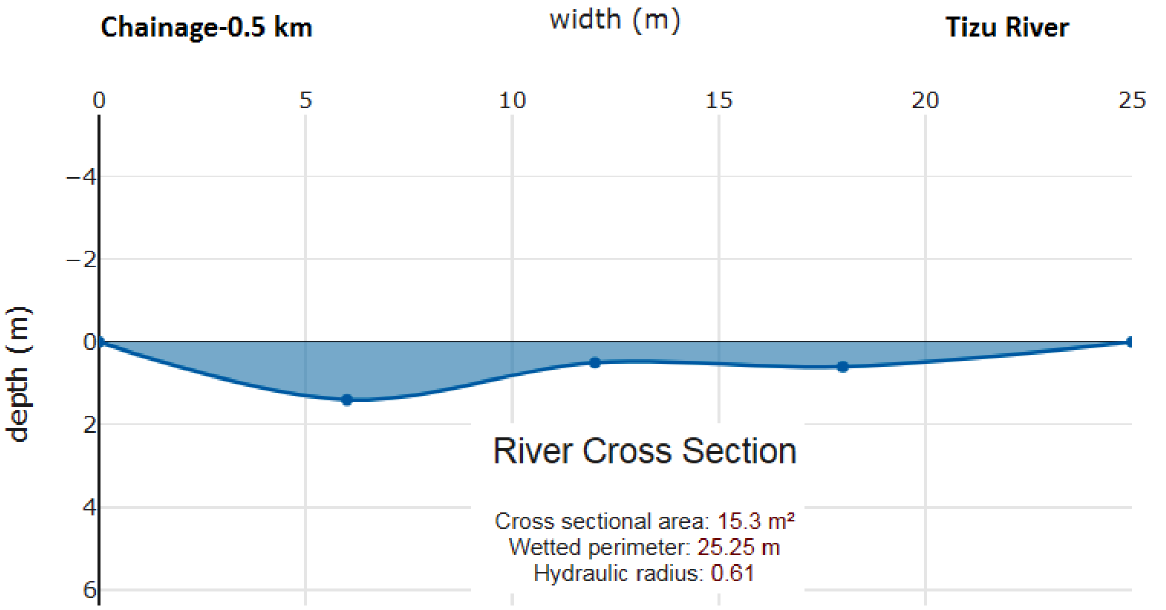


Fig. 5.11 Chainage v/s Discharge for LAD 2m

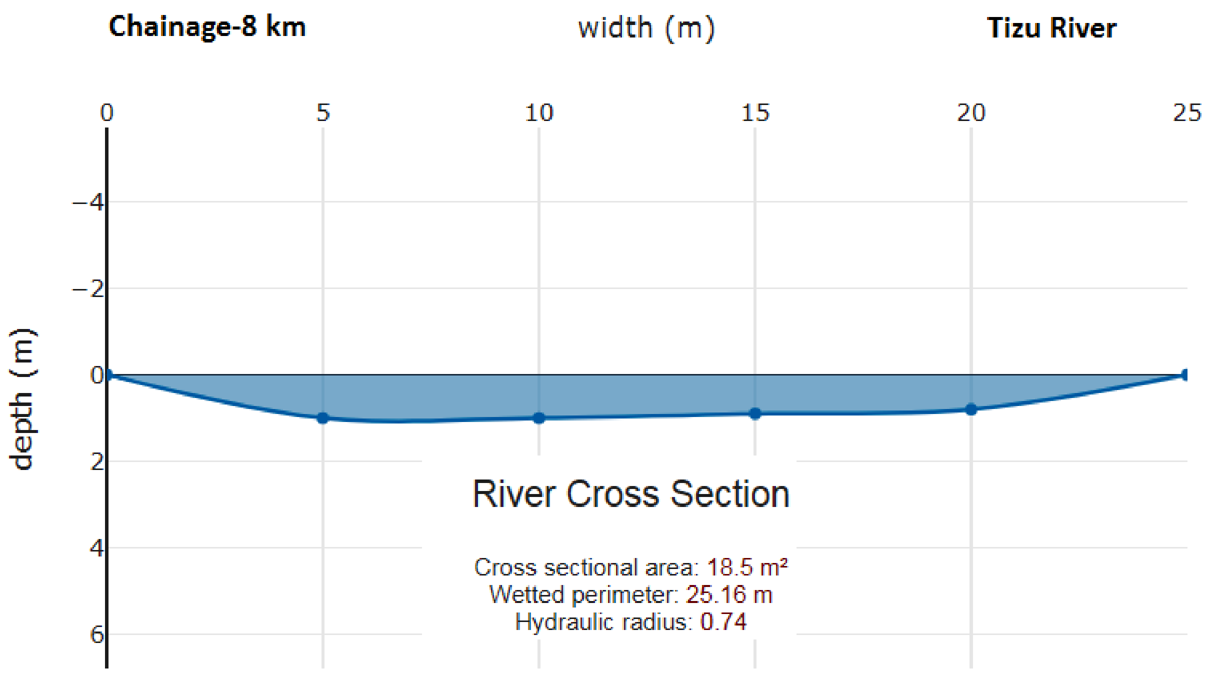
Form the above table and figures it is clear that we require higher discharges for maintaining higher LAD value. Hence we are developing the waterway for maintain LAD of 1m which can be achieved by minimal dredging or removal of stones/boulders from the navigational channel.

5.4 Discharge calculation from river cross sections

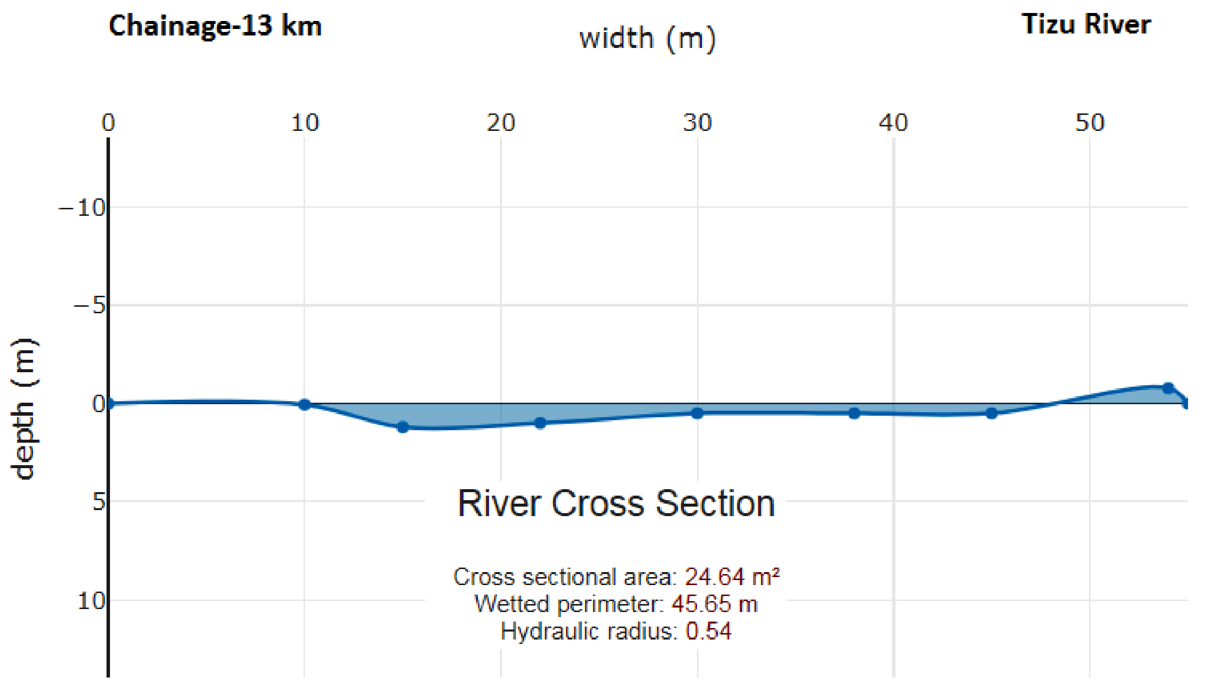
5.4.1 The actual discharge has been also calculated from river cross section provided from the hydrographic survey data at different chainages from the actual velocity measured during survey to ascertain the available discharge in the Tizu River.



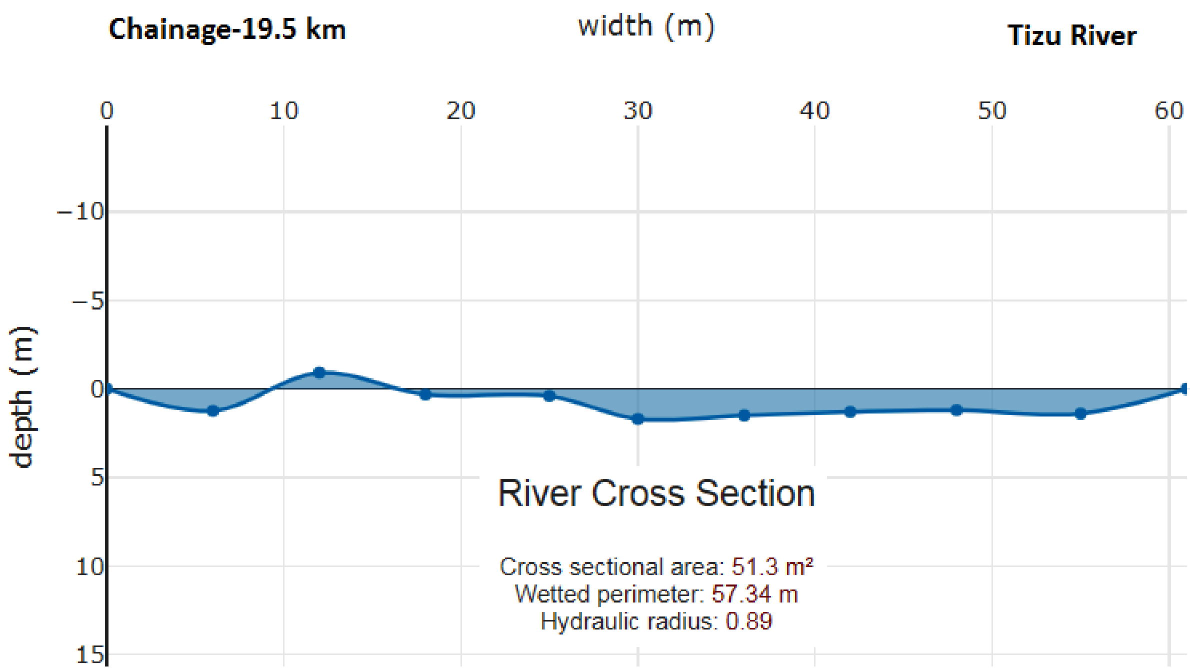
Velocity measured at location=3m/s ; Cross Section= 15.3sqm ;hence, Q=VA=3x15.3 =**45.9 Cumecs**



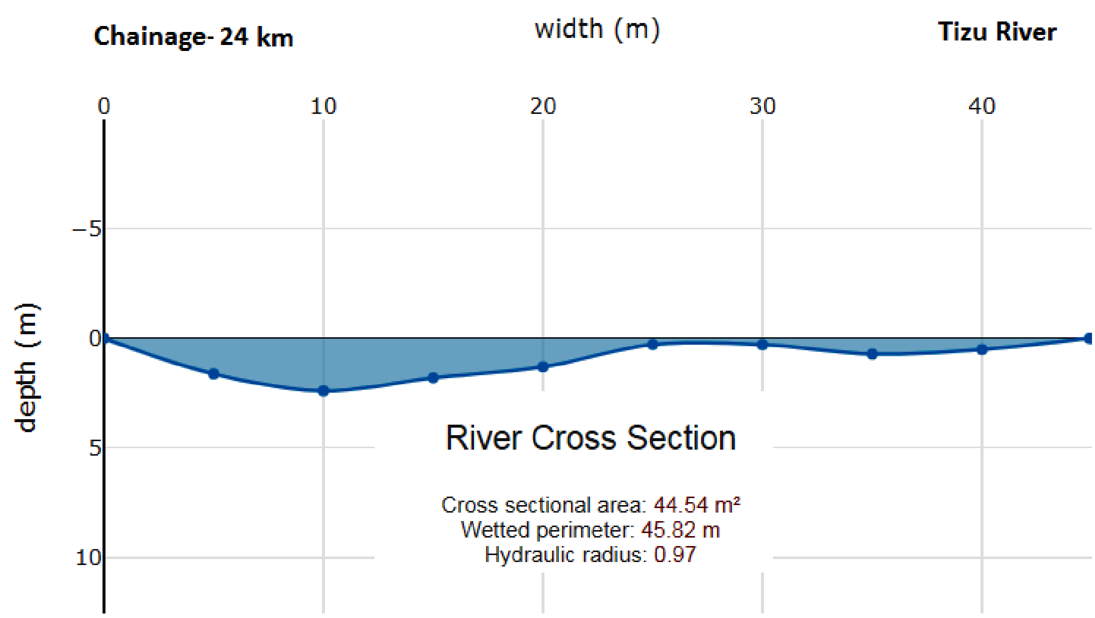
Velocity measured at location=2.9m/s ; Cross Section= 18.5sqm ;hence, Q=VA=2.9x18.5 =**53.65 Cumecs**



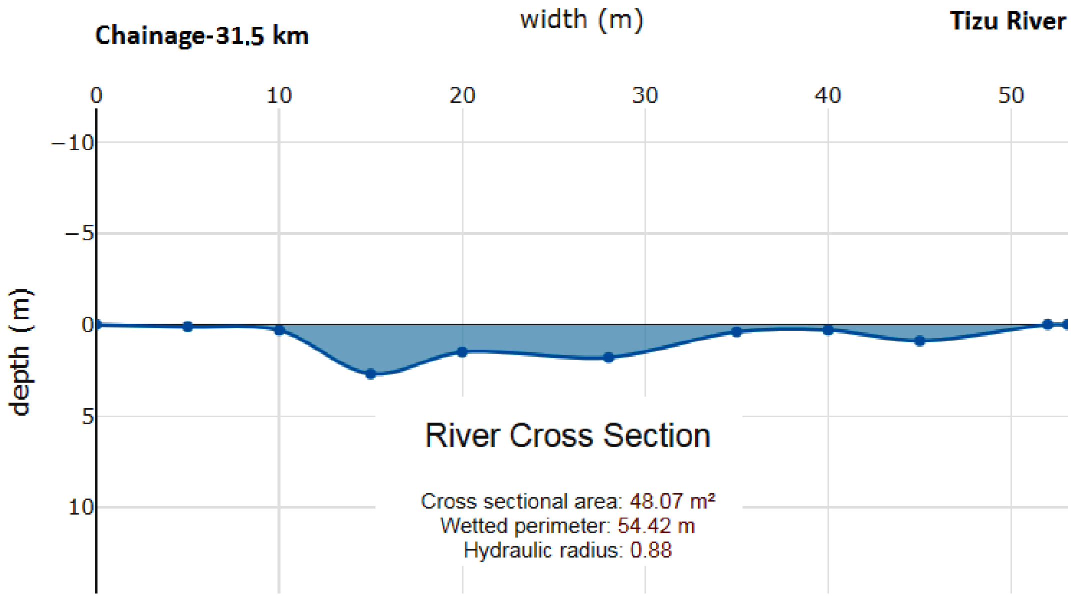
Velocity measured =2.9m/s ; Cross Section= 24.64sqm ;hence, Q=VA=2.9x24.64 =**71.45 Cumecs**



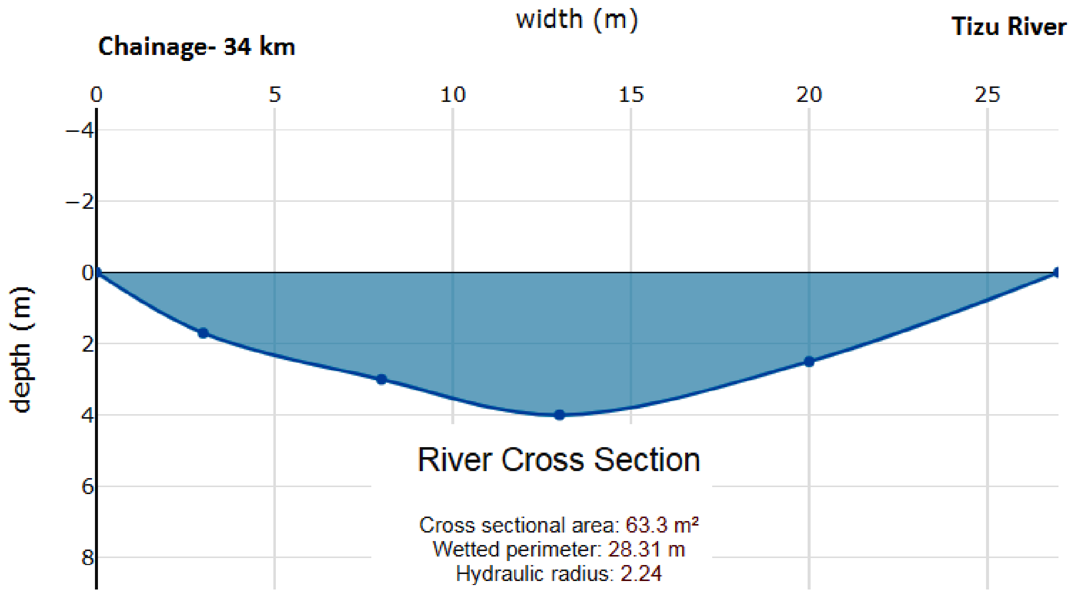
Velocity measured =2.92 m/s ;Cross Section= 51.3 sqm ;hence, Q=VA=2.92 x51.30 =**149.79 Cumecs**



Velocity measured =2.92 m/s ;Cross Section= 44.54 sqm ;hence, Q=VA=2.92 x44.54 =**130.06 Cumecs**



Velocity measured =3 m/s ;Cross Section= 48.07 sqm ;hence, Q=VA=3 x48.07 =**144 Cumecs**



Velocity measured =2.5 m/s ; Cross Section= 63.3 sqm ;hence, Q=VA=2.5 x63.3 =**158.25 Cumecs**

From the river cross section the calculated discharge vary from 45.9 to 158.25 cumecs from chainage 0 to 34 km (i.e towards upstream the discharges are high)

Also, from the data analysis shown in fig. 5.5 of Tizu river gauge station at phek at least 50 cumecs discharge is available for 180 days.

For maintaining 1m LAD the average discharge requirement has been already calculated for Tizu river which is 31.4 cumecs.
Hence we can say that the water availability will not be a problem in the development of waterway for LAD of 1m.

5.5 Calculation of Design flood Discharge

Design flood discharge is required for the design of the proposed controlling structure on NW-101.

5.5.1 Defining the design flood

The Design Flood for a hydraulic structure may also be defined in a number of ways, like:

- The maximum flood that any structure can safely pass.
- The flood considered for the design of a structure corresponding to a maximum tolerable risk.
- The flood which a project (involving a hydraulic structure) can sustain without any substantial damage, either to the objects which it protects or to its own structures.
- The largest flood that may be selected for design as safety evaluation of a structure.

5.5.2 Design flood for barrages and weirs

Estimation of Design Flood for the design of different type of hydraulic structures is an important component of hydrological studies. Proper selection of design flood value is of great importance, as the higher value results in increase of cost of hydraulic structures and under estimated value is susceptible to place the structure and population downstream at risk. The value of design flood should increase with increasing consequences of the failure of the structure.

Weirs and barrages, which are diversion structures, have usually small storage capacities, and the risk of loss of life and property would rarely be enhanced by failure of the structure. Apart from damage/loss of structure the failure would cause disruption of irrigation and communications that are dependent on the barrage. Hence design discharge is calculated which is safe and reliable for the construction.

Standard Project Flood (SPF)

This is the flood resulting from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the region. The SPF is computed from the Standard Project Storm (SPS) over the watershed considered and may be taken as the largest storm observed in the region of the watershed. It is not maximized for the most critical atmospheric conditions but it may be transposed from an adjacent region to the watershed under consideration.

5.5.3 Gumbel's Equations used for Calculation of Design Discharge

The design flood for the low height weirs should be taken as 100 year flood estimated on the basis of statistical analysis of yearly maximum flood data series for minimum 30 years which has been taken nearer site viz Lower Tizu HE project report(which is proposed in the tizu river at about 12 km downstream from confluence of Tizu and Zungki rivers.) – estimated data for 1985-2015. Gumbel EV distribution may be adopted for this purpose. This 100 year return period value will be much lower than SPF value adopted for dam design for HE project. Gumbel's Equations used for Calculation of Design Discharge are as follows:

Equation $X_T = X_{av} + K*\sigma$

Where ,

T Recurrence Interval

X_{av} is mean of the sample value

σ Standard Deviation of the sample $\sigma=(\sum(X-X_{av})^2/(N-1))$^0.5

K is frequency factor expressed as $K = (Y_T-Y_n)/S_n$

in which

Y_T Reduced variate, a function of T and given by

$Y_T = 0.834 + 2.303\log\log(T/T-1)$

Y_n Reduced mean, a function of sample size n

S_n Reduced standard deviation, a function of sample size n

Using above equation the calculation of 100 year flood discharge is given in the below table.

Table 5.11 Flood Discharge forecasting by Gumbel's Method

Gumbel's Method							
		Tp	31	N	30		
Year	**Discharge**	**Order**	**Discharge**	**Tp**	**X_{av}**	**$X-X_{av}$**	**$(X-X_{av})^2$**
2014-15	1888.75	1	1888.75	31.0	1101.65	787.10	619526.93
2013-14	1879.92	2	1879.92	15.5		778.27	605704.71
1995-96	1717.72	3	1717.72	10.3		616.07	379542.66
1997-98	1541.16	4	1541.16	7.8		439.51	193169.33
2012-13	1528.08	5	1528.08	6.2		426.43	181842.83
2011-12	1499.68	6	1499.68	5.2		398.03	158428.15
1998-99	1374.85	7	1374.85	4.4		273.20	74638.42
1993-94	1319.41	8	1319.41	3.9		217.76	47419.56
2007-08	1314.98	9	1314.98	3.4		213.33	45509.83
1999-00	1183.78	10	1183.78	3.1		82.13	6745.39
1994-95	1175.55	11	1175.55	2.8		73.90	5461.26

Gumbel's Method							
		Tp	31	N	30		
Year	**Discharge**	**Order**	**Discharge**	**Tp**	**X_{av}**	**$X-X_{av}$**	**$(X-X_{av})^2$**
1996-97	1147.8	12	1147.8	2.6		46.15	2129.85
2006-07	1142.37	13	1142.37	2.4		40.72	1658.15
2009-10	1098.44	14	1098.44	2.2		-3.21	10.30
1990-91	1070.63	15	1070.63	2.1		-31.02	962.22
2005-06	1019.11	16	1019.11	1.9		-82.54	6812.80
1992-93	998.2	17	998.2	1.8		-103.45	10701.83
2008-09	921.11	18	921.11	1.7		-180.54	32594.57
1989-90	893.62	19	893.62	1.6		-208.03	43276.34
1991-92	846.1	20	846.1	1.6		-255.55	65305.63
2003-04	828.39	21	828.39	1.5		-273.26	74670.85
2002-03	809.57	22	809.57	1.4		-292.08	85310.53
1987-88	807.35	23	807.35	1.3		-294.30	86612.29
2000-01	805.31	24	805.31	1.3		-296.34	87817.20
2010-11	778.61	25	778.61	1.2		-323.04	104354.63
2001-02	738.56	26	738.56	1.2		-363.09	131834.11
1985-86	727.91	27	727.91	1.1		-373.74	139681.34
1986-87	719.48	28	719.48	1.1		-382.17	146053.65
1988-89	655	29	655	1.1		-446.65	199495.92
2004-05	618.05	30	618.05	1.0		-483.60	233868.64
							3771139.93
						$\sum(X-X_{av})^2/(N-1)$	130039.31
						S.D. (σ)	360.61
						Y_n	0.5362
						S_n	1.1124
						$Y_T = 0.834 + 2.303\log\log(T/T-1)$	-4.601160867
							4.60
						$K = (Y_T-Y_n)/S_n$	3.654225878
						$X_t = X_{av} + K*\sigma$	2419.4
							say 2420

Hence, 2420 Cumecs discharge has been taken further for designing of structures like barrage/Weir in the waterway NW101.

it is also recommended that project development authorities should establish one Gauge and Discharge stations on Tizu River near Laruri Bridge site for measuring discharge at least twice daily. These measurements proposed to be utilized for updating the available discharge to incorporate the latest trend of discharge in the studies.

CHAPTER – 6
FAIRWAY DEVELOPMENT

6.1 Classification of Waterway

In India, the inland waterways are classified into seven categories for rivers by the Inland Waterways Authority of India (IWAI) vide Government of India (GOI) Gazette Notification dated 26thJanuary 2007 & 07th November 2016 including amendments for safe passage of self-propelled vessels up to 2000 Dead Weight Tonnage (DWT) and tug barge formation in push tow units of carrying capacity up to 8000 tonnes. The classification of waterways for Rivers is given below.

Table 6.1 Inland Waterway classification for Rivers

Class of Waterway	Rivers				
	Minimum Depth	Bottom Width	Bend Radius	Vertical Clearance	Horizontal Clearance
I.	1.2 m	30 m	300 m	4 m	30 m
II.	1.4 m	40 m	500 m	5 m	40 m
III.	1.7 m	50 m	700 m	6 m	50 m
IV.	2.0 m	50 m	800 m	8 m	50 m
V.	2.0 m	80 m	800 m	8 m	80 m
VI.	2.75 m	80 m	900 m	10 m	80 m
VII.	2.75 m	100 m	900 m	10m	100 m

The above classification for Rivers and Canals shall be effective if:

- Minimum depth of channel should be available for about 330 days in a year (about 90% days in a year).
- Vertical clearance at cross structures over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway.

A. Vertical Clearance for Power Cables / Telephone Lines for all Classes

- Telephone lines and Low Voltage lines 16.5 m
- High Voltage Transmission lines not exceeding 110 KV – 19 m
- High Voltage Transmission lines exceeding 110 KV – 19 m + 1 cm per each KV. In case of underground pipe / power lines and other cables norms to be decided as per conditions and navigational requirement

B. Reference level for vertical clearance for different types of channels

- Over navigational HFL which is highest flood level at frequency of 5% in any year over a period of last 20 years
- HTL for tidal channels

- For channels design FSL

C. Type of vessels to be used in different class waterways

Table 6.2 Type of vessels to be used in different class of waterways

Class	Self-propelled vessel	Tug with barges
I.	Self-propelled, carrying capacity 100 DWT, Size (32m X 5m), Loaded draft 1m	1 Tug + 2 barges – 200 DWT, length 80m X breadth 5m , loaded draft 1m
II.	Self-propelled, carrying capacity 300 DWT, Size (45m X 8m), Loaded draft 1.2m	1 Tug + 2 barges – 600 DWT, length 110m X breadth 8m , loaded draft 1.2m
III.	Self-propelled, carrying capacity 500 DWT, Size (58m X 9m), Loaded draft 1.5m	1 Tug + 2 barges – 1000 DWT, length 141m X breadth 9m , loaded draft 1.5m
IV.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 12m , loaded draft 1.8m
V.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 24m , loaded draft 1.8m
VI.	Self-propelled, carrying capacity 2000 DWT, Size (86m X 14m), Loaded draft 2.5m	1 Tug + 2 barges – 4000 DWT, length 210m X breadth 14m , loaded draft 2.5m
VII.	Self-propelled, carrying capacity 4000 DWT, Size (86m X 14m), Loaded draft 2.9m	1 Tug + 4 barges – 8000 DWT, length 210m X breadth 28m , loaded draft 2.5m

All cross structures to be constructed across national waterways should conform to respective requirement of vertical clearance and horizontal clearance before construction of any structure.

6.2 River stretch considered for development of terminals

As brought earlier in the Traffic survey chapter-3, Clause 3.9.four terminals locations were suggested based on the market survey study and data analysis. Class-I is suggested as per traffic study of the region that too in later stage. The terminals is shown below in the figure 6.1

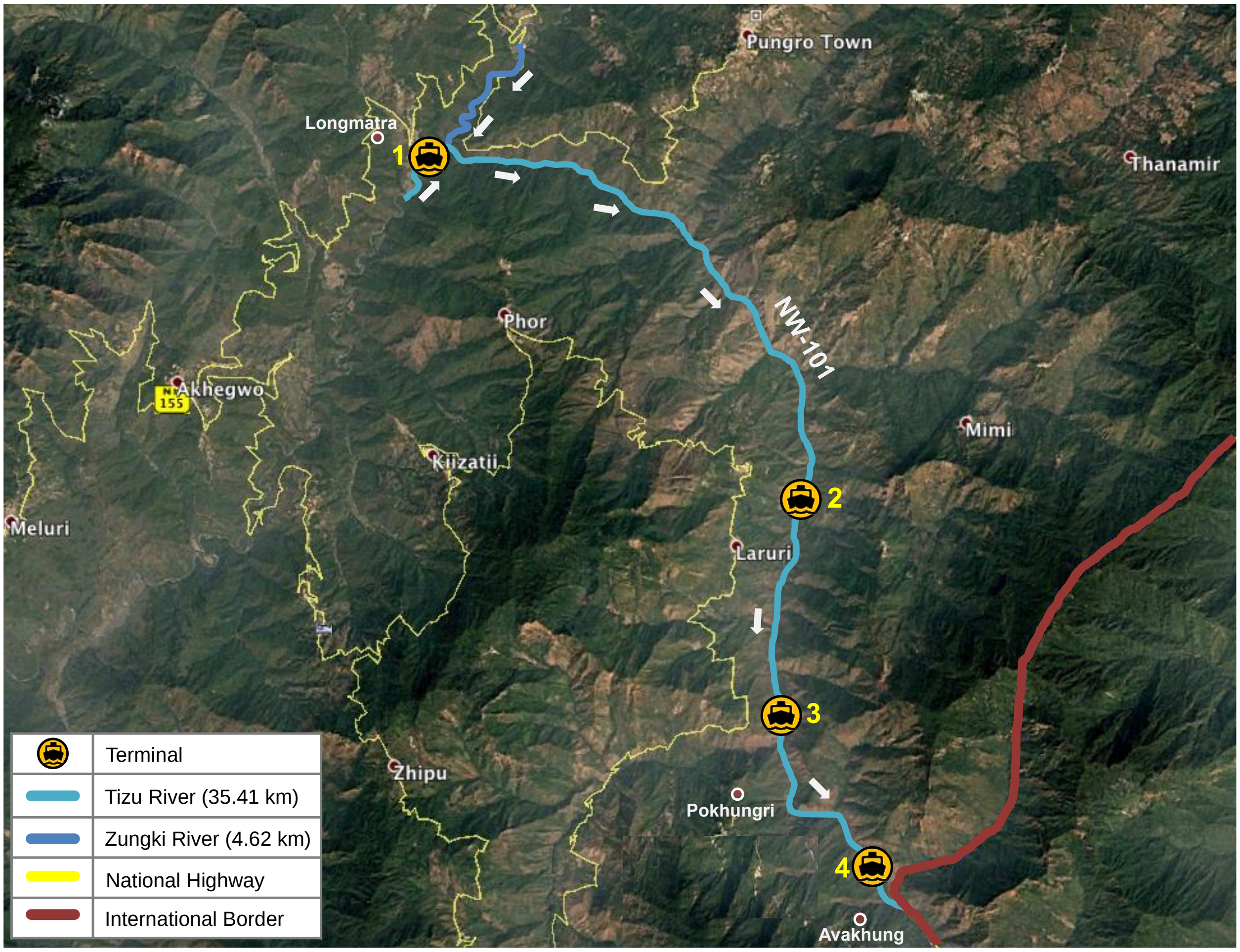


Fig. 6.1 Terminals on NW101

6.2.1 It is clear that the four terminals were suggested in NW-101 is only on the River Tizu (Ch 0-35.41) .Terminals are not suggested in the Zungki River due to presence of road network parallel to the river and very less traffic potential. In Zungki river, which has long enough 4.65km (details given in Table 1.3), therefore no fairway development in Zungki river.

Hence, Fairway development is considered for development of Tizu river (Ch. 0 to 35.41) of NW-101 only.

6.2.3 As mentioned in chapter 5 of data analysis of water availability studies have been carried out for Lower Tizu HE project which is proposed at the 12km downstream from longmatra in Tizu river, Minimum flow of 10 to 20 m^3/s is available during lean season and for rest of period enough flow prevails. The same has also been verified by analyzing the data of two gauge sites which are on the upstream of the waterway. In similar way the Minimum discharge with 75% dependability 15-20 m^3/s of water is available (The details of the same is analyzed in Chapter-5 of Data Analysis) .The river channel width is 30 to 40 m in upstream reach which gradually increases to 50m to 60 m near border of Myanmar.

The minimum depths observed (during hydrographic survey) in different reaches vary from 0.2 m to 0.6 m. The maximum depths in different reaches were in the range 3 m to 5.8 m. These facts indicate that water availability will not be an issue for waterway development. However, based on results of analysis of topographical, geological, hydraulic and sediment data analysis of Tizu river following major challenges for an inland navigation have been identified.

The average water depth available during the survey period was calculated based on the hydrographic survey charts which is presented below in ***table 6.3.***

Table 6.3 Tizu river details based on hydrographic survey

Chainage (Km)		Deepest Channel (m)			Average width of water portion during survey Aug 2015	Average width of river	River Gradient m / Km
From	To	Min.	Max.	Avg.	(m)	(m)	
0	1	0.50	1.80	0.937	16 - 25	65 – 100	1.37
1	2	0.50	1.80	1.223	18 - 27	65 – 100	0.27
2	3	0.20	2.00	1.166	17 - 25	65 – 100	0.60
3	4	0.00	4.00	1.127	21- 28	65 – 100	0.47
4	5	0.40	2.70	1.126	22 - 38	65 – 100	1.48
5	6	0.30	3.60	1.458	22 - 53	65 – 100	0.80
6	7	0.60	4.00	1.297	26 - 40	65 – 100	2.16
7	8	0.10	1.80	0.965	18 - 25	65 – 100	0.50
8	9	0.00	1.80	0.967	24 - 35	65 – 100	0.50
9	10	0.00	4.70	1.599	26 - 36	65 – 100	-1.43
10	11	0.30	3.80	1.196	32 - 38	60 – 100	3.83
11	12	0.20	3.80	1.255	27 - 48	60 – 100	-0.69
12	13	0.17	2.70	1.064	27 - 45	60 – 100	1.98
13	14	0.00	2.10	0.773	36 - 47	60 – 100	1.33
14	15	0.20	3.10	1.632	34 - 36	60 – 100	-0.48
15	16	0.10	2.20	0.876	29- 33	60 – 100	1.38
16	17	0.20	3.40	1.406	30 - 33	60 – 100	0.49
17	18	0.20	3.10	1.125	23 - 38	60 – 100	1.93
18	19	0.00	2.90	1.103	23 - 32	60 – 100	1.21
19	20	0.00	3.00	1.588	19 - 29	60 – 100	-0.15

Chainage (Km)		Deepest Channel (m)			Average width of water portion during survey Aug 2015 (m)	Average width of river (m)	River Gradient m / Km
From	To	Min.	Max.	Avg.			
20	21	0.20	3.10	1.652	16 - 25	65 – 90	1.34
21	22	0.00	6.10	1.558	13 - 17	65 – 90	1.05
22	23	0.10	6.10	2.376	16 - 24	65 – 90	2.61
23	24	0.00	2.80	1.166	18 - 34	65 – 90	0.93
24	25	0.20	5.20	1.976	14 - 24	65 – 90	0.86
25	26	0.20	4.90	1.559	15 - 24	65 – 100	0.67
26	27	0.00	4.10	1.375	18 - 32	65 – 100	2.29
27	28	0.00	4.60	1.400	18 - 25	65 – 100	-1.40
28	29	0.00	3.80	1.323	18 - 33	65 – 100	1.75
29	30	0.10	3.50	1.487	18- 21	65 – 100	1.93
30	31	0.10	2.70	1.290	16 - 27	65 – 100	0.88
31	32	0.30	3.20	1.484	14 - 19	65 – 100	0.94
32	33	0.20	4.20	2.324	14 - 31	65 – 100	1.16
33	34	0.40	4.90	3.355	22 - 27	65 – 100	-0.33
34	35	0.90	4.00	2.728	17 - 21	65 – 100	-0.86

Note:- The details of table with every 50m interval is attached in Annexure-III Pg.34 of volume-III

From the table it is clear that least available depth is 0.773m to 1.2m in maximum stretch and with more than 2 meters depth at some stretches of waterway.

Since, tizu is a hilly river and carries a lot of boulders, sand and stones with the flow of water in river channel, it has been observed that the major hurdles in the navigation is the presence of stones which are required to be cleared and stacked. Removal of boulders and stones from the river path will make the navigation easy and safe. The actual picture of the river is shown in pictures below.

Fig. 6.2 A view of Tizu river

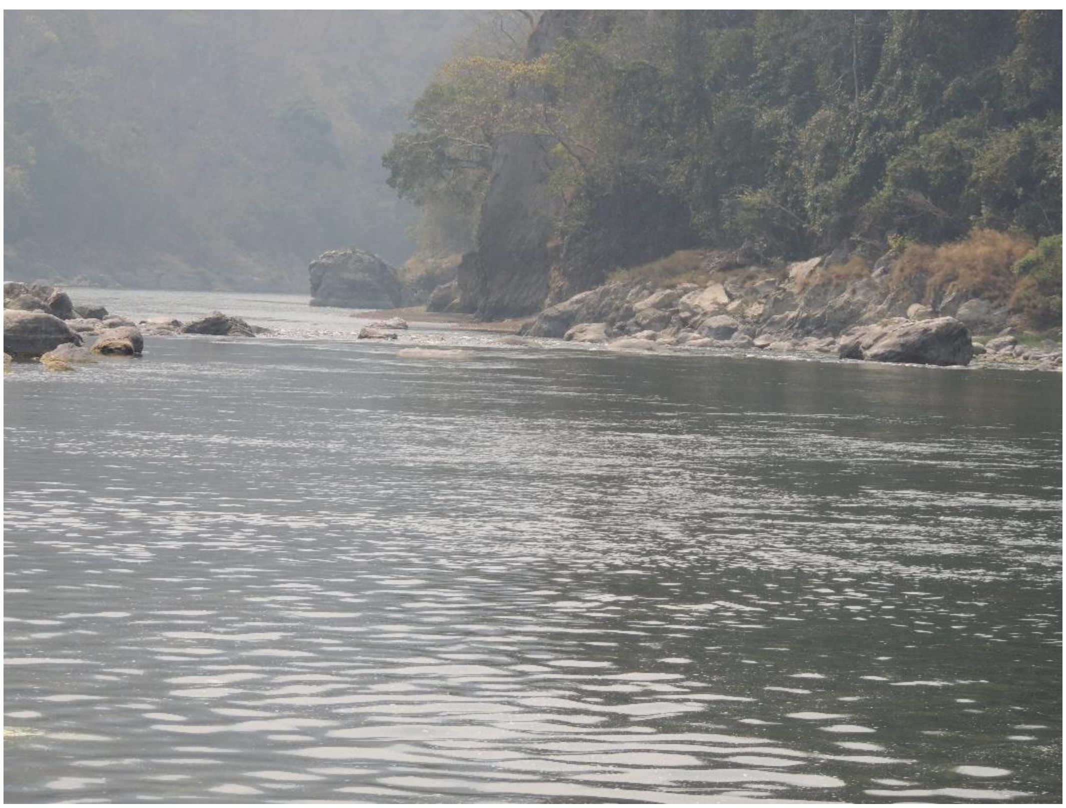


Fig. 6.3 A view of tizu river

Fig. 6.4 Tizu river view at laruri bridge

Fig. 6.5 Stones and boulder present in Tizu river

Fig. 6.6 Presence of big stones in the river making navigation difficult

Following are the findings of the river

- Steep river bed slopes of about 0.94 m /km generating high flow velocities.
- Mostly Rocky River bed with large size boulders and rapids in study reach of Tizu River.
- The river banks also on both side of river are rocky with large rock outcrops at many location
- Very narrow river valley with Steep Mountain slopes resulting in to landslides bringing boulders and debris on river bed. River channel width varies from 40 to 60 m.
- High concentration of suspended sediments of the order of 6000mg/l (6000 ppm) during monsoon period.

Considering above factors possible measures to enhance Navigability of stream could be as below.

6.3 Development Options

The waterway development must

i. Provide reliable navigation conditions during all seasons of the year;
ii. have good consideration for safety of navigation;

iii. prefer using low-impact river training measures, like dredging or low-impact design of embankment protection above high-impact works, where possible;
iv. include navigation locks with sufficient capacity for swift lock passages;
v. provide an infrastructure of terminals, and, therefore, include the planning of the terminal locations, their capacities, connection to railway and road networks;
vi. contain measures that prevent negative impacts on groundwater levels and soil conditions in the adjacent terrains;
vii. provide flood protection to surrounding areas;
viii. consider all types of environmental impacts of the waterway in operation and during construction, including impacts on flora, fauna, and landscape quality; and
ix. Include mitigating and compensating measures for environmental damage.

6.3.1 Prima facie, development options are considered as indicated in chart below. This is followed by discussions on merits, demerits and feasibility aspects in respect of each option, so as to facilitate selection of a suitable alternative and exclude others that have unacceptable demerits and feasibility. Thus, options that are considered in these studies are as under:

The development of NW-101 is also considered based on the fact that Lower Tizu Hydro Electric project(3x42 MW), 28m high concrete dam of Government of Nagaland, department of power is proposed in the river Tizu about 12 km downstream from confluence of Tizu and Zungki rivers i.e at Chainage 22km of River Tizu as per hydrographic survey. The dam site is located below Moya village in Kiphire district. Salient features of the proposed Lower Tizu hydro electric project are listed in below table.

Table 6.4 Salient Features of Lower Tizu Hydro Project

1.	Location	Facilities
(i)	State	Nagaland
(ii)	District	Kiphire
(iii)	Village	Moya
(iv)	Accessibility (Nearest airport and railhead at Dimapur)	Dimapur to Kohima (Capital of Nagaland)- 70 km
		Kohima to Kiphire - 259 km
		Kiphire to Moya- 69 km
		Moya to Project site- 9 km
(v)	Geographical Coordinates of Dam Site	Longitude- 94°50’2.68”E
		Latitude- 25°44’50.49”N
(vi)	No. of Units	3
(vii)	Installed Capacity (each unit)	42 MW
2.	**Hydrology**	
(i)	Catchment area at dam site	6573 km2
(ii)	River	Tizu

1.	Location	Facilities
(iii)	Average Annual Rainfall	1900 mm
(iv)	Min-Max temperature (°c)	1.0 °c & 36.5 (°c)
(v)	Min-Max humidity (%)	70 % to 100 %
(vi)	Standard Project Flood (SPF)	8638 (m3/s)
(vii)	Diversion Flood for construction of Dam and appurtenant works	1000 (m3/s)
3.	**Dam**	
(i)	Total Length of Dam	114.50 m
(ii)	Length of Overflow section	96.00 m
(iii)	Length of Right Non-overflow Section	18.5 m
(iv)	High Flood Level (HFL)	430 m
(v)	Full Reservoir Level (FRL)	430 m
(vi)	Deepest River Bed Level	±404 m
(vii)	Maximum Height of Dam above River bed level	28 m
(viii)	Bridge Deck Level	432 m
(ix)	Design Flood (PMF)	8638 m3/s
4.	**Spillway**	
(i)	Type	Gated
(ii)	No. of Bays	6 No.
(iii)	Sill Level	407 m
(iv)	Size of Gate	12.5 m (W) x 11.0 m (H)
(v)	Type of Gate	Radial gates
(vi)	Energy Dissipation arrangement and its length	Stilling Basin Type II, 68 m
5.	**Power Intake**	
(i)	Overall Length	44.25 m
(ii)	FRL	430 m
(iii)	MDDL	427 m
(iv)	Invert Level	El 415.00 m (Trashrack bottom)
(v)	Deck Level	El 432 m
(vi)	Size of Trash rack	6 number each of 5.5 m width x 17.00 m height
(vii)	Size of Intake Gates	2 numbers each of 6.5 m width x 6.5 m height
(viii)	Type of Gates	Vertical lift gates

The layout of the LTHEP dam and upstream view has been shown if fig.6.7 and fig.6.8 below

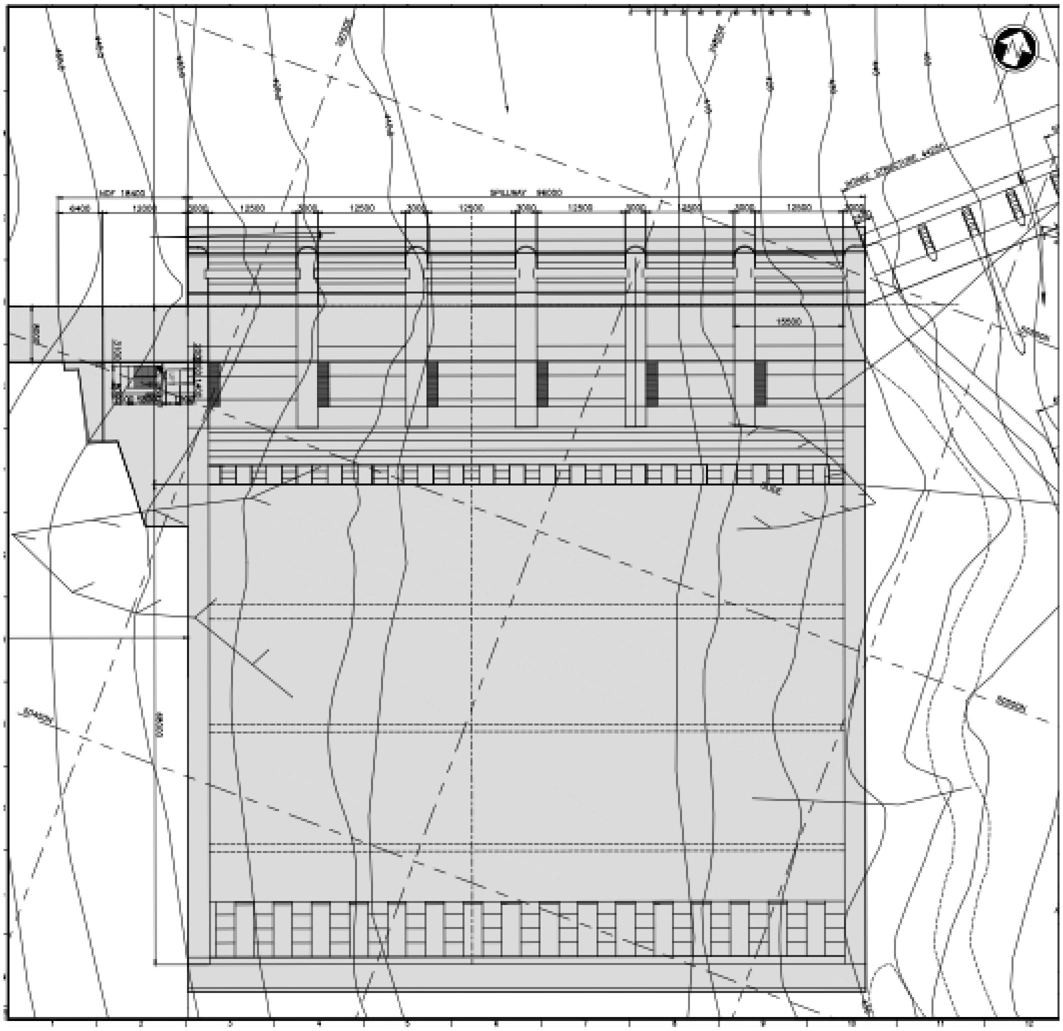


Fig. 6.7 Layout of LTHEP Dam

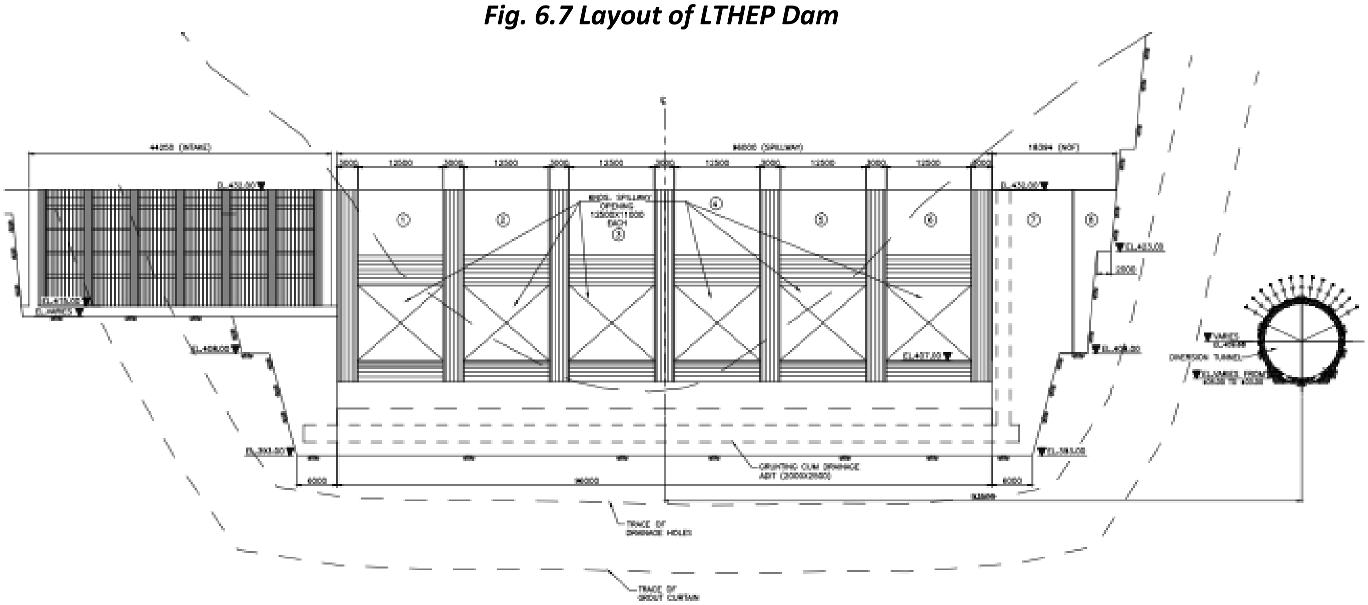
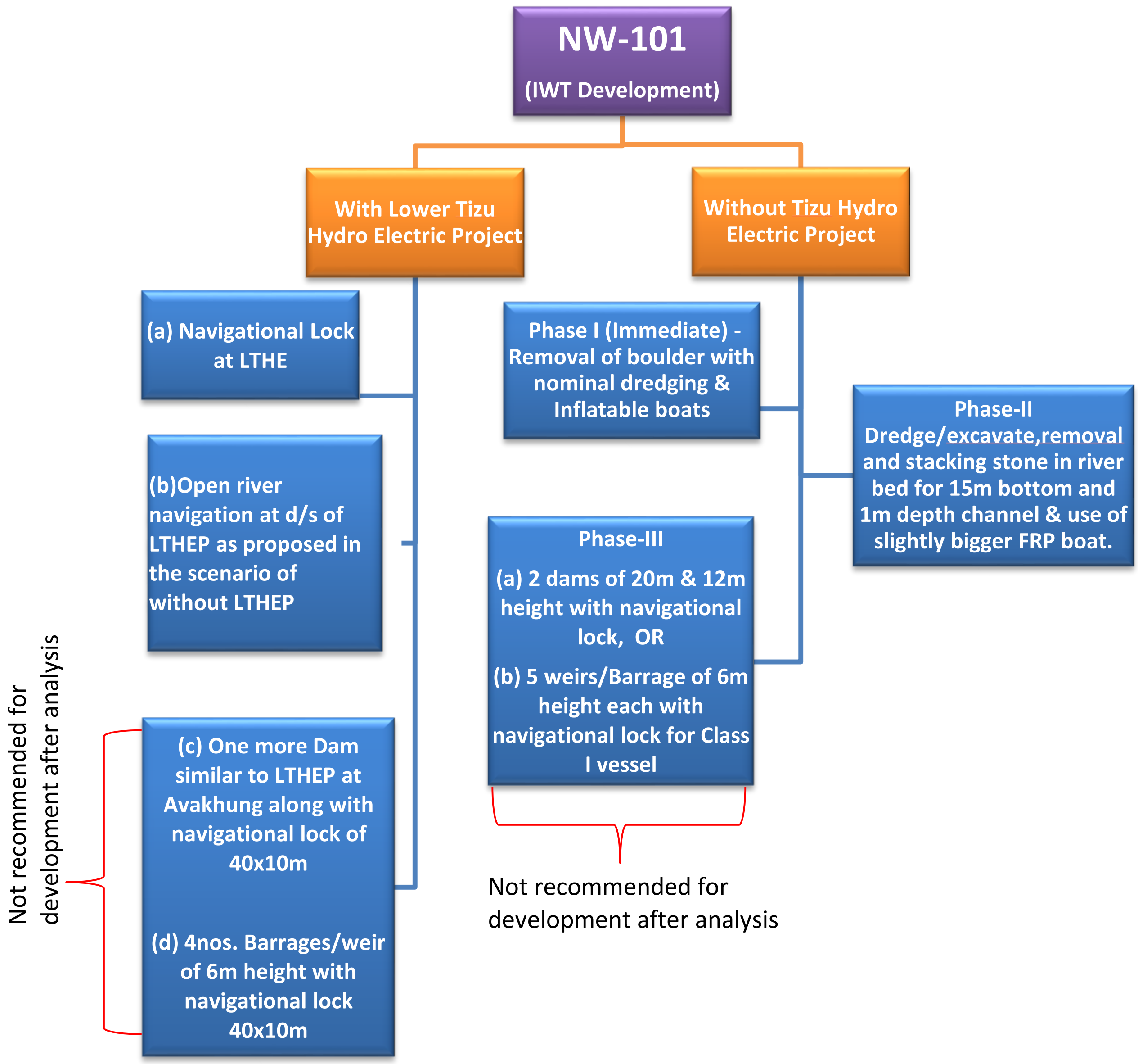


Fig. 6.8 Dam Upstream view

Source: DPR LTHEP, Dept. of Power Nagaland

As stated above the LTHEP dam is considered while conceptualizing the project development options which is shown below.

The IWT project development options for NW-101 is shown in chart below



The scenario of project development has been discussed in detail below

Scenario –I

1. ***Without Lower Tizu Hydro Electric Project***

   a. ***Phase I (Immediate) - Removal of boulder with nominal dredging & Inflatable boats Dredge/excavate, removal and stacking stone in river bed for 15m bottom width and 0.6m depth channel***

b. ***Phase-II Dredge/excavate,removal and stacking stone in river bed for 15m bottom and 1m depth channel & use of slightly bigger FRP boat.***

c. ***Phase-III Two dams of 20m & 12m height with navigational lock at chainage 0.5km and 22.km***

OR

d. ***five weirs/Barrage of 6m height each with navigational lock for Class I vessel at chainages 0.5km,7km,14km,21km & 26km***

Scenario -II

2. ***With Lower Tizu Hydro Electric Project.***

a. ***Upstream navigation only***
b. ***Open river navigation at d/s of LTHEP as proposed in the scenario of without LTHEP with Navigational lock at dam.***
c. ***One more Dam similar to LTHEP at Avakhung along with navigational lock of 40x10m***

OR

d. ***3 nos. Barrages/weir of 6m height with navigational lock 40x10m***

6.3.3 Without Lower Tizu Hydro Electric Project (LTHEP)

A. Phase I (Immediate) - Removal of boulder with nominal dredging & Inflatable boats Dredge/excavate, removal and stacking stone in river bed for 15m bottom width and 1m depth channel

6.3.3.1 Without LTHEP a immediate phase for development of waterway is considered which will not require much investment and will start immediately after the go ahead of the project. It will carry only passengers from longmatra to Avakhung to and fro.it has been suggested to use inflatable boats. For inflatable boats we have considered maximum draft required with all clearances is 0.6m. the details of vessels has been suggested in chapter 4 vessel design

The channel section considered for development is shown in figure 6.8 below, dredging quantity required to be estimated for a channel dimension of 15m x 0.6m with side slope of 1:2.5 along the deepest route

Hence for fairway development we need to Dredge/excavate, removal and stacking stone in river bed for 15m bottom and 0.6 m deep channel

Fig. 6.9 dredging section for 0.6m depth

The dredging has been calculated for the above in chapter -2 hydrographic survey in pg. no.2-26 which is 8640 cum for the provided section.

Hence,Total dredging/removal of boulder/stone required is **8640 cum** which is not much. Hence, immediate phase development can be taken up with minimal stone removal/dredging works.

B. Phase-II Dredge/excavate,removal and stacking stone in river bed for 15m bottom and 1m depth channel & use of slightly bigger FRP boat.

6.3.3.2 Next phase is considered for the project to take up in the Tizu river is by developing a fairway of 15m bottom width and 1 m deep channel with increase in passenger volume. for development of this phase draft required for plying of vessels is considered as 1m including all clearances. The details of vessel in this phase is shown in vessel design chapter 4.

(i) River dredging/Boulder removal works

The data analysis of River Tizu has been done by the hydrographic survey of the river conducted by IWAI in 2015,it has been observed that the LAD available during survey was from 0.77m to 1.2m shown above in table 6.3.The channel section considered for development is shown in figure below, dredging quantity was required to be estimated for a channel dimension of 15m x 1.0m with Side slope of 1:2.5 along the deepest route.

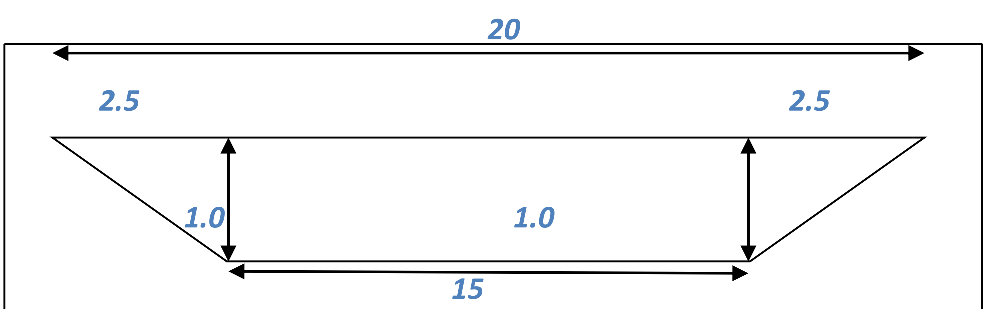


Fig. 6.10 Proposed navigational channel section 1 m deep

The dredging has been calculated for the above section in chapter -2 hydrographic survey in pg. no.2-22 which is 61020 cum for the provided section.

Hence total dredging/removal of boulder/stone required is 61020 cum The L-section of the Tizu river is shown below

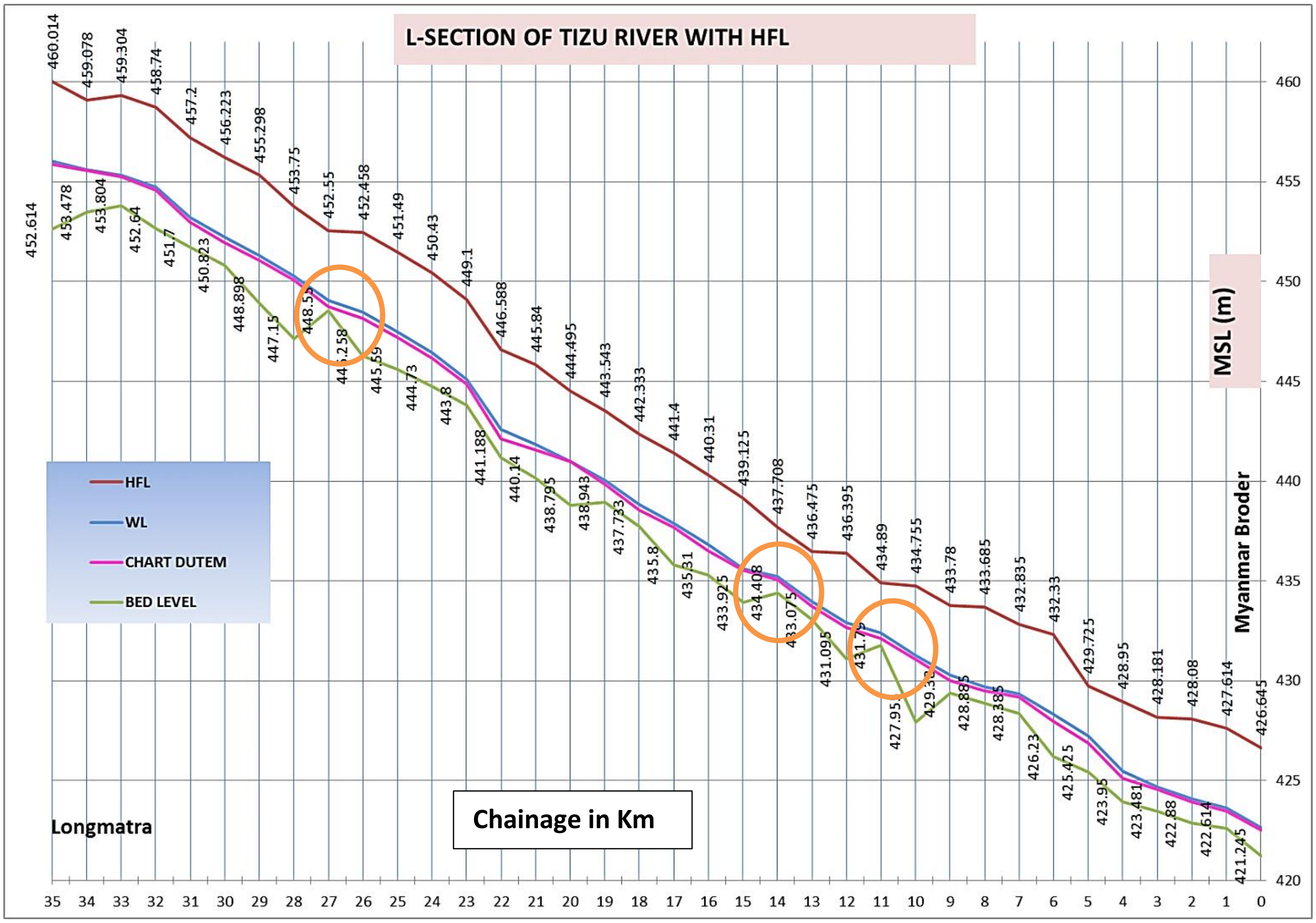


Fig 6.11 L- section of River Tizu

The L-section of the tizu river is shown above with Highest Flood Level (HFL). The HFL value of the river is plus 3.5 to 4m above the observed water level during survey.

The points of rapid or steep slope shown by orange circle at chainage 11km, 14km and chainage 27km in the L-section needs to be smoothened and dredged for smooth and safely passage of vessels with bottom width of 15m and depth of 1m.The schematic diagram of cutting/smoothening section at the steep locations is shown below in fig.6.12

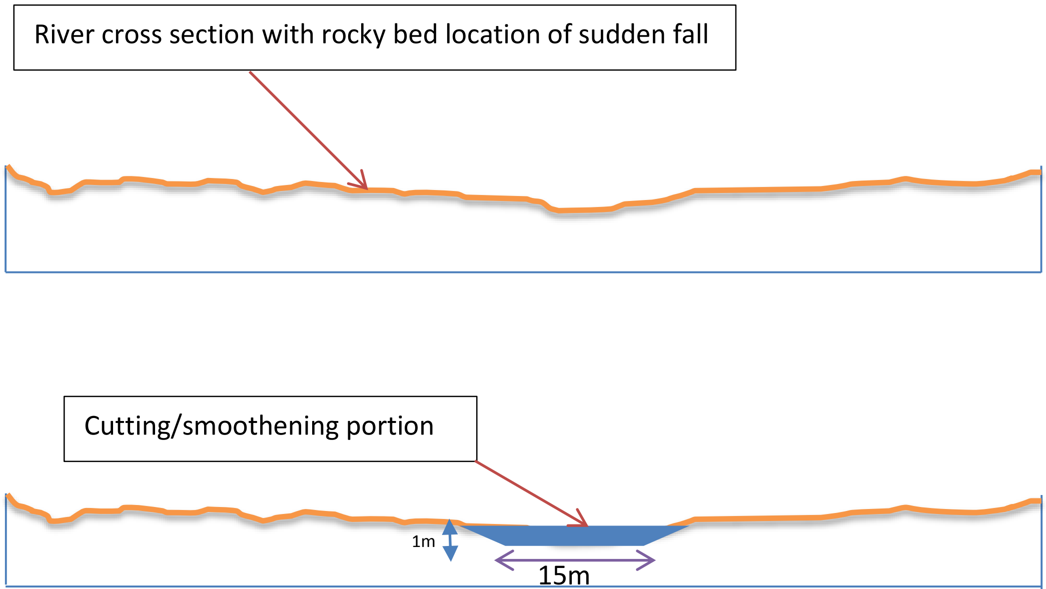


Fig. 6.12 Cutting portion at sudden fall locations

The schematic diagram of placing of boulder/stone not less than 40kg should be placed as shown in fig.6.11 for the development of waterway. The channel of 15m bottom width is already marked in the survey charts considering the maximum depths. The channel will be made inside the natural river cross section at the deepest point with Side slope of 1:2.5 whose schematic diagram is shown below.

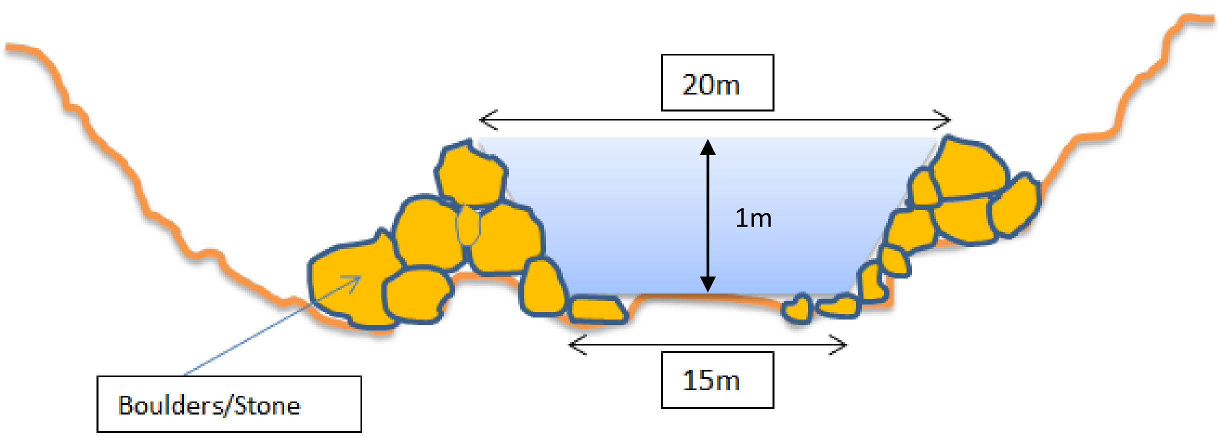


Fig. 6.13 stacking of boulder/stone along waterway

C. Phase-III – ALERNATIVE 1 : Two dams of 20m & 12m height with navigational lock at chainage 0.5km and 22.km

OR

D. *ALTERNATIVE –2 five weirs/Barrage of 6m height each with navigational lock for Class I vessel at chainages 0.5km,7km,14km,21km & 26km*

6.3.3.3 ***ALERNATIVE 1 : Two dams of 20m & 12m height with navigational lock at chainage 0.5km and 22.km.For maintaining water depth round the year*.**

Under this proposal it is proposed to construct two dams of 20m height.one at chainage 0.5 km and another at 20km.

The dam is proposed to be constructed at 500 m upstream of international border of India & Myanmar and another dam will be about 20 km upstream. The V shape valley with steep side slopes and presence of rock out crops on river bed and banks provide favourable situation for construction of high dams of shorter length.

This proposal has following advantages.

- The storage reservoir can be a multipurpose project and apart from navigation can be utilized for hydro power, water supply to villages, fisheries, tourism and water sports etc.
- Adequate depths will be available for inland navigation throughout the year.
- Flow velocities will be low so that navigation will be safe. This will be due to submergence of steep reaches with rapids.
- Most of reach will be free from hindrance due to boulders
- Capital dredging for navigation channel will be practically NIL and maintenance dredging will be minimum and that too in upstream most reach only.
- Navigation lock with about 20 m & 12m water level difference will be required.
- Water sports tourism can be started.
- Large water storage along valley will attract eco-friendly industries and also create more favourable conditions for livelihood of local population. Ferry services along and across valley will improve communication. Fig 6.14 below shows proposed locations of Dam.

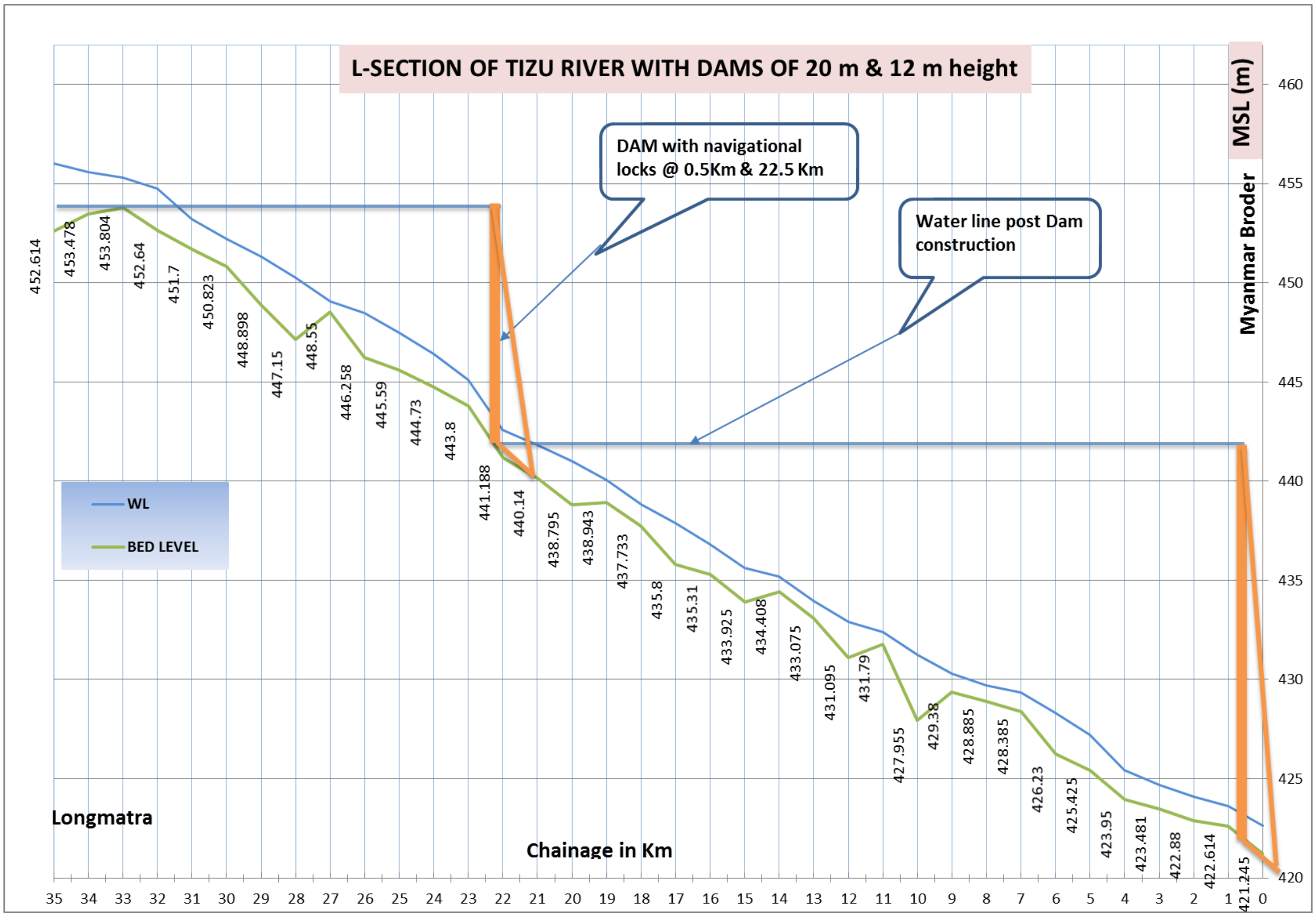


Fig. 6.14 Showing proposed locations of Dam

Following are the disadvantages and adverse factors of this project.

- Need of large capital investment approx. Rs. 1300 Crore for two dams which is difficult to justify for inland navigation project therefore need to be taken up as multipurpose project.
- This North-East region fall in Zone 5 which has highest risk of severe earthquakes
- Environmental issues due to submergence of forest area though there may be minimum issues regarding submergence of villages as the region is thinly populated
- The siltation rate in reservoir will be high
- Lot of HE projects in North-East did not materialize due to opposition from local tribal residents and political issues
- Water level difference for sole navigation lock is relatively high and skilled manpower will be necessary for operation.

  It may be mentioned here that one dam of height 28 m has already been proposed for lower Tizu HE project. Therefore, one more dam of appropriate height at 1 km upstream of international boundary will facilitate another multipurpose project including inland navigation aspect.

Design flood for Dams

The design flood for these dams should be adopted following IS-11223 guidelines which consider storage capacity and dam height. The dams discussed above fall in intermediate/medium size projects and hence SPF (Standard Project Flood) as in case of Lower Tizu HE project may be adopted which was taken as 8638 cumecs. Hence for the design of dams the same discharge can be considered.

6.3.3.4 *ALTERNATIVE –2 five weirs/Barrage of 6m height each with navigational lock for Class I vessel at chainages 0.5km,7km,14km,21km & 26km.*

Under this proposal/measure broad crested Barrage/weirs of 6 m height above deepest river bed level to be constructed at an interval of 6 km i.e. at chainages 0.5 km,7km,14km,21km and 26km so that cascade of pools will be formed with adequate water depths for class I waterway.

The crest level of central 20 m portion in case of weirs will be lowered to about 0.5 to 1 m above river bed level. Gates will be provided in this lowered portion to maintain water depth of 6 m on upstream of weir during non-monsoon period. During monsoon gates will be fully opened to allow flood discharges apart from flow passing over remaining portion of weir with higher crest level. Operation of gates during monsoon will help to flush deposited sediment from reservoir to downstream side. This will help to desilt the reservoirs to some extent. Proper gate operation during non-monsoon will help to maintain desired depths. For ease during operations we suggest air filled rubber barrages @ chainage 0.5 km,7km, 14km, 21km and 26km as they can be executed in shorter time as compared to conventional barrages and weirs also operational cost of rubber barrages is very less compared to conventional barrages.

For better performance of this project boulders on river bed will have to be removed out or at least staked along the edge of river channel. This will help to maintain required depths on central portion of river channel. Effective use of these boulders could also be made for construction of weirs, guide bunds, downstream protection works, bank protection works etc. Navigation locks will be necessary at all Barrages/weirs to negotiate water level difference across weirs.

Low head HE projects could be coupled with these barrages as run of the river plants if found feasible economically taking in to consideration power demand and capital and R&M cost of generation and transmission.

Navigational locks will have to be provided at each weirs and barrages to facilitate the navigation at each intervention.

This proposal appears to be more feasible as compared to proposal of two large dams. Following are plus points of this proposal.

- Minimum environmental issues related to forest land submergence or villages therefore there will be less opposition from localities.
- Relatively low cost of structural components
- Minimum capital and maintenance dredging cost
- Simple conventional structures for design and construction
- Due to low height less risk due to earthquake
- Relatively less siltation problem due to flushing during monsoon
- From navigation point all advantages a same as large dams except that navigation may not be feasible during periods of high floods when there will flow over weir portion with high crest level and without gates. But operation for 330days in a year will be feasible.
- Small hydro projects can meet local peak power requirements
- Small reservoirs can also cater need of local water supply and tourism and water sports can also be developed.
- Rocky River bed and availability of boulders on river bed will reduce construction cost of weirs and various allied structures.

The only disadvantage of this proposal will be closure of navigation during flood periods. Fig. 6.13 below shows proposed locations of barrages/weirs at 6 km interval starting from downstream at 0.5 km change. Depending upon local slope of bed height of barrage/weir at change is required to be modified to 7 m. Rest all weirs/barrages will be of 6 m height.

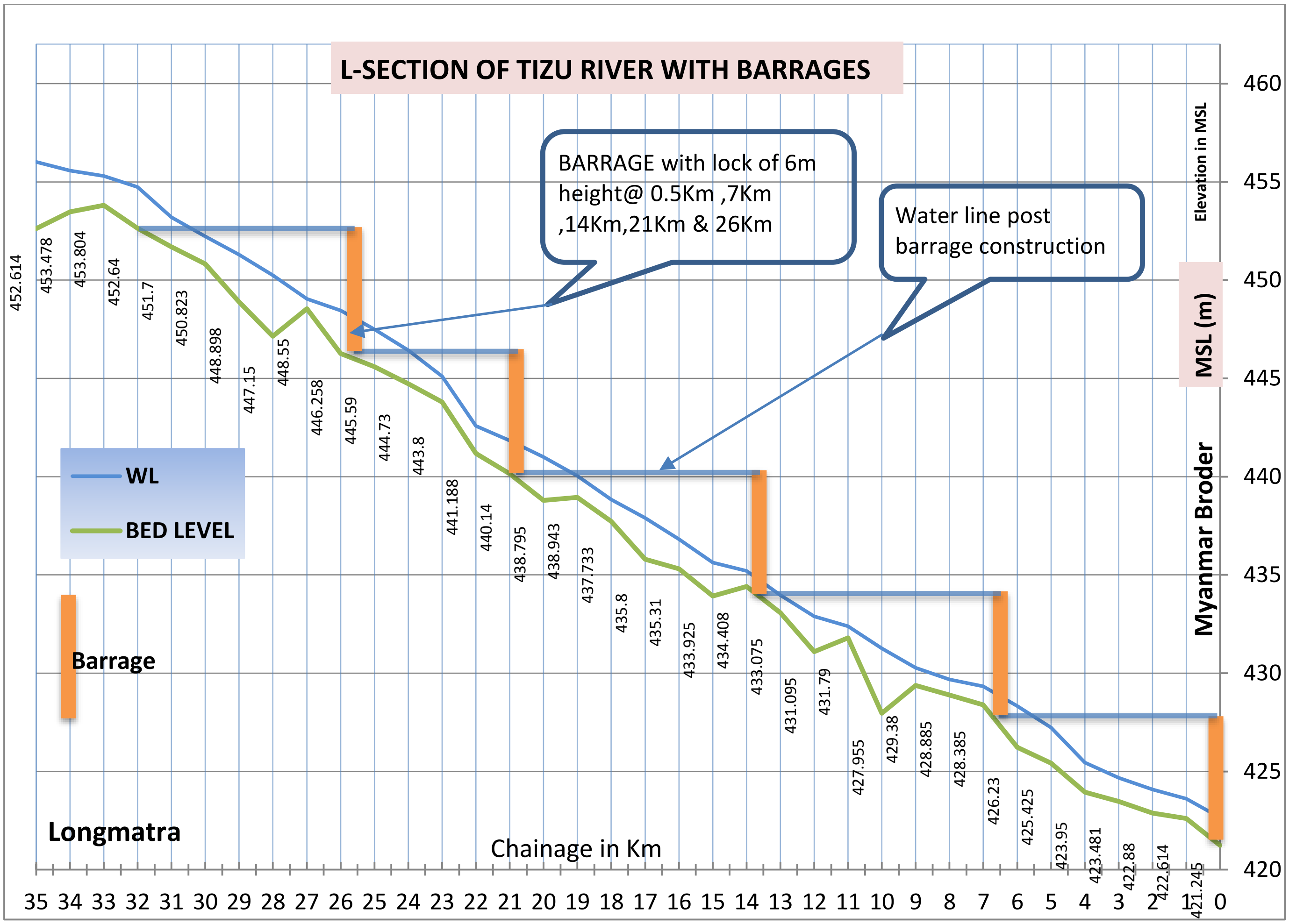


Fig. 6.15 Showing proposed position of Barrages

If Dam under Lower Tizu HE project likely to be constructed then low height weirs/barrage discussed under this proposal should be constructed in downstream reach of Tizu river .i.e below downstream from proposed dam site. The rubber navigational lock of 40x10m size is suggested at each barrages.

Design flood for Weirs/Barrage

The design flood for the low height weirs/barrage should be taken as 100 year flood estimated on the basis of statistical analysis of yearly maximum flood data series for minimum 30 years as used in design of Lower Tizu HE project report – estimated data for 1985-2015. Gumbel EV distribution may be adopted for this purpose. This 100 year return period value will be much lower than SPF value adopted for dam design for HE project. The same has been derived in chapter 5 (Data Analysis).The value has been calculated as 2420 Cumecs.

6.3.4 With Lower Tizu Hydro Electric Project. (28m high concrete gravity dam) at chainage 22km

a. Upstream navigation only

The presence of LTHEP dam at chainage 22km will make make the upstream reach till longmatra(Confluence point of Tizu and Zungki rivers) easily navigable without any dredging works.

b. Open river navigation at downstream of LTHEP as proposed in the scenario of without LTHEP with Navigational lock at dam.

6.3.4.1 If the proposed lower tizu hydroelectric project which is at 12km downstream from the confluence point of tizu and zungki river i.e at chainage 22 km. We need to provide one navigational lock at the DAM of size 40x10 m.

As per the DPR of LTHEP the provision of navigational lock is not considered. Hence it is recommended that one navigational lock should be provided in the LTHEP dam for making navigation possible in the downstream of the dam.

The LTHEP project will make the upstream reach of river easily navigable i.e. from Ch. 22km to Ch. 35.410 of tizu river. The downstream portion of the LTHEP will again require few intervention for making navigation possible in the entire tizu river under NW-101.the interventions proposed is discussed in the option below.

c. Alternative 1 - One more Dam similar to LTHEP at Avakhung along with navigational lock of 40x10m

OR

d. Alternative 2- 3 nos. Barrages/weir of 6m height with navigational lock 40x10m

6.3.4.2 For navigation of 330 days of class I vessels. We need to provide other intervention in the downstream of LTHEP. Since LTHEP is present at Ch. 22km whose impact will be till the longmatra upstream of the river. We need to provide one more similar dam like LTHEP at Avankhung at chainage 0.5km or alternatively we can provide three barrages/weirs of 6m height at chainages 0.5 km, 7km and 14km with navigational lock of size 40x10m at each barrages.

Apart from the same advantages and disadvantages of construction of barrage and Dam discussed above the proposed intervention for smaller traffic projections is not viable.

6.3.4.3 Conclusion of proposed development options

The analysis of the proposed intervention it was found that the options of

Without Lower Tizu Hydro Electric Project

a. ***Phase-III Two dams of 20m & 12m height with navigational lock at chainage 0.5km and 22.km***

OR

b. ***five weirs/Barrage of 6m height each with navigational lock for Class I vessel at chainages 0.5km,7km,14km,21km & 26km***

And

With Lower Tizu Hydro Electric Project.

a. ***Alternative 1 - One more Dam similar to LTHEP at Avakhung along with navigational lock of 40x10m***

OR

d. ***Alternative 2- 3 nos. Barrages/weir of 6m height with navigational lock 40x10m***

is economically not viable considering the volume of cargo and passengers in the region. Hence,it is recommended to develop the project in three phases which are mentioned below.

6.4 Recommended Phases of IWT Development on River Tizu

Phase-I(Immediate) –for passenger movement only with basic facility and low cost structure. (*for 2 years Fy21-22*)

Phase-II –for passenger movement only which is done by *Dredge/excavate, removal and stacking stone in river bed for 15m bottom width and 1m depth channel. (for 5 years fy23-27)*

Phase-III – for passenger as well as cargo three *Barrages of 6m height each with navigational lock 40x10m for Class I vessel at LTHEP and barrages (for 22 years fy28-30)*

For phase-II we have considered that LTHEP will be completed hence only intervention at downstream will be considered with one lock at LTHEP.

In Phase-III, NW 101 would handle Indo - Myanmar trade. Phase-III is a remote opportunity, as it depends on Myanmar Government to develop the waterway across the border till Hta Man Thiin Chindwin river. (Please refer traffic chapter-3, Section 3.8.2.3 for details on Chindwin River). Whether river route between India and Myanmar is developed or not, potential for NW 101 is remote, due to the hilly terrain and underdeveloped region.

WAPCOS recommend immediate phase-I and phase-II to be considered for development. Phase-2 is only viable if the trade with Myanmar through the route opens. Also it is

recommended to provide a navigational lock in LTHEP Dam.

6.5 *Proposed class of waterway*

WAPCOS has studied the possibility of developing waterway as Class-I and after analysis recommended the special class for present scenario.

Table 6.5 stretches for class of waterways

Sr.No	Phase	Stretch	Length of Waterway km	Class of Waterway	Remarks
1	Phase- I (Immediate)	Longmatra to Avakhung (with inflatable rubber boats)	35.41	Special class	15m bottom width,0.6 m depth
2	Phase-II	Longmatra to Avakhung	35.41	Special class	15m bottom width,1m depth
3	Phase-III	Longmatra to Avakhung (With Interventions)	35.41	Class-I	1.2 m depth and 30m bottom

Details of Terminal locations are shown in **Dwg No.: WAP-NW101-TL-01 to Dwg No.: WAP-NW101-TL-04.**

6.6 Dredging Plan for recommended options

Dredging will be carried out from Terminal 1 (Longmatra) to Terminal 4 (Avakhung) at different phases

Based on hydrographic survey report of year 2015 provided By IWAI dredging quantities were calculated which are mentioned below (the calculation of dredging quantities shown in table 6.3 and 6.4 above.

Table 6.6 Class of waterways development with dredging quantities

Sr.No	Phase	Stretch	Design Vessel	Qty (Cum)
1	Phase- I (Immediate)	Longmatra to Avankhung (with inflatable rubber boats)	15m bottom width,0.6 m depth	**8640**
2	Phase-II	Longmatra to Avankhung	15m bottom width,1m depth	**(61020- 8640) = 52380**
3	Phase-III	Longmatra to Avankhung (With Interventions)	Class-I	**NIL** ***(due to presence of dam/Barrages)***

*Dredging alone not a solution due to less discharge days

Details of Phases are shown in **Dwg No.: WAP-NW 101-TML-01 to Dwg No.: WAP-NW 101-TML-04.**

For dredging Long boom excavator+ short boom excavator is recommended to maintain above mentioned stretches for all mentioned phases. The boulders and stone which are of larger size and does not fit the bucket of excavator needs to broken through breaker mounted in the excavator. The pictures of long boom excavator and breaker arrangement is shown below.

Pictures of long boom excavator and excavator with breaker arrangement

Crawls on land and in shallow water due to tracks

Spuds provided on either side for stability during digging

Floats in deeper waters due to pontoon undercarriage

Excavator with breaker arrangement

6.6.1 Dredging Plan

phase-I (Immediate): The dredging plan of immediate phase can be done by using low Long boom excavator+ short boom excavator.

Table 6.7 dredging plan for immediate phase

Solid Quantity m3/ hr	Avg running hours per day	Solid Quantity m3/ day	No. of effective working days in a month	No. of effective days required for 8640cum	Solid Quantity m3 in 31 days	Long boom excavator+ short boom excavator (as per requirement)	Milestone days including contingencies
30	4	120	26	90	8640	1 each	120

Hence, for immediate phase total days required for dredging/removal of boulders of 8640 cum will be 120 days.

Phase-II : The dredging plan of phase I can also be done by using low long boom excavator + short boom excavator.

Considering dredging already executed in immediate phase-I 8640 cum the balance dredging in phase -II will be (61020- 8640) = 52380 cum

Table 6.8 dredging plan for phase II

Solid Quantity m3/ hr	Avg running hours per day	Solid Quantity m3/ day	No. of effective working days in a month	No. of effective days required for 52380 m3	Cumulative Qty (m3) in 187 days	Milestone month including contingencies	Long Boom Excavator And Short boom excavator
35	4	150	26	350	52380	12	2 each

Hence, for immediate phase total days required for dredging/removal of boulders of 52380 cum will be 12 month.

Phase-III : No dredging is required in phase-III as if executed the interventions proposed will provide more than required draft at the waterway

Typical long boom excavator specification

Table 6.9 Excavator Specification

Model	**PC450**
Total length(mm)	24000
Weight(kg)	7000
Max dig depth(mm)	18000
Max extensive Scope (mm)	23600
Max dig height(mm)	17300
Folding height(mm)	3400
Bucket volume(m3)	0.6
Excavator Tonnage(ton)	45

Other requirement

Vessel and equipment for Survey Work	INFLATABLE BOAT-4 PERSONS

6.6.2 Disposal of dredged material:

Generally dredged material can be disposed in the following way

(i) Within the river
(ii) Outside the river
(iii) On the bank of the river

From economical consideration the dredged material is proposed to be dumped outside the navigational channel considering at least 10 m margin on both the sides alternatively the same can be dumped in the bank with the provision of dowel/ Parapet wall so that dredged material may not slipped back into the river.

For better performance of this project boulders on river bed will have to be removed out or at least staked along the edge of river channel. This will help to maintain required depths on central portion of river channel. Effective use of these boulders could also be made for construction of weirs/Barrage, guide bunds, downstream protection works, bank protection works etc.

Clearance would be taken from the competent authorities before dumping the dredged material. Otherwise, Excess material can be dumped at the locations i.e low lying areas.

6.7 Bank Protection / Embankment Strengthening

As per the hydrographic report the banks of the river has been found stable. Only the chances of land slide from hill can be observed during monsoon seasons which can block the river with big rocks.

Note: The potential site where strengthening is required by soil nailing or protection by proper engineering solution needs to done by conducting survey of the hills on both the banks with a specialized agency

6.8 Navigation Marking/ Navigation Aids

The terms Aids to Navigation, Nav-aids and Navigational aids used interchangeably, are all meant to convey marks, including floating marks, such as buoys and beacons, transit and clearing marks as well as signalling systems, radio aids and communications, electronic systems, radar etc. which are installed on land or in water for guidance to all boats/ships for safe and regulated navigation in the channels, anchorages, berths, docks etc. It is envisaged that navigation will be carried out throughout the year, day by day and night except during times of high wind speeds and low visibility.

For day navigation, channel is demarcated by conventional bamboo marks but when frequency of IWT mode increases it becomes essential to provide night navigation facilities.The details of navigational aid required is discussed separately in chapter Chapter 12 - Navigation & Communication System

6.9 Modification Requirement in existing Bridges / Cables / Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

Sr. No.	Existing Structures	Total	Class-I	Design Vessel Class (1m depth and 15m bottom width)
1	Existing Bridge at Laruri Ch-14.5Km Horizontal Clearance-15 m Vertical Clearance- 4m w.r.t. HFL	1	As per Class-I HC -30m and VC-4m is required. Hence, Bridge is not satisfying the condition for class I vessel. It will require a modification to satisfy the condition	Satisfying the condition. The vessel can easily pass.

Details of Existing Bridges are shown in **Dwg No.: WAP-NW101-CS-01**

6.10 Existing & Proposed Dams / Barrages / Locks / Weirs to improve depth

No Existing Dam/Weir/Barrage is present on site.

It was learnt during survey that a Hydroelectric Dam namely **Lower Tizu HEP (3 X 14 MW)** DOP, Government of Nagaland project site is proposed in the river Tizu about 12 kilometres downstream from confluence of the Rivers Tizu and Zungki.The Construction work of the same has however not been started till date. As already proposed, this dam will have to be provided with a navigation lock of 40M (L) x 10M (B) size.

6.11 Proposed Dams / Barrages / Locks / Weirs to improve depth of water

We have proposed Barrages with navigational locks in Phase-III at chainages 0.5 km, 7km and 14km with navigational lock of size 40x10m at each barrages.

Note: *we have designed barrage and locks on the basis of available data of nearby projects. The actual designed has to be checked post soil investigation of each site.*

6.12 Topography/ Terrain near the terminals

We have proposed 4 terminals based on the traffic survey. The terrain near the terminal has been shown in the fig 6.14 to fig. 6.19 below. From the figure it shows that the terrain of the region is completely hilly and both side hills have average elevation of 700m to 900m in terminal 1 to terminal 3.The same can be seen in the contour. The terminal 4 have both side hills which have average elevation of 1200 to 1400m.

The approach road has to be built for all the four terminals.

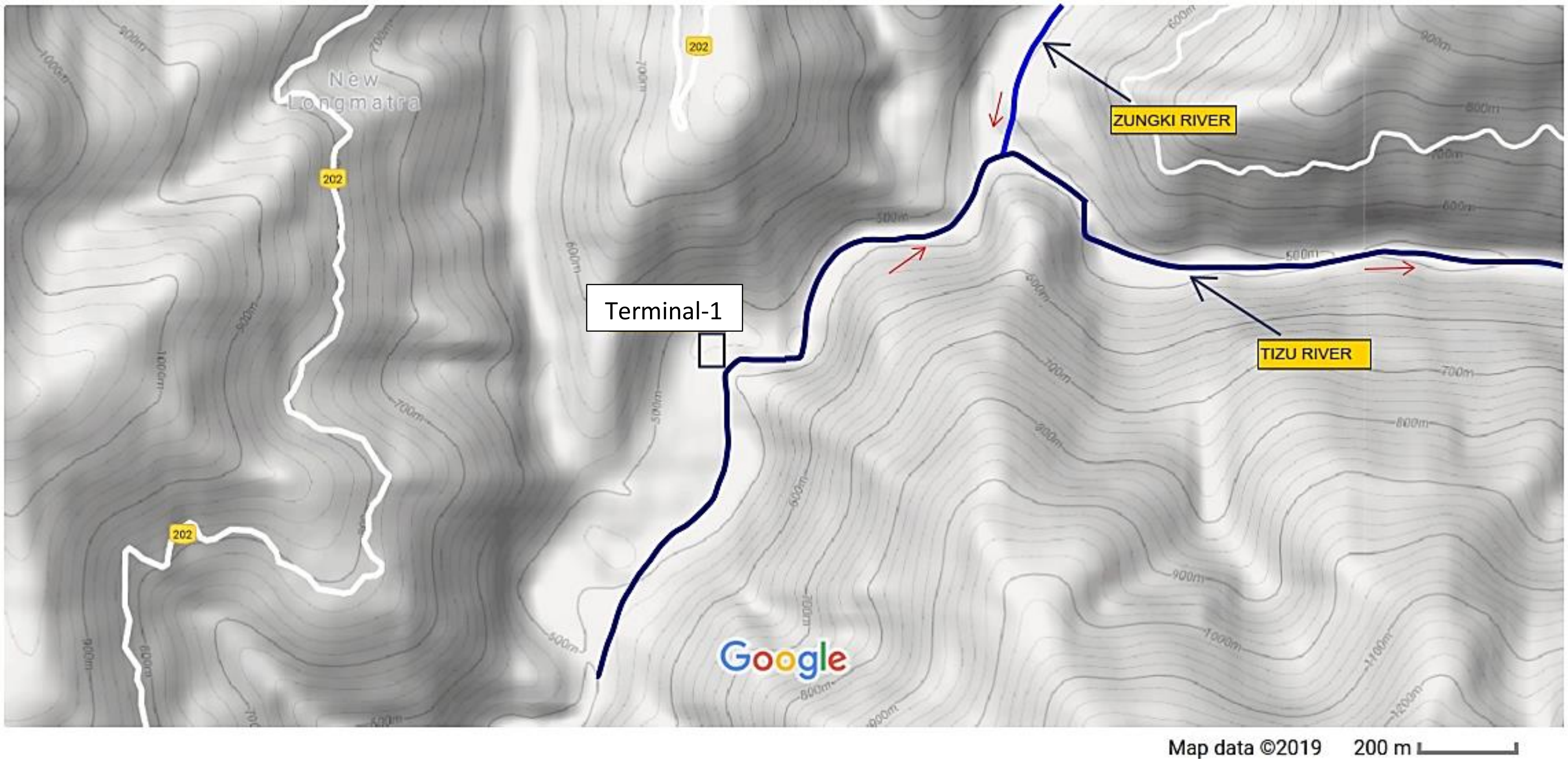


Fig. 6.16 Terrain near Terminal 1

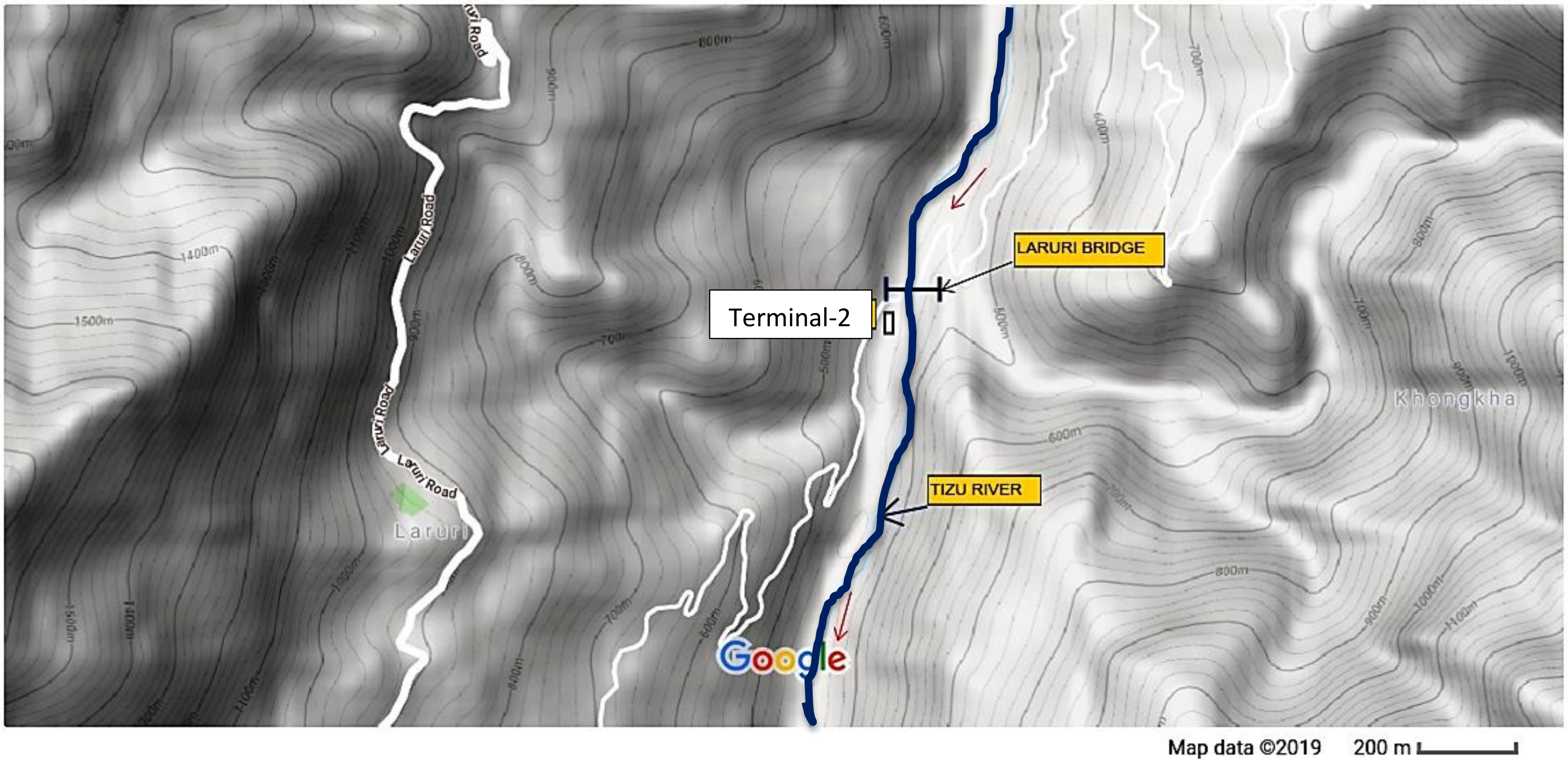


Fig. 6.17 Terrain near Terminal 2

Fig. 6.18 Terrain near Terminal 3

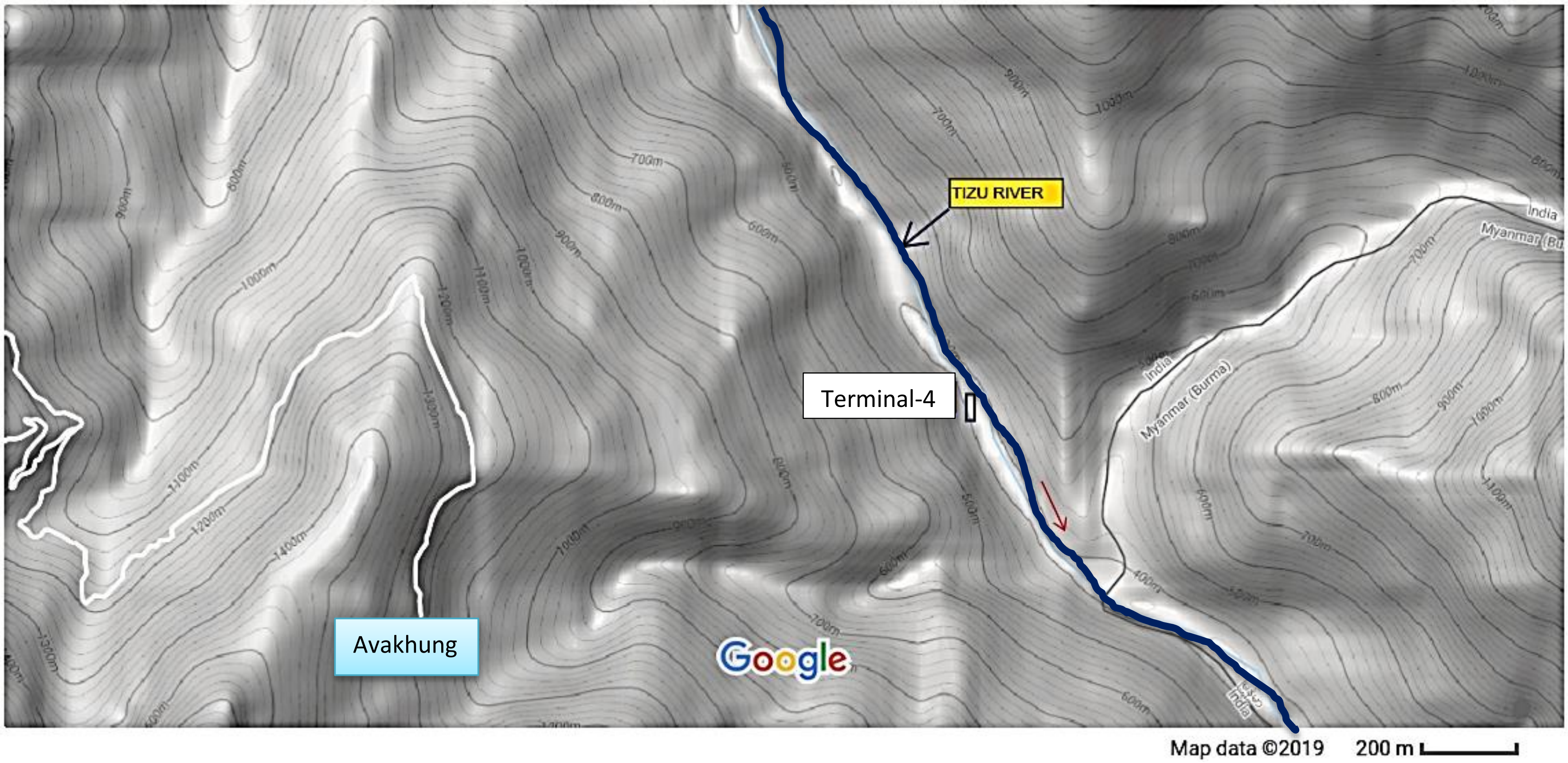


Fig. 6.19 Terrain near Terminal 4

CHAPTER – 7
WATERWAY AND INFRASTRUCTURE ANALYSIS

7.0 WATERWAY AND INFRASTRUCTURE ANALYSIS

7.1 Introduction

The identified stretch of river Tizu & Zungki for development as National Waterway 101 is currently non operational for cargo or passenger movement. The river stretch is surrounded by steep hills and forests and there is no existing ghat or terminal facility on the river. The below image shows V shape valley surrounding the defined stretch of Tizu river.

Fig. 7.1 Steep hills & valley surrounding Tizu river

Locations on the defined stretch of NW 101 are identified for development of the terminals. Proposed Terminal locations are based on traffic prospect, land availability, location, villages, mineral clusters and trade centers located in the region. However, development of inland waterway in the identified stretch of Tizu and Zungki river has technical hurdles, like hilly region, rocky terrain on the bank of river, sharp bends and curves in some parts of river, high velocity and rapids in river, rock outcrops in riverbed etc. A hydro power project is proposed in Lower Tizu. This project site is located in river Tizu about 12 km. downstream from confluence of Tizu and Zungki river. It is taken into consideration for Infrastructure Analysis that NW 101 would be developed by IWAI with suitable engineering solutions and the entire defined stretch would be navigable. Development of the upcoming hydro power project in Lower Tizu would be beneficial for NW 101, as due to the development of dam, the river will be navigable from the dam till Longmatra. This will solve the problem of dredging and result in saving cost. Due to the upcoming dam, the water level in the stretch from the dam till Avakhung will be high; hence vessels could be easily moved. However, due to the elevation near this project, vessel navigation on upstream of NW 101 (from dam towards Longmatra) would be a challenge. Installation of navigation lock in the dam would make the entire stretch of NW 101 navigable and vessels would be able to cross the dam.

Inland waterway NW 101 on Tizu & Zungki river would be developed in three phases, i.e. Phase I (Immediate Phase), Phase II and Phase III.

1. **Phase I (Immediate Phase)**

The development of waterway on NW 101 in Phase I (Immediate Phase) has been envisaged for 0.6m depth with 15m bottom wide navigational channel in the following way

- Deployment of Inflatable Boats with outboard motor
- Clearing channel of boulders and gravels
- Land filling/ leveling of ground
- Creation of platform by filling boulders
- Toilet facility
- A shed with seating arrangement
- Roads connecting from village to the terminal to be developed by PWD department, Nagaland.

In Phase I (Immediate Phase), the river stretch of Tizu & Zungki river would be made navigable by clearing channel of boulders (outcrops) and gravels. In this phase, basic infrastructure works, as listed above,would be developed.

In Phase I (Immediate Phase), there would not be any terminal development.However, landing points would be earmarked and platform would be created. Leveling of ground would also be done. In this phase, light floating motorized vessels, like inflatable boats with outboard motor would be deployed. These boats would be suitable to carry less number of passengers. These lightweight boat scan be stopped at any place on the bank of river. Platform would be used for embarking and disembarking of passengers. For safety measures, life jackets would be provided to passengers during their travel on NW 101. There would be a temporary shed with seating arrangements for passengers. Toilet facility would also be developed in this phase. The above mentioned basic facilities would be adequate to handle passenger traffic in Phase I (Immediate Phase). Considering the underdeveloped region, it is proposed that in Immediate Phase, only passenger traffic would be handled at NW 101. Cargo traffic could be targeted in near future, in Phase II.

2. **Phase II**

Terminal development would be done in Phase II for navigational channel of 1m depth and 15m bottom width. In Phase II, NW 101 would handle local movement between Longmatra to Avakhung. The development of waterway on NW-101 in Phase II has been envisaged in the following way

- Fairway development(1m LAD & 15 bottom width)
- Terminal development with additional facilities
- Development of Lower Tizu Dam with Navigational lock (It would be developed by Department of Power, Nagaland)

In Phase II, terminals could be developed by IWAI. The entire stretch of NW 101 would be made navigable by dredging and deepening the channel. The additional facilities in Terminals would also be developed in this Phase. It is also taken into consideration that during Phase II, Lower Tizu Hydro Power Project would be developed and navigational lock would be installed by Department of Power, Nagaland. This would ensure navigability in the entire stretch of NW 101.

After Phase II development, NW 101 would be operational for local movement of passengers and household commodities. The below sections would discuss in detail terminal and other infrastructure development on NW 101, as required in Phase II. Considering that the hinterland of NW 101 has remote and under developed villages, it is concluded that in Phase II, traffic of passengers and household commodities would not be large enough. Hence, one type of terminal would be adequate to handle both types of traffic. There is no need to categorize the proposed terminals as Passenger and cargo terminal.

3. Phase III

In Phase III, Indo-Myanmar trade is proposed to be done using IWT. Phase III however is a remote possibility, as it depends on Myanmar Government and IWAI has little say on development inland waterway (chindwin river) across the border till Hta Man Thi. Trade between India and Myanmar using IWT would be possible if Myanmar develops IWT connectivity between India and Myanmar till Hta Man Thi by connecting Tizu river with Chindwin river. At present, it is not recommended to develop Phase III, as there is no industrial cargo for movement on Indo- Myanmar route. The development of Phase III would happen only when upcoming industries would be developed and waterway would be developed in the river stretch in Myanmar till Hta Man Thi.

The development of waterway on NW-101 in Phase III has been envisaged in the following way

- Operationalisation of Indo - Myanmar trade using NW-101
- Maintenance of fairway & terminals

As fairway and terminals would be developed in Phase II; Only in Phase III, there would not be requirement of further development. There would be need of maintenance of fairway and terminals in Phase III. It is taken into consideration that in Phase III, IWT route between India and Myanmar would be developed and NW 101 would be linked with Chindwin River in Myanmar.

In Phase III, it is projected that minerals and cement produced in Laruri and Wazeho region would be transported to Myanmar using NW 101. Food grains, which are transported from Myanmar to Avakhung and nearby villages crossing the border, could also be shifted to NW 101. In PhaseIII, terminals and other infrastructure would be adequate to handle commodities, like minerals and cement, as discussed in Market Assessment Report. At present, it is not recommended to develop Phase III, as there is no industrial cargo for movement in Indo- Myanmar route. The development of Phase III would happen only when upcoming industries would be developed and waterway would be developed in the river stretch in Myanmar till Hta Man Thi.

The below chart shows proposed category of traffic, targeted by each proposed terminal on NW 101.

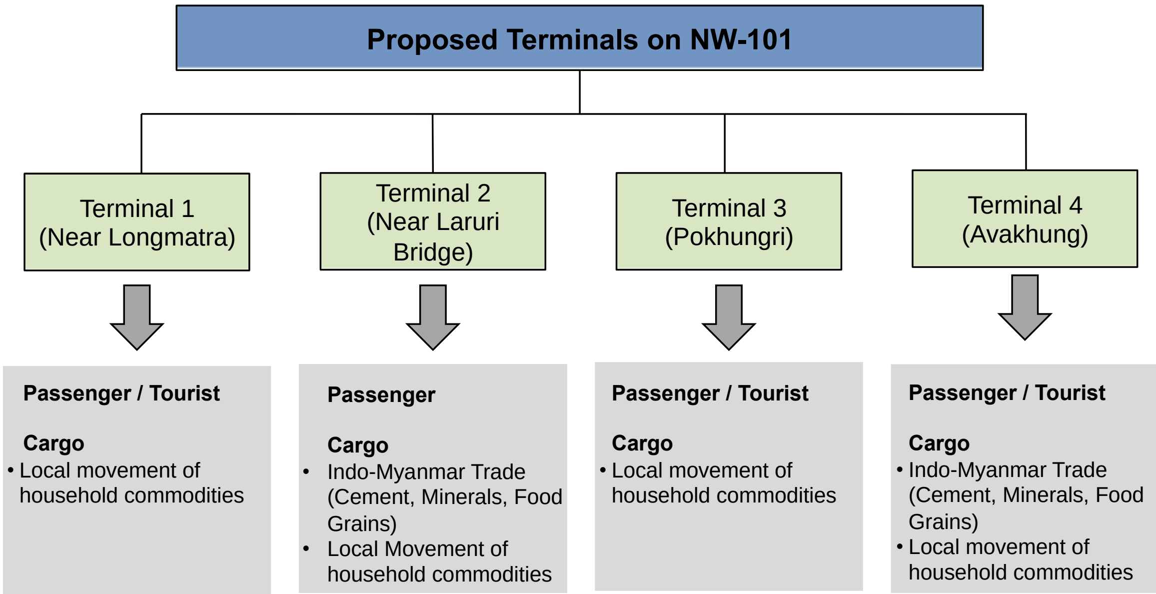


Fig. 7.2 Proposed Terminals on NW 101

Table 7-1 and Table 7-2 shows the detailed phase wise passenger and cargo traffic that above mentioned proposed terminals would handle in future.

7.2 Proposed Terminals

Total 7 terminal locations are examined on the identified stretch of Tizu and Zungki river. Traffic, availability of land and connectivity are the major decisive factors for the identification of terminals on NW 101. These 7 terminal locations are shown in the below image. Out of these 7 terminals, three terminal locations are discarded. These three terminal locations were considered near Zungki bridge, near the confluence of Tizu and Zungki river and near start point of Tizu river stretch near Longmatra.

Terminal near Zungki bridge is discarded due to existing parallel roads and less traffic from nearby villages. National Highway, i.e. NH 202 runs parallel to the defined stretch of Zungki. Another local road runs parallel to the stretch of Zungki river till Moya, near the confluence of Tizu & Zungki river. The distance between Zungki bridge to proposed terminal on Longmatra (Terminal 1) by roadway is around 14 km. It takes around 30 minutes to travel from Zungki Bridge to Terminal 1 on Longmatra by roadways. For such short distance, villagers would prefer roadways rather than waterways, as waterways is slower and time consuming due to loading and unloading on terminals. Considering these factors, it is advisable that there is no need to develop any terminal on the defined stretch on Zungki river, which is 4.62 km. For such short distance, IWT terminal would not be viable.Terminal, near the confluence of both the rivers is discarded as there is no village nearby. This land is surrounded by forest area. Terminal near start point of Tizu river stretch near Longmatra is discarded because Terminal 1 in Longmatra is already near start point of Tizu river stretch; hence there is no need of another terminal within 1 km. Considering the above mentioned factors, three proposed terminal locations are discarded and four locations are proposed for terminal development.

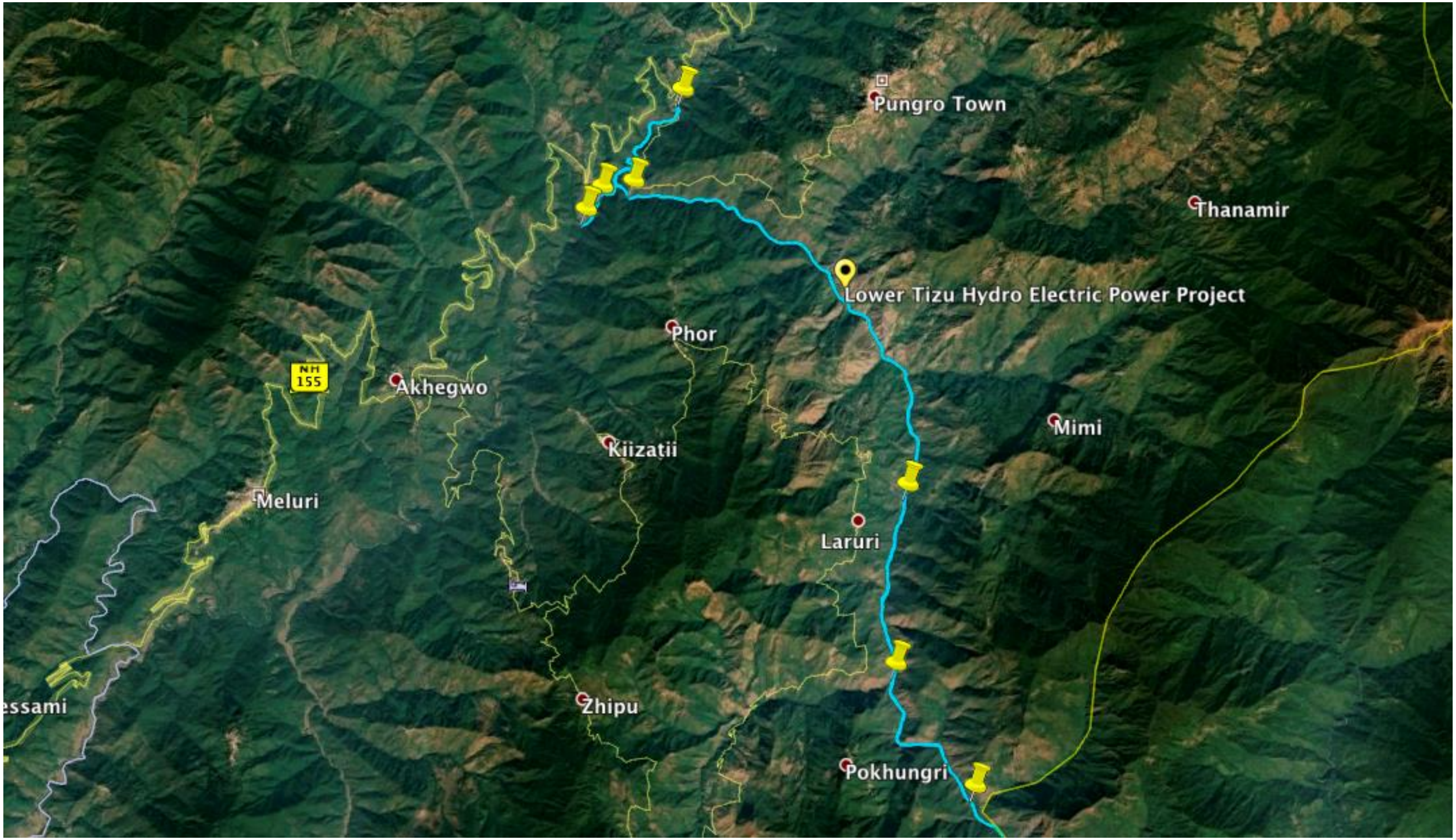


Fig. 7.3 Locations examined for Terminal Development on NW 101

Out of the 7 locations, as shown in the above image, 4 terminals (Terminal 1, 2, 3 & 4) are proposed at NW 101 for handling cargo and passengers. These terminals are located at various locations, on the bank of NW 101. All four terminals are proposed on River Tizu. The below image shows location of 4 proposed terminals on NW 101.

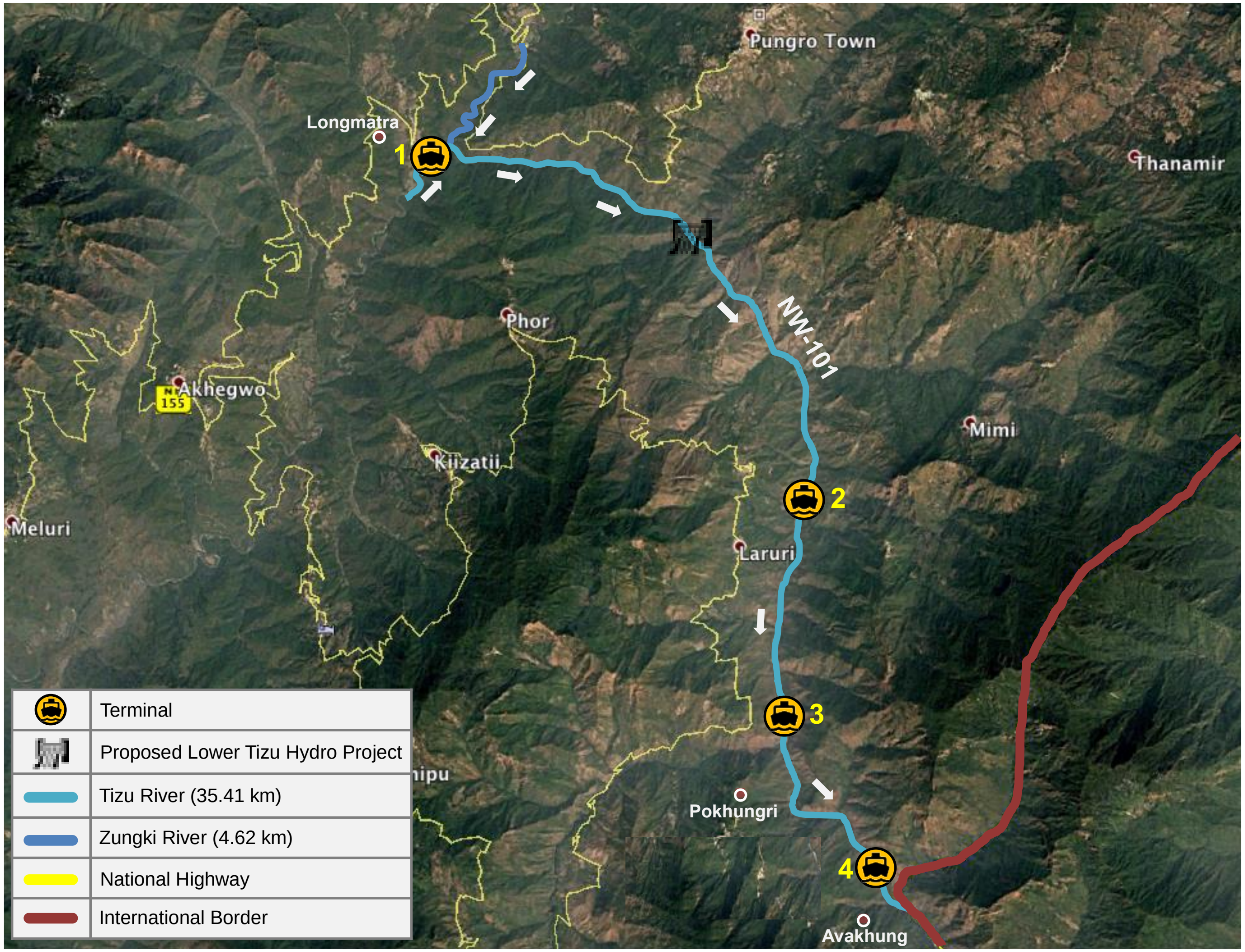


Fig. 7.4 Proposed Terminal Locations on NW 101

Terminal 1,2, 3 & 4 would cater to both cargo and passenger traffic. All these terminals would be used for handling local movement of household commodities between Longmatra to Avakhung. Indo - Myanmar trade could be shifted to NW 101, provided the river stretch in Myanmar would also be developed for navigation. Trade movement from Nagaland to Myanmar would mostly consist of minerals and cement from Laruri region near Terminal 2. Cement from Wazeho cement plant would also be transported to Myanmar using Terminal 2. Commodities, which would move from Myanmar to Nagaland would mostly consist of food grains, pulses etc.

All terminals would be used for passenger movement; however only three terminals, i.e. Terminal 1,3 & 4 would be used for tourist movement. Terminal 2 would not handle tourist traffic as it is a mineral rich area. This terminal would handle commodities, like cement and mineral from the region. Due to the upcoming cement plant at Laruri and extraction of minerals from the region in future, the surrounding area of the terminal would be dusty and polluted. This would deter tourists to visit the terminal. Another reason for no tourism opportunity in Terminal 2 is lack of tourism sites in the hinterland of this Terminal.

Terminal 1, 3 & 4 would be handling passengers and tourists likely to make local travels. At present, roadway is used for movement of all kinds of commodities in the hinterland of NW 101. Passenger movement is also solely dependent on roadways. All the villages located within 15 km of the identified stretch of NW 101 have been considered for passenger traffic.

Passengers usually choose any mode of transportation based on time, cost and reliability. Distance of waterways is at least 1 km away from the villages. Hence, any person willing to use waterways to travel to another village has to first travel minimum 1 km to reach the terminal. Roadway route is longer compared to the proposed IWT route. The hinterland is hilly region and roads are serpentine. Most of the roads are kaccha roads and not all weather roads. The condition of roads worsens during monsoon season, when hilly areas suffer from landslides and roads become muddy. At present, roadway is struggling to provide seamless service to remote villages; hence waterway would be an alternative mode of transportation.

Some remote villages near the Indo - Myanmar border do not have proper connectivity. Development of inland waterways would provide an alternate mode of transportation for cargo and passenger movement. Proposed terminals 1, 3 and 4 would mostly be catering tourists visiting various locations on the bank of River Tizu & Zungki. Inland waterway would attract tourists, as the surrounding region has some tourist spots and has abundance of natural beauty.

The below table depicts annual passenger and cargo traffic projected for each terminal on NW 101.

Table 7.1 Summary of Annual Projected Passenger & Tourist Traffic on NW 101

(Number)

Terminals	Chainage (km)	Phase I (Immediate Phase)		Phase II		Phase III				
		FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
Annual Local Passenger Traffic (Longmatra to Avakhung)										
T1 (Near Longmatra)	33.3	14,041	14,462	28,416	33,237	54,698	68,906	82,472	99,788	1,21,887
T2 (Near Laruri Bridge)	14	7,910	8,148	16,416	19,201	57,661	65,868	73,706	83,709	96,476
T3 (Pokhungri)	7.5	4,845	4,990	10,080	11,790	27,079	32,119	36,932	43,074	50,913
T4 (Avakhung)	1.2	3,263	3,361	6,720	7,860	15,453	18,813	22,021	26,116	31,342
Total		30,060	30,961	61,632	72,087	1,54,892	1,85,706	2,15,132	2,52,687	3,00,618
Annual Tourist Traffic (Longmatra to Avakhung)										
T1 (Near Longmatra)	33.3	5,323	5,483	5,647	6,480	6,739	8,868	11,318	14,446	18,437
T3 (Pokhungri)	7.5	2,219	2,285	2,354	2,701	2,809	3,696	4,717	6,021	7,684
T4 (Avakhung)	1.2	1,331	1,371	1,412	1,620	1,685	2,217	2,830	3,611	4,609
Total		8,872	9,139	9,413	10,801	11,233	14,782	18,866	24,078	30,730

Table 7.2 Summary of Annual Projected Cargo Traffic on NW 101

(Tonnes)

Terminals	Chainage (km)	Phase I (Immediate Phase)		Phase II		Phase III				
		FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
Annual Local Household Commodities Traffic (Longmatra to Avakhung)										
T1 (Near Longmatra)	33.3	0	0	293	342	360	506	646	824	1,052
T2 (Near Laruri Bridge)	14	0	0	121	141	149	209	267	340	435
T3 (Pokhungri)	7.5	0	0	74	86	91	128	163	208	266
T4 (Avakhung)	1.2	0	0	99	116	121	171	218	278	355
Total (Local household commodities)		0	0	587	686	721	1,014	1,294	1,651	2,107
Annual India to Myanmar Industrial Traffic (Cement, Minerals)										
T2 (Near Laruri Bridge)	14	0	0	0	0	181,500	181,500	181,500	181,500	181,500
Annual Myanmar to India Foodgrain Traffic										

Terminals	Chainage (km)	Phase I (Immediate Phase)		Phase II		Phase III				
		FY 21	FY 22	FY 23	FY 27	FY 28	FY 35	FY 40	FY 45	FY 50
T2 (Near Laruri Bridge)	14	0	0	0	0	130	146	162	178	197
T4 (Avakhung)	1.2	0	0	0	0	87	98	108	119	131
Total (Cements, Minerals & Foodgrains)		0	0	0	0	181,717	181,744	181,769	181,797	181,828

Table 7.3 Co-ordinates of each proposed terminal on NW 101

Terminal	Left 1	Left 2	Right 1	Right 2
1 (Near Longmatra)	25°46'38.46"N, 94°44'54.81"E	25°46'36.87"N, 94°44'54.66"E	25°46'38.13"N, 94°44'56.31"E	25°46'36.54"N, 94°44'56.06"E
2 (Near Laruri Bridge)	25°41'6.52"N, 94°51'12.80"E	25°41'4.40"N, 94°51'12.62"E	25°41'6.52"N, 94°51'13.92"E	25°41'4.29"N, 94°51'13.64"E
3 (Pokhungri)	25°37'48.72"N, 94°50'58.02"E	25°37'46.86"N, 94°50'57.62"E	25°37'48.90"N, 94°50'59.34"E	25°37'46.85"N, 94°50'58.77"E
4 (Avakhung)	25°35'29.62"N, 94°52'35.57"E	25°35'27.60"N, 94°52'36.11"E	25°35'30.09"N, 94°52'36.66"E	25°35'28.34"N, 94°52'37.20"E

Note : The Locations of Left1, Left2 & Right1, Right2 is shown in Fig. 7.6, 7.9, 7.10 & 7.12 respectively.

Roadway is the only mode of transportation in the hinterland of NW 101. Railway station is only in Dimapur. There is no railway line near the terminal locations. The below table shows existing connectivity and infrastructure around proposed terminals on NW 101.

Table 7.4 Existing connectivity and Infrastructure around Terminals on NW 101

Terminal Location	Connectivity with Roadway (km)	Infrastructure around Terminals			
		Bridges	FCI Godown (No.)	Border Trade Center (within 10 km)	Nearby Industries / Mineral Reserves
1. Near Longmatra	NH-202 - 0.8	-	1 (Tuensang), 1 (Kohima), 2 (Dimapur)	-	Meluri
2.Near Laruri Bridge	Laruri Road - 6.3	Laruri Bridge		1 (Mimi)	Laruri mineral belt, Proposed Cement Plant
3. Pokhungri	Laruri Road - 1	-		-	-
4. Avakhung	Local Road - 1.8	-		1 (Avakhung)	

Source: MSME

Table 7.5 Distance of FCI Godowns from proposed Terminals on NW 101

FCI Godown	Distance from Terminal (km)			
	T1 (Near Longmatra)	T2 (Near Laruri Bridge)	T3 (Pokhungri)	T4 (Avakhung)
Tuensang	161	272	274	303
Kohima	205	261	263	292
Dimapur 1	286	343	344	374
Dimapur 2	286	343	344	374

Fig. 7.5 Location of FCI in the Hinterland of NW 101

Four terminals have been identified based on the market survey and analysis of the needs of local economy and population. The below sub sections would discuss planning of each terminal in detail.

The identified stretch of Tizu and Zungki river is surrounded by steep hills and forest areas; hence development of connectivity to the terminals is necessary. It is necessary to develop the surrounding region and develop basic infrastructure, like approach road.

7.2.1 Terminal 1 –Near Longmatra

Terminal 1 is proposed near New Longmatra. This terminal has good connectivity as National Highway, i.e. NH 202 passes near the terminal. NH 202 is located within 0.75 km from Terminal 1. An approach road needs to be constructed for connecting the Terminal with NH 202 in Phase II. The road connecting to village road till terminals needs to be developed by State Govt.The location is surrounded by open land.

Terminal 1 would be crucial on NW 101, as it is proposed on a strategic location at Longmatra. Longmatra is near from Meluri (Phek), which has markets and other facilities. Villagers from remote villages on the bank of NW 101 could use waterway to reach Terminal 1 and further by roadways to Meluri to buy food items and other essential commodities. Due to poor road connectivity, locals from remote region find it difficult to travel to Meluri for procuring essential items. Roadway takes longer time and distance due to the geographical condition of the region and poor infrastructure. The roads between Longmatra to Avakhung is not well developed. Due to the poor condition of roads, the travel time between Longmatra to Avakhung takes longer time. The hilly region has serpentine and kaccha roads, which results in long travel time. Passenger movement using IWT in this stretch would save time because distance by IWT is shorter than roadway due to serpentine and curvy shape of roads.

In near future, after the development of NW 101, locals could switch to waterways, generating traffic for the terminal. Passenger movement, which happen by road at present, could be shifted to waterway. Villagers, who live in villages located near Avakhung, Pokhungri etc. need to travel a long distance to reach Kohima and Dimapur as these two cities are the centers. Passengers could take inland waterway to reach Terminal 1 and further could travel by road to Kohima and Dimapur. Kiphire Headquarter is another hub near Terminal 1. It is located on the northern side of the terminal. Kiphire town has few small MSME units. Banks, shops and other basic amenities are located in Kiphire. Villagers from remote villages on the bank of NW 101 could use waterway to reach Terminal 1 and further by roadways to Kiphire.

Meluri area in Phek district is designated as mineral belt, especially coal. However, coal extracted from this region could not be transported using Terminal 1 as it is locally consumed. The below figure depicts satellite image of the location near New Longmatra, identified for developing Terminal 1. The figure also shows road connectivity around the terminal. An approach road needs to be developed to connect the Terminal with NH 202.

Fig. 7.6 Location of Terminal 1 (Near Longmatra)

Source: By Analysis, Google Map

Actual pic of longmatra site

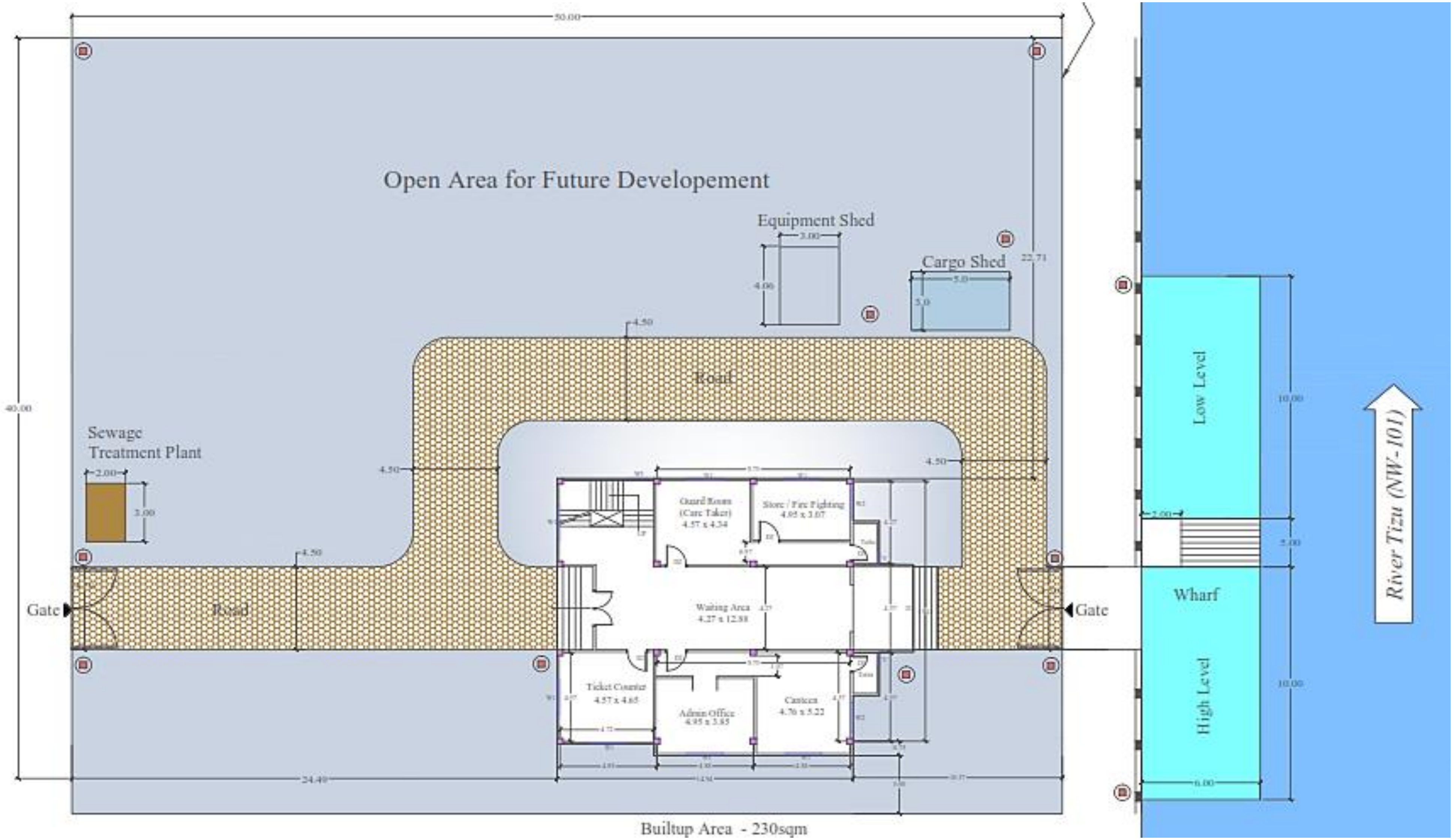


Fig. 7.7 Typical layout of Terminal in Phase-II

7.2.2 Terminal 2 – Near Laruri Bridge

Terminal 2 is proposed near Laruri Bridge in Laruri village. This bridge connects Laruri and Khongkha. This bridge across Tizu river connects the limestone deposit areas between Laruri village in Phek district and Mimi village in Kiphire district. This bridge is constructed in the Nimi – Laruri Mineral Link Road. This terminal is proposed for Phase III, i.e. Indo - Myanmar trade, provided Myanmar develops the navigation in river across the border till Hta Man Thi.

This proposed terminal would handle Indo-Myanmar trade of minerals, cement and food grains. Terminal 2 is located near mineral rich region. There exist reserves of limestone, granite and other minerals in the region. Mimi, which is within 7 km from the terminal is a mineral rich area.

To exploit the limestone reserves in the region, a cement plant is proposed in Laruri. Finished product of this plant, i.e. cement could be transported to Myanmar by using NW 101. Minerals, like granite from Mimi could also be transported using IWT to Myanmar. The terminal would also handle food grains movement, originated from Myanmar. This food grains would be unloaded at Terminal 2 for local distribution. Apart from Indo-Myanmar trade, this terminal could also be used for passenger movement. There are villages in nearby region. Locals could use inland waterway for traveling to Avakhung or Longmatra. Once cement plant at Laruri gets operational, workers from nearby villages would embark and other three terminals and get down at Terminal 2 to reach Laruri cement plant. Terminal 2 has good connectivity. A local road passes near the terminal. Laruri Road is at a distance of 1.5 km from the terminal. An approach road of 100m length could be developed to connect the terminal to Laruri Road directly in Phase II.

Fig. 7.8 Proposed Terminal 2 Location near Laruri Bridge

The below figure depicts satellite image of the location near Laruri Bridge, identified for developing Terminal 2. The figure also shows road connectivity around the terminal.

Fig. 7.9 Location of Terminal 2(near Laruri Bridge)

Source: By Analysis, Google Map

7.2.3 Terminal 3 – Near Pokhungri

Terminal 3 is proposed near Pokhungri village of Phek district. The location is surrounded by hills. Tizu river and its tributary merges near the proposed terminal location. To develop this land as terminal, there would be requirement of suitable engineering solutions. This location is selected because this parcel of land does not have thick vegetation and nearby village, Pokhungri is populated.

There is a need to develop an approach road of 3km – 5km to connect the Terminal with the nearest road, i.e. Laruri Road. This development would be done in Phase II. Population of the region could use inland waterway for transportation to other villages, located on the bank of NW 101.

Shilloi Lake, a major tourist spot is located in the hinterland of Terminal 3. It is at a distance of 12 km from the terminal. The region would attract tourists and would generate traffic for the terminal. The terminal would handle both passengers (locals) and tourists.

The below figure depicts satellite image of the location near Pokhungri, identified for developing Terminal 3. The figure also shows road connectivity around the terminal.

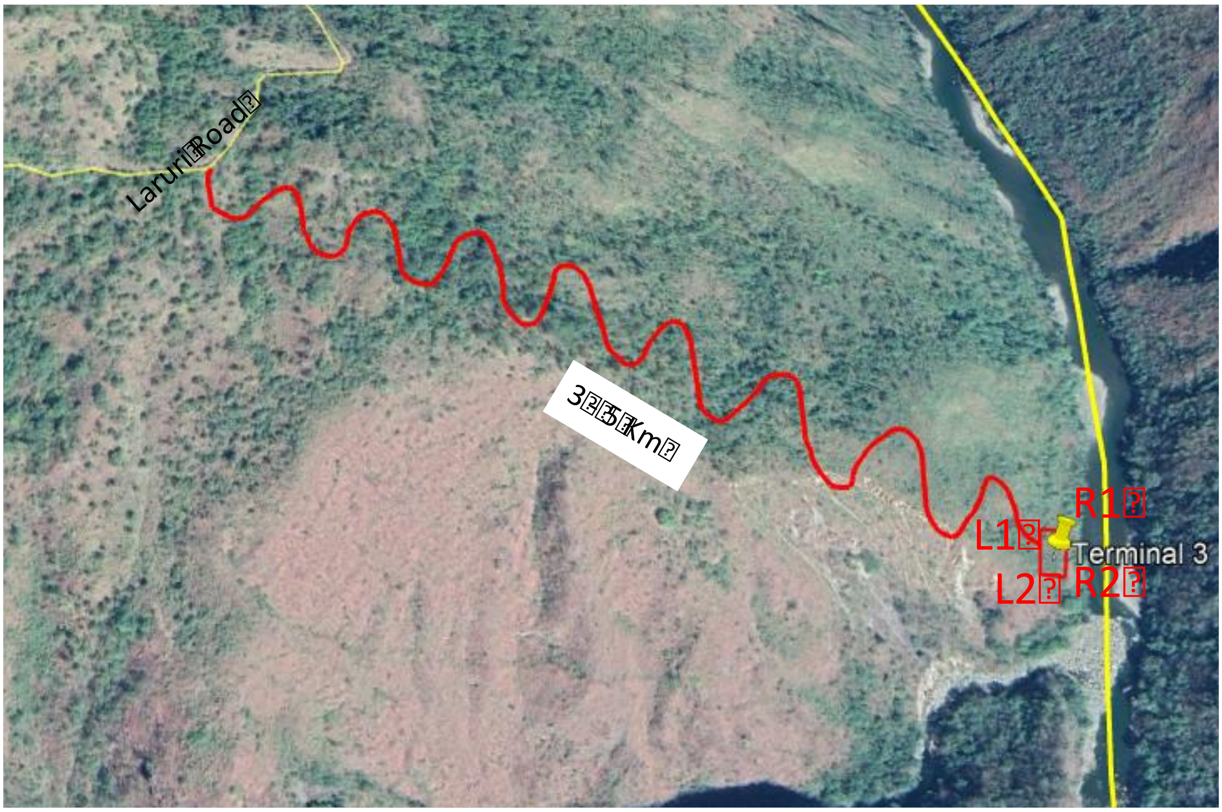


Fig. 7.10 Location of Terminal 3 (Pokhungri)

Source: By Analysis, Google Map

7.2.4 Terminal 4 – Avakhung

Terminal 4 is proposed at Avakhung near Indo- Myanmar border. This terminal is crucial for Indo - Myanmar trade through NW 101. Avakhung is a remote region with hilly terrains. Population in this region is less. There is no major road near the terminal. There is local kaccha road for local transportation. There is a need to develop an approach road to connect the terminal with the nearest road. This approach is proposed to be developed in Phase II.

The road between Pokhungri and Avakhung, a distance of 18.5 km. is getting developed by the North East Council (NEC). The construction of this road is in progress. The major challenge of this road development is steep rocky terrain. This road would be crucial for any kind of trading activity in Avakhung. This road would be a major competitor for NW 101.

After development of NW 101 and river stretch in Myanmar till Hta Man Thi, cargo movement (consisting of cement, mineral and food grains) between India and Myanmar could be shifted to NW 101. There exists an International Trade Center (ITC) in Avakhung; hence Terminal 4 would handle most of the Indo-Myanmar trade through Nagaland.

Fig. 7.11 Proposed Location for Terminal 4 (Avakhung)

The below figure depicts satellite image of the location near Avakhung, identified for developing Terminal 4. The figure also shows road connectivity around the terminal.

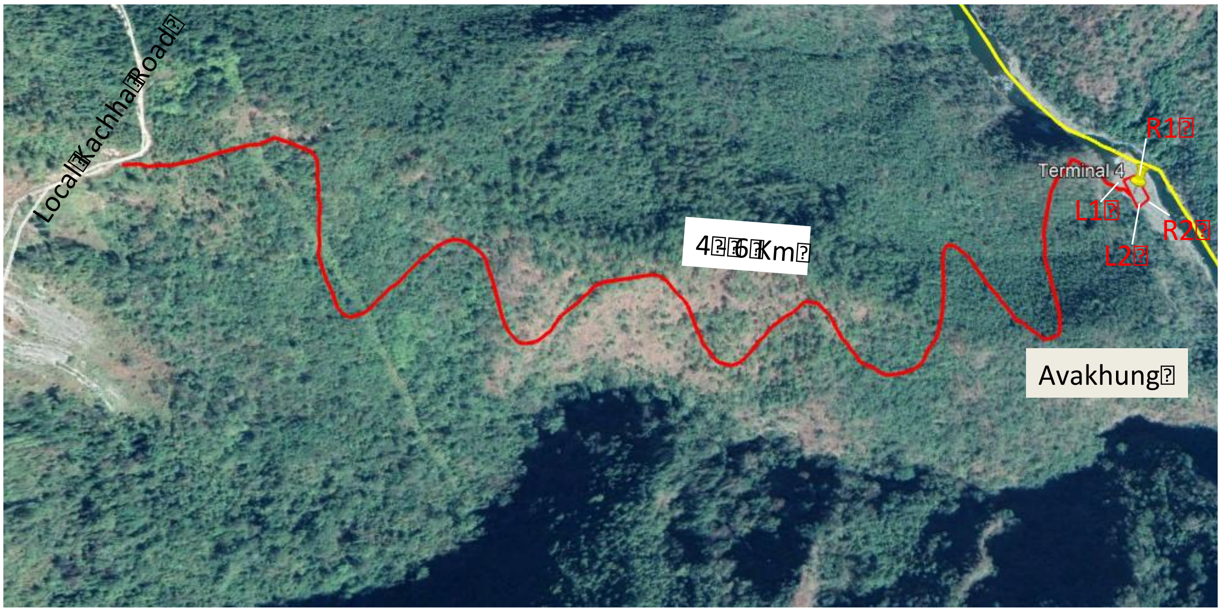


Fig. 7.12 Location of Terminal 4(Avakhung)

Source: By Analysis, Google Map

7.3 Infrastructure Planning

The section would discuss infrastructure planning for all 4 terminals on NW 101. The proposed facilities, infrastructure and other development required on NW 101 could be evaluated for all the terminals for handling cargo and passenger traffic. Apart from Terminal development, it is also important that the surrounding region should be developed along with proper connectivity. Approach road needs to be developed in all the terminals. Length of approach road would differ in each terminal based on the distance from the nearby roads and the terrain on which the respective terminal would be developed. Actual length of road will depend on survey of final route alignment.The survey and execution for the road connecting terminals is to be done through state govt. Infrastructures and facilities would be same in all the terminals on NW 101.

The hinterland is hilly terrain and not well developed. The population is very less near the proposed terminals. Traffic projection is done considering three Phases; i.e. Phase I (Immediate Phase), Phase II- local movement on NW 101 between Longmatra to Avakhung and Phase III- Indo- Myanmar trade when the stretch of river in Myanmar till Hta Man Thi would be developed by Myanmar Government for navigation.

Inland waterway on Tizu & Zungki river would be developed in three phases, i.e. Phase I (Immediate Phase), Phase II and Phase III (Please refer Section 7.1). Terminal development and additional facilities would be developed in Phase II. In Phase III, operation and maintenance of terminals would be done.It is proposed that basic facilities would be developed in all 4 Terminals because projected traffic would be low in both Phases due to the underdeveloped hinterland. Basic infrastructure and facilities would be adequate to handle the projected traffic. In below sub section, infrastructure planning is discussed in detail.

7.3.1 Terminal Infrastructure

This section would discuss in planning for wharf and other infrastructure for handling cargo, passengers/tourists. Passenger/tourist activities generally demand a relaxing place with seating arrangement. The terminal facility would include safe landing arrangement, eatery/canteen, toilet facilities and waiting area for resting. No night stay accommodation is envisaged for the passengers/tourists as the tourists are meant to stay for shorter duration, not requiring any night stay.

For cargo handling, cargo shed would be developed in each terminal. These sheds would be used for temporary storage of cargo, especially during monsoon season. Cargo, like cement, minerals, food grains could be stored in these cargo sheds. The below table depicts proposed infrastructure and facilities in each terminal on NW 101.

Table 7.6 Infrastructure & Facilities in each terminal on NW 101

Facilities	Terminal 1	Terminal 2	Terminal 3	Terminal 4
Admin Office	✓	✓	✓	✓
Ticket Counter	✓	✓	✓	✓
Guard Room (Caretaker)	✓	✓	✓	✓
Store/ Fire Fighting/ First Aid	✓	✓	✓	✓

Facilities	Terminal 1	Terminal 2	Terminal 3	Terminal 4
Waiting Area	✓	✓	✓	✓
Canteen	✓	✓	✓	✓
Rest Room	✓	✓	✓	✓
Cargo Shed	✓	✓	✓	✓
Equipment Shed	✓	✓	✓	✓
Fencing (Boundary)	✓	✓	✓	✓
Gate	✓	✓	✓	✓
Sewage Treatment Plant	✓	✓	✓	✓
Water Supply	✓	✓	✓	✓
Solar Powered LED Street Light	✓	✓	✓	✓
Electricity	✓	✓	✓	✓
Phone	✓	✓	✓	✓
Internet	✓	✓	✓	✓

Source: By Analysis

Table 7.7 Area requirement for Infrastructure development in each terminal on NW 101 (Phase II)

Facilities	Length (m) X Breadth (m)	Total Area (Sq. Mt.)
Total Land	-	2023.43
Admin Office	4.95 X 3.85	19.05
Ticket Counter	4.57 X 4.65	21.25
Guard Room (Caretaker)	4.57 X 4.34	19.83
Store/ Fire Fighting/ First Aid	4.95 X 3.07	15.19
Waiting Area	12.88 X 4.27	54.99
Canteen	4.76 X 5.22	24.84
Toilet (Each)	2.13 X 1.22	2.59
Cargo Shed	10.0 X 5.0	50.0
Sewage Treatment Plant	3.00 X 2.00	6.0
Road	-	159.59
Area for Future Development	-	1743.93

Source: By Analysis

As shown in the above table, there would be open area for future development in every terminal. Brief description of some of the proposed facilities is given in this section for terminal planning. Other infrastructural facilities like electrification, water requirement etc. are also considered.

7.3.1.1 Wharf Infrastructure

A Wharf would be used for handling both passengers and cargo. Dimension of wharf would be 25 x 6 sq. mtr. Wharf would be used to provide safe and rapid access to vessels. It would provide protection from rapids. In Phase II, commodities along with passengers would be handled manually due to low volume of commodities. Passengers themselves would carry these commodities and move from Wharf to the vessel. In Phase III, cargo, like cement, minerals and food grains would be transferred from Wharf to the vessel with the help of mechanized equipment, like mobile cranes. The cargo for local trade and Indo - Myanmar trade would be transported using river vessel at NW 101. The size of the vessel (Vessel classification) is discussed in detail in Vessel Design Chapter.

7.3.1.2 Terminal Connectivity

All the terminals should be well connected with nearby roadways to facilitate easy movement and evacuation of cargo and passengers. The proposed location for Terminal 2 is connected with nearby local road. Rest of the three terminals are not directly connected with the nearest roads. Hence, it is necessary to develop approach roads in all the terminals for linking them to the nearby roads and integrating inland waterway in the transportation system. **However as per the discussion with officials of government of Nagaland, roads from the state highway to the terminals will be developed by PWD of government of Nagaland . Therefore, cost of roads is not include in the Detailed Project Report.**

7.3.1.3 Cargo handling Equipments

Cargo handling equipments in terminals would be required in Phase II & III. The volume of cargo is less in Phase II; hence it is proposed that there would not be any requirement for heavy lifting equipment, like cranes etc. Cargo in Phase II would consist of household commodities carried by passengers between Longmatra to Avakhung. The volume of these commodities would be less; hence they could be handled manually. However, in Phase II, One number JCB Wheeled Loader would be installed in each terminal for removal of boulders etc. JCB Wheeled Loader could be used for multi purpose activities.

In Phase III, cargo would consist of Indo - Myanmar trade and local movement of household commodities between Longmatra to Avakhung. Mechanised equipment would be required for handling cargo, like cement, minerals and food grains. JCB Wheel Loader could be used in terminals in Phase III for handling cargo. Due to the low volume of cargo, there would not be any requirement for large equipments and cranes.

- JCB Wheel Loader

Wheeled Loaders are the versatile machines and are fuel-efficient. These JCB machines could be used for various purposes. These low cost, diesel fueled machines are compact and designed to handle different types of load. These JCB machines come in different shapes and sizes. At present, the range of JCB Wheeled Loaders include three models, 430ZX Plus, 432ZX and 455ZX. These machines come with bucket capacities ranging from 1.7 cum to 5 cum.

Considering the proposed cargo traffic volume on IWT terminals on NW 101, model430ZX Plus would be ideal for using in all IWT terminals. JCBs are highly efficient, versatile and flexible. They would facilitate handling of various types of commodities. These JCBs would be adequate to handle future traffic of cement, minerals and food grains in IWT terminals on NW 101. These JCB loaders would be suitable to transfer cargo from/to terminals to/from vessels.

JCB Wheeled Loaders are capable of performing for continuous hours and work with precision and perfection. They would also reduce the required number of equipments in each terminal, as there would not be any need for different equipments and cranes for different commodities.

Fig. 7.13 JCB Wheeled Loader: 430ZX Plus

Table 7.8 Product Specification of JCB Wheeled Loader

Specification of JCB Wheeled Loader	
JCB Wheeled Loader Model	430ZX Plus
Engine	133 HP (Diesel)
Engine Model	Ashok Leyland, H6ETIC3RU
Fuel Tank	195 Liter
Payload	3300 kg.
Maximum Operating Weight	11250 kg.
Bucket Width	2348 mm
Bucket Weight	1006 kg.
Maximum Bucket Capacity	1.7 cum
Bore Size (mm)	104 mm
Stroke (mm)	113 mm
Overall length with standard bucket	7060 mm
Rear Axle	17 liter
Dump angle max.	45 deg

Source: JCB India Limited

7.3.1.4 Lighting & Miscellaneous

Electrical power would be required in each terminal for general power requirement for lights, fans and miscellaneous electrical equipment in terminals. Department of Power, Nagaland would provide required electricity power to the terminal. Power would not be required for street lights inside the terminal as solar powered street lights would be installed in different parts of the terminals.

7.3.1.5 Admin Office (Back office)

The Administrative Office or Back office would serve as the base for the terminal. The office would be required for administration of the terminal. 19.05 sq. mtr. land would be required for development of admin office. Administration work, like paperwork, documentation etc. would be done in this office. The office would be used for administrative works to ensure effective, smooth and efficient functioning of the terminal.

7.3.1.6 Ticket Counter

There would be 2 window ticket counter in each terminal. 2 window ticketing booths would be sufficient to cater the peak passenger load.

7.3.1.7 Canteen

The terminal should have a canteen/ eatery for refreshment of tourists and passengers. This canteen could be built on 24.84 sq. mtr. of land in the terminal. The canteen would serve meals and snacks for passengers. There would be a small kitchen in the canteen for cooking food. It could also be used for storing food items.

7.3.1.8 Rest Rooms (Toilet)

Two toilets could be built in each Terminal. Each toilet would be built on 2.59 sq. mtr. of land. There would be separate toilet facilities for men and women. There would be proper ventilation in these toilets.

7.3.1.9 Guard Room (Caretaker)

A guard room or caretaker room shall be developed for the security of the property at site. Guard keep vigilance 24 hours on the activities taking place in the terminal premise.

7.3.1.10 Store/ Fire Fighting/ First Aid

15.19 sq. mtr. land would be assigned as Store. This area would also house fire fighting equipments, like fire extinguisher, fire hydrants, pipes, water tank etc. This is very crucial for the safety of human life and property in the terminal premise from fire. The area would also be used for storage and first aid facilities.

7.3.1.11 Waiting Area

Waiting area would be required in all the terminals. It would be difficult for passengers to arrive exactly few minutes prior to departure of boat/vessel; hence passengers could rest and wait in the waiting area. Waiting area should be sufficient enough to handle minimum 10 no. of passengers. A hall of 54.99 sq. mtr. would be adequate. The waiting area would have sufficient seating arrangement for tourists/passengers. Sufficient number of electrical points shall be provided for phone/laptop charging purpose.

7.3.1.12 Cargo Shed

It could be built on 50 sq. mtr. of land. The cargo shed would be used for temporary storage of cargo and miscellaneous items.

7.3.1.13 Equipment Shed

A tin shed would be built for keeping the Wheeled Loader and other equipments. The size of this shed would be 3 m X 4 m.

7.3.1.14 Sewage Treatment Plant

A small sewage treatment plant (STP) would be set up in each terminal. This small scale treatment plant would be adequate for the treatment of sewage in the terminal.

7.3.1.15 Barbed Fencing

The area of landing facility shall be provided with barbed wire system with pillars for supporting the fencing. The entrance to the terminal complex will be through a small gate.

7.3.1.16 Landscaping

Landscaping elements should be used on a part of open land. It can be used near the building and besides the internal roads. Landscaping will help improve the attractiveness of the site.

7.3.1.17 Area for future development

Open area would be left in all the four sites for terminal development. As per requirement, this open area could be developed in future.

7.3.1.18 Water & Power Requirement

Water and power would be required in construction and operational phase in each terminal. A transformer of 11 kVA capacity would be used in each terminal for supplying power.

Water requirement for each terminal in construction and operational phase is depicted in the below tables. In Construction phase, water will be required only in Phase I (Immediate Phase) and Phase II. In Phase I(Immediate Phase),only toilet facilities and a shed for seating would be created; hence water requirement would be less. Major development would happen in Phase II. Terminal and supporting infrastructure would be developed in Phase II. In Phase III, there would not be any construction; hence water would not be required.

Table 7.9 Water requirement in each terminal on NW 101 - Construction Phase

(Mn Liters)

Water Requirement	Terminal 1	Terminal 2	Terminal 3	Terminal 4
Phase I (Immediate Phase)(Liter)				
Water Requirement (Total)	5,000	5,000	5,000	5,000
Phase II(MN Liters)				
Internal Road	0.43	0.43	0.43	0.43
Total Built up Area	0.28	0.28	0.28	0.28
Water Requirement (Total)	0.71	0.71	0.71	0.71

Source: By Analysis

The below table depicts daily and annual water requirement during operational phase in each terminal on NW 101.

Table 7.10 Water Requirement in each terminal on NW 101 - Operational Phase

Type of Water		Unit	Phase I (Immediate Phase)	Phase II	Phase III
Drinking Water	Daily	Lpd	146	372	1,333
	Annual	Mn Liters	0.04	0.11	0.40
Other than drinking purpose	Daily	Lpd	1,204	1,204	1,204
	Annual	Mn Liters	0.41	0.47	0.76

Source: By Analysis

7.4 SWOT Analysis

SWOT of each terminal is discussed in this section.

7.4.1 Terminal 1- Near Longmatra

- Strength

Availability of open land for development of terminal is a major strength.This parcel of land is not part of elevated land; hence development of terminal would be easy. Close proximity with NH 202 is another strength. This National Highway is the major roadway in the hinterland. By developing an approach road of 3-5 km, the terminal could be directly connected to NH 202, which would connect the terminal to hubs, like Meluri, Pfutsero and Kohima.

- Weakness

At present, the terminal location does not have an approach road, which needs to be developed.Rock outcrops and boulders in the river is a major weakness, which would be hurdle for navigation. It would make dredging operation a costly feat. The Least Available Depth (LAD) of river is 0.6 mtr., which is not adequate for large vessels.

- Opportunity

The distance from Longmatra to Avakhung by road is 111 km, whereas by waterway it is only 32 km. Development of proposed terminal will provide better connectivity for the daily commuters of the region. Due to the hilly and rough terrain and poor roadways, locals would opt for inland waterway to move between villages and to reach Terminal 1 to further travel to Meluri, Kohima by roadways.

- Threat

Major threat for development of terminals on NW 101 is the geographical condition of the river. The river is surrounded by V shape valley, as shown in Figure 7-1. During monsoon, there is occurrence of landslide on the steep hills, which surround the river. Landslides could result in falling rocks and boulders in the river, which might cause accidents on inland waterway. Landslides could also affect operation in the Terminals.

7.4.2 Terminal 2- Near Laruri Bridge

- Strength

There is open land available for development of terminal.This terminal has good connectivity. It is located beside Laruri bridge. This bridge is built on Nimi – Laruri Mineral Link Road, which further connects to Laruri Road at a distance of 6.3 km.This Bridge across Tizu river connects the limestone deposit areas between Laruri village and Mimi village.The bridge and the road facilitates exploration of minerals, like limestone, granite and magnetite.

- Weakness

Hilly region with serpentine roads increases the actual distance of town or village from the terminal. Rock outcrops and boulders in the river would be hurdle for navigation. It would make dredging operation a costly feat.

- Opportunity

The terminal is proposed in Laruri, which is a mineral belt. Mimi also has mineral reserves.The terminal could be used for trade of limestone and granite, which is found in abundance in Laruri and Mimi. A cement plant has been proposed at Laruri, which would provide future opportunity for the terminal. Cement from the plant could be transported to Myanmar using inland waterways.

- Threat

The terminal would handle commodities, like cement and mineral from the region. Due to the upcoming cement plant at Laruri and extraction of minerals from the region in future, the surrounding area of the terminal would be dusty and polluted. Hence, the terminal would not attract tourist traffic. Tourism activity requires aesthetically pleasant surrounding. Lack of it would discourage tourists to visit the terminal and surrounding places. Another reason for no tourism opportunity in this terminal is lack of tourism sites in the hinterland of Terminal 2.

7.4.3 Terminal 3- Pokhungri

- Strength

There are tourist spots, like Shilloi Lake in the region. Shilloi lake and Pungro are the major tourist destinations near the terminal. The villages near the terminal, like Pokhungri have more population compared to villages near Terminal 2 and 4. Population of nearby villages would contribute in passenger traffic of Terminal 3.

- Weakness

The terminal is located near the confluence of Tizu river with a small tributary. There is no approach road near the terminal. Due to the steep rocky terrian, it is challenging to develop an approach road of 1 km that will connect the terminal to the nearest Laruri road. Developing roads on the hilly and mountainous terrain would require large investment. There is no major industry in the region; hence there would not be any industrial cargo movement from Terminal 3.

- Opportunity

The region is rich in scenic beauty and is home to some tourist spots. Development of the terminal would provide opportunity for tourism growth in the region and would contribute in tourist traffic at the terminal.Tourists would opt for boat ride on NW 101 to enjoy the natural beauty around the river.

- Threat

Upcoming Pokhungri- Avakhung road projectwould be a major threat for Terminal 3. It would serve the hinterland and Border trade center at Avakhung. Another threat is development of terminal on the proposed location. Tizu river and its tributary merges near the proposed terminal location. The land parcel could be unstable land due to the difficult terrain and might require suitable engineering solution and strong foundation for development of terminal on this land. This groundwork and foundation could require exorbitant costs, which would impact viability of the project.

7.4.4 Terminal 4- Avakhung

- Strength

The location of Terminal 4is near Border Trade Center at Avakhung. This center is very crucial for Indo- Myanmar trade across border; hence it would contribute in cargo traffic of the Terminal.

- Weakness

The region near Avakhung is hilly and remote with very less population. There is no well developed roads here. At present, the terminal location does not have an approach road. Hence, it is necessary to develop the surrounding area of the proposed terminal. Developing roads on the hilly and mountainous terrain would be a challenge and would require large investment. Large investment would also be required for construction, maintenance and overhead of the terminal. Passengers and cargo movement from the region to the Terminal is possible only when there is good road connectivity to the terminal.

- Opportunity

The terminal has potential to attract large volume of cargo in future due to presence of border trade center at Avakhung. After development of inland waterway in Tizu river and in Chindwin river (Myanmar), trade and passenger movement across border would provide opportunity to Terminal 4.

- Threat

The road between Pokhungri and Avakhung, a distance of 18.5 km. is under development. This road would be crucial for any kind of trading activity in Avakhung. This road would be a major competitor for Terminal 4.

Another major threat is development of connectivity around the terminal. River Tizu & Zungki is surrounded by steep hills and thick vegetation. Development of road to connect the terminal with nearby roads would be a cumbersome task, which would require large investment. Large investment on development of road connectivity would adversely impact the viability of the project.

Terminal 1

S. No	Salient Feature	Capacity/Quantity/Nos.
1	Location	Near Longmatra
2	Geographical Coordinates	• Left 1- 25°46'38.46"N, 94°44'54.81"E • Left 2- 25°46'36.87"N, 94°44'54.66"E • Right 1- 25°46'38.13"N, 94°44'56.31"E • Right 2- 25°46'36.54"N, 94°44'56.06"E
3	Proposed Traffic for Terminal 1	• Phase I (Immediate Phase)- Passenger- 30,060 (FY 21), 30,961 (FY 22); Tourist- 8,872 (FY 21), 9,139 (FY 22) • Phase II- Passenger- 61,632 (FY 23), 72,087 (FY 27); Tourist- 9,413 (FY 23), 10,801 (FY 27); Household Commodities - 587 Tonnes (FY 23), 686 Tonnes (FY 27) • Phase III- Passenger- 154,892 (FY 28), 300,618 (FY 50); Tourist- 11,233 (FY 28), 30,730 (FY 50); Household Commodities- 721 Tonnes (FY 28), 2,107 Tonnes (FY 50); Cargo (Cement, Mineral, Food Grains)- 481,830 Tonnes (FY 28), 482,001 (FY 50)
4	Connectivity	An approach road needs to be constructed for connecting the terminal to NH 202. NH 202 is located within 1 km from Terminal 2. There is no railway line near this terminal.
5	Topography of terminal site	Hilly terrain
6	Facilities Proposed for Terminal	Wharf, Ticket Counter, Admin Office, Guard Room (Security), Canteen, Restroom, Storage area, Fire Fighting equipments, First Aid facilities, Cargo Shed, Shed for Wheeled Loader, Internal Road, Electricity & Water
7	Facilities to be shifted	The Proposed Terminal at the waterfront is covered in vegetation and surrounded by agaricultural land. Therefore, no infrastructure has to be shifted while developing terminal.
8	Material Transportation System	• Phase I (Immediate Phase) - No cargo handling equipments required. • Phase II & III- JCB Wheel Loader
9	Shore Protection Works	Not required
10	LAD (Least Available Draft)	0.4 m
11	Extension of Off-shore structure in River	Wharf and floating concrete jetty
12	HFL of the River	458.74
13	Finished level of site	459.04
14	Top level of berth & approach trestle	459.74
15	Dredging During Construction Phase	-
16	Maintenance Dredging during operation phase	10% of capital dredging
17	Water Requirement- Construction phase-each terminal* (Total)	• Phase I (Immediate Phase)- 5,000 liter • Phase II- 0.71 mn liter
18	Water Requirement- Operation phase-each terminal (Annual)	• Phase I (Immediate Phase)- 0.45 mn liter • Phase II- 0.58 mn liter • Phase III- 1.16 mn liter
19	Power Requirement	11 kVA
20	STP Capacity-Operation Phase	2 KLD
21	Dust Suppression Methods	NA

(*In Phase III, there would not be any water requirement for construction phase, as there would not be any construction in this phase.)

Terminal 2

S. No.	Salient Feature	Capacity/Quantity/Nos.
1	Location	Near Laruri Bridge
2	Geographical Coordinates	• Left 1- 25°41'6.52"N, 94°51'12.80"E
		• Left 2- 25°41'4.40"N, 94°51'12.62"E
		• Right 1- 25°41'6.52"N, 94°51'13.92"E
		• Right 2- 25°41'4.29"N, 94°51'13.64"E
3	Proposed Traffic for Terminal 2	• Phase I (Immediate Phase)- Passenger- 30,060 (FY 21), 30,961 (FY 22); Tourist- 8,872 (FY 21), 9,139 (FY 22)
		• Phase II- Passenger- 61,632 (FY 23), 72,087 (FY 27); Tourist- 9,413 (FY 23), 10,801 (FY 27); Household Commodities - 587 Tonnes (FY 23), 686 Tonnes (FY 27)
		• Phase III- Passenger- 154,892 (FY 28), 300,618 (FY 50); Tourist- 11,233 (FY 28), 30,730 (FY 50); Household Commodities- 721 Tonnes (FY 28), 2,107 Tonnes (FY 50); Cargo (Cement, Mineral, Food Grains)- 481,830 Tonnes (FY 28), 482,001 (FY 50)
4	Connectivity	Terminal 2 is proposed near Laruri Bridge, which connects Laruri and Khongkha. A local road passes near the terminal. Laruri Road is at a distance of 1.5 km from the terminal. An approach road could be developed to connect the terminal to Laruri Road directly. There is no railway line near this terminal.
5	Topography of terminal site	
6	Facilities Proposed for Terminal	Wharf, Ticket Counter, Admin Office, Guard Room (Security), Canteen, Restroom, Storage area, Fire Fighting equipments, First Aid facilities, Cargo Shed, Shed for Wheeled Loader, Internal Road, Electricity & Water
7	Facilities to be shifted	The Proposed Terminal at the waterfront is open land and It is surrounded by forsest land. There are stones and boulders on the bank of the river. These stones and boulders need to be removed for construction of terminal. No infrastructure has to be shifted while developing terminal.
8	Material Transportation System	• Phase I (Immediate Phase) - No cargo handling equipments required. • Phase II & III- JCB Wheel Loader
9	Shore Protection Works	Not required
10	LAD (Least Available Draft)	0.4 m
11	Extension of Off-shore structure in River	Wharf and floating concrete jetty
12	HFL of the River	439.125
13	Finished level of site	439.425
14	Top level of berth & approach trestle	440.125
15	Dredging During Construction Phase	-
16	Maintenance Dredging during operation phase	10% of capital dredging
17	Water Requirement- Construction phase- each terminal* (Total)	• Phase I (Immediate Phase)- 5,000 liter
		• Phase II- 0.71 mn liter
18	Water Requirement- Operation phase- each terminal (Annual)	• Phase I (Immediate Phase)- 0.45 mn liter
		• Phase II- 0.58 mn liter
		• Phase III- 1.16 mn liter
19	Power Requirement	11 kVA
20	STP Capacity-Operation Phase	2 KLD
21	Dust Suppression Methods	NA

(*In Phase III, there would not be any water requirement for construction phase, as there would not be any construction in this phase.)

Terminal 3

S. No.	Salient Feature	Capacity/Quantity/Nos.
1	Location	Pokhungri
2	Geographical Coordinates	• Left 1- 25°37'48.72"N, 94°50'58.02"E • Left 2- 25°37'46.86"N, 94°50'57.62"E • Right 1- 25°37'48.90"N, 94°50'59.34"E • Right 2- 25°37'46.85"N, 94°50'58.77"E
3	Proposed Traffic for Terminal 3	• Phase I (Immediate Phase)- Passenger- 30,060 (FY 21), 30,961 (FY 22); Tourist- 8,872 (FY 21), 9,139 (FY 22) • Phase II- Passenger- 61,632 (FY 23), 72,087 (FY 27); Tourist- 9,413 (FY 23), 10,801 (FY 27); Household Commodities - 587 Tonnes (FY 23), 686 Tonnes (FY 27) • Phase III- Passenger- 154,892 (FY 28), 300,618 (FY 50); Tourist- 11,233 (FY 28), 30,730 (FY 50); Household Commodities- 721 Tonnes (FY 28), 2,107 Tonnes (FY 50); Cargo (Cement, Mineral, Food Grains)- 481,830 Tonnes (FY 28), 482,001 (FY 50)
4	Connectivity	An approach road needs to be constructed for connecting the terminal with the nearest road, i.e. Laruri Road. There is no railway line near this terminal.
5	Topography of terminal site	
6	Facilities Proposed for Terminal	Wharf, Ticket Counter, Admin Office, Guard Room (Security), Canteen, Restroom, Storage area, Fire Fighting equipments, First Aid facilities, Cargo Shed, Shed for Wheeled Loader, Internal Road, Electricity & Water
7	Facilities to be shifted	The Proposed Terminal location is on an open elevated land, at the waterfront. No infrastructure needs to be shifted while developing terminal.
8	Material Transportation System	• Phase I (Immediate Phase) - No cargo handling equipments required. • Phase II & III- JCB Wheel Loader
9	Shore Protection Works	Not required
10	LAD (Least Available Draft)	0.3 m
11	Extension of Off-shore structure in River	Wharf and floating concrete jetty
12	HFL of the River	432.835
13	Finished level of site	433.135
14	Top level of berth & approach trestle	433.835
15	Dredging During Construction Phase	-
16	Maintenance Dredging during operation phase	10% of capital dredging
17	Water Requirement- Construction phase- each terminal* (Total)	• Phase I (Immediate Phase)- 5,000 liter • Phase II- 0.71 mn liter
18	Water Requirement- Operation phase- each terminal (Annually)	• Phase I (Immediate Phase)- 0.45 mn liter • Phase II- 0.58 mn liter • Phase III- 1.16 mn liter
19	Power Requirement	11 kVA
20	STP Capacity-Operation Phase	2 KLD
21	Dust Suppression Methods	NA

(*In Phase III, there would not be any water requirement for construction phase, as there would not be any construction in this phase.)

Terminal 4

S. No.	Salient Feature	Capacity/Quantity/Nos.
1	Location	Avakhung
2	Geographical Coordinates	• Left 1- 25°35'29.62"N, 94°52'35.57"E • Left 2- 25°35'27.60"N, 94°52'36.11"E • Right 1- 25°35'30.09"N, 94°52'36.66"E • Right 2- 25°35'28.34"N, 94°52'37.20"E
3	Proposed Traffic for Terminal 4	• Phase I (Immediate Phase)- Passenger- 30,060 (FY 21), 30,961 (FY 22); Tourist- 8,872 (FY 21), 9,139 (FY 22) • Phase II- Passenger- 61,632 (FY 23), 72,087 (FY 27); Tourist- 9,413 (FY 23), 10,801 (FY 27); Household Commodities - 587 Tonnes (FY 23), 686 Tonnes (FY 27) • Phase III- Passenger- 154,892 (FY 28), 300,618 (FY 50); Tourist- 11,233 (FY 28), 30,730 (FY 50); Household Commodities- 721 Tonnes (FY 28), 2,107 Tonnes (FY 50); Cargo (Cement, Mineral, Food Grains)- 481,830 Tonnes (FY 28), 482,001 (FY 50)
4	Connectivity	There is no major road near the terminal. There is local kaccha road for local transportation. There is a need to develop an approach road to connect the terminal with the nearest road. There is no railway line near this terminal.
5	Topography of terminal site	
6	Facilities Proposed for Terminal	Wharf, Ticket Counter, Admin Office, Guard Room (Security), Canteen, Restroom, Storage area, Fire Fighting equipments, First Aid facilities, Cargo Shed, Shed for Wheeled Loader, Internal Road, Electricity & Water
7	Facilities to be shifted	The Proposed Terminal location is an open elevated land at the waterfront and is surrounded by forest. There are also stones and boulders in the land, which need to be removed. No infrastructure has to be shifted while developing the terminal.
8	Material Transportation System	• Phase I (Immediate Phase)- No cargo handling equipments required. • Phase II & III- JCB Wheel Loader
9	Shore Protection Works	NA
10	LAD (Least Available Draft)	0.6 m
11	Extension of Off-shore structure in River	Wharf and floating concrete jetty
12	HFL of the River	426.645
13	Finished level of site	426.945
14	Top level of berth & approach trestle	427.645
15	Dredging During Construction Phase	-
16	Maintenance Dredging during operation phase	10% of capital dredging
17	Water Requirement- Construction phase- each terminal* (Total)	• Phase I (Immediate Phase)- 5,000 liter • Phase II- 0.71 mn liter
18	Water Requirement- Operation phase- each terminal (Annual)	• Phase I (Immediate Phase)- 0.45 mn liter • Phase II- 0.58 mn liter • Phase III- 1.16 mn liter
19	Power Requirement	11 kVA
20	STP Capacity-Operation Phase	2 KLD
21	Dust Suppression Methods	NA

(*In Phase III, there would not be any water requirement for construction phase, as there would not be any construction in this phase.)

CHAPTER -8
PRELIMINARY ENGINEERING DESIGNS

8.1 General

8.1.1 The main objective of preliminary engineering is to ascertain quantitatively the feasibility of engineering works. Preliminary engineering is carried out to arrive at the preliminary sizing of all major facilities required at the terminal. The preliminary sizing, design and engineering and alternate options of the following facilities will be discussed:

- Navigational Channel
- Dredging
- Barrages
- Navigational Locks
- Berthing Structures

8.2 Navigational Channel

8.2.1 A channel may be navigable by vessels of certain dimensions i.e. length, beam (width), draft, air-draft etc. and not by larger vessels. Therefore, in ascertaining navigability of any channel, the first thing that needs to be determined is the size of the `design' vessel or the largest vessel to ply on the channel.

8.2.2 There are other sets of considerations which have a strong influence on dimensions of design vessels and thus on the entire issue of navigation. These considerations are related to the type and volume of traffic to be carried along the channel. Determination of typical parcel or shipment sizes will enable estimation of the typical pay-load (deadweight) which in turn will facilitate the design of a suitable vessel or vessels and the volume of traffic (number of voyages etc.).

8.2.3 Therefore, the approach taken is first to consider the size of the vessels that could ply in the channel with the navigational facilities. Simultaneously, the traffic survey and projections made in the previous chapter would be utilized to examine adequacy of the size and number of vessels arrived.

8.2.4 In the present context the design vessel may be taken as the largest - in terms of pay load - vessel that can safely ply in the river in the required numbers. Since design condition of maintaining least available depth (LAD) of 0.6m, 1m and 1.2m –round the year in the River Tizu of NW-101 for development of Inland Water Transport the design vessel and consequent effects on the adequacy of size and number of vessels are dealt.

8.2.5 The largest sized vessel that can ply on the river would depend on whether 1-way or 2-way navigation is to be catered to, the river width, depth and lock dimensions. There are several guidelines which have been evolved by various countries and authorities about the relationship between the dimensions of any restricted waterway and the vessels that may ply in it. However, the recommendations may vary widely from country to country or waterway to waterway. Normally, for inland and well sheltered (restricted) waterways, a vessel between 1/5 to 1/8ththe (bottom) width of the channel is considered to be safe for permitting 2 way navigation. A waterway, which is only 5 times the width of the largest vessel, is considered particularly narrow. This is based on provisions for `lanes' for bank clearance, for each vessel maneuvering and clearance between two vessels. It will be seen that channel which is just 5B wide provides only 1B for each of the lanes - an obvious bare minimum. Anything less would carry a high degree of risk of collision between approaching vessels and a tendency to go aground on/near the bank particularly if prevalent wind and current are across the river and strong. However, keeping in view the possible increase in cost of widening the channel, the hard nature of the river bed and banks, the relatively low speeds at which vessels could or would ply in the channel, the ratio of 1:5 between beam of design vessel and bottom width of channel is provisionally used for calculations. On this basis vessels with beam of 3 m would be the largest that could be accommodated in 15 m wide river channel with – two way navigation

8.2.6 Vessels with a draft (when underway) which is somewhat less than the depth of waterway can navigate through it. Obviously, therefore, vessels having a draft of less than 06.m,1 or 1.2 m could navigate. The question of how much less than the water depth the max. vessel draft (loaded) should be, depends on various considerations. The difference between water depth and the max. Permissible draft in any channel is termed the Under Keel Clearance (UKC). UKC depends mainly on waterway conditions i.e. turbulence of the water course and other environmental forces. In open water, vessels are inclined to pitch, roll and heave to a greater or lesser degree depending on the degree of disturbance and vessel size. A further factor to be considered is `Squat' which is the extra settlement of a vessel's stern when moving at operating speed, thereby increasing its maximum draft (which is generally of the stern end in any case).

As per IS 4651(PART V) SECTION 4.6.1 Minimum keel clearance required should not be less than 10% in the channel ,15% in turning circle and 20% at entrance to the channel

8.2.7 There is yet another important parameter, which will have a telling effect on permissible vessel dimensions. When a vessel is navigating in a very narrow and shallow channel its maneuverability as well as speed suffer due to a kind of drag that is imposed on the moving hull by the relative lack of water around it. This is especially true in artificially dug canals. The guidelines developed for this aspect is that the `n' factor should be as large as possible, preferably around 10 or above.

The `n' factor is defined by = Cross sectional wetted area of the channel

----

Largest cross section of the vessel

An `n' factor of 5.5 to 6 is about the lowest tolerable by most standards/guidelines.

8.2.8 Dimensions of waterway principally include the width and depth. Dimensioning or designing of waterway is of critical importance for safety and efficiency of barge operations in the waterway. The design parameters are depth, breadth and alignment. Cross sections of waterway may be expected to satisfy following requirements

- The waterway must be deep enough to prevent vessels from running a ground or being difficult to steer
- The waterway must be sufficiently wide to enable the standard traffic flow to pass safely and speedily
- Vessels must be able to reach a reasonable speed to keep down the cost of transport
- The cross current must not be too large and therefore uneconomical

In the present context, the vessels and their dimensions as given in Table 4.1, Table 4.2 and Table 4.3 taken for functional planning/designing of waterway. The waterway is planned to follow an alignment along the deepest portion waterway, as it is ideal for the particular waterway. The alignment is based on the hydrographic survey analysis

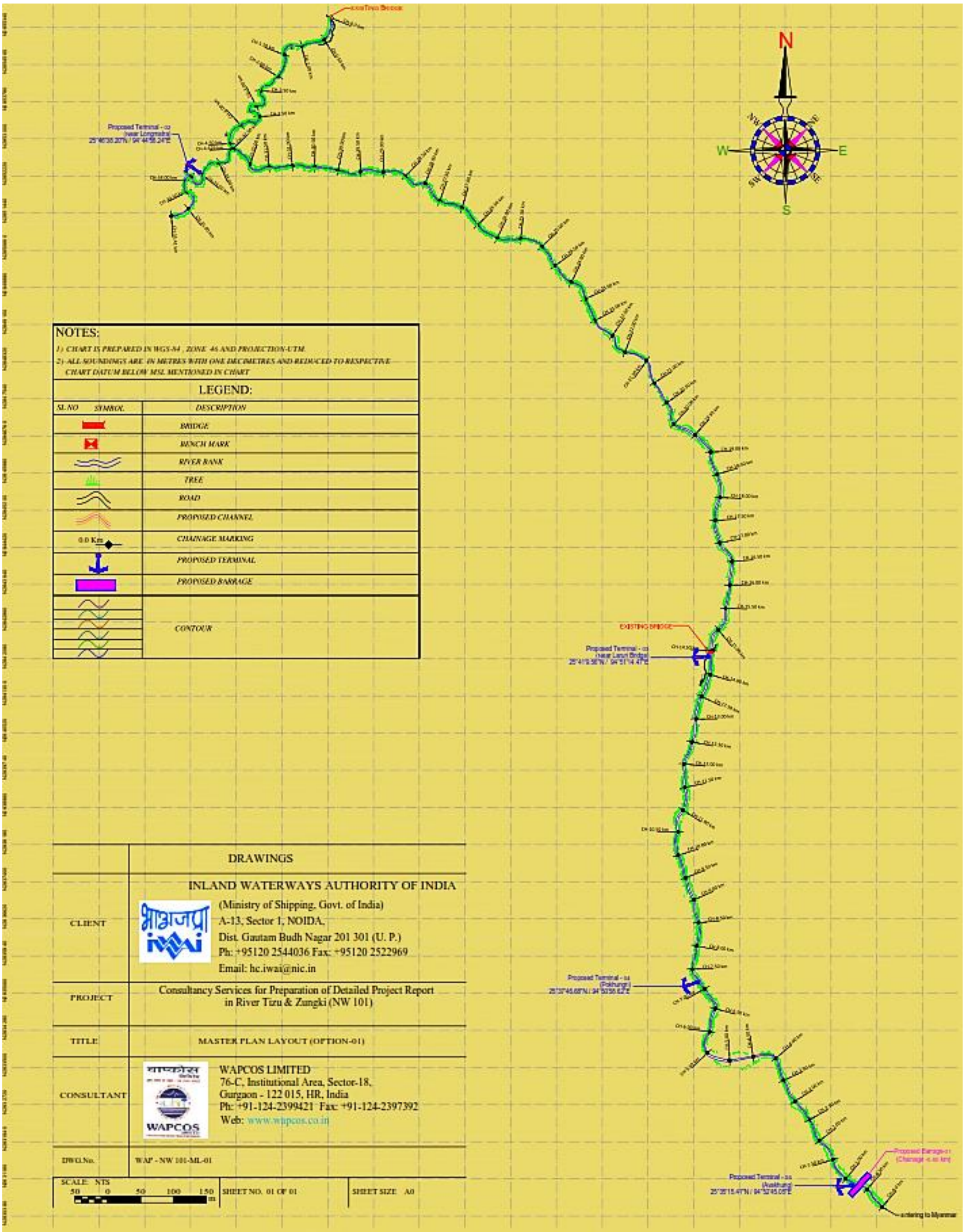


Fig. 8.1 Waterway Channel Alignment Master Plan

The waterway width for range of vessels would be as follows:

Table 8.1 Waterway Width

Category	DWT (t)	Length (L) (m)	Beam (B) (m)	Draft (D) (m)	Waterway Width (W) (m)
Immediate Phase	-	5	1.9	0.6	15
Phase-1	-	7	2.5	1.0	15
Phase-2	100	32	5	1.0	30

A vessel occupies a greater width on bend than on straight waterway consequently on bends a width allowance as square of length of vessel divided by bend radius has to be added.

The difference between water depth and the maximum permissible drafting any channel is termed the Under Keel Clearance (UKC). In the instant case vessel draft with 10% UKC for range of vessels would be as follows

Table 8.2 Waterway Depth

Category	DWT (t)	Length (L) (m)	Beam (B) (m)	Draft (D) (m)	UKC-(10% of Draft) or 10cm which ever is more(m)	Provided Waterway Depth (d) (m)
Immediate Phase	-	5	1.9	0.3	0.1	0.6
Phase-1	-	7	2.5	0.6	0.1	1.0
Phase-2	100	32	5	1.0	0.1	1.2

The cross sectional area ratio for range of vessels would be as follows

Table 8.3 Sectional Area Ratio of waterway

Category	DWT (t)	Length (L) (m)	Beam (B)	Draft (D) (m)	Cross section waterway	Cross section vessel	n

			(m)		(m^2)	(m^2)	
Immediate Phase	-	5	1.9	0.6	9.9	1.14	8.68
Phase-1	-	7	2.5	1.0	17.5	2.5	7.0
Phase-2	100	32	5	1.0	39.6	5.0	7.92

It is important to note a limitation on vessel length that the vessel's length on waterline (LWL) should be somewhat less than the width of the channel. If the length is kept the same or more than width of channel it would become virtually impossible for a vessel to be turned around even in an emergency. This, in a long/narrow waterway would be an unacceptable condition for obvious reason, unless special turning areas are dredged at relatively short intervals.

The cross sectional area ratio for adopted waterway are 8.68, 7.0 and 7.92 for Immediate Phase, Phase-1 and Phase-2 respectively are above the lowest tolerable by most standards/guidelines.

The size and/or diameter of the turning basin would depend on the geometry of water area available and berth arrangement. The diameter of the turning circle where vessels turn by free interplay of the propeller and rudder assisted by tugs should be 1.7 times the length of the design vessel.

Diameter of Turning Circle for

Immediate Phase = 1.7*5=8.5 provided 10.0

Phase-1 = 1.7*7=11.9 provided 14m

Phase-2 = 1.7* 32 = 54.4 provided 60m

Hence, turning circle with a margin of safety has been proposed at terminal sites.

Depth of Navigation Channel

With the above discussions, it is planned to maintain depth of 0.6m for immediate Phase, 1.0 m for phase-1 and 1.2 m for phase-2.

Width of Navigation Channel

It is planned to provide two-way vessel movements in the navigation channel and maintaining the width of channel 15m for immediate Phase, 15 m for phase-1 and 30 m for phase-2

8.3 Dredging

8.3.1 Generally dredging works in river areas are carried out to create depth in case of new developments and to maintain the dredged depths in the already existing developments for the safe movement of barges / vessels. Dredging will have to be carried out in the waterway (river), manoeuvring area and berth pocket to maintain the requisite depth. Dredging is classified as:

- Capital dredging
- Maintenance dredging

When dredging of waterway (river) is done for the first time, it is termed as capital dredging. When the dredging process is carried out for removing siltation in the existing waterways, it is termed as maintenance dredging. Hence it can be said that capital dredging is one time dredging whereas maintenance dredging is of recurring nature. However, in rivers the maintenance dredging quantities are very high to the order of 50% or even above. In present case maintenance dredging quantities are assumed as 10%.

8.3.2 Dredging Process

Dredging is usually carried out in the following four stages:

- Excavation, comprising of loosening, fragmentation or cutting of the soil/ rock.
- Raising the excavated materials to the surface by hydraulic or mechanical methods.
- Transport of the excavated materials to a reclamation or disposal area.
- Disposal or reuse of the dredged material.

Each stage of the process is significantly affected by the nature of the materials being dredged. Hence before designing a dredging project the soil characteristics are to be investigated. the dredging plan and equipment selection for dredging has been provided in chapter-6 fairway development refer clause 6.4.

8.3.3 Soil Investigations

The type and behaviour of the materials during dredging is of high importance in the selection of equipment, understanding the environmental effects and the characteristics of material. Hence it has become an accepted practice to carry out adequate soil investigations to obtain data for permanent works design, such as slope stability, suitability of materials for reuse etc.

8.4 Preliminary Engineering of Barrages

8.4.1 Design of conventional Barrage at proposed chainages 0.5 km, 7km and 14km with navigational lock of size 40x10m at each barrages

Design Discharge at site	=	2420 cumecs
Bed Level	=	422.60 m
Proposed	=	429.6 m
Pond Level	=	428.6 to pass vessel

Crest level of under sluices has been kept at bed at EL 422.60m & of weir bays's have been kept at 1m above crest of under sluices i.e. 422.60 m+ 1 m=423.60m being rocky stretch.

Lacey's waterway	=	$4.83 \sqrt{Q}$
	=	$4.83 \sqrt{2420}$
	=	237.6 m

But, we kept 88m due to restriction of rivers width along with one lock of 10 m width.
Provided 1 bays of 20 m each of under sluices + 2 bays of weir bays 24 m each + one lock 10 m.

Total waterway = 20 + 3 (Divide Wall) + 2x24 + 2 m(Pier Thickness) + 15 = 88 m due to restriction

Discharge Calculation

Q_1- from undersluice

Where H = 429.6-422.60
= 7 m + vel. Head
= 7 m + 0.36 = 7.36 m

$Q_1 = 1.7 (L - nH) H^{3/2}$
$= 1.7 (20 - 2 \times 7.36) 7.36^{3/2}$
$= 629 \text{ m}^3/\text{sec}$

Q_2-from weir bays

Where H = 429.6-423.6
= 6.0m + 0.36= 6.36m

$Q_2 = 1.84 (L - nH)H^{3/2}$
$= 1.84 (48 - 4 \times 6.86) 6.86^{3/2}$

=	1496 m^3/sec

Q3-Discharge through lock

= 1.70 L $H^{3/2}$ (Crest of lock is at bed)
= 1.7 x 10 x $7.36^{3/2}$
= 679 m^3/sec

Total discharge passing through Barrage
= Q1+Q2+Q3
= 629 + 1496+ 679 cumecs
= 2804 cumecs against 2420 cumecs
Hence Ok

Salient Features of Barrage

1. Design Discharge at site	=	2420 cumecs
2. Bed Level	=	422.60 m
3. HFL at site	=	429.6
4. Pond Level	=	428.6 m maintain
5. Bays		
Under sluices bays	=	1 No. of 20 m each
Weir bays	=	2 Nos. of 24 m each
6. Navigational Lock	=	10 m wide x 40m long(for class-I)
7. Pier Thickness	=	2 m thick
8. Divide wall	=	3 m thick

Rocky bed strata is at site hence monolithic foundation shall be provided in a floor thickness of 1 m.

8.5 Rubber Barrage (Air filled) Design for proposed location

Rubber Barrage can be considered for the proposed **chainages 0.5 km, 7km and 14km** location the detailed proposal is enclosed at **Annexure 3**.the typical section and plan is shown below

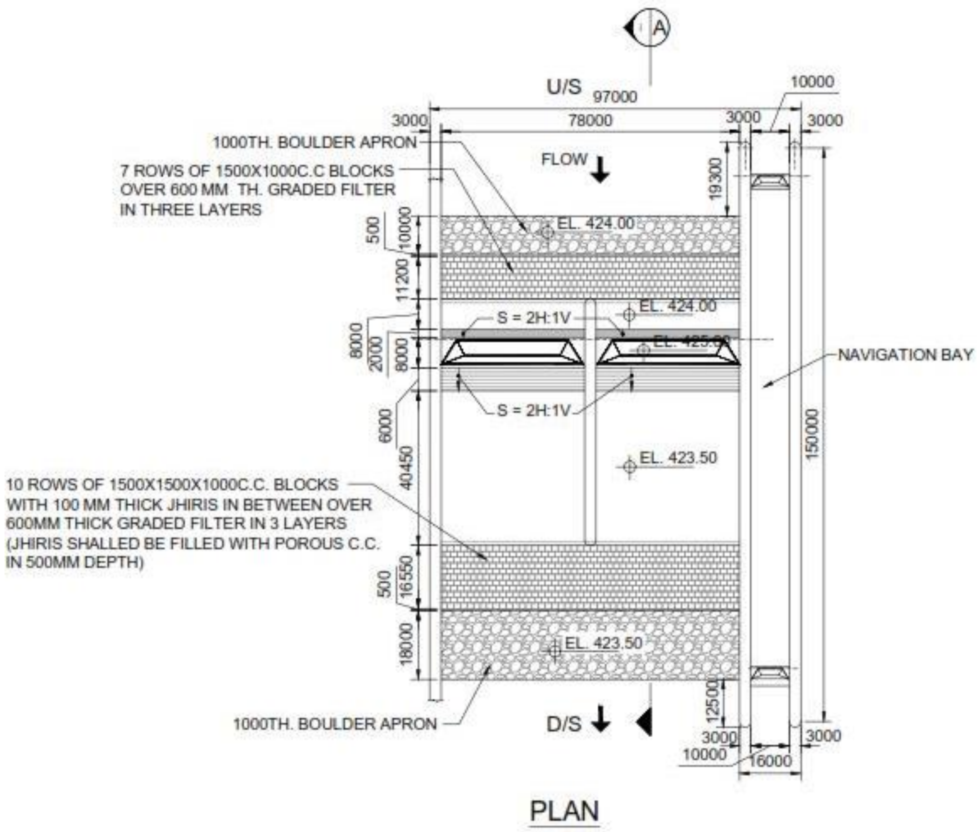


Fig. 8.2 Plan section of typical rubber dam in tizu river with lock

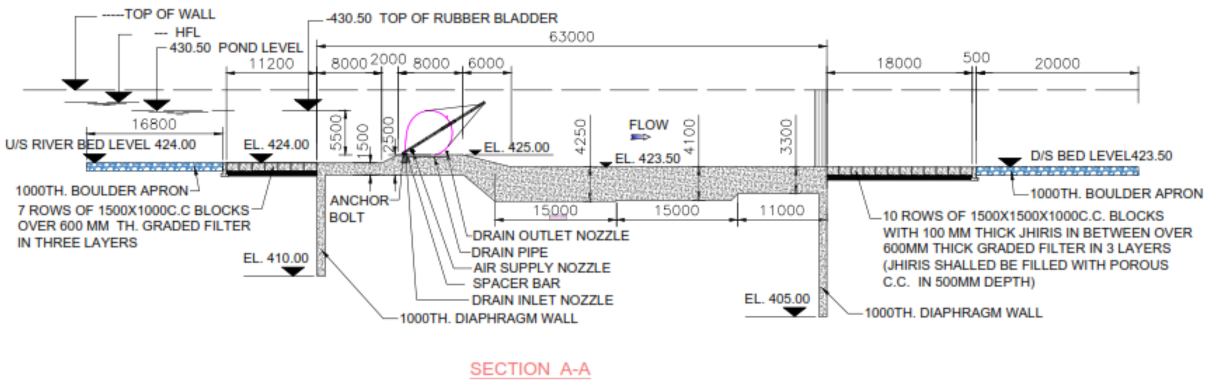


Fig. 8.3 Section-A-A of typical rubber dam in Tizu river

We recommend the air filled rubber barrages for construction as it is faster in execution and consumes less cost in operation and maintenance compared to conventional barrages due absence of steel gates and motors. It can be completely automated and can be used with less manpower.

8.6 Navigation Lock

The functional requirements of a lock are mainly intended for navigation. The most important general functional requirement is that vessels have to be able to pass as rapidly and safely as is deemed socially (macro-economically) acceptable. Speed expressed as passing time is used to indicate the extra time required by a vessel participating as part of a fleet (with a particular number and composition) to progress from one side of the lock to the other, compared to the situation if the lock would not have been there. In this sense, the word lock is understood to mean a coherent whole of the lock approaches, lock heads and chamber(s) as well as the lay out and facilities provided in this. The passing time is determined by the time necessary for waiting, sailing in and out, mooring and unmooring and the operational time (closing and opening the gates and leveling out the chamber). This time largely depends on the amount of traffic (being the lock load or the relation between the intensity and capacity of the lock).Safe passage through the lock complex is determined by the degree of certainty in which navigation traffic can be dealt with (smoothly), without danger and/or damage to people, material and the environment and still guarantee quality of life in the direct vicinity. The main parts of locks are mentioned below:

- The lock chamber;
- Lock approach structures;
- Filling/emptying systems;
- Lock gates;
- Mechanical and electrical equipment;
- Control systems,
- Instrumentation (including water level and flow monitoring equipment),
- Power supplies;
- Communications systems;
- Mooring equipment;
- Lighting and signaling equipment;
- Safety equipment;
- Stocks of spares;
- Maintenance equipment;

Lock Chamber

The necessary chamber dimensions mainly depend on:

- The dimensions of the largest vessel;
- The volume and pattern of navigation;
- Optimal chamber filling with several vessels;
- The inland or recreational navigation purpose.

Methods for determining chamber dimensions of a capacity lock

It starts with an assumption of preliminary chamber dimensions and number of chambers. For the provisionally chosen lock complex and a normative volume of navigation, one of the models used to determine the value of characteristic parameters to test the design at hand on:

- the average passing through time (particularly important to the captain because of costing,
- the permitted intensity;
- the necessary waiting space (-length),
- the locking time cost for navigation, per week (possibly converted to cost per annum).

Lock approach structures

The lock approach is the navigation area between the connecting waterway and the lock complex, where approaching vessels have the opportunity to decrease speed and moor to a guiding structure if necessary (mooring is usually not an option for large vessels; they keep their position, whether or not with tugboats). With this, sufficient view and overview should be ensured both by day and by night. The lock approach should therefore be free of obstacles and not be situated in a bend. In addition, transverse and longitudinal currents in the lock approach should be avoided as much as possible, in view of the reduced manoeuvrability of the vessel when reducing speed and stopping. The lock approach is functionally divided into:

The line-up area

This area has to be equipped with proper mooring facilities and be situated as such that moored vessels are not an obstruction to departing vessels. This area is intended for vessels that will be locking through in the next locking process. From the mooring area, vessels should be able to enter the chamber quickly via the leading jetties. A mooring area is required per chamber and per side. The size of the mooring area corresponds with a completely filled chamber. A general guideline is a length of 1.2 or 1.3 times the chamber length.

The waiting area

This area is also equipped with mooring facilities. This area is only created at locks where the expected navigation intensity will be such that, on busy days, the mooring area will be too small for all the waiting vessels. This area is intended for vessels that will not be able to lock through at the next locking process after arrival. For a lock with one chamber, one waiting area per side is necessary or a communal area for a lock complex with several chambers.

Free area

Meant to provide vessels with the opportunity to decrease speed and start manoeuvres to moor in the line-up or waiting area. Furthermore, the free area provides the opportunity to, where necessary; adjust the profile of the waterway to the profile of the lock approach. For stopping and mooring, the following length should be available; an indication of inland navigation is approximately 2.5 times the normative vessel length.

Chamber and heads

The number of important parts of the primary function of the locking process takes place in the chamber and the heads, namely

- The sailing in and tying up of one or several vessels,
- The untying and sailing out of one or several vessels,
- The closing and opening of gates and
- The levelling of the water level in the chamber.

Cables and mains

In general, we strive for an integration of crossing cables and mains (the small infrastructure) in the lock and/or lock approaches, as long as this does not result in unnecessary risks for the locking process. During construction, existing cables and mains will have to be moved temporarily if necessary or other facilities could be necessary in order to disrupt the performance as little as possible. This is executed under instructions of the authorities in charge of small infrastructure. Often, these authorities will function as customers in relation to the moving or execute the moving under own management. To reduce costs, every effort will be made to consider the definite situation when planning the temporary diversions. In the definite situation, the crossing itself will generally be under the bottom of the lock or the lock approaches. Certain cables and mains of third parties could be housed in cable manholes and tunnels for lock operation, which can be made larger to allow for this. Between the cable manholes, extra lead through pipes can be added to the lock floor for these cables and mains. This is only possible if your operation is not exposed to additional risks or hindrance. Cables and mains that cross a lock and/or lock approaches and the facilities those have to be made or provided for this have to meet the following requirements:

- The cables should not yield unacceptable risk for the lock, lock operation and navigation.
- That which is unacceptable should be substantiated with a risk analysis.
- Gas mains are not included in a lock.
- Navigation must be unable to damage the cables and mains.

- Where visual inspection is impossible (and this will generally be the case) the condition of the cables and mains will have to be established in a different way, certainly in those cases where failure will have serious consequences.
- Cables and mains, with serious failure consequences, must immediately be disconnected or be free of electrical charge when necessary.
- Replacement, expansion or maintenance should take place without prolonged hinder to navigation.

Furthermore, attention has to be paid to possible transmission lines that cross the lock or the lock approaches.

Illumination, signalling and boarding

- Unsafe situations due to dazzling should be avoided. The correct combination of armature, lamp and positioning is of importance.
- The colour of the light is one of the factors in the recognition of boards and signalling. Both white and yellow light can be used. In the lamp choice of illumination, both high-pressure and low-pressure lamps as well as energy saving lamps qualify. In the application of low-pressure (monochromatic) sodium (vapour) light, colour recognition is impossible. If this is the case, separate illumination of traffic signs is recommended.

Safety facilities

Design and management of safety facilities of personnel will be executed in accordance with Health and Safety Regulations, construction regulations, labour regulations and safety regulations. A number of facilities are mentioned below.

Railings are attached to the top of gates. If the lock coping is more than 2.5 m above minimum locking level, fencing is placed behind the bollards. This fencing is always desirable where it concerns recreational navigation and where tourists are allowed on the lock coping.

Steel ladders should not be in regular use. Straight stairs, a spiral staircase or step ladders should be installed.

Basement chambers that could possibly flood (for instance those of operating mechanisms of mitre gates) have to be provided with an exit that can be opened from the inside. In addition, sufficient natural ventilation will be required as well as plunger pumps.

Usable length of Chamber = 1.1*L (Where L is the length of reference vessel)

= 1.1*32m

= 35.2m

Provide 40m

Width of Chamber = 1.1*B (Where B is the beam of reference vessel)

= 1.1*5m

= 5.5m

Plus 0.2 m wide fender on either side of the ship while it is moored up

= 16.5+.4

= 5.9m

Provide 10m

Sill depth in the Chamber = Maximum draught of reference vessel + keel clearance; an extra increment may need to be introduced for translation waves

= 1.0+.1+.1

=1.2m

Provide 1.5m

Discharging capacity of lock chamber = $1.7*10*7.6^{3/2}$

= 340 cumec

Volume of Chamber = 40*10*1.5

= $600m^3$

Time to fill the lock chamber = 600/340

= 1.76 sec say 2 sec.

This is too fast; therefore partial gate opening may be done to fill the chamber up to desired level.

Navigational lock of 40m X 10m has been proposed at every barrage.

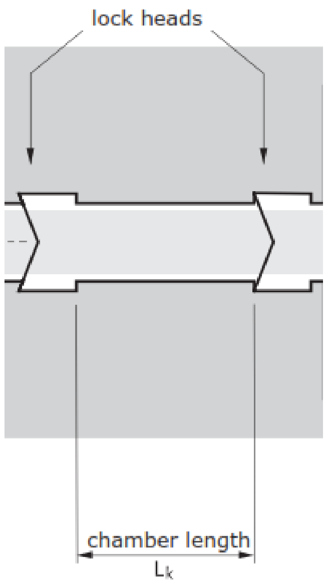


Fig. 8.4 Schematic representation of a navigational lock

8.7 Design of Berthing Structures

Berthing structures are to be designed such that they provide safe berthing of barges / vessels without damaging the barges / vessels as well as the structure. These structures should also cater to the requirements of the various equipment's to be used for loading/ unloading of vessels. The requirements of the berth differ depending on the nature of cargo being handled at the berth. The size of the structure depends on the largest vessel likely to use the berth and the type of handling equipment to be used on the deck. The berth should be designed for all possible loads that are likely to act on the structure. The total number of berths required for the proposed terminal and their arrangement was fixed based on the nature of cargo, traffic, alignment of contours and predominant wind, water levels. The berth is planned for handling 1 Nos. passenger vessel at a time.

Total 4 nos. of terminal have been identified.

Table 8.4 Design of Terminals

Sr. No.	Tentative Location	Districts	Size of WHARF(M)	Type	HFL (m)*	Chainage (km)	Lat-Long
1	Near Longmatra	Phek	25x6	Concrete	458.74	33.3	25°46'38.46"N, 94°44'54.81"E
2	Near Laruri Bridge	Phek	25x6	Concrete	439.12	14.0	25°41'6.52"N, 94°51'12.80"E
3	Near Phonkhuri	Phek	25x6	Concrete	432.83	7.5	25°37'48.72"N, 94°50'58.02"E
4	Near Avankhung	Phek	25x6	Concrete	426.65	1.2	25°35'29.62"N, 94°52'35.57"E

*HFL has been considered from the derived values of the IWAI hydrographic survey report.

Detailed drawings is shown in **Dwg No.: WAP-NW101-TL-01- WAP-NW101-TL-04**

8.7.1 Deck Level

The first step towards the development of a berthing structure is to arrive at the deck level. The deck level is decided based on the following aspects:

- Considering the optimum position of the cargo transfer equipment to cater for two extreme conditions, viz., the largest vessel in light displacement condition at highest water and the smallest vessel fully laden at lowest water

- On consideration to prevent over topping of the deck during extreme conditions based on codes like IS 4651 (or) other guidelines.

- By comparing with the deck level at the nearby jetty terminals

<u>As per IS 4651 (Part V)-1980</u>

The top of deck level arrived as per Clause 3.6.7 of IS 4651 (Part V)-1980 is as below:

Deck level is calculated by considering following parameters:
Danger flood water level(HFL) = EL 426.65 m MSL (For Terminal near Avankhung)
Free board = 1.20 m

The deck level for the wharf is worked out to be + EL 427.85 m MSL.
Similarly deck level for other terminal sites is given below

Near Longmatra = EL 459.95 m MSL the *HFL at longmatra is 458.74 m*
Near Laruri Bridge = EL 440.35 m MSL *HFL at Laruri bridge is* 439.12 m
Near Phonkhuri = EL 434.05 m MSL *HFL at* Phonkhuri is 432.83 m

Deck of berthing structures is provided in two parts with level difference of 4m. Lower berth level is kept 4m below upper berth level.

Lower berth deck level of terminals is given below:

Near Longmatra = EL 455.95 m MSL
Near Laruri Bridge = EL 436.35 m MSL
Near Phonkhuri = EL 430.05 m MSL
Near Avankhung = EL 423.85 m MSL

8.7.2 Deck Dimension

The dimensions of the Wharf are decided on the basis of the dimension of the largest vessel that is likely to use the terminal facilities in the final phase. The design of berth requires special considerations, as they are governed by the type of unloading facilities provided. The dimensions chosen for the berth should allow for safe and efficient flow of materials between vessels/ barges and river banks.

Length of Berth

The length of the berthing structure is to be decided based on overall length of barge /vessel to cater the requirement of cargo loading and unloading or passenger vessel. The required berth length is given in following Table No. 9.5.

Table 8.5 Berth Length

Nos. of Berths	Design Vessel (DWT)	LoA of Design Vessel (m)	Length of Berth (m)			
1	-	7	Lower level(m)	High Level(m)	Stairs(m)	Total Length(m)
			10m	10m	5m	25m

Width of Deck Structure

The width of the berths depends on the type of commodity and the relevant type of handling system as well as the location of the berths within the harbour. The width required at berths is 6.0 m.

8.7.3 Structural System

The width of the wharf/quay is 6.0 m and the length calculated is 25m. The deck system has to be designed suitably. The concrete structural system comprises of wharf which is recommended and the General Arrangement drawing of the berth structure and terminal is shown in Fig.8.5 and Fig.8.6 below and attached as dwg. The layout is suggested for phase-I is with basic facility mentioned in infrastructure chapter-7 and typical layout with required facility is planned for phase-II.

Sr	Components	Dimensions
01	Earmarked for Passenger Wharf	20 x 6 (m x m)
02	Rest Rooms	04 x 03 (m x m)
03	Seating Area	04 x 03 (m x m)

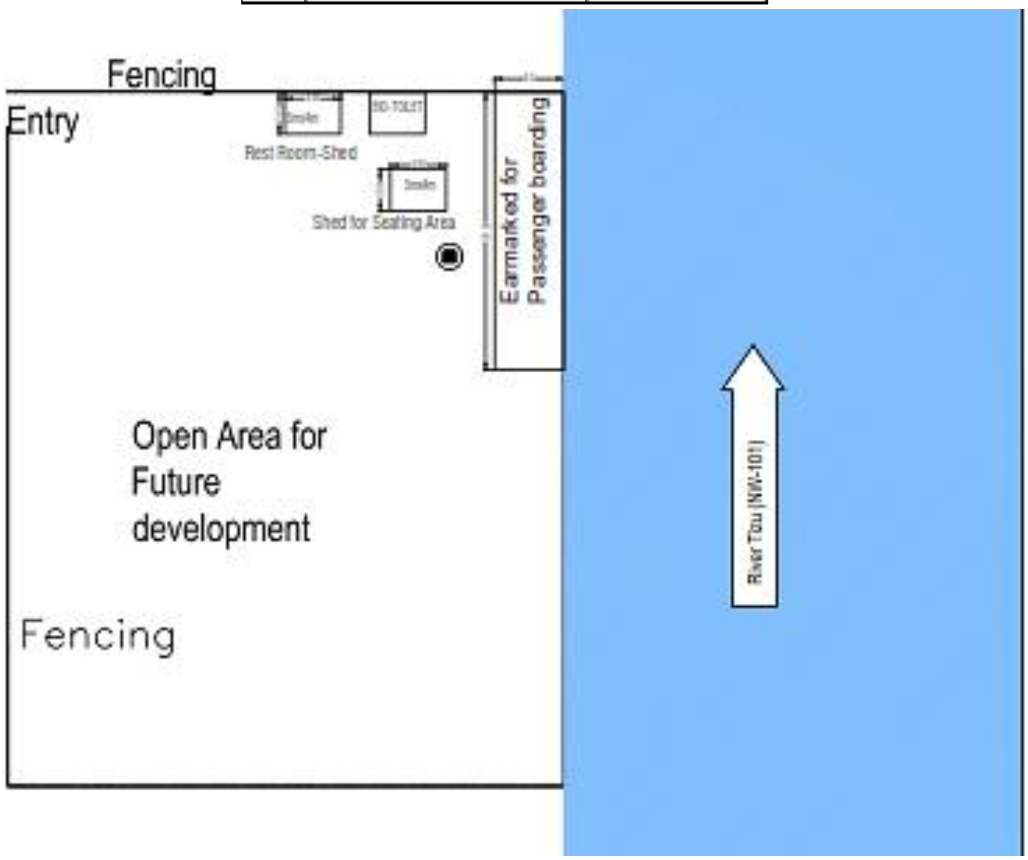


Fig. 8.5 typical layout of terminal in Phase-I (immediate)

Infrastructure

Sr.	*Components*	*Dimentions*
01	*Wharf*	6.00 x 25.00 (m x m)
02	*Store/Fire fighting*	4.95 x 3.07 (m x m)
03	*Ticket Counter*	4.57 x 4.65 (m x m)
04	*Admin Office*	4.95 x 3.85 (m x m)
05	*Canteen*	4.76 x 5.22 (m x m)
06	*Guard Office(Caretaker)*	4.57 x 4.34 (m x m)
07	*Cargo Shed*	5.0 x 3.0 (m x m)
08	*Waiting Area*	12.88 x 4.27 (m x m)
09	*Sewage Treatment Plant*	2.00 x 3.00 (m x m)
10	*Toilet*	1.22 x 2.13 (m x m)
11	*Total Road Area*	159.59 SqMt
12	*Equipment Shed*	3.00 x 4.00 (m x m)
13	*Vacant Land (Total Area)*	1731.93 SqMt

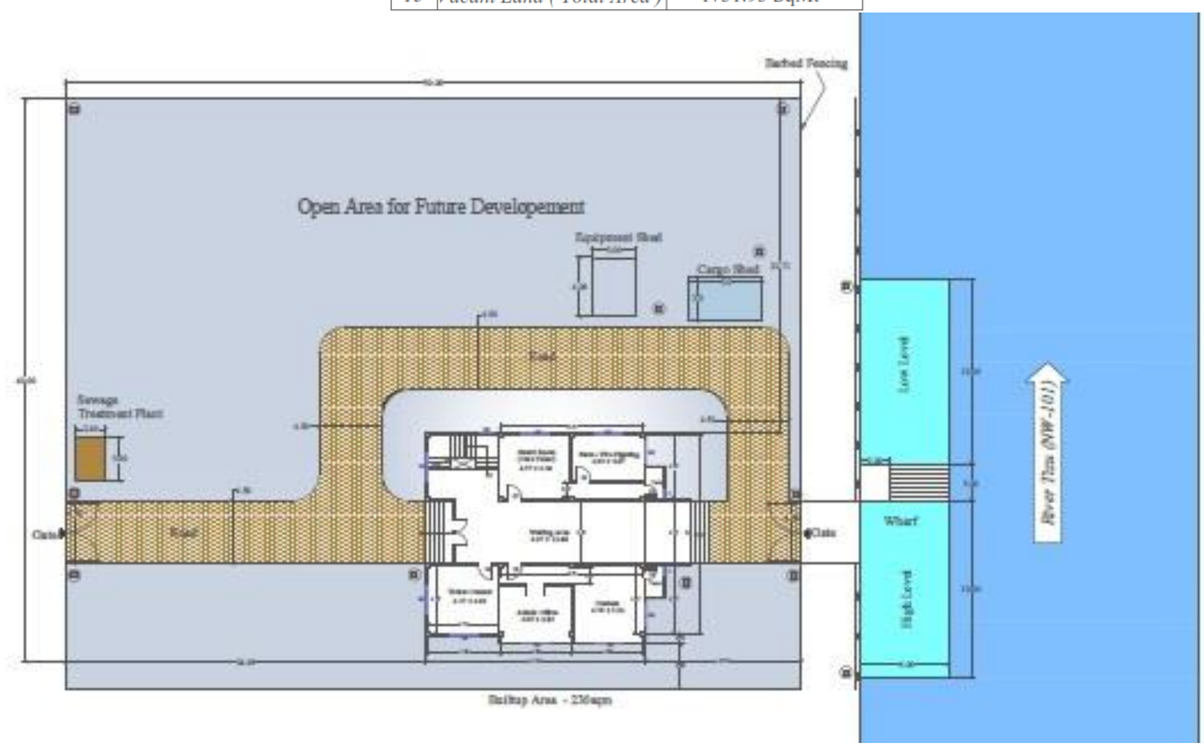


Fig 8.6 typical layout of terminal in Phase-II

8.7.4 Design of Wharf

All works shall satisfy the requirement of the latest relevant codes and standards. Generally Indian Standards shall be followed. Wherever, the details for part of works are not defined adequately in Indian standards, the relevant acceptable International Standards shall be adopted. The List of codes and standards covering the major part of the works to be followed is listed below:

Table 8.6 List of Codes and Standards

IS: 456	Code of practice for Plain and Reinforced Concrete
IS: 875	Code of practice for Design Loads for Buildings & Structures
IS: 1893	Criteria for Earthquake Resistant Design of Structures
IS: 4326	Earthquake resistant design and construction of Buildings – Code of practice
IS: 4651	Code of practice for Planning and Design of Ports and Harbours
IS: 9527	Code of practice for Design and Construction of Port and Harbour Structures
BS 6349-part 2	Code of practice for Marine structure quay, Wharves, jetties & Dolphins
IS: 800	Code of practice for General Construction in Steel
IS: 1786	Specification for High Strength Deformed Steel bars and wires for Concrete Reinforcement
IS: 13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice
IS: 2911	Code of practice for Design and Construction of Pile Foundations
IS: 1904	Code of practice for Design and Construction of Foundations in Soils : General Requirements
SP: 7	National Building Code of India
SP: 16	Design aids for Reinforced Concrete to IS: 456
SP: 34	Hand book on Concrete Reinforcement and Detailing
IRC : 21	Standard Specifications and Code of Practice for Road Bridges Section III
IRC : 6	Standard Specifications and Code of Practice for Road Bridges Section II

Salient Features of Wharf:

Wharf to be supplied shall meet the following broad technical specifications:

Table 8.7 Salient Features of wharf

Sr. No.	Particulars	Details
A.	WHARF	
1.	Total Size	25m. x 6m
2.	Max. loaded Draft	1.0m.

Sr. No.	Particulars	Details
3.	Minimum Free Board	1.2 m. for loading of 2 KM/m^2 on total deck area of 120 sq. m.
4.	Load Capacity	Deck designed for UDL of 5 KN/m^2
5.	Material for construction of module / block	Concrete/Stones with the density of 25kn/m3
8.	Deck/Top Cover	Concrete
9.	Minimum Reserve Buoyancy	25% under design loading conditions
10.	Working Life	50 years or more
11.	Handrails	Fabricated out of Stainless Steel, 750 mm high. Reflective stickers to be provided on all the four sides.

The layout and plan of wharf is shown in figure 8.7 below

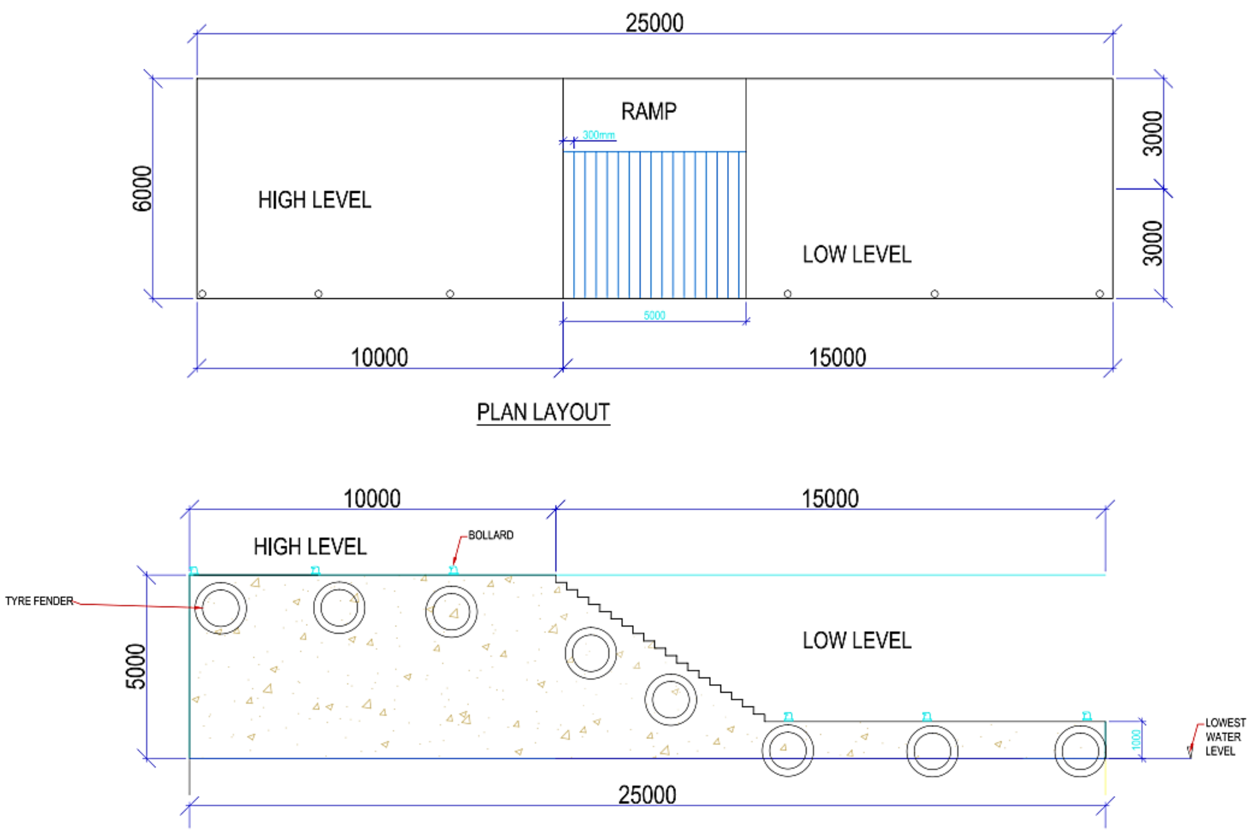


Fig. 8.7 typical design of wharf for phase-II

Mooring arrangements

Eight bollards, on the berthing side for vessel will be fixed for the safe mooring of the vessels.

Fenders

Protective fenders shall be provided on berthing side to prevent damage at the interface area. Floating fenders can also be used.

CHAPTER – 9
IMPLEMENTATION SCHEDULE

9.1 General

Project Implementation schedule is an techno-economic process and must be planned judiciously in order to achieve over all economy and efficiency. It must be recognized that careful planning, and pre engineering would precede construction of a project, so that, the construction activity proceeds without any hindrance.

The detail plan for developing Tizu River into National Waterway 101 suggest a few engineering interventions. The civil works and other related activities are proposed to be implemented within a period of 3 months for immediate phase after getting Technical and Administrative Sanction from the Government or from the respective funding agency. The entire implementation plan has been proposed into three phases as given below. The project implementation is proposed to be undertaken by IWAI in an EPC mode.

9.2 Phasing

The development can be divided in to pre-construction and construction activities. Various activities identified under pre-construction are:

- **Pre-construction activities**
    - Clearance from various authorities
    - Preparation of detailed engineering drawings/ Layouts
    - Preparation of tender related documents
    - Tender process Clearances (including Environmental Clearance)
    - Land acquisition
    - Water supply
    - Power supply
- **Construction activities**
    - Dredging/Removal of boulders & stones from waterway
    - Construction of wharf
    - Approach Trestle, if required
    - Fencing/boundary of terminal area
    - Buildings proposed on terminals
    - Procurement and installation of Mechanical and electrical equipment
    - Procurement and installation of Navigational Aids

- Interventions along with Navigational Lock

- **Post Construction Activities**
  - Post Construction Surveys
  - Preparation of as built drawings
  - Commissioning of equipment's and control systems

- **Ancillary Activities**
  - Agreement with stakeholders
  - Recruitment and training of waterway operation manpower
  - Contracting of O&M Agencies

9.2.1 Looking at the site condition, wharf construction appears to be most appropriate and construction schedule for the same has been worked out**.**

It is presumed that specialized dredging contractors would be deployed for the dredging/removal and stacking of boulders in the fairway channel. It is assumed that extra boulders/stones would be dumped the banks of river. Some material will be utilized in reclamation and filling works of terminal areas.

It is assumed that the above-mentioned activities can be completed within three months after Government's approval. Various activities identified under construction are:

9.2.2 Dredging/removal of stone is the major activity in the development of the channel, which is critical. In this implementation schedule, it is assumed that the whole of the dredging/removal of stones is to be carried out in as a single contract.

Construction of terminal structures: Construction of terminals is an important stage in the development of waterway projects. In NW-101 Nagaland waterway development project, the terminals are developed in phased manner.

Procurement of vessels and navigation aids: The procurement of vessels and navigation aids can be so planned that the same and construction of terminals are completed simultaneously.

Commissioning: After completion of works of Immediate Phase, the waterway will be ready for commissioning by concerned authorities. The bar chart for implementation schedule is prepared and presented in Figure 9.2.

9.2.3 Phasing of the project has been considered on the basis of navigable depth, traffic potential and economic considerations. The project has been proposed to be developed in following two phases immediate phase-I and Phase-II, Phase-III is not recommended for development.

Phase-I Immediate: Development consists of development of basic facilities at the terminals with one rest room and waiting area. Inflatable boats has been suggested in this phase. Total time frame considered for this phase is 1 year.

Phase II : Phase II consists of development of terminals with dredging and removal of stones for 1m LAD and full fledged facility at the terminals with two level wharf. Total time frame considered for this phase is 1.5 years.

Phase III : Phase III is not recommended for development as it is only viable if the industries gets developed in the vicinity as suggested in traffic chapter-3 and it also consist of interventions like rubber barrages (air filled rubber barrages has been suggested as it is faster in execution and very low in maintenance cost. The operation can be fully automated) for movement of class-I vessel which requires huge investment.

9.3 Implementation Schedule

The Progress of construction of various Project components are depicted in a schedule phase wise is shown below in fig 9.1 to 9.2

Phase-I (immediate) Work Schedule- 1 year													
Sl. NO	**Item**	**1M**	**2M**	**3M**	**4M**	**5M**	**6M**	**7M**	**8M**	**9M**	**10M**	**11M**	**12M**
1	Land acquisition and possession												
	Part A - Civil Works												
2	Tendering and awarding of works												
3	Mobilization												
4	Construction of rest room, sitting arrangements												
5	Dredging/removal of stones												
6	Plumbing , Electrification												
7	Installation of channel markings												
8	Commissioning												
	Part B - Ferry Vessel												
9	Tendering and awarding of works												
10	Procurement, Transporttion, Placement and Trial run												

Fig. 9.1 Implementation Schedule for Phase-I Immediate

Phase II Work Schedule - 1.5 Years																			
Sl. NO	**Item**	**1M**	**2M**	**3M**	**4M**	**5M**	**6M**	**7M**	**8M**	**9M**	**10M**	**11M**	**12M**	**13M**	**14M**	**15M**	**16M**	**17M**	**18M**
	Part A - Civil Works																		
1	Tendering and awarding of works																		
2	Construction of rest room, sitting arrangements																		
3	Construction of Super Structure of building, wharf																		
4	Plumbing , Electrification																		
5	Landscaping																		
6	Dredging/removal of stones																		
7	Installation of channel markings																		
8	Commissioning																		

Fig. 9.2 Implementation Schedule for Phase-II

CHAPTER-10

ENVIRONMENT IMAPCT ASSESSMENT

10.1 GENERAL

As per The National Waterways Act, 2016, 111 waterways have been declared as National Waterways (NWs) including the five existing NWs. Out of the 111 NWs, NW-1, 2, & 3 are already operational. Cargo as well as passenger / cruise vessels are plying on these waterways. For the newly declared 106 NWs, techno-economic feasibility studies have been initiated. Prior to undertaking any developmental activities on NWs, a Techno-Economic Feasibility Study is conducted which inter-alia, includes, Environmental Impact Assessment (EIA), Environmental Management Plan (EMP) and Environmental & Social Impact Assessment (ESIA). Based on these study reports, necessary mitigation measures are taken up. As per this act, the stretch from Longmatra to Avankhu comprising of Tizu & Zungki rivers have been declared as NW – 101 by the GoI during April 2016.

Tizu river forms an important drainage system in the eastern part of Nagaland.It runs in northeast direction, while flowing through Zunheboto, Phek district empties itself in the Chindwin River of Myanmar. The Zunki river which is the biggest tributary of Tizu, starts from the Northeastern part of Changdong forest in the south of Teku and flows in southerly direction towards Noklak, Shamator and Kiphire and finally joins Tizu below Kiphire.

Inland Waterways Authority of India (IWAI) proposes to develop the stretch of Tizu and Zungki river from Longmara to Avankhu at National Waterway-101 to facilitate Inland Water Transport in the state of Nagaland.The location map is shown in Figure-10.1.

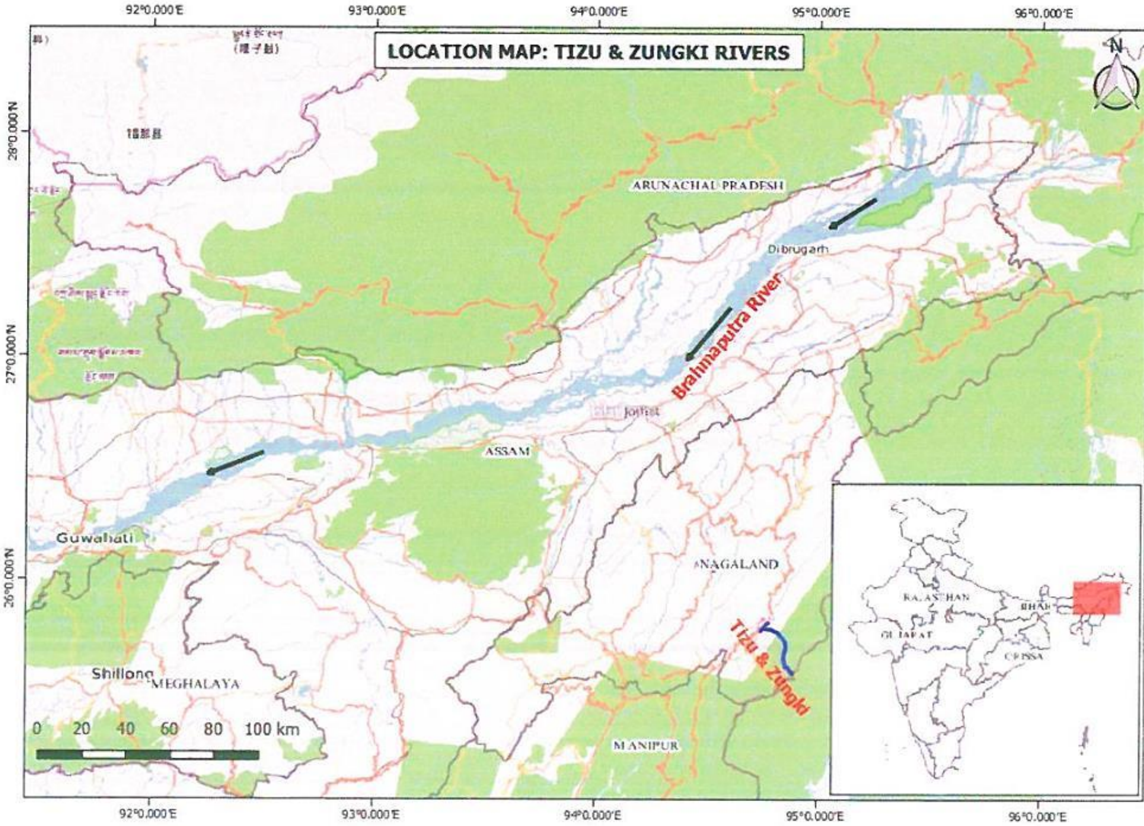


Fig. 10.1 Location of Tizu and Zungki River

10.1.1 RIVER COURSE : BACKGROUND INFORMATION

Nagaland is dissected by a number of seasonal and perennial rivers and rivulets. The major rivers of Nagaland are Doyang, Dikhu, Dhansiri, Tizu, Tsurong, Nanung, Tsurang or Disai, Tsumok, Menung, Dzu, Langlong, Zungki,Likimro, Lanye, Dzuza and Manglu. All these rivers are dendritic in nature. Of the rivers, Dhansiri, Doyang and Dikhu flow westward into the Brahmaputra River that falls into Bangladesh.

The Tizu River, on the other hand,flows towards eastern part of Nagaland and joins the Chindwin River in Burma. The stretch of Tizu and Zungki Rivers are selected for round the year navigation and development of water transport facilities. The length of this stretch of the river is 40.039 km and the maximum width in this stretch is approximately 100 m to 150 m. The waterway flow direction of the river is from Longmatra to Avakhung. The Figure-10.2 shown below depicts various rivers of Nagaland.

The Stretch of River under study falls at Lat 25°46’11.98”N, Lon 94°44’35.04”E to Avanghku at Myanmar border Lat 25°35’2.94”N, Lon 94°53’6.12”E and in Zungki river from bridge at Lat 25°48’26.10”N,Lon 94°46’35.96”E to confluence of Zungki and Tizu rivers at Lat 25°46’58.03”N,Lon 94°45’20.51”E.

Fig. 10.2 River Maps of Nagaland

10.1.2 ROLE OF INLAND WATERWAYS AUTHORITY OF INDIA (IWAI)

The Inland Waterways Authority of India (IWAI), Ministry of Shipping, Government of India is primarily responsible for undertaking projects for development and maintenance of IWT infrastructure on national waterways. Presently, there are 111 new NWs in the country. As part of this initiative, IWAI has selected the Tizu and Zungki rivers in Nagaland as NW – 101.

IWT has the potential to provide a cost efficient, economic, reliable, safe and environmental friendly form of transport. When developed for use by modern inland vessels operating on dependable rights of way, it can reduce congestion and investment needs in rail and road infrastructure, promote greater complementarities in the riparian states, enhance intra-regional trade and, through increased economies of scale, significantly reduce overall logistics costs for the benefit of the entire economy and India's global trade competitiveness.

Inland Waterways are economic multipliers, as they induce factors in development of an area, both through planned development policies and by the unplanned growth of related industries thus providing space for industrial clusters. They also nurture growth of other related industries like ship repairs and dredging activities. The clustering of related activities improves the competitive advantage of players by augmenting their productivity and reducing costs in movement and also paving the way for technological innovation. So, Inland Waterways create a kind of value chain of interrelated activities of the hinterland that are mutually supportive and continuously growing.

10.1.3 WATERWAY DEVELOPMENT

The stretch of river under area of study is along the river from Longmatra in Kiphire District to Avankhu in Phek district, near international border of India and Myanmar. The average width of Tizu river from Ch. 0.00 Km to 5 Km is 65m to 100m approximately. Average water portion of the river is 40 – 45 m. The stretch of the river passes through the Phek District Nagaland. Avankhu village is situated at the western side of the river stretch. River gradient along this stretch is 0.9m approx. High hills are situated both sides of the river. Several submerged rocks lay underneath of the river. The main flow of water can be seen along the bank and it is observed to be having out crop rocks and rapids.

10.1.4 NEED FOR THE EIA STUDY

The major thrust of the EIA study shall be to assess the impacts of various activities of proposed development on various aspects of environment. The study shall cover the impacts on water quality, noise, air quality, terrestrial ecology, wildlife, aquatic ecology including fisheries, etc. The study will include collection of baseline data, prediction of impacts and formulation of Environmental Management Plan (EMP) for amelioration of adverse impacts. The EIA study will be carried out by collecting/generating primary and secondary data through site reconnaissance survey, field visits, review of literature etc. For primary data collection a 100 meters wide corridor (50 m from the centre line of the waterways of each river and for secondary data collection 10 km wide corridor on both the sides of waterway of each river will be considered. Socio-economic impact will be conducted based on secondary data.

The objectives of the Environment Impact Assessment study are to:

- Determine the baseline status of the marine ecology, terrestrial environmental conditions, Ambient Air Quality, Land use, Noise levels, socioeconomic aspects of the study area.
- Identify and assess the probable impacts of the project on marine and terrestrial environment in the study area during dredging and dumping operation of the project.
- Suggest adequate mitigation measures to minimize the negative impacts during dredging operation and operational phases of the project.
- Recommend Environment Management Plan to ensure that the project implementation does not impact the environment adversely.
- Preparation of Risk assessment and Disaster Management Plan considering the project activity

Proposed project envisages the development of Water Way 101 in river stretch of Tizu and Zungki rivers from Longmatra in Kiphire District to Avankhu in Phek district of Nagaland. Total 4 Nos. of passenger and cargo Terminals are proposed to be developed as a part of the project. Cargo, which originated from Kohima, Dimapur and Meluri (Phek) could be transported using NW 101 for local distribution in the villages, which are located on the bank of NW 101. In addition to the development of Terminals dredging is also envisaged at certain locations to enable the movement of ferry service. As per the list of projects or activities requiring prior environmental clearance (EC) under the EIA Notification dated 14th September 2006 issued by the Ministry of Environment, Forest and Climate Change (MoEF&CC), the proposed project is listed on S. No. 7(e) in the notification and requires EC from MoEF&CC, New Delhi.

10.1.5 OBJECTIVES OF THE EIA STUDY

The major thrust of the EIA study shall be to assess the impacts of various activities of proposed project on various aspects of environment. The study shall cover the impacts on water quality, noise, air quality, terrestrial ecology, wildlife, aquatic ecology including fisheries, etc. The study will include collection of baseline data, prediction of impacts and formulation of Environmental Management Plan (EMP) for amelioration of adverse impacts. The Study Area for the EIA Study shall be the area within 10 km radius of the periphery of the proposed navigation channel. The objectives of the Environment Impact Assessment study are to:

- Determine the baseline status of the Marine Ecology, Terrestrial Environmental Conditions, Ambient Air Quality, Land use, Noise Level and Socio-economic aspects of the Study Area.
- Identify and assess the probable impacts of the project on marine and terrestrial environment in the study area during dredging and dumping operations of the project.
- Suggest adequate mitigation measures to minimize the negative impacts during dredging operation and operational phases of the project.
- Recommend Environment Management Plan to ensure that the project implementation does not impact the environment adversely.

10.1.6 STUDY AREA

As per the Ministry of Environment, Forests and Climate Change (MOEF&CC) guidelines, for primary data collection a 100 meters wide corridor (50 m from the centre line of the waterways of each river and for secondary data collection 10 km wide corridor on both the sides of waterway of each river will be considered. Socio-economic impact will be conducted based on secondary data.

10.1.7 STAGES IN AN EIA STUDY

The purpose of this section is to enumerate the steps involved in an Environmental Impact Assessment (EIA) Study. The same are given in following paragraphs.

Scoping: An exhaustive list of all likely impacts drawing information from as many sources as possible shall be prepared to assess the impacts due to various activities of the proposed Dredging Project. The next step shall be to select a manageable number of attributes, which are likely to be affected as a result of the proposed project.

Various criteria applied for selection of the important impacts are as follows:

- magnitude
- extent
- significance
- special sensitivity

Baseline Study: Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters, which could be significantly affected by the implementation of the project. The planning of baseline survey emanated from shortlisting of impacts prepared during identification. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Impact Prediction: is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the proposed project. An attempt was made to forecast future environmental conditions quantitatively to the extent possible. But for certain parameters which cannot be quantified, general approach is to discuss such intangible impacts in quantitative terms so that planners and decision-makers are aware of their existence as well as their possible implications.

Environmental Management Plan: For the proposed coastal development projects an Environmental Management Plan (EMP) is formulated to maximize the positive environmental impacts and minimize the negative ones. After selection of suitable environmental mitigation measures, the cost required for implementation of various management measures is estimated, to have an idea of their cost-effectiveness.

Environmental Monitoring Programme: An Environmental Monitoring Programme for implementation during project dredging operation and operation phases shall be suggested to oversee the environmental safeguards, to ascertain the agreement between prediction and reality and to suggest remedial measures not foreseen during the planning stage but arising during operation and to generate data for further use.

10.1.8 OUTLINE OF THE REPORT

The contents of the EIA report are arranged as follows:

Chapter 10: The chapter gives an overview of the need for the project, objectives and need for EIA study etc. The methodology adopted for conducting the EIA study for the proposed dredge the existing navigation channel is also described in this chapter.

: A brief write-up on various project appurtenances, infrastructure facilities proposed to be developed as a part of the project have been covered in this chapter.

: Baseline environmental conditions regarding physio-chemical and Biological and social environment have been described in this Chapter. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

: This chapter covers the anticipated impacts due to the proposed project and mitigation measures

Chapter 11: Environmental Management Plan has been covered in this chapter

: Delineates the Environmental Monitoring Programme for implementation during construction and operation phase are outlines in the chapter.

: Cost estimate for the implimentaion of EMP and AMoP

: Delineates the Disclosure of Consultants.

10.2 PROJECT DESCRIPTION

10.2.1 GENERAL

The Government of India has placed a great emphasis on development of Inland Water Transport and in the process, in April, 2016, 106 waterways are declared as National Waterways on various rivers along the length and breadth of the country. The stretch from Longmatra to Avankhu comprising of Tizu & Zungki rivers have been declared as NW – 101 by the GoI during April 2016.

Proposed project envisages the development of Water Way 101 in river stretch of Tizu and Zungki rivers from Longmatra in Kiphire District to Avankhu in Phek district of Nagaland. Total 4 Nos. of passenger and cargo Terminals are proposed to be developed as a part of the project. Cargo, which originated from Kohima, Dimapur and Meluri (Phek) could be transported using NW 101 for local distribution in the villages, which are located on the bank of NW 101. In addition to the development of Terminals dredging is also envisaged at certain locations to enable the movement of ferry service.

Terminal development is considered for two phases, Phase I- on the stretch of NW 101 which is immediate and Phase II,Phase-III is not recommended for development presently as - Indo-Myanmar trade using IWT is a remote possibility, as it depends on Myanmar Government and IWAI has little say on development of waterway across the border till Hta Man Thi. Trade between India and Myanmar using IWT would be possible if Myanmar develops waterway from the border till Hta Man Thi.

10.2.2 THE TIZU-ZUNGKI INLAND WATERWAY SYSTEM (NW - 101)

The identified stretch of river Tizu & Zungki for development as National Waterway 101 is currently non-operational for cargo or passenger movement. The river stretch is surrounded by steep hills and forests and there is no existing ghat or terminal facility on the river. Five locations on the defined stretch of NW 101 are identified for development of the terminals.

Proposed Terminal locations are based on traffic prospect, land availability, location, villages, mineral clusters and trade centers located in the region. However, development of inland waterway in the identified stretch of Tizu and Zungki river has technical hurdles, like hilly region, rocky terrain on the bank of river, sharp bends and curves in some parts of river, high velocity and rapids in river, rock outcrops in riverbed etc. Lower Tizu hydroelectric power project proposed on river Tizu about 12 km. downstream from confluence of Tizu and Zungki river, would also be a technical hurdle for vessel movement.

Considering that the hinterland of NW 101 has remote and under developed villages, it is concluded that cargo and passenger traffic would not be large enough. Hence, one type of terminal would be adequate to handle both cargo and passenger traffic. There is no need to categorize the proposed terminals as Passenger and cargo terminals. Hence, total of 4 Nos. of Terminals are proposed to be developed as a part of the NW 101 in river stretch of Tizu and Zungki rivers from Longmatra in Kiphire District to Avankhu in Phek district of Nagaland. The Figure 10.3 shows proposed terminals on NW-101.

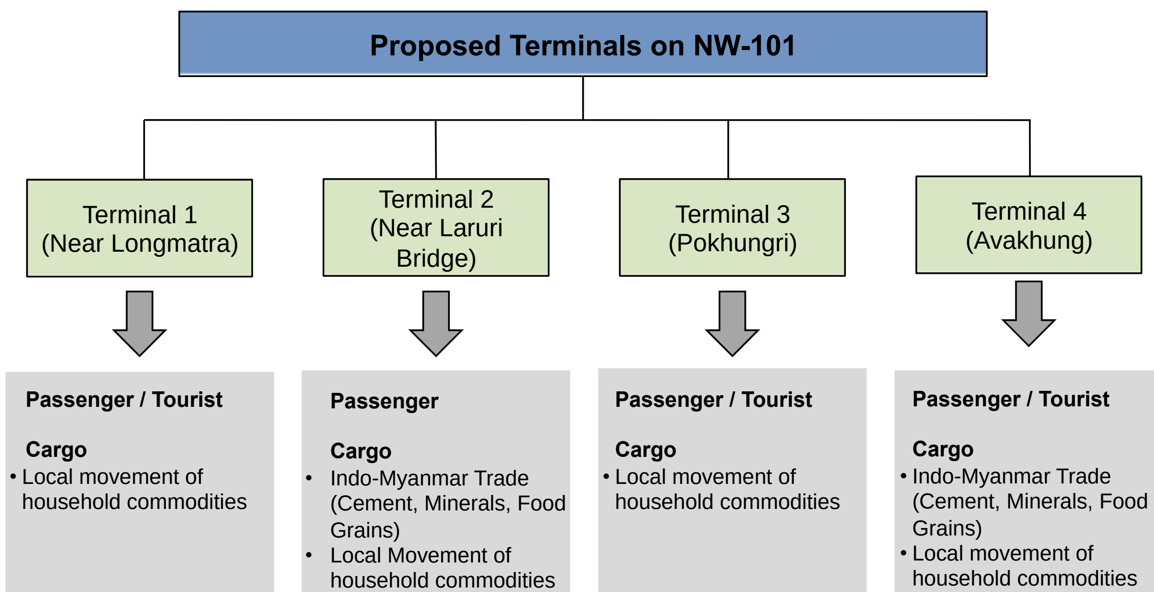


Fig. 10.3 Proposed Terminals on NW 101

10.2.3 ALTERNATIVES CONSIDERED FOR THE DEVELOPMENT

Two Phases have been considered for the development of NW 101.

10.2.4 Phase-I and Phase-II envisages the development Water Way 101 in river stretch of Tizu and Zungki rivers from Longmatra in Kiphire District to Avankhu in Phek district of Nagaland. Total of 4 Nos. of Terminals are proposed to be developed as a part of the NW 101. These terminals would be handling passengers and tourists likely to make local travels. At present, roadway is used for movement of all kinds of commodities in the hinterland of NW 101. Passenger movement is also solely dependent on roadways. Most of the roads are kaccha roads and not all weather roads. The condition of roads worsens during monsoon season, when hilly areas suffer from landslides and roads become muddy. At present, roadway is struggling to provide seamless service to remote villages; hence waterway would be an alternative mode of transportation. All the villages located within 15 km of the identified stretch of NW 101 have been considered for passenger traffic.

10.2.5 PROPOSED TERMINALS

Total of 4 Nos. of Terminals are proposed to be developed as a part of the NW 101 in river stretch of Tizu and Zungki rivers from Longmatra in Kiphire District to Avankhu in Phek district of Nagaland. Locations of the proposed Terminals are depicted in Figure 10.4.

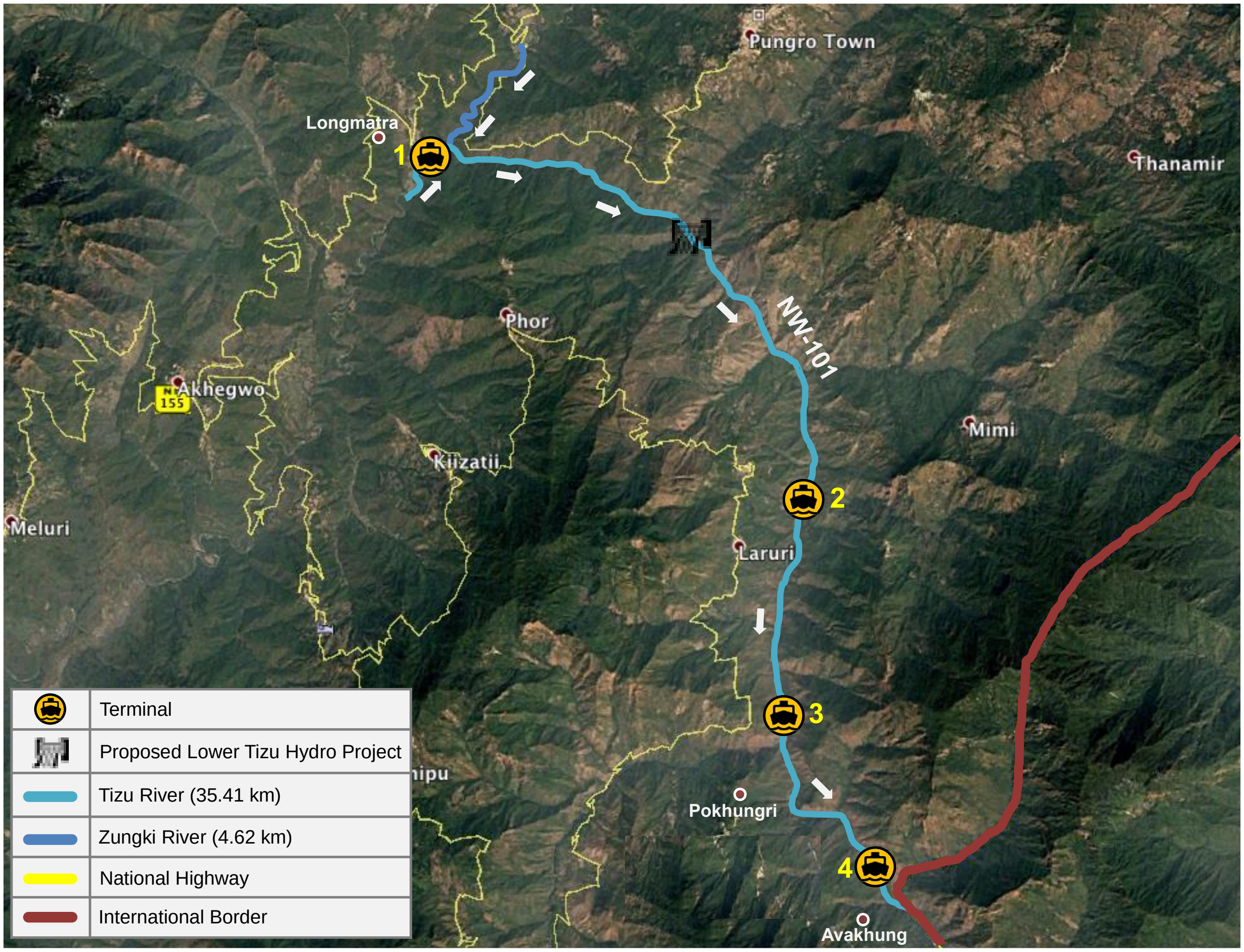


Fig. 10.4 Locations of proposed Terminals on River Tizu and Zungki

10.2.6 INFRASTRUCTURE FACILITIES

The development of 4 Terminals on NW 101 would include the development of associated infrastructure facilities including Terminals building, administration office, ticket counter, canteen, firefighting equipment, parking, cargo sheds, approach roads, cargo handling facilities. Details of various facilities are summarised as below:

Table 10.1 Infrastructure Facilities at Terminals

Facilities	Terminal 1	Terminal 2	Terminal 3	Terminal 4
Admin Office	✓	✓	✓	✓
Ticket Counter	✓	✓	✓	✓
Guard Room (Caretaker)	✓	✓	✓	✓
Store/ Fire Fighting/ First Aid	✓	✓	✓	✓

Facilities	Terminal 1	Terminal 2	Terminal 3	Terminal 4
Waiting Area	✓	✓	✓	✓
Canteen	✓	✓	✓	✓
Rest Room	✓	✓	✓	✓
Cargo Shed	✓	✓	✓	✓
Equipment Shed	✓	✓	✓	✓
Fencing (Boundary)	✓	✓	✓	✓
Gate	✓	✓	✓	✓
Sewage Treatment Plant	✓	✓	✓	✓
Water Supply	✓	✓	✓	✓
Solar Powered LED Street Light	✓	✓	✓	✓
Electricity	✓	✓	✓	✓
Phone	✓	✓	✓	✓
Internet	✓	✓	✓	✓

10.2.7 DREDGING REQUIREMENTS

The river bed material consists of coarse sand with rocky shores on either bank with dense forest. In the present form, the river is navigable between Longmatra to Avakhung without much dredging requirement but removal of boulders/stones underneath the water are required and minimum dredging is required. Maintenance of minimum depth in the waterway by dredging is required to for maintaining navigable waterway. The total quantity of dredged material has been estimated as 61,000 m^3. Dredged material will be used in river training work such as bank protection works, bundling works, bottom panelling works etc.

10.2.8 FRESH WATER REQUIREMENT

Annual fresh water requirement for the project would be 44 Million Litres during construction phase and 11 Million Litres during operation phase. The details of the water requirements are given in Table 10.4.

Table 10.2 Water Requirement (Unit: Million Litres / Year)

Water Requirement	Terminal Location			
	Longmatra	Near Laruri Bridge	Pokhungri	Avakhung
Construction Phase	0.71 Mn litres	0.71Mn litres	0.71 Mn litres	0.71 Mn litres
Operation Phase	0.58 Mn Litres	0.58Mn litres	0.58 Mn Litres	0.58 Mn Litres

10.2.9 POWER REQUIREMENTS

Power requirement for each Terminal will be 11 KVA and the same will be sourced from Nagaland Electricity Board.

10.3 ENVIRONMENTAL BASELINE STATUS

10.3.1 GENERAL

Assessment of baseline environment of the project area is an important component of the EIA study. As a part of the study, a Scoping Matrix was prepared, based on which, various parameters to be analyzed for assessment of base line environmental were identified. The assessment of environmental impacts due to construction and commissioning of proposed cargo capacity enhancement at the berths requires a complete and scientific consideration of various environmental aspects and their interaction with the natural resources, namely, physico-chemical parameters i.e. meteorology, geology, soil, land use and water quality, biological parameters i.e. terrestrial flora and fauna, marine flora and fauna, fish species, etc in the study area. It also includes the socio-economic parameters i.e. demography, occupational profile, etc.As a part of the EIA study, a large quantum of related data available with various departments including Forest Department, Fisheries Department, and Directorate of Economics & Statistics were collected and analyzed. Field studies for primary data collection on various parameters were also carried out as part of the EIA study.

10.3.2 STUDY AREA

The Study Area for the EIA study has been considered as the area covering 10 km on either side of the alignment of navigation channel proposed to be dredged as part of the project. The Study Area Map is enclosed as Figure-3.1. As apart of the EIA study, the base line status has been ascertained on the following environmental aspects:

- Meteorology
- Ambient Noise level
- Land use
- Terrestrial Ecology
- Marine Ecology

- Socio Economic Profile

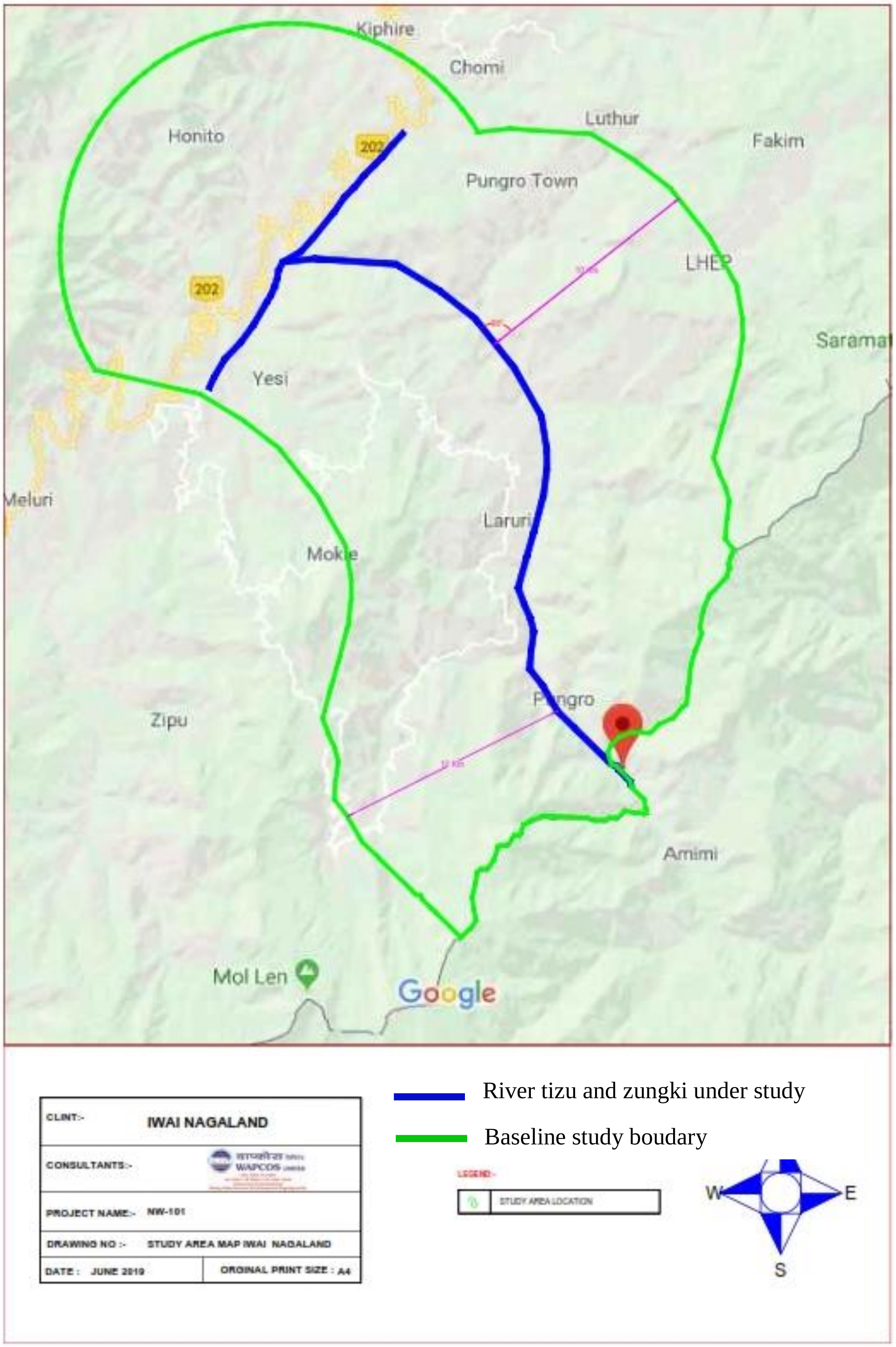


Fig. 10.5 Study Area Map

10.3.3 METEOROLOGY

The climate of the basin over the foot hills is warm and subtropical. It is cool during the winter and occurrence of frost over large tracts is observed in the high hill ranges. The temperature varies from 5º C to 25º C on the hills and from 12º C to 32º C on the foot hills. Over the year four different seasons can be defined:

- Pre-monsoon;
- Monsoon;
- Post-monsoon;
- Winter season.

Pre-monsoon

In the region of the East-Himalaya the first pre-monsoon precipitation sets in at the end of March, mostly in the form of thunderstorms. The months of April and May are characterized with thundershowers.

Monsoon

The onset of the monsoon in northeast India happens normally between the 30th of May and the 5th of June. This happens when the southern trade winds cross the equator and move towards the extreme low- pressure region in Northern India.

Post-monsoon

In September the influence of the monsoon begins to decrease. In northern India a withdrawal of the monsoon-troughs sets in suddenly and the weather becomes clearer. During the post-monsoon season the temperature and the precipitation decline noticeably. This time of the year is generally the most pleasant season due to the stable weather condition and the warm climate. In the morning the valleys are filled with dense fog, but in higher reaches the sky is clear.

Winter season

In the northeast Indian mountain range the winter is severe and characterized by low temperature, but without significant snowfall. Precipitation only occurs in conjunction with western disturbances (flat low-pressure areas). Starting February the temperature begins to rise slowly again.

However, Manu Energy established meteorological station near dam site and daily temperatures have been recorded since Nov 2008.

10.3.4 LANDUSE LANDCOVER

Land use describes how a patch of land is used (e.g. for agriculture, settlement, forest), whereas land cover describes the materials (such as vegetation, rocks or buildings) that are present on the surface. Accurate land use and land cover identification is the key to most of the planning processes. The land use pattern of the study area has been studied through digital satellite imagery data. The land use pattern has been studied through satellite imagery data. Remote sensing satellite data of Resource Sat- 2 Satellite (LISS-IV, Path 113, Row 053, Sub-scene D dated 24.01.2019) Data of was procured from National Remote Sensing Agency (NRSA), Hyderabad. The data was processed through ERDAS software package available with WAPCOS. Ground truth studies were conducted in the area to validate various signals in the satellite images and correlate them with different land use domains. The FCC of the study area is shown in Fig. 10.6 and the classified imagery of the study area is enclosed as Fig. 10.7. The land use pattern is summarized in the Table 10.5.

Table 10.3 Land use pattern of the study area

Description	Area (ha)	Area (%)
Water/River	306	0.30
Dense Vegetation	48159	47.90
Open Vegetation	27900	27.75
Scrub	21590	21.47
Exposed Rock	1386	1.38
Built up area/Settlement	1198	1.19
Total	**100539**	**100**

The major land use category is vegetation accounting for about 75.65% of the total study area, out of which dense vegetation is 47.9% and open vegetation is 27.75%. The area under scrub in the study area is 21.47 %. Area under exposed rock and built up area is 1.38 and 1.19% respectively. The area under water is about 0.30% of the total Study Area.

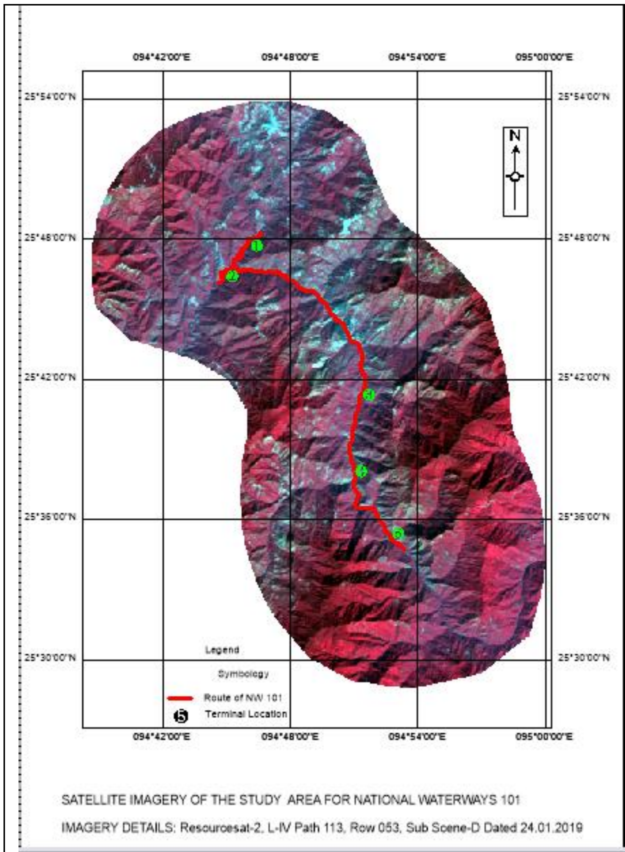


Fig. 10.6 Satellite Imagery of the Study Area

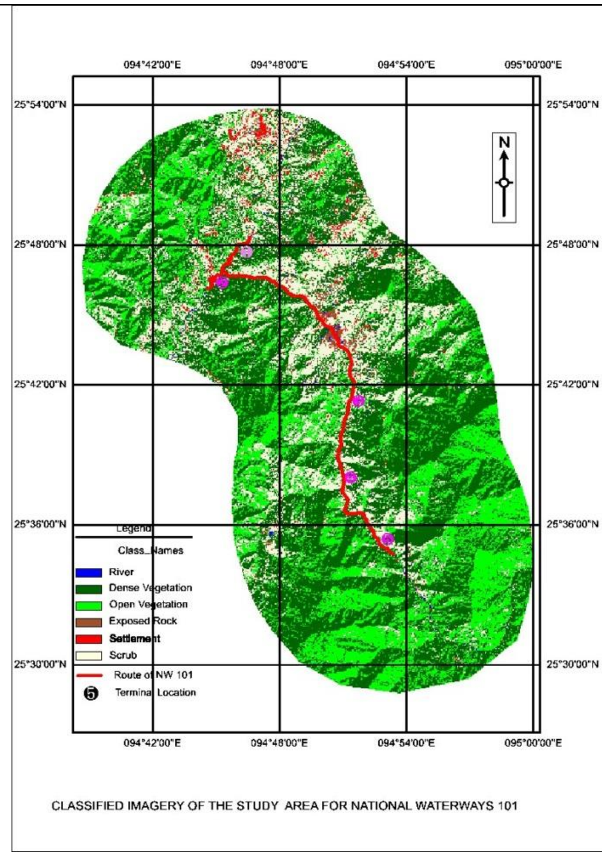


Fig. 10.7 Classified Satellite Imagery of study area

10.3.5 SURFACE WATER

As a part of EIA Study, surface water quality was monitored at 6 locations given in Table 10.7. Surface water quality monitored in the month of May 2019.The results of surface water quality are given in Table10.6. The sampling location area presented in Fig. 10.8

Table 10.4 Location of Surface Water Monitoring Stations

Station Code	Station Location	Latitude	Longitude
SW1	Tsulate Gref Camp	25°48'57.26"N	94°46'28.98"E
SW2	Siloli Lake	25°35'43.63"N	94°47'45.91"E
SW3	Avankhu	25°34'19.41"N	94°52'31.43"E
SW4	New Longmatra	25°46'6.42"N	94°43'46.85"E
SW5	Yowzuti River	25°39'37.63"N	94°49'33.72"E
SW6	Lururi Bridge at Tizu River	25°41'9.53"N	94°51'14.56"E

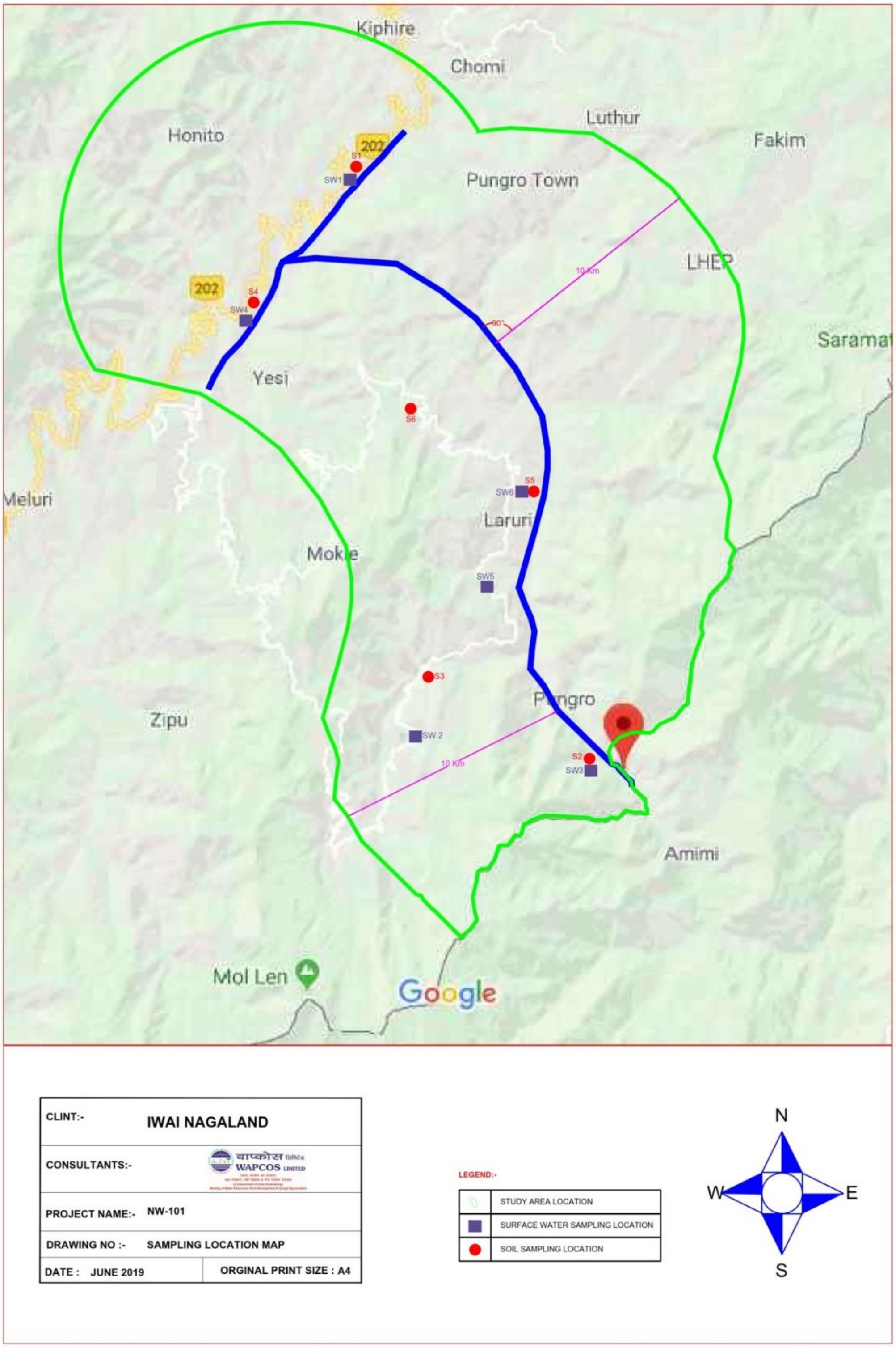


Fig. 10.8 Sampling location map for Water and Soil sampling

Table 10.5 Surface Water Quality in the study area

S. No.	Parameters	Sample No.					
		SW-1	SW-2	SW-3	SW-4	SW-5	SW-6
1.	pH Value	8.21	7.15	8.69	8.45	8.11	7.58
2.	Conductivity, µS/cm	593.7	47.6	257.1	349.2	250.8	482.5
3.	Turbidity, NTU	0.3	0.7	17.9	1.6	2.6	6.8
4.	Colour, Hazen Unit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
5.	Total Hardness (as CaCO3), mg/l	324	4.0	144.0	216.0	112.0	268.0
6.	Total Dissolved Solids, mg/l	374	30.0	162.0	220.0	158.0	304.0
7.	BOD, mg/l	<0.4	<0.4	3.0	<0.4	2.0	4.0
8.	C.O.D, mg/l	<1.0	<1.0	8.45	<1.0	6.4	7.9
9.	Phosphate (as PO4), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10.	Chloride (as Cl), mg/l	3.94	3.94	3.94	1.97	11.83	3.94
11.	Fluoride (as F), mg/l	0.31	<0.01	0.28	0.14	0.29	0.29
12.	Sulphate (as SO4), mg/l	90.68	6.55	17.63	10.58	26.70	77.59
13.	Sodium (as Na),mg/l	10.0	5.9	4.9	1.1	12.8	2.8
14.	Potassium (as K),mg/l	0.3	1.8	1.6	1.2	1.8	0.5
15.	Calcium (as Ca), mg/l	92.18	1.60	36.07	40.08	36.07	92.18
16.	Magnesium (as Mg), mg/l	22.84	<1.0	13.12	28.19	5.35	9.23
17.	Iron (as Fe), mg/l	0.2	0.2	1.1	0.2	0.2	0.2
18.	Chromium (as Cr), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19.	Manganese (as Mn), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20.	Copper (as Cu), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21.	Zinc (as Zn), mg/l	<0.01	1.2	<0.01	<0.01	<0.01	<0.01
22.	Dissolved Oxygen, mg/l	6.2	6.5	6.2	6.4	6.3	2.6
23.	Nitrate (as NO3), mg/l	0.36	0.14	0.19	0.26	0.21	0.48
24.	Sodium Absorption ratio	0.24	1.3	0.18	0.03	0.53	0.07
25.	Residual Sodium Carbonate, meq/l	0	0.09	0	0	0	0
26.	Coliform count, MPN/100ml	92	Absent	161	54	35	92
27.	E.coli, MPN/100ml	92	Absent	35	54	28	54

pH values ranged from 7.15 to 8.69 and is neutral to moderately alkaline in nature. Total Dissolved Solids ranged between 30 mg/l to 374 mg/l.

The Electric Conductivity (EC) in water samples ranged from 47.6 to 593.7 μS/cm in summer season. The low hardness level can be attributed low calcium and magnesium levels, which are responsible for soft nature of water. The low EC values indicate the lower concentration of cations and anions. This is also reflected by the fact that the concentration of most of the cations and anions are well within the permissible limit.

Dissolved Oxygen ranged from 2.6 mg/l to 6.5 mg/l in, which indicates absence of pollution loading. Total Cruciform ranged from 35 CFU/100 ml to 161 CFU/100 ml in and Fecal Cruciform ranged from 28 CFU/100 ml to 92 CFU/100 ml.

10.3.6 SOILS

Soil is the product of geological, chemical and biological interactions. The soils in the region vary according to altitude and climate. The soil in the project area and study area are young like any other region of Himalayas. The vegetal cover is one of the most important influencing factors characterizing the soil types in a region and vice-versa. Soil on the slope above 30^{o}, due to erosion and mass wasting processing, are generally shallow and usually have very thin surface horizons. Such soils have medium to coarse texture. Residual soils are well developed on level summits of lesser Himalayas, Sub-soil are deep and heavily textured.

The soils of the study area are derived from tertiary rocks belonging to Bareli and Disang series. Though the district is small, due to large variation in topography and climate, there is a wide variety of soil types prevailing in the district. Both Alluvial and Residual soils are found in the district. Under the alluvial soil type, Recent alluvium (Entisol); Old alluvium (Oxizols and Ultisol) and Mountain valley soil (Entisol) is found. Under the Residual soils also three different types – Laterite soils (Oxizols and Ultisol); Brown forest soils (Mollisols and Inceptisols) and Podzolic soils (Spodesols) are found in the district.

As a part of field studies, soil samples were collected from 6 locations in the Study area. The depth of locations ranged from 20 to 50 cm below the ground. Sampling locations are listed in Table-10.7. The results of the analysis of soil sampling conducted for summer (May, 2019) season is given in Table 10.8.

Table 10.6 Details of Locations of Soil Sampling

Sampling Code	Location	Latitude	Longitude
S1	Tsulate Gref Camp	25°48'57.26"N	94°46'28.98"E

Sampling Code	Location	Latitude	Longitude
S2	Avnakhu	25°34'19.41"N	94°52'31.43"E
S3	Luyakti River	25°37'11.93"N	94°48'10.24"E
S4	New Longmatra	25°46'6.42"N	94°43'46.85"E
S5	Lururi Bridge at Tizu River	25°41'9.53"N	94°51'14.56"E
S6	Phor	25°43'20.39"N	94°48'9.46"E

Table 10.7 Results of soil sampling analysis of study area for summer season

S. No.	Parameters	Sample No.					
		S-1	S-2	S-3	S-4	S-5	S-6
1.	pH Value	6.31	7.43	8.27	7.97	6.10	6.99
2.	Conductivity, millimohs/cm	0.070	0.52	0.08	0.047	0.201	0.027
3.	Sodium (as Na), mg/kg	541.77	902.75	372.79	263.26	760.33	487.33
4.	T. Nitrogen, % w/w	0.07	0.6	0.02	0.03	0.04	0.05
5.	Available Potassium (as K), mg/kg	951.17	1516.45	40.18	33.23	698.94	150.10
6.	Total Organic Carbon, %	2.43	0.44	0.17	0.22	0.27	0.27
7.	Total Organic Matter, %	4.18	0.76	0.29	0.38	0.47	0.47
8.	Available Phosphate (as P), mg/kg	0.24	1.90	31.30	22.43	150.96	53.08
9.	Exchangeable Sodium percentage	16.28	15.47	5.50	3.73	5.45	1.89
10.	Calcium (as Ca), mg/kg	1966.10	1546.30	4231.52	2988.18	1286.72	2988.95
11.	Magnesium (as Mg), mg/kg	6938.13	732.93	25637.67	18104.56	4808.94	26640.66
12.	Sodium Absorption ratio	0.41	1.49	0.15	0.13	0.69	0.20
13.	Particle size distribution						
	Clay, %	46.26	39.82	8.34	11.51	30.22	37.07
	Sand, %	50.05	58.28	91.42	88.12	68.51	54.64
	Silt, %	3.69	1.90	0.24	0.37	1.27	8.29

The pH of the soil varies from 6.10 to 8.27, which indicates that it is in neutral range. The low EC values indicate low salt content. The levels of nutrients indicate that the soil has moderate to high productivity. The soil type of the area is majorly sandy clay category.

10.3.7 AMBIENT AIR QUALITY

The ambient air quality with respect to the study area of 10 km radius around the proposed NW 101 forms the baseline information. There are no major sources of air pollution in the project area. There is no major source of air pollution in the study area except vehicular traffic, dust emissions from unpaved village roads and domestic fuel burning. Hence, ambient air quality in the study area is generally good and well within permissible limit.The details of AQI primary data has been attached as *Annexure-XI of Volume III*.

10.3.8 TERRESTRIAL FLORA

The forest cover in the State of Nagaland is more than 41 % out of which dense forest constitute about 25 % and the remaining area (16%) is covered by open forests. Shifting cultivation has severely degraded the forest cover and forests mainly secondary in nature. Therefore, degraded forest/ scrub account for more than 27 % of the area whereas as under jhum cultivation is more than 20% River and flood plains also constitute a sizable percent of this area (2%).

Forest Types

Nagaland is endowed with a wide variety of forest types on account of its unique geographical location and wide range of physiographic terrain. The major types of forests, as per the revised classification of Champion and Seth (1968), are as follows.

- Northern Tropical Wet Evergreen Forests
- Tropical Evergreen and Semi Evergreen Forests
- Northern Sub- Tropical Broad Leaved Wet Hill Forests
- Northern Sub-Tropical Pine Forests
- Temperate Forests
- Secondary Forests (Bamboo and *Musa* sp.)

Forest Type in Project Area

The study area is marked by steep hills along the river banks and slope covered with dense forest which is mainly characterized with Tropical Evergreen, Semi Evergreen Forest and Secondary forests.

Tropical Evergreen and Semi Evergreen Forest

This forest type is confined to elevations between 505 and 550 m. The study areas on both the river banks are represented by this type of forest. The top canopy is characterised by some of the important timber species such as *Terminalia myriocarpa, Duabanga grandiflora, Artocarpus chaplasa, Michelia champaca, Altingia excelsa, Mangifera sylvatica, Dipterocarpus gracilis*, etc. The middle canopy is represented by *Mesua ferrea, Ficus semicordata, Toona hexandra, Garuga pinnata,* etc. In some areas, these forests have patches of bamboo species such as *Dendrocalamus hamiltonii* and *Bambusa tulda*. The ground layer is covered with shrubs like *Calamus floribundus, Calamus erectus, Strobilanthes coloratus, Hedychium* sp. The herbaceous layer is less prominent because of the dense tree canopy and only represented mainly by some Grasse species and *Elatostemma sessile, Lecanthes peduncularis, Commelina paluda*, etc.

Secondary Forest

These forests are mainly confined to old jhum fallows and are mainly comprised of *Dendrocalamus hamiltonii, Bambusa tulda* and *Musa* sp. The *Musa* sp. is common along the river banks in the downstream of the dam site.

List of the common floral species recorded from the study area is given in Table 10.10.

Table 10.8 List of Plant Species recorded from the study area

S. No.	Family	Scientific Name
TREES		
1	Anacardiaceae	*Mangifera indica*
2	Anacardiaceae	*Mangifera sylvatica*
3	Arecaceae	*Trachycarpus martianus*
4	Arecaceae	*Caryota urens*
5	Bignoniaceae	*Oroxylum indicum*
6	Bombacaceae	*Bombax ceiba*
7	Burseaceae	*Garuga pinnata*
8	Burseraceae	*Canarium strictum*
9	Caesalpinaceae	*Acrocarpus fraxinifolius*
10	Caesalpiniaceae	*Bauhinia purpurea*
11	Clusiaceae	*Mesua ferrea*
12	Comberataceae	*Terminalia myriocarpa*
13	Dilleniaceae	*Dillenia indica*
14	Dipterocarpaceae	*Dipterocarpus gracilis*
15	Euphorbiaceae	*Bischofia javanica*

S. No.	Family	Scientific Name
16	Euphorbiaceae	*Macaranga denticulata*
17	Euphorbiaceae	*Sapium baccatum*
18	Fabaceae	*Dalbergia pinnata*
19	Fabaceae	*Erythrina variegate*
20	Fagaceae	*Castanopsis indica*
21	Flacourtiaceae	*Gynocardia odorata*
22	Hammamelidacea e	*Altingia excels*
23	Juglandaceae	*Engelhardtia spicata*
24	Lagerstromiaceae	*Lagerstroemia parviflora*
25	Lauraceae	*Actinodapne obovata*
26	Lauraceae	*Cinnamomum obtusifolia*
27	Lauraceae	*Litsea salicifolia*
28	Lauraceae	*Phoebe paniculata*
29	Lauraceae	*Phoebe cooperiana*
30	Magnoliaceae	*Michelia champaca*
31	Meliaceae	*Toona hexandra*
32	Mimosaceae	*Albizia chinensis*
33	Mimosaceae	*Albizia procera*
34	Mimosaceae	*Albizia lucida*
35	Moraceae	*Artocarpus chaplasa*
36	Moraceae	*Artocarpus fraxinifolius*
37	Moraceae	*Artocarpus heterophyllus*
38	Moraceae	*Ficus oligodon*
39	Moraceae	*Ficus cunea*
40	Moraceae	*Ficus roxburghii*
41	Moraceae	*Ficus semicordata*
42	Moraceae	*Morus laevigata*
43	Myrtaceae	*Syzygium tetragonum*
44	Pandanaceae	*Pandanus odoratissma*
45	Rubiaceae	*Haldina cordifolia*
46	Sabiaceae	*Meliosma simplicifolia*
47	Sapindaceae	*Sapindus rarak*
48	Sapotaceae	*Sarcosperma griffithii*
49	Simaroubaceae	*Ailanthus integrifolia*
50	Simaroubaceae	*Alangium begoniifolium*
51	Sonneratiaceae	*Duabanga grandiflora*
52	Sterculiaceae	*Pterospermum acerifolium*
53	Sterculiaceae	*Sterculia villosa*
54	Ulmaceae	*Alnus nepalensis*
55	Verbenaceae	*Callicarpa arborea*
SHRUBS		

S. No.	Family	Scientific Name
1	Acanthaceae	*Phlogancanthus tubiflorus*
2	Acanthaceae	*Strobilanthes coloratus*
3	Acanthaceae	*Strobilanthes echinata*
4	Araliaceae	*Trevesia palmate*
5	Arecaceae	*Calamus floribundus*
6	Arecaceae	*Calamus erectus*
7	Arecaceae	*Calamus leptospadix*
8	Asteraceae	*Eupatorium* sp.
9	Bischofiaceae	*Bischofia javanica*
10	Euphorbiaceae	*Euphorbia pulcherrima*
11	Euphorbiaceae	*Ricinus communis*
12	Malvaceae	*Sida rhombifolia*
13	Melastomataceae	*Oxyspora paniculata*
14	Melastromiaceae	*Melastoma malabathricum*
15	Mimosaceae	*Acacia* sp.
16	Musaceae	*Musa acuminate*
17	Musaceae	*Musa balbisiana*
18	Musaceae	*Musa intinerans*
19	Musaceae	*Musa laterita*
20	Myrsinaceae	*Mesua indica*
21	Oleaceae	*Jasminum amplexicaule*
22	Poaceae	*Arundinaria callosa*
23	Poaceae	*Arundinaria hirsute*
24	Poaceae	*Arundinaria suberecta*
25	Poaceae	*Bambusa pallid*
26	Poaceae	*Bambusa tulda*
27	Poaceae	*Bambusa vulgaris*
28	Poaceae	*Bambusa khasiana*
29	Poaceae	*Bambusa nana*
30	Poaceae	*Bambusa balcooa*
31	Poaceae	*Bambusa* sp.
32	Poaceae	*Dendrocalamus strictus*
33	Poaceae	*Dendrocalamus hamiltonii*
34	Poaceae	*Dendrocalamus giganteus*
35	Poaceae	*Saccharum spontaneum*
36	Poaceae	*Thysanolaena maxima*
37	Poaceae	*Schizostachyum polymorphum*
38	Rutaceae	*Murraya paniculata*
39	Solanaceae	*Datura metel*
40	Tiliaceae	*Triumfetta bartramia*
41	Urticaeae	*Urtica* sp.

S. No.	Family	Scientific Name
42	Zingiberaceae	*Hedychium* sp.
HERBS		
1	Acanthaceae	*Strobilanthes rhombifolius*
2	Acanthaceae	*Erantheumum pulchellum*
3	Acanthaceae	*Asystasia neesiana*
4	Acanthaceae	*Justicia khasiana*
5	Amaranthaceae	*Amaranthus viridis*
6	Amaranthaceae	*Achyranthes bidentata*
7	Apiaceae	*Centella asiatica*
8	Araceae	*Aglaonema hookerianum*
9	Araceae	*Alocasia fallax*
10	Araceae	*Ariopsis peltata*
11	Araceae	*Arisaema concinnum*
12	Araceae	*Colocasia forniculata*
13	Asteraceae	*Ageratum conyzoides*
14	Asteraceae	*Bidens pilosa*
15	Asteraceae	*Eupatorium odoratum*
17	Balsaminaceae	*Impatiens brachycentra*
18	Balsaminaceae	*Impatiens bicornuta*
19	Begoniaceae	*Begonia nepalensis*
20	Begoniaceae	*Begonia griffithiana*
21	Begoniaceae	*Begonia palmate*
22	Boraginaceae	*Cynoglossum glochidiatum*
23	Chenopodiaceae	*Chenopodium album*
24	Commelinaceae	*Commelina paluda*
25	Commelinaceae	*Commelina bengalensis*
26	Commelinaceae	*Cynotis vaga*
27	Cyperaceae	*Cyperus rotundus*
28	Cyperaceae	*Carex longipes*
29	Cyperaceae	*Cyperus exaltatus*
30	Cyperaceae	*Cyperus irria*
31	Euphorbiaceae	*Euphorbia hirta*
32	Lamiaceae	*Clinopodium* sp.
33	Lamiaceae	*Leucas ciliate*
34	Lamiaceae	*Clerodendrum* sp.
35	Malvaceae	*Abutilon indicum*
36	Malvaceae	*Sida rhombifolia*
37	Malvaceae	*Urena lobata*
38	Mimosaceae	*Mimosa pudica*
39	Oxalidaceae	*Oxalis corniculata*
40	Oxalidaceae	*Oxalis debilis*

S. No.	Family	Scientific Name
41	Poaceae	*Cynodon dactylon*
42	Poaceae	*Poa* sp.
43	Poaceae	*Imperata cylindrical*
44	Poaceae	*Moliniera cucuboides*
45	Poaceae	*Phragmites karka*
46	Poaceae	*Pogonatherum* sp.
47	Polygonaceae	*Fagopyrum* sp.
48	Polygonaceae	*Persicaria capitata*
49	Polygonaceae	*Polygonum persicaria*
50	Polygonaceae	*Persicaria chinensis*
51	Polygonaceae	*Polygonum flaccidum*
52	Solanaceae	*Solanum nigrum*
53	Solanaceae	*Solanum indicum*
54	Solanaceae	*Solanum viarum*
55	Solanaceae	*Physalis minima*
56	Urticaceae	*Elatostemma sessile*
57	Urticaceae	*Pouzolzia glaberrima*
58	Urticaceae	*Lecanthes peduncularis*
59	Urticaceae	*Pilea* sp.
60	Urticaceae	*Pouzolzia fulgens*
61	Urticaceae	*Urtica dioca*
62	Violaceae	*Viola diffusa*
63	Zingiberaceae	*Alpinia allughas*

10.3.9 FAUNA

The recorded forest area in the state is 55.62 percent of the geographical area of the state, which provide good habitat for wildlife. Animals such as Hollock Gibbons, Panther, Jungle Cat, Bison, Sambar, Barking Deer, Wild Boar, wild Mithuns etc are commonly found. Birds species found in the study area are, Indian Horn Bill, Grey Pheasant, Jungle Fowl, Green Pigeon, Doves,Tragopan etc.

Protected area (Fakim Wildlife Sanctuary)

Fakim Wildlife Sanctuary lies at the foot hill of Mt. Saramati under Pungro Sub-Division, 79 Kms away from the District Headquarters. This 641 Ha area of virgin forest was notified and declared as Fakim Wildlife Sanctuary by the state Government on 16th January 1984. This Bio-diversity rich area is home to the State Bird Blythe Tragopan and many other floral and faunal species.

This tract of pristine dense forest is linked with Myanmar on the Eastern side and serves as an important corridor for movement of animals and plant species. The Fakim Sanctuary receives high rainfall and houses some of the rare species of Flora & Fauna. The route of NW 101 is about 12 km away from the Fakim Wildlife Sanctuary

10.3.10 FISHERIES

Nagaland is a vibrant hill state located in the extreme north eastern end of India. Nagaland has good fisheries potential. It is endowed with rich and unique natural resources which provide immense potential for aquaculture development. With vast and varied fisheries resources, fishery plays an integral part which has tremendous potential of becoming a major contributor towards the improvement of states economy providing livelihood and employment to the local populace. Special efforts have been made to promote fish culture by way of adopting semi-intensive to intensive fish culture, paddy cum fish culture, reservoir fisheries, integrated farming etc in the state. Fisheries Department in Nagaland focuses towards achieving a level of self-sustenance in fish production through identification of weaker aspects of the resource utilization and development such as managing the rivers and reservoirs ensuring responsible fishing and sustainable fisheries, efficient application of technologies and strengthening the domestic marketing system.

Fishery resources of the state are meagre, comprising of about 30,000 hectares of lentil and 1600 Kms. of lotic resources. Utilization percentage is also remarkably low, being about 4.50% of lentil resource. The State is bestowed with hill streams and rivers, which abounds in some interesting and endemic fish fauna. The state has a potential of developing more reservoirs in future, which is under study and consideration by the Govt. This will boost more avenues in sport fishery, fish culture and production in the state. At present, Doyang reservoir having a total water area of 2258 hectares is also another fishery asset of the state. Lakes and reservoirs in the state have a total area of about 3528 hectares.

Paddy-Cum-Fish Culture is the second major resource for fish production in the state and is being practised in considerable areas. Presently the total area of paddy field that can be harnessed for integration with fish culture is about 75,700 hectares. There is still vast scope for developing more areas under this system that can be taken up through application of Scientific

Technologies for augmenting fish production. Details of fish species available in river Tizu and Zungki is given in Table 10.11 below:

Table 10.9 Fish species reported in river Tizu and Zungki

S. No.	Scientific Name	Common Name
	River Tizu	
1.	*Barilius vagra*	Korang
2.	*Chagunius nicholsi*	Chagunie Nicholsova
3.	*Neolissocheilus hexagonolepis,*	Boka, Chocolate mahseer
4.	*Neolissocheilus hexastichus*	Kuusliin-lauskmokk
5.	*Puntius clavatus*	Puntio barb
6.	*Tor chelynoides*	Dark mahseer
7.	*Tor putitora*	Common Himalayan mahseer
8.	*Schizothorax richardsonii*	Alawan snowtrout
9.	*Garra kempi*	Kemp garra
10.	*Garra lissorhynchus*	Khasi napplõug
11.	*Garra naganensis*	Naga garra
12.	*Psilorphynchus homaloptera*	Homaloptera minnow
13.	*Bagarius yarrellii*	Goonch
	River Zungki	
14.	*Barilus barna*	Bhola,
15.	*Crossocheilus latius latius*	Gangetic latia
16.	*Danio naganensis*	Anju
17.	*Puntius clavatus*	Masya puntius
18.	*Raiamas bola*	Indian trout
20.	*Garra annandalei*	Nungnga, Annandale garra
21.	*Garra notata*	Tenasserim garra, Kallunakki
22.	*Nemacheilus manipurensis*	Kai chau, Barred loach
23.	*Nemacheilus reticulogasciatus*	Ikan batu, Memayur
24.	*Nemacheilus sikmaiensis*	Gadela, Raitasistura
25.	*Nemacheilus vinciguerrae*	Marangi kivitrulling
26.	*Exostoma vinciguerrae*	sisorid catfishes
27.	*Glyptothorax cavia*	Catfish,
28.	*Channa stewarti*	Assamese snakehead

10.3.11 AGRICULTURE

Majority of the people in Nagaland are living in the villages and agriculture remains the main occupation of the people of the project area district as well. The primary mode of agricultural practice is jhum, also known as swidden or slashes & burn method of cultivation. The main crops grown in the jhum are largely traditional crops such as upland rice, maize, millet and varieties of beans. The farmers are slowly taking to growing cash crops such as potatoes with encouragement from the Agriculture department. Also traditional crops such as soya beans, local varieties of bean called '*Kholar'(Phaseolus sps)* is grown as cash crop using traditional methods. Farmers are also taking up permanent paddy cultivation in terraced fields in favourable terrains. However, maize which is primarily cultivated as fodder for the domestic animals is being increasingly cultivated on a larger scale for market purposes. The variations of jhum cycle are influenced by a variety of factors such as population, farming households, soil types and area under the control of the village. Therefore, there is no uniformity among the different villages.

The other system of farming is T.R.C (Terrace Rice Cultivation). It is practiced on the gentler hill slopes and also in the low lying areas where terrace benches are made using irrigated water from the streams. Only paddy of various varieties is cultivated during Kharif season. During the Rabi season paddy cultivation becomes problematic due to non availability of sufficient water. District wise area, production and yield of food grain is given in Table 10.12and district wise cropping area is also presented in Table 10.13.

Table 10.10 District wise area, production and yield of various crops

Type of Crop	District					
	Phek			Kiphire		
	Area (X1000 ha)	Production (X1000 MT)	Yield (kg/ha)	Area (X1000 ha)	Production (X1000 MT)	Yield (kg/ha)
Cereals	28.61	68.02	2577	20.04	42.66	2129
Pulses	3.5	3.99	1140	4.34	5.41	1235
Oil Seed	6.79	6.85	1009	3.05	3.12	1023
Commercial Crop	4.14	44.45	10737	1.57	21.01	13382
Total	**43.04**	**123.37**	**2865**	**29.04**	**72.20**	**2986**

Table 10.11 Cropping pattern of project area districts

S. No.	Areas	Districts	
		Phek	Kiphire
1.	Double Cropping Area (x1000 ha)	11.35	6.36
2.	Net Area Sown (x1000 ha)	31.69	22.68

3.	Net Irrigated Area (x1000 ha)	15.29	3.64
4.	Gross Irrigated Area (x1000 ha)	15.52	3.74

10.3.12 MINERAL RESOURCES

The state of Nagaland is mineral rich. The mineral rich opheolite belt of the Indo-Myanmar continental plate runs through the district. Consequently, the district is endowed with fairly rich mineral resources like extensive deposits of high grade Limestone, Magnetite and various Dimensional/Building Stones spread all over the district. This however may not be exhaustive because the prospect of mineral inventory is expected to rise after thorough prospecting in other locations in the district. The available Minerals in respect of their occurring locations are listed in Table 10.14 below:

Table 10.12 Availability of Mineral deposit alongwith their locations

Mineral Deposits	Location
Limestones	Mimi; Salumi; Kamkur
Magnetite	Pokphur; Thongsnyu
Granite	Mimi and Luthur
Sandstones	Seyochung, Rishitsu, Chanchore, Old Monger, Kisetong, & other areas
Green Spillite	Moya; Likhimro
Boulders &Silty Sand	River sides of Züngki and Thanaki rivers
Sheared Serpentinite	Mimi- Pungro- Salumi road

10.3.13 INDUSTRIES

Nagaland does not have many industries likewise project area districts also don't have major industry. As per statistical handbook of Nagaland 2017, the number of MSME industries registered in Phek and Kiphire are 47 and 37 respectively. The details are shown in Table 10.15.

Table 10.13 No. of Trade wise EM part-II Registered (MSME) during 2016-17

S. No	Particulars	Phek	Kiphire
1	Manufacturing of fabcricated metal products	3	2
2	Manufacturing of Furniture	10	5
3	Maintenance & repair of Motor Vehicle &motor cycle	9	6
4	Maintenance & repair of Personal and household goods	3	2
5	Computer and related activities	2	2
6	Other business activities	20	20
	Total	**47**	**37**

Source: Directorate of industries & Commerce

10.3.14 SOCIO-ECONOMIC BASELINE STATUS

The aim of the socio-economic study is to assess the overall impact on various facets of socio-economic environment due to establishment of the project in the Study Area Villages. The present chapter outlines baseline socio-economic scenario of the study area villages. The information presented in this chapter has been mainly extracted from Primary Census Abstract 2011.The length of NW 101 is 42 km from Longmatra Village to Avankhu Village then finally. Socio economic profile of the area covering 1 km on either side of the proposed NW 101 is outlined in the following section:

10.3.14.1 District Profile

Kiphire

Kiphire district, bifurcated from Tuensang district, was inaugurated as a full-fledged district on 24th January, 2004. It is located in the eastern part of the State and is 254 Kilometers away from the State capital, Kohima. The total area of the district is 1161.853 sq.km. It is bounded by Tuensang district in the North, Phek district in the south, Myanmar (Burma) in the east, and Zunheboto district in the West.The district is home to people of the Sangtam, Yimchungrü, and Sumi Naga tribe. Like most part of the State, the people of Kiphire district has diverse culture, customs and practices and they exist in perfect harmony with each other, displaying both unity and diversity. With the majority of the people living in the rural villages, agriculture remains the main occupation of the people of the district.

The district have five blocks namely Kiphire, Pungro, Sitimi, Longmatra and Khonsa. Longmatra and Khonsa are newly created blocks with the Government of Nagaland Notification dated 20th January,2012.The blocks part of the project area are Pungro and Longmatra.

Major activities identified as per the available resources in the area and market potential it is observed that Piggery, Poultry, Diary development and Bee keeping under area based schemes for the year 2016-17.

The main issues confronting the district with regard to agriculture and rural development are poor communication and transportation facility. To meet the infrastructural gap the State Government can avail funds under RIDF/NIDA for creating the required infrastructural facilities in the district. Focus needs to be given for creating more agri-link roads, storage- marketing infrastructure and land development for terrace cultivation.

With the implementation of the project it is expected to play a game changer as the facility of cargo proposed the exporting of the local products will become easier leading to change in the economic conditions of the residents.

Phek District

Phek District was earlier a Sub-Division of Kohima District. It was upgraded to a district w.e.f 21, December,1973. With an area measuring 2026 sq. Km Phek district is the second largest district in the State. Phek accounts for about 12.22% of the total geographical area of the State. The topography of the district is characterized by steep hills and these ranges are interspersed with a number of fast flowing perennial streams.

There are 8 blocks viz. Sekhrezu, Chetheba, Kikruma, Pfutsero, Chizami, Phek, Meluri and Weziho in the district. Project area is in Phek block.As per availability of resource and market potential, Fruit and Agro - Processing, Piggery, Poultry and Dairy development has been identified as major activities under area based schemes for the year 2016-17.

Similar to the Kiphire District Agriculture is the major occupation of the people of the district and crop production is the main activity which provides livelihood-cum-employment opportunities for the rural people. The new emerging/economic activities in the district is dairy farming and pisci culture. With the high demand for milk the farmers have shown interest in dairy activity as their additional income earning activity. Demand for fish of the district is met through supply from other states. Thus, farmers have started rearing fish as an activity for earning income. Bee keeping is another activity which have potential in the district and also good demand for honey in the market, farmers have now started this venture as an income generating activity.

The growth trend in the district is low since no major industries exist and employment scope is also very much low. Roads are the main means of transport and communication. However, the condition of most of these roads are below standard which are hampering the expansion of economic activities in the district.

As per the data it is observed that non-availability of approach roads which leads to lack of connectivity is the one of the major reason behind the slow development of the area. The project will provide solution to the problem of connectivity to the villages falling on 42 km stretch of waterways from Lomgmatra to Avankhu and will lead to smooth transportation of passengers as well as goods.

10.3.14.2 DEMOGRAPHIC PROFILE

10.3.14.2.1 Population

As mentioned the proposed project is located in the Sub-district Longmatra and Pungro of District Kiphire and Sub-district Phokhungri of District Phek. The study area or the Project Influence Area comprises of about 7 villages. The total population in the study area villages is of the order of 2919 persons as per Census of India 2011. The distribution of population and demographic profile in the study area villages is outlined in the table:

Table 10.14 Demographic profile in the study area villages

S.No	Name	Total Households	Total Population	Total Male Population	Total Female Population	Population <6	Average Family Size	Sex Ratio
	District Kiphiri							
	Sub-district Longmatra							
1	Longmatra	119	762	414	348	188	6	841
	Subtotal	**119**	**762**	**414**	**348**	**188**	**6**	**841**

S.No	Name	Total Households	Total Population	Total Male Population	Total Female Population	Population <6	Average Family Size	Sex Ratio
	Sub-district Pungro							
2	Lofukhong	38	243	131	112	68	6	855
3	Hakumti	40	142	74	68	38	4	919
	Subtotal	**78**	**385**	**205**	**180**	**106**	**5**	**878**
	District Phek							
	Sub-district Phokhungri							
4	Sutsu	120	485	244	241	101	4	988
5	Laruri	112	472	245	227	90	4	927
6	Phokhungri Vill.	126	629	331	298	112	5	900
7	Avankhu	42	186	84	102	48	4	1214
	Subtotal	**400**	**1772**	**904**	**868**	**351**	**4**	**960**
	Total	**597**	**2919**	**1523**	**1396**	**645**	**5**	**917**

Source: Primary Census Abstract, 2011

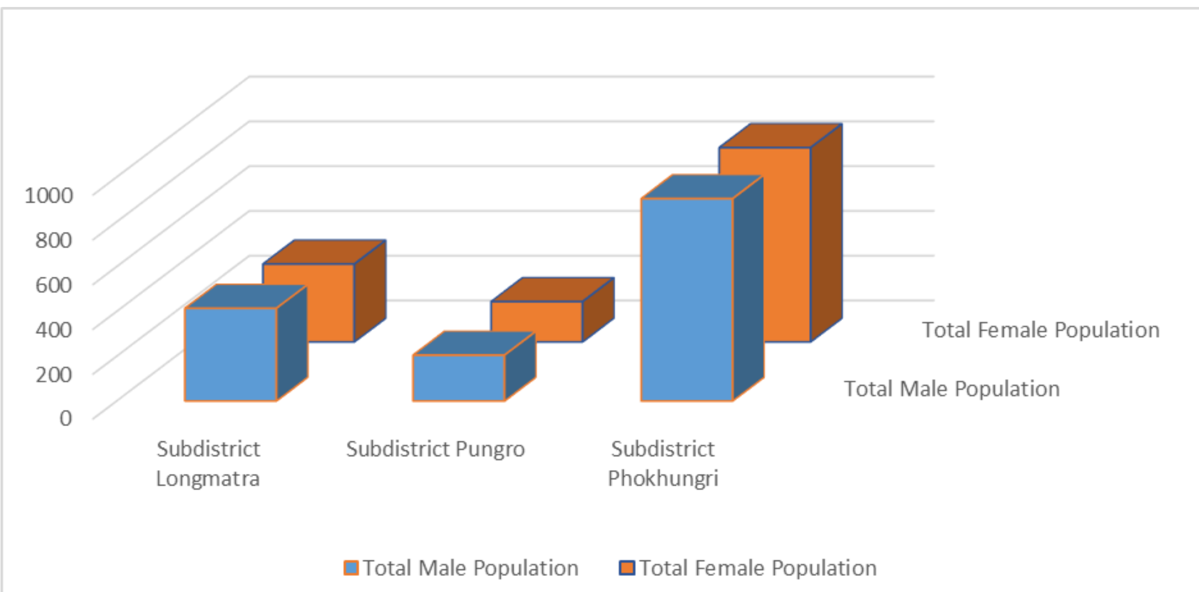


Fig. 10.9 Demographic profile in the study area villages

The male and female population in study area villages comprises about 52.18% and 47.82% respectively of the total population. The population comprising of children below the age of 6 years accounts for about 22.10% of the total population in the study area villages. The sex ratio (no. of females per 1000 males) and average family size in the study area villages is 917 and 5 persons per family respectively.

10.3.14.2.2 Caste Profile

The distribution of population in study area villages on the basis of caste is summarized in Table 10.17. The General Caste is the dominant caste in the study area accounting for about 1.92% .Schedule Tribe accounts for 98.08% majority of the total population in the study area villages.

Table 10.15 Caste profile in the study area villages

S.No	Name	Total Population	Population Schedule Tribe	Population General Caste
	District Kiphiri			
	Sub-district Longmatra			
1	Longmatra	762	747	15
	Subtotal	**762**	**747**	**15**
	Sub-district Pungro			
2	Lofukhong	243	242	1
3	Hakumti	142	142	0
	Subtotal	**385**	**384**	1
	District Phek			
	Sub-district Phokhungri			
4	Sutsu	485	481	4
5	Laruri	472	445	27
6	Phokhungri Vill.	629	623	6
7	Avankhu	186	183	3
	Subtotal	**1772**	**1732**	40
	Total	**2919**	**2863**	**56**

Source: Primary Census Abstract, 2011

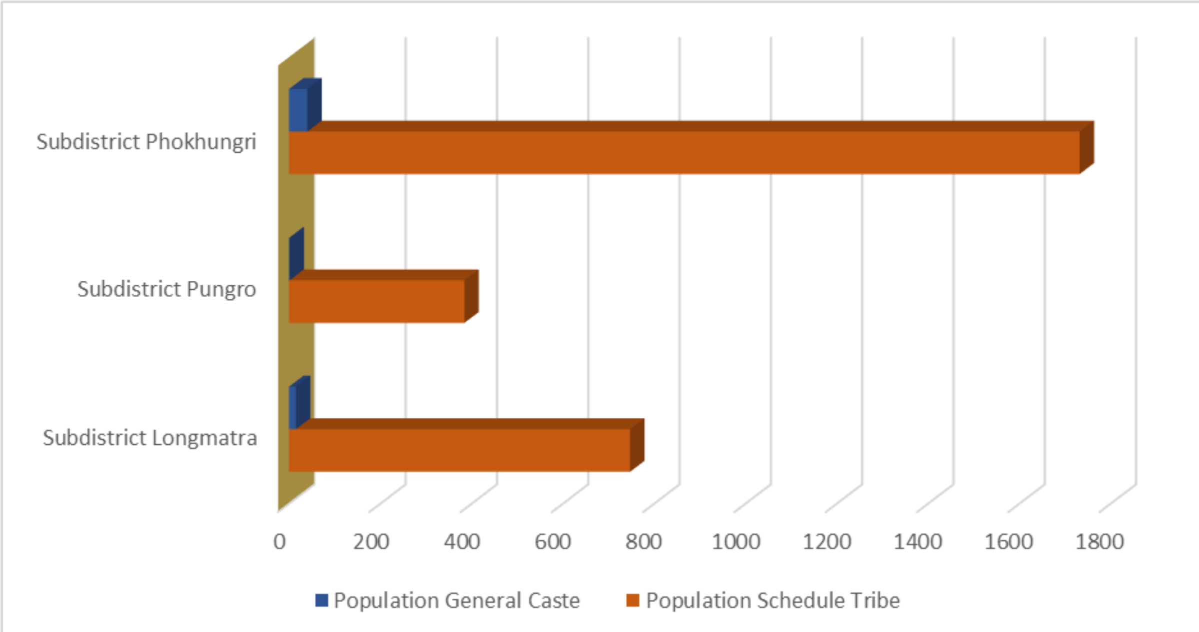


Fig. 10.10 Caste profile in the study area villages

10.3.14.2.3 Literacy Levels

The details of literate and illiterate population amongst the total population of study area villages are shown in Table 10.18. It is observed that about 54.0% of the total population in the study area villages is literate, while about 46.0% are illiterate . The literacy rate among male and female population is 59.9% and 47.5% respectively.

Table 10.16 Distribution of literate and illiterate population in study area villages

S.No	Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
	District Kiphiri							
	Sub-district Longmatra							
1	Longmatra	762	455	275	180	307	139	168
	Subtotal	**762**	**455**	**275**	**180**	**307**	**139**	**168**
	Sub-district Pungro							
2	Lofukhong	243	53	35	18	190	96	94
3	Hakumti	142	33	22	11	109	52	57
	Subtotal	**385**	**86**	**57**	**29**	**299**	**148**	**151**
	District Phek							
	Sub-district Phokhungri							
4	Sutsu	485	309	169	140	176	75	101

S.No	Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
5	Laruri	472	307	178	129	165	67	98
6	Phokhungri Vill.	629	405	224	181	224	107	117
7	Avankhu	186	14	10	4	172	74	98
	Subtotal	**1772**	**1035**	**581**	**454**	**737**	**323**	**414**
	Total	**2919**	**1576**	**913**	**663**	**1343**	**610**	**733**

Source: Primary Census Abstract-2011

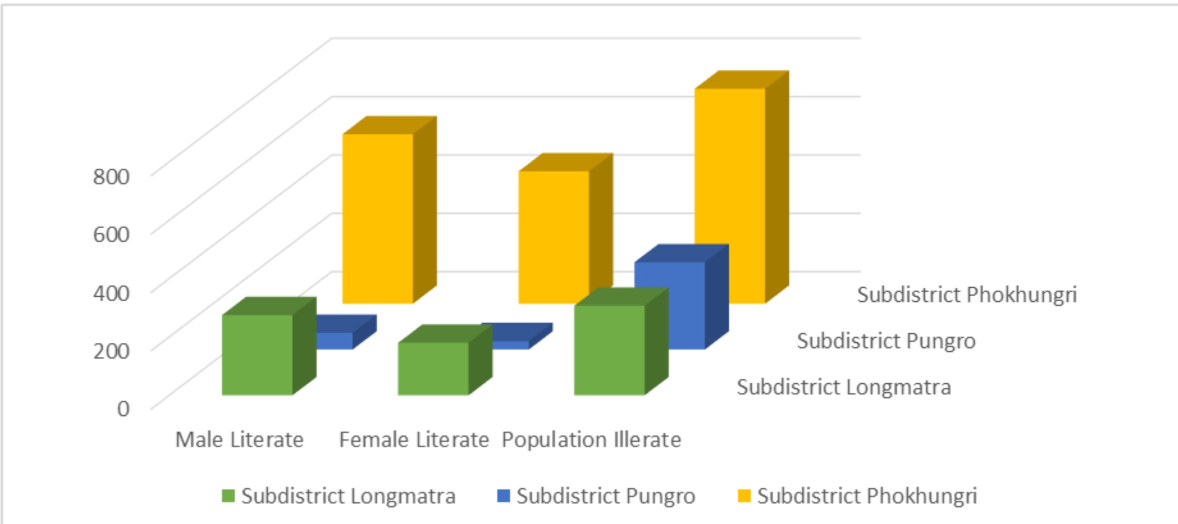


Fig. 10.11 Literacy profile in the study area villages

10.3.14.2.4 Occupational profile

The details on occupational profile in the study area villages are given in Table 10.17. It is observed that 44.74% of the total population is engaged in some form of economically productive activity or vocational activity, and have been designated as Total Working population. On the other hand, Non-workers or persons who are dependent on the population, which is engaged in economically productive work accounts for about 55.26% of the total population. Among the population that is working about 86.06% has been designated as Main workers while the remaining 13.94% has been designated as Marginal workers.

Table 10.17 Occupational profile in the study area villages

S.No	Name	Total Population	Working Population	Main Workers	Marginal Workers	Non Workers
	District Kiphiri					
	Sub-district Longmatra					
1	Longmatra	762	309	235	74	453
	Subtotal	**762**	**309**	**235**	**74**	**453**
	Sub-district Pungro					
2	Lofukhong	243	91	77	14	152
3	Hakumti	142	88	70	18	54
	Subtotal	**385**	**179**	**147**	**32**	**206**
	District Phek					
	Subdistrict Phokhungri					
4	Sutsu	485	214	192	22	271
5	Laruri	472	209	207	2	263
6	Phokhungri Vill.	629	279	277	2	350
7	Avankhu	186	116	66	50	70
	Subtotal	**1772**	**818**	**742**	**76**	**954**
	Total	**2919**	**1306**	**1124**	**182**	**1613**

Source: Primary Census Abstract 2011

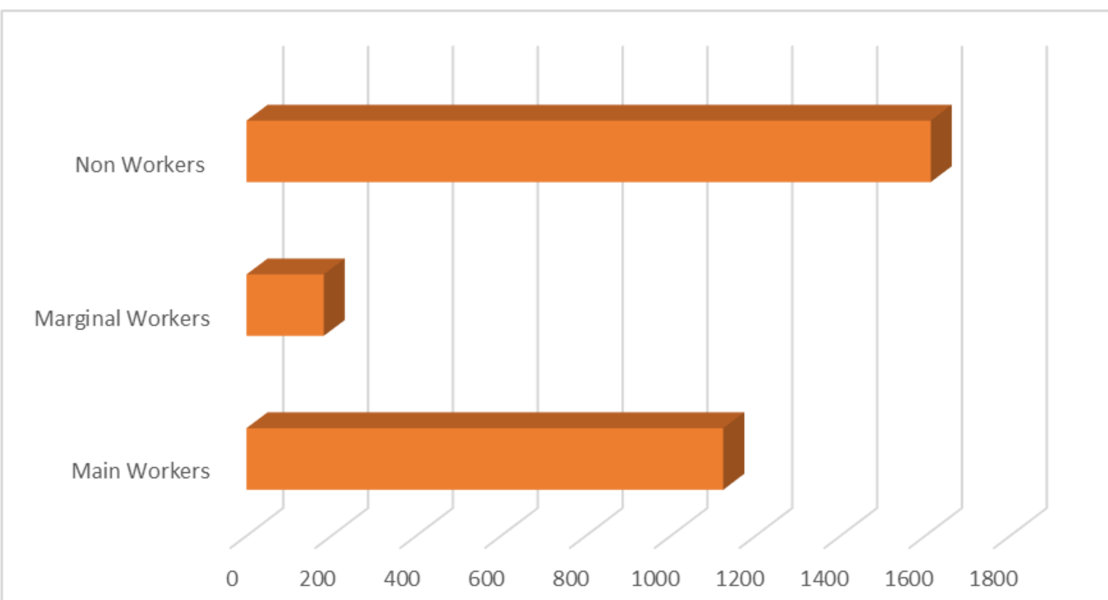


Fig. 10.12 Occupational profile in the study area village

10.4 PREDICTION OF IMPACTS

10.4.1 INTRODUCTION

Based on the project details and the baseline environmental status, potential impacts that are expected to accrue as a result of the proposed project have been identified. The assessment exercise for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, impacts have been quantified. However, for intangible impacts, qualitative assessment has been done. The construction and operational phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impact on the environmental attributes and are discussed in the subsequent sections. The dredging proposals are mainly carried out to provide more navigable water depths in the river. The probable impacts of each of these activities on various parameters of environment have been mentioned below in two phases:

- Construction Phase
- Operation Phase

10.4.2 IMPACTS DURING CONSTRUCTION PHASE

Construction of Terminals and Dredging are the key elements of the present project. Development of Terminals will include the land acquisition, clearing and levelling of land for the terminal infrastructure facilities. Total land requirement for each Terminal shall be 0.5 acre. The impacts during construction phase will be localized and short-term and primarily related to civil works and erection of equipment. The duration of impact will be limited to the construction phase only. The following activities may cause environmental impacts during construction of the proposed project:

- Site preparation
- Excavation and backfilling
- Hauling of earth materials
- Dredging activities

- Piling, cutting and drilling
- Noise from heavy equipment operation
- Road construction
- Landscaping and Green belt development

The details of activities and probable impacts during construction phase are depicted in Table 10.18.

Table 10.18 Identification of Activities & Probable Impacts during Construction Phase

Activities	**Sector**	**Anticipated Impacts**
Site clearing and leveling (cutting, stripping excavation, earth movement, compaction, Dredging)	Air	Fugitive dust emission
		Air emission from construction equipment and machinery
	Water	Run off from grass stripped area.
	Land	Loss of fertile top soil
		Change in drainage pattern
	Terrestrial Ecology	Loss of vegetation
	Aquatic Ecology	Impacts on planktons, benthic fauna,
Transportation and storage of construction material/ equipment	Air	Air emission from vehicles
		Fugitive dust emission due to traffic movement
	Water	Spilling of construction material and flow into streams
		Run–off from storage areas of construction material
	Soil	Deposition of spilled construction material and flow into streams
	Public utilities	Increased flow of traffic and congestion
Civil construction activities	Air	Fugitive dust emission from construction
	Water	Run–off from erection areas containing oils, paints
	Socio-economic	Increase in employment
Influx of labours	Socio-economic	Stress on infrastructure
		Stress on social relation

10.4.2.1 Impacts on Air Environment

Project terminals shall be developed in the areas having very less population density, very less traffic movement and negligible industrial activity. Hence, ambient air quality in the area is good. However, construction activities would involves clearing of vegetation and tree cutting at few locations and construction of approach roads. The potential source of air quality impact during construction phase would be generation of fugitive dust from arising from the construction activities and operation of construction equipment and vehicular movement over roads, etc. The possible construction activities that contribute to the environmental impacts are broadly given below:

- Dust generation during leveling of earth
- Dust generation due to the movement of vehicles on unpaved roads
- Emission of pollutants from vehicular exhaust
- Unloading of raw materials and removal of unwanted waste material from site
- Accumulation of excavated earth material

The impact will be for short duration and confined within the project boundary and is expected to be negligible outside the plant boundaries. However, the plant site is cordoned off by a high boundary wall and planned green belt; such impacts will be confined only within the plant site.

10.4.2.2 Impact on Noise Environment

The major sources of noise during construction phase are due to operation of various construction equipment. The noise levels generated by various construction equipment are given in Table 10.21. Under the worst case scenario, considered for prediction of noise levels during construction phase, it has been assumed that equipment required during construction phase is operating at a common point. Likewise, to predict the worst case scenario, attenuation due to various factors too has not been considered during noise modelling.

Table 10.19 Average noise levels generated by the operation of construction equipment

Equipment	Noise level (dB(A))
Batching Plant	90
Transit mixer	75
Generator	85
Concrete mixer	75
JCB-3D	85
Trailor	85
Excavator	80
Dumper	85

Equipment	Noise level (dB(A))
EoT cranes	80
Ordinary cranes	75

Modeling studies were conducted to assess the increase in noise level due to operation of various construction equipment, and the results of this exercise are given in Table 10.22. It would be worthwhile to mention here that in absence of the data on actual location of various construction equipment, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier.

Table 10.20 Predicted noise levels due to the operation of construction equipment

Distance (m)	Ambient noise level (dB(A))	Increase in noise level due to construction activities (dB(A))	Noise level due to construction activities (dB(A))	Increase in ambient noise level due to construction activities (dB(A))
30	45	70	70	25
50	45	66	66	21
100	45	60	60	15
200	45	54	55	10
500	45	46	49	4
1000	45	36	46	1
1500	45	36	45.5	0.5
2000	45	34	45	-

Walls of various houses or other structure will attenuate at least 30 dB(A) of noise. In addition there is noise attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric in-homogeneous
- Vegetal cover

Thus, no increase in noise levels are anticipated as a result of various activities, during the project construction phase due to the following:

- assumption that all equipment are operating from a common point leads to over-estimation of increase in noise level
- attenuation of 30 dB(A) of noise by wall of any structure
- noise attenuation due to various factors.

10.4.2.3 Impacts Of Noise On Labour Population

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as in Table 10.23.

Table 10.21 Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	**8**
95	**4**
100	**2**
105	**1**
110	**½**
115	**¼**
120	**No exposure permitted at or above this level**

The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in our country through rules framed under Factories Act.

10.4.2.4 Impact on Water Environment & Hydrology

The primary construction impact will be the increased soil erosion from the construction sites as these sites will be cleared of all vegetation. The erosion will also cause some increase in the quantity of suspended solids and turbidity during heavy rainfall in monsoon months in nearby drainage due to run-off from site area. However, reducing the area denuded of vegetation for construction work at any given time will reduce significantly this problem. Furthermore, this impact will be of temporary nature and may not last as soon as excavated soil and construction debris are disposed-off properly.

10.4.2.5 Impacts due to effluents from labour camps

During construction phase, peak labour requirement has been estimated as 30 at each Terminal location. The total water requirement has been estimated as 40.5 m^3/day (@ 135 lpcd) for each Terminal. The sewage generated is normally taken as 80% of the total water requirement. Thus, the sewage generated would be of the order of (0.8 x 40.5) 32.4 m^3/day. The disposal of sewage without treatment could lead to significant problems related to water pollution and public health. Hence, it is proposed to provide Community toilet with septic tanks at each Terminal.

10.4.2.6 Impact on Topography & Land-use

Land requirement for each Terminal has been estimated as 0.5 acre. Most of the land is the community land/Forest, which shall be leveled to the desired level to avoid inundation during floods. The project site is more or less leveled land thus there will be not much cutting filling and leveling of land. Clearing of vegetation and tree cutting would be required at few locations.

10.4.2.7 Impact on Ecological Environment

The terminal are proposed on the river bank and the there is no reserve / protected forest in and around proposed site. There is no ecologically sensitive site habitat in the study area. However tree felling would be required for the construction of the Terminals and approach roads. In order to prepare the site for the construction work there might be cleaning of shrubs present at the site. It is recommended that, proper landscaping and tree plantation and Green belt development from beginning of construction activities be done. The project proponent shall follow the process of environmental preservation by plantation at the site and its surroundings right from the commencement of construction phase Therefore, significant ecological impacts are not envisaged during construction phase of the proposed project.

10.4.2.8 Impact on phyto plankton and primary productivity

Release of untreated effluent from construction site and dredging activities may lead to increased turbidity and consequent reduction of light penetration for short periods. This may affect primary productivity and plankton biomass. However, increase in turbidity will be observed only in a localized area and only for a very short duration. Hence impacts on this account are expected to be marginal in nature.

Water quality monitored as a part of the study did not indicate the presence of and source of pollution in the area. The proposed project brings no change in the physico-chemical characteristics of the river system as there is no proposed plan for any kind of effluent discharge in the project. There are no records or sighting of rare / endangered / threatened organisms in the region.

10.4.2.9 Impact on fisheries

The project envisages the construction of Terminals and dredging in river at few stretches which will lead to increased turbidity and consequent reduction of light penetration for short periods, which may affect the gills of the fishes and would result in the reduction in availability of feed to fishes. However, increase in turbidity will be observed only in a localized area and only for a very short duration and fishes are likely to avoid the construction and dredging areas during construction phase. Hence impacts on this account are expected to be marginal in nature.

10.4.2.10 Impact on Existing Traffic Scenario

During construction of any large project, there is always chance of traffic congestion on nearby roads due to vehicular movement. However increase in vehicles during construction phase will not have much impact on the traffic scenario. Also some of the existing roads will be strengthen to accommodate the heavy vehicles and reduce inconvenience of local population. A traffic management plan for the area will be made before start of construction to ease the traffic congestion during construction phase.

10.4.2.11 Impacts on Socio-Economic

The construction phase would have both positive and negative impacts on the people as there may be displacement or effect on the source of livelihood of the residents due to acquisition of community forest land. Similarly project will lead to several positive impacts as the requirement of mass number of labourers shall be required during construction phase. Details on positive and negative impacts during construction phase are listed below:

- **Employment opportunities**

  The construction phase will last for about 2 years. The peak labour force and technical staff required is estimated at about 300. The construction phase of any project is rather an unsettled stage characterized by uncertainties and often disorders. The basic problem relates to management of large population, which migrates to the project area or near major construction sites, in search of jobs. It has been estimated that about 300 persons will inhabit the area during construction phase, which is likely to last for a period of about 2 years.

  The construction of the proposed project would invariably create a number of direct employment opportunities. However, indirect employment opportunities would also be generated which would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The locals would also avail these opportunities arising from the project and increase their income levels.

The construction of the project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project construction phase.

- **Increase in incidence of vector- borne diseases**

  The construction of project would convert riverine ecosystem into a lacustrine ecosystem. The vectors of various diseases may breed in shallow parts of the impounded water. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water is in direct proportion to the length of the shoreline. The increase in submergence area in the proposed project would lead to increase in the incidence of vector-borne disease on account of proliferation of mosquitoes. The project area could face increased incidence of malaria as a result of various factors like aggregation of labour, formation of stagnant pools near labour camps, colonies, etc. may lead to the increased incidence of such diseases around the project area.

- **Inadequate facilities in labour camps**

  Improperly planned labour camps generally tend to become slums, with inadequate facilities for potable water supply and sewage treatment and disposal. This could lead to outbreak of epidemics of water-borne diseases. Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan outlined in Volume-III of this Report.

10.4.3 IMPACT DURING OPERATION PHASE

10.4.3.1 Impact on Air Quality

The source of air emissions during operation phase would be operation of ships. Suspended as well as respirable particulates are expected to be generated from cargo handling, operation of ship engines as well as generators, vehicular movement, etc.

However number and frequency of ship movement would be very less. Project envisages the operation of passenger ferry service. As the quantity of cargo is also very less small barges shall be used for Ships. Hence, no major impact on ambient air quality is anticipated during operation phase.

In the present scenario, loading and unloading of materials, movement of dumper and other vehicles on road are the major sources to generate fugitive dust. However, the air pollution caused due to ground level sources like movement of vehicles, wind effects etc. does not rise to very high elevation and thus do not disperse beyond the area.

10.4.3.2 Impact due to transportation of materials

The project area is having hilly terrain and road connectivity is not good in the area. Hence, the proposed project would be very help full in providing the cargo transportation facilities to the local community and will provide impetus to the developmental activities in the region.

10.4.3.3 Impact on Noise

During operation phase, noise pollution would be generated mainly from ships' generators, engines and propellers and road transportation arising from the terminals. It is proposed that all the cargo handling equipment will comply with the MoEF & CC's rules and stipulations. All vehicles including Cargo handling equipment will be well maintained to mitigate undesired noise pollution. A planned green belt will also reduce noise pollution within terminal premises.

10.4.3.4 Impact of Oil Spills

Oil spills may occur accidentally during bunkering operations & accidents of ships. Oil spills often poses a great threat to the natural resources, fishes, birds and mammals as also to a wide range of subsurface aquatic organisms. It is proposed to provide oil response kit at each Terminal/ship.

10.4.3.5 Impact of Solid Wastes

While loading & unloading of cargo proper care to be taken to avoid spillage. The impact of accidental release of solid cargo, particularly during rough weather, can take place. Cargo operations produce wastes like remains of bulk cargo storage, waste packaging materials, floating garbage and other wastes, generated from day to day activities. Such solid wastes will be segregated into recyclable and non-recyclable wastes. The former type will be handed over to the recyclers, and non-recyclable wastes will be disposed off. Proper storage facility will be created for temporary storage of such wastes. Domestic solid waste likely to be generated at each Terminal shall be collected and disposed off at Municipal dumping grounds. Thus, no negative impact to the environment due to handling of solid wastes is anticipated.

10.4.3.6 Impact due to Ships generated wastes

The other problem envisaged during operation phase could be the disposal of garbage. This could comprise floating materials, packaging, polythene or plastic materials. Garbage accumulated on the deck is also problematic and should be suitably disposed. The solid waste in the proposed project could also be generated mainly from three sources viz. institutional/ office waste, domestic waste and waste from cargo handling etc. The office waste in the proposed project could be in the form of packing material, cardboard, etc. which is not expected to be significant. The same is proposed to be routinely collected and are disposed as per the prescribed Municipal Solid Waste (MSW) Rules.

10.4.3.7 Impact on Land Environment

The total land requirement for each Terminal would be about 0.5 acre, which belongs to the community in forest and generally covered by open vegetation. Vegetation shall be cleared for the development of Terminals. Proper compensation of land shall be paid to the community as per market rates in accordance with prevailing guidelines. A lot of ancillary developments like shops, restaurant, repair shops, etc. would develop around the Proposed Terminals. This will lead to conversion of land into commercial use.

10.4.3.8 Impact on Biological Environment

Green belt will be developed at each Terminal and road side plantation shall also be raised on approach road, which will improve the bio aesthetics in the project area. The waste water will undergo proper treatment before discharge into the river. Hence, there will be insignificant impact on the aquatic environment of the river. Waste water generated from the Terminals will be treated as per CPCB standards & the same will be used for gardening/dust suppression. Hence, no negative impact is anticipated due to the operation of the proposed project on biological environment.

10.4.3.9 Impact on Socio-Economic Environment

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed development of national waterway -

101 from Longmatra to Avankhu in the state of Nagaland Project on Social Aspects have been covered in the subsection

The present Inland waterways Project likely to affect land in 7 Villages of Phek and Kiphirie Districts. It is expected that there will be acquisition of 0.5 acre of Community / forest land shall be done. The Details of affected land is given in Table 10.24.

Table 10.22 Details of Affected Land

S. No.	Description	Name of village	Acquired Area (acre.)
1.	Terminal-1	Near Bridge on Zungki river	0.5
2.	Terminal-2	Near Longmatra	0.5
3.	Terminal-3	Near Laruri Bridge	0.5
4.	Terminal-4	Near Pokhungri	0.5
	Total		**2**

The loss of community forest/land shall be compensated on the basis of the guidelines elucidated in “Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013” and if any applicable guidelines/ rules and regulation of “Forest Right Act 2006” and Tribal Rules.

10.4.3.9.1 IMPACTS DUE TO LAND AQUISITION

Forced resettlement carries severe risks of impoverishing the uprooted people, many of who are poor even before displacement. Thus, the main socio-economic concerns in resettlement operations revolve around reducing the impoverishment risks and restoring resettlers livelihoods.

A project is likely to entail both positive as well as negative impacts on the socio-cultural and socio-economic fabric of the area.

10.4.3.9.2 IMPOVERISHMENT RISK ASSESSMENT (IRA)

In project feasibility and preparation studies, the IRA performs two basic functions. Foremost, it serves as a diagnostic and predictive tool, to anticipate risks in resettlement and to assess their nature and their expected intensity. Secondly, IRA is also used as a problem resolution and planning function, to guide the incorporation of measures matching each main risk, either for prevention or mitigation. The IRA identifies impoverishment not only in terms of income, but also in terms of employment opportunities, health care, nutrition, food security, common assets, education, shelter or social capital.

The IRA framework has been synthesized from the knowledge of past experiences, which saves considerable time and effort in feasibility work by not demanding general risk analysis to start afresh in each project, but rather by *ex-ante* offering a well-tested starting point. The matrix of eight basic risks in light of historical experience, predictable in most resettlement situations: Landless, loss of access to common property, and social (community) dis articulation. Each of these risks is discussed in Table 10.25.

Table 10.23 Impoverishment Risk Assessment

S. No.	Risks involved	Description of risks involved	Details
1.	Landless	Expropriation of land removes the main foundation on which people build productive systems, commercial activities, and livelihoods. Often land is lost forever, sometimes it is partially replaced, and seldom is it fully replaced or fully compensated. This is the principal form of de-capitalization and pauperization of displaced people, as they lose both natural and man-made capital.	As per our assessment, there are about 2 acre of who are likely to lose their lands in varying proportions due to the process of land acquisition. The villagers depend on their lands for their livelihood. In addition, there are a number of families that are dependent on these lands for their livelihood, who work as agricultural labour work force. Acquisition of lands would invariably affect their means of livelihood and sustenance.
2.	Improper Management of Money (Compensation Amount)	The affected population will get lot of money in form of compensation of their properties and other grants as per applicable R&R Policy.	Some of the Villagers are not wise enough to invest their money in purchase of agriculture land or in other sources of alternative

S. No.	Risks involved	Description of risks involved	Details
			livelihoods. Money becomes a great cause of family rift also so the money should be invested wisely having a foresighted approach of life.
4.	Other Indirect Losses of Displacement (Women Insecurity)	Displaced people often internalize a sense of helplessness and powerlessness because of their encounter with the powerful external world, although there are also several examples of active resistance movements against development-induced displacement. Displacement also leads to deterioration in health and high mortality rates as services in those selected areas are the first to be cut.	

10.4.3.9.3 POSITIVE IMPACTS

The benefit of the Project will be accrued to 7 Villages. There will be number of positive changes on the socio-economic conditions of the affected people as well as on the population to be benefited by the Project living in the surrounding areas. There will be obvious change in the scenario leading into the Socio-economic development of the area. Some of the probable positive impacts on socio-economic environment due to the project are given in below:

Positive Impacts likely to accrue as a result of the project

- **Employment Potential/Local Trade:** The project will provide adequate employment opportunity during construction as well as operation phase. Many families will get job which will improve their socio-economic condition. Due to increase in the connectivity it will lead to access to better amenities and facilities and passenger ferry will mushroom small business like Tea stall, Newspaper and Magazine stalls, Snack Joints. The Cargo will promote growth in export of the local products and handloom.

- **Improvement in Lifestyle, Social Status and confidence building:** The economic growth and availability of more job opportunities in the area will lead to be improvement in lifestyle and social status of the people. The social status of the people can change only when there is economic growth in the society. The construction of the project will bring many positive changes resulting into the development of the area. This will give immense confidence to the people to achieve better prospects in life which is certainly going to increase their social status.
- **Provide local services like education, healthcare, community forests etc.:**
  The commissioning of the project will increase gross money flow in the project area. This will lead to significant impacts in the project area. The area will have increased demands for services, such as sewerage system, communication, transportation, medical and educational facilities, etc. It is presumed that all these developments would result in generation of additional employment. Thus, with the increased income level, there will be an improvement in the local service facilities.
- **Business opportunities**
  Apart from direct employment, opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in the income levels, there will be an improvement in the infrastructure facilities in the area.

  The project construction will improve the subsidiary employment opportunities on account of commissioning of workshops, small vehicle and equipment repair shops etc. The locals will avails these opportunities arising from the project.

- **Local participation in the project activities**

  After the construction work is over, the project will require some permanent posts for the smooth operation and regular maintenance of project components. Locals will be recruited for administrative and technical works according to their qualification and skills. These will give permanent income source to some of the local people.

10.4.3.10 Impact on local economy

The construction phase would lead to generation of temporary employment opportunities such as requirement of manpower/vessels to trans-ship the materials, ground clearing, road laying works etc. These activities would temporarily increase the income levels of the local population. Thus, this will not only improve the economy of the port but also the economy of the entire region as a whole.

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CHAPTER-11

ENVIRONMENTAL MANAGEMENT PLAN

11.1 INTRODUCTION

Environmental Management Plan is a plan that seeks to achieve a required end state and describes how activities that have or could have an adverse impact on the environment, will be mitigated, controlled, and monitored.

The EMP will address the environmental impacts during design, construction and operation phases of a project. Due regard must be given to environmental protection during the entire project. In order to achieve this, number of environmental specifications/ recommendations has been made. These are aimed at ensuring that the proponent/contractor maintains adequate control over the project in order to minimize the extent of impact during construction, ensuring appropriate restoration of areas affected by construction, and preventing long term environmental degradation.

Environmental impacts arising due to development activities are the key aspects on EIA study. An equally essential element of this process is to develop measures to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning has been done by clearly defining the environment requirements within an Environment Management Plan (EMP). The Management Action Plan aims at controlling pollution at the source of generation itself to the maximum possible extent with the available and affordable technology followed by treatment measures before they are discharged.

Formulating Environmental Management Plan, which specify mitigation, monitoring activities and indicators to be attached to Annual and periodic activity plans for project implementation.

11.2 ENVIRONMENTAL MANAGEMENT PLAN - CONSTRUCTION PHASE

The potentially negative impacts of proposed dock are expected during construction phases. Good constructions practices are key to minimize, if not eliminate such negative impacts. The measures to be adopted during the construction phase to mitigate the adverse impacts are described in the following paragraphs.

11.2.1 Ambient Air Quality

The major source of air pollution in the proposed project is the use of DG sets, increased vehicular movement and dredging activities during project construction phases. The movement of vehicles is likely to increase during construction phase, which would lead to increase in air pollution. Thus, following mitigation measures are recommended:

- All machinery of dredgers, barges etc. used for Terminal and jetty construction are to be maintained properly for optimum consumption of fuel and to mitigate air pollution.
- It is recommended to use low sulphur diesel oil in DG sets as well as other equipment used at construction site that are run on fuel.
- Vehicles like trucks, trailers, tankers etc. having valid Pollution Under Control (PUC) certificates will only be used at the construction site.
- All the roads in the vicinity of the project site should be paved or black topped to minimize the entrainment of fugitive emissions
- Regular water sprinkling to be done for dust suppression in the construction site.
- Suitable plant species shall be planted in and around proposed project site.
- The workers would be advised to prevent open fires within the work site.

11.2.2 Noise Environment

The use of DG sets, increased vehicular movement and dredging activities during construction phases are likely to increase the ambient noise levels mainly along the road alignment. During construction phase, use of various construction equipment is the major source of noise. However, based on the modeling studies, the noise due to operation of various construction equipment is not likely to have any adverse impact on the habitations in nearby villages. However, efforts need to be made to reduce the noise generated by the various construction equipment. The various measures that could be implemented are as follows:

- It is proposed to develop a greenbelt at each Terminal and along the approach roads. Three rows of trees will be planted.
- Vehicles and construction equipment with internal combustion engines without proper silencer will not be allowed to operate at the construction site.
- Cargo loading and unloading operation would be done in such a manner to ensure minimum noise generation.
- Construction equipment to be maintained properly to ensure minimum noise generation.
- Noise from air compressors to be reduced by fitting exhaust mufflers and intake mufflers.
- Chassis and engine structural vibration noise can be dealt by isolating the engine from the chassis and by covering various sections of the engines.
- Noise levels from the dredger shall be minimized by fitting of exhaust mufflers and the provision of damping on the steel tool.
- Exposure of workers near the high noise levels areas shall be minimized by job rotation/automation, use of ear plugs, etc

The effect of exposure of high noise levels on the workers operating the various construction equipment is likely to be harmful. It is known that continuous exposure to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, has to be avoided. To prevent the adverse impacts, the exposure to high noise levels should be restricted as per the exposure period outlined in Table 11.1. Workers operating in the high noise areas shall be provided with ear plugs.

Table 11.1 Maximum Exposure Periods specified by Occupational Safety and Health Administration (OSHA)

Maximum equivalent continuous Noise level dB(A)	**Unprotected exposure period per day for 8 hrs/day and 5 days/week**
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

11.2.3 Water resources

Surface Water Quality

- Passenger and cargo vessels will be sized such that adequate clearance is maintained between vessels and the riverbed in all tide conditions, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash.
- Dredged material will be excavated and disposed of in such a manner to minimize loss of contaminants either into solution or by re-suspension.
- The decks of ships and dredgers will be kept tidy and free of oil or other substances that might be accidentally or otherwise washed overboard. Litter and loose objects, e.g. tools, will not be left lying around.
- Vessels used for construction purposes will not discharge of sewage and oily waste into the river, rather the same will be collected at Terminal
- Used oil will be collected and handed over to registered re-recyclers
- No vessels will be allowed to discharge their garbage in the river. Such garbage should be disposed off at Terminal, wherein it will be stored and disposed off at designated sites
- Construction wastes like rubbish, food wastes, oil or chemicals etc. will not be disposed off into the river.
- High standards of waste management shall be observed on the works vessels and barges to ensure that no waste arising or fuel/diesel oils are disposed to the surrounding marine waters.

Ground Water Quality

- Ground water abstraction is not envisaged. For construction purposes water required for this port will be available from the river/streams.

Sanitation Facilities in Labour Camps

The major source of water pollution in the construction phases is the sewage generated from the labour camps and construction activities. During construction about 300 labours will be working for all five jetty locations. The total water requirement during construction phase is

120.5 m^3/day. The total domestic water requirement for labour and staff has been estimated as 40.5 m^3/day. Thus sewage generated in this phase, would be of the order of 32.4 m^3/day. It is proposed to construct 5 Nos. of community toilets with septic tanks within Terminal premises. An amount of Rs. 8 lakh (Rs 2 lakh/ per Terminal) has been earmarked for construct of community toilets and sewage conveyance system.

Effluent from workshops, oil storage etc.

The effluent from workshops, oil storage, etc. will contain oil and grease particles which shall be treated in an oil skimmer and suitably disposed after treatment. The collected oily matter shall be stored in cans, etc. and sold to registered recyclers.

11.2.4 Land Environment

Total land requirement for each Terminal is 1 acre, and which is a community land. Appropriate compensation shall be paid for the land as per prevailing norms. However, during construction and operation phase, lot of ancillary developments like shops, restaurant, repair shops, etc. may develop around the Terminal locations. This may lead to additional load on the existing infrastructure in the area. The following measures are recommended to be taken during construction phase:

- Unwanted material will be properly disposed off in designated areas in consultation with the Municipal authority.
- All wastes, unused construction materials and construction equipment shall be removed from the construction site after completion of the construction activities.
- Hazardous wastes, generated during construction phase will be segregated in two categories viz. usable and non-usable. Usable fractions will be handed over to the registered waste recyclers and the non-usable fractions will be disposed off in consultation with Municipal authority.
- Recyclable solid waste be segregated & handed over to Material Management division for recyclable. Non-recyclable waste to be handed over to Municipal authority.

- Proper storage and site practices would be encouraged to minimize the potential for damage or contamination of construction materials.
- Training of site personnel in proper waste management procedures would be undertaken.

11.2.5 Biological Environment

Proposed project envisages the development of 4 Nos. of passenger and cargo Terminals in river stretch of Tizu and Zungki rivers for passenger and cargo Terminals are proposed to be developed as a part of the project. Total land requirement for each Terminal is about 0.5 acre. It is advisable; tree cutting should be avoided during the construction phase. During construction phase, labours will stay at the construction site, they have tendency to cut tree to meet their fuel requirement. Hence, it is proposed that fuel would be supplied for labour camp at subsidized rates to prevent illegal tree cutting for fuel wood. The contractor will make necessary arrangement for provision of free fuel.

11.2.6 Socio-economic Environment

- Maximum utilization of the local population in the construction activities will be made.
- Potable water will be made available to the construction workers.
- Outstation workers will be provided with proper shelter to be set-up within the project site. Accommodations potable water and proper sanitation facilities to be provided to workers.
- Proper drainage systems will also be provided to ensure efficient drainage of surface run-off.
- Garbage bins will be provided near the temporary shelter of workers for collection of domestic solid waste.
- Garbage will be removed regularly from the bins and will be disposed off in consultation with the local civic authority.

11.3 ENVIRONMENT MANAGEMENT PLAN - OPERATION PHASE

Environmental Management measures suggested for Terminals operation phase are described in the following sections.

11.3.1 Air Environment

During project operation phase of the Terminals major activity would be passenger ferry service and cargo handling. The major source of air emissions would be from ship movement and vehicular movement. Since the quantity of cargo is very small, no major air pollution is anticipated during cargo handling. Majority of cargo will be handles manually. The following measures are recommended to control air pollution during operation phase:

- Good housekeeping will be maintained in the Terminal complex to avoid accumulation of dust.
- Vessels/ ships moored at the jetty will switch off their engines.
- All internal roads will be paved.
- Informatory sign will be provided within the Terminal towards vehicle maintenance, safe drinking and adherence of the emission standards.
- Adequate traffic rules will be formulated and implemented for the Terminals.
- Best possible care will be taken to ensure minimum queuing of trucks outside the dock complex.
- Suitable preventive measures should be taken to protect workers against dust emanating from Terminal operations.
- Transport vehicles having valid Pollution under Control (PUC) Certificate will only be allowed to ply within the dock complex.
- Low sulphur fuel will be used by the cargo handling equipments.
- Ships shall strictly follow Annex VI of MARPOL (73/78).

11.3.2 Noise Environment

- Regular activities will be planned in such a manner that similar activities will be carried out regularly at a fixed time.

- The equipment/machines will be maintained properly with particular attention to the silencers and mufflers.
- Old noise producing economically unviable cargo handling equipment will be replaced by new low noise producing equipments.
- Ear muffs or other protective devices will be provided to the workers working in noise prone areas.
- A well design green belt will be established within the dock complex to control noise pollution.
- Total land requirement for each Terminal is 0.5 acre, hence green belt will be developed in an area equivalent to 33% of the total area of each Terminal

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- Maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set shall be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests.
- Acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- DG set should also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

11.3.3 Water Environment

To prevent water pollution, following measures will in general be adopted:

- Best possible care will be taken to protect the surface water resources in the area.
- All wastewater generated in the Terminals will be treated in septic tanks. Treated water will be used for gardening, greenbelt and dust suppression within Terminal premises.
- All steps will be taken to avoid spillage of bulk cargo, oil and other materials into the river.
- A speed limit of 20 kmph will be maintained within the Terminal complex.
- Restriction will be imposed on blowing of air horns within the dock complex.

The surface and ground water may get polluted in terms of suspended solids, heavy metals etc. as these pollutants may enter these water systems through diffused locations on bulk cargo stack yards.

Total 3-5 staff are likely to work at each Terminal during operation phase. Around 100 passengers will use each Terminal every day. Total water requirement during operation phase will be 54.5 m^3/day. It is proposed that the sewage generated form the jetty during operation phase shall be treated in the septic tanks with in Terminal complex. The following measures will be taken for prevention and control of water pollution.

- Slope of the Terminal building and cargo storage facility will be towards landward side to avoid storm water draining into the river.
- Runoff will be collected in a sump and allowed to settle.
- An oil separator will be installed prior to the sump to arrest oil and grease from entering into the sump.
- Cargo area will be paved and made impermeable for any leachate to percolate to the subsurface water table.
- While pumping out waste water from ship to shore, care will be taken to avoid spillage.

11.3.4 Land Environment

- Waste reduction is best achieved at the planning and design stage, as well as by ensuring the implementation of good site practices.
- To minimize the impact on land environment, the solid wastes likely to be generated will be properly collected and disposed off to maintain hygienic situation in and around the proposed project site.
- Shore bins near the Terminal will be provided, such shore bins will have four equal compartments to receive biodegradable waste, oily waste, non-biodegradable waste and recyclable waste. .
- Garbage generated in the Terminal complex will be removed regularly out side port premises.
- One non recyclable hazardous shore bin will also be provided near jetty to receive hazardous wastes from ships as well as from jetties and office areas. Hazardous waste will be handed over to the approved facility holders.

11.3.5 Biological Environment

Greenbelt Development

Extensive plantation programme will be taken in and around Terminals. This plantation programme will be taken up to upgrade the ecological status of the area and to improve the aesthetic quality of area. The greening programme, particularly the green belt will help in reducing pollution due to vehicular activities and other port operations. While selecting plant species, following criteria will be kept in view:

- Native plant species will be preferred
- Fast growing plants will be planted
- Plants having thick canopy cover will be used
- Preferably perennial and evergreen species will be selected
- Plants having large leaf area index will be considered
- Road sides will be planted with local vegetation

Land requirement for each Terminal has been estimated as 0.5 acre, hence total land requirement is 2 acre. Green belt will be developed in an area equivalent to 0.66 acre. An amount of Rs. 5 lakh has earmarked for Green Belt Development including maintenance cost for 3 years, for the proposed project. Green belt will be developed @1500 nos. of tree per hectares. Plant species that would be considered for the plantation programme outside port area are given in Table 11.2

Table 11.2 Species recommended for greenbelt development

Scientific Name	**Local Name**
Flowering, Ornamental and Timber trees	
Acacia farnesiana	Vilati Babul
Acacia auriculaeformis	Sonajhuri
Albizzia lebbeck	Siris
Alstonia scholaris	Chatim
Anthocephalus cadamba	Kadam
Bauhinia sp	Kanchan
Barringtonia acutangula	Hijal
Bombax malabarica	Simul
Butea frondosa	Palas
Cassia fistula	Sondal
Casuarina equisetifolia	Bilati Jhau
Couroupita guianensis	Cannon ball tree
Dalbergia sissoo	Sishu
Erythrina indica	Coral tree
Ficus indica	Banyan
Ficus religiosa	Peepul
Lagerstroemia flosregineae	Jarool
Michelia champaca	Swarna Champa
Millingtonia hortensis	Akash Neem
Mimusops elengi	Bakul
Poinciana regia	Gulmor
Polyalthia longifolia	Debdaru
Saraca indica	Asoka
Tectona grandis	Segun
Terminalia arjuna	Arjun
Thespesia populnca	Parash
Thevetia nerifolia	Kulkiphool
Fruit Plants	
Artocarpus integrifolia	Jack Fruit
Mangifera indica	Mango
Achras sapota	Sapota
Cocos nucifera	Coconut
Syzygium javanica var: Alba	Jamrul

Scientific Name	Local Name
Citrusgrandis chakort	Batabi Neboo
Averrhoa carambola	Kamranga

Pits for plantation will be opened measuring 30 x 30 cm and be kept exposed to sun for at least one day. Recommended dose of fertilizers be added and sapling be planted during peak monsoon season to obtain higher survival rate. On completion of plantation, maintenance of the above sapling to be carried out for at least 3 (three) years from the date of plantation for getting effective result.

11.3.6 Socio-Economic Environment

Following measures will be adopted to improve socio-economic environment:

- The workers/staffs will be provided toilet and bathroom facilities.
- The workers/staffs will be paid as per the minimum wage Act.
- Roads will be properly maintained.
- The local people will be given preference in providing employment for unskilled and semi-skilled category.
- Workers will be provided with personal protective equipments.

11.4 FIRE AND SAFETY MANAGEMENT

Full-fledged fire fighting facilities will be provided in the port to tackle any fire contingency. Regular safety audits will be carried out for improving safety performance. On-site and off-site Disaster Management Plans shall be developed and mock drills will be conducted at regular intervals to keep the disaster management team in a state of full preparedness.

Fire-fighting arrangements will be made as per the requirements. Basic fire-fighting arrangements consisting of fire hydrants and fire pump will be provided for fire control. The medium for the Fire Hydrant system to fight fire is river water. The system can be used by the in-house trained or fire department personnel in case of emergencies to combat fire. The system will be capable of providing effective water stream / jet required in the advanced stage of fire for cooling the burning surface and the adjacent areas in order to extinguish the fire.

Common pumping arrangement is proposed for hydrant system. Sprinklers will be installed not only to control dust pollution but also to guard against self-ignition. Provision of Rs. 10.00 lakh has been earmarked for fire extinguishers to be installed at 5 Nos. of Terminal.

11.5 ENERGY CONSERVATION PLAN

Various energy conservation measures are proposed shall be adopted as outline below:

- Control of unnecessary illumination at unmanned area using switching de-lamping etc.
- Reduce Illumination level to standard levels by using lower wattage lamps (400W HPSV to 250W HPSV), changing lamp types (2x40W Fluorescent lamp to 70W Metal halide & 400W Mercury.
- Vapour to 250W Metal Halide), etc. for street lighting as well as building inside lighting.
- Control lighting with clock timers, photocells, and/or occupancy sensors.
- Control of Electrical utilities like Air Conditioner beyond working hours.
- Installation of LED lamps in place of Incandescent lamp for panel indication, decorative lamps, exit lamps, etc.
- Continuous improvement of building area fluorescent lamps by using Electronic ballasts and low wattage fluorescent lamps in place of copper ballasts and high wattage fluorescent lamps.
- Reduction in Illumination lamp usage by day lighting in Workshop area

Provision of Rs. 1.00 lakh has been earmarked for purchase of energy efficient/LED lightings for 5 Nos. of Terminal.

11.6 SOLID WASTE MANAGEMENT

Arrangements will be made within the Terminal area for collection and temporary storage of bi degradable and non bio-degradable wastes. Recyclable hazardous wastes will be sold/handed over periodically to registered recyclers/re-refiners having the approval of

MoEF&CC. Non-recyclable Hazardous wastes will be stored separately in a secured enclosure and would be transported to the Municipal dumping site in consultation with district administration. Provision of Rs. 25 lakh has been kept for the purchase of covered mini truck for the transportation of solid waste to the designated dumping sites.

11.7 IMPLEMENTATION OF EMP

Constitution of Environmental Management Cell

Various control measures have been suggested in the EMP for environmental protection. It is suggested that the IWAI should maintain a full-fledged Environmental Management Cell (EMC) reporting to the top management. The EMC will closely monitor the environment aspects of the proposed project and identity problems and accordingly, suggest certain measures to mitigate the same. In addition it will also all the statutory requirements in the area of environmental protection.

11.8 ENVIRONMENTAL MONITORING PROGRAMME

11.8.1 THE NEED

Monitoring is an essential component for sustainability of any developmental project. It is an integral part of any environmental assessment process. Any development project introduces complex inter-relationships in the project area between people, various natural resources and biota, as new environment is created during construction and operation phase. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence, monitoring of critical parameters is essential during project construction and operation phases.

Monitoring of environmental indicators signal potential problems and facilitate timely prompt implementation of effective remedial measures. It will also allow for validation of the assumptions and assessments made in the present study. Monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation. It is proposed to conduct the environmental monitoring is carried out prior to the construction, during construction and during operation phase.

Baseline monitoring

Baseline monitoring is undertaken prior to project construction activities to define the existing or ambient environmental conditions and thereby assist with the designing and planning of the construction activities. It establishes the starting point from where environmental change can be monitored. Further, the baseline monitoring supports and documents the understanding of the aquatic environment, of the physical, chemical and biological parameters as well as parameters indicating water and sediment quality and ecology.

Surveillance monitoring

Surveillance monitoring compares baseline monitoring data to environmental measurements during construction activities to determine whether environmental changes are occurring and are acceptable. Based on this it may be decided whether the dredging can continue unchanged or should be altered. Technological advances have allowed monitoring during the construction activities to be made on a continuous basis. Real-time observations and rapid data processing and evaluation systems can be used to identify environmental changes and, if necessary, trigger an alarm to inform decision-making about when, where and how to alter a construction plan to control environmental changes to an acceptable level.

Compliance monitoring

Compliance monitoring may be conducted during and after the construction activities to demonstrate whether dredging complies with the requirements of environmental protection mechanisms including legislation (e.g. permit conditions), contract conditions and, if relevant, sustainability protocols. Compliance monitoring can extend over short-term or long-term periods post- construction, depending on the time over which the environment reacts to and recovers from the changes caused by the project. It is worth noting that altered dredging methods may translate into altered monitoring needs. Care should be taken to ensure that sufficient flexibility exists within permits, contracts, etc. to allow monitoring schemes to be reduced or increased if, it is reliably established (and accepted by those in authority) that monitoring needs should be modified. Such changes are usually a substantial undertaking in terms of time and effort.

11.8.2 AREAS OF CONCERN

From the monitoring point of view, the important parameters are water quality, sediment quality, ambient air quality, noise, green belt etc. An attempt is made to establish early warning system which indicate the stress on the environment. Suggested monitoring parameters and programme is described in the subsequent sections.

11.8.3 WATER & SEDIMENT QUALITY

11.8.3.1 Construction phase

The chemical characteristics of marine water quality shall be monitored once in three months during project construction phase, close to the Terminal locations and dredging areas. Both surface and bottom waters samples shall be collected and analyzed for physico-chemical and biological parameters. The chemical characteristics of water quality should be monitored once in three months and biological parameters once a year during project construction phase. The parameters to be monitored are as follows:

A) ***Water Quality***

Physico-chemical parameters

- pH
- Salinity
- Conductivity
- TDS
- Turbidity
- D.O.
- BOD
- Phosphates
- Nitrates
- Sulphates
- Chlorides

Biological parameters

- Light penetration

- Chlorophyll
- Primary Productivity
- Phytoplankton
- Zooplankton

B) Sediments

Physio-chemical parameters

- Texture
- pH
- Total Kjeldahl Nitrogen
- COD
- Sodium
- Potassium
- Phosphates
- Chlorides
- Sulphates

Biological Parameters

- Benthic Meio-fauna
- Benthic Macro-fauna

A provision of Rs. 1.00 lakh/year would be required for the analysis of water and soil samples. Assuming construction phase is to last for 2 (Two) years and considering as escalation of 10%, an amount of Rs. 2.10 lakh is earmarked.

11.8.3.2 Operation Phase

The chemical characteristics of water quality should be monitored once in six months and biological parameters once a year during project operation phase. Both surface and bottom waters should be sampled and analyzed. The parameters to be monitored are as follows:

A) ***Marine Water***

Physico-chemical parameters

- pH

- Salinity
- Conductivity
- TDS
- Turbidity
- D.O.
- BOD
- Phosphates
- Nitrates
- Sulphates
- Chlorides

Biological parameters

- Light penetration
- Chlorophyll
- Primary Productivity
- Phytoplanktons
- Zooplanktons
- Mangroves

B) Sediments

Physio-chemical parameters

- Texture
- pH
- Total Kjeldahl Nitrogen
- COD
- Sodium
- Potassium
- Phosphates
- Chlorides
- Sulphates

Biological Parameters

- Benthic Meio-fauna
- Benthic Macro-fauna

A provision of Rs.1.5 lakh/year has been earmarked for the monitoring of physico-chemical and biological parameters during operation phase.

11.8.4 AMBIENT AIR QUALITY

11.8.4.1 Construction Phase

Ambient air quality monitoring is recommended to be monitored at one stations near the each Terminal. The monitoring can be conducted for two seasons. For each season monitoring can be conducted twice a week for 4 consecutive weeks. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2. An amount of Rs. 10 lakh/year would be required. Considering, construction phase of 2 (Two) years and escalation of 10%, an amount of Rs. 21 lakh/year can be earmarked for this purpose. The ambient air quality monitoring during project operation phase can be conducted by an agency approved by Nagaland State Pollution Control Board.

11.8.4.2 Operation Phase

The ambient air quality monitoring will have to be conducted at one stations near the each Terminal. Air quality could be monitored for two seasons in a year. High volume samplers can be used for this purpose. The frequency of monitoring shall be twice a week for 24 hours for four consecutive weeks. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2. The ambient air quality monitoring during project operation phase can be conducted by an agency approved by Nagaland State Pollution Control Board. An amount of Rs. 12 lakh/year can be earmarked for this purpose.

11.8.5 NOISE

Personnel involved in work areas, where high noise levels are likely to be observed during project construction and operation phases. For such in-plant personnel, audiometric examination should be arranged at least once a year. The noise level monitoring during construction and operation phases will be carried out by the project staff and a noise meter can be purchased. An amount of Rs.0.10 million has been earmarked for this purpose.

11.8.6 GREENBELT DEVELOPMENT

Sites of greenbelt development should be monitored once every month during project operation phase to study the growth of various species and to identify the needs if any, such as for irrigation, fertilizer dosing, pesticides, or replacement of saplings etc. The monitoring can be conducted by project staff.

11.8.7 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

The summary of Environmental Monitoring Programme for implementation during project construction and operation phases is given in Tables 11.3 and 11.4 respectively.

Table 11.3 Summary of Environmental Monitoring Programme for implementation during project construction phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
1.	**Marine water**			
	Physico-chemical parameters	pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.	Once in three months	1 location near each Terminal
	Biological parameters	Light penetration, Chlorophyll, Primary Productivity, Phytoplanktons, Zooplanktons	Once in three months	1 location near each Terminal
2.	**Sediments**			
	Physico-chemical parameters	Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates	Once in three months	1 location near each Terminal
	Biological parameters	Benthic Meio-fauna, Benthic Macro-fauna	Once in three months	1 location near each Terminal
3.	**Ambient air quality**	PM_{10}, $PM_{2.5}$, SO_2 & NOx	- Summer and Winter seasons. - Twice a week for four consecutive weeks per season.	1 location near each Terminal
4.	**Noise**	Equivalent Noise Level	During peak construction activities	1 location near each

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
				Terminal

Table 11.4 Summary of Environmental Monitoring Programme for implementation during project operation phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	Location
1.	**Marine water**			
	Physico-chemical parameters	pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.	Once in three months	1 location near each Terminal
	Biological parameters	Light penetration, Chlorophyll, Primary Productivity, Phyto-planktons, Zooplanktons	Once in three months	1 location near each Terminal
2.				
	Physico-chemical parameters	Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates	Once in three months	1 location near each Terminal
	Biological parameters	Benthic Meio-fauna, Benthic Macro-fauna	Once in three months	1 location near each Terminal
3.	**Ambient air quality**	PM_{10}, $PM_{2.5}$, SO_2 & NOx	- Summer, & Winter seasons. - Twice a week for four consecutive weeks per season.	1 location near each Terminal
4.	**Noise**	Equivalent Noise Level	Once per month	1 location near each Terminal
5.	**Greenbelt Development**	Rate of survival and growth of various species	Once per month	Various plantation sites.

11.8.8 BUDGET

The cost required for implementation of Environmental Monitoring Program (EMoP) during project construction phase is Rs. 43 lakh. The budget is given in Table 11.5

Table 11.5 Summary of Cost estimation for Implementation of Environmental Monitoring Programme during Construction Phase

S. No.	Parameters	Cost (Rs. lakh)
1	Water and Sediment Quality	21
2	Ambient Air Quality	21
3	Noise	1.0
	Total	**43**

The cost required for implementation of Environmental Monitoring Program (EMoP) during project operation phase is Rs. 27 lakh/year. The detailed budget is given in Table 11.6

Table 11.6 Summary of cost estimation for implementation of Environmental Monitoring Programme during operation phase

S. No.	Parameters	Cost (Rs. lakh)
1	Water and Sediment Quality	15
2	Ambient Air Quality	12
	Total	**27**

11.8.9 ENVIRONMENTAL MANAGEMENT CELL

Environmental Management Cell (EMC) will be constituted at for implementation and monitoring of Environmental management Plan during construction and operation phases. Environmental Management Cell (EMC) will be responsible for management of the environment in all environment retreated activities for all the five Terminals. The Head (Environment) will be responsible for Environmental Management activities in the proposed project. Basically, this Cell will supervise the monitoring of environmental pollution levels and management of the same (viz. source emissions, ambient air quality, water sediment quality, noise levels, regular compliance with the conditions of EC and Nagaland State pollution Control Board etc.). This task will be achieved either departmentally or by appointing external expert agencies accredited by NABL, wherever necessary. In case the monitored results of environmental parameters are found to exceed the permissible limits. The Environmental Management Cell will suggest remedial action and get these suggestions implemented through the said procedure.

The EMC will also coordinate relevant activities such as collection of official statistics on health (of "workers/residents" of project area), fisheries and important socio-economic parameters likely to be influenced by Terminal activities.

11.9 BUDGET FOR EMP

The cost estimates for implementing EMP shall be Rs.96.0 lakh. The details are given in Table 11.7

Table 11.7 Summary of cost estimate for implementing Environmental Management Plan (EMP)

S. No.	Parameter	Total Cost (Rs. lakh)
1.	Sanitary facilities at labour camps	10.0
3.	Solid waste management	25.00
4.	Greenbelt Development	5.00
5.	Purchase of noise meter	1.00
7	Firefighting equipment's	10.00
8	Purchase of energy efficient/LED lightings	2.00
9.	Implementation of Environmental Monitoring Programme during construction phase (Refer Table-7.2)	43.00
	Total	**96.0**

11.10 ENVIRONMENTAL MONITORING PROGRAMME

The cost required for implementation of Environmental Monitoring Programme during construction phase is Rs.43.00 lakh. The details are given in Table 11.8

Table 11.8 Summary of cost estimates for implementing Environmental Monitoring Programme (EMoP) during construction phase

S. No.	Parameters	Cost (Rs. lakh)
1	Water and Sediment Quality	21
2	Ambient Air Quality	21
3	Noise	1.0
	Total	**43**

The cost required for implementation of Environmental Monitoring Programme during operation phase is Rs.37.00 lakh/year. The details are given in Table 11.9

Table 11.9 Summary of cost estimates for implementing Environmental Monitoring Programme (EMoP) during operation phase

S. No.	**Parameters**	**Cost (Rs.** lakh**)**
1	Water and Sediment Quality	15
2	Ambient Air Quality	12
	Total	**27**

CHAPTER – 12
NAVIGATION AIDS

12.1 Navigational Aids: Navigational Aids (navaid), also known as aids to navigation (ATON), are any device external to a vessel or aircraft specifically intended to assist navigators in determining their position or safe course, or to warn them of dangers or obstructions to navigation. In case of inland waterways, the navigational marks indicate edge of the navigation channel/ fairway. They also serve to warn of hidden dangers and assist in making approaching a terminal or a port.

12.2 Navigation aids used on NW-1 and NW-2: In case of inland waterways of India, the navigation marks can be fixed, temporary or floating. In NW-1 (Ganga river) and NW-2 (Brahmaputra river) which have been significantly developed by IWAI and on which a lot of transportation of cargo and passengers/ tourists already takes place since many years, IWAI provides and maintains various types of navigation marks to facilitate safe and efficient navigation by various types of inland vessels. These include, standard temporary marks made up of bamboos and bamboo mats, floating buoys, transit marks, beacons, markings on bridge piers etc. In addition, pilotage by experienced navigators and communication between vassel to vessel as well as between vessel to shore are also important aids to navigation. IWAI's National Waterway Safety of Navigation and Shipping Regulations, 2002 provide detailed guidelines for navigation marks to be provided on National Waterways.

12.3 Navigation marks proposed for NW-101: Aids to navigation are important especially a waterway like Tizu river, where channel width is restricted, river sloe is steep, current is high and river bed is full of boulders and gravel. At the same time it is also a fact that there is no scope of transportation of cargo on this waterway. Only passenger transportation is envisaged in Phase I and II on this waterway. Night navigation is also not proposed. Hence it is not advisable to use floating buoys which are costly and difficult to maintain. Hence a combination of temporary bamboo marks (left hand marks, right hand marks, transit marks, snag marks, danger marks etc) as proposed in IWAI's Regulations cited above are proposed to be installed and maintained on NW-101.

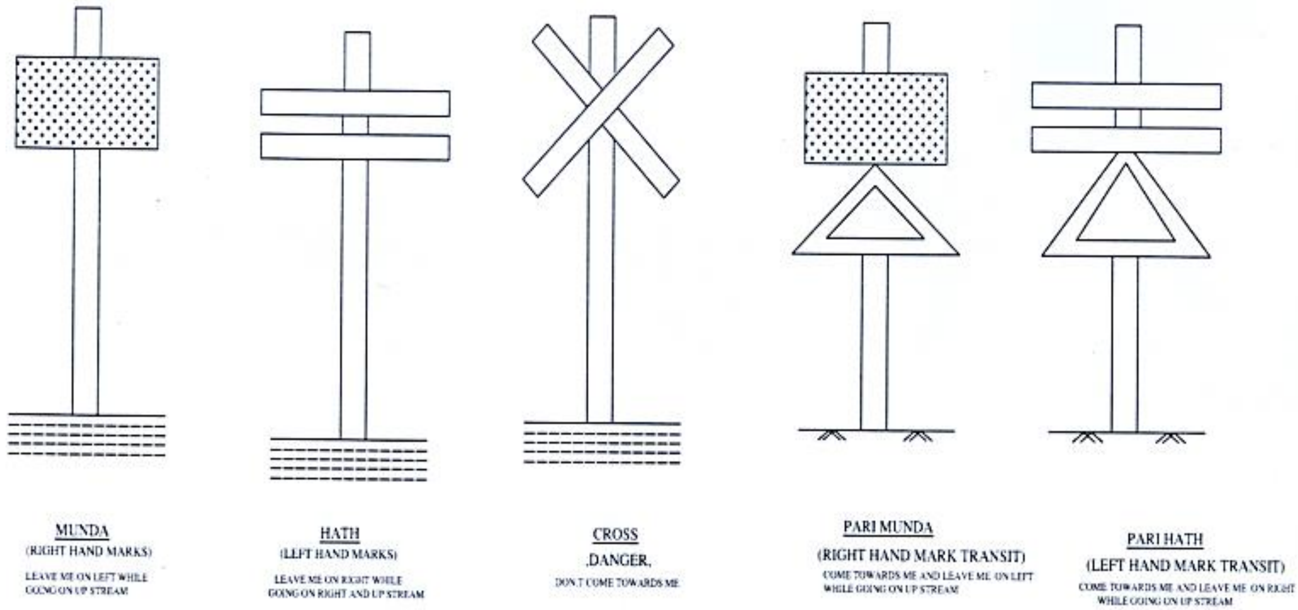

Fig.12.1 Conventional marks

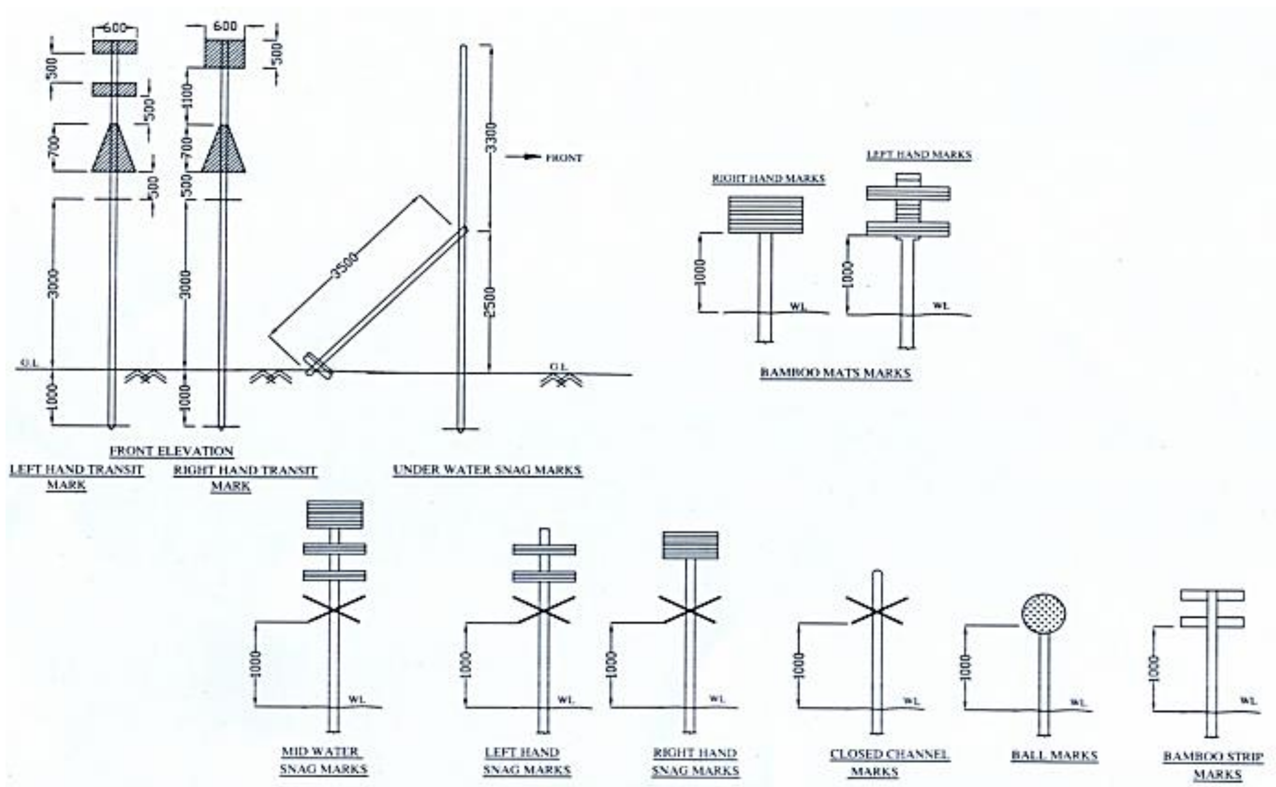

Fig. 12.2 Typical Drawing of Bamboo Mat Marks

In addition to these bamboo marks, it will also be useful to provide appropriate markings and signages on rocky outcrops, big trees and piers of bridges to indicate chainage, sharp bends, low depths, rapids ahead, terminal ahead etc using fluorescent paints of appropriate colour. It is also proposed to provide some marks on MS Poles/Towers to ensure better visibility from a distance for safe and easy navigation.

It is proposed to provide 50 numbers of conventional bamboo marks, 25 numbers of MS Poles/ Towers and fluorescent painting on rocks, trees, bridge piers etc as per requirement in the entire length of 40 km of NW-101.

12.4 Capital Cost

Table 12.1 Capital Expenditure for proposed navigation systems

Sl. No.	Specifications	Unit	Quantity	Cost	Amount
	PHASE-I (IMMEDIATE)				
1.	Providing and fixing Conventional marks are made of bamboo strips set (Phase-I-Immediate)	Nos.	50	1500/-	75000/-
2.	Providing and fixing MS pole tower on 1mx1m MS plate with fluorescent paint fixed with concrete grouting.	Nos.	25	10000/-	250000/-
3.	Providing and Fixing reflector tape at various location as directed by engineer in charge	LS	1	100000/-	100000/-
4.	Total				4.25 lakh (Say Rs 5 lakh)
	PHASE-II				
5.	Providing and fixing Conventional marks are made of bamboo strips set(PHASE-II)	Nos	50	1500/-	75000/-
6.	Providing and fixing MS pole tower on 1mx1m MS plate with fluorescent paint fixed with concrete grouting.	Nos.	25	10000/-	250000/-
7.	Providing and Fixing reflector tape at various location as directed by engineer in charge	LS	1	100000/-	100000/-
8.	Total				4.25 lakh (Say Rs 5 lakh)

12.5 O&M Cost

The operation and maintenance cost for the system proposed is around 5% of the capital cost.

Table 12.2 O&M Expenditure for proposed navigational marking systems

Description	Phase-I Immediate Costs (Lakhs)	Phase II Costs (Lakhs)
Maintenance	2	3

CHAPTER – 13
ORGANISATIONAL STRUCTURE

13.0 ORGANISATIONAL STRUCTURE

The organisation planning of any business either developed by Government department or private sector has to be customised to the local business needs. National Waterway no. 101 is proposed to be developed by the Inland Waterways Authority of India (IWAI). This organisation, being part of Ministry of Shipping, Government of India has a formal structure for administrating and operating waterways. Every state with National waterways has a regional office headed by Director, IWAI to administer and operate waterways. The infrastructure development, population needs and business prospects for all the waterways located in North-Eastern states of India are small compared to the waterways and waterways related business requirements in other states. IWAI already has a Regional Office at Guwahati which can administer all the NWs of NER. Therefore, it is proposed to develop an organisation structure including manpower and resource planning customised to local business needs.
Also, Government of Nagaland has recently constituted Nagaland Inland Water Board (NIWB) for taking care IWT projects of Nagaland. Therefore, it will be obvious that under overall supervision of IWAI this NIWB plays an important role in development, operation and management of IWT infrastructure proposed to be developed on NW-101. This would on one hand help in reduction of overheads of IWAI and at the same time it would also help in generation of a localised organisation by training and utilising local talent well suited to local customs and process.

During discussion with IWAI officials it was gathered that IWAI has decided that all the National Waterways located in North-Eastern states of India would be developed and operated under the administrative jurisdiction of Guwahati Regional Office of IWAI. Accordingly it is suggested that development, maintenance and management of NW-101 may be carried out through NIWB under technical guidance and supervision of Director IWAI, Guwahati, Assam.

The immediate development for transportation infrastructure on NW-101 requires basic investments and quick turnaround. Further development would be undertaken in a phased manner based on how responsive the local population are to basic development of waterway. It is believed that the popularity and usage of waterways by local population would increase in proportion to the value addition by waterway in the following forms:

- Time Savings
- Cost Savings
- Reliability
- Safety

Further development of infrastructure and enhancement of resources would take place with the increase in acceptability of waterway and allocation of funds by Government for development. The development of waterway on NW-101 has been envisaged in the following way

- **Phase I (Immediate Phase)–**Deployment of Inflatable Boats, Clearing channel of boulders and gravels, land filling/ leveling of ground, creation of platform by filling boulders, toilet facility and a shed with seating arrangment
- **Phase II (Further Development)–**Fairway development, terminal development with additional facilities, development of Lower Tizu Damwith Navigational locks (developed by Department of Power, Nagaland)
- **Phase III (Final Development)-** Operationalisation of Indo Myanmar trade using NW-101, maintenance of fairway & terminal

The manpower and resource planning would have to be synchronised with the infrastructure development and operational needs.

13.1 Organisational Set Up

The Organisational Set Up on NW 101 in three phases, i.e. Phase I (Immediate Phase), Phase II & Phase III including a set up at Kohima as well as at each terminal is briefly described in section below.

13.1.1 Phase I (Immediate Phase)

The immediate development requirement consists of deployment of 4 Inflatable boats with outboard motors, which would have transportation capacity of 5 to 8 person each. The fairway development would be done by clearing boulders from the channel to make pathways for inflatable boats requiring less than 0.3 m water depth. Four terminal locations would be earmarked on the river. Due to its small size and versatility, the inflatable boats could stop at multiple locations in between. Hence, it is proposed to allocate boats to nearby village. The operation of boatshas to be handled by a responsible person from the village itself. The person would be trained for safe operation of boat. He would be operating boats between designated terminals earmarked on the river banks. Following flow chart describes the organisation structure to be followed in Immediate Phase.

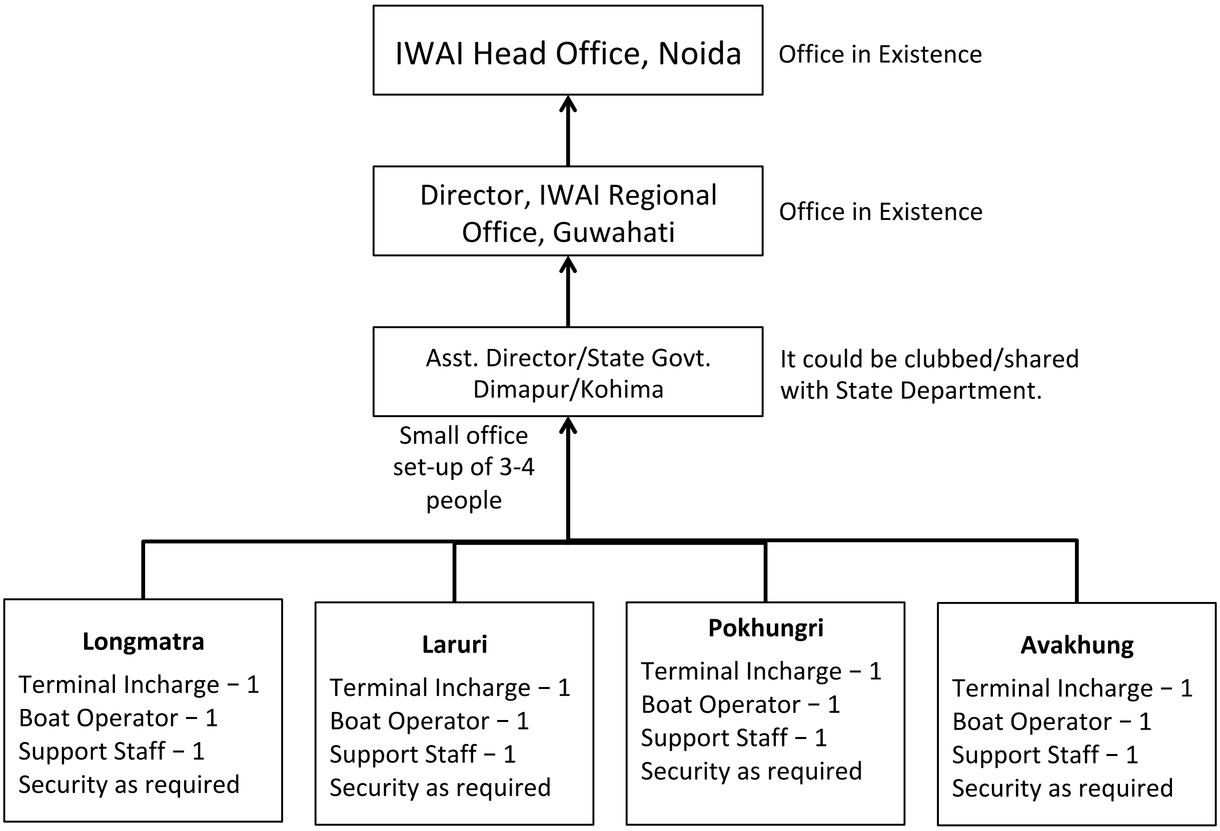

Figure 13-1 Organisation Structure in Phase I (Immediate Phase)

13.1.2 Phase II (Further Development)

The waterway and related infrastructure would further be developed after Immediate Phase. The further development in Phase IIwould involve following activities

- Deepening of Channel to 1.0 m water depth
- Development of basic infrastructure at each of the earmarked terminals
- Installation and maintenance of navigation marks
- Continue operation of inflatable boats provided in Phase I
- Deployment of higher capacity boat - 15 Pax to 25 Pax

In Phase II, fairway as well as terminals could be developed by IWAI. The entire stretch of NW 101 would be made navigable by dredging and deepening the channel. The additional facilities on Terminals would also be developed in this Phase. After Phase II development, NW 101 would be operational for local movement of passengers and household commodities.

The organisation chart in Phase II for management and administration of NW-101 is explained in the following chart

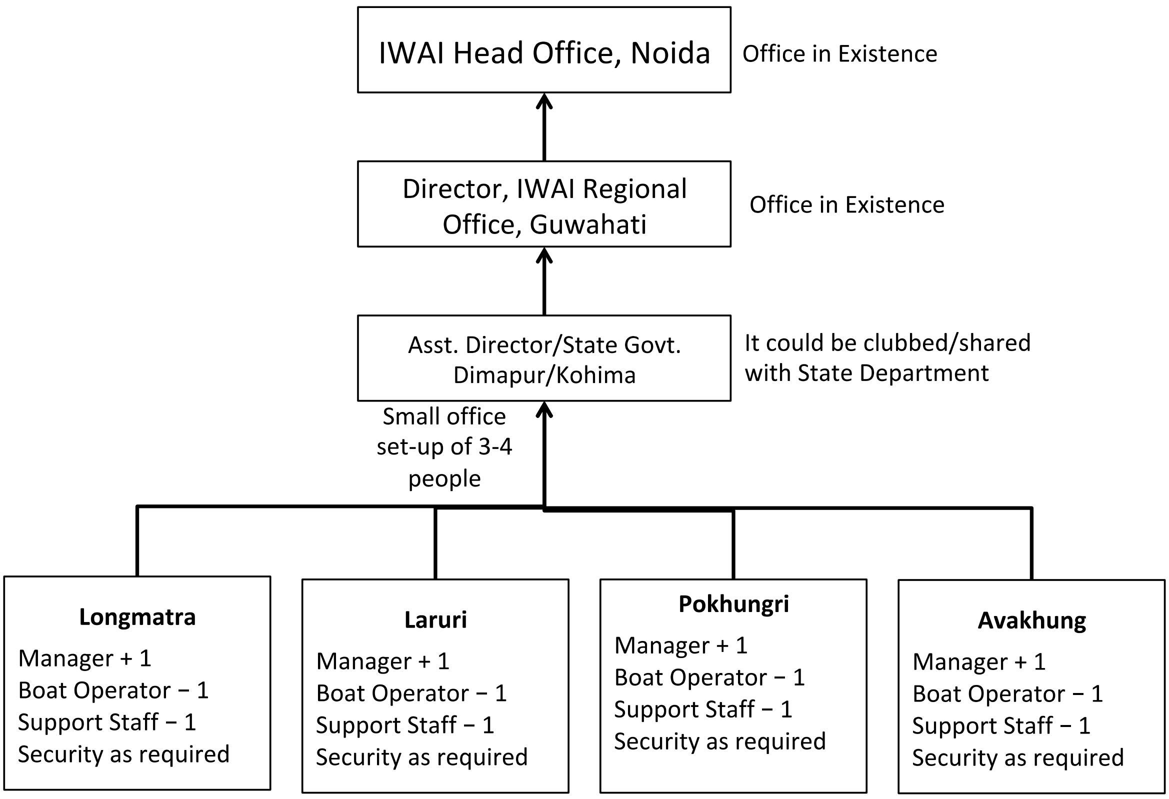

Figure 13-2 Organisation Structure in Phase II

It is proposed to deploy three persons (as shown in the above chart) on every terminal to facilitate movement of passenger and their belongings on the river.

13.1.3 Phase III (Final Development)

As fairway, navigation aids and terminals would be developed in Phase II; hence in Phase III, there would not be requirement of further development. There would be need of maintenance of fairway, navigation aids and terminals in Phase III. It is taken into consideration that in Phase III, IWT route between India and Myanmar would be developed and NW 101 would be linked with Chindwin River in Myanmar. However, at present, it is not recommended to develop Phase III, considering lack of industrial cargo for movement in Indo- Myanmar route. Phase III is a remote possibility and its development would depend on the development of industries in the hinterland of NW 101 and development of waterway in Myanmar till Hta Man Thi. If Phase III would be developed in future, development in this Phase would involve following activities

- Operationalisation of Indo Myanmar trade using NW-101
- Maintenance of dedicated terminals
- Maintenance of fairway by deepening of Channel to 1.2 m water depth
- Deployment of higher capacity boat - 15 Pax to 25 Pax
- Deployment of cargo vessels

The organisation chart in Phase III for management and administration of NW - 101 is explained in the following chart

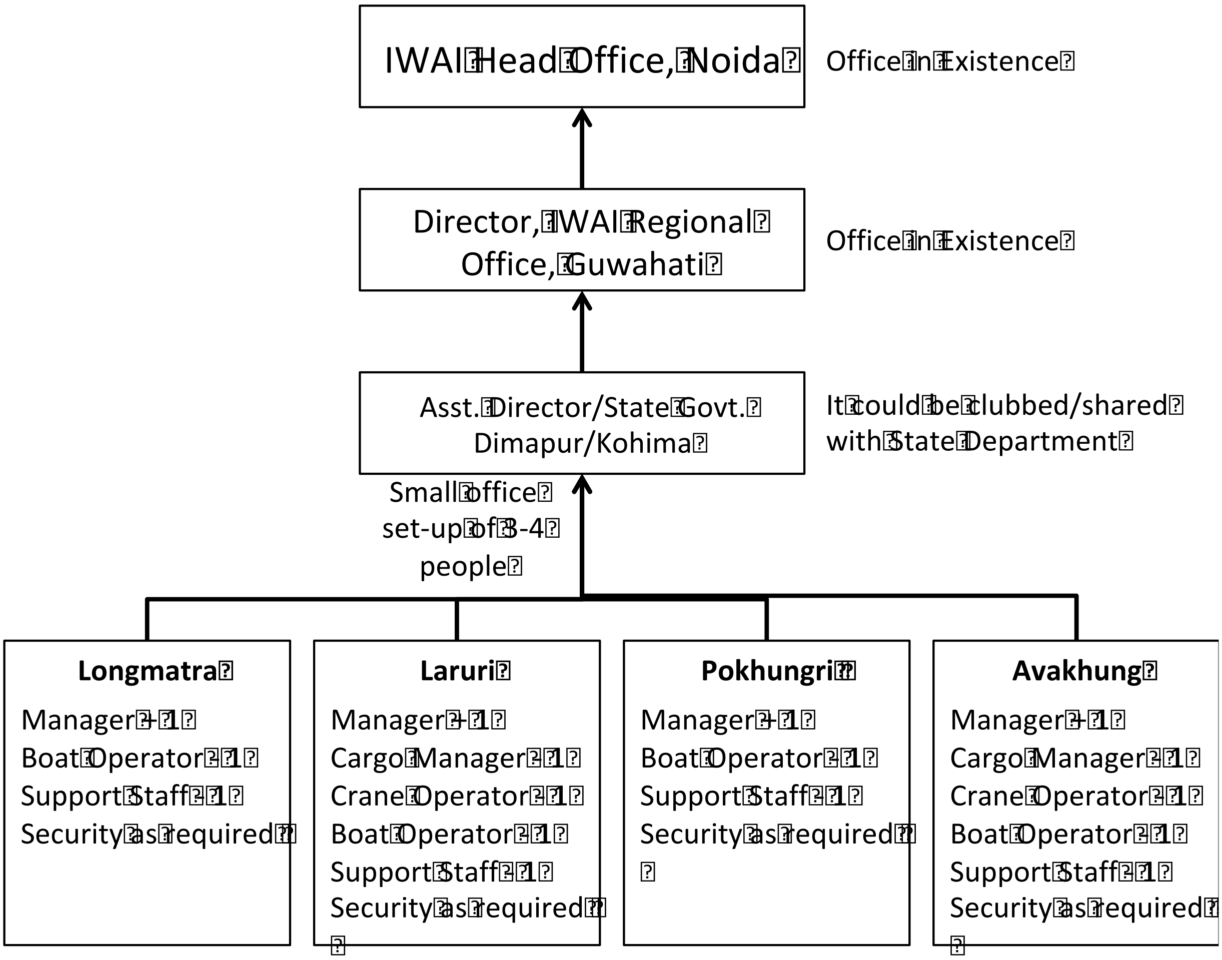

Figure 13-3 Organisational Structure in Phase III

13.2 Role of Personnel for Management & Administration of NW-101

As discussed above, in all three phases, there would be personnel to undertake management and administration activities of NW 101. This sub section would discuss the role of each personnel.

13.2.1 Director

The entire organisation set up for NW-101 is headed by Director, IWAI, Guwahati, who will also be responsible for maintenance and administration of all the other NWs of NER.

Director IWAI, Guwahati is incharge of all the departments, like construction, operation, maintenace of infrastructure and fairway, security of waterway & terminals, salvage duty and repair division. These departments will perform following tasks:

- Finding and marking best channel for navigation.
- Maintenance of minimum depth in the waterway by removal of outcrops, boulders and gravels and dredging wherever required.

- Maintenance of river training work such as bank protection works, bandalling works, bottom paneling works etc. (normally major works are sub-contracted out).
- Checking rules and regulations of waterways and bring to book the offenders.

13.2.2 Deputy Director/ Asstt Director/ NIWB

Under Director IWAI, Guwahati, there would be a Deputy Director/ Asstt Director for NW-101. The Asstt Director can be potsed either at Guwahati or at Dimapur or Kohima. His regional offie would be located at Dimapur/ Kohima. He will be the incharge of all Inland Waterways, including NW 101 in the state. All terminal managers and staffs would work under the Deputy Director. Local villagers would be trained for operation and maintenance of terminals. These locals would work as support staff, boat operator and crane operator.

Alternatively (and preferably), Nagaland Inland Water Board can be made responsible for all the works related to development, mainetance, operation and management of NW-101, under overall supervision of Director, IWAI Guwahati. For this purpose, it is proposed that IWAI and Government of Nagaland should enter into an Mamorandum of Understanding.

13.2.3 Terminal Manager

Each terminal will be under the control of a Terminal Manger who will be responsible for operation and maintenance of the terminal. His responsibilities would include:

- Operations and maintenance of terminals
- Maintenace of a certain stretch of navigation channel of NW-101.
- Berthing of vessels
- Direct and monitor all embarkment and disembarkment activities, vessel tracking and routing
- Collection of usage charges
- Operation and maintenance of all utilities in the terminal area
- Terminal security and communication. Ensure staff members complywith safety rules and policies

13.2.4 Support Staff

There would be one Support Staff in each terminal. This Support Staff would be multi tasking and handle various activities, like ticket booking, collecting fees, cleaning and maintaining the terminal facilities etc.

13.2.5 Boat Operator

Boat opeartion in NW-101 would be taken up by local villagers. Hence, there is no need for development of office for the same. The opertaor could deflate boat in the evening and take it back to village for again deployment back in the morning. The Boat Operators could be trained and also be entrusted with the responsibility to inspect the condition of navigation and channel in the river.

13.2.6 Crane Operator

Crane operator would be deployed in Phase III in two terminals, i.e. Terminal 2 (Near Laruri Bridge) and Terminal 4 (Avakhung). These two terminals would be handling Indo-Myanmar trade in Phase III. For handling commodities, like cement, mineral and food grains, mobile cranes would be required in both the terminals. For handling these cranes, crane operator would be appointed. The task of the crane operator would include handling commodities using cranes in the terminals,safekeeping of materials and equipment during loading and unloading activities etc. He would reportthe Manager about any defects/ damage, malfunctions or accidents to the equipment.

13.2.7 Cargo Manager

Cargo Manager would be deployed in Phase III in two terminals, i.e. Terminal 2 (Near Laruri Bridge) and Terminal 4 (Avakhung). The Cargo Manager would be incharge for handling cargo, like cement, minerals and food gains in Terminal 2 & 4. The Manager would take care of activities, like storing cargo in Cargo sheds in the terminals, evacuation of cargo from the terminals etc.

13.3 Man Power Requirement

Man power requirement for operation of waterway in NW101 includes terminaloperations and Navigation operation.Every terminal will require institutional setup for proper functioning of terminal operations. The following table depicts requirement of manpower atall terminals on NW 101.

Table 13-1 Requirement of Manpower at allTerminals

Sr. No	Manpower	Phase I (Immediate Phase)	Phase II	Phase III
1	Deputy Director	1	1	1
2	Terminal Manager	4	4	6
3	Operator	4	4	6
4	Support Staff	4	4	4
	Total Manpower	**13**	**13**	**17**

Source: By Analysis

13.3.1 Training Requirement

Training is the process by which the Organization assesses and assists in sustainable development and improvement of the performance. NW 101 would be developed by IWAI and would be handed over to local villagers for operation and maintenance of waterway and terminals. In order to improve the efficiency of working personnel at the terminal,education& training would be provided to the respective manpower regarding inland navigation and terminal operation. Locals, especially youths would be trained for activities, such as boat operation, crane operation, dredging etc.

13.3.2 Infrastructure

- **Immovable:** Immovable infrastructure like Administrative Office & ticket counter, cargo shed, parking area, food stalls, toilet facilities etc. should be planned in detail.
- **Movable:** Movable cranes, vehicles and survey boats will also be required at terminals.

13.3.3 Cost Implications

Cost implication for establishing institutional requirement will includesalaries of employees deployed at terminals and regional office. Institutional setup is required for operation and maintenance of waterway and terminals. Capacity building through education and trainingto the staff and employees will also have cost implications. Average annual salary of top management like Director and Terminal Managers is taken as INR12,00,000. Average annual salary of manpower at Regional and Terminal Offices is taken as INR 3,00,000.

Table 13-2 General Annual Salary for Operation of Terminals and Fairway

Phases	Items	Quantity	Annual Salaries (INR)	
			Rate	Amount
Phase I (Immediate Phase)	Top Management	01	12,00,000	12,00,000
	Other Staff	16	3,00,000	48,00,000
Phase II	Top Management	01	12,00,000	12,00,000
	Other Staff	20	3,00,000	60,00,000
Phase III	Top Management	01	12,00,000	12,00,000
	Other Staff	24	3,00,000	72,00,000

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CHAPTER – 14
PROJECT COSTING

14.1 General and Financial Assumptions

The technical aspects of development of National Waterways for handling of the projected traffic are dealt with in the previous chapters. In the present chapter project cost estimates has been done. In order to arrive at capital cost for the proposal it is necessary to ascertain, for budgetary purposes, unit rates of materials used for construction, dredging etc. Accordingly, efforts were made to obtain the above information from the relevant sources.

14.2 Basis of Costing

An estimate of the capital cost of various facilities is made. The cost arrived at are based on the budgetary quotes and the in house data base available on cost estimates. The rates for various items of work have been prepared on the basis of current rates for various items of work prevailing in the region.

The items and costs have been arrived at broadly on the following:

- Rates taken from current works of similar nature
- Updated rates of work of similar nature completed in the recent past.
- Consultant's in house data bank of cost estimates and budgetary quotations.

The rates for preparation of cost estimates for the scheme have been worked out based on Nagaland PWD Schedule of Rates 2016 and Schedule of Rate for NH, MORT work in Nagaland 2016. The general cost abstract and detailed cost estimates have been prepared as per the general guidelines.

14.3 Development Cost

Development cost of waterway in Tizu and Zungki River is given as below:
Waterway development cost includes;

- Dredging
- Bank Protection
- Aids to Navigation
- Land Acquisition (community forest land)
- Civil Works including Land Acquisition for terminals
- Mechanical Handling Facilities
- Miscellaneous

14.4 Capital Expenditure

The estimate of capital cost is made for the various items of civil, mechanical, electrical and utilities works for the development of terminals in the waterway stretch, cost estimate is presented in Table 14.1 to Table 14.3.

Table 14.1 Capital Cost Estimate (Phase- I (Immediate))

Capital Cost for Phase- I (Immediate)		
Sl. No.	**Description**	**Amount in Crores (Rs.)**
(I)	**Fairway Development**	
(i)	Dredging / Removal of Boulders	1.47
	Add 3% Contingency & 7% Supervision Charges	0.15
	Total Fairway Development Cost	**1.62**
(II)	**Civil Cost**	
A	**Terminals**	
(i)	Rest Rooms - 4 Nos.	0.07
(ii)	Area for Passenger Wharf - 4 Nos.	0.003
(iii)	Sitting Area - 4 Nos.	0.04
(iv)	Solar Lights – 4 Nos.	0.02
	Total Cost (II)	0.13
	Add 3% Contingency & 7% Supervision Charges	0.01
	Total Civil Cost	**0.14**
(III)	**Navigation & Communication Cost**	
(i)	Conventional Marks made of bamboo strips	0.04
	Add 3% Contingency & 7% Supervision Charges	0.004
	Total Navigation & Communication Cost	**0.047**
(IV)	**Vessel Cost**	
(i)	Vessels (Inflatable Boat) - 4 Nos.	0.22
	Total Vessel Cost	**0.22**
(V)	Other cost including financing cost and interest during construction (10% of (II))	**0.01**
(VI)	**Land for terminal development @ 0.5 acre per terminal - 4 Nos**	
	*Considering Rs.10 lacs per acre	**0.20**
	Total Capital Cost	**2.24**

Detailed BOQ for the capital cost estimate is given in Volume-III in Annexure-VIII from Pg.104-167

Table 14.2 Capital Cost Estimate (Phase – II)

Capital Cost for Phase II		
Sl. No.	**Description**	**Amount in Crores (Rs.)**
(I)	**Fairway Development**	
(i)	Dredging / Removal of Boulders	8.90
	Add 3% Contingency & 7% Supervision Charges	0.89
	Total Fairway Development Cost	**9.79**
(II)	**Civil Cost**	
A	**Terminals**	
(i)	Wharf - 4 Nos.	2.86
(ii)	Terminal Building - 4 Nos.	2.28
(iii)	Equipment Shed – 4 Nos.	0.03
(iv)	Fencing - 4 Nos.	0.82
(v)	Gate - 4 Nos.	0.09
(vi)	STP - 4 Nos.	0.20
(vii)	Path - 4 Nos.	0.23
(viii)	Internal Road	0.07
(ix)	Solar Lights– 8 Nos.	0.032
B	**Miscellaneous**	
	For Retaining Wall/ Drainage etc.	3.00
	Total Cost (II)	9.60
	Add 3% Contingency & 7% Supervision Charges	0.96
	Total Civil Cost	**10.56**
(III)	**Navigation & Communication Cost**	
(i)	Conventional Marks made of bamboo strips	0.04
	Add 3% Contingency & 7% Supervision Charges	0.004
	Total Navigation & Communication Cost	**0.05**
(IV)	**Handling Equipment Cost**	
(i)	Backhoe Loader - 4 Nos.	0.80
(ii)	Fire Fighting Equipment - 4 Nos.	0.005
	Total Cost (II)	0.81
	Add 3% Contingency & 7% Supervision Charges	0.08
	Total Handling Equipment Cost	**0.89**
(V)	Other cost including financing cost and interest during construction (10% of (II))	**1.06**

Capital Cost for Phase II		
Sl. No.	**Description**	**Amount in Crores (Rs.)**
(VI)	**Environment Cost**	
(i)	During Implementing Environmental Management Plan (EMP)	0.96
(ii)	Monitoring Programme (EMoP) during construction phase	0.27
	Total Environment Cost	**1.23**
	Total Capital Cost	**23.57**

Detailed BOQ for the capital cost estimate is given in Annexure-VIII.
**Land cost already taken in phase-I development*

14.5 Operation and Maintenance Expenditure

The annual operation and maintenance cost on different components of the project will be dependent on a number of variables such as the life of the component, repair and maintenance requirements, wages of crew of consumables, etc. Hence, accurate assessment of cost is not possible. Further even if all the variables are fixed such as the maintenance schedules for each structure and equipment is determined, crew strength is fixed, requirement of consumables quantified, etc., the estimation of O&M costs cannot be precise because of unpredictable breakdowns incurring considerable expenditure on repairs and replacement. The only practicable approach in this scenario is to fix the annual repair expenditure as a percentage of capital cost of project. This percentage is to be fixed on the basis of the past performance of similar structures and equipment functioning in the project or elsewhere under similar marine conditions.

Based on above criteria, the annual maintenance cost is estimated as a percentage and is presented in Table 14.4 and Table 14.6.

Table 14.3 Operation & Maintenance Cost (Phase I (Immediate))

Sr. No	Operation & Maintenance Cost	Amount in Crores (Rs.)
1	Dredging / Removal of Boulders @ 10%	0.16
2	Civil works @ 1%	0.001
3	Navigation & Communication	0.02
4	Fuel Cost @ 10Ltr/Hr. for 10 Hours - 300 days	0.84
5	Manpower Cost	0.24
6	Miscellaneous	0.10
	Total	**1.36**

Table 14.4 Operation & Maintenance Cost (Phase – II)

Sr. No	Operation & Maintenance Cost	Amount in Crores (Rs.)
1	Dredging / Removal of Boulders @ 10%	0.98
2	Civil works @ 1%	0.11
3	Mechanical & Electrical Cost @ 5%	0.04
4	Navigation & Communication	0.03
5	Power Cost	0.10
6	Manpower Cost	0.48
7	Miscellaneous	0.20
	Total	**1.94**

Detailed BOQ for the capital cost estimate is given in Volume-III in Annexure-VIII from Pg.104-167

15.0 FINANCIAL & ECONOMIC ANALYSIS

Tizu - Zungki River (NW101) has been approached with the scope of handling Passengers, Tourists and cargo (household products). The entire stretch will be used for along the river movement. This chapter consists of financial model all 4 terminals combined with Fairway development. Market-driven rates, benchmarks, and assumptions have been considered to develop financial models for Terminals and Fairway.

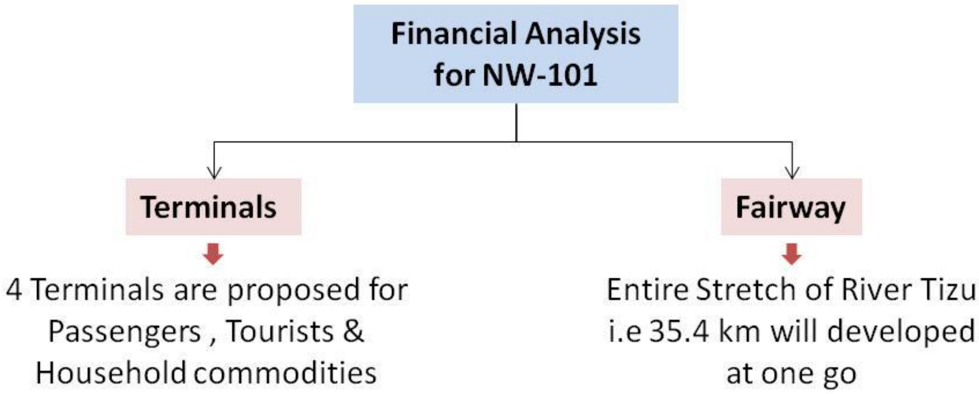


Fig. 15.1 Structuring of Financial Model

It is assumed that Phase I (immediate) would start operating within a year of development. FY21 is considered for development of fairway and construction of terminals, in same operation would start till next 1 year i.e FY22. Thereafter, development of Phase II would start. It is assumed that Phase II would take minimum 1.5 years – 2 years of time to get operational. FY23 & FY24 are considered for development and construction of fairway and terminals respectively, last year of development phase would start handling traffic. Entire project will commenced from FY21 till FY50, Financial Analysis for fairway and terminals is done for next 30 years

Table 15.1 Development Schedule of NW101

Fairway & Terminal	Phase I (Immediate)		Phase II				
	FY21	FY22	FY23	FY24	FY30	FY40	FY50
	Development Period		Development Period				
	Operational Period – Phase I			Operational Period – Phase II			

15.1 Assumptions for Financial Analysis

This section depicts the assumptions considered for undertaking the financial analysis of NW101. Industry benchmarks have been considered for validating a few assumptions. The details of the basis of assumptions have been mentioned in the subsequent sections.

- **Tariff**

Separate tariff rates would be charged for terminal and fairway usage. The table below shows the same. These tariff rates are very competitive in order to attract more traffic for IWT on NW101.

Table 15.2 Tariff Structure

Various Revenue Sources	Rate (INR)	Unit
Passenger Fee for Terminals	200.00	Per Pax
Passenger Fee for Viewing Deck	50.00	Per Pax
Consumer Cargo Handling	1000.00	Per Ton
Fairway Usage Charges – Passenger / Tourist	3.00	Per Pax - Km
Average Fairway Usages Assumed	20	Km Per Pax

Source: Industry Inputs

- **Operation & Maintenance Cost**

Assumptions for calculating Operation and Maintenance (O&M) Cost of NW101 is shown in below table. O&M activities would include civil infrastructure (Terminal construction, supporting infrastructure, approach road, etc.), maintaining desired depth of the identified stretch of NW101, Mechanical activities, and Insurance.

Table 15.3 Assumption for Calculation of O& M Cost

Description	Item	Unit
Civil Infrastructure	1%	Total Capital Cost
River Excavation	10%	Total Capital Cost
Mechanical	5%	Total Capital Cost
Civil Insurance Cost	1%	Capex Civil
Mechanical Insurance Cost	2%	Capex Mechanical

- **Other General Assumptions**

For Tax calculation of terminals and fairways, 30% corporate tax is assumed. It is considered that Operator would pay IWAI INR 10/Tonne per annum as Royalty and 4% of total Revenue share from terminals and fairways. 2% of total revenue is considered as Administrative Cost of terminals and fairways.

Table 15.4 General Assumptions

Description	Unit	Item
Corporate Tax	-	30%
Royalty to IWAI	INR/Tonne or Pax	10
Revenue Share	-	4%
Administrative Cost	Revenue	2%
Escalation Rate	This financial is prepared for constant pricing. The escalation rate is null.	

15.2 Traffic on NW101

Initially, as per the traffic study, NW101 was proposed to be developed in three Phases. In Phase I would be Immediately implemented by just leveling the ground and earmarking the landing points. No terminals would be constructed. This phase demands very nominal investment i.e removal of boulders for ground levelling along with supporting activities like navigation and communication, construction of basic facilities at earmarked areas like rest rooms, sitting area, etc. One inflatable boat at each terminal costing around INR 22 Lakhs in total along with fuel cost i.e INR 84 Lakhs annual would be borne by IWAI. Capital & operational cost of vessel is not considered in this financial analysis.

In Phase II, Fairway development and Terminal along with all supporting facilities would be constructed in this phase. This phase would handle local traffic (Passengers along with their household goods and tourists) movement between Longmatra and Avankhung. While Phase III was proposed to handle Indo-Myanmar Traffic. However, Phase III is remote possibility as its traffic depends upon Myanmar Government plans to develop its waterways till Hta Man Thi. At present, Phase III is not recommended as there is no industrial cargo in this route. Phase III would happen only when upcoming industries get operational and IWT gets developed till Hta Man Thi. This is unlikey to happen in near future. Hence, development of Phase is discarded. Financial Analysis is done only for Phase I & Phase II. Entire responsibility of vessel acquisition in Phase II would be with private operator. Any kind of cost or revenue involved in vessel operation is not considered in this chapter.

Development of NW101 is proposed to attract traffic from roadways for IWT movement. The table below shows projected traffic for NW101 for next 30 years.

Table 15.5 Annual Passenger Traffic projected on NW101 (Nos.)

Terminals	2021	2025	2030	2035	2040	2045	2050
T1	14,041	29,268	37,355	47,675	60,847	77,658	99,113
T2	7,910	16,908	21,580	27,542	35,152	44,863	57,258
T3	4,845	10,382	13,251	16,912	21,584	27,548	35,158
T4	3,263	6,922	8,834	11,275	14,390	18,365	23,439
Total	**30,060**	**63,481**	**81,020**	**103,404**	**131,972**	**168,434**	**214,969**

Table 15.6 Annual Tourist Traffic projected on NW101 (Nos.)

Terminals	2021	2025	2030	2035	2040	2045	2050
T1	5,323	5,991	7,289	8,868	11,318	14,446	18,437
T3	2,219	2,497	3,038	3,696	4,717	6,021	7,684
T4	1,331	1,498	1,822	2,217	2,830	3,611	4,609
Total	**8,872**	**9,986**	**12,149**	**14,782**	**18,866**	**24,078**	**30,730**

Table 15.7 Annual Household Commodities projected on NW101 (Tons)

Terminals	2021	2025	2030	2035	2040	2045	2050
T1	-	311	396	506	646	824	1,052

Terminals	2021	2025	2030	2035	2040	2045	2050
T2	-	128	164	209	267	340	435
T3	-	78	100	128	163	208	266
T4	-	105	134	171	218	278	355
Total	**-**	**622**	**794**	**1,014**	**1,294**	**1,651**	**2,107**

15.3 Financial Analysis

This section duscuss the financial analysis of Fairway i.e River Tizu & Zungki for IWT movement and 4 proposed terminals on it. It has been assumed that fairway is fully developed by the Government (IWAI). Entire stretch of 35.4kms is proposed to be developed for passenger, tourist and household commodities. Total 4 terminals are proposed for passenger, tourist and household commodities handling. All the terminals will be handling passenger & household commodities traffic, while tourist will be handled at T1, T2 and T4.

15.3.1 Capital Cost

Capital Expenditure for construction of 4 Terminals on NW101 for handling projected traffic is given in the table below. This includes, all the expenditure made on construction of terminal and supporting infrastructure like, parking area, admin building, ticket counter, canteen, etc. , development of approach road, cost incurred mechanical segment, and other cost

Table 15.8 Project Cost for Construction of Terminals (INR Lakhs)

Sl. No.	Description	Phase I	Phase II	
		FY21	FY23	FY24
1	Terminal Contruction	0.3	143.0	143.0
2	Approach Road	-	153.5	153.5
3	Building & Other Civil Infrastructure	10.9	182.2	182.2
4	Mechanical Cost	2.5	93.9	93.9
5	Contingencies & Supervision (10%)	1.4	114.3	114.3
	Total Capex	**15.1**	**686.9**	**686.9**

Source: By Analysis

Capital Expenditure for development of fairway for handling projected traffic is given in the table below. This includes, all the expenditure made on fairway development, dredging, navigation, other mechanical.

Table 15.9 Project Cost for Development of Fairway (INR Lakhs)

Sl. No.	Description	Phase I	Phase II	
		FY21	FY23	FY24
1	Fairway Development	161.6	489.8	489.8
2	Navigation &Communication Cost	4.7	2.5	2.5
3	**Total Capex**	166.3	984.5	984.5

Source: By Analysis

Means of Financing for this project i.e development of fairway and construction of 4 terminals is proposed to be made by IWAI on behalf of government.

15.3.2 Financial Indicators

Financial indicators that leads to generation of Financial Internal rate of returns (FIRR) are mentioned in this section. Revenue generated each terminals, Cost incurred in Operation of Terminals, Profit & Loss Statement, Balance Sheet, helps out to umnderstand the expected returns agaits the investment made on the terminals.

Revenue from Terminals would be generated from the core operation like handling of passengers and their cargo. Terminal usage and viewing deck fees would be charged to passengers and tourists, while very nomical fees for cargo handling. Terminal wise revenue generation is shown in below table.

Table 15.10 Revenue from IWT Operation (INR Lakhs)

Particulars	FY21	FY23	FY25	FY30	FY35	FY40	FY45	FY50
Revenue from Passenger & Tourist Traffic								
T1	22.0	23.4	38.3	48.3	61.0	77.8	99.3	126.8
T2	7.9	8.4	16.9	21.6	27.5	35.2	44.9	57.3
T3	8.2	8.7	14.1	17.8	22.5	28.7	36.6	46.7
T4	5.3	5.6	9.2	11.6	14.6	18.6	23.8	30.4
Total	**43.4**	**46.0**	**78.5**	**99.2**	**125.6**	**160.3**	**204.6**	**261.1**
Revenue from Household Commodities								
T1	-	-	3.1	4.0	5.1	6.5	8.2	10.5
T2	-	-	1.3	1.6	2.1	2.7	3.4	4.3
T3	-	-	0.8	1.0	1.3	1.6	2.1	2.7
T4	-	-	1.0	1.3	1.7	2.2	2.8	3.6
Total	**-**	**-**	**6.2**	**7.9**	**10.1**	**12.9**	**16.5**	**21.1**
Revenue from Fairway Usage								
T1	11.6	12.3	21.2	26.8	33.9	43.3	55.3	70.5
T2	4.7	5.0	10.1	12.9	16.5	21.1	26.9	34.4
T3	4.2	4.5	7.7	9.8	12.4	15.8	20.1	25.7
T4	2.8	2.9	5.1	6.4	8.1	10.3	13.2	16.8
Total	**23.4**	**24.8**	**44.1**	**55.9**	**70.9**	**90.5**	**115.5**	**147.4**
Total Revenue (Terminal + Fairway)	**66.7**	**70.8**	**128.8**	**163.1**	**206.6**	**263.7**	**336.6**	**429.6**

The table below indicates all the cost incurred while operating IWT on NW101.

The table below summaries the Revenue generated by Terminals and Fairway and total cost incurred in their operation. Cost includes Operating cost, O&M Cost, out-flow to IWAI in terms of Royality (INR 10 /Person or Ton) and Revenue Share (4% of revenue).

Table 15.11 Direct & Indirect Cost (INR Lakhs)

Particulars	FY21	FY23	FY25	FY30	FY35	FY40	FY45	FY50
Operating Cost								
Salary	-	24.0	48.0	48.0	48.0	48.0	48.0	48.0
Administration Cost	-	0.7	1.3	1.6	2.0	2.6	3.3	4.2
Others	21.3	24.7	21.9	21.9	21.9	21.9	21.9	21.9
Maintenance Cost								
Civil	16.1	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Mechanical	2.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Misc.	10.0	10.0	20.0	20.0	20.0	20.0	20.0	20.0
Insurance Cost								
Civil Insurance	1.7	10.9	16.1	7.2	3.2	1.4	0.6	0.3
Mechanical Insurance	0.1	2.0	3.1	1.4	0.6	0.3	0.1	0.1
Regulatory to IWAI								
Royality to IWAI	3.9	4.1	7.3	9.3	11.8	15.1	19.3	24.6
Revenue Share	1.3	1.4	2.5	3.2	4.0	5.1	6.5	8.3
Total Cost	**56.5**	**95.9**	**138.2**	**130.4**	**129.5**	**132.3**	**137.6**	**145.2**

The following table depicts the P/L statement for development of IWT on NW101.

Table 15.12 Profit & Lost Statement (INR Lakhs)

Particulars	FY21	FY25	FY25	FY30	FY35	FY40	FY45	FY50
Revenue	33.6	35.7	62.5	79.0	100.0	127.6	162.8	207.8
Cost	56.5	193.9	236.2	228.4	227.5	230.3	235.6	243.2
PBDIT	-22.9	-158.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Depretiation	0.0	101.9	192.2	146.2	146.2	0.0	0.0	0.0
Interest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PBT	-22.9	-260.2	-365.9	-295.6	-273.7	-102.7	-72.8	-35.4
Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAT	**-22.9**	**-260.2**	**-365.9**	**-295.6**	**-273.7**	**-102.7**	**-72.8**	**-35.4**

This project does not generate any profit till FY50. This is mainly because of high development cost and very less revenue. Investment and returns in terms of revenue are the major factors that heavily impacts commercial prospects of proposed terminals.

Table 15.13 Balance Sheet (INR Lakhs)

Sources of Funds	FY21	FY25	FY25	FY30	FY35	FY40	FY45	FY50
Sources of Funds								
Capital	181	1,360	2,539	2,539	2,539	2,539	2,539	2,539
Reserves & Surplus	-23	-341	-1,054	-2,693	-4,105	-5,135	-5,561	-5,816
Total Funds	**158**	**1,019**	**1,486**	**-153**	**-1,566**	**-2,595**	**-3,021**	**-3,277**
Usage of Funds								
Net Block	181	1,247	2,041	1,196	465	0	0	0
Net Current Assets	-23	-228	-556	-1,349	-2,031	-2,595	-3,021	-3,277
Total Assets	**158**	**1,019**	**1,486**	**-153**	**-1,566**	**-2,595**	**-3,021**	**-3,277**

15.3.3 Financial IRR

Financial IRR would help IWAI to measure the return on investment and understand the viability for developing proposed 4 terminals on NW101. It assists in taking the decision on implementation of development.

Table 15.14 Financial IRR Calculation (INR Lakhs)

Particulars	FY21	FY23	FY25	FY30	FY35	FY40	FY45	FY50
PBDIT	-22.9	-158.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Equity	181.4	1,179.0	0.0	0.0	0.0	0.0	0.0	0.0
Debt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Investment	181.4	1,179.0	0.0	0.0	0.0	0.0	0.0	0.0
Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash flow to Equity(Pre-tax)	-204.3	-1,337.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Equity IRR(Pre-tax)	**Not-Exists**							
Cash flow to Equity(Post-tax)	-204.3	-1,337.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Equity IRR(Post-tax)	**Not-Exists**							
Project Cash flow(Pre-tax)	-204.3	-1,337.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Project IRR(Pre-tax)	**Not-Exists**							
Project Cash flow(Post-tax)	-204.3	-1,337.3	-173.7	-149.4	-127.5	-102.7	-72.8	-35.4
Project IRR(Post-tax)	**Not-Exists**							

15.4 Conclusion

Above analysis gives the overview of financial viability of the project. All the cost involved in development of fairway and construction of terminals, supporting infrastructure, approach road, etc. has to be borne by IWAI, that's why 100% equity is considered by undertaking financial analysis. Apart from this, IWAI also has to cut down its tariff rate even further in order to attract more traffic. Projected traffic on each terminal and revenue generated from them is not sufficient to cover the day to day operation cost of operating terminal and fairway. Hence no returns are anticipated in the project 30 years lifespan of the project. In such situation, IWAI needs to take additional measures like subsidizing operational cost in order to keep IWT in NW101 functioning at no returns but for social benefit.

CHAPTER – 16
SWOT ANALYSIS & CONCLUSION

16.1 INTRODUCTION

SWOT analysis is a framework used to evaluate a project strengths, weaknesses, opportunities and threats. Specifically, **SWOT analysis** is a foundational assessment model that measures what project can and cannot do, and its potential opportunities and threats.

16.2 STRENGTH

(1) Water Availability throughout the year.

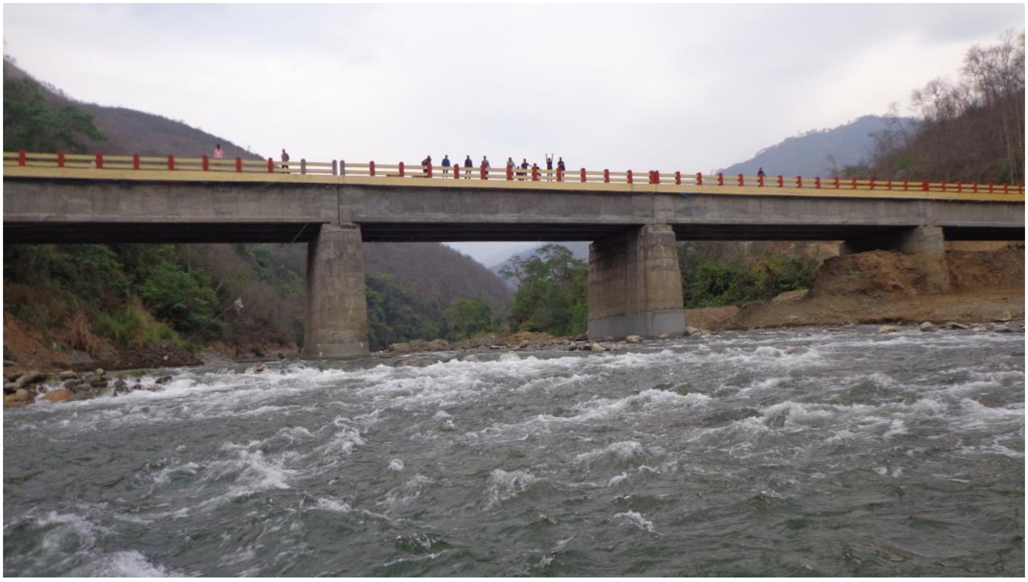
(2) People are showing good response in IWT as road transport is not well developed and it's a hilly Himalayan terrain with land slide prone areas disturbing the commuting of the villagers.

(3) Presence of International trade centre ITC centre near Avakhung

(4) Presence of rich mineral belt which is untapped. Post development of project IWT can be good option for transportation as the road condition is very poor in the region

16.3 WEAKNESS

(1) High Velocity of water and steep slope of river making the navigation difficult



(2) Presence of rock outcrops in the main channel making navigation difficult

(3) Very less traffic volume

Total annual passenger till year 2022 is 30,961 numbers and total annual passenger till year 2027 is 61,632 numbers.
The detailed traffic analysis has been provided in chapter-3

(4) Lack of Financial strength for local vessel operators

The project area is very remote and no skilled man power is present. The lack of financial strength of local vessel operator make it a remote possibility for development.

16.4 SWOT AT GLANCE

Strength	Weakness
• Availability of water and depths • Local People and Govt. Support • Availability of deposits of Mineral belt • Increasing Opportunity and Livelihood of local people • Scope of Mineral Mining • River Tizu is a transboundary International river. It crosses the border of Nagaland state and reaches Myanmar. • International Trade with Myanmar if other side of the water way gets developed it can be connected the Hta-Man-Thi port of Myanmar • will encourage improvements in infrastructure, aiding the safe and smooth operation of cargo movement	• Availability of Road Network • Sinking Land Slide Zone. Landslides leads to closure of roads. • Very high velocity of water in river and presence of rapids • Very Less population to commute. • Lack of Financial Strength for local vessel operators • Lack of Marketing Strategies • Local Unrest and Agitations for various reasons • Flood uncertainties, fully rocky terrain and boulders throughout the river. • Inadequate credit for agricultural operations. • High cost of infrastructure maintenance due to recurring floods • No assured return on investment. • No Repairing and other ancillary facilities for vessels

Opportunities	Threats
• Potential for Industrial Investment. • Tourism can be developed. • Availability of new technologies and farming practices. • Rising demand for diversified agriculture and horticulture product. • Focused area of central and state Govt. schemes • Commercialization and globalization of agricultures and	• Risk of Natural calamities • Local and Political Support and Unrest • High cost of Operation • Competition from other Modes • Shortage of skilled labour • Timely implementation of projects • Private Investment cannot be expected

16.5 Major Bottlenecks & Suggestions for development of NW 101

Major challenges are identified, which could threaten the development and viability of IWT at River Tizu & Zungki. These challenges and suggestive methods are listed below.

Major Bottlenecks & Suggestive Methods

Bottlenecks

1. River Morphology and geographical condition of Tizu & Zungki river
2. Proposed Hydro Electric Power plant in Lower Tizu
3. Less Available Depth of Tizu river
4. Poor road connectivity & no railway line
5. Under developed hinterland of NW 110 & less population
6. Regulatory constraints & no policy for promoting IWT by law enforcement
7. Political unrest in the region
8. Security & safety in Inland Navigation & high cost of security measures
9. Project is not profitable due to large investment and less traffic

Suggestive Methods

1. Dredge the river to maintain draft, width & easements around bends in the river
2. Install navigation lock for navigability
3. Maintain depth in the river through dredging
4. Develop roads for easy access to terminals
5. State Government should promote trade & commerce & develop rural area
6. Government should promote IWT with policies & incentive programs
7. Government should ensure peace, law & order in the region
8. Develop a Security Plan for inland navigation & terminal operation
9. Government could develop NW 101 for the benefit of society and growth of the region

Fig. 16.1 Major Bottlenecks & Suggestive Methods

The above mentioned bottlenecks and suggestive methods are described in detail below.

16.5.1 River Morphology and geographical condition of Tizu and Zungki river

The Zungki river stretch has sharp bends and curves before it merges with Tizu river. Due to the morphology of the river at this stretch, navigation for vessels would be challenging. The riverbed consists of rock outcrops and boulders. Tizu river's velocity is very high and rapids would be hurdle for navigation.

Suggestive Method

Dredging is necessary to maintain drafts, widths and easements around bends in the river for navigation of vessels. However, due to the geographical condition and abovementioned technical obstacles in the river, dredging operation would be a costly feat.

16.5.2 Proposed Hydro Electric Power Project in Lower Tizu

A hydro electric project is proposed to be developed in Lower Tizu stretch in Kiphire district. The proposed project site is located in river Tizu about 12 km. downstream from confluence of Tizu and Zungki rivers. This upcoming hydro power project is a major hurdle for the development of NW 101. Due to the elevation near this project, vessel navigation on NW 101 would be a challenge. Vessels would not be able to cross the dam unless a navigation lock is installed. Installation of navigation lock is a cumbersome and expensive option.

Suggestive Method
Navigation lock needs to be installed for navigation in the entire stretch of NW 101. The lock of size 40x10 would make the stretch of NW 101 navigable for vessels.

16.5.3 Least Available Depth (LAD) of Tizu river

The Least Available Depth (LAD) of Tizu river from Longmatra to Avangkhu (India) varies from 0.6 to 10.0 m. Due to the rocky bed of the river, only after dredging, the least available depth of 0.6 mtr could be attained. This depth is not adequate for large vessels.

Suggestive Method
To make NW 101 sustainable for water transportation, it is necessary to maintain depth in the river throughout the year. Dredging to a sufficient depth would ensure water availability in NW 101 in all seasons. This would enable water navigation throughout the year. A CLASS-1 type inland waterway could be developed and a medium size vessel can easily navigate throughout the season. The depth of Tizu river is not adequate for large vessels; however due to the underdeveloped region and less traffic volume, large vessels would not be required in NW 101.

16.5.4 Poor road connectivity & absence of rail connectivity

Inadequacy of the infrastructure and poor road connectivity in the hinterland is a major bottleneck. Roadway is the the only mode of transportation in the hinterland. There is no railway line in the hinterland. Many villages near the river stretch lack proper road network. Local roads are kaccha, fair weather roads. During monsoon, road connectivity suffers due to occurrence of landslides. Sometimes, local roads are completely washed away during monsoon.

The riverbank has steep terrain. Developing roads on the hilly and mountainous terrain would be a challenge and would require large investment. Hilly region with serpentine roads increases the actual distance of town or village from the terminal. This will reduce competitiveness of the River Tizu for Transportation compared to roads.

Suggestive Method
To integrate inland waterways in supply chain, it is necessary that IWT is linked with other modes of transportation. New roads needs to be developed in the hinterland, like

link road between Pokhungri and Avakhung. Repair and maintenance work of the existing road network should be undertaken.

16.5.5 Under developed hinterland of NW 101 & less population

Due to the geographical condition and isolation, the hinterland of NW 101 is under developed. The hinterland of Tizu & Zungki river is mostly hilly and covered in thick vegetation, which is a major hurdle for the economic growth of the region. The districts of the hinterland are rural. Few villages in the hinterland are uninhibited. Most of villages in the catchment area are located in remote region. Per capita income of individuals is low. Due to remoteness, isolation and a land locked situation, the villages of the hinterland has poor access to markets. Villagers need to travel a long distance to buy essential commodities etc. Due to less population of the hinterland there is no sufficient manpower for agriculture and industrial labour. Moreover, the growing educated population is focused mainly on Government jobs.

For a profitable IWT service, a balanced traffic flow is required. The disparity in economic development in the hinterland of river Tizu & Zungki leads to unbalanced cargo flows, which make it difficult to run a profitable IWT service. Also, there is problem related to the consignment sizes. Small consignment would not be ideal for waterway transport service on river.

Suggestive Method
The development of rural areas is critical for the economic growth of the hinterland. The State Government needs to give attention to regional and social disparity in the region and develop transportation and other infrastructure in cities/towns. Economic development would result in maximum traffic volume in the waterway. Development of infrastructure and connectivity will promote trade and commerce that will open up large employment opportunities in the hinterland.

16.5.6 Regulatory Constraints

At present, integrated transport planning to minimize logistics costs and law enforcement capability is not adequate. The many policy directives to encourage IWT development focus on promotion of infrastructure and give little consideration to market players, policy instruments, implementation arrangements and financial support.

Suggestive Method
It will be imperative to review, assess and if needed, amend or formulate appropriate policies, laws and rules that will provide the legal frameworks, executive powers and directions for implementation of the inland waterway and its sustainable development strategies.

The Government should act as an advocate to promote policies, which make waterways more attractive and easier to use. It should direct inland waterway transport incentive programs toward market players to pursue them to opt IWT as choice of transport mode and integrate it in their intermodal transport chain. This would help NW 101 to attain long-term sustainability and gain a wider recognition as a waterway dedicated for transport and leisure. Following are the suggestions for promoting IWT and increasing efficiency of NW 101.

- NW 101 has advantage because hinterland of NW 101 is remote and suffers from poor connectivity. There is no railway in the hinterland. Existing roadways are not well developed and in poor condition. Due to hilly region, roads are serpentine and take longer transportation time. IWT would save time and cost of transportation as the distance of IWT is less than roadways. It is very likely that villagers would opt for IWT for short distance as well as long distance movement. For passenger movement, cost of IWT would be cheaper. Due to less volume of cargo, it is necessary that transportation cost of cargo movement is subsidized.
- Government should develop infrastructure and facilities on NW 101.
- After development of NW 101 and IWT terminals on the river, Government should hand over the facility to locals for operation and maintenance. This would reduce IWAI overheads in Operating and Management of NW 101.
- Government should provide training to local villagers, especially youths to operate vessels/boats and other activities (like repairing vessels, dredging services, terminal operation etc.) related to national waterway and terminal on NW 101. It would generate employment in the hinterland and locals residing near the bank of river would be exposed to bigger opportunities.
- For Indo- Myanmar trade using IWT, it is necessary that Government of both countries would develop waterway in their stretch of the river. IWAI would develop waterway (NW 101) till Indo- Myanmar border near Avakhung. Myanmar Government needs to develop waterway from the border till Hta Man Thi.
- To boost Indo- Myanmar trade through NW 101, it is necessary that Government of both the countries would ensure smooth navigation of vessels in the proposed inland waterway. There should not be any hurdle in vessel movement.
- The international laws for trade between both the countries, using IWT should be flexible and favorable for Indo-Myanmar trade.

16.5.7 Political unrest in the region

Due to Naga political problem, the hinterland suffers from political unrest. This caused lack of environment for investment. This would also adversely affect the construction and operation in terminals and waterway on NW 101.

Suggestive Method
Government should ensure that peace, law and order will prevail in the hinterland and the entire state. This would attract investors in the region.

16.5.8 Security & Safety in Inland Navigation

Safety and security of staffs, passengers, vessels, terminal infrastructure, equipments and cargo is one of the major concerns. Like Ports, the areas of inland navigation are also threatened by terrorist attacks and other anti social elements. Security measures would be required for safety in terminals and on vessels. High cost associated with the security measures would further hinder the viability of IWT.

Suggestive Method

IWAI needs to develop a security plan for IWT infrastructure and other facilities on NW 110. The security plan must include measures to prevent unauthorized access in terminals, measures to prevent weapons or dangerous substance on board of vessels or in terminals, procedures to respond to security threats, evacuation process during emergency, duties of personnel responsible for security etc.

16.5.9 Project is not profitable

Large investment would be required for construction, maintenance and overhead of the terminal. Due to lack of traffic and under development in the region, it could be assumed that the capital and operational cost of NW 101 would be high and the project would not be financially profitable.

Suggestive Method

Government could develop NW 101 for the benefit of the society and development of the region. This project could be developed for the overall growth of the hinterland and the state.

16.6 Safety and Security

Following measures of safety and security need to be taken care to ensure safe operations on terminals and in the IWT route in Tizu & Zungki river.

- Vessel operator and wharf management authorities are the main responsible party for vessels' safety.
- Some of the major factors leading to vessel accidents on IWT route are unqualified crew, exceeding vessels capacity, ageing of vessels, faulty designs and lack of regulatory standards. Hence, these factors need to be taken care for safety on terminals and inland waterway route.
- Central Water Commission is the responsible body for providing water level forecast in rivers. Such information would be helpful in smooth and safe operations of vessels.
- State IWT officials need to conduct regular inspection of the vessels and ensure all necessary equipments are available on board.
- Local authorities should be in charge of providing adequate facilities at terminals for passenger embarkment and disembarkment. As per water level in river, appropriate landings need to be provided such as wharf etc. Terminal should be equipped with guard to stop damage to vessels when berthing.
- Standard fire extinguisher to be established at each terminal and to be carried on vessels to prohibit fire accidents on the river.

16.7 Conclusions & Recommendations

WAPCOS has studied the entire stretch of study of River Tizu & Zungki (from Longmatra to Avakhung) and identified development of for passenger movement with small household cargo. Four terminal locations at various places on the basis of traffic potential, water availability and land availability. The details of these terminals are given in table 16.1 below.0.5 acre of land is suggested for development of each terminals:

Table 16.1 Phase-wise details of terminals

Sr. No.	Tentative Location	Districts	Size of wharf	Type of wharf	HFL (m)*	Chainage (km)	Lat-Long
1	Near Longmatra	Phek	25x6	Concrete	458.74	33.3	25°46'38.20"N / 94°44'56.24"E
2	Near Laruri Bridge	Phek	25x6	Concrete	439.12	14.0	25°41'9.56"N / 94°51'14.47"E
3	Near Phonkhuri	Phek	25x6	Concrete	432.83	7.5	25°37'46.68"N / 94°50'58.62"E
4	Near Avakhung	Phek	25x6	Concrete	426.65	1.2	25°35'15.41"N / 94°52'45.05"E

Phase wise details of waterway in terms of length of each phase, dredging quantity, proposed class is given below in Table 16.2.

Table 16.2 Phase-wise details of length, dredging quantity, proposed class

Sr. No	Phase	Stretch	Design Vessel	Qty (Cum)
1	Phase-I (Immediate)	Longmatra to Avankhung (with inflatable rubber boats)	15m bottom width,0.6 m depth	**8640**
2	Phase-II	Longmatra to Avankhung	15m bottom width,1m depth	**(61020- 8640) = 52380**

Phase-III is not recommended due to high cost of investment and less traffic potential

Outcomes of study

The NW-101 was studied for development of IWT in Nagaland which consists of two rivers Tizu and Zungki.After study the zungki river was discarded for development based on traffic and engineering studies.Tizu river was proposed for development in two phases for passenger and household cargo movement.

1) The slope of the river is steep and is average 0.94m per Km.

2) The average LAD is ranging from 0.4m to 0.6 m in the stretch and maximum depth observed is 3m to 5.8m.

3) The vessel suggested for the waterway passenger and cargo is shown below

Vessel's Specification for Immediate Phase – Inflatable Boats with OBM-For Phase-I

Company / Ferry Name →	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	4.2	4.1	4.5 – 4.7	4.4
Beam (m)	1.8	1.7	1.9	1.8
Passenger Capacity (PAX)	6-7	4-6	8-10	8-10
Engine Power (HP)	25	25	25	25
Make	Indian	Indian	Indian	Indian
Fuel	Diesel	Diesel	Diesel	Diesel
Price (INR)	7,50,000/-	5,83,000/-	1,55,000/-	5,50,000/-

Vessel's Specification for Phase -II

Ferry→	Vessel Type 1	Vessel Type 2	Vessel Type 3	Vessel Type 4
Length (m)	5.6	6	11	7
Beam (m)	2.28	2.5	3.84	2
Draft (m)	0.6	0.5	0.6	0.4
Passenger Capacity (No.)	18	20	20	10
Speed (Knots)	10	10	12	12
Fuel Consumption (Ltr/Hr)	4.5	2.6	20	6.8
Type of Fuel	Diesel	Diesel	Petrol	Diesel
Engine Capacity (HP)	25	15	2 X 70	40
Make	Indian	Foreign	Foreign	Indian
Fuel	Diesel	Diesel	Diesel	Diesel

4) Revenue generated from Terminal and Fairway operation is based on the projected traffic for next 30 years. Tariff rates considered in the financial analysis, for terminal and fairway usage, is as per the market standards. At terminals, INR 100 per passenger/tourist will be charged for using ferry service, INR 50 for using viewing deck at the terminal and INR 1/Kg for carrying cargo (household products). For Fairway usage, passenger and tourists will be charged INR 3 Pax-Km.

5) Estimated project cost for development of fairway and all 4 terminals is INR 2.24 Cr. In immediate phase and Rs.23.57 Crores in Phase-II. Phase-III is discarded Due to high development cost of Rs.981 Crores (CAPEX & OPEX) and very less revenue in return, there is huge difference between outflow and inflow. Revenue generated from terminals and fairway is not sufficient even to cover day to day operating expenses. In such scenario, this project does not generate any returns.

To develop and continue operation on NW 101 for social benefit, heavy subsidy would be required.

6) It is also recommended to conduct modeling study before construction of any intervening structure on the waterway.

7) It is also recommended to build the road connecting to all terminals under PMGSY or state govt. funding. The cost for construction of roads is around Rs.24 crores for four terminals which is required to be made before taking works of phase-II.

8) It is recommended to conduct soil investigation and topographic survey of terminals and the interventions proposed for detail designing.

Note: The potential site where strengthening is required by soil nailing or protection by proper engineering solution needs to done by conducting survey of the hills on both the banks with a specialized agency

This report can be updated at a later stage when required, by considering the fresh cargo analysis, change in requirement of the Government or change in policy either of the state or government of India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