ASSAM ELECTRICITY GRID CORPORATION LIMITED

INITIAL ENVIRONMENTAL EXAMINATION
&
ENVIRONMENT MANAGEMENT PLAN

TRANSMISSION SYSTEM EXPANSION

ASSAM POWER SYSTEM ENHANCEMENT PROJECT

GUWAHATI: APRIL 2010

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Abbreviations and Terminology

ADB	Asian Development Bank
EMF	Electromagnetic Fields
EMP	Environmental Monitoring Plan
EIA	Environment Impact Assessment
IEE	Initial Environment Examination
MOEF	Ministry of Environment and Forests
SEIA	Summary Environment Impact Assessment
SIEE	Summary Initial Environmental Examination

ELECTRICAL TERMINOLOGY

V	Volt	Unit of Voltage
kV	Kilovolt	1000 volts
W	Watt	Unit of active power
kW	Kilowatt	1000 watts
MW	Megawatt	1000 kW
kWh	Kilowatt hour	Unit of energy
MWh	Megawatt hour	1000 kWh
VA	Volt ampere	Unit of apparent power
MVA	Million volt ampere	10^6 VA
Transmission System	400 kV, 220 kV, 132 kV and/or 66 kV lines supplying (incoming & outgoing feeder) grid substations (Substation) with primary voltage of 400 kV, 220 kV, 132 kV, or 66 kV	
LILO	Line - In - Line - Out	

WEIGHTS AND MEASURES

C	degree Celsius
DB(A)	decibels measured in the audible noise bands
Ha	Hectare
Km	Kilometre
M	Meter
m^3	cubic meter
kg	Kilogram
mg/l	milligram per liter
t	Ton
t/a	ton per annum

NOTES

(i) The fiscal year of the Government ends March 31

(ii) In this report "$" refers to US dollars.

CHAPTER - 1

INTRODUCTION

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION AND SCOPE OF ASSESSMENT

1. The Government of India (GOI) and Government of Assam (GOA) have requested Asian Development Bank (ADB) to provide $200 million in loan funding via a multi-tranche financing facility (MFF) to support continued investment in the state power sector, specifically for transmission and distribution system expansion and upgrades. The Assam State Electricity Board (ASEB) is the GOA coordinating agency for the MFF. GOA and ASEB will be the Executing Agencies for the MFF. The power sector investments are necessary to support continued investment in the state power sector, which is necessary for economic growth and poverty reduction.

2. The MFF will partly finance the expansion and augmentation of the transmission and distribution (T&D) networks. The proposed investments are necessary to: (i) facilitate increased power transfers to accommodate increased demand and economic growth; (ii) improve supply-side energy efficiency by system de-bottlenecking and reducing technical losses; (iii) reduce the intensity of greenhouse gas (GHG) and other emissions via improved system efficiency; (iv) support expanded private sector participation in distribution system operations and other energy services; and (v) facilitate poverty reduction via improved electricity services and economic growth.

3. For the purpose of project preparation, a Detailed Project Report (DPR) has been prepared for the transmission system expansion to be supported by ADB (the Project).[1] The Implementing Agency (IA), Assam Electricity Grid Corporation Ltd. (AEGCL), has prepared this Initial Environmental Examination (IEE) for the proposed transmission system project, with consulting support from ADB TA 7096-IND. This IEE describes the proposed transmission system investments, environmental benefits and negative impacts, public consultations, proposed mitigation measures, and preliminary environmental management plan (EMP).[2]

4. The proposed Project is classified as Category B under Asian Development Bank (ADB) *Safeguard Policy Statement* (2009). This category is assigned due to "greenfield" transmission lines and substations which are assigned Category B. The IEE of the proposed investments is being carried out following the Asian Development Bank's (ADB) *Safeguard Policy Statement* (2009*), Environmental Assessment Guidelines* (2003), and the Government of India (GOI) environmental

[1] A separate DPR is being prepared for the distribution system investments.
[2] The IEE and EMP may be updated periodically if necessary during project implementation.

assessment regulations and guidelines. The primary statutory body responsible for ensuring environmental compliance by the Project is the Assam Department of Environment and Forests (ADEF), and the Assam State Pollution Control Board (APCB) which operates under the aegis of ADEF.[3,4]

5. An Environmental Assessment and Review Framework (EARF)[5] has been prepared which is applicable to all investments funded by the proposed MFF, including subsequent tranches that have not been fully defined. The EARF outlines the policies, procedures, and institutional requirements for preparing subsequent tranches. The EAs are responsible for preparing the required environmental assessments and obtaining ADB concurrence before implementation. These approvals must be in place before contracts are finalized and work begins. The EARF specifically notes that sensitive areas will be avoided at the design and planning stage to the maximum extent possible. ADB requirements for environment Category B-sensitive (or A) projects may be applied in cases where technical design constraints require access to reserved forests or other environmentally sensitive areas.[6]

6. A preliminary EMP that will apply to all components and subprojects has been prepared (see Chapter 5). The EMP is developed based on environmental analysis of the proposed transmission system components, as well as a review of environmental impacts of other typical power transmission and distribution projects in India. The mitigation measures for distribution system investments in subsequent tranches will be developed in accordance with the EARF and EMP framework.

1.2 BACKGROUND AND PRESENT SCENARIO

7. Assam Electricity Grid Corporation Limited (AEGCL), a successor company of Assam State Electricity Board (ASEB) came into existence in the year 2004 as a part of the reforms program in the power sector initiated by the GOI. AEGCL was created out of the Transmission and Transformation (T & T) wing of ASEB to operate, maintain and develop the transmission system in the entire state of Assam.

[3] The Ministry of Environment and Forests updated environmental assessment procedures prescribed in the Environment (Protection) Rules, 1986, via notification published in the Gazette of India, Extraordinary, Part-II, and Section 3, Sub-section (ii). Transmission systems are not included in the list of projects subject to the notification and environmental impact assessment clearance requirements. Government of India regulations consider transmission and distribution systems to be non-polluting activities, and as such do not require environmental assessments or prior regulatory approval from the Ministry of Environment and Forests. State- and central-level regulatory approval is required for right-of-way and sites located in reserved forests, wildlife preserves, national parks, and other designated sensitive areas.

[4] The following acts, laws, rules and guidelines may be applicable to the investment program: (i) Air (Prevention and Control of Pollution) Act, 1981; (ii) Water (Prevention and Control of Pollution) Act, 1974; (iii) Forest (Conservation) Act, 1980 and its amendments; (iv) Forest (Conservation) Rules, 2003 and its amendments; (v) Wildlife (Protection) Act, 1972; (vi) Wildlife (Protection) Amendment Act, 2002; and (vii) IS Codes and CPCB Guidelines for monitoring and analysis of air, water, soil, etc.

[5] The Draft EARF is presented separately in the Framework Financing Agreement.

[6] Environmentally sensitive areas are avoided to the maximum extent possible in the planning and design stage. Some transmission lines may cross reserved forest areas; ADEF has a built-in mitigation procedure for such instances (see discussion in Chapter 4 and Appendix 3).

8. Earlier as a part of ASEB, the T & T wing was created in the year 1978 to look after a large numbers of transmission projects taken up for construction at that time. Till that time the transmission system of ASEB was consist of few 66 kV lines and substations in Upper Assam area and a very small numbers of 132 kV lines and 132 kV substations in Lower Assam area. Both these 132 kV and 66 kV systems were operated in isolated mode at that time.

9. Since the creation of Transmission and Transformation wing under ASEB, the transmission system in Assam has grown substantially until the financial crunch in 1990s. The situation continued to worsen until the reforms program in power sector was initiated in early 2000 and as a part of the same reform program Asian Development Bank (ADB) and Government of India (GOI) provided funds for development power sector in Assam under the *Assam Power Sector Development Program*.

10. Under the said *Assam Power Sector Development Program*, AEGCL has taken up the following works in transmission sector:

- Fourteen numbers (14) of new 132/33 kV substations spreading all over Assam.
- 431 and 98 circuit KMs of 132 kV and 220 kV transmission lines respectively.
- Augmentation and Extension of 14 nos. of existing 132 and 220 kV substations.
- Reactive compensation by way of 33 kV Bus Capacitors totaling 205 MVAR in 17 Grid Substations of AEGCL.
- Introduction of a new SCADA covering all substations of AEGCL.
- Replacement of aged and obsolete substation equipments, e.g. Circuit Breakers, Instrument Transformers, Relay & Control Panels and Protection Relays in various Grid Substations of AEGCL.
- Complete revamping of Power Line Carrier Communication system.

11. Though some schemes have been taken up during this period with Govt. funds and finance from other sources, the investment made under the *Assam Power Sector Development Program* was the single major investment in the Transmission sector. As this *Assam Power Sector Development Program* along with the other schemes is now nearing completion, the situation in the transmission sector appears to be on the road of recovery. However, as the growth in power demand is a continuous process it is responsibility of the AEGCL to continue its efforts in developing the Transmission System in Assam.

1.3 EXISTING TRANSMISSION INFRASTRUCTURE

Transmission Lines

12. At present, AEGCL has transmission lines of 66 kV, 132 kV and 220 kV voltage classes. The total Route Length and the Circuit kilometers (km) of these lines are listed below. These include lines coming up under *Assam Power Sector Development Program* and other on-going schemes.

Sl. No.	Voltage Class	Route Length, KM	Circuit KMs
1	220 kV D/C Transmission Lines	506.5	1013
2	220 kV S/C Transmission Lines	320	320
3	132 kV D/C Transmission Lines	510	1020
4	132 kV S/C Transmission Lines	1692	1692
5	66 kV D/C Transmission Lines	205	410
6	66 kV S/C Transmission Lines	192	192
7	**TOTAL**	3425.5	4647

Grid Substations

13. The numbers of existing substations of different voltage classes are listed below along with the available transformation capacities. This includes substations coming up under Assam Power Sector Development Program and other on-going schemes. The detailed lists of these existing Substations are furnished in Exhibit-1.1 at the end of this Chapter.

Substation Voltage Class	Nos.	Transformation Capacity (MVA)				
		220/132	132/33	132/66	132/11	66/33
220/132/33	5	815	212.5			
220/132/66/33	3	400	31.5	150		122
132/33	38		1278.05			
132/33/11	1		101.5		10	
132/66/33	5		217			92
132/11	1				16	
66/33	1					20
TOTAL	54	1215	1840.55	150	26	234

Other Facilities

14. The existing *State Load Dispatch Center (SLDC)* is also operating under *AEGCL*. Though the *SLDC* exists from a long time it is expected to be fully operational only after completion of the new SCADA system coming up under ongoing *Assam Power Sector Development Program*.

15. Also, under *Assam Power Sector Development Program*, AEGCL have already completed the installation of 205 MVAR of 33 kV Bus Capacitors in various Grid Substations to provide Reactive Compensation to the system.

Grid Map and Details of the Transmission System

16. The detailed lists of existing Substations and Transmission Lines are furnished in Exhibit-1.1 and Exhibit-1.2 respectively. Map 1 shows the existing transmission system and proposed new facilities. Exhibit-1.3 shows some of the recently completed works supported by the *Assam Power Sector Development Program*.

EXIHIBIT – 1.1
DETAILS OF EXISTING SUBSTATIONS

SL No.	Name of Substation	Transformation Capacity, MVA					PEAK LOAD. MW
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	2007-2008
I	II	III	IV	V	VI	VII	VIII
1	Gauripur			2x16			15.8
2	Gossaigaon			2x16			8.6
3	Dhaligaon			2x25			13.6
4	Salakati (BTPS)**	1x80+1x 160		1x16			3.0
5	Barnagar			2x25			20.6
6	Nalbari*			2X16			11.0
7	Rangia			2x25			13.0
8	Amingaon (Sishugram)			2x31.5 +1x40			36.1
9	Sarusazai	3 X 100		3X31.5			36.0
10	Kahelipara			2X5+ 2X30+ 1X31.5			85.0
11	Dispur**					1x16	6.0
12	Narangi*			2X25,			22.0
13	Chandrapur			1x16,1X 30			15.0
14	Jagiroad			2x16			20.2
15	Azara**			2x25			12.0
16	Boko*	1x50		2x10			6.0
17	Sipajhar*			2x16,			8.2
18	Rowta			2x25			15.0

SL No.	Name of Substation	Transformation Capacity, MVA					PEAK LOAD. MW
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	2007-2008
I	II	III	IV	V	VI	VII	VIII
19	Depota			2x31.5			26.0
20	Balipara(I)**			1x16			6.0
21	Gohpur			2x10			10.0
22	Biswanath Chariali*			2x16			8.8
23	N.Lakhimpur			2x10			10.8
24	Majuli*			1 x 16.05			2.0
25	Dhemaji			2x16			6.5
26	Samaguri	3 X 50		2x25			37.0
27	Sankardevnagar			2x16			24.0
28	Diphu			2x16*	2 x 5		7.9
29	Bokajan			2x16**	2x5		10.2
30	Golaghat			2x25*	1x10+ 1x20		15.0
31	Bokakhat*			2x16,			7.0
32	Mariani	2 x 100	2 x 20		2x16		18.6
33	Jorhat			1x16+ 2x25			35.0
34	Nazira			2x25	2x16		25.6
35	LTPS (Lakwa)			2x7.5			12.3
36	Sibsagar*			2x16			15.0
37	Moran*			2x16			12.0
38	Dibrugarh			2x31.5	1x10		22.0
39	Tinsukia	2 x 50	3x20		3x20		42.0
40	Margherita			2x10,			16.5
41	Doomdooma				2x10,		17.5
42	Namrup	2X50*	2x25	1x31.5	1x30		24.2
43	Haflong			2x10,			5.6
44	Khandong			1x16			7.4
45	Panchgram (new)			2x25,			21.0
46	Panchgram (old)			2x10			8.0

SL No.	Name of Substation	Transformation Capacity, MVA					PEAK LOAD. MW
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	2007-2008
I	II	III	IV	V	VI	VII	VIII
47	Pailapool			3x10			8.9
48	Dullavcherra			1x10.5			7.8
49	Srikona*			2X25			25.0
50	Agia	1x50 +1x25		2x16 MVA			12.0
51	Gogamukh			1x16			1.5
52	Jogighopa(APM)			1x16 +1x12.5			6.1
	TOTAL	**1215**	**150**	**1840.55**	**234**	**26**	**862.3**

* *Under construction (under Assam Power Sector Development Program) and likely to be completed very soon.*

** *Under construction (under NLCPR and other Program) and likely to be completed in near future.*

EXHIBIT-1.2

EXISTING TRANSMISSION LINES

SL. NO.	NAME	No. of Circuit	Route Length (KM)	Circuit KM	Type of Conductor
I	II	III	IV	V	VI
A	**220 KV Lines**				
1	Tinsukia-Namrup*	2	49	98	AAAC 'ZEBRA'
2	Tinsukia-Kathalguri	2	30	60	ACSR 'ZEBRA'
3	Mariani-Samaguri-I	1	164	164	ACSR 'DEER'
4	Mariani-Samaguri-II	1	169	156	ACSR 'ZEBRA'
5	Sarusajai-Samaguri	2	96.5	193	ACSR 'ZEBRA'
6	Samaguri-Balipara (P)	2	55	110	ACSR 'ZEBRA'
7	Longpi-Sarusajai	2	118	236	AAAC 'ZEBRA'
8	Sarusajai-Agia	1	88	88	AAAC 'ZEBRA'
9	Sarusajai-Boko	1	47	47	AAAC 'ZEBRA'
10	Boko-Agia	1	41	41	AAAC 'ZEBRA'
11	Agia-BTPS	2	70	140	AAAC 'ZEBRA'
12	**TOTAL**		**826.5**	**1333**	
	Single Circuit		**320**	**320**	
	Double Circuit		**506.5**	**1013**	
B	**132 KV Lines**				
1	BTPS (Salakathi)-Dhaligaon	2	35	70	ACSR 'PANTHER'

SL. NO.	NAME	No. of Circuit	Route Length (KM)	Circuit KM	Type of Conductor
I	II	III	IV	V	VI
2	Dhaligaon-Gossaigaon	1	62	62	ACSR 'PANTHER'
3	Gossaigaon-Gauripur	1	40	40	ACSR 'PANTHER'
4	Dhaligaon-Barnagar	1	55	55	ACSR 'PANTHER'
5	Dhaligaon-APM	1	37	37	ACSR 'PANTHER'
6	Dhaligaon-Nalbari	1	115	115	ACSR 'PANTHER'
7	Nalbari-Rangia	1	25	25	ACSR 'PANTHER'
8	Barnagar-Rangia	1	75	75	ACSR 'PANTHER'
9	Rangia_Amingaon	1	32	32	ACSR 'PANTHER'
10	Amingaon-Kahilipara	1	15	15	ACSR 'PANTHER'
11	Rangia-Kahilipara	1	50	50	ACSR 'PANTHER'
12	CTPS-Dispur	1	30	30	ACSR 'PANTHER'
13	Dispur-Kahilipara	1	6	6	ACSR 'PANTHER'
14	Kahilipara-Sarusajai-I	2	3.5	7	ACSR 'PANTHER'
15	Kahilipara-Sarusajai-II*	2	3.5	7	AAAC 'PANTHER'
16	CTPS-Narangi	1	24	24	ACSR 'PANTHER'
17	Narengi-Kahilipara	1	12	12	ACSR 'PANTHER'
18	CTPS-Jagiroad	1	38.5	38.5	ACSR 'PANTHER'
19	Jiribam-Pailapool	1	15	15	ACSR 'PANTHER'
20	Pailapool-Srikona	1	32	32	ACSR 'PANTHER'
21	Srikona-Panchgram(N)	1	20	20	ACSR 'PANTHER'
22	Panchgram(N)-Dullavcherra	1	55	55	ACSR 'PANTHER'

SL. NO.	NAME	No. of Circuit	Route Length (KM)	Circuit KM	Type of Conductor
I	II	III	IV	V	VI
23	Mariani-LTPS	1	70	70	ACSR 'PANTHER'
24	LTPS-NTPS	2	53	106	ACSR 'PANTHER'
25	LTPS-Nazira	2	22	44	ACSR 'PANTHER'
26	Nazira-Jorhat**	1	65	65	AAAC 'PANTHER'
27	NTPS-Tinsukia	1	40	40	ACSR 'PANTHER'
28	Tinsukia-Ledo (Margherita)	2	53	106	ACSR 'PANTHER'
29	Tinsukia-Dibrugarh	1	53	53	ACSR 'PANTHER'
30	Dibrugarh-Moran	1	52	52	ACSR 'PANTHER'
31	Moran-LTPS	1	22	22	ACSR 'PANTHER'
32	Samaguri-Lanka	1	61	61	ACSR 'PANTHER'
33	Lanka-Diphu	1	76	76	AAAC 'PANTHER'
34	Mariani-Jorhat	2	20	40	ACSR 'PANTHER'
35	Rangia-Rowta	1	80	80	ACSR 'PANTHER'
36	Rangia-Sipajhar*	1	59	59	AAAC 'PANTHER'
37	Sipajhar-Rowta*	1	58	58	AAAC 'PANTHER'
38	Rowta-Depota-I	1	72	72	ACSR 'PANTHER'
39	Rowta-Depota-II*	1	72	72	AAAC 'PANTHER'
40	Depota-B.Chariali	1	70	70	ACSR 'PANTHER'
41	Depota-Balipara(I)	1	25	25	ACSR 'PANTHER'
42	Balipara(I)-Balipara(P)	1	14	14	ACSR 'PANTHER'
43	Balipara(P)-Gohpur	1	90	90	ACSR 'PANTHER'

SL. NO.	NAME	No. of Circuit	Route Length (KM)	Circuit KM	Type of Conductor
I	II	III	IV	V	VI
44	B.Chariali-Gohpur	1	70	70	ACSR 'PANTHER'
45	Gohpur-N.Lakhimpur	2	80	160	ACSR 'PANTHER'
46	N.Lakhimpur-Dhemaji	1	63	63	ACSR 'PANTHER'
47	N.Lakhimpur-Majuli	1	59	59	ACSR 'PANTHER'
48	Mariani-Golaghat	1	44	44	ACSR 'PANTHER'
49	Golaghat-Bokajan	1	56	56	ACSR 'PANTHER'
50	Bokajan-Dimapur	1	21.5	21.5	ACSR 'PANTHER'
51	Nazira-Sibsagar*	1	15	15	AAAC 'PANTHER'
52	Jorhat-Bokakhat*	1	84	84	AAAC 'PANTHER'
53	**TOTAL**		**2180**	**2712**	
	Single Circuit		**1692**	**1692**	
	Double Circuit		**510**	**1020**	
D	**66 KV Lines**				
1	Tinsukia-Namrup	2	37	74	ACSR 'WOLF'
2	Tinsukia-Doomdooma	1	25	25	ACSR 'WOLF'
3	Golaghat-Mariani	2	40	80	ACSR 'WOLF'
4	Bokajan-Golaghat	1	64	64	ACSR 'WOLF'
5	Bokajan-Diphu	1	39	39	ACSR 'WOLF'
6	Nazira-NTPS	2	74	148	ACSR 'WOLF'
7	Mariani-Nazira	2	54	108	ACSR 'WOLF'
8	Dibrugarh-Tinsukia	1	48	48	ACSR 'WOLF'
9	Dimapur-Bokajan	1	16	16	ACSR 'WOLF'
TOTAL			**397**	**602**	
Single Circuit			**192**	**192**	
Double Circuit			**205**	**410**	

* *Under construction (under Assam Power Sector Development Program) and likely to be completed very soon.*

** *Under construction (under NLCPR and other Program) and likely to be completed in near future.*

EXIHIBIT-1.3 PHOTOGRAPHIC VIEWS OF ONGOING ASSAM POWER SECTOR DEVELOPMENT PROGRAM

Photo 1: Commissioned 16 MVA 132/33 kV Transformer at Agia Substation

Photo 2: New 132/33 kV 2x16 MVA Substation at Boko

Photo 3: Erected Towers of New 132 kV S/C Jorhat-Bokakhat

Photo 4: Commissioned 5 MVAR 33 kV Bus

Photo 5: New 132/33 kV 2x16 MVA Substation at Nalbari

Photo 6: 50 MVA 220/132 kV Transformer

Photo 7: Erected Towers of New 220 kV D/C Capacitor at Gauripur Substation during testing (meant for Boko Substation) Namrup-Tinsukia Transmission Line

CHAPTER - 2

DESCRIPTION OF THE PROJECT

CHAPTER-2

DESCRIPTION OF THE PROJECT

2.1 NEED FOR THE PROJECT

17. The Government of India and Government of Assam have requested ADB to provide $250 million in loan funding via a multi-tranche financing facility (MFF) to support continued investment in the state power sector, which is necessary to support economic growth and poverty reduction. The MFF will partly finance the expansion and augmentation of the transmission and distribution (T&D) networks. The proposed investments are necessary to:

(i) Facilitate increased power transfers to accommodate increased demand and economic growth; peak demand is projected to increase from the current 848 megawatts (MW) to 1443 MW, and total energy demand will increase from current 4398 gigawatt-hours (GWh) to 7585 GWh by 2012;
(ii) Improve supply-side energy efficiency by system de-bottlenecking and reducing technical losses;
(iii) Reduce the intensity of greenhouse gas (GHG) and other emissions via improved system efficiency;
(iv) Support expanded private sector participation in distribution system operations and other energy services; and
(v) Facilitate poverty reduction via improved electricity services and economic growth.

18. **Transmission Capacity Expansion Tranches.** ADB funding of $ 200 million, divided into tranches (projects) with $60.3 million for Tranche 1 (T1) and $89.70million for Tranche 2 (T2), will partly finance transmission system expansion and augmentation including:

(i) Sixteen (16) new transmission lines, with total length of 604 (T1 = 262+T2 = 342) kilometers (km); 10 (T1 = 3 + T2 = 7) of these lines are relatively short line-in/line-out (LILO) lines 25 km or less to be connected to existing transmission lines;
(ii) Fourteen (14) new substations to accommodate the new transmission lines;
(iii) Expansion of six (T1=2 + T2 = 4) existing substations to accommodate new transmission lines;
(iv) Augmentation of eight (8=T2) existing substations which are currently overloaded;
(v) Installation of capacity banks for reactive power at eight (8) existing substations; and

(vi) Installation of integral power line carrier communications and system control and data acquisition (SCADA) system.

19. The basic design of the major system components are discussed in detail in this chapter. As shown in Map 1, the Project will help complete the state-level transmission "backbone" over a broad geographic area in western, central, and eastern Assam, serving the major load centers including the Guwahati urban area. Individual transmission lines have a 3-year construction schedule, and substations have a 2-3 year construction schedule depending on specifics (new vs. augmentation and expansion). Overall project implementation is scheduled over the 5-year period from 2009 through 2014. The proposed facilities will be constructed mainly in existing transmission and transportation corridors, avoiding reserved forests, wildlife preserves, and national parks. Due to technical constraints, some reserved forest may be crossed by new transmission lines. In such cases, there is an established procedure for regulatory approval which includes payment for offsetting reforestation. Appendices 1 and 2 present site sketches and photographs of the new substations and selected project sites which were evaluated in 2009 and 2010, respectively. Appendix 3 presents a discussion of reserved forests, explaining the built-in mitigation process required for diversion of such forests to other uses.

2.2 BASIC OBJECTIVES

20. The basic objective of strengthening and improvement of the transmission system is to ensure quality and reliability in operation of the system, bring down technical losses to an optimal minimum value, and phase the system to match the growing power demand in the system under study.

21. To study the system AEGCL has used the computer aided power system study tool *'MiPower'* supplied by M/S Power Research and Development Consultants Pvt. Ltd. (PRDC), Bangalore, India. While carrying out the power system studies, the *'Manual on Transmission Planning Criteria'* published by *Central Electricity Authority* of India is generally followed.

2.2.1 Voltage Regulation

22. The basic parameter in any power system study is the voltage of the system and its variation at various load conditions. As Indian Electricity Rules provides some voltage variation limits over the declared voltage, these are taken as one of the guiding factors in formulating various system improvement proposals. The Indian Electricity Rules sets the following limits for various voltage levels of a system:

a) Low tension (LT) Lines : (-)6% to (+)6%
b) 11 KV & 33 KV : (-)9% to (+)6%
c) Extra-high voltage (EHV) : (-)12.5% to (+)10%

23. The above voltage variation limits refer to actual system operating conditions. For planning a transmission system the *'Manual on Transmission Planning Criteria'* published by *Central Electricity Authority* of India specifies a

voltage limit of (+) 5% to (-) 5%. In this particular study this guideline has been followed as far as possible.

2.2.2 Technical Losses

24. The target levels and maximum tolerable loss levels for each voltage level on the system are fixed in India as follows:

Sl. Nos.	*System components*	*Levels for Peak Power Loss*	
		Target Level %	*Maximum Tolerable, %*
1	Step up transformer and EHV transmission system	0.50	1.00
2	Transformation to inter-mediate voltage level, transmission system & step down to sub-transmission voltage level	1.50	3.00
3	Sub-transmission system and step-down to distribution voltage level	2.25	4.50
4	Distribution lines and service connections	4.00	7.00
5	**TOTAL**	**8.25**	**15.50**

2.2.3 System Security

25. As the transmission system handles power in bulk quantities, the system has to be secured to disturbances in the system, so that the large scale disruption of power supply is avoided. As the system consists of mainly 132 kV and to somewhat limited 220 kV systems, a security evaluation is limited to only steady state operation. Some vital transmission line and interconnecting transformers are taken out of service to test the capability of the system to withstand such contingencies without resorting to load shedding or rescheduling of generation.

2.2.4 Design

26. Central bodies like Central Board of Power and Irrigation and Central Electricity Authority have already issued certain guidelines regarding design, layout, Protection System etc. for transmission lines and substations. Moreover, requirements of Indian Electricity Rules and Assam Electricity Regulatory Commission shall have to be taken into consideration in designing and construction of transmission lines and substations. While preparing the cost estimates not only the requirements of above bodies are taken into consideration; international standards and practices are also kept in mind.

2.3 PROPOSED TRANSMISSION SYSTEM EXPANSION

27. The new proposals, specifically the new substations, augmentations of existing ones, and new transmission lines included in the DPR are broadly based on power system studies carried out by *M/S SMEC Inc.* under the ongoing *Assam*

Power Sector Development Program. However, few changes are made to the original studies carried out by *M/S SMEC Inc.* to take care of changed priority and requirements due to changing scenario and new development during the intervening period of original study and the time of DPR preparation.

28. A fresh Power System Studies has been carried out broadly following the guidelines brought by *Central Electricity Authority* of India in the *'Manual on Transmission Planning Criteria.'* The results of these fresh studies have been incorporated into the DPR.

2.3.1 Basis of New Proposals

29. In the original Power System Studies (noted in paragraph 27 above) *M/S SMEC* was asked to carry out the studies considering peak demand of 1000 MW, 1400 MW, 1800 MW and 2163 MW. As the demand of 1400 MW closely tally with the peak demand forecasted in *Seventeenth Electric Power Survey* report published by the *Central Electricity Authority of India* at the end of the year *2011-12*, the proposals covered under the DPR are based on the studies carried out for that demand only. Peak Demands and Energy for the last two years and the forecasted demands and energy for the year *2011-2012* as recorded in the *Seventeenth Electric Power Survey* report are reproduced below**.**

YEAR*	***PEAK DEMAND (MW)***		***ENERGY (MU)***	
	REQUIREMENT	***MET***	***REQUIREMENT***	***MET***
2006-2007	771	688	4297	3984
2007-2008**	848	766	4398	4079
2011-2012	1443	-	7585	-

*****Year is from April to March.

**Figures for the year 2007-2008 are for April to February.

2.3.2 Transformation Capacity

30. Whenever loading of transformers in an existing substation is found to exceed 80%, augmentation of transformer capacity of the substation or creation of a new substation nearby is proposed. Creation of a new substation is considered only when (i) new load center is coming up some distance away and/or (ii) the substation in question is feeding power to a large area or (iii) the substation in question is already saturated or nearing saturation in terms of capacity or space.

31. *Present peak demand* (peak demand recorded during the year *2007-08*) in existing substations with its transformation capacities are listed in *Exhibit-2.1* at the end of this Chapter. *Peak Demands in year 2011-2012 conditions* in existing substations without the new proposals and same with new proposals are listed in same *Exihibit 2.1.*

2.3.3 New Substations

32. Altogether 14 new substations are proposed. A brief introduction to these new substations is presented below. Substations to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.

i) **132/33 kV, 2x40 MVA Kamalpur SS (T1)**

The area at the North Bank of River Brahmaputra beside the Saraighat Bridge near Guwahati is a major Industrial and Commercial belt of Assam. The Indian Institute of Technology, Guwahati is also situated in this area. This area at present is being fed from a single 132/33 kV substation at Sishugram. Several requests for a substantial quantum of power are already pending in the area for which the existing substation at Sishugram is found quite inadequate as it has already become congested. As such, a new substation at nearby Kamalpur is proposed to cater the increasing load demand of the area. It is also expected that by setting up this new substation will help in reducing the line losses in the long and overloaded 33 kV lines emanating from the existing substation at Sishugram. It is proposed to LILO the both ckt of the 132 kV Sishugram- Rangia line at this substation.

ii) **132/33 kV, 2x25MVA Nagaon SS (T1)**

Nagaon is the Head Quarters of the Nagaon District of State of Assam. This substation is proposed to cater to the increasing industrial and agricultural loads coming up in Nagaon Town and its adjacent area. At present these areas are fed by long 33 kV lines from the 220kV Samaguri substation causing very poor voltage regulation and consequent losses. It is proposed to construct 132kV single ckt line on D/C tower from Samaguri.

iii) 220/132 kV, 2x100 MVA, Rangia SS (T1)

As observed from the load flow studies for the 2011-12 condition it is seen that a 220/132 kV substation at Rangia is required to act as a hub for the 132 kV sub stations at Rangia, Nalbari, Bornagar, Rowta, Sipajhar etc with load of about 110 MW by the year 2012; which are now being fed by long 132 kV lines. The 220 kV substation at Rangia is proposed by connecting a new 220 kV link from BTPS substation to Rangia. This will also enable to evacuate the power from the new NTPC/BTPS power station and pass on the benefit to the sub stations in the northern bank of River Brahmaputra.

iv) **132/33 kV, 2x40 MVA Sonari SS (T1)**

This substation is proposed with the same view of bringing back the high value Tea garden consumer back to its fold by improving the power scenario. Besides the LTPS generating Station which is at present the source of power to these areas through 33 kV lines wishes to dissociate itself from the power distribution function.

v) **132/33 kV, 2x25 MVA Rupai SS (T1)**

At present the load demand of the Rupai and Doom Dooma area is catered to by the 66/33 kV Substation at Rupai. There are a number of

Tea gardens in this area who have to rely on their own captive generators for Tea production due to the inability of the substation to meet the load demand of the area because of transmission and transformation bottleneck. Often forced load shedding has to be resorted to (both in the peak and off peak load hours). Besides AEGCL is planning to phase out the 66 kV system from its transmission network. Therefore a 132/33 kV substation is proposed at Rupai near the existing 66 kV substation It is proposed to draw a S/C line on D/C towers from Tinsukia to Rupai. This substation is expected to handle a load demand of about 24 MW.

vi) **132/33 kV, 2x25MVA Khanikar (Behiating / New Dibrugarh) SS (T1):**

Dibrugarh town situated on the bank of river Brahmaputra and the District Head Quarters of Dibrugarh District is a centre for commercial, educational activities and is also growing at a rapid rate compared to the other parts of the state. As a result its load demand which was a suppressed one appears to be increasing quite fast and is expected to touch 50 MW by 2011-12. It is therefore proposed to have a substation towards the west of Dibrugarh town at the village of Khanikar (near Behiating). This will ease the overloaing of the existing 132/66/33 kV Dibrugarh substation. A Gas Cracker project is also coming up near Behiating and some ancillary industries are likely to come up in this area. It is proposed to construct this substation by LILO of the Moran-Dibrugarh 132 kV line. The substation is expected to handle a load demand of about 17 MW.

vii) **220/132 kV, 2x100 MVA and 132/33 kV, 2x25MVA, Sonapur SS (T2)**

The development of Greater Guwahati Area is taking place at a very fast rate, and its load demand is expected to shoot up to 324 MW (loads of 132 kV substations in south bank of River Bhrahmaputra namely, Kahilipara, Narangi, Sarusajai, Dispur including Jagiroad) by the end of 2011-12. At present there is only one substation of 220/132 kV level for this entire area and this alone will not be able to handle the entire system load. Therefore it is proposed to have another 220 kV substations for this sothern part of the entire greater Guwahati area to support the 132 kV existing and new substations at Sonapur. Sonapur is situated at the east of Greater Guwahati area and is a new commercially and industrially developing area. The proposed substation at Sonapur will also meet the growing load demand of Sonapur and nearby Jorabat area. Keeping this in mind a 220/132 kV substation at Sonapur situated towards the east of Guwahati is proposed. In the Sonapur area, new industrial belt is also coming up with high load demands, as such a 132 /33 kV substation has also become very much essential to cater to the 33 kV loads in and around Sonapur, Jorabat area.

viii) 132/33 kV, 2x40 MVA Kamakhya SS (T2)

Due to the fast growth of Guwahati City, its load demand by 2011-12 is expected to shoot up to about 324 MW. At present this area is being mainly fed from the 132/33 kV substations located at Kahilipara and Sarusajai area of the City. To meet this fast growing load demand, the existing substations will not be suitable as further capacity addition at these substations is not possible due to constraint in space and constraints in distributing large amount of power from same locations. Therefore, it has become imperative to construct new sub stations in and around Guwahati city. Besides due to the fast development in the city, land and right of way problems will arise in future. Therefore the substations at Kamakhya is proposed in a long term perspective.

ix) **132/33 kV, 2x25 MVA Jorhat (West) SS (T2)**

Jorhat town is also fast expanding towards its western side and the long 33 kV lines feeding this area have very poor voltage regulation As a result most of the tea gardens in this area rely on their captive generating sets and hardly use ASEB power. To bring back these consumers, supply of reliable and quality power is essential. As such the substation at Jorhat (West) is proposed by LILO of 132 kV Jorhat-Bokakhat Line.

x) **132/33 kV, 2x40 MVA Bordubi SS (T2)**

The area around Bordubi has many Tea Gardens and it has been witnessing rapid growth. This area is fed by 33 kV heavily loaded lines from the Tinsukia grid substation. Consequently there is very poor voltage regulation and consequent losses in the lines are high. It is therefore proposed to have a 132 /33 Kv substation at Bordubi by LILO of the existing Namrup - Tinsukia 132 kv line. Due to installation of this substation, the high value consumers are expected to return to ASEB's fold thus increasing the revenue earnings.

xi) **132/33 kV, 2x16 MVA Matia SS (T2)**

One industrial growth centre will be coming up in the area adjoining the proposed substation which will also cater to the load demand of Dudhnoai area. It may be mentioned that this area is located on the Assam – Meghalaya border and is a trade centre for the two states. These areas are fed by long 11kV lines from Agia resulting in poor voltage profile. Hence to provide reliable and quality power to this area construction of the 132/33 kV substation has become very much essential. Power to the substation will be fed from the proposed 132 kV line from Agia.

xii) 220/132 kV, 2x100 MVA, Sonabil SS (T2):

This substation is proposed for evacuation of power from the Balipara (PGCIL) 400/220 kV substation and distribute to the 132kV sub stations at Depota, Gohpur, Biswanath Chariali , North Lakhimpur, Dhemaji etc

so as to ensure reliability and improvement in quality of power supply on the northern bank of the Brahmaputra. The Balipara-Samaguri 220kV D/C line passes over the proposed substation therefore the cost of constructing a transmission line is also minimized. The construction of this substation and the connectivity were initiated in the early nineties but the work of the substation could not be completed due the acute fund constraint ASEB was going through as a result the substation had to be postponed although the transmission lines had been completed.

xiii) **132/33 kV, 2x16 MVA Hailakandi (Chanpur) SS (T2)*:*.**

The Hailakandi Substation is proposed to cope up with the increasing load growth of Hailakandi (District Headquarter of Hailakandi District), Lala, Katlicherra, Algapur and Ramkrishna nagar areas of Hailakandi and Karimganj District in the southern part of Assam. Presently these areas are fed by long 33 kV lines from Pancgram substation, so the quality of power supply is very poor. This substation will not only improve the voltage profile but will also help to reduce the load shedding due to system constraints. It is proposed to LILO the 132 kV S/C Panchgram - Dullavcherra line at Hailakandi.

xiv) 132/33 kV, 2x25 MVA Bilasipara SS (T2)*:*

Bilasipara is an important town in the Dhubri District of Assam and at present receives power by long 33 kV lines with poor voltage regulation and with appreciable losses. Construction of this substation will not only provide reliable and quality power supply to this area and at the same time will relieve the transformers at Dhaligaon from overloading.

2.3.4 Augmentations and Extension Of Existing Substations

33. Based on peak demand of the year *2011-12* and to limit the loadings of transformers in substations, transformation capacities of the following substations are proposed to be augmented by addition of new transformers or by replacing old transformers by new high capacity transformers. The following substation modifications will be funded under Tranche 2:

1) **Jagiroad (Baghjap),** 132/33 kV Substation **(T2)**:
   New 2x25 MVA 132/33 kV in place of old 2x16 MVA transformers.
2) **Gohpur, 132/33 kV** Substation **(T2)**:
   New 2x25 MVA 132/33 kV in place of old 2x10 MVA transformers.
3) **North Lakhimpur, 132/33 kV** Substation **(T2)**:
   New 2x25 MVA 132/33 kV in place of old 2x10 MVA transformers.
4) **Lanka (Sankardevnagar),** 132/33 kV Substation **(T2)**:
   New 2x25 MVA 132/33 kV in place of old 2x16 MVA transformers.
5) **Margherita (Ledo)**, 132/33 kV Substation **(T2)**:
   New 2x25 MVA 132/33 kV in place of old 2x10 MVA transformers.

6) **Tinsukia**, 220/132/33 kV Substation **(T2)**:
Addition of new 2x40 MVA 132/33 kV transformers and new 2x100 MVA 220/132 MVA transformers in place of old 2x50 MVA, 220/132 transformers.

7) **Kahilipara**, 132/33 kV Substation **(T2)**:
New 2x40 MVA, 132/33 MVA transformers in place of old 2x10 MVA, 132/33/11 kV transformers.

8) **Mariani**, 220/132/66/33 kV Substation **(T2)**:
Addition of new 2x25 MVA, 132/33 MVA transformers.

9) **Boko**. 220/132/33 kV Substation **(T2)**Addition of new 1x100 MVA, 220/132 MVA transformers.

34. In addition to the above augmentations, the following existing substations are also proposed to be extended to accommodate the new transmission lines proposed under the DPR. These substations are listed below. Substations to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.

1) **Samaguri**, 220/132/33 kV Substation **(T1)**:
Two numbers of 132 kV Line Bays for Samaguri – Nagaon 132 kV S/C Transmission Line, Samaguri – Lanka 132 kV second circuit stringing.

2) **Salakathi (BTPS)**, 220/132/33 kV Substation **(T1)**:
Two numbers of 220 kV Line Bays for Salakathi – Rangia 220 kV D/C transmission Line.

3) **Mariani** 220/132/66/33 kV Substation **(T2)**:
Two numbers of 220 kV Line Bays for Mariani – Namrup 220 kV S/C transmission Line on D/C towers.

4) **Namrup**, 220/132/33 kV Substation **(T2)**:
Two numbers of 220 kV Line Bay for Mariani – Namrup 220 kV S/C transmission Line.

5) **Tinsukia**, 220/132/33 kV Substation **(T2)**:
One number of 132 kV Line Bays for Tinsukia – Rupai 132 kV S/C Transmission Line.

6) **Agia**, 220/132/33 kV Substation **(T2)**:
One number of 132 kV Line Bays for Agia – Matia 132 kV S/C Transmission Line.

2.3.5 New Transmission Lines

35. As described above, there are 16 new substations proposed in the DPR. To feed these new substations and also to provide system security the following new transmission lines are proposed. Lines to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.

1) **Double Circuit LILO Line of** 132 kV D/C Rangia – Sishugram/Kahilipara Line **(T1)**: for new **Kamalpur 132/33 kV Substation**.
2) **Samaguri - Nagaon** 132 kV S/C Line on D/C Towers **(T1)**: for new **Nagaon 132/33 kV Substation**.
3) **Salakathi (BTPS) – Rangia** 220 kV D/C Line **(T1)**: for new **Rangia 220/132 kV Substation**.
4) **Single Circuit LILO Line of** 132 kV D/C Lakwa– Namrup Line **(T1)**: for new **Sonari 132/33 kV Substation**.
5) **Tinsukia - Rupai** 132 kV S/C Line on D/C Towers **(T1)**: for new **Rupai 132/33 kV Substation**.
6) **Single Circuit LILO Line of** 132 kV S/C Dibrugarh – Moran Line **(T1):** for new **Khanikar (New Dibrugarh /Behiating) 132/33 kV Substation**.
7) **Double Circuit LILO Line of** 220 kV D/C Samaguri – Sarusajai Line at new **Sonapur 220/132/33 kV Substation (T2)**.
8) **Mariani - Namrup** 220 kV S/C Line on D/C Towers **(T2)**
9) **Double Circuit LILO Line of** 132 kV D/C Kahilipara – Rangia/Sishugram Line at new **Kamakhya 132/33 kV Substation (T2)**.
10) **Double Circuit LILO Line of** 132 kV D/C Chandrapur – Kahilipara/Narangi Line at new **Sonapur 220/132/33 kV Substation**.
11) **Single Circuit LILO Line of** 132 kV S/C Jorhat– Bokakhat Line at new **Jorhat (West) 132/33 kV Substation (T2)**.
12) **Single Circuit LILO Line of** 132 kV S/C Namrup– Tinsukia Line at new **Bordubi 132/33 kV Substation (T2)**.
13) **Agia - Matia** 132 kV S/C Line on D/C Towers: for new **Matia** (Dudhnoi**) 132/33 kV Substation (T2)**.
14) **Double circuit LILO** line of 132 kV D/C Depota-gohpur Line at new **Sonabil** 220/132 KV Substation.

2.3.6 Reactive Compensation Scheme

36. To maintain the system voltage at desired level Reactive Compensation is generally required in any power system. Based on the load flow studies carried out following substations are identified for installation of *130 MVAR 33 kV Switched Bus Capacitor Banks*. These substation modifications will be funded under Tranche 2.

1) **Pailapool 132/33 kV Substation**: 2x5 MVAR
2) **Gohpur 132/33 kV Substation**: 2x5 MVAR
3) **Jorhat (Gormur) 132/33 kV Substation**: 2x10 MVAR
4) **Sishugram 132/33 kV Substation**: 2x10 MVAR
5) **Nazira 132/33 kV Substation**: 2x5 MVAR

6) **Panchgram 132/33 kV Substation**: 2x5 MVAR

7) **Chandrapur (CTPS) 132/33 kV Substation**: 2x5 MVAR

8) **Barnagar 132/33 kV Substation**: 2x10 MVAR

2.3.7 SCADA

37. It may be mentioned here that a new *SCADA* system is now being installed under the ongoing Assam Power Sector Development Program with ADB finance. It is essential that the new substations coming under this scheme are also included in the said *SCADA*.

2.3.8 COMMUNICATION *(PLCC and Fiber Optics)*

38. The *Power Line Carrier Communication (PLCC)* not only provide voice and data (such as SCADA) communication it is also a pre-requisite in EHV transmission lines considering protection of the system. PLCC equipments are provided in all 220 KV and 132 KV transmission lines proposed in this Project Report. Considering this following links are proposed to be provided with PLCC equipments:

(i) BTPS (Salakathi) – Rangia 220 kV.

(ii) Samaguri – Sonapur 220 kV.

(iii) Sonapur – Sarusajai 220 kV.

(iv) Mariani – Namrup 220 kV.

(v) Sonapur – Chandrapur 132 kV.

(vi) Sonapur – Narangi 132 kV.

(vii) Sonapur – Dispur 132 kV.

(viii) Samaguri – Nagaon 132 kV.

(ix) Jorhat – Jorhat (West) 132 kV.

(x) Jorhat (West)-Bokakhat 132 kV.

(xi) Sonari-Namrup 132 kV.

(xii) Sonari-Lakwa 132 kV.

(xiii) Bordubi-Namrup 132 kV.

(xiv) Bordubi-Tinsukia 132 kV.

(xv) Tinsukia - Rupai 132 kV.

(xvi) Bihiating – Dibrugarh 132 kV.

(xvii) Bihiating – Moran 132 kV.

(xviii) Agia – Matia 132 kV.

(xix) Kokrajhar – Gauripur 132 kV.

(xx) Kamalpur – Rangia 132 kV.

(xxi) Kamalpur – Sishugram 132 kV.

(xxii) Kamakhya – Sishugram 132 kV.

(xxiii) Kamakhya – Kahilipara 132 kV.

(xxiv) Sonabil – Samaguri 220 kV

(xxv) Sonabil – Balilpara 220 kV

(xxvi) Sonabil – Depota 132 kV

(xxvii) Sonabil – Gohpur 132 kV

39. Studies made in implementing the ongoing *SCADA* system mentioned in above reveal that PLCC alone is not sufficient in certain links to meet the communication requirements of SCADA. With system expansions as proposed problems will be more critical. Following links are identified as very critical for successful operation of the SCADA and proposed to be provided with Fiber Optics:

(i) Samaguri – Mariani 220 kV.

(ii) Samaguri – Sarusajai 220 kV.

(iii) Sarusajai – Kahilipara 132 kV.

(iv) Kahilipara – Amingaon - Rangia 132 kV

2.3.9 Refurbishment of Existing Substations

40. Large numbers of old substations are in operation in the transmission system of AEGCL with aged, worn-out and outdated equipments which causes frequent and prolonged outages in the system. It may be noted that provisions was made in the ongoing Assam Power Sector Development Program to replace some of such equipments. Provisions are made in the DPR to replace the remaining aged, worn-out and outdated equipments in the existing substations. Equipments identified for replacement include Circuit Breakers, Instrument Transformers, Relay and Control Panels, Protective Relays and Isolators. List of such equipments and name of substations where these equipments will be installed are furnished in ***Exhibit – 2.1 and Exhibit – 2.2*****.**

EXIHIBIT – 2.1
PEAK DEMAND AND TRANSFORMER CAPACITY

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	**Gauripur**			2x16			15.8	23.0	15.0	
2	**Gossaigaon**			2x16			8.6	12.6	12.6	
3	**Dhaligaon**			2x25			13.6	25.2	25.2	
4	**Bilasipara****								8.0	2x16 (132/33 kV)
5	**Kokrajhar****			2x16			6.0	9.4	9.4	
6	**Salakati (BTPS)****	1x80+1x160		1x16			3.0	5.0	5.0	
7	**Barnagar**			2x25			20.6	31.8	31.8	
8	**Nalbari***			2X16			11.0	16.1	16.1	
9	**Rangia**			2x25			13.0	20.5	20.5	
10	***Rangia (new)***									2x100 (220/132 kV)
11	**Amingaon (Sishugram)**			2x31.5 +1x40			36.1	80.0	35.0	
12	**Amingaon (New)****									2x100 (220/132 kV)
13	***Kamalpur***								33.0	2x40 (132/33 kV)
14	**Sarusazai**	3 X 100		3X31.5			36.0	64.8	54.8	

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
15	Kahelipara			2X5"+ 2X30+ 1X31.5		2X5"	85.0	159.0	99.8	***2x40 (132/33 kV)****
16	Dispur**					1x16	6.0	6.8	6.8	
17	Narangi*			2X25,			22.0	32.0	32.0	
18	GMC **								30.0	2x40 (132/33 kV)
19	*Kamakhya*								30.0	2x40 (132/33 kV)
20	Jawahanagar**								25.0	2x25 (132/33 kV)
21	Chandrapur			1x16+1X30			15.0	22.0	22.0	
22	*Sonapur*								15.0	2x25 (132/33 kV), 2x100 (220/132 kV)
23	Jagiroad			2x16			20.2	39.2	24.2	***2x25 (132/33 kV)***
24	Azara**			2x25			12.0	21.0	21.0	
25	Boko*	1x50		2x10			6.0	9.4	9.4	1x50 (220/132 kV)
26	Sipajhar*			2x16,			8.2	12.9	12.9	
27	Rowta			2x25			15.0	22.0	22.0	
28	Depota			2x31.5			26.0	38.1	38.1	
29	Balipara(I)**			1x16			6.0	6.0	9.4	

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
30	**Sonabil****									2x100 (220/132 kV)
31	**Gohpur**			2x10			10.0	15.7	15.7	***2x25 (132/33 kV)***
32	**Biswanath Chariali***			2x16			8.8	13.8	13.8	
33	**N.Lakhimpur**			2x10			10.8	17.0	17.0	***2x25 (132/33 kV)***
34	**Majuli***			1 x 16.05			2.0	2.4	2.4	
35	**Dhemaji**			2x16			6.5	12.6	12.6	
36	**Samaguri**	3 X 50		2x25			37.0	56.2	25.2	
37	**Sankardevnagar**			2x16			24.0	37.8	25.8	***2x25 (132/33 kV)***
38	***Nagaon***								25.0	2x25 (132/33 kV)
39	**Lumding****								12.0	2x16 (132/33 kV)
40	**Jakhalabandha****								8.0	2x16 (132/33 kV)
41	**Diphu**			2x16*	2 x 5		7.9	12.4	12.4	
42	**Bokajan**			2x16**	2x5		10.2	16.0	16.0	
43	**Golaghat**			2x25*	1x10+1 X20		15.0	23.6	23.6	
44	**Bokakhat***			2x16			7.0	11.0	11.0	
45	**Mariani**	2 x 100	2 x 20		2x16		18.6	25.3	25.3	2x25 (132/33 kV)

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
46	**Jorhat**			1x16+ 2x25			35.0	55.1	35.1	
47	***Jorhat (West)***								20.0	2x25 (132/33 kV)
48	**Nazira**			2x25	2x16		25.6	42.5	37.5	
49	**LTPS/Banferra**			2x7.5			12.3	19.4	0.0	
50	***Sonari***								19.4	2x25 (132/33 kV)
51	**Sibsagar***			2x16			15.0	22.0	22.0	
52	**Moran***			2x16			12.0	17.6	17.6	
53	**Dibrugarh**			2x31.5	1x10		22.0	42.7	25.7	
54	**Tinsukia**	2 x 50	3x20		3x20		42.0	66.1	36.1	***2x40 (132/33 kV), 2x100 (220/132 kV)***
55	***Behiating***								17.0	***2x25 (132/33 kV)***, 2x50 (220/132 kV)
56	***Bordubi***								30.0	2x40 (132/33 kV)
57	**Margherita (Ledo)**			2x10			16.5	24.1	24.0	***2x25 (132/33 kV)***
58	**Doomdooma**				2x10		17.5	32.0	15.0	
59	***Rupai (New}***								23.9	2x25 (132/33 kV)

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
60	Namrup	2X50*	2x25	1x31.5	1x30		24.2	43.9	32.9	
61	Haflong			2x10,			5.6	9.5	9.5	
62	Khandong			1x16			7.4	13.4	0.0	
63	Umrangso**								13.4	2x16 (132/33 kV)
64	Panchgram (new)			2x25			21.0	35.9	35.9	
65	Panchgram (old)			2x10			8.0	8.3	8.3	
66	Pailapool			3x10			8.9	14.0	14.0	
67	Hailakandi**								10.0	2x16 (132/33 kV)
68	Dullavcherra			1x10.5			7.8	9.5	9.5	
69	Srikona*			2X25			25.0	34.0	24.0	
70	Agia	1x50 +1x25		2x16			12.0	18.9	10.9	
71	*Matia*								8.0	2x16 (132/33 kV)
72	Gogamukh**			1x16			2.0	3.0	3.0	
73	Silapathar**			1x16			1.5	3.2	3.2	
74	Jogighopa(APM)			1x16 +1x12.5			6.1	9.0	9.0	

SL NO	Name of Substation	Existing Transformation Capacity, MVA					SUBSTATION WISE PEAK LOAD. MW			New Transformer Capacity proposed by 2011-2012 (No x MVA)
		220/132 kV	132/66 kV	132/33 kV	66/33 kV	132/11 kV	Existing, 2007-2008	2011-12 (without new proposals)	2011-12 (with new proposals)	
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	TOTAL	**1215**	**150**	**1898.55**	**234**	**26**	**870.3**	**1424.7**	**1424.7**	**1354 MVA,132/33 kV, 1050 MVA,220/132 kV**
	TRANSFORMER CAPACITY ADDED, MVA	**900**	**0**	**962**	**0**	**-10**				
	FINAL TRANSFORMATION CAPACITY BY THE YEAR 2011-2012	**2115**	**150**	**2860.55**	**234**	**16**				

***** *Substations coming up under ongoing **Assam Power Sector Development Program*** financed by ***ADB*** *and nearing completion**.***

****** *Substations coming up under **NLCPR** and other Government funded schemes and program and expected to complete in near future.*

- ***Names of New Substations** proposed under this **Project Report** are indicated in bold.*
- ***Transformer Capacities** proposed to be augmented under this Project Report are indicated in bold.*

EXIHIBIT – 2.2
REFURBISHMENT OF EXISTING SUBSTATIONS
LIST OF EQUIPMENTS AND SUBSTATIONS

1. CIRCUIT BREAKERS *(Numbers)*					
Name of Sub-station		**220 kV Line Breaker**	**220 kV Transformer Breaker**	**132 kV Breaker**	**33 kV Breaker**
1	**Samaguri SS**	5			2
2	**Mariani SS**	1	3	2	6
3	**Gossaigaon**			2	2
4	**Gauripur**			3	2
5	**Dhaligaon**			6	2
6	**Barnagar**			2	2
7	**Rangia**			3	2
8	**Rowta**			2	1
9	**Depota**			1	4
10	**Gohpur**			3	4
11	**N. Lakimpur**			3	4
12	**Dhemaji**			1	2
13	**Sisugram**			2	
14	**Kahilipara**			4	2
15	**Dullavcherra**			1	2
16	**Panchgram**			2	
17	**Haflong**			1	4
18	**Chandrapur**			3	2
19	**Baghjap**			2	
20	**Sankardevnagar**			4	1
21	**Garmur**			4	1
22	**Nazira**			1	2
23	**Namrup**			2	
24	**Tinsukia**			3	4
25	**Dibrugarh**			2	2
26	**Margherita**			4	4
27	**Rupai**				4
28	**BTPS**	2	1	3	
	TOTAL	8	4	66	61

2. CURRENT TRANSFORMERS *(Numbers)*							
Name of Sub-station		220 kV Line CT	220 kV Trans.	132 kV Line	132 kV Transf.	33 kV Line	33 kV Transf.
1	Samaguri SS	6				3	
2	Gossaigaon						
3	Gauripur			3		6	
4	Dhaligaon			6	6	3	6
5	Barnagar			3		6	
6	Rangia			9			
7	Rowta			3		3	
8	Depota						
9	Gohpur			3		6	
10	N. Lakimpur			3		6	
11	Dhemaji			3			
12	Dullavcherra				3	3	
13	Panchgram						
14	Haflong				3		
15	Sankardevnagar			3			
16	Garmur			9			
17	Tinsukia			3			
18	Dibrugarh						
19	Margherita			9			
TOTAL		**6**		**57**	**12**	**36**	**6**

3. POTENTIAL TRANSFORMERS *(Numbers)*				
Name of Sub-station		220 kV PT	132 kV PT	33 kV PT
1	Dhaligaon			3
2	Barnagar		3	
3	Gohpur		3	3
4	Haflong			3
5	Margherita		3	
TOTAL			**9**	**9**

4. CONTROL & RELAY PANELS AND PROTECTIVE RELAYS							
Name of Substation		220 kV Line Panel	132 kV Line Panel	132/33 kV Transf. Panel	132 Bus Coupler Panel	Distance Relay	Differential Relay
1	Samaguri	2					
2	Gossaigaon		1				
3	Gauripur		1				

4. CONTROL & RELAY PANELS AND PROTECTIVE RELAYS							
Name of Substation		220 kV Line Panel	132 kV Line Panel	132/33 kV Transf. Panel	132 Bus Coupler Panel	Distance Relay	Differential Relay
4	Barnagar		2	2			
5	Rangia				1		
6	Rowta		1				
7	Gohpur		2		1	1	
8	N. Lakimpur		1		1		
9	Dhemaji		1		1		
10	Kahilipara		2		1		
11	Sankardevnagar				1		
12	Garmur		2		1		
13	Tinsukia		1				
14	Margherita		1		1	2	2
	TOTAL	2	15	2	8	3	2

5. ISOLATORS *(Sets)*					
Name of Sub-station		220 kV E/S	220 kV W/E/S	132 kV E/S	132 kV W/E/S
1	Samaguri SS	2	4		
2	Mariani SS				
3	Gossaigaon			1	1
4	Gauripur			1	1
5	Rangia				2
6	Rowta			1	1
7	Gohpur			1	1
8	N. Lakimpur			1	1
9	Dhemaji			1	1
10	Sankardevnagar			1	1
10	Garmur			2	4
11	Tinsukia			1	1
12	Margherita			1	1
TOTAL		2	4	11	15

2.4 COST BENEFIT OF THE PROJECT

41. Financial analyses in the DPR include the following considerations:

a) Total Energy Transmitted during the base year (2007-08) = 4097million kilowatt-hours (MkWh; also referred to as million units, MU.
b) Total Energy Transmitted per year at end of year (2011-12) = 7585 MkWh.
c) Additional Energy handled per year at end of year (2011-12) = 3488 MkWh.
d) Peak Load Loss in 2011-12 loads without the new proposals = 76.7 megawatts (MW)
e) Peak Load Loss in 2011-12 loads with the new proposals = 31.5 MW
f) Peak Load Loss Reduction= 45.2 MW
i) Energy Loss reduction per year (at 0.60 Load Factor) = 171 MkWh.
k) O&M Charges = 1%
l) Salvage Value = 10%
m) Discount Rate = 12%

Investment and Gross Return

a) Total project cost = Rs 1046,65.08 Lakhs = US$ 218,052,250 (Including Physical & Price Contingency)
b) Total benefit due to additional sale of energy = Rs 191.84 Crore per year = US$ 39,966,667 per year
c) Total benefit due to reduction of technical losses = Rs 38.34 Crore per year = US$ 7,987,500 per year
d) Gross return (b + c) per year after implementation of the Project = Rs 230.18 Crore = US$ 47,954,167.[7]

NPV and FIRR

42. The *NPV* and *FIRR* calculations are estimated as follows:

(a) Plant life after completion of the Project : 25 years
(b) Discount Rate : 12%
(c) NPV : 481.63
(d) FIRR : 19.38%

2.5 COMPLETION SCHEDULE

43. The whole works are scheduled for completion within 36 months from effective date of project approval from ADB. However, works such as land requisition for new substations, survey & right of way works for transmission lines and other preliminary works under Counter Part funding shall required to be undertaken 5 to 6 months prior to the loan effective date to meet the time schedule. *Work Schedules* in the form of Bar Charts for each Project Components OF Tranche 1 & 2 are furnished in *Exhibit – 2.3* to *Exhibit – 2.18*.

[7] The exchange rate is taken as US$1 = Rs. 48

EXHIBIT - 2.3

Tranche 1

BAR CHART FOR CONSTRUCTION OF NEW 132 /33 KV SUBSTATIONS

Sl No	Description of Job	2009												2010												2011												2012							
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
1	Land Identification and Acquisition																																												
2	Setlement of land compensation and resettlement issues																																											
3	Development of land																																											
4	Construction of colony																																											
5	Invitation for ICB for turnkey construction of sub-station																																											
6	Opening of bid and commencement of technical bid evaluation																																											
7	Approval of technical bid evaluation by ADB & AEGCL																																											
8	Opening of Price Bid and evaluation																																											
9	Approval of price bid evaluation by ADB & AEGCL																																											
10	Contract Agreement																																											

Sl No	Description of Job	2009												2010												2011												2012							
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	with successful bidder																																												
11	Design approval by AEGCL																																												
12	Testing & inspection of equipment including transformers																																												
13	Transporation of material & delivery at site																																												
14	Switchyard civil work & Construction of control room																																												
15	Erection of sub-station equipment																																												
16	Procurement of conductors & Cables by AEGCL																																												
17	Control cable laying termination,stringing of conductors																																												
18	Testing & Commissioning																																												
19	Taking over of sub-stations by AEGCL																																												

EXHIBIT - 2.4
Tranche 1
BAR CHART FOR CONSTRUCTION OF NEW 220 / 132 KV TRANSMISSION LINES

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
1	Land Identification and Acquisition																																												
2	Setlement of land compensation and resettlement issues																																											
3	Development of land																																											
4	Construction of colony																																											
5	Invitation for ICB for turnkey construction of sub-station																																											
6	Opening of bid and commencement of technical bid evaluation																																											
7	Approval of technical bid evaluation by ADB & AEGCL																																											
8	Opening of Price Bid and evaluation																																											
9	Approval of price bid evaluation by ADB & AEGCL																																											
10	Contract Agreement																																											

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	with successful bidder																																												
11	Design approval by AEGCL																																												
12	Testing & inspection of equipment including transformers																																												
13	Transporation of material & delivery at site																																												
14	Switchyard civil work & Construction of control room																																												
15	Erection of sub-station equipment																																												
16	Procurement of conductors & Cables by AEGCL																																												
17	Control cable laying termination,stringing of conductors																																												
18	Testing & Commissioning																																												
19	Taking over of sub-stations by AEGCL																																												

EXHIBIT - 2.5
TRANCHE 1
BAR CHART FOR CONSTRUCTION OF NEW 132 KV TRANSMISSION LINES

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
1	Tendering for route survey of lines, evaluation & award of contracts																																											
2	Route survey, finalization & approval																																											
3	Environment & resettlement issues & solution																																											
4	Invitation of ICB for turnkey construction of lines																																											
5	Opening of bid & commencement of technical bid evaluation																																											
6	Approval of technical bid evaluation by ADB & AEGCL																																											
7	Opening of price bid and evaluation																																											
8	Approval of price bid evaluation by ADB & AEGCL																																											
9	Contract agreement																																											

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	with successful bidder																																												
10	Design approval by AEGCL																																												
11	Testing & Inspection of prototype towers																																												
12	Transpotation of line material & delivery at site																																												
13	Foundation work of towers																																												
14	Erection of towers																																												
15	Procurement of conductors by AEGCL																																												
16	Stringing of conductors																																												
17	Testing & commissioning																																												
18	Taking over of transmission lines by AEGCL																																												

EXHIBIT - 2.6
TRANCHE 1
BAR CHART FOR CONSTRUCTION OF NEW 220 KV TRANSMISSION LINES

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
1	Tendering for route survey of lines, evaluation & award of contracts																																											
2	Route survey, finalization & approval																																											
3	Environment & resettlement issues & solution																																											
4	Invitation of ICB for turnkey construction of lines																																											
5	Opening of bid & commencement of technical bid evaluation																																											
6	Approval of technical bid evaluation by ADB & AEGCL																																											
7	Opening of price bid and evaluation																																											
8	Approval of price bid evaluation by ADB & AEGCL																																											
9	Contract agreement																																											

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	with successful bidder																																												
10	Design approval by AEGCL																																												
11	Testing & Inspection of prototype towers																																												
12	Transpotation of line material & delivery at site																																												
13	Foundation work of towers																																												
14	Erection of towers																																												
15	Procurement of conductors by AEGCL																																												
16	Stringing of conductors																																												
17	Testing & commissioning																																												
18	Taking over of transmission lines by AEGCL																																												

EXHIBIT - 2.7
TRANCHE 1
BAR CHART FOR AUGMENTATION OF EXISTING SUBSTATIONS

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
1	Invitation of ICB for turnkey augmentation of sub-station																																											
2	Opening of Bid and commencement of technical bid evaluation																																											
3	Approval of technical bid evaluation by ADB and AEGCL																																											
4	Price bid evaluation																																											
5	Approval of Price Bid Evaluation by ADB and AEGCL																																											
6	Contract agreement with successful bidder																																											
7	Design approval by AEGCL																																											
8	Testing and inspection of equipments including transformers																																											
9	Switch yard civil works																																											
10	Erection of substation																																											

Sl No	Description of Job	2009												2010												2011												2012						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	equipment																																												
11	Procurement of conductors and cables by AEGCL																																											
12	Control cable laying, termination, stringing of conductors																																											
13	Testing and commissioning																																											
14	Taking over of project by AEGCL																																											

EXHIBIT - 2.8
TRANCHE 1
BAR CHART FOR INSTALLATION OF COMMUNICATION SYTEM (FIBER OPTICS)

Sl No	Description of Job	2009												2010												2011												2012											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1	Invitation of ICB for suply of communication equipment																																																
2	Opening of Bid and commencement of technical bid evaluation																																																
3	Approval of technic																																																

Sl No	Description of Job	2009												2010												2011												2012											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	al bid evluation by ADB and AEGCL																																															
4	Price bid evaluation																																															
5	Approval of Price Bid Evaluation by ADB and AEGCL																																															
6	Contract agreement with																																															

Sl No	Description of Job	2009												2010												2011												2012											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	successful bidder																																																
7	Design approval by AEGCL																																															
8	Testing and inspection of equipments																																															
9	Transportation of material and delivery at site																																															
10	Erection of equipment																																															
11	Power																																															

Sl No	Description of Job	2009												2010												2011												2012											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	and co-axial cable laying and termination																																															
12	Testing and commissioning of links																																														
13	Taking over of project by AEGCL																																													

EXHIBIT - 2.9
TRANCHE 2
BAR CHART FOR CONSTRUCTION OF NEW 132/33 KV SUBSTATIONS

Sl No	Description of Job	2010												2011												2012												2013					
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
1	Land Identification and Acquisition																																										
2	Setlement of land compensation and resettlement issues																																									
3	Development of land																																									
4	Construction of colony																																									
5	Invitation for ICB for turnkey construction of sub-station																																									
6	Opening of bid and commencement of technical bid evaluation																																									
7	Approval of technical bid evaluation by ADB & AEGCL																																									
8	Opening of Price Bid and evaluation																																									
9	Approval of price bid evaluation by ADB & AEGCL																																									
10	Contract Agreement																																									

Sl No	Description of Job	2010												2011												2012												2013				
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
	with successful bidder																																										
11	Design approval by AEGCL																																										
12	Testing & inspection of equipment including transformers																																										
13	Transporation of material & delivery at site																																										
14	Switchyard civil work & Construction of control room																																										
15	Erection of sub-station equipment																																										
16	Procurement of conductors & Cables by AEGCL																																										
17	Control cable laying termination,stringing of conductors																																										
18	Testing & Commissioning																																										
19	Taking over of sub-stations by AEGCL																																										

EXHIBIT - 2.10
TRANCHE 2
BAR CHART FOR CONSTRUCTION OF NEW 132/33 KV SUBSTATIONS

Sl No	Description of Job	2010												2011												2012												2013				
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
1	Land Identification and Acquisition																																										
2	Setlement of land compensation and resettlement issues																																									
3	Development of land																																									
4	Construction of colony																																									
5	Invitation for ICB for turnkey construction of sub-station																																									
6	Opening of bid and commencement of technical bid evaluation																																									
7	Approval of technical bid evaluation by ADB & AEGCL																																									
8	Opening of Price Bid and evaluation																																									
9	Approval of price bid evaluation by ADB & AEGCL																																									
10	Contract Agreement																																									

Sl No	Description of Job	2010												2011												2012												2013				
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
	with successful bidder																																										
11	Design approval by AEGCL																																										
12	Testing & inspection of equipment including transformers																																										
13	Transporation of material & delivery at site																																										
14	Switchyard civil work & Construction of control room																																										
15	Erection of sub-station equipment																																										
16	Procurement of conductors & Cables by AEGCL																																										
17	Control cable laying termination,stringing of conductors																																										
18	Testing & Commissioning																																										
19	Taking over of sub-stations by AEGCL																																										

EXHIBIT - 2.11
TRANCHE 2
BAR CHART FOR CONSTRUCTION OF NEW 220/132 KV SUBSTATIONS

Sl No	Description of Job	2010												2011												2012												2013					
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
1	Land Identification and Acquisition																																										
2	Setlement of land compensation and resettlement issues																																									
3	Development of land																																									
4	Construction of colony																																									
5	Invitation for ICB for turnkey construction of sub-station																																									
6	Opening of bid and commencement of technical bid evaluation																																									
7	Approval of technical bid evaluation by ADB & AEGCL																																									
8	Opening of Price Bid and evaluation																																									
9	Approval of price bid evaluation by ADB & AEGCL																																									
10	Contract Agreement																																									

Sl No	Description of Job	2010												2011												2012												2013				
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
	with successful bidder																																										
11	Design approval by AEGCL																																										
12	Testing & inspection of equipment including transformers																																										
13	Transporation of material & delivery at site																																										
14	Switchyard civil work & Construction of control room																																										
15	Erection of sub-station equipment																																										
16	Procurement of conductors & Cables by AEGCL																																										
17	Control cable laying termination,stringing of conductors																																										
18	Testing & Commissioning																																										
19	Taking over of sub-stations by AEGCL																																										

EXHIBIT - 2.12
TRANCHE 2
BAR CHART FOR CONSTRUCTION OF NEW 220 KV TRANSMISSION LINES

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
1	Tendering for route survey of lines, evaluation & award of contracts																																																		
2	Route survey, finalization & approval																																																		
3	Environment & resettlement issues & solution																																																		
4	Invitation of ICB for turnkey construction of lines																																																		
5	Opening																																																		

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	of bid & commencement of technical bid evaluation																																																		
6	Approval of technical bid evaluation by ADB & AEGCL																																																	
7	Opening of price bid and evaluation																																																	
8	Approval of price bid evaluation by ADB & AEGCL																																																	
9	Contract agreement with successful																																																	

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	bidder																																																			
10	Design approval by AEGCL																																																		
11	Testing & Inspection of prototype towers																																																		
12	Transpotation of line material & delivery at site																																																		
13	Foundation work of towers																																																		
14	Erection of towers																																																		
15	Procurement of conductors by AEGCL																																																		
16	Stringing of																																																		

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	conductors																																																			
17	Testing & commissioning																																																		
18	Taking over of transmission lines by AEGCL																																																		

EXHIBIT - 2.13
TRANCHE 2
BAR CHART FOR CONSTRUCTION OF NEW 220 KV TRANSMISSION LINES

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
1	Tendering for route survey of lines, evaluation & award of contracts																																																		
2	Route survey, finalization & approval																																																		
3	Environment & resettlement issues & solution																																																		
4	Invitation of ICB for turnkey construction of lines																																																		
5	Opening																																																		

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	of bid & commencement of technical bid evaluation																																																		
6	Approval of technical bid evaluation by ADB & AEGCL																																																	
7	Opening of price bid and evaluation																																																	
8	Approval of price bid evaluation by ADB & AEGCL																																																	
9	Contract agreement with successful																																																	

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	bidder																																																			
10	Design approval by AEGCL																																																		
11	Testing & Inspection of prototype towers																																																		
12	Transpotation of line material & delivery at site																																																		
13	Foundation work of towers																																																		
14	Erection of towers																																																		
15	Procurement of conductors by AEGCL																																																		
16	Stringing of																																																		

Sl No	Description of Job	2009												2010												2011												2012												2013		
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
	conductors																																																			
17	Testing & commissioning																																																		
18	Taking over of transmission lines by AEGCL																																																		

EXHIBIT - 2.14
TRANCHE 2
BAR CHART FOR AUGMENTATION OF EXISTING SUBSTATIONS

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Invitation of ICB for turnkey augmentation of sub-station																																								
2	Opening of Bid and commencement of technical bid evaluation																																								
3	Approval of technical bid evluation by ADB and AEGCL																																								
4	Price bid evaluation																																								
5	Approval of Price Bid Evaluation by ADB and AEGCL																																								
6	Contract agreement with successful bidder																																								
7	Design approval by AEGCL																																								
8	Testing and inspection of equipments including transformers																																								
9	Switch yard civil works																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
10	Erection of substation equipment																																								
11	Procurement of conductors and cables by AEGCL																																								
12	Control cable laying, termination, stringing of conductors																																								
13	Testing and commissioning																																								
14	Taking over of project by AEGCL																																								

EXHIBIT - 2.15

TRANCHE 2

BAR CHART FOR INSTALLATION OF 33 KV BUS CAPACITORS

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Invitation of ICB for suply of communication equipment																																								
2	Opening of Bid and commencement of technical bid evaluation																																								
3	Approval of technical bid evluation by ADB and																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	AEGCL																																									
4	Price bid evaluation																																								
5	Approval of Price Bid Evaluation by ADB and AEGCL																																								
6	Contract agreement with successful bidder																																								
7	Design approval by AEGCL																																								
8	Testing and inspection of capacitor banks																																								
9	Transpor																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	tation of material and delivery at site																																								
10	Foundation work of equipment																																								
11	Erection of equipment																																								
12	Procurement of conductors and cables by AEGCL																																								
13	Stringing of conductors and cabling works																																								
14	Testing																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	and commissioning																																								
15	Taking over of project by AEGCL																																								

EXHIBIT - 2.16
TRANCHE 2
BAR CHART FOR INSTALLATION OF COMUNICATION SYSTEM (PLCC)

Sl No	Description of Job	2010												2011												2012												2013				
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Invitation of ICB for suply of communication equipment																																								
2	Opening of Bid and commencement of technical bid evaluation																																								
3	Approval of technical bid evluation by ADB and AEGCL																																								
4	Price bid evaluation																																								
5	Approval of Price																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	Bid Evaluation by ADB and AEGCL																																								
6	Contract agreement with successful bidder																																								
7	Design approval by AEGCL																																								
8	Testing and inspection of equipments																																								
9	Transportation of material and delivery at site																																								
10	Erection of equipment																																								
11	Power and co-axial																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	cable laying and termination																																								
12	Testing and commissioning of links																																								
13	Taking over of project by AEGCL																																								

EXHIBIT - 2.17
TRANCHE 2
BAR CHART FOR INSTALLATION OF SCADA

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Invitation for IS for turnkey SCADA expansion (SLDC)																																								
2	Opening of Bid and commencement of technical bid evaluation																																								
3	Approval of technical bid evluation by ADB and AEGCL																																								
4	Price bid evaluation																																								
5	Approval																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	of Price Bid Evaluation by ADB and AEGCL																																								
6	Contract agreement with successful bidder																																								
7	Design and GTP approval by AEGCL																																								
8	Testing and inspection of RTU																																								
9	Transportation of material and delivery at site																																								
10	Erection																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	of Sub-station SCADA equipment																																								
11	Testing and commissioning																																								
12	Taking over of project by AEGCL																																								

EXHIBIT - 2.18
TRANCHE 2
BAR CHART FOR REFURBISHMENT OF EXISTING SUBSTATIONS

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
1	Inivitation for ICB for supply of Switchgears and Control gears																																								
2	Opening of Bid and commencement of technical bid evaluation																																								
3	Approval of technical bid evluation by ADB and AEGCL																																								
4	Price bid evaluation																																								
5	Approval of Price Bid Evaluation																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	by ADB and AEGCL																																								
6	Contract agreement with successful bidder																																								
7	Design approval by AEGCL																																								
8	Testing and inspection of equipments																																								
9	Transportation of material and delivery at site																																								
10	Foundation of switchgears and breakers																																								
11	Erection of switchgears and control																																								

Sl No	Description of Job	2010												2011												2012												2013			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
	gears																																									
12	Control cable laying, termination, stringing of conductors																																								
13	Testing and commissioning																																								
14	Taking over of project by AEGCL																																								

CHAPTER - 3

DESCRIPTION OF THE ENVIRONMENT

CHAPTER-3

DESCRIPTION OF THE ENVIRONMENT

3.1 PHYSICAL RESOURCES

44. Assam is located in the North East region of India, between 24^o and 28^o north latitude and 90^o and 96^o east longitude. Total area is 78,438 square kilometers (km^2). Assam is dominated geographically by the Brahmaputra River, which flows generally from east to west across the northern part of the state, and the Barak River which flows north from Mizoram State, then westward through the city of Silchar, then into Bangladesh. The Brahmaputra River valley is approximately 720 km long with an average width of 80 km.[8] Assam is in India's Seismic Zone 5, the most seismically active classification. The Barak River valley is approximately 200 km long with an average width of 40 to 50 km.

3.1.1 Climate And Meteorology

45. The state lies in the sub-tropical belt with a monsoonal climate, with heavy summer rainfall, winter drought, and high humidity. Summers are hot (maximum temperature between 33^0C and 44^0C) and at some places it remains humid, while winters are reasonably comfortable (between 27^0C and 10^0C). The monsoon season runs from late May or early June to early October, with average rainfall of 2,263 millimeters per year and 144 rainy days. Assam has been divided into six agro-climatic zones: (i) North bank plains (Dhemaji, Lakhimpur, Sonitpur and Darrang districts), (ii) Upper Brahmaputra Valley (Goalaghat, Jorhat, Sibsagar, Dibrugarh and Tinsukia districts), (iii) Central Brahmaputra Valley (Nagaon and Morigaon districts), (iv) Lower Brahmaputra (Dhubri, Bongaigaon, Kokrajhar, Goalpara, Barpeta, Nalbari and Kamrup districts), (v) Barak Valley (Karimganj, Cachar and Hailakandi districts), and (vi) Hill districts of Karbi Anglong and North Cachar. The project components will be located in the broad river valley of the Upper, Central, and Lower Brahmaputra zones.

3.1.2 Topography, Soils, And Water Resources

46. Satellite imagery shows that surface morphology in the Project area is dominated by the major river systems, with numerous tributary rivers and streams, oxbow lakes, relict oxbow lakes, and relict stream channels. In the project area, some rocky hills are present with elevations less than 1 kilometer (km) above the surrounding river valley.

[8] Except for 1 new substation and 1 substation augmentation component in the Barak River valley, all proposed components are located in the Brahmaputra valley.

47. Soils[9] can generally be divided into four groups: alluvial soils, piedmont soils, hill soils and lateritic soils. Soil chemistry varies from acidic to alkaline, with varying porosity, cation exchange capacity, and organic matter content. Surface soils have been extensively altered by agricultural development, primarily rice paddies, tea estates, and livestock grazing.

48. There are two types of alluvial soils – younger alluvium and older alluvium. The alluvial soils are extensively distributed over the Brahmaputra and Barak plains. The piedmont soils are confined to northern narrow zones along the piedmont zone of the Himalayan foot hills. These soils comprise the Bhabar soil and the Tarai soil covering the respectively the Bhabar and Tarai belt of the Brahmaputra valley. The hill soils are generally found in the southern hilly terrains of the state. The hill soils can be divided into red sandy soils and the red loamy soils. The lateritic soils in the state extensively occur almost entirely over the North Cachar hills district.

49. Surface water and ground water are used for drinking, agriculture, municipal supply, and industrial processes. Surface water resources cover an area of 365,000 hectares (ha), of which 56% is rivers and streams, 28% is oxbow lakes and wetlands (“beels”), and 7% is ponds (including man-made ponds, or “tanks”). The Brahmaputra has low organic load and dissolved mineral content. The SPCBs of Assam, Nagaland, and Sikkim monitor water quality at 31 stations along the river and its tributaries. Water quality is variable, with pH and conductivity within drinking water norms.[10] Dissolved oxygen (DO) varies from 4.0 to 7.3 milligrams per liter (mg/L) vs. the standard of 4.0 mg/L; biochemical oxygen demand (BOD) varies from 4.6 to 12 mg/L vs. the standard of 3.0 mg/L; total coliform is exceeded at all monitoring stations, and faecal coliform is exceeded at some stations.[11] There is essentially no modern sewage treatment at any cities or towns along the river, which probably accounts for the high levels of DO, BOD, and coliform.

50. Surface water quality monitoring data from various environmental assessment reports for industrial projects were obtained from the Assam PCB website. Results are summarized in Tables 3.1a and 3.1b which indicate that surface water quality is within GOI Class C limits for drinking water after conventional treatment.

[9] Source: Geography of Assam,2007, edited by Dr. A.K. Bhagbati, Dr. A.K. Bora & Dr. B.K. Kar; (Reader in Geography, Gauhati University)

[10] GOI standard IS 2296 for surface water class C, suitable for drinking after conventional treatment and disinfection.

[11] Data from http://www.cpcb.nic.in/oldwebsite/New%20Item/images/content_chapter-6.pdf

Table 3.1a: Surface Water Quality Monitoring Results

APGCL = Assam Power Generation Company, Ltd., BDL=Below Detection Limit, ISWM = Integrated Solid Waste Management Facility, ND=Not Detected

Parameters (mg/L except as noted)	(IS:2296)Surface Waters Tolerance Limits	Location				
		Coal India	Oil India	Naftogaz	ISWM, Guwahati	APGCL
		Ledo pani nallah	Jhanji River	Dihing River	Mora Nallah	Namrup
Colour, Hazen units	300	16	Colorless	-	-	-
Dissolved oxygen	4	6.3	-	7.3	4.92	5.2-6.1
pH	6.5 to 8.5	6.7	7.9	7.5	7.1	7.1-7.3
Iron (as Fe)	50	2.4	-	0.2	0.69	
Chlorides (as Cl)	600	63	-	15	14	16.1-19.1
BOD (3 days at 27ºC)	30	11	12	-		4.8-8.1
Total dissolved solids	1500	228	152	104	48	200-235
Copper (as Cu)	1.5	ND	-	-	0.01	-
Total chromium (as Cr)	--	ND	-	-		-
Sulphates (as SO4)	400	104	6.1	-	7	14.2-16.8
Nitrates (as NO3)	50	17.2	0.5	0.16	0.85	-
Fluorides (as F)	1.5	ND	ND	0.05	-	-
Total coliform (MPN/100 ml)	5000	267	-	-	-	-
Cadmium (as Cd)	0.01	ND	-	-	-	-
Selenium (as Se)	0.05	ND	-	-	-	-
Arsenic (as As)	0.2	ND	-	-	-	-
Lead (as Pb)	0.1	ND	-	-	BDL	-
Zinc (as Zn)	15	0.19	-	-	0.26	-
Chromium (as Cr+6)	0.05	ND	-	-	0.04	-
Phenolic compounds (as C6,H5OH)	0.005	ND	-	-	-	-
Oil & grease	0.1	ND	-	-	-	max 0.8

Sources:

- *EIA Report for Coal India Tikak Open Pit Coal Mine, Tinsukia District, data from January 2008*
- *EIA Report for Oil India Drilling Project in Amguri, data from January - February 2008*
- *EIA Report for Naftogaz Oil Drilling Project, data from December 2007 and January 2008*
- *EIA Report for Integrated Solid Waste Management Facility in Guwahati, data from February-March 2007*
- *EIA Report (Executive Summary) for Namrup 100 MW Combined Cycle Gas Turbine plant*

Table 3.1b: Water Quality of River Barak and Kushiyara

Date	Location	pH	Dissolved oxygen	BOD (3 days @ 27° C)	Suspended Solids	COD
6.12.09	1 km upstream of effluent discharge	7.6	7.4	-	110	16.0
	At effluent discharge point	7.8	8.0	-	94	16.0
	1 km downstream of effluent discharge	7.6	8.0	-	115	11.2
	15 km downstream at Bhanga	8.0	8.0	-	102	14.4
13.12.09	1 km upstream of effluent discharge	7.9	9.0	0.9	100	17.6
	At effluent discharge point	8.0	8.0	0.8	92	19.2
	1 km downstream of effluent discharge	7.9	8.7	0.6	89	19.2
	15 km downstream at Bhanga	8.0	8.8	0.7	82	19.2
20.12.09	1 km upstream of effluent discharge	7.7	8.3	0.4	196	8.0
	At effluent discharge point	8.0	8.3	0.5	216	8.0
	1 km downstream of effluent discharge	7.9	8.3	0.5	282	6.4
	15 km downstream at Bhanga	7.7	8.2	0.5	158	8.0
27.12.09	1 km upstream of effluent discharge	7.8	7.6	0.9	112	9.6
	At effluent discharge point	7.8	7.6	0.9	212	9.6
	1 km downstream of effluent discharge	7.8	7.5	0.5	222	6.4
	15 km downstream at Bhanga	7.7	7.5	0.5	154	
IS: 2296 – Surface Water Tolerance Limits		6.5 to 8.5	4	30	100	10

Source: Test Result Submitted To Assam State Pollution Control Board by Cachar Paper Mill (Hailakandi District), for the month of December 2009

51. Groundwater resources have been mapped by drilling of 304 exploratory tube wells and 381 observation wells. Sustainable groundwater resources are estimated at 27.23 billion cubic meters (Bm^3), with annual availability of 24.89 Bm^3,

and annual withdrawals of only 5.44 Bm^3. Groundwater is generally suitable for drinking water and other uses,[12] but high iron concentrations are common on the north bank of the Brahmaputra River, and high fluoride concentrations have been observed in the districts of Kamrup, Nagaon, and Karbi Anglong on the south side of the Brahmaputra. Arsenic has been detected above drinking water limits in Dhemaji and Karimganj districts; the arsenic source has not been determined.

52. Ground water quality monitoring data from various environmental assessment reports for industrial projects were obtained from the Assam PCB website. Results are summarized in Tables 3.2a which indicates that ground water quality is within GOI limits for drinking water after conventional treatment. Table 3.2b presents limited groundwater data taken near the Cachar Paper mill in the Silchar / Hailakandi area.

[12] Based on groundwater sampling data conducted in the course of environmental impact assessments for 4 industrial projects listed on ADEF/SPCB website; data are from 2007 - 2008.

Table 3.2a: Ground Water Quality Monitoring Results

Parameters (mg/L except as noted)	(IS:10500) (Desirable Limit for drinking water)	Location				
		BCPL	Oil India	Naftogaz	ISWM	APGCL
		Lanka	Amguri	Margherita	Maghuwapara village	Namrup
pH	6.5 - 8.5	6.8	7.7	7.1	6.9	6.5-7.5
Turbidity (NTU)	5	10		1.1		
Specific conductance (micromhos/cm)		261		134	-	100-500
Total Dissolved Solids	500	167	140		152	16-34.3
Total Alkalinity as CaCO3	200	89	100	66.2		-
Total Hardness as CaCO3	300	104	96	73	96	-
Calcium as Ca		71	20.8	54.8	28	-
Magnesium as Mg		33		16.3	9.1	-
Chlorides as Cl	250	17	22.7	17.6	5.9	-
Sulphates as SO4	200	25	0.8		7.1	-
Nitrates as NO2	45	0.3	0.5	0.17	-	-
Fluoride as F	1	0.05		0.5	-	-
Arsenic as As	0.05	<0.002	-	-	-	-
Selenium as Se	0.01	<0.005	-	-	-	-
Cadmium as Cd	0.01	<0.002	-	-	BDL	-
Copper as Cu	0.05	<0.020	-	-	0.045	-
Lead as Pb	0.05	<0.03		-	BDL	-
Zinc as Zn	5	0.023	ND	-	0.32	-

BCPL= Bulland Cements (P) Limited, ISWM = Integrated Solid Waste Management Facility, APGCL = Assam Power Generation Company, Ltd., ND=Not Detected; BDL=Below Detection Limit

Sources:

- *REIA Report for Buland Cement (P) Limited, Nagaon, undated*
- *EIA Report for Oil India Drilling Project in Amguri, data from January - February 2008*
- *EIA Report for Naftogaz Oil Drilling Project, data from December 2007 and January 2008*
- *EIA Report for Integrated Solid Waste Management Facility in Guwahati, data from February-March 2007*
- *EIA Report (Executive Summary) for Namrup 100 MW Combined Cycle Gas Turbine plant*

Table 3.2b: Ground Water Quality in Hailakandi Area

Date	Location	pH	Mercury (mg/L)
8.12.09	Adm Building	7.0	BDL
8.12.09	Bore Well near Brine Sludge Pit	7.7	BDL
15.12.09	Railway Station	7.1	BDL
15.12.09	Bore Well near Brine Sludge Pit	8.4	0.025
22.12.09	Adm Building	7.6	BDL
22.12.09	Bore Well near Brine Sludge Pit	7.2	0.005

Source: Test Result Submitted To Assam State Pollution Control Board by Cachar Paper Mill (Hailakandi District), for the month of December 2009

3.1.3 Mineral Resources

53. Assam's energy resources include coal, crude oil, hydropower, and natural gas.[13] Coal reserves are estimated at 320 million tons, with 2 surface mines operating in eastern Assam. The identified coal reserves have high sulfur content and high volatile matter content, making it unsuitable for coke production and less than desirable for power generation. Proven Crude oil reserves are 1.3 billion tons. In the past 4 years, exploratory activity resulted in 32 new discoveries.

54. Proven natural gas reserves are 156 Bm^3. Natural gas is used as a fertilizer feedstock and for power generation with about 220 MW of gas-fired capacity in operation at 2 plants (Namrup and Lakwa). Total installed hydropower capacity is 375 MW, mostly in the Barak river watershed. Additional potential of 159 MW has been identified at 93 sites with less than 5 MW per site.[14]

55. Other natural resources include limestone and granite, estimated at 703 million tons and 1 billion m^3, respectively. Limestone is used for cement production and some granite is quarried for construction material.

3.1.4 Air Quality and Noise

56. Routine ambient air quality data for residential sites in the Guwahati urban area for 2006, 2007, and 2008 are presented in Table 3.3. Air quality is well within the standards for residential areas for sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) at all stations. Respirable particulate matter (RPM) and suspended particulate matter (SPM) standards for residential areas are exceeded at all stations on all monitoring dates. RPM and SPM are attributable mainly to mobile sources (vehicle emissions), small point sources (e.g., open trash burning), and non-point

[13] One of the 1st commercial crude oil discoveries in Asia was made in the 19th century at Naharkotia, in Dibrugarh District. The world's oldest continuously operating oil refinery is located at Digboi.

[14] The Northeast Grid, which includes Assam, has the lowest emissions factor of India's 5 regional grids: 0.42 tons CO_2-equivalent per megawatt-hour (tCO_2/MWh), vs. an average of 0.88 tCO_2/MWh for the other 4 grids. Despite the relative abundance of potential energy resources, Assam remains under-developed due to a shortage of reliable electric power supplies.

sources (e.g., unpaved roads) rather than electric power generation and/or other power sector facilities. [15]

Table 3.3: Ambient Air Quality in Guwahati Residential Areas

Date	Parameters	Location				
		Bamunimaidan	Dispur	ITI	Santipur	Paltan Bazar
	SO2	Standard = 80 micrograms per standard cubic meter				
February 2006	Maximum	8.0	13.8	7.8		7.5
	Average	4.8	5.5	4.8		6.3
March 2007	Maximum	18.5	14.0	17.5	13.0	
	Average	12.7	9.3	12.8	8.2	
February 2008	Maximum	13.3	12.5	12.3	11.8	
	Average	9.1	8.8	7.9	8.4	
	NO2	Standard = 80 micrograms per standard cubic meter				
February 2006	Maximum	25.6	39.5	23.0		33.5
	Average	9.8	27.2	20.1		32.5
March 2007	Maximum	28.0	22.3	26.8	21.3	
	Average	21.6	17.2	21.1	15.7	
February 2008	Maximum	25.5	23.0	22.5	22.3	
	Average	20.5	18.0	17.4	18.0	
	RPM	Standard = 60 micrograms per standard cubic meter				
February 2006	Maximum	501.5	326.0	462.5		114.0
	Average	213.4	165.8	227.5		103.0
March 2007	Maximum	484.5	223.0	257.0	220.5	
	Average	234.3	145.2	144.8	132.3	
February 2008	Maximum	234.0	224.0	230.0	197.0	
	Average	176.2	162.0	155.6	148.7	
	SPM	Standard = 140 micrograms per standard cubic meter				
February 2006	Maximum	864.0	811.5	728.0		250.0
	Average	395.1	340.1	406.		241.7

[15] In the Guwahati area, only new substations are proposed, which will have no air emissions. The sectoral scope of the project does not provide the opportunity for urban air quality management interventions.

Date	Parameters	Location				
		Bamunimaidan	Dispur	ITI	Santipur	Paltan Bazar
				8		
March 2007	Maximum	951.5	417.0	393.5	341.5	
	Average	466.6	226.2	226.6	197.9	
February 2008	Maximum	304.0	307.0	314.0	256.0	
	Average	249.6	233.3	226.5	209.7	

NO2 = nitrogen dioxide, SO2 = sulfur dioxide, RPM = respirable particulate matter, SPM = suspended particulate matter
Source: Assam State Pollution Control Board. Standards are annual average for residential areas.

57. Additional air quality monitoring data from various environmental assessment reports for industrial projects were obtained from the Assam PCB website. Results are summarized in Tables 3.4a and 3.4b. Data indicate that standards SO_2 and nitrogen oxides (NO_X) are met at all stations. SPM standards are met at all locations. RPM standards are met with 1 exceptions which is in the Amguri project area. Data in Tables 2 and 3 indicate that SO_2 and NO_X standards are met in most areas near proposed Project sites, but that RPM and SPM are routinely exceeded in urban areas and occasionally exceeded in some industrial areas.

Table 3.4a: Other Ambient Air Quality Monitoring Results

Parameters	Location					
	Oil India	Raksha	ISWM	Naftogaz	APGCL	Coal India
	Amguri	Koraibi	Guwahati	Margherita	Namrup	Tikak
SO_2	Standard = 80 micrograms per standard cubic meter					
Maximum	21.5	11.0	4.0	8.9	19.0	28.0
Minimum	3.2	6.0	3.0	3.0	8.0	8.0
NO_x	Standard = 80 micrograms per standard cubic meter					
Maximum	35.8	26.0	22.0	12.6	25.0	36.0
Minimum	4.1	12.0	14.0	3.1	10.0	10.0
RPM	Standard = 120 micrograms per standard cubic meter					
Maximum	136.0	62.0	107.0	17.0	61.0	62.0
Minimum	21.0	23.0	73.0	5.0	31.0	12.0
SPM	Standard = 360 micrograms per standard cubic meter					
Maximum	321.0	175.0	336.0	65.0	221.0	110.0
Minimum	46.0	88.0	203.0	30.0	75.0	39.0

APGCL = Assam Power Generation Company, Ltd., ISWM = Integrated Solid Waste Management Facility, NO_x = nitrogen dioxides, SO_2 = sulfur dioxide, RPM = respirable particulate matter, SPM = suspended particulate matter

Standards are annual averages for industrial areas.
Sources:
EIA Report for Coal India Tikak Open Pit Coal Mine, Tinsukia District, data from January 2008
EIA Report for Naftogaz Oil Drilling Project, data from December 2007 and January 2008
EIA Report for Oil India Drilling Project in Amguri, data from January - February 2008
EIA Report for Raksha Cement Plant in Kamrup District, undated
EIA Report for Integrated Solid Waste Management Facility in Guwahati, data from February-March 2007
EIA Report (Executive Summary) for Namrup 100 MW Combined Cycle Gas Turbine plant

Table 3.4b: Ambient Air Quality in Hailkandi Residential Areas

Date	Parameters	Location
		CISF Campus, Panchgram, Hailakandi,
	SO2	Standard = 80 micrograms per standard cubic meter
October 2006	**Maximum**	9.00
	Average	7.53
June 2007	**Maximum**	5.25
	Average	3.53
January 2008	**Maximum**	7.00
	Average	4.81
	NO2	Standard = 80 micrograms per standard cubic meter
October 2006	**Maximum**	21.5
	Average	18.13
June 2007	**Maximum**	13.75
	Average	9.31
January 2008	**Maximum**	16.75
	Average	11.35
	RPM	Standard = 60 micrograms per standard cubic meter
October 2006	**Maximum**	87.00
	Average	36.19
June 2007	**Maximum**	32.00
	Average	21.17
January 2008	**Maximum**	110.50
	Average	65.11
	SPM	Standard = 140 micrograms per standard cubic meter
October 2006	**Maximum**	110.50
	Average	63.19
June 2007	**Maximum**	69.50
	Average	49.33
January 2008	**Maximum**	162.00
	Average	101.11

NO2 = nitrogen dioxide, SO2 = sulfur dioxide, RPM = respirable particulate matter, SPM = suspended particulate matter

Source: Assam State Pollution Control Board. Standards are annual average for residential areas.

58. Noise survey data from various environmental assessment reports for industrial projects (the EIAs referenced in Table 3.4a) were obtained from the Assam PCB website. Results are summarized in Table 3.5 indicate that noise in villages and rural areas is within allowable standards.

Table 3.5: Noise Monitoring Results

Permissible Noise dB(A) (Residential Areas)			Location			
			BCPL	Coal India	Naftogaz	Raksha
			Bamunigaon	Tikak	Ketetang	Silasundari ghopa
Equivalent Levels dB(A) Leq	Day	55	51	49	55	56
	Night	45	41	38	48	42

BCPL= Bulland Cements (P) Limited, dB(A) Leq = decibel acoustic level
Sources:
REIA Report for Buland Cement (P) Limited, Nagaon, undated
EIA Report for Coal India Tikak Open Pit Coal Mine, Tinsukia District, data from January 2008
EIA Report for Naftogaz Oil Drilling Project, data from December 2007 and January 2008
EIA Report for Raksha Cement Plant in Kamrup District, undated

3.2 ECOLOGY: FAUNA, FLORA, AND FORESTS

59. Assam has a broad spectrum of flora and fauna, with eco-systems broadly grouped into 7 categories: tropical wet evergreen forest, tropical semi-evergreen forest, tropical moist deciduous forest, sub-tropical broadleaf hill forest, sub-tropical pine forest, littoral and swamp forest, and grassland and savannahs. Of the thousands of species that have been catalogued, 433 plant species are identified as endangered, and 71 species are identified as vulnerable or threatened (ADEF website).

60. The notable wildlife species include are one horned rhino, elephant, Indian bison, swamp deer, sambar, hog deer, sloth bear, tiger, leopard cat, jungle cat, hog badger, capped langur, hollock gibbon, jackal, goose, hornbills, ibis, cormorants, egret, heron, and fishing eagle. Potentially endangered and rare species include pigmy hog, hispid hare, white winged wood duck, and great Indian hornbills among many others. The protected area network is host to 105 species of mammals, 49 species of fish, and 581 species of birds. Assam also hosts a variety of aquatic fauna and reptiles, including 19 species of tortoises, 77 species of snakes and lizards, and 39 species of freshwater snails. Assam and other parts of the Northeast region host at least 70 species of amphibians.

61. Assam has 5 national parks, 17 wildlife sanctuaries, and 3 proposed wildlife sanctuaries.[16] The total protected area network is 3,925 km^2, about 5% of the state's total area.

62. The total forested area in the state is about 27,829 square kilometers (km^2), which constitutes 35.48% of total land area of Assam. A substantial amount of forest land is degraded to some extent, with actual forest cover of about one-quarter of total land area (about 19,608 km^2). Of this, about one-half is reserved forest (about 9804 km^2). ADEF has approved diversion of 6212 ha of reserved forests (0.6% of reserved forest area), and has afforested 9889 ha (about 1% of reserved forest area).[17]

63. Although surface water resources are relatively abundant, and 90% of the population eats fish as a staple food, commercial fisheries have not been developed. Some artisanal fishing is practiced, but most fish are imported from other states, especially Andra Pradesh.

3.3 SOCIOECONOMIC CONDITIONS

64. The population of the state was 26.6 million people in 2001.[18] Average population density is about 340 persons per km^2. The economy is based primarily on agriculture, crude oil and natural gas production, and petrochemical production. Per capita income is $355 per year, about two-thirds of the national average.

3.3.1 Agricultural Development

65. About 73% of the population lives in rural areas, and 77% of the workforce is employed in the agriculture sector. About 40% of total land area is cultivated. Agriculture and allied activities account for about 40% of GDP. The main crops are tea (over 50% of total Indian production), bamboo, ginger, chilies, peas, rice, wheat, and oil seeds. By 2010, rice, wheat, and oil seed production is projected to reach 1.47 million tons, 74,000 tons, and 107,000 tons respectively. Assam is the 6th–ranked state in fruit and vegetable production. Livestock includes 8 million head of cattle, 2.7 million goats, 1.1 million pigs, and 700,000 water buffalo. Poultry are raised mainly in "backyard" operations.

66. Despite the large share of GDP accounted for by agriculture, food demand outstrips supply, and this demand-supply gap is expected to grow. Farm mechanization is very low, and energy supplies constrain groundwater extraction for irrigation; supply is limited to 0.3 horsepower per ha, which limits most farm operations to a single crop per year. Livestock productivity is also limited by the lack of technical and extension support. Average farm size is 1.27 ha. Landholding distribution is summarized in Table 3.6

[16] The project components will not be located in any of these sensitive areas.
[17] Data in this paragraph are from GOA Official Website and ADEF website.
[18] Statistics are taken from *Statistical Data Handbook of Assam, 2007*. Directorate of Information & statistics, GOA, Guwahati.

Table 3.6: Landholding Distribution

Landholding Size (ha)	% of Total Landholdings	% of Total Operated Area
< 1	60.3	19.3
1 to 2	22.2	24.5
2 to 20	16.6	44.9
>20	0.9	11.3

Source: Road Map for Agrarian Prosperity in Assam[19]

3.3.2 Educational Facilities

67. The literacy rate is nearly 64.28%, comparable to the all-India average. Assam has 5 universities, 4 engineering colleges (including Indian Institute of Technology), 3 medical colleges, 23 vocational training institutes, 8 polytechnic schools, and 1 junior technical school.

3.3.3 Infrastructure Development

68. About 78% of villages have been electrified, but the household electrification rate is currently about 22%. Per capita electricity consumption is 170 kilowatt-hours per year (kWh/y), which is 27% of the national average. Piped water supply is available in larger towns and cities. Hand-pumped wells are common in villages. Sewage systems are essentially non-existent, and solid waste management systems and management facilities are not well-developed.

69. Transportation infrastructure includes 69,000 km of roads, 2435 km of railways, and 6 airports (Dibrugarh, Guwahati, Jorhat, North Lakhimpur, Silchar, and Tezpur). Two GOA-owned enterprises operate inland water transport of passengers and freight. Water is the only means of transport in some hinterland areas. The Brahmaputra River connects Assam to ports in Haldia and Kolkatta in West Bengal, and Chittagong in Bangladesh. Assam has 269 telephone exchanges with 120,000 connections. Mobile phone service is readily available and affordable.

3.3.4 Industrial Estates

70. Industrial development includes 4 crude oil refineries, 3 fertilizer plants, several fuel storage and distribution plants, 2 paper mills, 3 cement plants, numerous brick kilns, and steel mini-mills. A 27 ha Export Promotion Industrial Park has been established at Amingaon (Kamrup district on the north bank of the Brahmaputra, about 15 km from the Guwahati airport); 37 firms have established a presence, including 17 manufacturing facilities. A food processing park is being set up in Chaygaon, a rural area in Kamrup district. An industrial growth center is being established at Matia in Goalpara district (western Assam); a 280 ha site has been defined of which 180 ha will be developed. A second industrial growth center (160 ha) is being set up at Balipara in Sonitpur district (about 15 km from the city of

[19] Dr. Arun K. Bandyopadhyay, Chief General Manager, National Bank for Agriculture and Rural Development, Assam RO, Guwahati, 2004. Information in paragraphs 66 and 67 and Table 3.6 are from this reference. Available at http://assamagribusiness.nic.in/Agrarianprosperity/Forward.pdf

Tezpur in eastern Assam). Industrial infrastructure development centers are planned for 4 districts, and 3 border trade centers have been approved.[20]

3.3.5 Religious and Cultural Resources

71. As is the case throughout India, Assam is host to numerous religious and cultural sites. The Kamakhya Temple complex near Guwahati is the only such site identified which may be affected by the project. Schools and hospitals have not been observed near any of the new substation sites or along proposed transmission right-of-way, except for a small local nursing college under construction in the village near the proposed Kamalpur substation site.

3.4 Environmental Sustainability

72. The Institute for Financial Management and Research (IFRM) based in Chennai publishes Environmental Sustainability Indices (ESI) for all states of India.[21] ESI is a powerful tool that can be used to identify priorities; a state might be facing several environmental changes such as water pollution, air pollution and loss of forest and biodiversity. Using ESI it can be determined which of these issues needs the most urgent attention. It can be effectively used to formulate targeted policies and to allocate funds more rationally, within states and within sectors. The ESI is based on 15 indicators: air pollution, air quality, energy, greenhouse gases, government's initiatives, health, land use, natural resource depletion, natural disasters, natural resource endowments, people's initiatives, population pressure, waste generation, water pollution, and water quality. These indicators are grouped into 5 performance categories: environment and health impact, environmental governance, environment stress, environment systems, and population pressure. Assam is 10th–ranked state for year 2008.[22] Assam ranks among the best states with respect to air pollution, and is above average with respect to water pollution.

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[20] Most of the information in this section is from the GOA Official Website, "Assam at a Glance."
[21] ESI results are published online at www.greenindiastandards.com
[22] The top 6 states in 2008 were all in the North East Region: Manipur, Sikkim, Tripura, Nagaland, Mizoram, and Arunachal Pradesh. Meghalaya was ranked number 11 after Assam.

CHAPTER - 4

SCREEING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

CHAPTER - 4

SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 Environmental Effects Due to Project Location and Design

73. Transmission systems have an inherently small footprint compared to other "linear" infrastructure (e.g., expressways and other roads which typically alter topography and drainage in an irreversible manner). Geotechnical and structural engineering considerations favor flat, open areas with bedrock or stable soils which are not being used for other economic purposes. Rivers, lakes, and wetlands are avoided, as these types of sites tend to be relatively unstable, requiring special foundation engineering which increases design and construction costs. Tall vegetation and forests are viewed by design engineers as a nuisance to be avoided, because clearing of vegetation adds to construction and operations cost. Use of reserved forests is a tedious administrative process, which also increases transaction cost at the planning and approvals stage. At the planning and design stage, environmentally-sensitive areas are avoided on engineering and government policy bases. Disturbance of topography, soils, and drainage patterns is minimal, with some minor alterations occurring at new substation sites, and minimal and partly reversible alteration in transmission right-of-way.

74. During project preparation the Detailed Project Report (DPR) was reviewed, along with the existing grid map, and a map of the protected area network published by ADEF. The proposed facilities will be constructed mainly in existing transmission and transportation corridors, avoiding reserved forests, wildlife preserves, national parks, social infrastructure, and other public utilities. The proposed project facilities do not pose any threat to other flora, fauna, public utilities, or other social infrastructure. Sketch maps of proposed substation sites, and photos from proposed project sites are presented in Appendices 1 and 2.

75. If access to reserved forests is required due to technical design constraints, regulatory approval from ADEF and MOEF must be obtained in advance; the user must pay a fee for use of the land, which is used for afforestation in other locations. Diversion of reserved forest for other uses has a built-in mitigation mechanism for afforestation/reforestation, and any potential use of reserved forests will not constitute significant environmental impact. Appendix 3 discusses the genesis of the reserved forest system, and explains that designation of reserved forests does not connote sensitive ecosystem (as is the case with wildlife preserves and national parks).

76. The total area required for transmission right-of-way is estimated at 596 ha,[23] and area required for new substations and expansion of existing substations

[23] Area is calculated as follows: 596 km x 10 m x 1000 m/km x 1 ha/10,000m^2 = 596 ha.

is estimated at 47.2 ha. The land to be acquired is mostly government and/or agricultural land, and landholders will be compensated as per GOI norms. No land acquisition will be required for substation augmentation. Substations will not be located in reserved forests or protected areas.

77. Substations will be sited and designed to ensure noise level at the site boundary will not exceed 70 dB(A) at any time. Substations will be equipped with appropriate sanitation facilities. Transformers containing polychlorinated biphenyls (PCBs) will not be used.[24]

4.2 Environmental Effects During Construction

78. Given the small construction and operations footprint noted above, topography, soils, and drainage will not be altered significantly by the project. Typical area required for a new substation is a maximum of 4 ha, requiring some earth moving for civil works. The land surface beneath transmission towers can be returned to previous use, except for the tower footings, which typically require a total of 10 square meters (m^2) per tower. Minor changes in surface water flow may result from substation construction, but is not considered to be environmentally significant. The proposed transmission system expansion comprises 5 types of facilities, each with slightly different - but minimal - potential impacts, discussed below.

79. **Substation augmentation**: no new land is required. Some old equipment will be decommissioned, and new equipment (mainly transformers) will be brought to the sites and installed. Off-site waste disposal and/or recycling will be required. Construction traffic will be limited to several truckloads of equipment and materials brought to the site, and a few truckloads of obsolete equipment taken off-site.

80. **Substation expansion**: maximum area required is estimated at 4000 m^2; some of the substations slated for expansion have sufficient space within existing boundaries. New equipment will be transported to the sites and installed. Minimal quantities of construction waste will be generated. Construction traffic will be limited to several truckloads coming in to the site.

81. **New substations**: land acquisition will be required; maximum area per substation is estimated at 4 ha. New, permanent, access roads will be required. Surface soils will be disturbed by civil works; drainage patterns may be slightly altered. New equipment and materials will be brought to the site. Minor quantities of construction waste will be generated.

82. **Line-in / line-out transmission lines**: 8 lines ranging from 3 km to 25 km in length will be constructed, with aggregate length of 86 km and average length of 10.75 km. A 10 meter right-of-way will be used during construction, with 3 m preserved during operations. Lines will be constructed mainly on tea estates and

[24] India has phased out the use of polychlorinated biphenyls (PCBs); new transformers available in the Indian and international markets do not contain PCBs.

other agricultural land, which can be restored to prior use after construction. Vegetation in a 3 m wide strip will be trimmed to maintain required vertical separation from conductors. Trucks will be used to bring equipment and materials to construction sites. Permanent access roads are not required. Construction will use manual labor for the most part, with minimal requirement for heavy equipment.

83. **Point-to-point transmission lines**: 6 lines ranging from 25 km to 180 km in length will be constructed, with aggregate length of 510 km and average length of 85 km. Construction and operational impacts are the same as for line-in/line-out lines.

4.2.1 Augmentation of Existing Substations

84. **Jagiroad (Bagjhap,) 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 16 MVA transformer with new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

85. **Gohpur, 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 10 MVA transformer with new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

86. **North Lakhimpur, 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 10 MVA transformer with new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

87. **Lanka (Sankardev Nagar), 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 16 MVA transformer with new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

88. **Margherita (Ledo), 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 10 MVA transformer with new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

89. **Tinsukia, 220/132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 50, 220/132 MVA transformer with new 2 x 40 MVA, 132/33 kV transformer and new 2 x 100 MVA, 220/132 transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No

land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

90. **Kahilipara, 132/33 kV substation (T2):** The proposed work comprises replacement of old 2 x 10, 132/33/11 kV transformer with new 2 x 40 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

91. **Mariani, 220/132/66/33 kV substation (T2)**: The proposed work comprises addition of new 2 x 25 MVA, 132/33 kV transformer. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

92. Boko. 220/132/33 kV Substation **(T2)**Addition of new 1x100 MVA, 220/132 MVA transformers. No land acquisition is required. The potential impact is the storage/reuse/disposal of the old transformer.

4.2.2 Extension of Existing Substations

[Substations to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.]

92. **Salakathi (BTPS), 220/132/33 kV substation (T1):** The proposed work comprises addition of two numbers of 220 kV line bays for Salakathi-Rangia 220 kV D/C transmission line. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required.

93. **Samaguri, 220/132/33 kV substation (T1):** The proposed work comprises addition of two numbers of 132 kV line bays for Samaguri-Nagaon 132 kV D/C transmission line, Samaguri-Lanka 132 kV second circuit stringing. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land is acquisition required.

94. **Mariani 220/132/66/33 kV substation (T2):** The proposed work comprises addition of two numbers of 220 kV line bay for 220 kV S/C transmission line. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required.

95. **Namrup, 220/132/33 kV substation (T2):** The proposed work comprises addition of two numbers of 220 kV line bay for Mariani-Namrup 220 kV S/C transmission line. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required.

96. **Tinsukia, 220/132/33 kV substation (T2):** The proposed work comprises addition of one number of 132 kV line bay for Tinsukia-Rupai 132 kV S/C

transmission line. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required.

97. **Agia, 220/132/33 kV substation (T2):** The proposed work comprises addition of one number of 132 kV line bay for Agia-Matia 132 kV S/C transmission line. Construction traffic will be limited to one/two truck load of equipment and material brought to the site. No land acquisition is required.

4.2.3 New substations

[Substations to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.]

98. **Kamalpur 2 x 40 MVA, 132/33 kV (T1):** The proposed Kamalpur substation site is located on agricultural land, adjacent to a village road. Reserve forest exists, about 250 meters to the south of the proposed site, with the road and commercial / residential buildings asa a buffer the forest and the proposed substation site. About 4 ha of land will be acquired, which would be compensated at market price by the District Commissioner. There would be slight disturbance of the surface soil by the civil work. Drainage pattern would be slightly altered. Minor quantity of construction waste would be generated. A short access road from the village road into the substation site is anticipated. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

99. **Nagaon 2 x 25 MVA, 132/33 kV (T1):** The proposed substation site is located on barren government land which is slightly higher than the adjacent agricultural fields. Strengthening of the access road may be required. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

100. **Rangia 2 x 100 MVA, 220/132 kV (T1):** The proposed substation site is located adjacent to the existing Rangia substation. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required, but the existing road may require minor re-alignment to provide desired setback.

101. **Sonari 2 x 25 MVA, 132/33 kV (T1):** The proposed substation is located on abandoned tea estate land. About 4 ha land will be acquired and would be compensated at market price by the District Commissioner. No new access road is required. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

102. **Rupai 2 x 25 MVA, 132/33 kV (T1):** The proposed substation site is located within the existing Rupai substation. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required.

103. **Khanikar (New Dibrugarh) 2 x 25 MVA, 132/33 kV (T1):** The proposed substation site is located on abandoned tea estate land. About 4 ha land will be acquired and would be compensated at market price by the District Commissioner. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant. No new access road is required.

104. **Jorhat (West) 2 x 25 MVA, 132/33 kV (T2):** The proposed substation site is located on barren private land. About 4 ha land will be acquired and would be compensated at market price by the District Commissioner. Strengthening/construction of the access road may be required. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

105. **Bordubi 2 x 40 MVA, 132/33 kV (T2):** The proposed substation site is located on abandoned tea estate land. About 4 ha land will be acquired and would be compensated at market price by the District Commissioner. Strengthening of the access road is perceived. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

106. **Matia 2 x 16 MVA, 132/33 kV (T2):** The proposed substation site is located on barren government land. There would be slight disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant. No new access road is required.

107. **Sonapur 2 x 100 MVA, 220/132 and 2 x 25 MVA, 132/33 kV (T2):** The proposed substation site is located on private land which is higher than the adjacent agricultural field. About 4 ha land will be acquired and would be compensated at market price by the District Commissioner. There would be slight

disturbance of the surface soil and alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required.

108. **Kamakhya 2 x 40 MVA, 132/33 kV (T2):** the proposed substation site will be located near the intersection of existing 132 kV and 33 kV lines near the northwest Frontier Railway headquarters on the west side of the Guwahati metropolitan area. The substation will provide power delivery to the railway for electrified rail operations. The area is hilly, but urbanized (including numerous squatters). The Kamakhya Temple complex is located on top of the hilly area. Six sites have been considered, of which 4 have been eliminated from further consideration. The 2 remaining ("semi-finalist") sites are located on the southern side of the hilly area on unoccupied land. One is located adjacent to and on the west side of the existing 33/11 kV substation. The second site is about 250 meters north of the 33/11 kV substation. Each of these sites would require cut-and-fill foundation engineering including retaining walls, as well as the erection of a new transmission tower to connect to the existing 132 kV transmission line. The northern site would provide the easiest connection to the existing 132 kV transmission line, while the western site would provide the easiest connection to the existing 33/11 kV substation. Minor quantity of construction waste would be generated. No new access road is required. There will be no direct impacts on the temple complex.

109. **Sonabil 220/132/33 kV (T2):** the proposed site is located near the intersection of the 220 kV Samaguri-Balipara line and the 132 kV Depota-Gaupur line. The site is on unused land owned by the Sonabil Tea Estate Company. There would be slight disturbance of the surface soil and possible minor alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required.

110. **Hailakandi 2 x 40 MVA, 132/33 kV (T2):** the proposed substation site will be located adjacent to the existing 132 kV Panchgram - Dullavcherra line near Chanpur village. The site is on flat agricultural land adjacent to an existing unpaved road. There would be slight disturbance of the surface soil and possible minor alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required.

111. **Bilasipara, 132/33 kV (T2):** the proposed substation site will be located on the Gauripur-Kokrajhar 132 kV transmission line to deliver power adjacent to the Bilasipara area. The site is on open, unused land adjacent to an existing unpaved road. There would be slight disturbance of the surface soil and possible minor alteration in drainage pattern. Minor quantity of construction waste would be generated. No new access road is required.

4.2.4 New Line-in / line-out (LILO) transmission lines

[Lines to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.]

112. **Rangia – Sishugram/Kahilipara 132 kV double circuit LILO Line to new Kamalpur 132/33 kV Substation (T1)**: this 15 km line will cross flat agricultural land adjacent to the existing 132 kV transmission line. Only minor surface disturbance is expected during construction.

113. **Lakwa – Namrup 132 kV single circuit LILO Line to new Sonari 132/33 kV Substation (T1)**: this 7 km line will cross tea estates, bamboo groves, and rice paddies near existing transmission lines. Only minor surface disturbance is expected during construction.

114. **Dibrugarh – Moran 132 kV single circuit LILO Line to New Dibrugarh (Khanikar) 132/33 kV Substation (T1)**: this 5 km line will cross tea estates, rice paddies, and bamboo groves, near existing transmission lines. Only minor surface disturbance is expected during construction.

115. **Samaguri – Sarusajai 220 kV double circuit LILO Line to new Sonapur 220/132/33 kV Substation (T2):** this 20 km line will cross arable land, grassy fields, and areas of un-irrigated agriculture. The area is hilly with plains between hills. The proposed route is in an area with existing 220 kV and 33 kV lines. Only minor surface disturbance is expected during construction.

116. **Chandrapur – Kahilipara/Narangi Line 132 kV Double Circuit LILO Line to new Sonapur 220/132/33 kV Substation (T2)**: this 25 km line will cross land similar to that along the Samaguri-Sarusajai route, in an existing transmission corridor near the Chandrapur Thermal Power Station site (the power plant is currently inactive). The line will not be connected to the Chandrapur power station. Only minor surface disturbance is expected during construction.

117. **Kahilipara – Rangia/Sishugram 132 kV double circuit LILO Line to new Kamakhya 132/33 kV Substation (T2)**: this line will run through urbanized area on the west side of Guwahati; the line will be less than 1 km in length based on the 2 substation sites under consideration. The area has been extensively altered by human activity. Some temporary disruption to local traffic during construction is expected.

118. **Jorhat – Bokakhat 132 kV single circuit LILO Line to new Jorhat (West) 132/33 kV Substation (T2):** this 5 km line will cross plains with rice paddies and bamboo groves, adjacent to the existing 132 kV transmission line. Only minor surface disturbance is expected during construction.

119. **Namrup – Tinsukia 132 kV single circuit LILO Line to new Bordubi 132/33 kV Substation (T2)**: this 6 km line will cross tea estates, bamboo groves, and rice paddies near existing transmission lines. Only minor surface disturbance is expected during construction.

120. **Samaguri – Balipara 220 kV double circuit LILO and Depota – Gohpur 132 kV double circuit LILO to new Sonabil Substation (T2):** these LILOs will be located within 3 km from the new Sonabil substation. The 220 kV LILO will be about 2.5 km in length and the 132 kV LILO will be about 1.5 km in length. The site is unoccupied and unused land, with minor vegetation. The land will be acquired

from the Sonabil Tea Estate Company. An existing access road will be upgraded and only minor surface disturbance is expected during construction.

121. **Panchgram – Dullavcherra 132 kV LILO to new Hailakandi Substation (T2):** these lines will total about 4 km and will be constructed on open unused land owned by the Sonabil Tea Estate Company, which will be acquired for the project. Only minor surface disturbance is expected during construction.

4.2.5 Point-to-point transmission lines

[Lines to be included in Tranche 1 and Tranche 2 are noted with (T1) and (T2) respectively.]

122. **Salakathi (BTPS) – Rangia 220 kV D/C Line (T1):** this 180 km line will connect the existing Salakathi substation to the new Rangia 220/132 kV Substation. The line will be routed to avoid reserved forests near the Salakathi substation and will mostly run parallel to existing transmission lines. The route is characterized as agricultural land including rice paddies, bamboo, and some homesteads. The line will carry power from the new 3 x 250 MW Bongaigaon power plant being constructed by NTPC Ltd. (see Appendix 2 for discussion of associated facilities). Only minor surface disturbance is expected during construction.

123. **Samaguri - Nagaon** 132 kV S/C Line on D/C Towers **(T1)**: this 25 km line will connect the existing Samaguri substation to the new Nagaon 132/33 kV Substation. The line will run through flat, grassy and un-irrigated agricultural areas roughly parallel to the existing 132 kV line. Only minor surface disturbance is expected during construction.

124. **Tinsukia - Rupai 132 kV S/C Line on D/C Towers (T1)**: this 30 km line will connect the existing Tinsukia substation to the new Rupai 132/33 kV Substation. The line will cross agricultural land, mainly rice paddies and some tea estates, adjacent to existing rail and road corridor. Only minor surface disturbance is expected during construction.

125. **Agia - Matia 132 kV single-circuit (S/C) line on double-circuit (D/C) towers (T2)**: this 35 km line will run from the existing Agia substation to the new Matia (Dudhnoi) 132/33 kV Substation. The line will be routed around a small wetland and standing forests near the Agia substation, and mainly cross agricultural land. Only minor surface disturbance is expected during construction. A second circuit can be added in the future when demand requires increase in line capacity.

126. **Mariani - Namrup 220 kV S/C Line on D/C Towers (T2)**: this 140 km line will connect the existing Mariani and Namrup substations. The line will be routed across the existing Namrup power plant site, avoiding reserved forests adjacent to the power plant site. Because of space constraints, the line may be as close as 200 meters from the forest area on the east side of the plant site, but will not cross the forest area. The line will mainly cross tea estates, rice paddies, bamboo groves, and irrigated agricultural land. The route is approximately parallel to existing

transmission lines. The line will carry power from the new 100 MW gas-fired power plant on the existing Namrup power plant site (see Appendix 2 for discussion of associated facilities). Only minor surface disturbance is expected during construction.

127. **Samaguri – Lanka (Sankardevnagar) stringing of 2nd circuit of 132 kV line on existing towers (T2):** the existing transmission line is mainly agricultural land and does not cross reserved forests. Potential impacts will be minor disturbance during construction.

4.2.6 General Impacts and Mitigation Measures During Construction

128. The SCADA system and communications facilities (noted in Chapter 2) are integral with the transmission system design, and do not present any additional environmental impacts. Refurbishment of existing stations (noted in section 2.16 of Chapter 2) is considered as ongoing operations and maintenance, with negligible impacts.

129. Trucks will be used to bring equipment and materials to construction sites. Permanent access roads are not required for transmission lines, but will be required for some new substations. Temporary access roads might be needed for transmission lines in some locations. The environmental impacts associated with the establishment of temporary access roads will include disturbance of soils and disruption of small streams or other water bodies. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required.

130. Construction will use manual labor for the most part, with minimal requirement for heavy equipment. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

131. Compensation will be paid for temporary loss in agricultural production in accordance with the resettlement action plan. Topsoil will be protected and reinstated after construction is completed, and damaged bunds and irrigation facilities will be maintained in working condition throughout project implementation.

132. To minimize impacts to topography, soils, and surface water, established roads and tracks will be used wherever possible. Compensation will be paid for temporary loss in agricultural production in accordance with the resettlement action plan. Topsoil will be protected and reinstated after construction is completed, and damaged bunds and irrigation facilities will be maintained in working condition throughout project implementation.

133. Temporary access roads might be needed in some locations. The environmental impacts associated with the establishment of temporary access roads will include disturbance of soils and disruption of small streams or other water bodies. Soil erosion and silt runoff are likely to be minor due to the limited amount of excavation required. Construction will generate noise for a short duration in predominantly rural locations, and is considered insignificant.

134. Construction contract clauses will include specification of construction practices per the environmental management plan (EMP) and compensation paid for any losses in agricultural production. Discharge of wastes such as waste lubricating oils from construction equipment and domestic solid waste and sewage from construction camps and substations will be prevented through design and installation of appropriate oil containment and sewerage systems.

135. Obsolete equipment, including any hazardous wastes, will be disposed of according to the norms of Ministry of Environment and Forests. Health hazards from potential explosions or fire, electric shocks, and accidents to staff and the public will be minimized through implementation of measures including (i) designs using appropriate technologies to minimize hazards, (ii) safety awareness raising for construction and operational staff and the public, (iii) substations equipped with modern fire control systems, (iv) provision of adequate water supply and sanitation facilities for substations and construction camps, (v) provision of adequate staff training in operations and maintenance, and (vi) security fences and barriers around substations and transmission towers in populated areas.

4.3 Environmental Effects During Operation

136. During construction of transmission lines, right-of-way with a maximum width of 10 meters will be cleared, of which 3 meters will be kept clear as a maintenance right-of-way. The balance of the right-of-way will be returned to agricultural use or allowed to naturally recover. Vegetation will be trimmed to ensure that the required vertical spacing between conductors and vegetation are maintained for safety

reasons. To minimize the risk of accidents and exposure to electric fields, houses and other structures will not be allowed within the right-of-way, but agricultural activities can be continued. Table 4.1 (see following page) summarizes the potential impacts and mitigation measures. The Project's minimal potential negative impacts can be mitigated readily and cost-effectively.

Table 4.1: Potential Project Impacts and Mitigation Measures

Project Stage	Project Activity	Potential Impacts	Mitigation Measures	Institutional Responsibility	Cost Estimate ($)
Pre-Construction Period	No field activities	None: impacts are avoided through design	Built-in to routing and design	AEGCL	No incremental costs
	Possible access to reserved forest area	Some clearing of trees and vegetation	Reforestation measures as per Forest Act Rules	AEGCL and ADEF	n/a
Construction Period	Clearing of trees and vegetation	Temporary loss of forest cover	Reforestation activities as agreed with ADEF	AEGCL, ADEF	n/a
	Noise from construction equipment operations and maintenance	Noise could exceed 70 dB(A) at site boundary	Equipment to meet local noise standards; construction scheduling to avoid evening and nighttime disruption	Construction Contractor to implement. AEGCL to include appropriate contract clauses. ADB to confirm contract clauses are sufficient	Included in contractors, costs. Incremental cost of all mitigation measures estimated at less than 0.5% of total contract value
	Soil erosion and wastewater from work site and construction camps	BOD and fecal coliform contamination	Primary treatment if needed	Construction contractors' responsibility with AEGCL and ADB oversight	Included in contractors' costs.

Project Stage	Project Activity	Potential Impacts	Mitigation Measures	Institutional Responsibility	Cost Estimate ($)
	Industrial wastewater from construction equipment maintenance yards	Petroleum and detergent contamination	Sedimentation and biological treatment if necessary	Construction contractors' responsibility with AEGCL and ADB oversight	Included in contractors' costs.
	Waste oil from phased out transformers and other equipment, possible oil with PCBs	Possible soil contamination	Waste oil may be reused after filtration. Other equipment will be managed off-site by registered equipment recycling companies or vendors	Construction contractors' responsibility with AEGCL and ADB oversight. AEGCL is directly responsible for PCB management	Included in contractors' costs. Treatment / disposal of PCBs estimated at maximum $500 / ton
Construction Period (continued)	Dust during construction and exhaust gases from construction machinery and vehicles (particulate matter, NO_2, SO_2)	Increased SPM, NO_2, SO_2 levels at construction sites, and surrounding areas	Dust control with water sprays. Contractors' equipment to meet GOI equipment and vehicle emissions standards	Construction contractors' responsibility with AEGCL and ADB oversight	Included in contractors' costs.
	Spoils from earth moving; construction debris	Contaminated soil and non-hazardous solid waste	Spoils to be used as base material for substations and greenbelts	Construction contractors' responsibility with AEGCL and ADB oversight	Included in contractors' costs.
	Waste equipment (e.g., steel structures, conductors, circuit breakers)	Possible soil and groundwater contamination if not properly managed	Can be stored in secure depot, and disposed / recycled off-site in compliance with GOI standards	AEGCL has primary responsibility. Disposal / recycling vendors have secondary responsibility	Nil: waste equipment and materials can be auctioned off to licensed salvage vendors

Project Stage	Project Activity	Potential Impacts	Mitigation Measures	Institutional Responsibility	Cost Estimate ($)
Operational Period	Noise from transmission lines and associated substations	Noise could exceed 70 dB(A) at site boundary	Locate facility 70–100 m from nearest receptor; walls, fencing, and/or greenbelt to provide partial noise barrier	AEGCL	Nil: noise impacts avoided at design stage
	Domestic wastewater from substations and storage yards	BOD, fecal coliform contamination in groundwater and surface water	Primary treatment if needed	AEGCL to include in design. Contractors to build to specification	Nil: no incremental cost
	Wastes from transformer replacement (scrap metal, possible oils with PCB)	Potential soil and groundwater contamination	Secure on-site storage, or off-site disposal at licensed facility	AEGCL has primary responsibility. Disposal / treatment vendors have secondary responsibility	Treatment / disposal of PCBs estimated at maximum $500 / ton
Operational Period (continued)	Air emissions from equipment using CFCs and halons (e.g. fire suppression systems)	Minor GHG releases to atmosphere	Replace equipment with non-CFC and non-halon equipment; dispose in accordance with GOI standards	AEGCL has primary responsibility. Disposal / treatment vendors have secondary responsibility	Cost included in design and construction budget (see Table 5.5)
	Garbage from substations and storage yards; process waste or scrap waste	Potential soil and groundwater contamination	Dispose at on-or off-site facilities approved by APCB	AEGCL and solid waste system operators	Recurring cost estimated at less than $1000 per month

APCB = Assam Pollution Control Board, BOD = biochemical oxygen demand, CFC = chlorofluorocarbons, dB(A) = decibel acoustic, GHG = greenhouse gases, NO_2 = nitrogen dioxide, NO_x = nitrogen oxides, PCB = polychlorinated biphenyl, SO_2 = sulfur dioxide, SPM = suspended particulate matter.
Source: Asian Development Bank assessment

4.4 Potential Cumulative and Induced Effects

137. The proposed investment program does have potential cumulative and induced effects, which are considered largely positive. Direct impacts result from acquisition of right-of-way and land for transmission lines and substations. Indirect impacts include increased air emissions from a new thermal power plant at Bongaigaon, possible increases in air and water pollution loads from new industrial development, and possible increases in groundwater withdrawal for irrigation as electricity supplies increase. These potential impacts are expected to be minimal. Computer modeling conducted for the power plant EIA concluded that ambient air quality standards will be met in the Bongaigaon area after the new power plant becomes operational. New industrial development is being concentrated in designated industrial zones and is subject to environmental assessment requirements and regulation by MOEF, ADEF, and APCB, with an overall development objective of meeting ambient environmental standards. Groundwater withdrawal is currently about 22% of identified reserves; therefore there is ample margin for increasing groundwater utilization over the long term.

138. Positive effects will result from improvements in power system efficiency: the transmission system efficiency improvements will result in energy savings of at least 171,000 MWh per year, with corresponding GHG emissions reduction estimated to be 68,400 tons CO_2-equivalent per year.[25] The Project will reduce reliance on captive diesel-fired power generation units used by industrial and commercial facilities. Railway electrification will be expanded from the western Assam border at Srirampur to Guwahati, further reducing diesel fuel consumption.

139. Indirect effects include: (i) expansion of the power generation base (facilitated by the transmission and distribution system investments); (ii) increased investment in energy efficiency; (iii) economic growth related to improved power supplies; and (iv) reallocation of government funding away from loss-incurring utility operations and toward social investment in education, health, water supply, and sanitation.

140. Transmission lines will evacuate power from 2 new power plants: a 100 MW combined cycle gas turbine plant at Namrup, and a 3 x 250 MW coal-fired plant at Bongaigaon. Clean energy technologies employed at Namrup will offset partially emissions from the new thermal power plant at Bongaigaon. Additional hydropower development in the North East region will more than offset the incremental emissions from the new plant at Bongaigaon. The EIA reports for the Namrup and Bongaigaon power plants have been reviewed by the ADB project team. Associated facilities and cumulative and induced impacts are summarized in Appendix 4.

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[25] The India Northeast Region Grid, which includes Assam, has the lowest GHG emissions factor of the 5 regional grids: 0.42 tons CO_2eq/MWh vs. an average of about 0.8 tons CO_2eq/Mwh for the other grids.

CHAPTER - 5

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN AND INSTITUTIONAL REQUIREMENTS

CHAPTER – 5

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN AND INSTITUTIONAL REQUIREMENTS

5.0 Introduction

141. The Environmental Management Plan (EMP) includes:

(i) Summary of potential impacts (see Chapter 4),
(ii) Mitigation measures (see Chapter 4),
(iii) Description of monitoring programs and parameters (section 5.1),
(iv) Public consultation activities (section 5.2);
(v) Description of responsibilities and authorities for mitigation and monitoring requirements (section 5.3),
(vi) Description of responsibilities for reporting and review (section 5.4),
(vii) Work plan (section 5.5),
(viii) Procurement plan (section 5.6);
(ix) Preliminary cost estimates (section 5.7); and
(x) Mechanisms for feedback and adjustment (section 5.8).

142. The EMP will be updated during the project inception stage and will be updated afterward if necessary based on field conditions, construction contractor performance, and stakeholder feedback.

5.1 Description of Monitoring Programs and Parameters

143. Table 5.1 presents the provisions for environmental monitoring. Monitoring activities made be modified during implementation depending on contractor performance. If field inspections and monitoring indicate good environmental performance, then successive monitoring intensity and frequency made be reduced. Conversely, if environmental performance is less than expected, the ESMC will recommend corrective measures and monitoring activities will be adjusted accordingly to resolve any problems.

Table 5.1: Minimum Provisions for Environmental Monitoring[26]

Project Stage	Mitigation Measure	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Pre-construction	Route survey to define alternative alignments	Possible encroachment on reserved forests	All transmission and substation sites	Field mapping with Global Positioning System (GPS) equipment	1-time survey to finalize design	AEGCL / PMU through route survey contractor	n/a
Construction	Dust, equipment emissions, erosion, and noise control Waste management	Incorporation of appropriate clauses in construction contracts	All construction contracts for all substation and transmission sites	Field inspection to ensure that appropriate measures are implemented and facilities are installed	1 time per month	AEGCL and PMU to include in bidding documents. ADB to verify through review of bidding documents. [27]	To be included in construction contract (see Table 5.5)
	Dust, equipment emissions, and erosion control Waste management	Suspended particulate matter (SPM) Noise Water: pH, dissolved oxygen (DO), biochemical oxygen	All substation sites and selected transmission lines.	"Grab" samples for air and water Spot check for noise using portable monitoring device Spot check for	Every 6 months, beginning with initial activity, for total of 18 months Monitoring will be extended if	Contractors to implement, PMU staff to provide oversight via regular field inspections; ADB to audit during project review	See details in Table 5.5

[26] Monitoring of issues related to compensation of landowners for land acquisition will be included in the resettlement plan.
[27] ADB will review documents and provide "no objection" at each stage of bidding, contract evaluation, and contract award.

Project Stage	Mitigation Measure	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
		demand (BOD), total suspended solids (TSS), hydrocarbons and PCBs[28] Solid waste generation and disposal		solid waste generation and disposal	necessary Spot checks for solid waste activities	missions AEGCL has responsibility for solid waste management	
Operations and Maintenance	Dust, equipment emissions, and erosion control Waste management	Same parameters as during construction period	All substations and transmission lines.	Spot checks based on visual inspections and any complaints	As necessary based on inspections and complaints	AEGCL through PMU ADB to audit during project review missions	See Table 5.5

Source: Asian Development Bank assessment.

Note:

ADB = Asian Development Bank, AEGCL = Assam Electricity Grid Corporation Ltd., BOD = biochemical oxygen demand, DO = dissolved oxygen, PCB = polychlorinated biphenyls, PMU = project management unit, SPM = suspended particulate matter, TSS = total suspended solids

[28] These parameters should be monitored if warranted based on visual observations or complaints.

5.2 Public Consultation Activities

144. Public consultation and stakeholders' participation is an important device for successful planning and implementation of any development investment program. The aim of the public consultation is not only to make the people aware about the developmental activities being undertaken in their locality but, also, to incorporate their views for making a sustainable plan during the design to the successful completion of the project. Various consultations with all stakeholders at different stage of the project preparation were undertaken and issues related to local needs, environment, problem and prospects of resettlement, compensation options etc. were discussed. The project will therefore ensure that the affected people and other stakeholders are informed, consulted, and allowed to participate actively in the development process. This will be done throughout the project cycle i.e. project preparation, implementation, and monitoring of project results and impacts.

5.2.1 Consultations at Project Level

145. Consultations process has been initiated during the concept stage of the investment program and will be continuing during the entire project cycle. Consultations have been initiated with various stakeholders such as government officials, ASEB's officials (EA) both at head quarters and project level and especially with the officials of the existing PMU. However, additional consultations were also carried out, as part of the continuous participation during the execution of the environment and social/ resettlement study. The consultations involved individual interviews, informal discussions and focus group discussions (FGDs) with the community. The individual consultations involved the census survey of approximately 26 affected households who are supposed to lose some of their agricultural land. The views and the detailed assessment of the likely impact have been collected by a door-to door- questionnaire survey. Additionally, approximately 100 households have been consulted by administering a environmental/socio-economic questionnaire to know about the environment impact and general socio-economics of the proposed investment program.

146. As part of the community participation, FGDs were conducted at various substations site where the community people were involved to share their views on the proposed investment program. The consultations conducted at various places are: (i) Nagaon substation (11 February 2009) with 26 participants, (ii) Sonarie substation (12 Feb 2009) with 10 participants, (iii) Dibrugarh substation (13 February 2009) with 11 participants, (iv) Matia substation (10 February 2009) with 13 participants), (iv) Kamakhya substation (19 February 2009) with 10 participants, (v) Sonapur substation (18 February 2009) with 8 participants), (v) Amin Gaon substation (21 February 2009) with 10 participants), (vii) Kamalpur substation (21 February 2009) with 5 participants and (viii) Sualkachi (February-March, 2009) with 23 participants. The participants involved in the consultation process are affected persons, village leaders, farmers, women, tribal people and other stake holders.

147. Additional consultations were undertaken during the route survey work in 2009 as noted below.

Name of Transmission Line	Approx. Length (Km)	Dates of Consultation
Salakathi (BTPS) – Rangia 220 kV D/C Line: for new Rangia 220/132 kV Substation.	180	18th, 19th,20th & 21st April
Double Circuit LILO Line of 220 kV D/C Samaguri – Sarusajai Line at new Sonapur 220/132/33 kV Substation	20	21st March
Mariani - Namrup 220 kV S/C Line on D/C Towers	140	23rd. 24th , 25th & 26th March
Double Circuit LILO Line of 132 kV D/C Chandrapur – Kahilipara/Narangi Line at new Sonapur 220/132/33 kV Substation	25	22nd March
Samaguri - Nagaon 132 kV S/C Line on D/C Towers: for new Nagaon 132/33 kV Substation	25	5th April
Single Circuit LILO Line of 132 kV S/C Jorhat– Bokakhat Line at new Jorhat (West) 132/33 kV Substation	5	30th March
Single Circuit LILO Line of 132 kV D/C Lakwa– Namrup Line at new Sonari 132/33 kV Substation	7	27th March
Single Circuit LILO Line of 132 kV S/C Namrup– Tinsukia Line at new Bordubi 132/33 kV Substation	6	1st April
Double Circuit LILO Line of 132 kV D/C Rangia – Sishugram/Kahilipara Line at new Kamalpur 132/33 kV Substation	15	7th April
Tinsukia - Rupai 132 kV S/C Line on D/C Towers: for new Rupai 132/33 kV Substation	30	1st -2nd April
Single Circuit LILO Line of 132	5	4th April

Name of Transmission Line	Approx. Length (Km)	Dates of Consultation
kV S/C Dibrugarh – Moran Line at Khanikar 132/33 kV Substation.		
Agia - Matia 132 kV S/C Line on D/C Towers: for new Matia (Dudhnoi) 132/33 kV Substation	35	10th & 11th April

148. Further consultations were undertaken in 2010 for Tranche 2 components as noted below.

Date	Project Component / Venue	Number of Participants	Issues Discussed / Remarks
28 January 2010	Kamakhya S/S	14	– Awareness about the project and environmental pollution – Benefits of the projects – Social and Environmental problems in the region – Presence of environmental sensitive areas in the region – Health and safety issues – Compensation payment mechanism initiatives for minimal environmental/social impacts – Presence of Indigenous People – Likely participation of the people for the future project implementation
29 January 2010	Sonabil S/S	10	
01 February 2010	Hailakandi S/S	12	
13 March 2010	Bilasipara S/S	20	

149. Following points were taken in to account while conducting the public consultations as major objectives.

- Disseminating information on the project to the stakeholders.
- Gaining a better understanding of existing environmental conditions.
- Helping the stakeholders contribute meaningfully to the Project design.
- Gaining greater trust with the Project Proponent and support for the Project.
- Reducing potential conflicts and substantial delays.
- Helping recognize possible alternatives.
- Ensuring the sustainability of the Project.

- Identify and assess major economic and social characteristics of the villages to enable effective planning and implementation.
- Examine APs' opinions on health safety issues during the construction and selection garbage materials or the waste materials.
- Identify levels and extent of community participation in project implementation and monitoring.
- To establish an understanding for identification of overall developmental goals and benefits of the project.
- To align with the government's policy on right to information.

5.2.2 Methods of Public Consultation

150. Public consultations in the project area were held at various project levels. The following methodology has been adopted for carrying out public consultations in this project:

- Disseminating information and requesting villagers to attend the public consultation meetings at all substations sites.
- Walk over survey and informal discussion with people along the transmission routes.
- Filling up of structured formats for public consultation
- Conducting focused group discussions
- Individual interviews with concerned stake holders.
- Sharing the opinions and preferences of the APs.
- Involving the APs and all other stake holders in decision-making including resettlement plan and environment plan implementation.

5.2.3 Key Findings of the Consultation

151. The key findings of the consultation on various issues are as follows.

- Most of the people are aware about the project because of the existing ADB loan under implementation.
- The proposed investment program, according to the people, will be beneficial to the local community. The EAs consulted and took the informal no objection from the people for the sub stations sites and availability of land during the project preparation. Therefore, People are aware about the project and welcomed the project.
- People consented to cooperate during the project implementation stage.
- Local people opined that adequate cash compensation should be given for land acquisition and for the crop damage as per the market rate.

- Setting up the towers and transmission lines will require some temporary acquisition. Cultivators prefer cash compensation and sufficient prior notification to harvest the crop
- It was advised that project implementation should be planned mostly during the off season in order to avoid the damage.
- APs requested local representation in the Grievance Redress Committee.
- People asked about possible creation of temporary employment opportunities during project construction and later phases of the project.
- People suggested that mechanism for involvement of small local contractor during construction period can be developed by project authority and contractor.
- People suggested that adequate safety measures should be provided such as uninterrupted social life.
- People perceived certain benefits from the proposed investment program, such as improved electricity, good power supply, better irrigation and better living condition, etc.
- Metering should be perfectly right and monitoring of the theft should be initiated by the local people.
- According to the female participants, it has been observed that supply of better electricity through this investment will be more beneficial to the women and children community as the living condition will be improved and people will get more time for entertainment etc.
- There was an appeal from the local people that all the schools and hospitals in the village areas should be compulsorily electrified in the priority basis which will attract more students to join the school.
- According to the farmer crop should be compensated keeping in view the annual yielding and the market rate of the crop.
- All the consultations were very much successful and people showed their interest in the project

152. The detailed issues raised and the feedbacks received from various consultations are summarized in the following Table 5.2.

Table 5.2: Summary of the Public Consultations

Issues Discussed	Participants' Opinion, Comments and Suggestions
General perception about the project and the awareness about the proposed project.	Most of the people are aware about the project
Support of local people for the proposed project?	People assured their full support to the project

Issues Discussed	Participants' Opinion, Comments and Suggestions
Any critical issue or concern by the local people regarding the project?	There is no such specific concern except the suggestions that project should avoid any adverse impact on the villagers especially their religious and cultural entity.
Any criteria you would like to see considered during project design, construction and operation stage?	Identification of the substations should mostly be done on the government land and the routing work should avoid crop season. Villagers want to participate in the construction work of Sub-station and in the operational stage. Sub-station should be maintained with necessary safety measures and it should not create problem to the villagers.
General socio-economic standing: What are the economic activities? Land use, cropping pattern (Seasonal), types of crops, value of the crops, Average land holding size etc.	Most of the villagers depend on agriculture. The cultivation pattern here is seasonal and mostly depends on rain water. Most of the farmer do paddy and wheat cultivation. Average land holding size is 01 Acre. Average price per quintal of Paddy is Rs. 800 and Wheat is Rs. 1500.
Is the land Irrigated and what are the sources of Irrigation?	Irrigation facilities are not adequate in the project area. Villagers mostly depend on the rain water cultivation. They also use river and independent pump station as their source of irrigation for cultivation.
Access to the forest land and the use of the forest land (if any)	People do have the access to the forest in some places however; they don't earn their livelihood from the forest. They sometime use forest, at some places, for collection of fire wood.
What are the main sources of electricity? (write the most used source at top followed by other sources Govt. Grid; Micro hydro Power; Gen set; Solar; Bio-Gas; Battery; Other	The power supply to the village is usually done by the ASEB through its grid.
What is the average amount of electricity used by per households per day (kWh/household).	The average electricity usage in a house per day is 1.5 kWh.
Source of drinking water	Hand Pump (Tube Well)
Loss of residential/commercial structures, if any due to the project	No loss of residential or commercial structures are envisaged due to this project

Issues Discussed	Participants' Opinion, Comments and Suggestions
Loss of community life like any Market Places or community activities to be affected	No loss of community life like, market places or community activity center is envisaged.
Shortage of water for human consumption, irrigation, and other downstream uses? How extensive are they?	Yes, shortage of water for human consumption and irrigation are available for the village people.
Any conflicts on water use rights and social impacts?	No conflicts on water use rights and no social impacts over this issue are expected.
Resettlement and Land acquisition (if foreseen due to setting up of sub-station, distribution/transmission line especially on private land).	Most of the proposed sub-station will be built on the Government land, which has been acquired by AEGCL. However, in some cases there will be some requirement which will be minimal and people are willing to sell land for the development work.
Protected areas (national park, protected forest, religiously sensitive sites, historical or archaeological sites), if any	It may be the case. However, necessary mitigations should be taken during the planning stage to avoid any adverse impact.
Health status, Availability of Hospitals. Is there any chronic disease prevalent in this area and are you aware about HIV/AIDS and STD?	The health status of the villager is good. No such major illness has been observed amongst the villagers except seasonal cold or viral fever. The awareness level of the villager regarding HIV/AIDS and STD is good.
Education Status: Literate, illiterate etc	The literacy rate in the village area is around 80% and 20% is illiterate.
Employment Status: Percentage of employment/ unemployment/ underemployment	In the village area, approximately 30% people are employed, 20% people are under employed and rest 50% people are unemployed.
Migration Pattern (If any), inward or outward	Around 10% people migrate to other districts for work.
Perceived benefits from the project	There will be better power supply for domestic and commercial use. So that the level of efficiency, output and business will grow both in domestic sector as well as commercial sector. Villagers do expect some employment opportunities from this power project.
Perceived losses from the project	No loss or any such fear from this project.
What other organizations of a social nature (NGOs/CBOs/ Civil Society) active in the area?	In the village some NGOs / CBOs / Civil Society is working, they are Kaziranga Wild Life Society, Rupali Sangh, Mohamaya Mohila

Issues Discussed	Participants' Opinion, Comments and Suggestions
Name of these organizations	Goth and Rohino NGO is working for the development of society.
Organization of the village and its structure. Do you have a village committee? What is the decision-making system in your village/Who are the decision makers on community related issues in your village? Are they elected or selected? If elected: By consensus or By majority vote .	Yes, there is village committee in the village. The members of the village committee are selected on the basis of proposal given by the villagers. Gram Panchayat along with village committee takes decision about the village. Head of the village is selected by consensus.
Is this consultation useful? Comments	This consultation is very useful to them because they got the knowledge and awareness about the project. Villagers feel that Government is asking their permission to build this station and simultaneously taking them into confidence.
Will there be likely involvement of local people in the implementation of the project?	Yes, they would like to be involved in this project during the time of implementation and maintenance.

Source: AEGCL and ADB safeguards consultants

5.2.4 NGO Consultations and Contined Public Consultations

153. Consultations have been initiated with the local NGOs in order to gather their views on the proposed investment program and to involve them in the planning and implementation stage. An active NGO dealing with the environment issues, 'Kaziranga Wildlife Society,' has been consulted on 9th February 2009 along with the ASEB's official to gather their feedback and consensus on the project. They are pro-active and assured their full cooperation when needed.

154. The consultation process, by the EAs, will continue over the entire period of project implementation. Consultations during RP and EMP implementation will be carried out. The other round of consultations will occur when compensation and assistance are provided and actual resettlement begins. Information disclosure is pursued for effective implementation and timely execution of the safeguards issues. The PMU will provide information on R&R policies and features of the Resettlement Plan. For continued consultations, the following steps are envisaged in the project:

5.2.5 Public Disclosure

155. The safeguards documents will be disclosed to the affected people. For the benefit of the community in general and APs in particular, the RP, RF and IPDF will be translated into Hindi (or Assamese) to be made available at following offices.

- District Magistrate Office of the concerned project affected area;
- PMU; and
- Village community/ Panchayat Office where there is resettlement impact.

156. During implementation and monitoring, information will be disseminated to project affected persons and other key stakeholders in appropriate ways. This information will be prepared in local language (Assamese) by the EAs as required, describing the main project features including the entitlement framework. Consultation will be carried out in ways appropriate for cultural, gender-based, and other differences among the stakeholders. Where groups or individuals have different views/opinions, particular emphasis will be laid on the views and needs of the vulnerable groups. The initial project notice was published in the Gazette. The draft Resettlement Plan, the Resettlement Framework (RF) and IPDF will be disclosed by concerned EAs to the affected persons and other stakeholders before the Management Review Meeting (MRM) of ADB. This will further be placed in the web site of AEGCL (or ASEB). The information on resettlement will also be posted on the resettlement website of ADB.

157. The summary IEE and EMP for the Project will be translated into local language (Hindi or Assamese) and made available to the public. A grievance redress mechanism has been established by ASEB: a special office has been set up at the ASEB headquarters, which is open on a regular schedule to receive visitors with complaints. The GOI Right to Information Act (2005) provides an additional legal channel for affected to people to obtain information about the proposed Project.

5.3 Description of Responsibilities for Mitigation and Monitoring Requirements

158. The PMU will assume primary responsibility for the environmental assessment as well as implementation of EMPs for their respective components. At the direction of the ASEB, an environmental and social management cell (ESMC), responsible for environment, resettlement, and any other social development obligations, will be established at the PMU.[29]

159. The ESMC will be physically located at ASEB's Head Office (along with the PMU). Proposed staffing includes:

(i) A senior level engineer from the PMU will be assigned as head of the ESMC; as this officer will perform double duty, this will be a full-time position;

[29] ADB advises that all EAs develop in-house capability for environmental, health, and safety (EHS) program consistent with international best practices. The EHS program should include accounting for environmental benefits resulting from investment projects. Presently, ASEB does not have a separate environmental cell for dealing with the various environmental issues.

(ii) A land acquisition officer will be assigned from ASEB; this will require full-time effort in initial project stages, and may transition to a part-time effort as implementation proceeds;

(iii) A senior level personnel officer will be assigned from ASEB; this may be a part-time position; and

(iv) A senior level civil engineer with experience in soil management, water management, land profiling and contouring, etc. will be assigned from ASEB (or AEGCL or one of the other power utility companies); this position will be designated as "environmental engineer" and will require full-time effort in initial project stages, and may transition to a part-time effort as implementation proceeds.

160. In order to maintain an unbiased social and environmental management effort, personnel from the AEGCL Transmission and Transformation Wing should not be included in the ESMC.

161. Project-funded consulting services will be mobilized as necessary to assist in initial operations, to ensure that the ESMC will be self-sufficient for EMP implementation. Consultants will assist ESMC in preparation and delivery of progress reports, and preparation of environmental assessment for subsequent tranches. Additional third-party services may be employed by the AEGCL as necessary.

162. The ESMC should provide guidance to the project personnel to adopt good environmental practices. The duties of the social and environmental management cell will at least include:

(i) Monitoring and implementation of mitigation measures;
(ii) Prepare and implement environment policy guidelines and environmental good practices;
(iii) Advising and coordinating regional environmental management cells activity towards effective environment management;
(iv) Prepare environment and safety manual for the operation of sub-station;
(v) Liaise with the Ministry of Environment Forest (MoEF), New Delhi, ADEF, and APCB as needed to solve environment related issues during project implementation;
(vi) Advise the project planning cell of the AEGCL Transmission Wing on environmental and social issues during route selection of the alignment at the planning stage to avoid negative environmental impact;
(vii) Provide Training and awareness on environmental and social issues related to power transmission projects to the project staff.
(viii) Prepare environmental management reports every 6 months

163. Construction contractors will be responsible for implementation of mitigation measures during the construction stage. The environmental engineer of the ESMC will ensure inclusion of environmental mitigation measures in contract documents.

ADB will (i) review and endorse IEEs and EMPs before contracts are finalized and work begins; (ii) review monitoring reports; and (iii) officially disclose environmental safeguards documents on its Web site as necessary in accordance with the ADB *Public Communications Policy* (2005).[30]

164. AEGCL through the PMU will be responsible for internal monitoring of EMP implementation, and will forward semiannual progress reports to GOA, GOI, and ADB. The reports will cover EMP implementation with attention to compliance and any needed corrective actions. On-going consultation measures will be incorporated in the EMP. Project documents will be made publicly available in accordance with the ADB *Public Communications Policy 2005*. AEGCL is in the process of creating a new website, which will include provisions for public disclosure and public comments.

165. Table 5.3 presents the overall EMP. In the pre-construction stage, AEGCL and the Project Management Unit (PMU) will have primary responsibility for planning and design activities that will minimize project impacts. Detailed design work will follow the recommendations of the IEE and EMP. AEGCL will certify that the detailed designs comply with IEE and EMP recommendations before contracts can be made effective.

166. During construction, the construction contractors will have primary responsibility for EMP implementation, with oversight and monitoring conducted by PMU and the ESMC.

167. Assam state agencies, mainly ADEF and APCB, will exercise regulatory oversight. ADB will also conduct periodic review missions which will include field visits and auditing of EMP implementation.

[30] ADB. 2005 *Public Communications Policy.* Manila

Table 5.3: Preliminary Environmental Management Plan

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Pre-construction Stage				
Substation and transmission line design: location of substations and transmission towers; and transmission line alignment and design	Long-term exposure to nearby residents and safety related risks, including exposure to electromagnetic interference	Setback of dwellings to overhead line route determined accordance with design standards for voltage, capacity, and frequency. Buffer zones and access control at substations. Transmission line design to comply with the limits of electromagnetic interference from overhead power lines	Design by AEGCL Design review by implementation consultants	"No objection" from ADB prior to contract tender and awards
	Impact on water bodies, wetlands, and forests	Design practice is to avoid sensitive areas due to incremental engineering, environmental, and administrative costs. Route survey will determine alternative transmission alignments around any sensitive areas. Substations will not be sited in any environmentally sensitive areas.	Route survey contractor, environmental consultants	AEGCL, ADB
	Social inequities	Route selection to avoid existing settlements and minimize disturbance of agricultural land	Route survey contractor, social safeguards consultants	AEGCL, ADB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Possible encroachment into reserved forests and / or environmentally-sensitive areas	Loss of ecological values/ damage to precious species	Approximately 5 km of transmission right-of-way in reserved forests may be necessary (route survey to confirm). AEGCL will obtain prior approval from Assam Department of Environment and Forests (ADEF) and Ministry of Environment and Forests (MOEF), with agreed reforestation activities for mitigation.	AEGCL and route survey contractor	ADEF, MOEF
Temporary encroachment into farmland	Temporary loss of agricultural productivity during construction	Farmers to be compensated for the loss as per GOI guidelines and Resettlement Plan (RP, prepared with assistance of safeguards consultants). ADB to monitor AEGCL implementation of RP.	AEGCL and social safeguards consultants	ADB
Noise control	Nuisance to neighbouring properties	Setbacks to be designed according to horizontal and vertical separation guidelines for substations and transmission lines to ensure noise will not be a nuisance. Noise to be limited to 70 dB(A) at site boundaries.	AEGCL / PMU	APCB
Interference with drainage patterns/ Irrigation channels	Flooding hazards/loss of agricultural production	Design and siting of towers and substations to avoid and/or minimize surface water interference.	AEGCL and route survey contractor	ADEF, APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Fire /explosion safety and control design	Exposure hazards to workers, nearby buildings and residents, flora, and fauna	Right-of-way (RoW) and vertical clearance will be defined to avoid fire hazards due to short circuiting in forests. Fire safety design and provision of fire fighting equipment consistent with Indian Standards. Non-CFC and non-Halon systems to be procured. Budget included in Detailed Project Report (DPR) cost estimate	AEGCL / PMU / ESMC	ADEF, APCB
Construction Phase				
Equipment layout and installation	Noise and vibrations	Construction techniques and machinery selection to minimize noise and vibration. Noise to be limited to 70 dB(A) at site boundaries. Environmental and Social Management Cell (ESMC) of Project Management Unit (PMU) to conduct periodic spot checks to confirm compliance.	Construction Contractors PMU / ESMC	APCB
Physical construction (manual labor)	Disturbance of farming activity	Construction activities on cropping land timed to avoid disturbance of field crops (within one month of harvest wherever possible).	Construction Contractors PMU / ESMC	ADEF
Mechanized construction	Noise, vibration, and operator safety, equipment wear and tear	Construction equipment to be maintained in accordance with GOI standards for noise exposure to workers. Equipment to be shut off when not in use.	Construction Contractors PMU / ESMC	APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Substation site clearance	Removal of trees and other vegetation	Marking of trees / vegetation to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance.	Construction Contractors PMU / ESMC	ADEF
Trimming / cutting of trees within Right-of-Way (RoW)	Fire hazards Temporary loss of vegetation and permanent deforestation	Trees allowed growing up to a height within the RoW by maintaining adequate clearance between the top of tree and the conductor as per transmission design standards. Trees that can survive pruning to comply with vertical and horizontal separation requirements should be pruned instead of cleared. Felled trees and other cleared or pruned vegetation to be disposed of as authorized by ADEF	Construction Contractors PMU / ESMC	ADEF
Wood / vegetation harvesting	Temporary loss of vegetation and permanent deforestation	Construction workers prohibited from harvesting wood in the project area (apart from locally employed staff continuing current legal activities).	Construction Contractors PMU / ESMC	ADEF

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Temporary encroachment into farmland	Temporary loss of agricultural productivity	Use existing access roads wherever possible. Ensure existing irrigation facilities are maintained in working condition. Protect /preserve topsoil and reinstate after construction completed. Repair /reinstate any damaged bunds after construction completed.	Construction Contractors PMU / ESMC	APCB
	Social inequities	Compensation for temporary loss in agricultural production as per Resettlement Plan	AEGCL / PMU	ADB
Ambient air quality and noise nuisance	Dust, exhaust, and noise emissions from construction equipment. Noise impacts on nearby communities and construction workers	Controlled construction activities and maintenance of machineries, timely scheduling of construction activities to avoid nuisance to nearby communities. Construction equipment to meet GOI emissions and noise control standards. Water sprays to be used for dust control as necessary.	Construction contractors	PMU / ESMC APCB
Storage of chemicals and any hazardous materials	Possible spills resulting in contamination land, water, and air	Fuel and any other hazardous materials will be securely stored to prevent spills. Contractors to provide spill response kit in accordance with Material Safety Data Sheets for chemicals and hazardous materials	Construction contractors	PMU / ESMC APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Construction equipment maintenance	Industrial wastewater from maintenance may cause petroleum and detergent contamination of soil and water	Construction contractor to provide sedimentation and biological treatment if necessary.	Construction contractors	PMU / ESMC APCB
Construction schedules	Noise nuisance to neighbouring properties	Construction activities only undertaken during the day and local communities informed of the construction schedule.	Construction Contractors	PMU / ESMC APCB
Health and safety	Injury and sickness of workers and members of the public	Contract provisions specifying minimum sanitation, health, and safety requirements for construction camps. Contractor to prepare and implement a health and safety plan including worker training and daily/weekly briefings.	Construction Contractors PMU / ESMC	APCB, Assam Department of Health
Provision of sanitary facilities for construction workers	Potential BOD and faecal coliform contamination	Construction workforce facilities to include proper sanitation, water supply, and waste disposal facilities, including primary treatment for domestic sewage and secure disposal of domestic solid wastes.	Construction contractors	PMU / ESMC APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Construction waste management	Air, soil, and water pollution due to inadequate management and control	Construction wastes to be managed in accordance with GOI standards and industry best practices. Waste lubricating oils to be disposed or recycled off-site by licensed service companies. Transformer oils to be returned to vendors via existing arrangements for transformer maintenance. Scrap steel and other salvaged materials to be auctioned and disposed / recycled off-site by licensed vendors.	Construction contractors	PMU / ESMC APCB ADB Review Missions
Construction stage monitoring	Inadequate monitoring and mitigation leading to environmental impairments at and around project sites	Training of AEGCL / PMU / ESMC staff.	PMU / ESMC and safeguards consultants	APCB
		Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements. [See air, noise, and water monitoring program in Table 5.1 and EMP budget in Tables 5.5a and 5.5.b.]		
		Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	PMU / ESMC and safeguards consultants	APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Operation and Maintenance Phase				
Design and location of substations and transmission towers.	Exposure to noise and other safety related risks	Setback of dwellings to overhead line route designed in accordance with transmission design standards. Buffer zones and access control at substations. Transmission line design to comply with the limits of electromagnetic interference from overhead power lines	AEGCL / PMU / ESMC	APCB
Provision of staff/workers health and safety during operations	Injury and sickness of staff and other workers. Soil and water contamination from domestic wastewater and solid wastes	Best design practices will be followed to minimise hazards. Housekeeping and maintenance at substations in accordance with GOI standards and industry best practice.	AEGCL / PMU / ESMC	APCB, Assam Department of Health
		Safety awareness for staff		
		Preparation of fire emergency action plan and relevant staff training		
		Provide adequate sanitation, water supply, wastewater control, and solid waste management facilities		
Electric Shock Hazards	Injury/mortality to staff and public	Careful design using appropriate technologies to minimise hazards	AEGCL / PMU / ESMC	APCB, Assam Department of Health
		Barriers to prevent climbing on/dismantling of transmission towers		

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
		Appropriate warning signs on facilities		
		Electricity safety awareness raising in project areas		
Fire and explosion hazards	Loss of property and heath hazards	Maintaining adequate clearance from conductors and ground vegetation, adequate safety design in substations to avoid fire hazards due to flashovers	AEGCL / PMU / ESMC	APCB
Industrial waste generation	Potential soil and water contamination	Wastes to be managed in accordance with GOI standards and industry best practices. Waste lubricating oils to be disposed or recycled off-site by licensed service companies. Transformer oils to be returned to vendors via existing arrangements for transformer maintenance. Scrap steel and other salvaged materials to be auctioned and disposed / recycled off-site by licensed vendors.	AEGCL / PMU / ESMC	APCB ADB Review Missions
Transmission line maintenance	Exposure to electromagnetic interference	Transmission line design to comply with the limits of electromagnetic interference from overhead power lines	AEGCL / PMU / ESMC	ADEF, APCB

Project Activity	Environmental Issues	Management / Mitigation Measures	Responsibility	
			Planning and Implementation	Supervision and Monitoring
Operations and maintenance staff skills	Potential lost-time accidents and injuries, and possible environmental losses of various types	Adequate training in O&M to all relevant staff of transmission line and substation maintenance crews.	AEGCL / PMU / ESMC	APCB, other relevant State agencies
		Preparation and training in the use of O&M manuals and standard operating practices.		
Periodic environmental monitoring	Inadequate monitoring may result in diminished ecological and social values	AEGCL/PMU staff to receive training in environmental monitoring of project operations and maintenance activities.	AEGCL / PMU / ESMC	ADB Review Missions

ADB= Asian Development Bank, AEGCL = Assam Electricity Grid Corporation Ltd., ADEF = Assam Department of Environment and Forests, APCB = Assam Pollution Control Board, CFC = chlorofluorocarbons, dB(A) = decibel acoustic, DPR = Detailed Project Report, ESMC =Environmental and Social Management Cell, GOA = Government of Assam, GOI = Government of India, PMU = Project Management Unit, RoW = right of way

5.4 Description of Responsibilities for Reporting and Review

168. AEGCL through the PMU will be responsible for internal monitoring of EMP implementation, and will forward semiannual progress reports to GOA, GOI, and ADB. The reports will cover EMP implementation with attention to compliance and any needed corrective actions. On-going consultation measures will be incorporated in the EMP.

169. Project documents will be made publicly available in accordance with the ADB *Public Communications Policy 2005*. AEGCL is in the process of creating a new website, which will include provisions for public disclosure and public comments.

170. Construction contractors will be responsible for implementation of mitigation measures during the construction stage. The environmental engineer of the ESMC will ensure inclusion of environmental mitigation measures in contract documents, including reporting requirements.

171. ADB will (i) review and endorse IEEs and EMPs before contracts are finalized and work begins; (ii) review monitoring reports; and (iii) officially disclose environmental safeguards documents on its Web site as necessary in accordance with the ADB *Public Communications Policy* (2005).[31] ADB will conduct periodic project review missions during project implementation. At least one review mission per year will be fielded, and additional missions may be scheduled if necessary.

5.5 Work Plan

172. The preliminary work plan for the EMP is presented in Table 5.4 (see following page; this general schedule will be followed for each tranche of the transmission system expansion). Pre-construction mitigation measures to be completed as soon as possible include route selection and possible regulatory approval for access to reserved forests. These activities are expected to be completed by the 2nd quarter (Q2) of the first year of the project.

173. PMU / ESMC will conduct monthly field inspections to ensure that contractors are implementing the required mitigation measures. Monitoring will be conducted with support of environmental consulting services during years 1 and 2, and afterward by the ESMC staff. The ESMC and environmental consultants will develop a training program during the first quarter of year 1and conduct the training activities by the 3rd quarter of year 1.

[31] ADB. 2005 *Public Communications Policy.* Manila

Table 5.4: EMP Work Plan																				
Activity	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Mitigation Measures																				
Route Selection (AEGCL / PMU)	XX																			
Forest Access (AEGCL)	XX	XX																		
Dust, Noise, Wastewater and Solid Waste Control (PMU / ESMC monthly inspections)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Monitoring																				
Air, Noise, Water (by consultants)		X		X		X		X												
Air, Noise, Water (by ESMC staff)										X		X		X		X		X		X
Solid Waste Management (ESMC quarterly inspections)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Institutional Strengthening and Training																				
Environmental and Social Awareness for AEGCL staff	x		x																	
Environment, Health, and Safety Manual development	x		x																	

5.6 Environmentally Responsible Procurement Plan

174. The transmission system project will have minimal environmental impacts as discussed in the preceding sections. Given the nature of the design and technologies to be employed, a separate environmentally responsible procurement plan is not required. However, ADB guidelines for environmentally responsible procurement will be followed. The specific procurement provisions are:

(i) New transformers shall not contain polychlorinated biphenyls (PCBs);
(ii) Circuit breakers containing sulfur hexafluoride (SF6) will be avoided to the extent possible within design constraints;
(iii) New fire protection systems will be free of halons and chloro-fluorocarbons; and
(iv) Procurement shall not include any items on ADB's "negative list."

5.7 Preliminary Cost Estimates

175. Estimated costs for monitoring measures, including sampling and analyses, are provided in Tables 5.5a and 5.5b. The Design and Construction costs are taken from the DPR cost estimates, and should be reflected in construction contracts. The environmental services costs are estimated based on EMP requirements, and should be reflected in the budget for loan-funded consulting services. Cost estimates will be updated after the first year of project activity.

TABLE 5.5A: Estimated Costs for Tranche 1 EMP Implementation

Environment Monitoring items	Unit	Unit Cost (Rs.)	Tranche 1				
			Transmission Lines (KM - 262)	Sub-Total	Sub-stations (no. 8)	Sub-Total	Total
Ambient Air monitoring	Sample	8500	660	5610000	8	68000	5678000
Ambient Noise monitoring	Sample	4000	660	2640000	8	32000	2672000
Drinking water monitoring at camp site (both surface & ground water)	Sample	7500	660	4950000	8	60000	5010000
						Sub Total A:	13360000
Environmental Training			Lumpsum				720,000

Environment Monitoring items	Unit	Unit Cost (Rs.)	Tranche 1				
			Transmission Lines (KM - 262)	Sub-Total	Sub-stations (no. 8)	Sub-Total	Total
Consultant Services (remuneration)	Month			240000	16		3840000
Consultant Services (per diem)	Month			120000	16		1920000
Consultant Services (transportation)	Month			62400	16		998400
ESMC Staff (8 person-months)	Month			72,000	8		576000
Report/Communication	Lumpsum						240000
						Sub Total B:	8,294,400
						Sub-Total (A+B)	21,654,400
						Contigency 10%	2165440
						Total:	23,819,840

Assumptions

1. Air, Water and Noise sampling/testing at sub-stations and Transmission lines (where ever there is a tower line traversing through a settlement). The cost of the Sampling will be for Air = Rs.8500 per sample, Water = Rs.7500 per sample and Noise = Rs.4000 per sample. Total of 60 samples each (of air, noise, and water) x 4 events. Testing frequency proposed at commencement of construction, and every 6 months afterward for the following 18 months, for a total of 4 testing events.
2. Environmental monitoring and compliance training for ESMC personnel and project staff is estimated at 2 person-months for domestic consultants' @Rs.3,60,000/- per month.
3. Consultant services for total of 4 person-months per monitoring event x 4 events spread over initial 18 month implementation period; domestic consulting @ Rs.2,40,000/-p-m.
4. Per diem and transportation and other costs is @ Rs.1,82,400 pm for a period of 16 months.
5. ESMC Staff to conduct field inspections; 2 people x 4 months during the 18 month project period; 8 person months Rs.72,000/p-m

TABLE 5.5B: Estimated Costs for Tranche 2 EMP Implementation

Environment Monitoring items	Unit	Unit Cost	Tranche 2				
			Transmission Lines (KM - 342)	Sub Total	Sub-stations (no.14)	Sub Total	Total
Ambient Air monitoring	Sample	8500	660	5610000	14	119000	5,729,000
Ambient Noise monitoring	Sample	4000	660	2640000	14	56000	2,696,000
Drinking water monitoring at camp site (both surface & ground water)	Sample	7500	660	4950000	14	105000	5,055,000
						Sub Total A:	13,480,000
Environmental Training	Lumpsum						720,000.00
Consultant Services (remuneration)	Month				240000	16	3840000
Consultant Services (per diem)	Month				120000	16	1920000
Consultant Services (transportation)	Month				62400	16	998400
ESMC Staff (8 person-months)	Month				72000	8	576000
Report/Communication	Lumpsum						240000
						Sub Total B:	8,294,400
						Sub-Total (A+B)	21,774,400
						Contingency 10%	2,177,440
						Total:	23,951,840

Assumptions

1. Air, Water and Noise sampling/testing at sub-stations and Transmission lines (where ever there is a tower line traversing through a settlement). The cost of the Sampling will be for Air = Rs.8500 per sample, Water = Rs.7500 per sample and Noise = Rs.4000 per sample. Total of 60 samples each (of air, noise, and water) x 4 events. Testing frequency proposed at commencement of construction, and every 6 months afterward for the following 18 months, for a total of 4 testing events.

Environment Monitoring items	Unit	Unit Cost	Tranche 2				
			Transmission Lines (KM - 342)	Sub Total	Sub-stations (no.14)	Sub Total	Total
2. Environmental monitoring and compliance training for ESMC personnel and project staff is estimated at 2 person-months for domestic consultants' @Rs.3,60,000/- per month.							
3. Consultant services for total of 4 person-months per monitoring event x 4 events spread over initial 18 month implementation period; domestic consulting @ Rs.2,40,000/-p-m.							
4. Per diem and transportation and other costs is @ Rs.1,82,400 pm for a period of 16 months.							
5. ESMC Staff to conduct field inspections; 2 people x 4 months during the 18 month project period; 8 person months Rs.72,000/p-m							

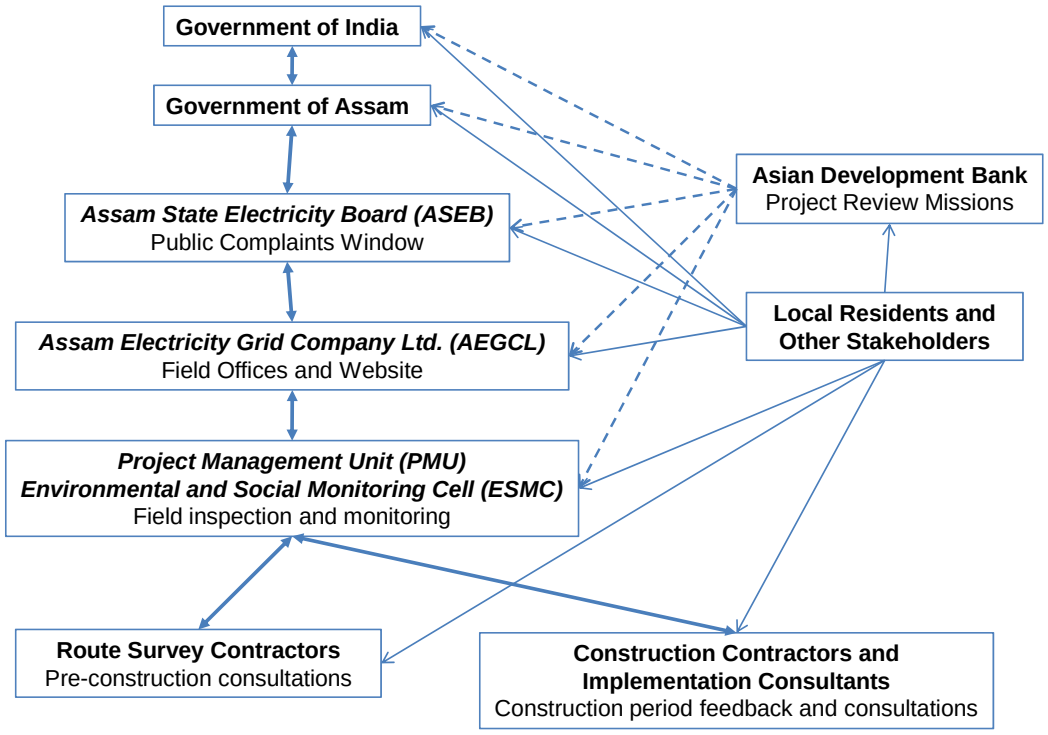
5.8 Mechanisms for Feedback and Adjustment

176. Feedback and adjustment mechanisms are depicted schematically in Figure 5.1 (see following page). The Assam State Electricity Board (ASEB) is the coordinating agency for the ADB investment program, and has fiduciary oversight responsibility for the Assam Electricity Grid Company Ltd. (AEGCL). As the Executing Agency (EA) for the transmission system project, AEGCL will be the primary point of contact for day-to-day project activities and communications. The Project Management Unit (PMU), and the Environmental and Social Monitoring Cell (ESMC) to be established in the PMU will have direct interaction with route survey and construction contractors, as well as local residents and other stakeholders (and *vice versa*).

177. Residents and other stakeholders can communicate directly with contractors, PMU / EMSC, AEGCL, and ASEB. ASEB has an open door policy for fielding complaints and inquiries. AEGCL is creating a new website which will allow for electronic information dissemination and solicitation of stakeholder input. Stakeholders may also communicate with the Government of Assam, Government of India, and ADB, if desired.

178. The ESMC will have responsibility for compiling environmental inquiries and complaints, which will be included in routine monitoring reports. ESMC and PMU will communicate feedback to AEGCL, ASEB, and ADB. Any necessary adjustments to the EMP will be initiated by ESMC and PMU and agreed to by AEGCL, ASEB, and ADB.

Figure 5.1: Feedback and Adjustment



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CHAPTER - 6

FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

CHAPTER – 6

FINDINGS AND RECOMMENDATIONS

6.1 FINDINGS AND RECOMMENDATIONS

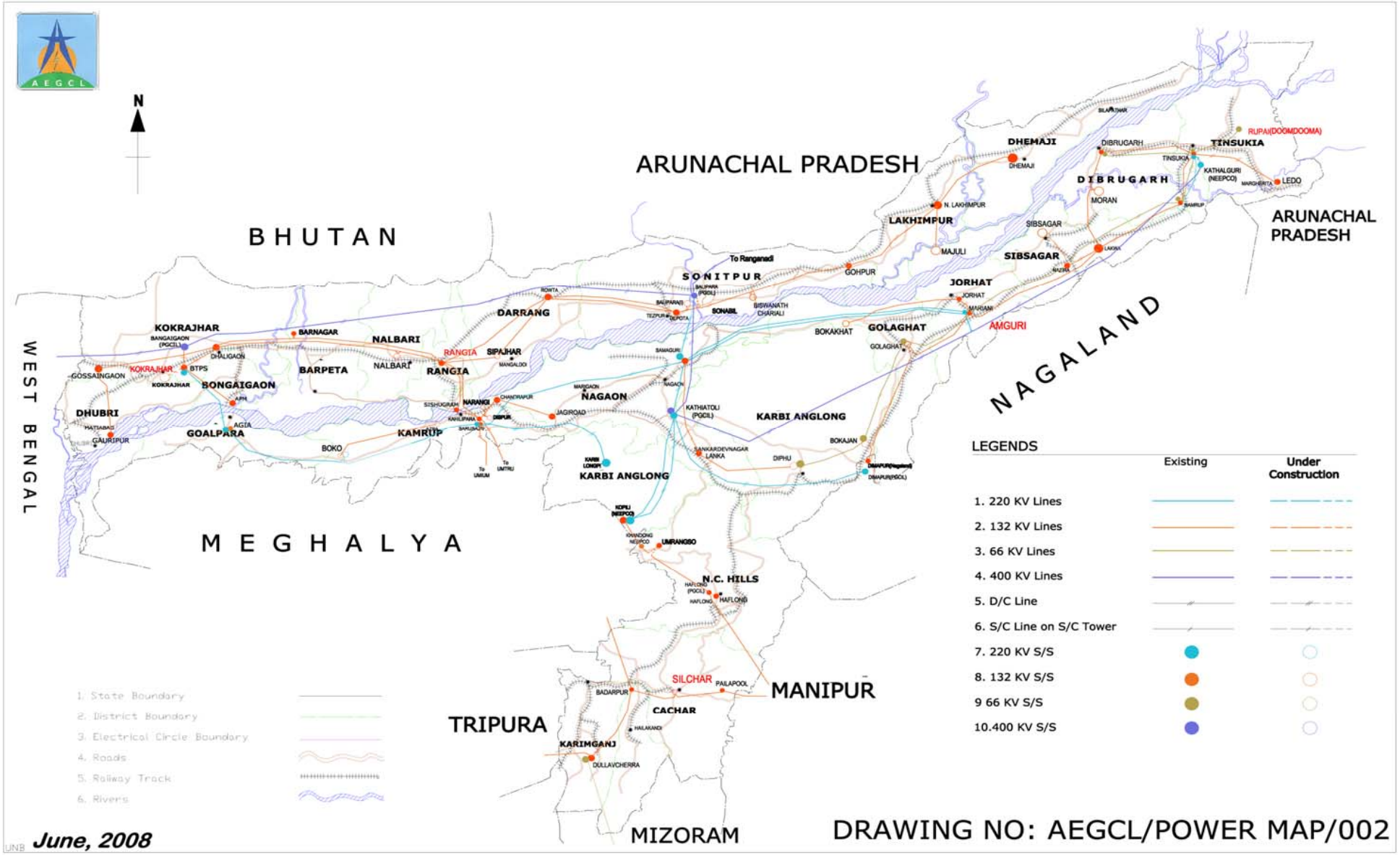
179. The Project has been planned and is being designed with careful attention to environmental and social safeguards issues. Environmentally sensitive areas are avoided as a routine engineering design objective, and potential impacts are minimized during the siting and routing stage. Project components will not be sited in protected areas. Reserved forest areas will be avoided as well. If reserved forest land is required due to technical design constraints, advance clearance by ADEF will be required. ADEF has a built-in mitigation system for such cases. The Project will have minimal environmental impacts during construction and operations. Negative environmental impacts, mainly during construction, are considered temporary and insignificant provided mitigation measures are implemented as detailed in the EMP. The Project will have long term positive impacts arising from improved quality and reliability of electricity supplies.

180. Mitigation and monitoring measures with cost estimates have been developed in the EMP. The EMP will be implemented by the AEGCL and construction contractors, with oversight by ASEB, Assam state regulatory agencies, and ADB. Public consultation has been undertaken during project preparation. ASEB maintains an open-door policy for receiving complaints, and will conduct additional consultations as necessary during project implementation.

6.2 CONCLUSIONS

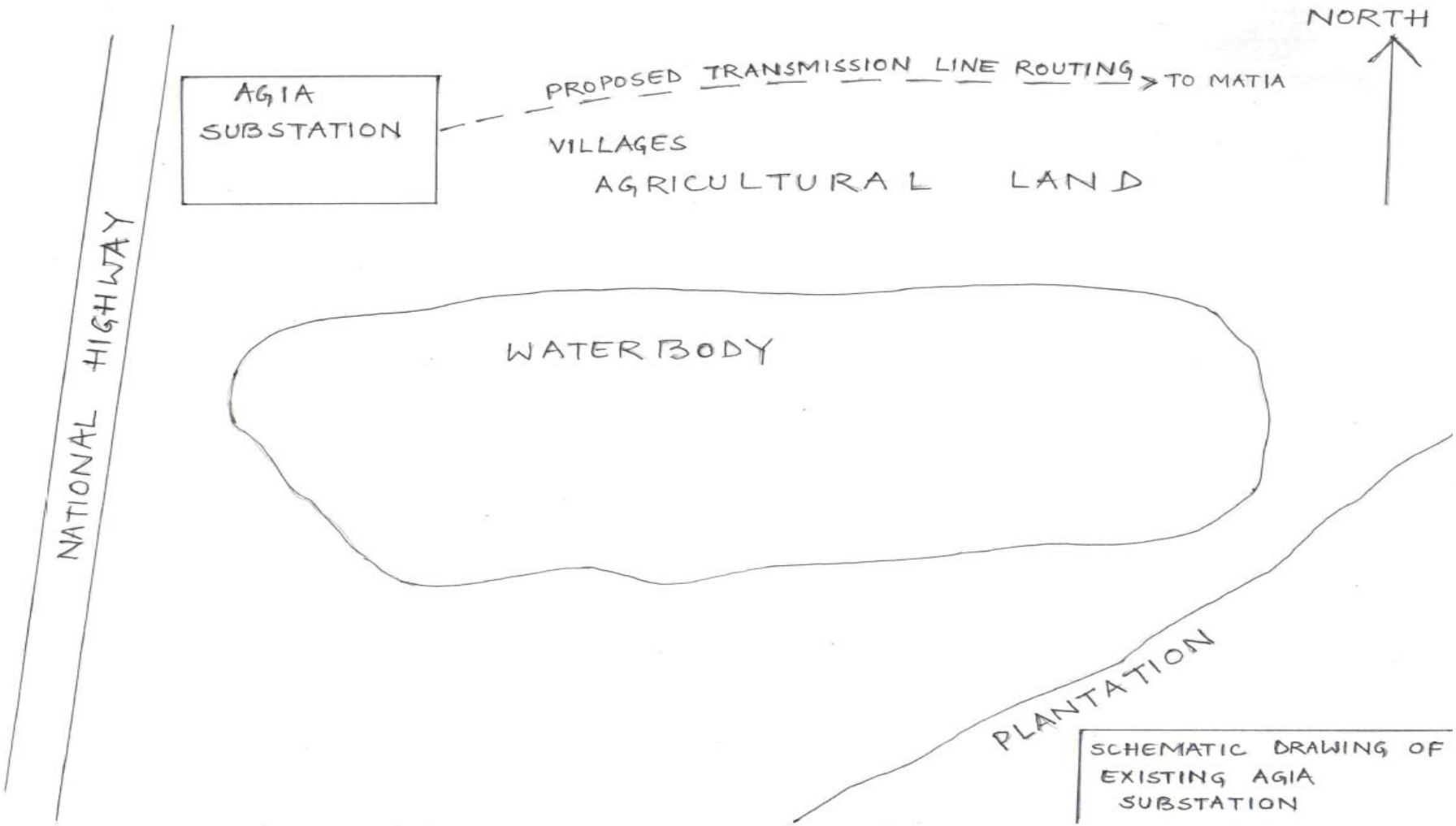
181. None of the Project components are in environmentally sensitive areas. The Project will not result in any long-term significant adverse impacts. Minimal negative environmental impacts are anticipated, mostly during construction. These can be mitigated successfully by implementing the EMP. Environmental and social benefits of the Project and long-term investment program objectives outweigh the negative impacts.

182. Based on environmental assessment activities conducted to date, the Project is confirmed as environmental category B and the IEE, including the EMP, is considered sufficient to meet the environmental assessment requirements of ADB, GOI, and GOA. A full environmental impact assessment study is not required.


AEGCL
N
ARUNACHAL PRADESH
BHUTAN
WEST BENGAL
MEGHALYA
NAGALAND
TRIPURA
MANIPUR
MIZORAM
SONITPUR
LAKHIMPUR
DHEMAJI
DIBRUGARH
TINSUKIA
SIBSAGAR
JORHAT
GOLAGHAT
KARBI ANGLONG
N.C. HILLS
DARRANG
NALBARI
KAMRUP
NAGAON
BARPETA
KOKRAJHAR
DHUBRI
GOALPARA
SONGAIGAON
CACHAR
KARIMGANJ
SILCHAR
AMGURI
To Ranganadi
LEGENDS
Existing
Under Construction
1. 220 KV Lines
2. 132 KV Lines
3. 66 KV Lines
4. 400 KV Lines
5. D/C Line
6. S/C Line on S/C Tower
7. 220 KV S/S
8. 132 KV S/S
9 66 KV S/S
10.400 KV S/S
1. State Boundary
2. District Boundary
3. Electrical Circle Boundary
4. Roads
5. Railway Track
6. Rivers
June, 2008
DRAWING NO: AEGCL/POWER MAP/002

APPENDIX

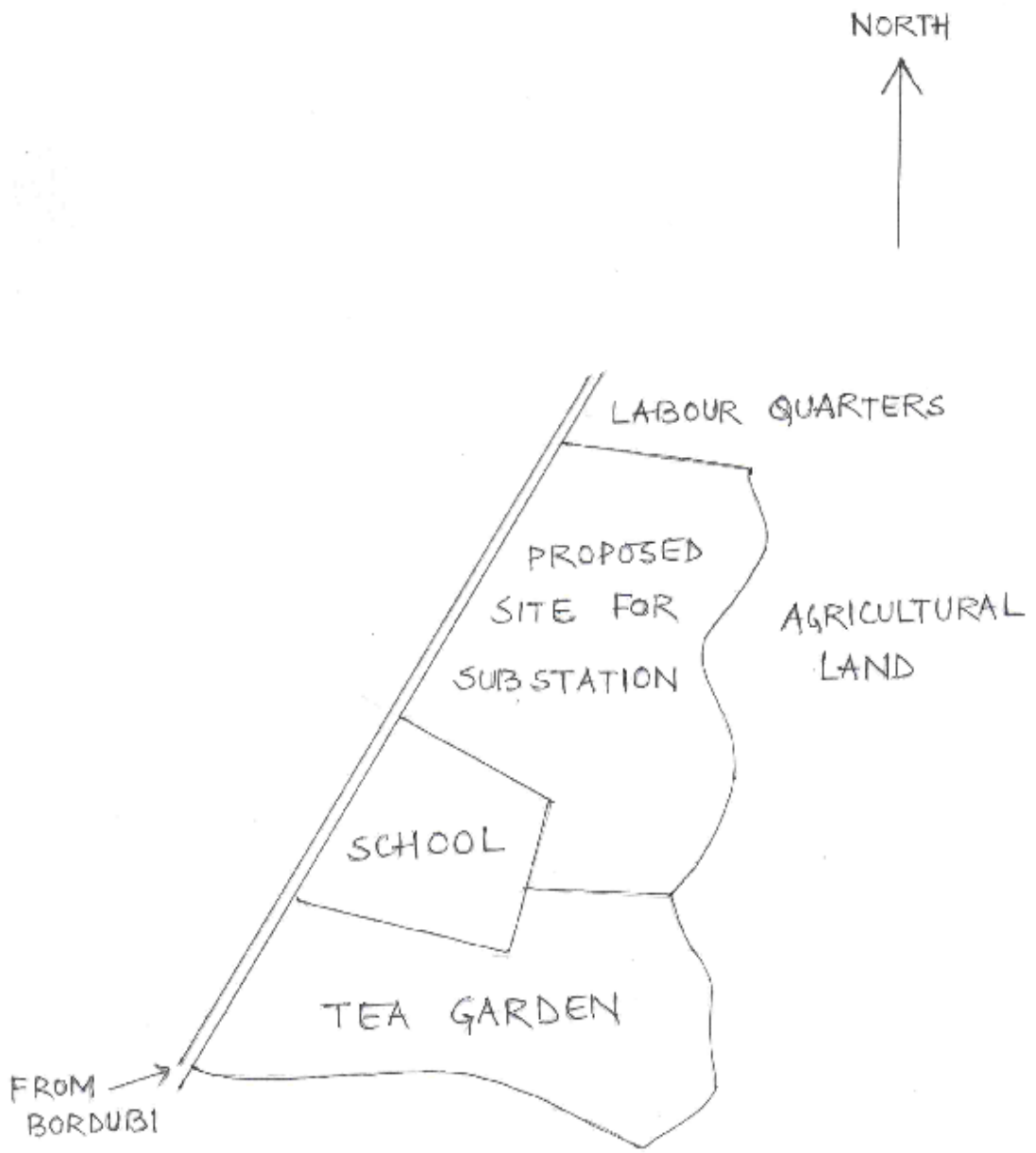
APPENDIX 1


NORTH
AGIA
SUBSTATION
PROPOSED TRANSMISSION LINE ROUTING
TO MATIA
VILLAGES
AGRICULTURAL LAND
NATIONAL HIGHWAY
WATER BODY
PLANTATION
SCHEMATIC DRAWING OF
EXISTING AGIA
SUBSTATION

South-West Side of the Waterbody With Existing Agia Sub-Station in the Background

Closer View of existing Agia Sub-station from South-West side of the Waterbody

Plantation on the South-Eastern direction of the Waterbody

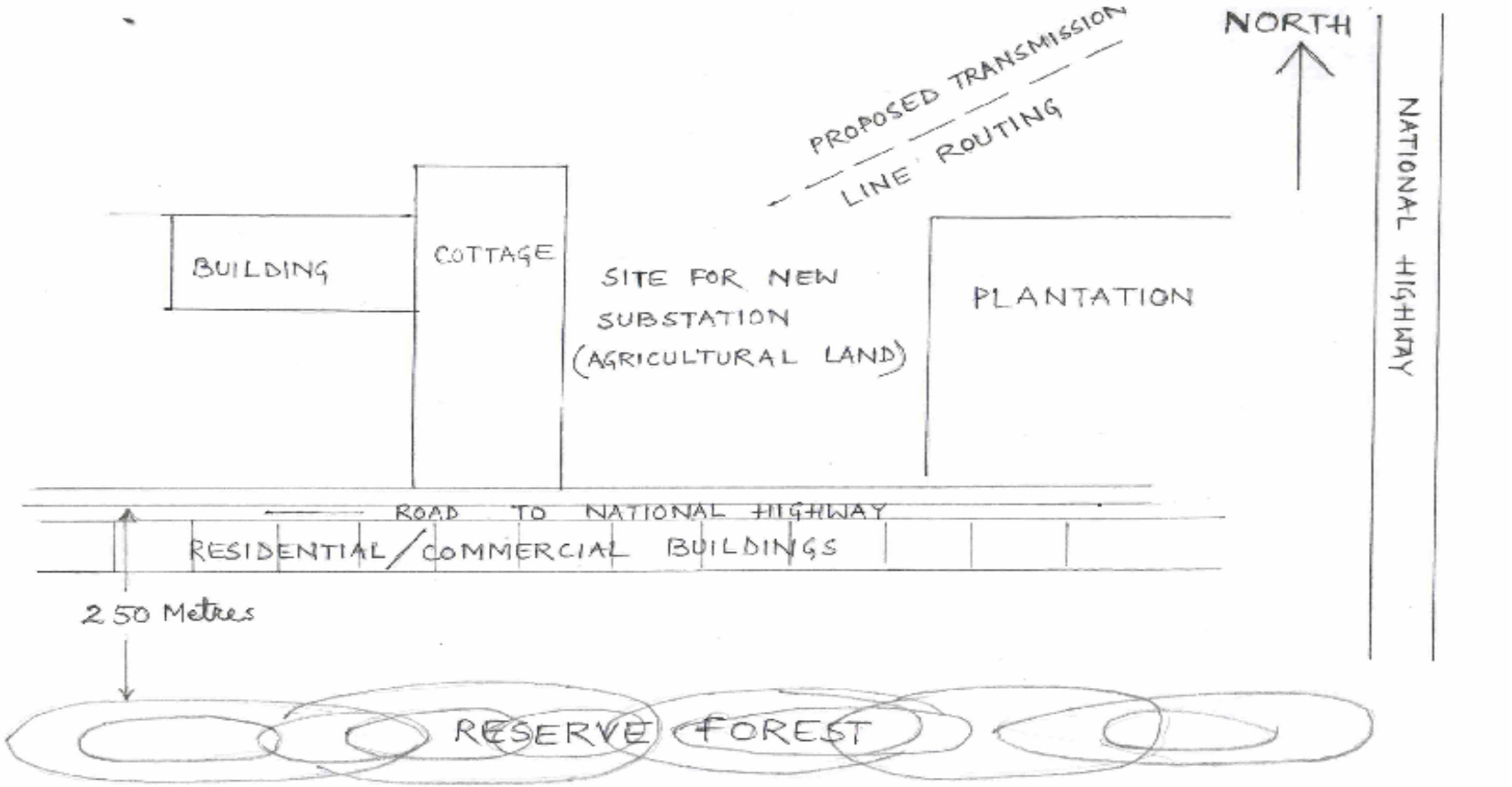


SCHEMATIC DRAWING OF PROPOSED BORDUBI SUBSTATION

Site for Proposed Bordubi Sub-Station on abandoned Tea Garden

Agricultural land on the East of Proposed Bordubi Sub-Station Site

Tea Garden on the South of Proposed Bordubi Sub-Station Site

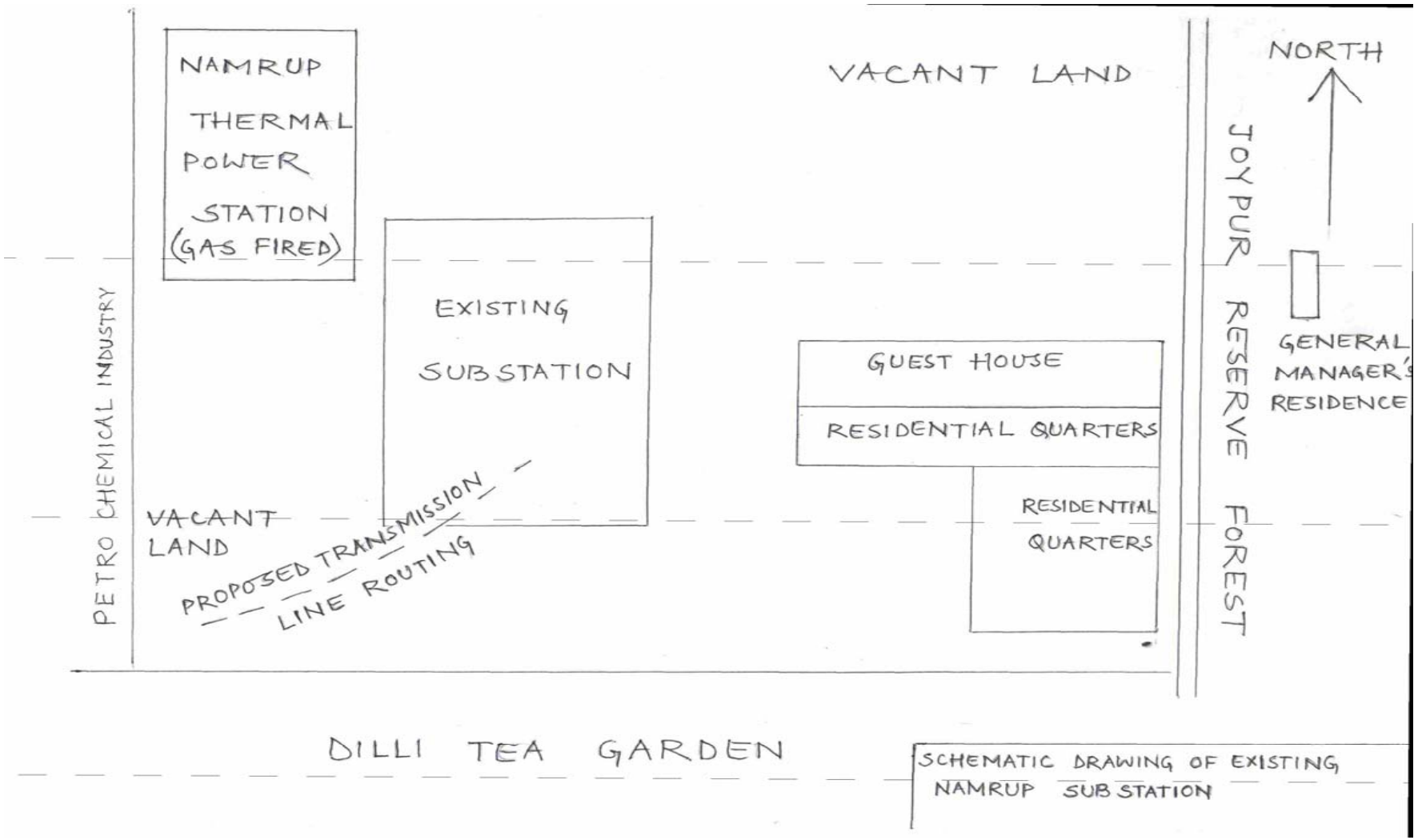


SCHEMATIC DRAWING OF PROPOSED KAMALPUR SUBSTATION

Proposed Kamalpur Sub-Station Site

North-Eastern Edge of the Proposed Kamalpur Sub-Station Site

Reserve Forest 250 metres South of the Road



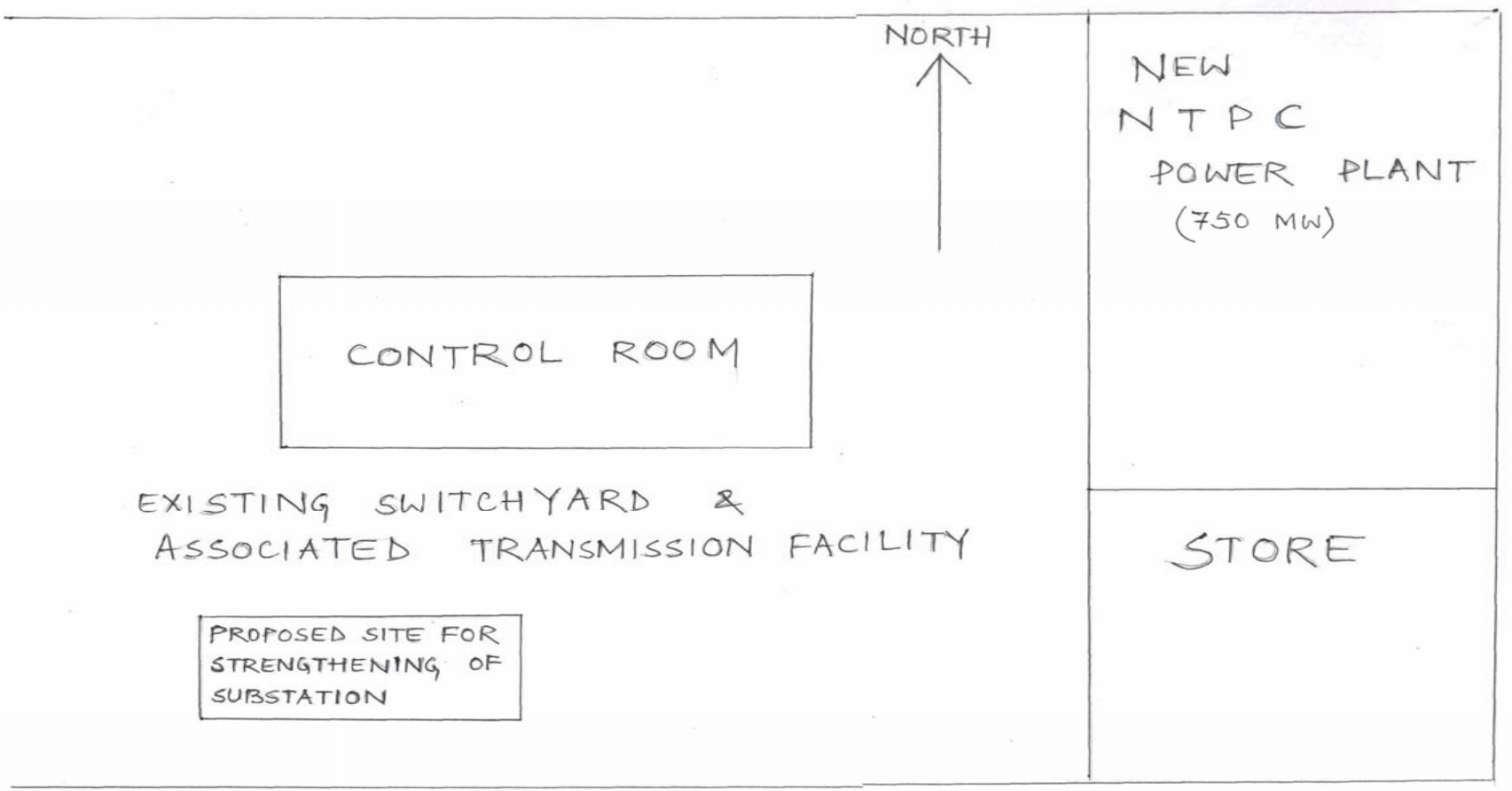
SCHEMATIC DRAWING OF EXISTING
NAMRUP SUB STATION

Existing Namrup Sub-Station from the East Side

Residence of General Manager NamrupThermal Power-Station within the Reserve Forest

Road Forming the Eastern Boundary of NamrupThermal Power-Station with the Reserve Forest

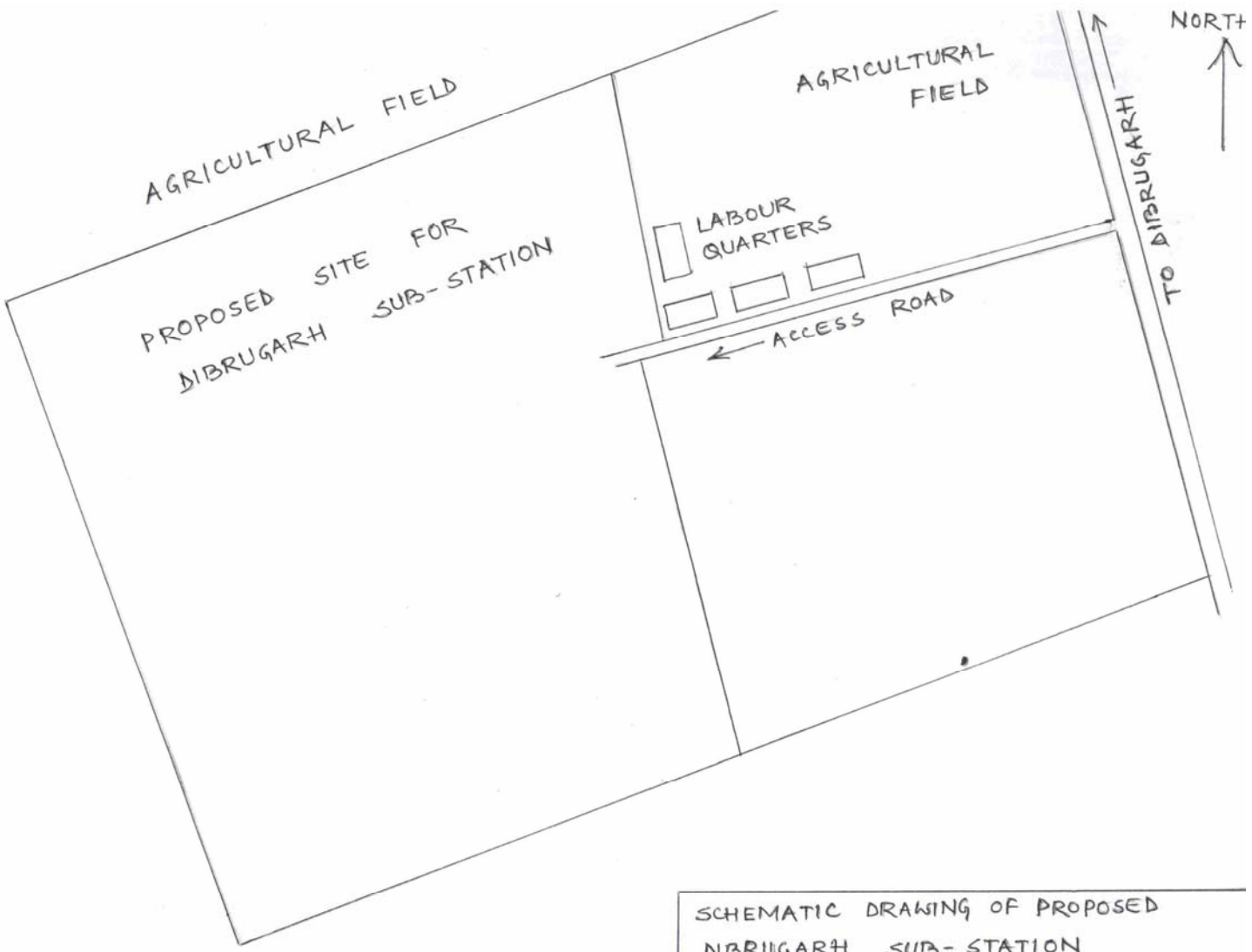
View of the Existing Sub-Station from top of NamrupThermal Power-Station



SCHEMATIC DRAWING OF EXISTING
SALAKATHI SUBSTATION

Existing Sub-Station at Salakathi

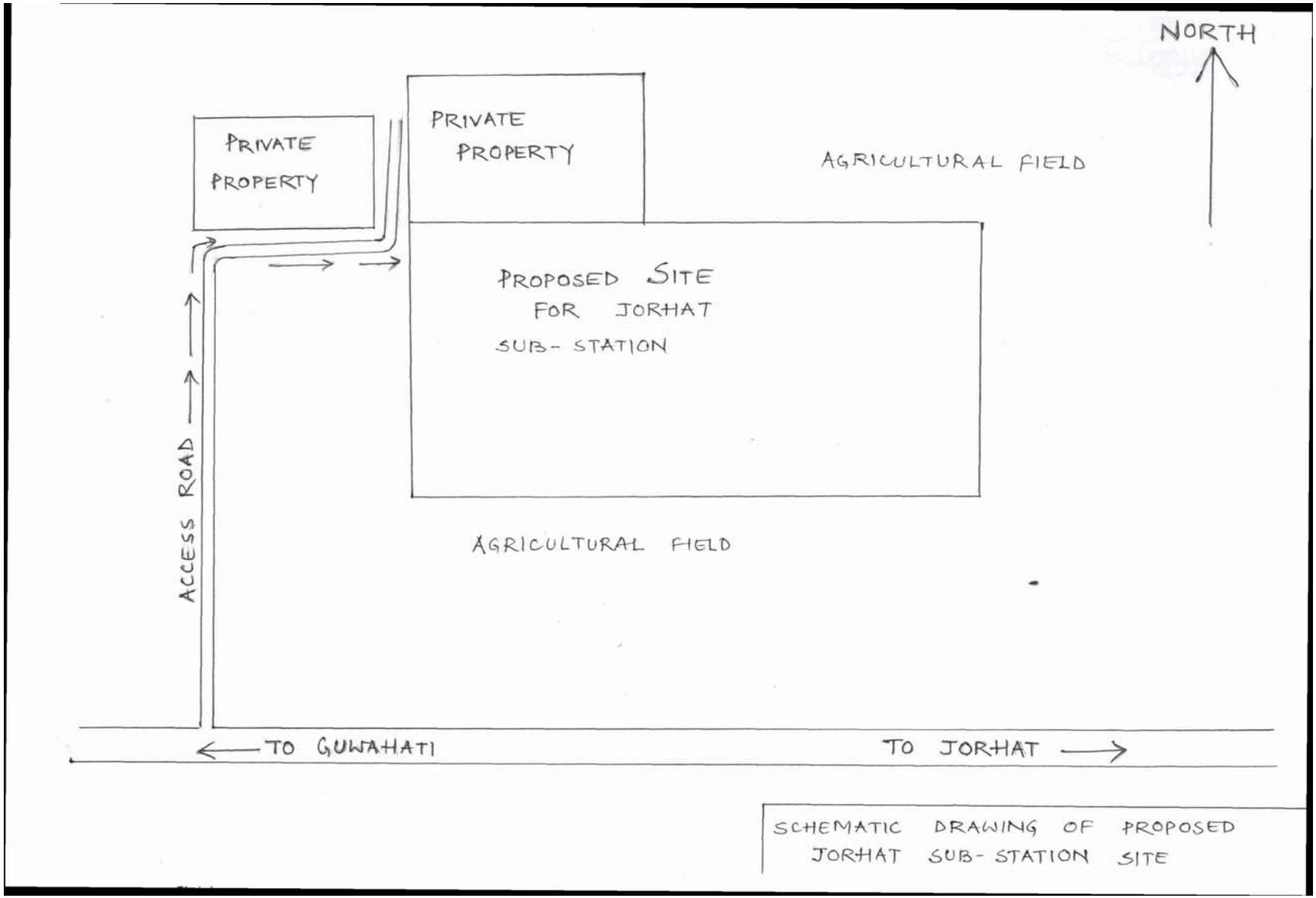
Existing Sub-Station at Salakathi



SCHEMATIC DRAWING OF PROPOSED DIBRUGARH SUB-STATION

Proposed Site for Dibrugarh Sub-Station (Abandoned Tea Garden)

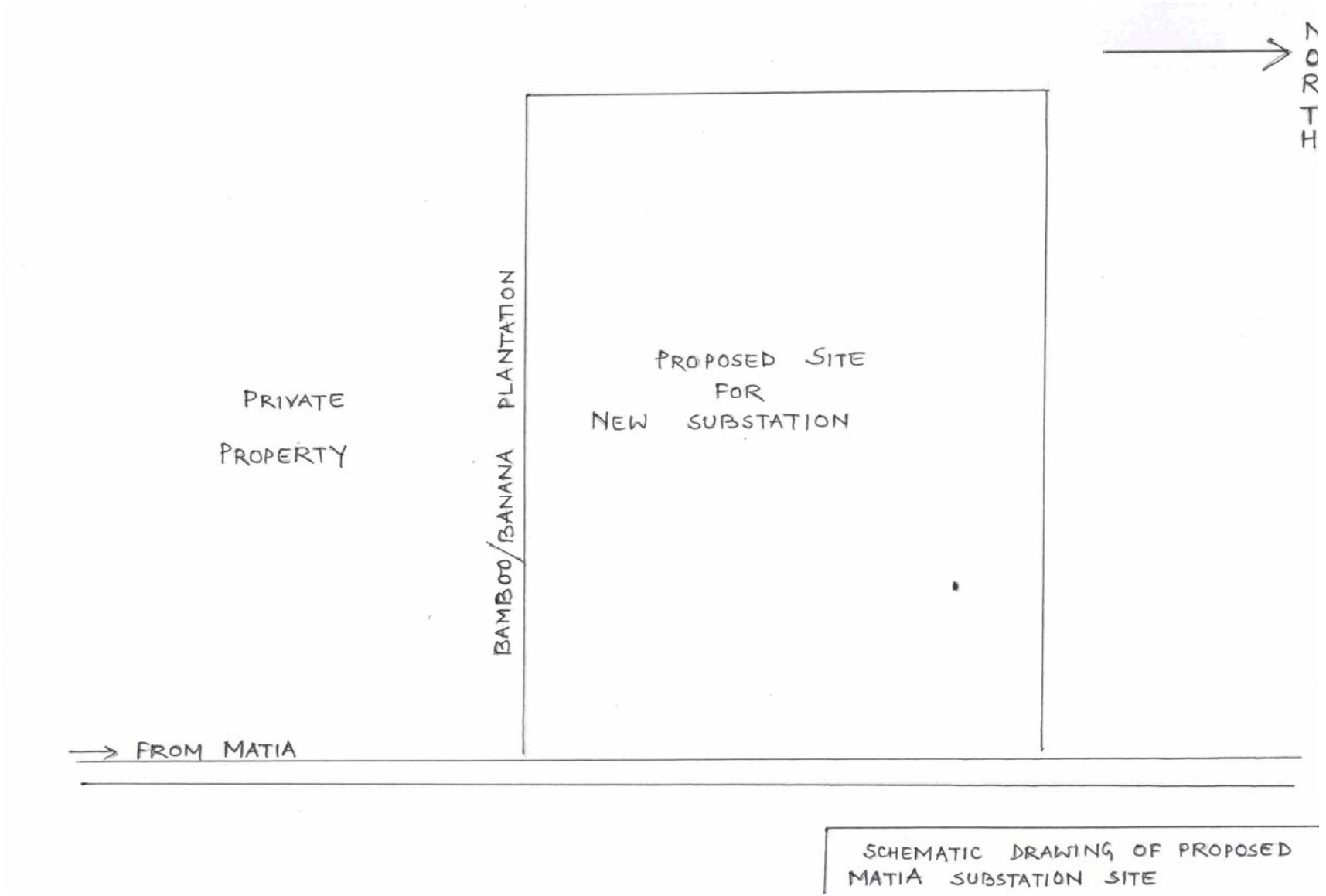
Proposed Site for Dibrugarh Sub-Station(Abandoned Tea Garden)



SCHEMATIC DRAWING OF PROPOSED JORHAT SUB- STATION SITE

Northern Side of Proposed Jorhat Sub-Station

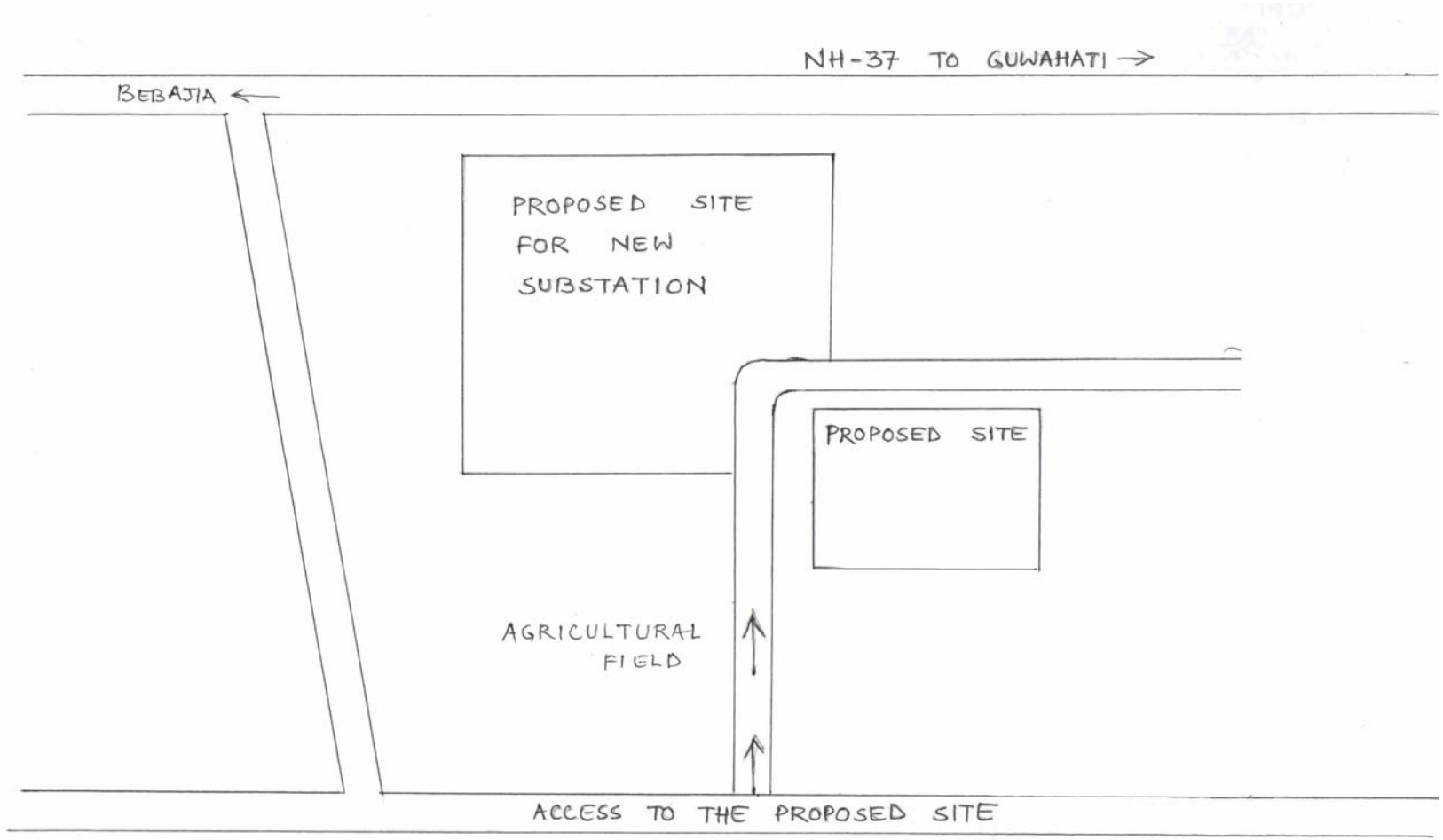
Western Side of Proposed Jorhat Sub-Station



SCHEMATIC DRAWING OF PROPOSED MATIA SUBSTATION SITE

North-West Side of the Proposed Matia Sub-Station Site

Proposed Matia Sub-Station Site



SCHEMATIC DRAWING OF PROPOSED NAGAON SUB-STATION SITE

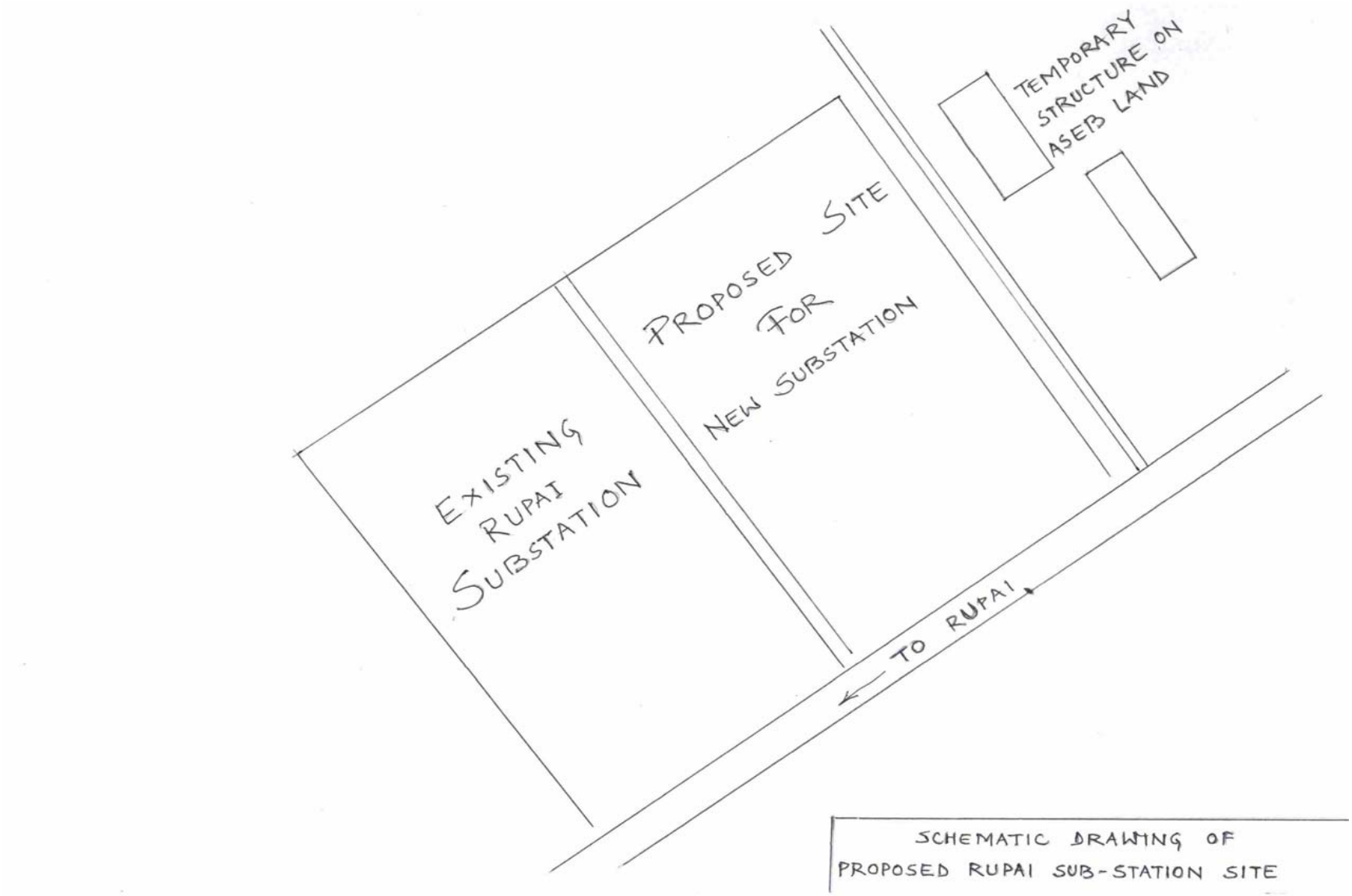
Access to Proposed Nagaon Sub-Station Site

Proposed Nagaon Sub-Station Site

SCHEMATIC DRAWING OF PROPOSED RANGIA SUB-STATION SITE

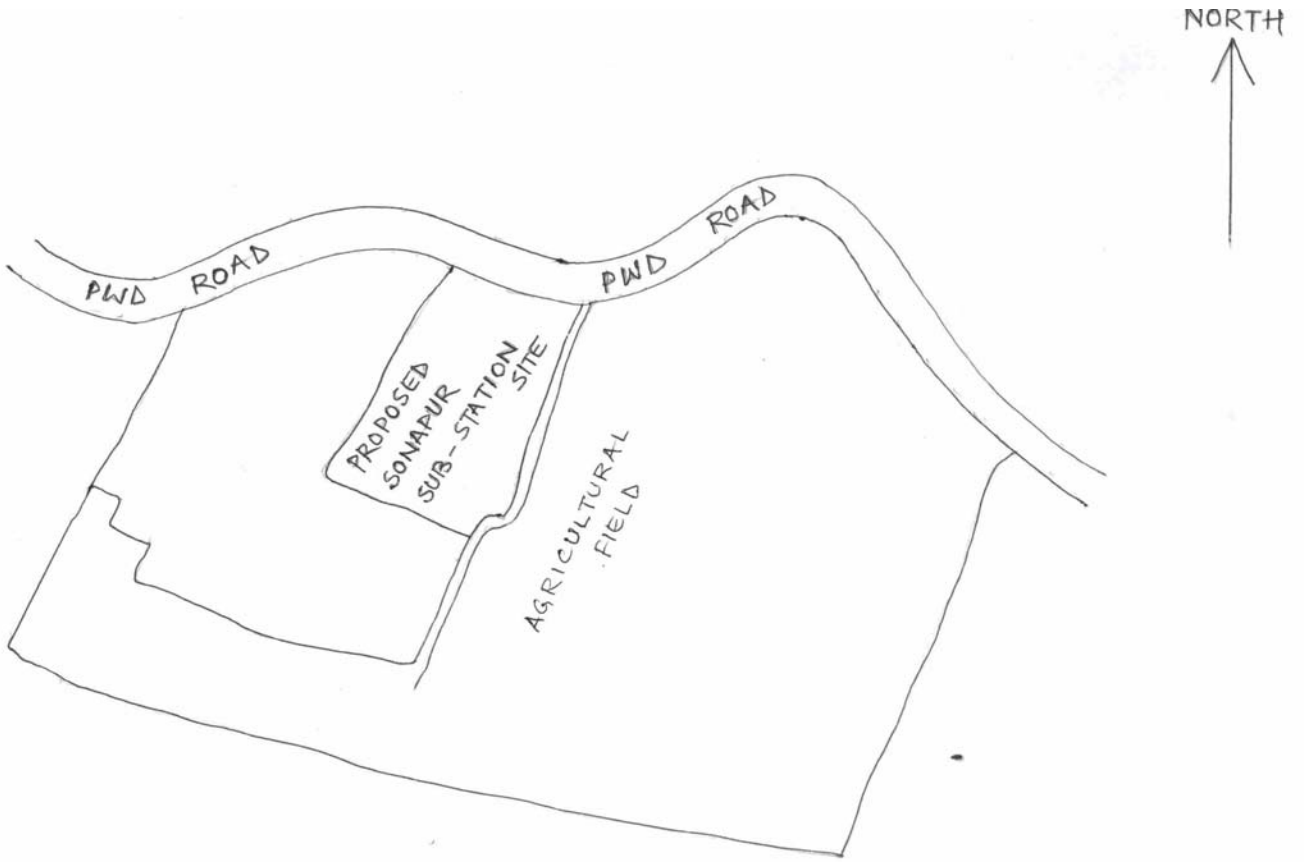
North-Western Side of Proposed Rangia Sub-Station Site

Proposed Rangia Sub-Station Site



SCHEMATIC DRAWING OF
PROPOSED RUPAI SUB-STATION SITE

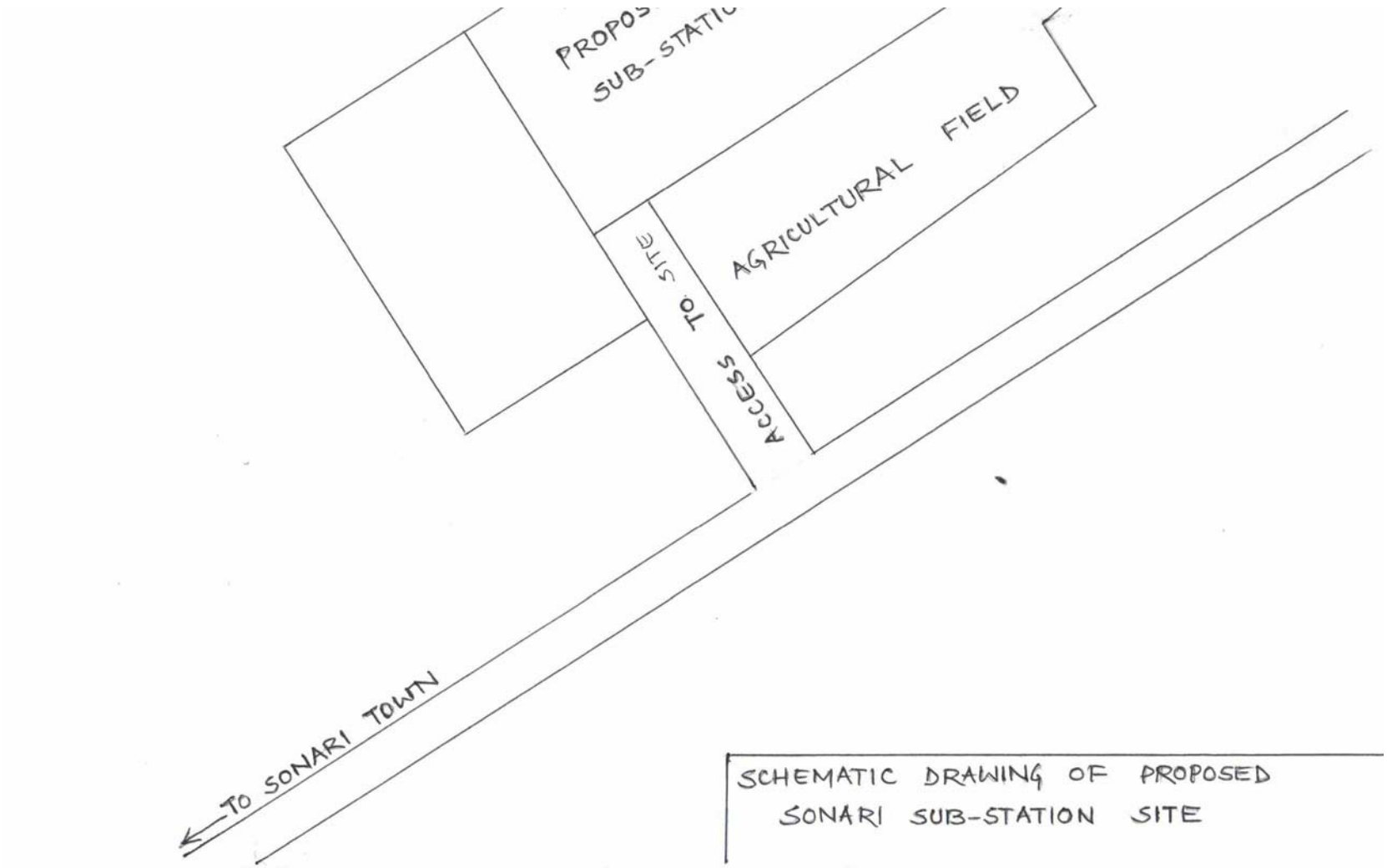
Proposed Rupai Sub-Station Site (Existing Sub-Station is in Background)



SCHEMATIC DRAWING OF
PROPOSED SONAPUR SUB-STATION SITE

Proposed Sonapur Sub-Station Site

South-Eastern Edge of the Proposed Sonapur Sub-Station Site

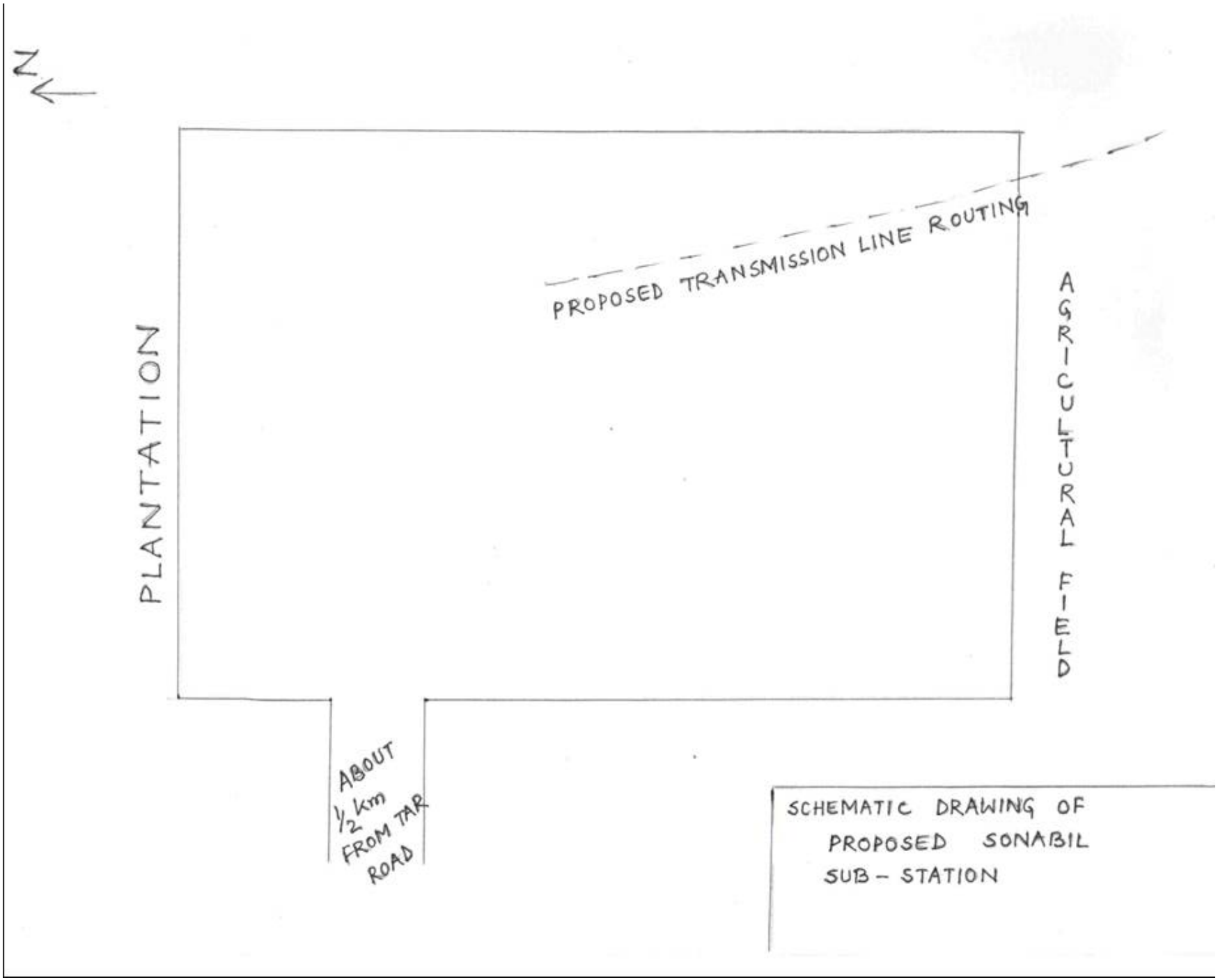


SCHEMATIC DRAWING OF PROPOSED
SONARI SUB-STATION SITE

Access to the Proposed Sonari Sub-Station Site

Proposed Sonari Sub-Station Site (Abandoned Tea Garden)

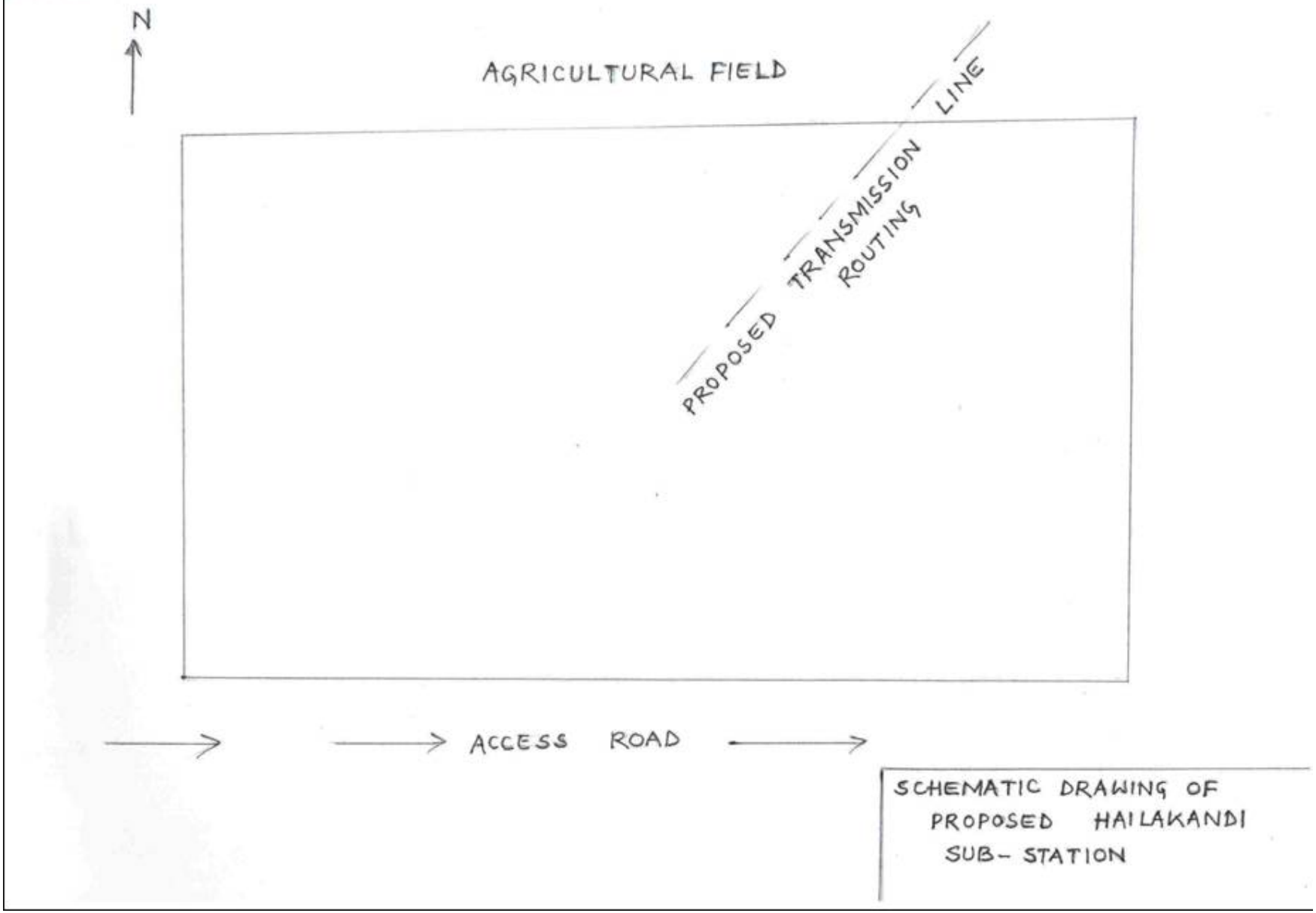
APPENDIX 2


N
PROPOSED TRANSMISSION LINE ROUTING
PLANTATION
AGRICULTURAL FIELD
ABOUT ½ km FROM TAR ROAD
SCHEMATIC DRAWING OF PROPOSED SONABIL SUB – STATION

Plantation on the North Side of the proposed Sub-Station Site

Agricultural Field on the South Side of the proposed Sub-Station Site

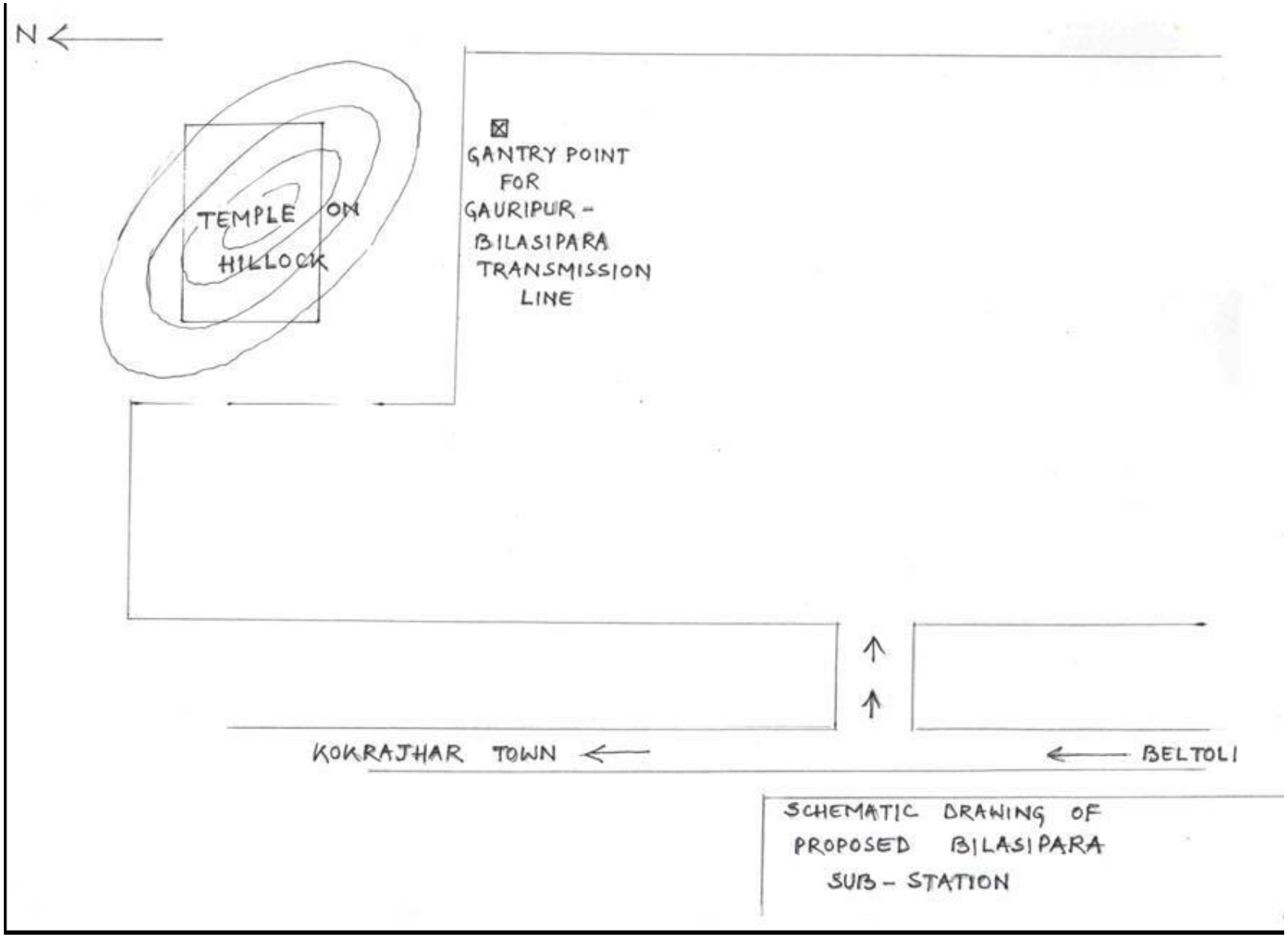
Existing Access to the proposed Sub-Station Site



SCHEMATIC DRAWING OF PROPOSED HAILAKANDI SUB- STATION

North –Western View of the proposed Sub-Station Site from the Existing Access Road

Proposed Transmission Line Routing across Agricultural Field


N
TEMPLE ON HILLOCK
GANTRY POINT FOR GAURIPUR - BILASIPARA TRANSMISSION LINE
KOKRAJHAR TOWN
BELTOLI
SCHEMATIC DRAWING OF PROPOSED BILASIPARA SUB - STATION

Temple on top of the Hillock - North of the Proposed Sub-Station

Proposed Sub-Station Site

APPENDIX 3

IEE Appendix 3 *Tranche 2, Q2 / 2010*

Access to Reserved Forests

1. The Government of Assam (GOA) manages forests pursuant to the Forest (Conservation) Act 1980 (the Forest Act) and its amendments, and the Forest (Conservation) Rules 2003 and its amendments. These are unique pieces of legislation, which elucidate a regulatory mechanism that reflects the collective will of the nation to protect its rich forests, biodiversity and natural heritage and resources. The act permits only unavoidable use of forest land for various development purposes. It embodies the firm commitment of the GOA and the Assam Department of Environment and Forests (ADEF) to balance the conservation of forests with the sustainable developmental need of the society contributing to better environment, health and economy.

2. The Forest Act implicitly acknowledges the demarcation of forested areas during the British colonial period, which reflected prevailing knowledge of forest management at the time, but obviously predates current concepts such as “ecosystem services” and “global commons.” In effect, the areas mapped as “reserved forests” were not designated on the basis of modern procedures for defining ecologically-sensitive areas (the youngest of the forest maps being at least 50 years old). Alternatively stated, designation as “reserved forest” does not imply the presence of endangered or threatened species or globally significant bio-diversity: areas with such special ecological resources are defined as wildlife sanctuaries and national parks. Reserved forests are, simply stated, areas designated for conservation.[1] In fact, reserved forest areas have been significantly altered by human activity, and the designation does not warrant that a particular site is actually covered by forest.

3. The Forest Act is regulatory in nature and not prohibitory, and provides a built-in mitigation process for cases where forest access is unavoidable. Project proponents request use of forest land. ADEF reviews the request, and if granted, the project proponent pays user fees to ADEF. The fees are used for afforestation and reforestation in other areas. The reserved forest area used by the projects is “diverted,” or effectively re-zoned for project purposes. This type of environmental offset mechanism is consistent with other market-based regulatory instruments such as wetlands mitigation and banking and emissions trading.

4. As of March 2006, ADEF has granted clearance to divert forest for 169 cases, including 23 cases for pipelines and transmission lines. Reserved forest area diverted is 6212 hectares, and total afforested area (in reserved forests) is 9889 hectares. An additional 745 hectares have been afforested. Table A1.1 summarizes the forest clearance and afforestation activity as of year-end 2006.

[1] In this context, reserved forests are not to be equate with “environmentally sensitive areas” as defined by ADB, and as such, encroachment on reserved forest areas should not automatically trigger the classification of environment Category A or “highly sensitive and complex” designation.

5. The proposed transmission project to be supported by ADB will minimize forest use by design. New substations will not be located in reserved forests. Some forest area may be requested if technically necessary due to design constraints. Total right of way is estimated as: 596 km total line length x 10 m right of way x 1000 m/km x 1 ha/10,000m^2 = 596 ha. If the entire right-of-way were to be located in reserved forest, the area required (596 ha) represents only 0.0006% of total reserved forest area (9804 km^2 = 98,040,000 ha). Assuming that 1% of the ROW crosses reserved forest, the area required would be 1% x 596 ha = 5.96 hectares. This area is equal to about 0.06% of the total area afforested (9889 ha), and is well within the capacity of ADEF management. As mitigation is built-in to the forest diversion process, no significant impacts will result from the Project.

Table A2.1: Summary of Forest Diversion Activities in Assam

1	**Purpose of Diversion**	**Nos.**
(I)	Irrigation Projects	2
(II)	Hydroelectric Projects	3
(III)	Mining	2
(IV)	Construction of Road	3
(V)	Laying of Railway lines	4
(VI)	Laying of Transmission line/pipe line	23
(VII)	Others	132
Total		**169**
2	**Forest Area Diverted (hectares)**	**6211.53**
3	**Compensatory Afforestation Stipulated (hectares)**	
(I)	On Forest Land	6548.615
(II)	On Non- Forest Land	1263.664
Total (hectares)		**7812.279**
4	**Compensatory Afforestation done as of 31.12.2006 (hectares)**	
(I)	On Forest Land	9889.054
(II)	On Non- Forest Land	744.964
Total (hectares)		**10634.018**

Source: Assam Department of Environment and Forests

APPENDIX 4

ADB Assam Power Enhancement Project
Cumulative and Induced Impacts Assessment

1. Introduction and Scope of Assessment

1. The Government of India (GOI) and Government of Assam (GOA) have requested Asian Development Bank (ADB) to provide $200 million in loan funding via a multi-tranche financing facility (MFF) to support continued investment in the state power sector, specifically for transmission and distribution system expansion and upgrades. The ADB Operations Manual for MFF investments OM D14/OP Section I(v) states: "Where significant cumulative and induced environmental impacts from the entire MFF are considered probable, a sector or regional assessment will be prepared and submitted to the Board together with other MFF documents for Board consideration." This assessment covers reasonably foreseeable cumulative and induced impacts attributable to the ADB-funded investments in electric power transmission and distribution (also referred to as the "core projects").

2. Induced impacts are those from activities and projects that would not proceed without the ADB-funded investments. Cumulative impacts are defined as potential environmental effects from activities and projects that take place in parallel in the same project area with possible economic linkage to the core project. The impact of a single project on an environmental factor may not be significant, but the impacts of induced and parallel projects may combine to produce irreversible damage. The purpose of assessing the cumulative and induced impacts is to identify combined effects and identify limiting and mitigating factors to ensure that the cumulative impacts will not exceed the carrying capacity of the environment.

3. For this assessment, the spatial context is the grid-connected service area of the Assam power utilities, comprising the greater Brahmaputra River valley and most of the state in terms of area and population. The temporal context is the near-term development period, i.e., 2009-2014. Potential impacts are considered on the basis of economic dependency, and degree of certainty that collateral activities will proceed. In this case, some additional power sector investments are seen as certain and/or reasonably foreseeable. Industrial growth and increased agricultural activity can be reasonably foreseen based on current development planning, e.g., industrial estates noted in the main IEE report, and possible increases in cropping as more power supplies enable additional irrigation.

4. Impacts and effects are categorized as additive, compensatory, synergistic, and masking. Additive impacts increase environmental stress, e.g., additional pollution loads from new industrial plants. Compensatory effects offset negative impacts, and might include specific environmental management and ecological preservation activities implemented on a regional or sectoral basis, e.g., common effluent and waste management plants in industrial estates. Synergistic effects mutually reinforce effects of the core project and could be positive or negative. Masking effects arise from activities that are not obviously linked to the core project, but may occur partly as a result of the core projects; e.g., access roads to a new hydropower plant may facilitate uncontrolled entry to environmentally sensitive areas.

5. In the context of transmission and distribution projects in India, most of the ADB-funded projects are addressing under-served areas with suppressed energy demand. Such transmission and distribution projects are in fact induced by economic growth, not *vice versa*.

6. For the proposed Assam investment program the scope of assessment covers the following potential activities and projects:

(i) "Upstream" power plants which may be associated facilities;

(ii) Potential "downstream" energy sector investments, specifically end-use efficiency (EE) programs and new distributed generation (DG);

(iii) Industrial development which is dependent on reliable power supplies; and

(iv) Increased agricultural activities facilitated by additional power for irrigation.

7. Aside from the agricultural and industrial sectors, electricity consumers "downstream" of the distribution substations are considered in general terms with respect to demand forecast by sector. Development indicators are included in the Design and Monitoring Framework to evaluate the overall economic impact of the project. In terms of overall environmental impact, the key issue for evaluation of the associated facilities and downstream development is whether ambient environmental quality objectives will be maintained within GOI standards in the spatial and temporal context.

2. General Benefits and Greenhouse Gas Implications

8. The ADB funded investments in transmission and distribution will remove transmission bottlenecks and reduce transmission and distribution losses, reducing the emissions intensity of delivered power. Based on computer modeling of the transmission system, the components proposed for ADB financing will result in power savings of 45 MW compared to business-as-usual, and energy savings of 171,000 MWh/year. The corresponding GHG emissions reduction is estimated to be 68,400 tons CO_2-equivalent per year.[1] The distribution system expansion will reduce system losses and reduce reliance on back-up diesel generators, which will further reduce emissions from electricity consumers. The ADB-supported investments will also facilitate railway electrification, which will further reduce diesel consumption.

3. Sectoral Trends In Power Demand

9. Table A3.1 and Figure A3.1 portray projected power demand by sector until 2014. Domestic demand accounts for the largest share and is expected to increase from 63% to 69%. Industrial demand, including tea gardens and high-tension "bulk" customers, is the second largest category and is expected to decline from 24% to about 19%. Commercial demand is expected to decline slightly from 11% to 10%. The domestic, industrial, and commercial sectors will benefit from the core projects. Additive effects will be partly compensated by technical loss reductions in the transmission and distribution system.

[1] The India Northeast Region Grid, which includes Assam, has the lowest GHG emissions factor of the 5 regional grids: 0.42 tons CO_2eq/MWh vs. an average of about 0.88 tons CO_2eq/MWh for the other grids.

10. In terms of total demand (or consumption), domestic growth is projected at 71% vs. 46% for commercial, 24% for industry, and 45% for agriculture. Water works and street lighting are projected to grow 20% and 21% respectively. Domestic and commercial consumption is mainly for lighting, refrigeration, and air conditioning, which can all benefit from EE gains. Industrial consumption is mainly for motive power, which can also benefit from EE gains. The industrial sector is also the largest user of captive power plants, which are mostly diesel-fired except for some facilities in Upper Assam which use natural gas.[2] Agricultural consumption is mainly for groundwater pumping for irrigation. Potential impacts are presented schematically in Figure A3.2, summarized in Table A3.1, and discussed below.

Table A 3.1: Demand Projections (million kWh)

Year	Domestic	Commercial	Industry	Agriculture	Water works	Street lighting	Total
2010-11	4117	690	1596	82	50	14	6549
2011-12	5261	783	1731	94	54	15	7938
2012-13	6722	887	1852	106	57	16	9640
2013-14	7032	1004	1982	119	60	17	10214
% Increase	71%	46%	24%	45%	20%	21%	
% of total							
2010-11	63%	11%	24%	1.25%	0.76%	0.21%	100%
2011-12	66%	10%	22%	1.18%	0.68%	0.19%	100%
2012-13	70%	9%	19%	1.10%	0.59%	0.17%	100%
2013-14	69%	10%	19%	1.17%	0.59%	0.17%	100%

NOTE: "Industrial" includes Tea Gardens and Bulk Supply

Source: ADB TA 7099-PRC Inception Report, January 2009

[2] Back-up generator sets are common in the commercial and residential sector, but represent lower overall energy consumption relative to industry.

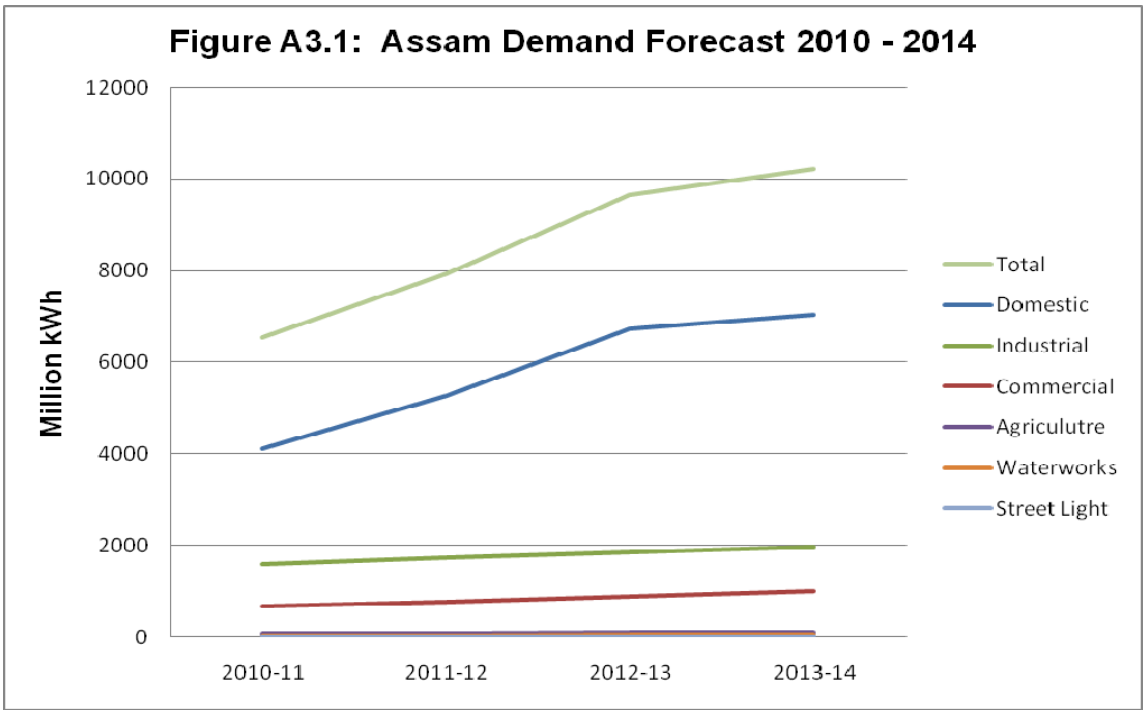


Figure A3.2: Assam Power Sector Enhancement Program: Cumulative and Induced Impacts

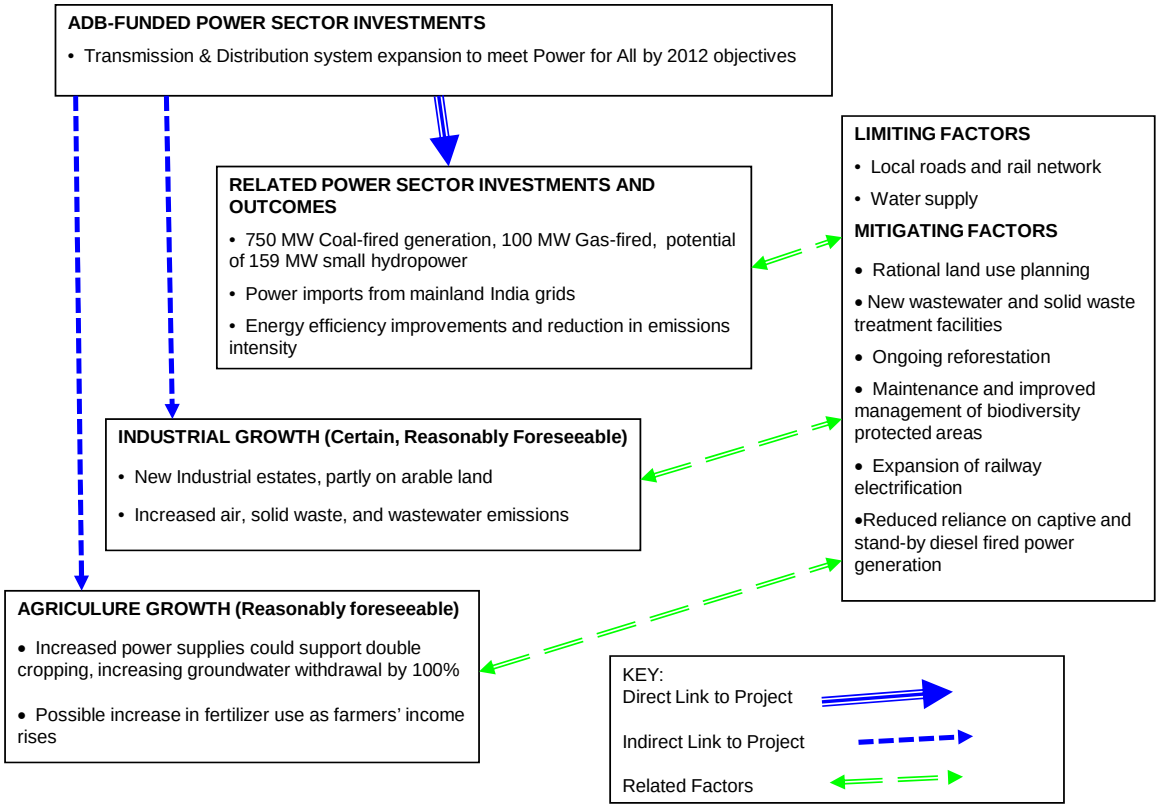


TABLE A3.1: IMPACT CHARACTERIZATION

Project or Sector	Impact Characteristics				Comments
	Additive	**Compensatory**	**Synergistic**	**Masking**	
Related power sector investments	New 3 x 250 MW coal-fired power plant at Bongaigaon will increase local air pollutant load, but ambient standards are expected to be met after plant becomes operational. Some coal will be supplied from mine in Upper Assam. No significant increase in air pollution load from the 100 MW gas-fired power plant at Namrup.	Additional hydropower development in Assam and Northeast Region will offset new coal-fired generation. Each 10,000 GWh of hydropower offsets 3.5 Million tons of coal used in thermal power plants. Power system efficiency will improve, reducing emissions intensity. Further efficiency improvements expected from demand side management and other end-use efficiency gains.	Additional power supplies will support industrial estates and other infrastructure. Commercial and residential power consumption will increase, with improved efficiency.	New power generation units at Bongaigaon and Namrup will replace decommissioned and obsolete plants. Bongaigaon will have net emissions increase; Namrup is emissions neutral. Remaining hydropower potential in Assam will be mainly small run-of-river plants.	Expanded power supplies are necessary to support economic growth. Investments in new power generation capacity and transmission system expansion are effectively induced by economic growth, rather than *vice versa*. Improved power supplies will benefit social infrastructure, especially public health facilities and schools.
Industrial Activity	Increased air emissions (PM, SO_2, and NO_x) will increase local pollutant load, but ambient air quality objectives are expected to be maintained.	Value-added employment opportunities create social benefits for local residents, including backward classes/indigenous peoples.	Emissions fallout may be transferred to soil and water.	Limited effects due to rational land use planning and siting. New access roads will not facilitate increased forest and tourist access.	Pollutant emissions can be minimized with advanced, cleaner process technologies. Improved grid-supplied power reduces need for diesel-fired captive and standby generation.
Agriculture	Groundwater withdrawal theoretically could increase by up to 100% to support 2 crops per year vs. current single crop.	Use of chemical fertilizers expected to be limited in favor of organic fertilizers due to relative costs. Only 22% of groundwater resource is currently utilized.	Increase in chemical fertilizer use could contaminate surface and shallow groundwater	Expanded agricultural output will support overall economic growth	Increased farmers' income is consistent with economic growth and poverty reduction objectives.

3.1 Related Power Sector Investments

11. Power sector investments related to the ADB-funded activity include: (i) new replacement power plants at Bongaigaon and Namrup; and (ii) end-use energy efficiency investments and distributed generation. The power plants at Bongaigaon and Namrup are being financed independently of ADB. End-use efficiency and distributed generation (e.g., small hydropower plants, solar systems on residential and commercial buildings) investments may be supported by ADB via financing to the state-level energy conservation fund.[3]

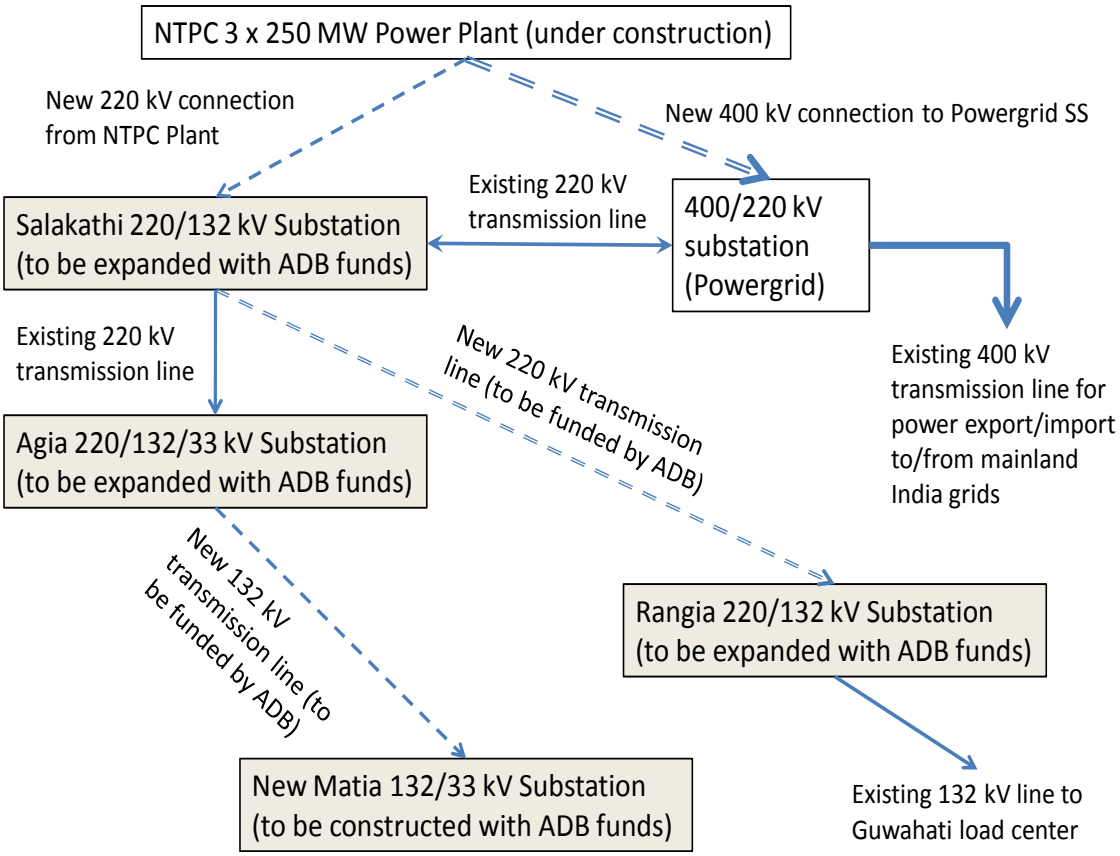
3.2. Upstream Power Plants: Possible Associated Facilities

12. Associated Facilities are referenced in a footnote of the Resettlement OM, which states simply that if there are associated facilities with safeguards implications, then ADB may conduct due diligence. In practice, if a facility is economically dependent on ADB's direct investment, then it is considered to be an "associated facility" and may be subject to due diligence. In the context of safeguards compliance, due diligence is limited to a determination of whether the facilities are in compliance with the host country regulatory requirements. Due diligence may logically include a review of potential financial risks.[4] The safeguards categories of the ADB investments are determined independently.[5] The transmission project includes 2 possible associated facilities, discussed below.

13. ADB financing is proposed for a transmission line which will evacuate power from a new 3 x 250 MW coal-fired power plant at Bongaigaon (owned by NTPC, Ltd., an ADB client) built on the site of a decommissioned 4 x 60 MW coal-fired plant which was owned by the Assam Power Generation Company Ltd. The proposed transmission system layout is shown schematically in Figure A3.3. The transmission system will allow the NTPC plant to deliver power into the mainland grids and into the Assam state grid. The overall transmission system upgrade will allow imports of power from the mainland grids as well. The NTPC plant is not economically dependent on the ADB-funded transmission line, as all of the power could be delivered into the mainland grids. On this basis, the NTPC plant is not necessarily an associated facility. However, the Assam distribution companies have committed to buy 381 MW of power from the NTPC plant, and on this basis the NTPC plant may be deemed an associated facility. The plant is considered to be in compliance with GOI standards at this time. NTPC has a corporate environmental, health, and safety (EHS) department, and is acknowledged as the one of the best-performing power utility companies in India.[6]

[3] This concept is in early discussion stages as of April 2010.
[4] ADB standards are not imposed on the associated facilities.
[5] The ADB Rapid Environmental Assessment checklists do not include associated facilities. Determination that an associated facility is present does not change the category of the ADB-supported investments.
[6] ADB has approved 2 sub-sovereign financial packages for NTPC, prior to which extensive due diligence was conducted.

Figure A3.3: Transmission System Layout from Bongaigaon Power Plant



14. An environmental impact assessment (EIA) has been prepared and a No Objection Certificate (NOC) was issued by the Ministry of Environment and Forests (MOEF) on 7 June 2007, providing regulatory clearance to proceed with plant construction. The ADB project team visited the plant site in March 2009 and reviewed the EIA report. The following key findings are presented in the EIA report:

- The plant will utilize a mix of low- and high-sulfur coal, some mined in eastern Assam, with maximum sulfur concentration of 1.97%. A wet-lime flue gas desulfurization (FGD) system will be installed to control sulfur dioxide (SO2) emissions. Electrostatic precipitators with 90% removal efficiency will be installed to control particulate matter (PM).

- The World Bank 1998 stack emissions standards for NOx and SO2 will be met (stack emissions for PM are not reported in the EIA). The IFC 2008 stack emissions standard for NOx will not be met, but the standard for SO2 will be met.

- Ambient air quality modeling predicts that ambient air quality objectives for SO2, PM, and nitrogen oxides (NOX) in industrial areas will be maintained in the project area after the plant becomes operational.

- Ash will be controlled on-site and will be reused off-site at cement plants, brick kilns, road construction projects, and possibly as a concrete supplement at new hydropower plants.[7] Estimated demand for ash is 3015 tons/day vs. expected generation of 2383 tons/day.

- Cooling and process water will be re-cycled on-site to the maximum extent practical. Residual process water and domestic sewage will be treated prior to discharge to the Tarang River. Ambient water quality in the river will be maintained.

15. The EIA methodology and content are consistent with that required for ADB projects, except accounting of stack emissions could be presented in more detail. ADB has conducted due diligence on other NTPC power projects, with similar findings. NTPC has a well-developed environmental management system. The Bongaigaon project will contribute to the overall development objectives of the Assam power sector, with minimal environmental impact.

16. ADB financing is proposed for a transmission line that will evacuate power from the Namrup gas-fired power plant, which comprises a total of 134 MW of gas-fired generation units. The plant began operations in 1965 and currently generates a maximum of about 75 MW of power. A new 100 MW combined combined-cycle gas turbine (CCGT) plant is proposed to replace the old units.[8] The existing power plant is connected to the grid and will not rely on the ADB-funded line to dispatch power to the state grid. However, the new plant will benefit from the ADB-funded line and therefore may be considered as an associated facility.

17. The new 100 MW CCGT power plant at Namrup will replace 134 MW of existing gas turbine plants owned by the Assam Power Generation Company Ltd., which originally entered service in 1965. An EIA has been prepared and a No Objection Certificate (NOC) was issued by the Ministry of Environment and Forests (MOEF) on 31 December 2008, providing regulatory clearance to proceed with plant construction. The ADB project team visited the plant site in March 2009 and reviewed the EIA report. The following key findings are presented in the EIA report:

- The plant will utilize best-available gas-fired generation technology, using local natural gas supplies. Low-NOX burner technology will be employed. PM and SO2 control are not required.

- Ambient air quality modeling predicts that ambient air quality objectives for SO2, PM, and nitrogen oxides (NOX) in industrial areas will be maintained in the project area after the plant becomes operational.

[7] MOEF has introduced ash reuse mandates for power plants, and brick kilns.
[8] ADB investigated the possibility of financing this power project in 2007, but it was not included in the India program. The ADB Assam Power Sector Development Program approved in 2003 partly financed a transmission line from the existing Namrup power plant.

- Gas supplies are currently limited to 0.66 million metric standard cubic meters per day (M m^3/d), sufficient to power the new 100 MW unit plus one of the existing 23 MW gas turbine units. Overall generation efficiency will improve by 231,000 megawatt-hours per year (MWh/y), with an offset of 92,400 tons per year carbon dioxide equivalent (tCO_2/y).

- Total water use will increase from 600 m^3/hour to 635 m^3/hour. Cooling and process water will be treated on-site using existing wastewater treatment facilities, which have sufficient capacity to treat the wastewater flow from the new plant. Some treated effluent will be used for watering green space within the plant boundaries. Residual process water and domestic sewage will be treated prior to discharge to the Dilli River. Ambient water quality in the river will be maintained.

18. The EIA methodology and content are consistent with that required for ADB projects, except accounting of stack emissions and wastewater discharge could be presented in more detail. The Namrup project will contribute to the overall development objectives of the Assam power sector, with minimal environmental impact.

19. The Bogaigaon power plant will have an additive effect due to increased air pollution loads. The Namrup plant is neutral with respect to air pollution and water pollution loads. Large hydropower development in the Northeast Region will have a compensatory effect: more than 2000 MW of new run-of-river hydropower plants are under development, which will more than offset the air emissions from the thermal power plants. The overall pollution intensity associated with power delivery to Assam will decline.

3.3 Downstream Energy Services: End-use Efficiency and Distributed Generation

20. The Energy Conservation Act (2001) provides the legal framework for end-use efficiency (EE), and includes a provision for creation of state-level energy conservation funds (ECF) to facilitate EE investments. The Electricity Act (2003) includes provision for “open access,” which requires transmission system operators to connect independent power producers to the grid, and which allows for power purchase agreements directly between generators and distribution companies. Current baseload generation is less than demand, providing some incentive for EE and distributed generation (DG, generally small-scale generation capacity installed at or near the point of use). Typical EE applications are efficient lighting (replacement of incandescent bulbs with compact fluorescent lamps [CFLs] or light-emitting diode [LED] bulbs.), and efficiency improvements in refrigeration and space cooling and heating. In Assam, one of the most common DG applications is captive diesel-fired generating units, mainly used for captive power generation in industries and for stand-by operations in commercial buildings. Other DG applications being pursued in Assam include village-scale biomass gasification, rooftop solar photovoltaic systems, and small hydropower (159 MW potential has been identified at 93 sites). DG systems may be stand-alone or grid-connected.

21. EE and DG development would have compensatory and possibly masking effects. EE clearly provides compensatory benefits: end-use efficiency gains can be thought of as “free”

power,[9] which reduce emissions and pollution intensity of central generating plants. Technical loss reductions in the distribution network (directly resulting from the core projects), along with other end-use efficiency improvements, will provide compensatory effects. During the past 5 years, technical losses in some areas have been reduced to around 10 – 15%. An aggressive EE program could probably achieve 10% systems-wide reduction in total consumption, particularly in domestic, commercial, and industrial sectors.

22. DG will be compensatory if renewable energy technologies are employed (e.g., small hydropower and solar PV), but could be considered masking or even additive if fossil fuels are used. The core project is expected to reduce reliance on standby diesel-fired generators, with a net compensatory effect. ADB support for the nascent Assam ECF could accelerate EE and DG investments, with compensatory effects.

3.4 Industrial Growth

23. Future industrial growth appears to be a certainty based on the Government of Assam's economic development plans. Several industrial estates are being established with an expectation of grid-supplied power. Industrial estates can employ DG systems for power supply, which could have compensatory effects if natural gas or RE technologies are employed. Increased air, wastewater, and solid waste emissions can be expected from new industrial development. The primary mitigating factors are land use planning (industrial estates), and enforcement of existing EIA and environmental management regulations.

3.5 Agricultural Development

24. Agricultural productivity increases are reasonably foreseeable. Current power supplies limit the amount of groundwater which can be pumped for irrigation, and most farmers can only produce one crop per year. Assuming that the core project will facilitate sufficient power supplies, double-cropping could theoretically result in a 100% increase in groundwater withdrawals (vs. projected demand growth of 45%). At present, only about 22% of groundwater resources are being exploited, therefore any additive effects would be minimal. Synergistic effects could result from increase in chemical fertilizer applications, but the incremental expense to farmers is a limiting factor. Increased cropping should improve farmers' incomes, which is consistent with economic development objectives.

4. Conclusions

25. The proposed ADB financing program will improve energy efficiency in the Assam state electricity grid, with significant reduction in emissions intensity from upstream power plants. Emissions from some downstream consumers will also be reduced. The associated facility at Namrup is a clean energy power plant which will have reduced emissions intensity after expansion. The associated facility at Bongaigaon is owned by an existing ADB client with has a good environmental performance track record. The environmental impact reports for the 2 associated power plants have been obtained and reviewed to determine the possible impacts on ambient air quality. As gas supplies to the Namrup plant are currently limited to 0.66 million

[9] Hence the Assam State Electricity Board motto is "energy saved is energy produced."

M m^3/d, any increases in ambient air pollutant loads will be insignificant; this conclusion is consistent with air dispersion modeling conducted for the EIA. The EIA for the Bongaigaon plant also concluded that ambient air quality standards will be met after the plant becomes operational. Other ambient environmental objectives will be met after the power plants become operational. Based on the review conducted to date, the associated facilities do not have significant environmental impacts.

26. Downstream investments in EE and DG are expected to have compensatory impacts. Cumulative and induced impacts are expected to result from agricultural and industrial sector growth. In the case of agriculture, a 100% increase in groundwater pumping for irrigation would still result in use of less than 50% of the identified groundwater resources. Additive impacts from industrial development will be mitigated by rational land use planning and enforcement of existing environmental regulations.

27. The ADB-funded investments will have cumulative and induced impacts, which can be mitigated effectively under the current regulatory regime, and are considered to be insignificant.