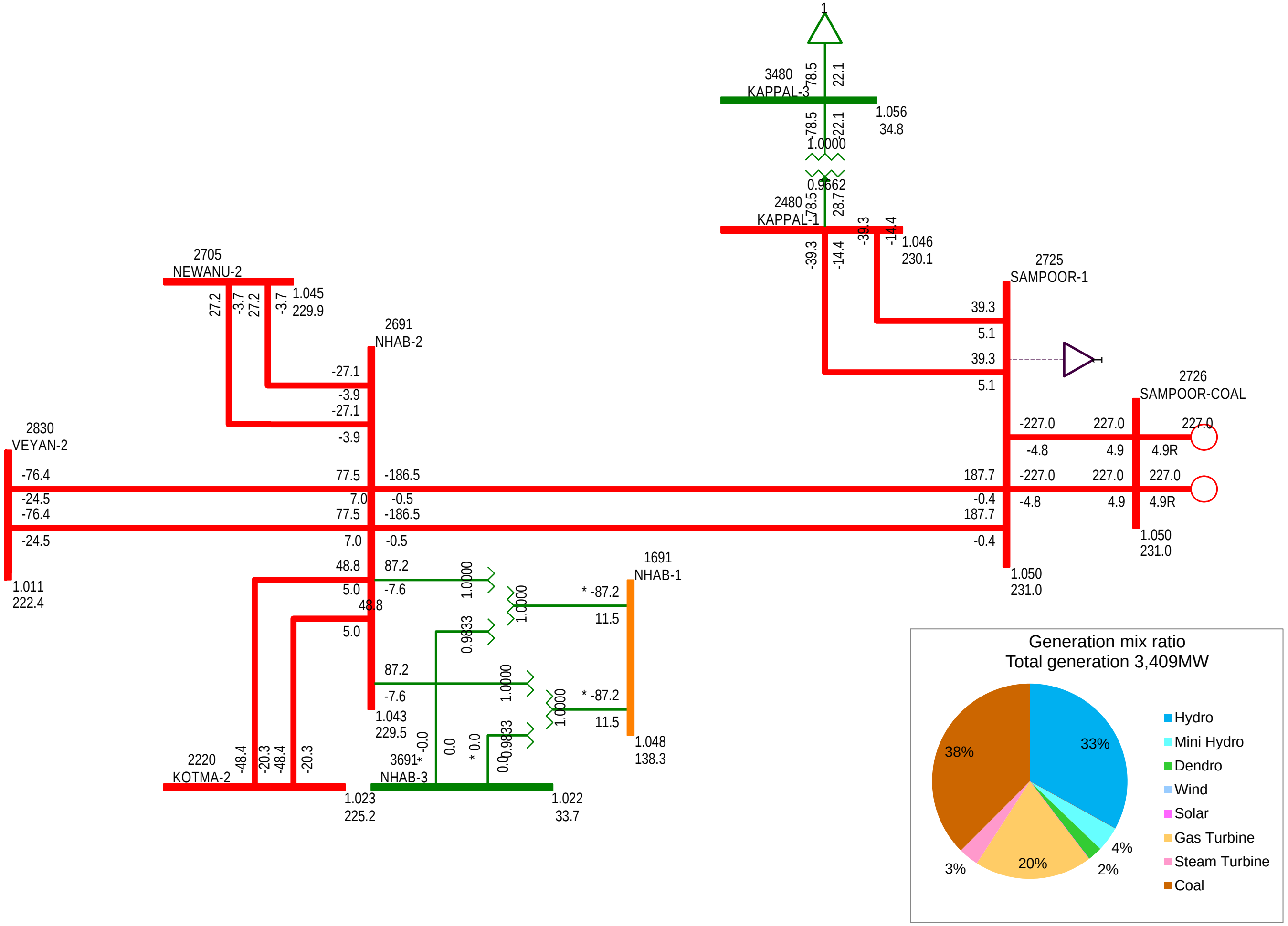
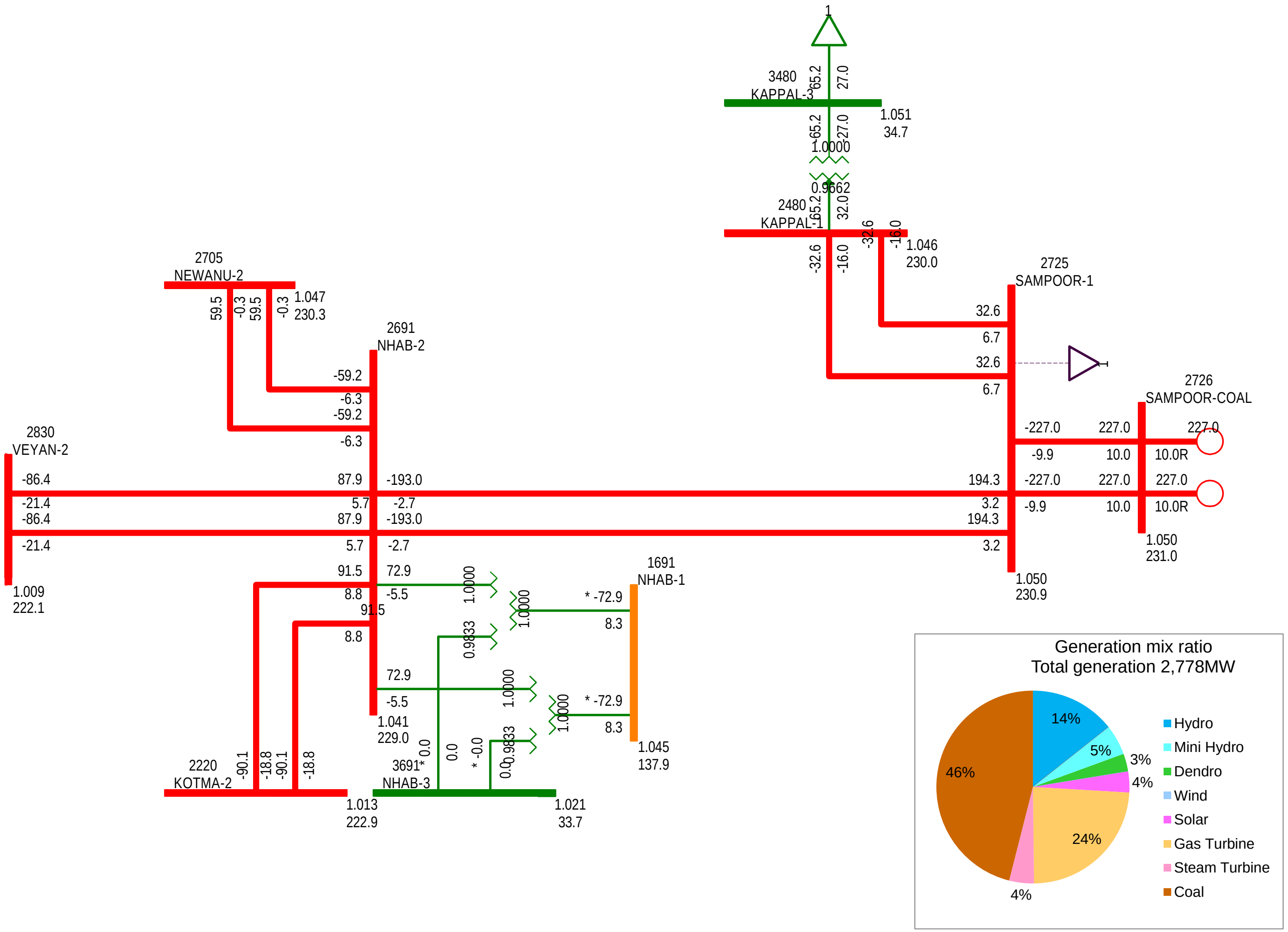
Detailed Power Flow around the Sampoor Substation in 2020

Grid condition : 2020 Year
Generator condition : Thermal maximum
Load condition : Night peak



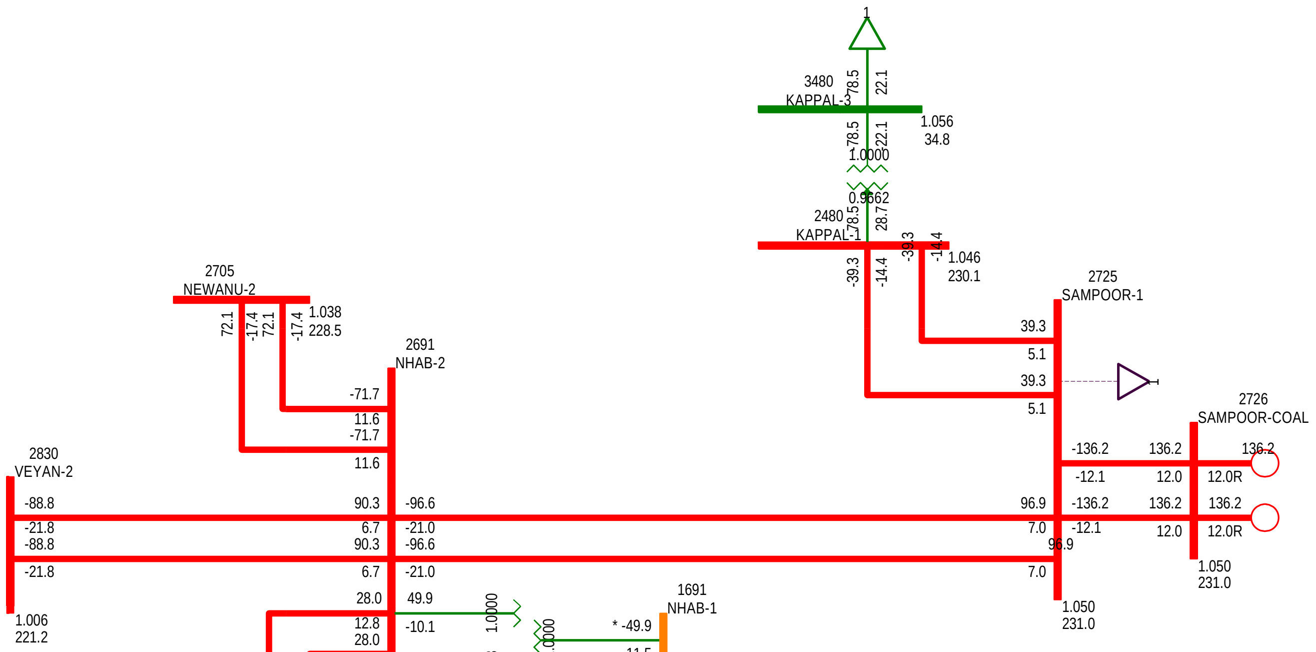
Detailed Power Flow around the Sampoor Substation in 2020

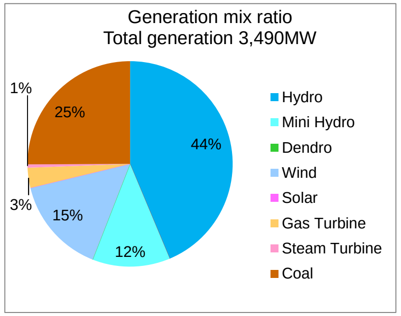
Grid condition	: 2020 Year
Generator condition	: Thermal maximum
Load condition	: Day peak



Detailed Power Flow around the Sampoor Substation in 2020

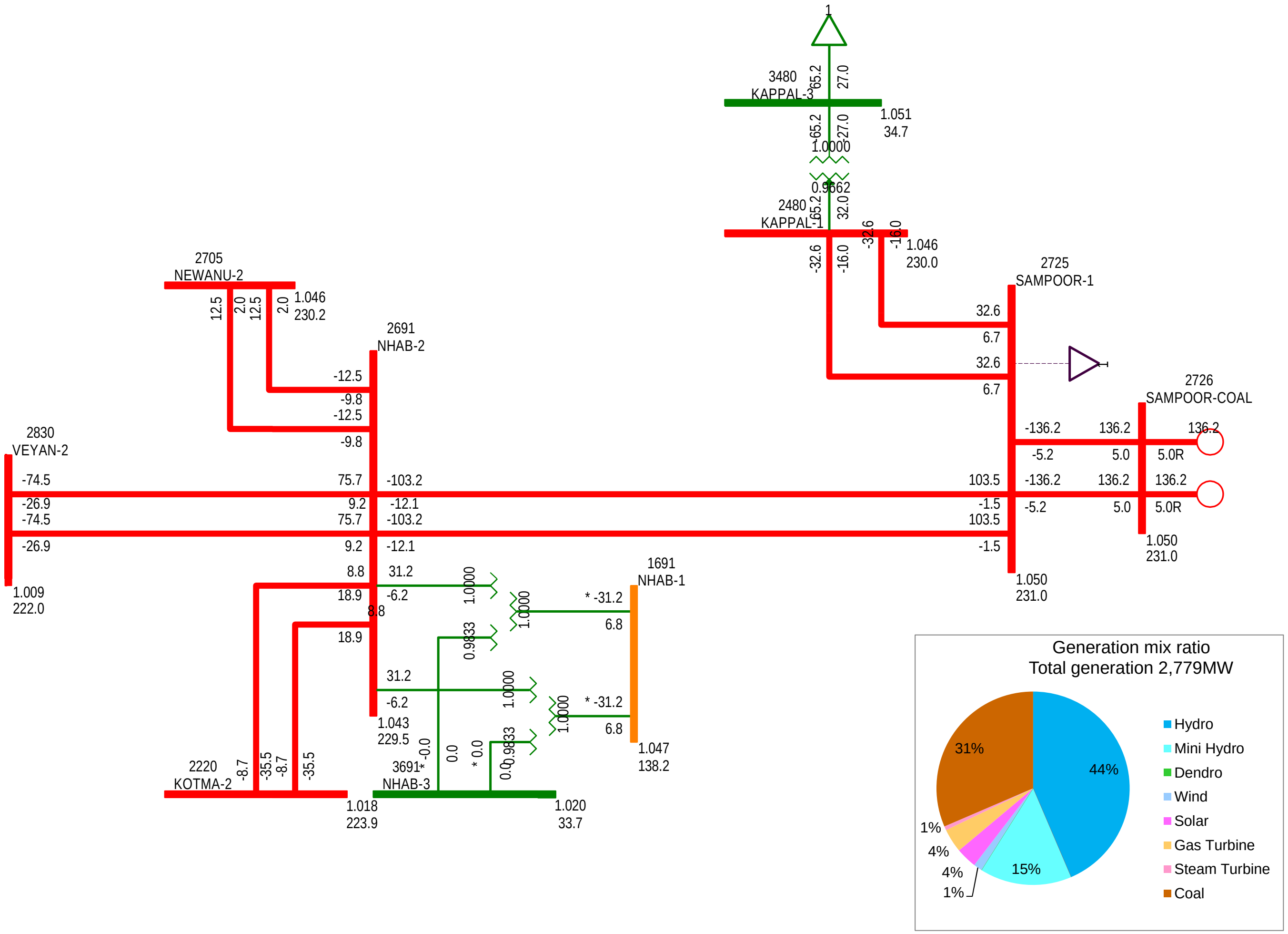
Grid condition : 2020 Year
Generator condition : Hydro maximum
Load condition : Night peak





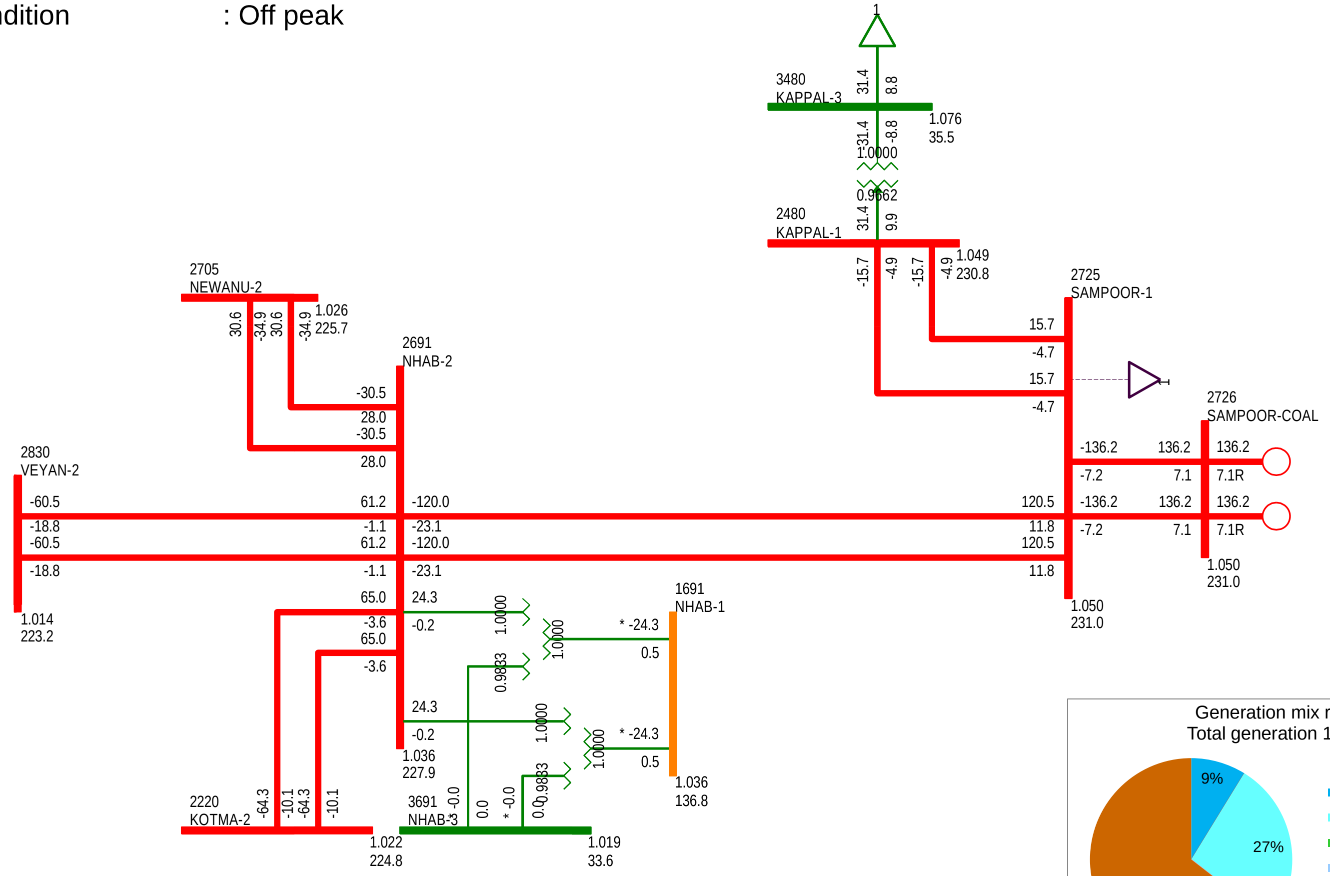
Detailed Power Flow around the Sampoor Substation in 2020

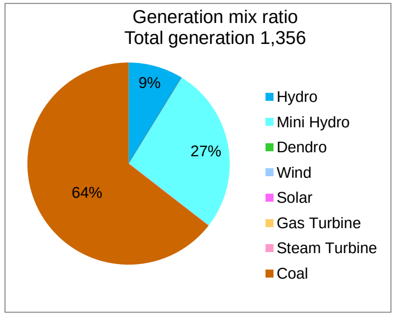
Grid condition	: 2020 Year
Generator condition	: Hydro maximum
Load condition	: Day peak



Detailed Power Flow around the Sampoor Substation in 2020

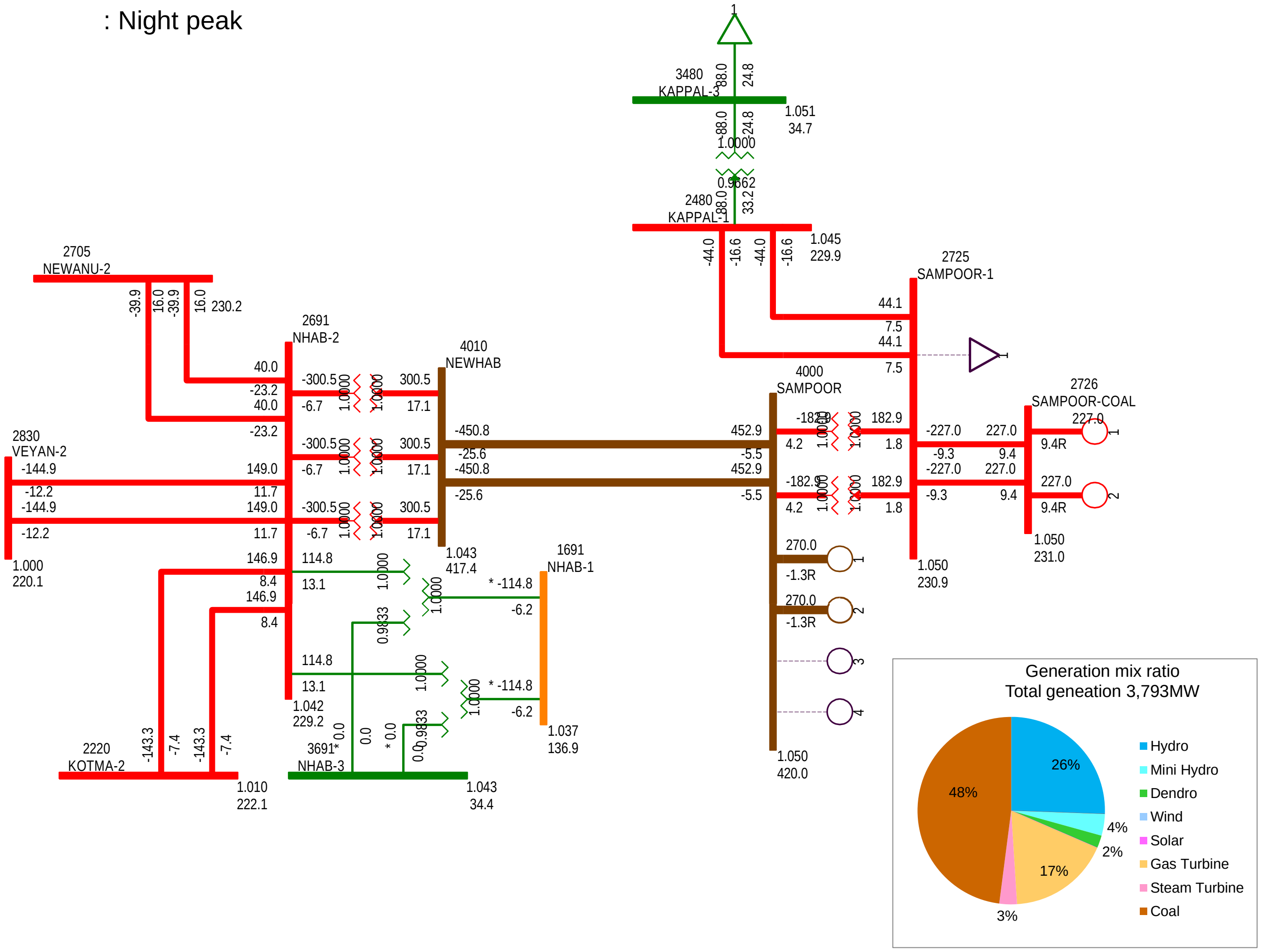
Grid condition : 2020 Year
Generator condition : -------------
Load condition : Off peak





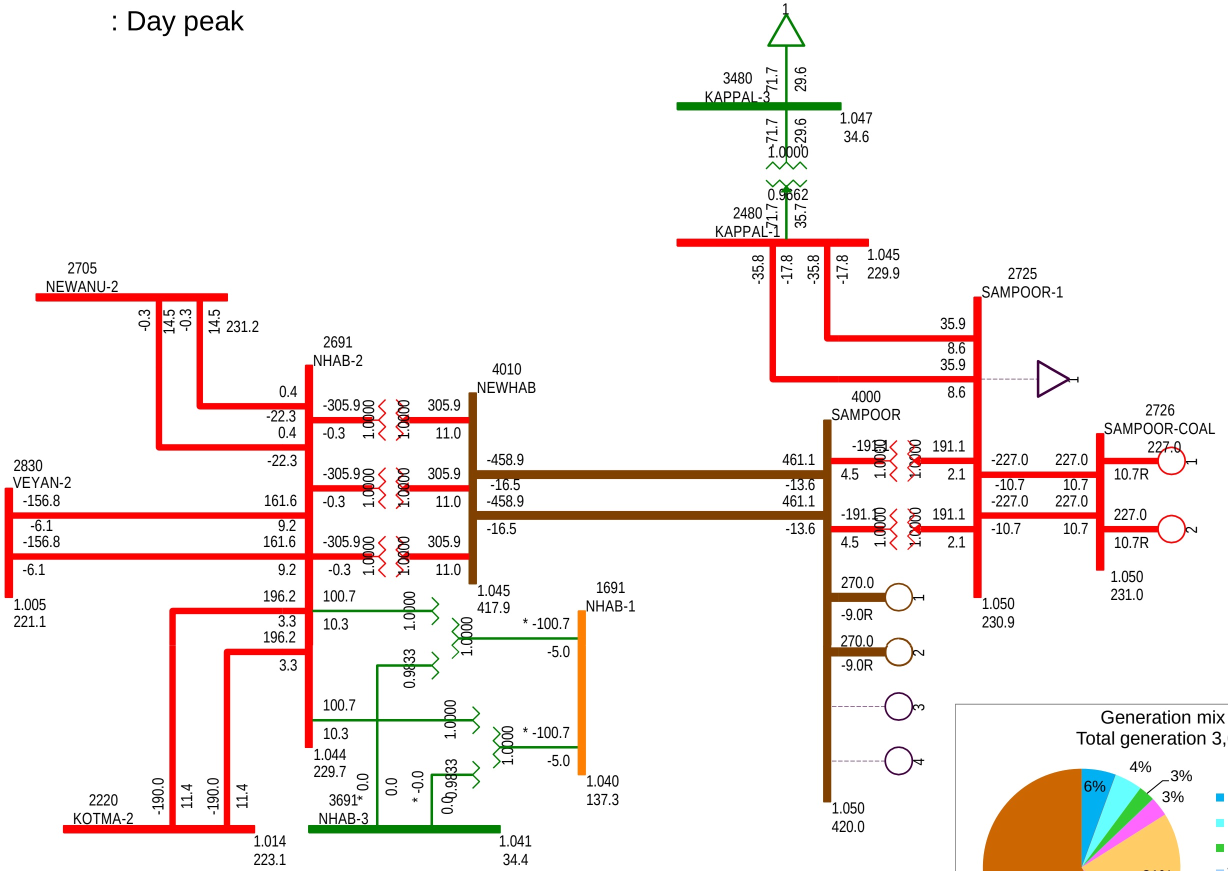
Detailed Power Flow around the Sampoor Substation in 2022

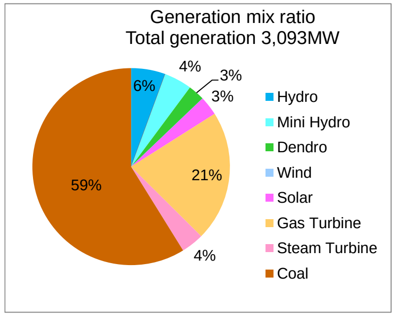
Grid condition : 2022 Year
Generator condition : Thermal maximum
Load condition : Night peak



Detailed Power Flow around the Sampoor Substation in 2022

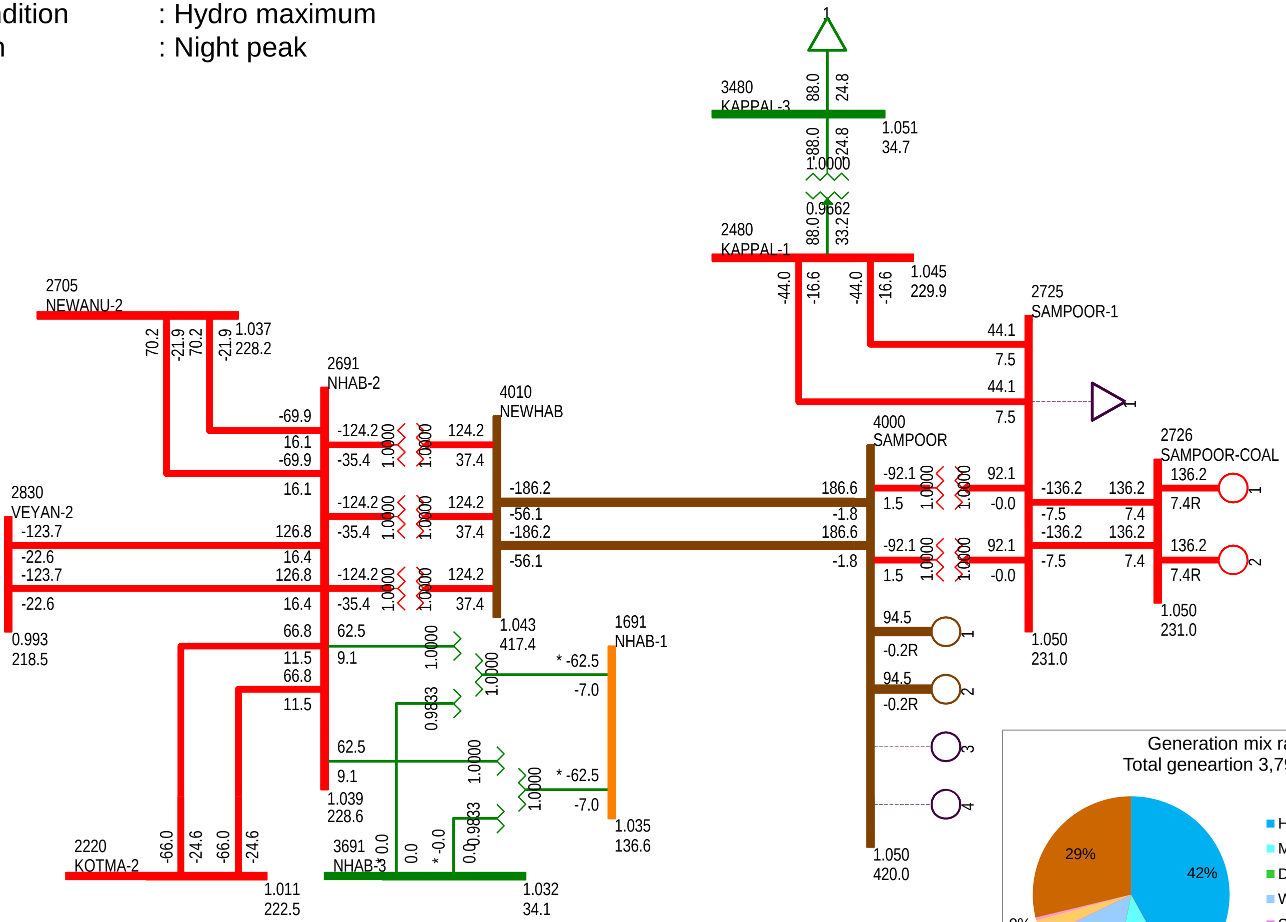
Grid condition	: 2022 Year
Generator condition	: Thermal maximum
Load condition	: Day peak

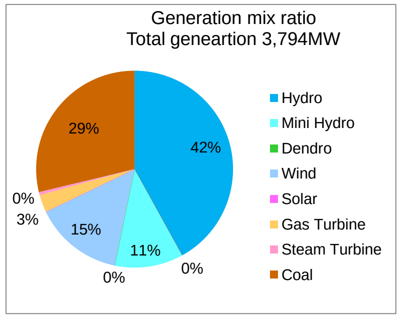




Detailed Power Flow around the Sampoor Substation in 2022

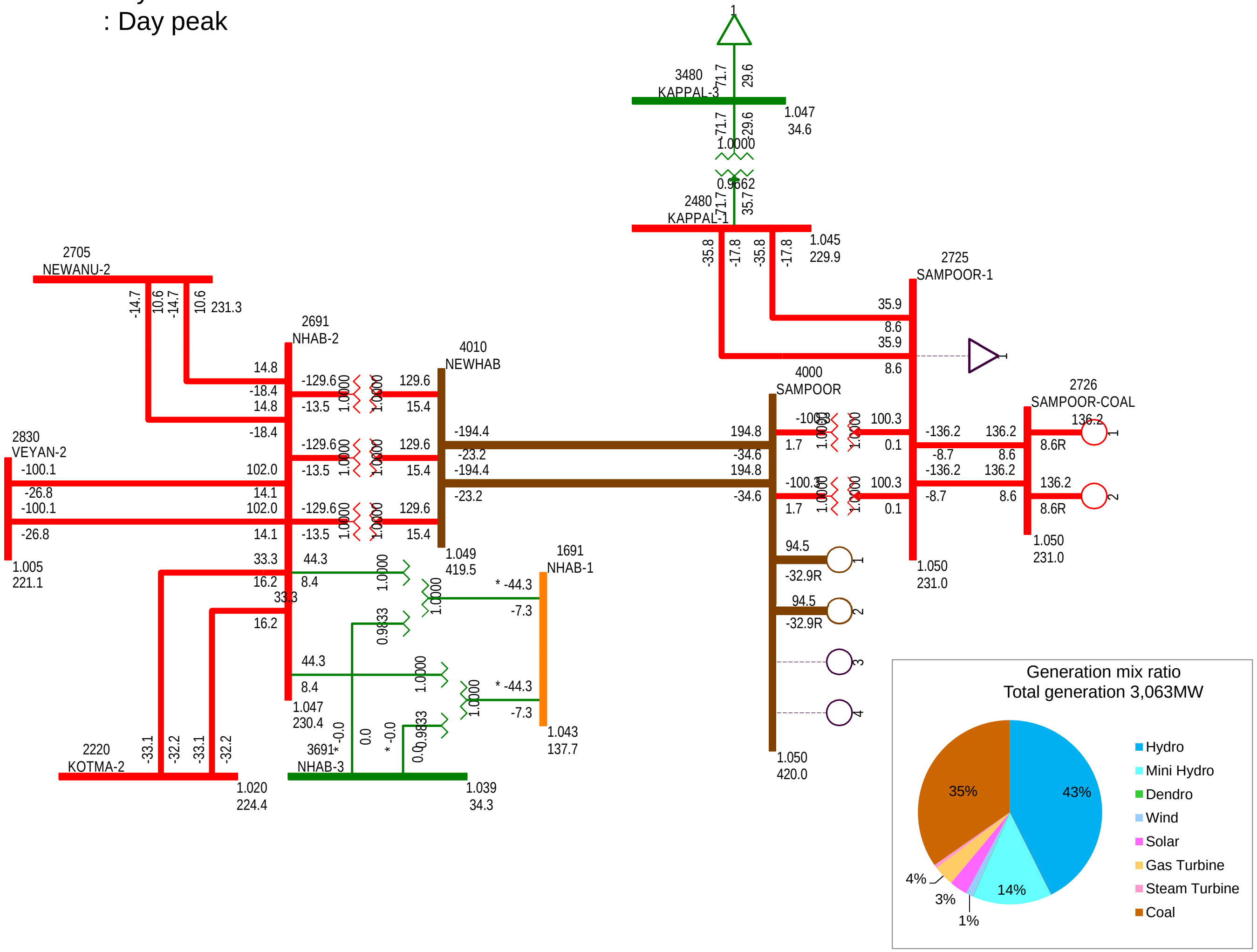
Grid condition	: 2022 Year
Generator condition	: Hydro maximum
Load condition	: Night peak





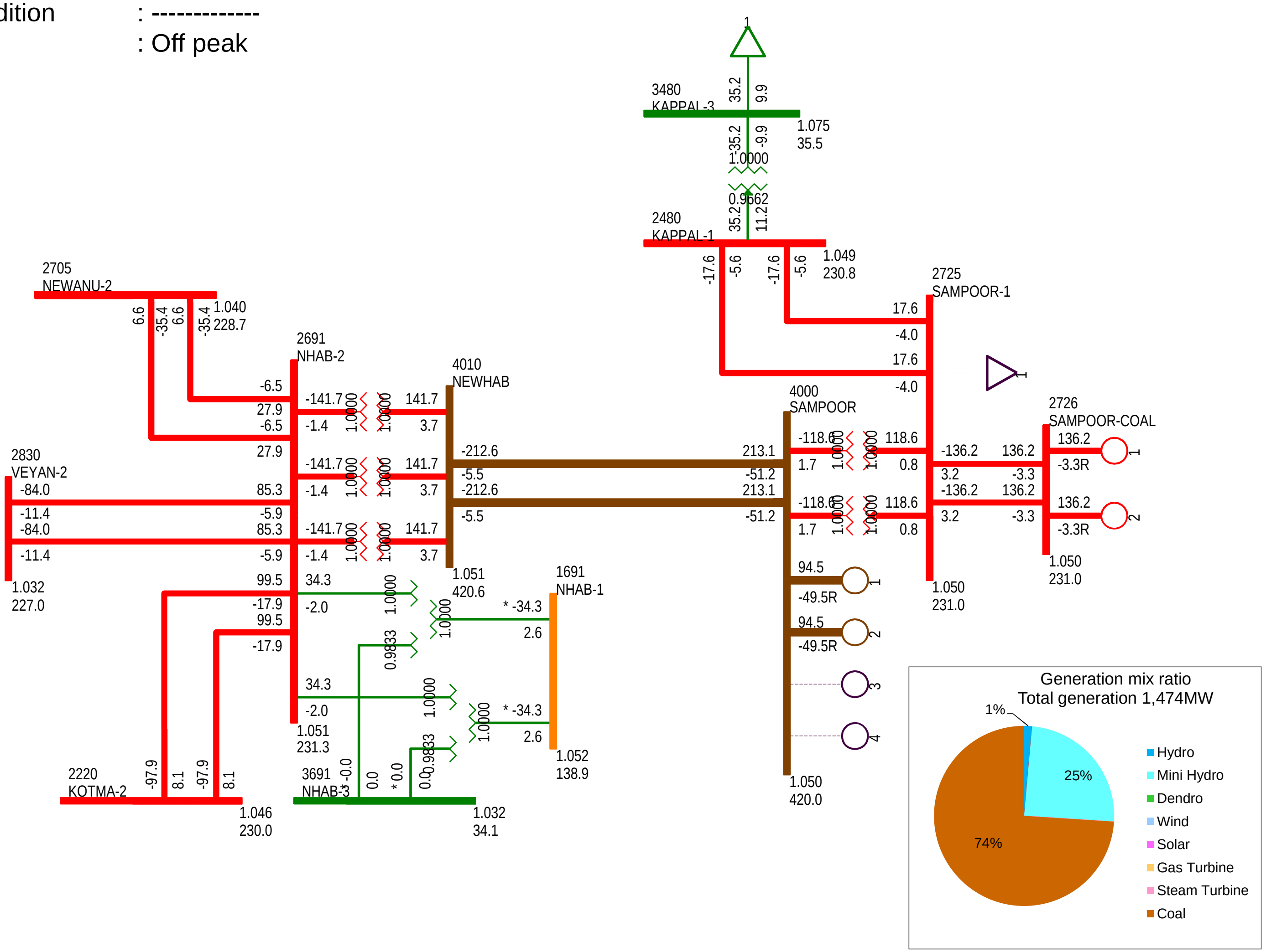
Detailed Power Flow around the Sampoor Substation in 2022

Grid condition : 2022 Year
Generator condition : Hydro maximum
Load condition : Day peak



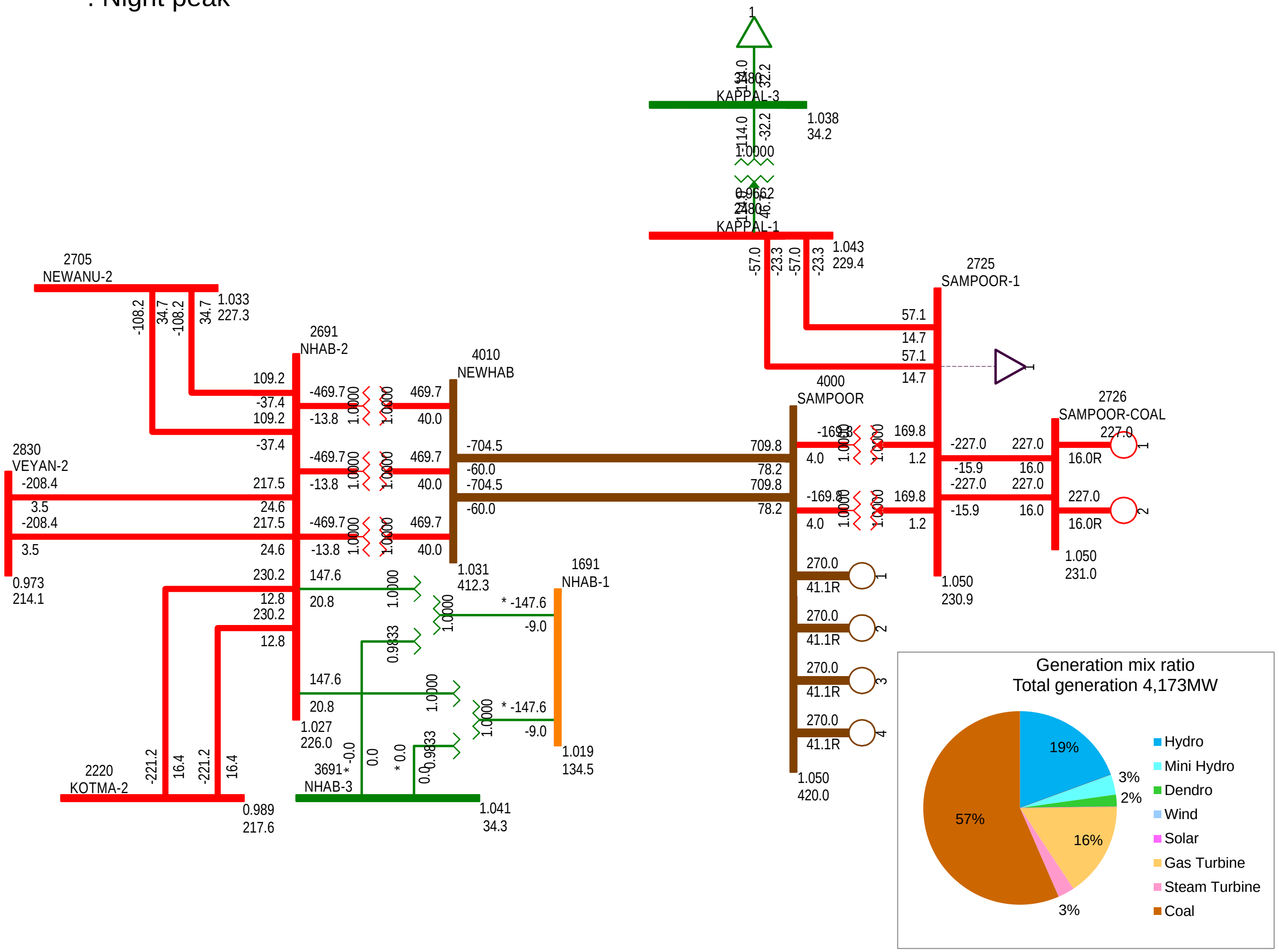
Detailed Power Flow around the Sampoor Substation in 2022

Grid condition : 2022 Year
Generator condition : -------------
Load condition : Off peak



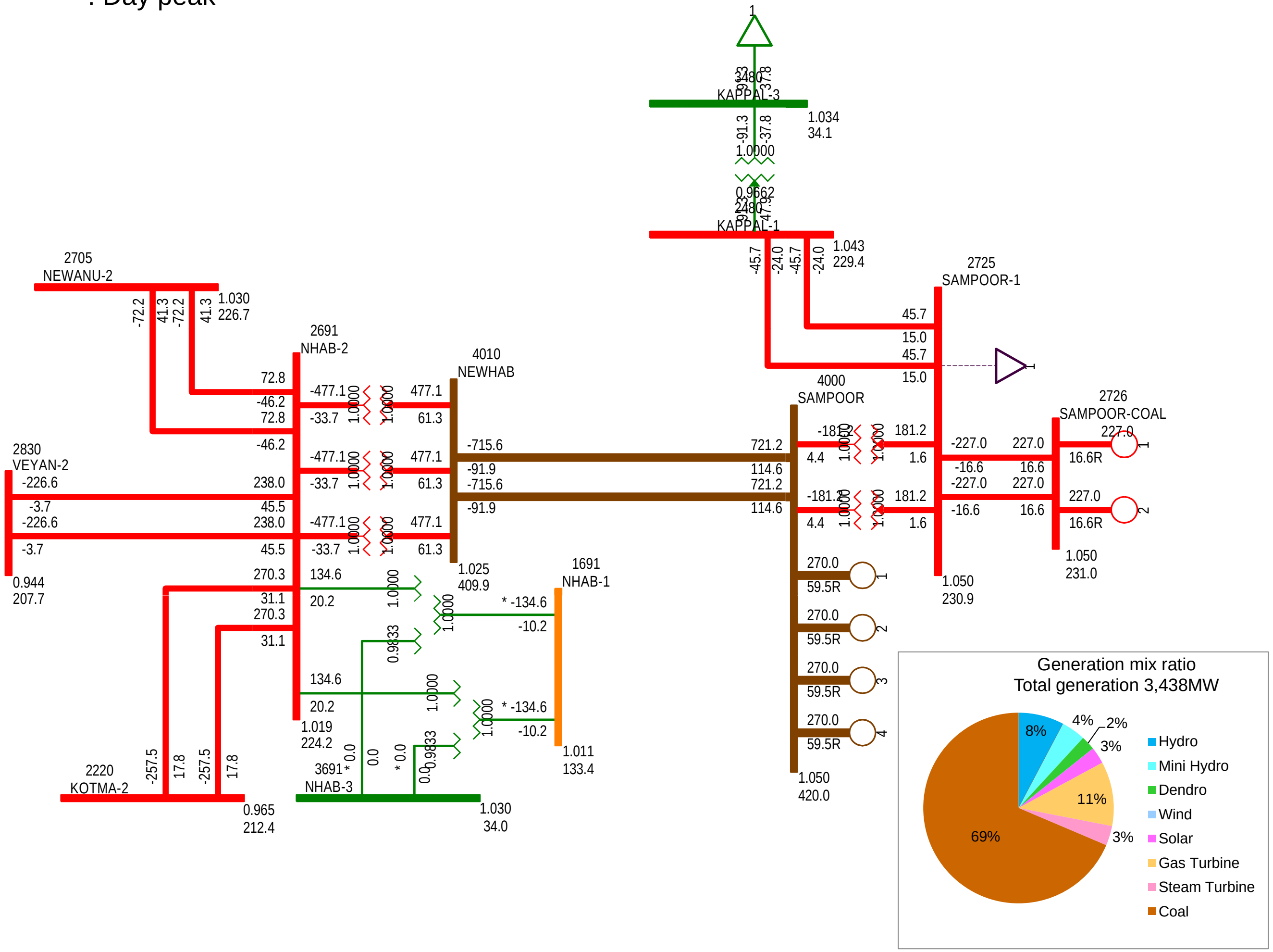
Detailed Power Flow around the Sampoor Substation in 2024

Grid condition : 2024 Year
Generator condition : Thermal maximum
Load condition : Night peak



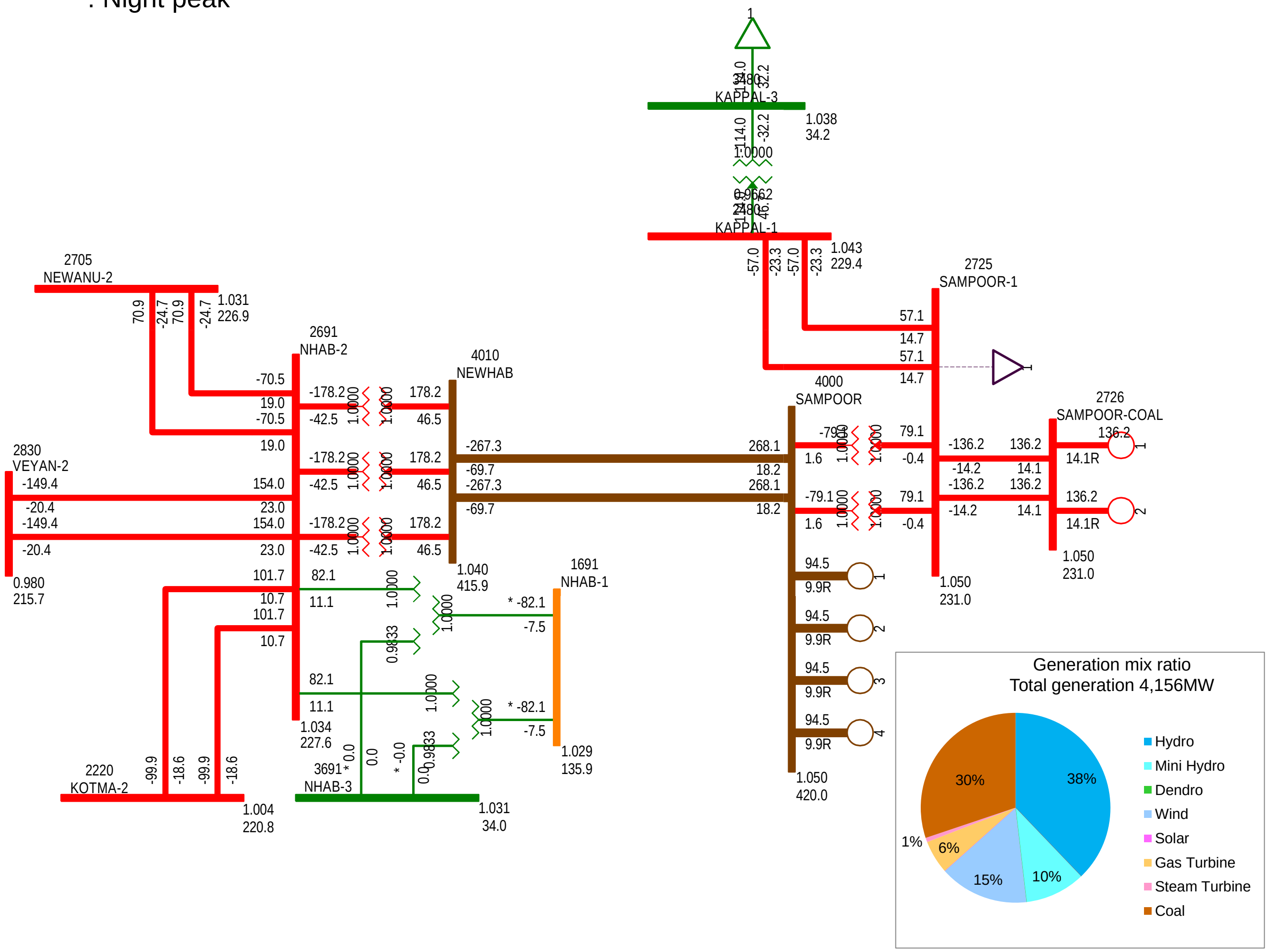
Detailed Power Flow around the Sampoor Substation in 2024

Grid condition : 2024 Year
Generator condition : Thermal maximum
Load condition : Day peak



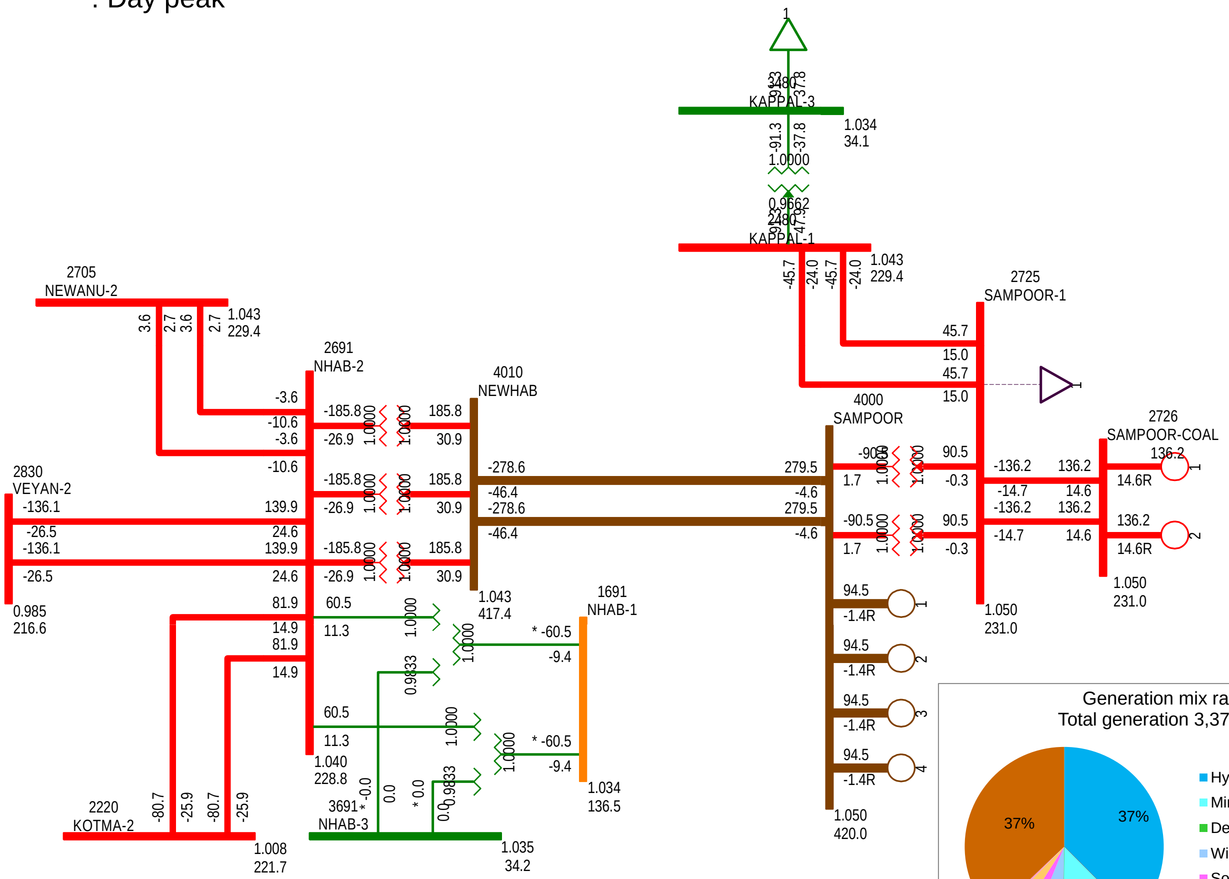
Detailed Power Flow around the Sampoor Substation in 2024

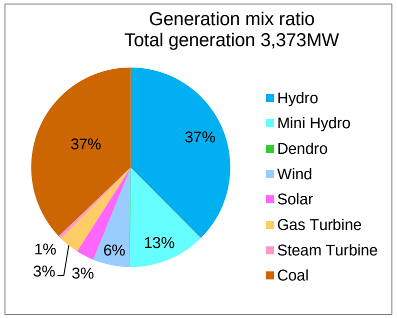
Grid condition : 2024 Year
Generator condition : Hydro maximum
Load condition : Night peak



Detailed Power Flow around the Sampoor Substation in 2024

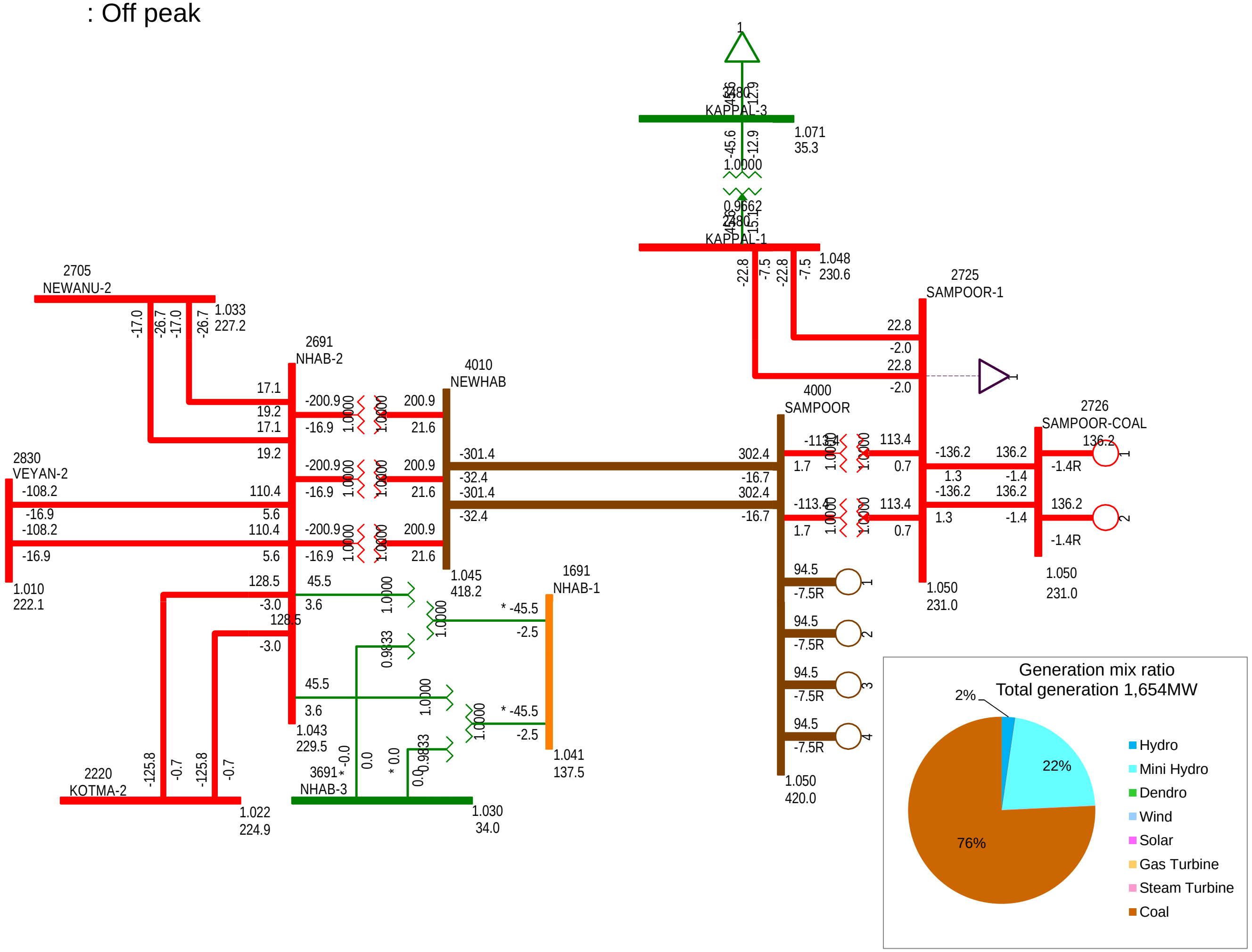
Grid condition	: 2024 Year
Generator condition	: Hydro maximum
Load condition	: Day peak





Detailed Power Flow around the Sampoor Substation in 2024

Grid condition : 2024 Year
Generator condition : -------------
Load condition : Off peak



Lanka Hydraulic Institute Ltd

Natural Condition Survey for 400kV Sampur – Habarana Transmission Line Project

Final Report

March 2015

Tokyo Electric Power Services Co., Ltd.

Client Tokyo Electric Power Services Co., Ltd.		**Client's Representative** Mr. Fumiyasu MINAGAWA				
Project Natural Condition Survey for 400kV Sampur – Habarana Transmission Line Project		**Project No.** 1502				
Authors Dr. D. P. C. Laknath Mr. K. B. A. Silva Mr. K. Maiyourathaan Ms. S. Hewavidana		**Date** March 2015 **Approved by** Mr. H. N. R. Perera Dr. K. Raveenthiran				
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Coast and Water

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CHAPTER 1
INTRODUCTION

1.1. Project Synopsis

The Tokyo Electric Power Services Co Ltd. (TEPSCO) is the Consultant for Japan International Cooperation Agency (JICA) for the *Preparatory Study on National Transmission and Distribution Network Development and Efficiency Improvement Project (II)*. In line with the project objectives, Lanka Hydraulic Institute Ltd. (LHI) was awarded consultancy services for "*Natural Condition Survey for 400kV Sampur - Habarana Transmission Line Project*" by TEPSCO on 30th January 2015.

1.2. Scope of Service

The Scope of Service of this project mainly focuses on (1) *Meteorological Survey* (2) *Hydrological Survey and Investigation*.

Meteorological Survey:

Objective: The objective of this task is to collect and analyse of meteorological data, such as wind speed and direction, ambient temperature, humidity, precipitation, solar radiation and thunder days.

Activities:

- Collect wind data at Trincomalee and Polonnaruwa stations for as long as possible period and analyse wind speed for maximum, minimum and mean.
- Collect wind data at Trincomalee and Polonnaruwa stations for a period of three year and analyse wind direction.
- Collect ambient temperature data at Trincomalee and Polonnaruwa stations for as long as possible period and analyse for maximum, minimum and mean of ambient temperature.
- Collect humidity data at Trincomalee and Polonnaruwa stations for a period of one year and analyse for maximum humidity.
- Collect precipitation data at Trincomalee, Polonnaruwa, Palampodaru/Alai Tank, Kantale, Habarana and Kaudulla Wewa stations for a period of five years and analyse for annual precipitation.
- Collect solar radiation data at Trincomalee and Polonnaruwa stations for a period of three years and analyse for maximum solar radiation.
- Collect thunder days data at Trincomalee and Polonnaruwa stations for a period of three years and analyse for mean thunder days.

Output: The analysed data is presented in tabular and graphical formats in this report.

Hydrological Survey and Investigation:

Objective: The objective of this task is to survey the levels at specified points (i.e. LP1 to LP11 points along the transmission line), and investigate the Ordinary High Water Level (OHWL) and Maximum High Water Level (MHWL), where the transmission line crosses the Mahaweli River. LP1 to LP11 locations along the transmission line are explained and illustrated in *Chapter 3*.

Activities: The following activities were carried out under this task;

- Survey the levels of LP1 to LP11 by using DGPS, Auto Level and Total Station.
- Investigate the OHWL and MHWL by using numerical model simulation (*DHI MIKE21 software* was used).

Output: The survey and modelling results are given in tabular and graphical forms.

Under the Scope of Service of LHI, following deliverables are expected to submit to TEPSCO.

- Draft Final Report
- Final Report

The Draft Final Report was submitted to client on 11th March 2015.

1.3. Organization of the Report

The brief descriptions about the content of each chapter of this "*Final Report*" are summarized as follows:

Chapter 1 includes project synopsis, the scope of services and organization of the report.

Chapter 2 explains about the study area, details about meteorological stations and meteorological data. Further, analysis results of each meteorological parameter are also included in this chapter.

Chapter 3 explains about survey results and investigations about HWLs on the basis of numerical simulation and field investigations.

CHAPTER 2
METEOROLOGICAL SURVEY

2.1. Study Area

The project site is located between Sampur in Trincomalee district to Habarana district. The 400kV Sampur – Habarana transmission line starts from Sampur GS, through north of Polonnaruwa district, and ends up at Habarana GS. This transmission line will be aligned in order to connect Sampur GS and Habarana GS. The approximate distance between Sampur GS and Habarana GS is 95 km. The proposed alignment map of the transmission line is shown in *Figure 2.1*.

Figure 2.1: The Proposed Transmission Line - Route Map

2.2. Meteorological Survey

2.2.1. Data Requirement by Client

As explained in the *Scope of Service (i.e. Section 1.2)*, expected details of meteorological parameters around the proposed transmission line with expected durations are tabulated in *Table 2.1.* Data recorded intervals, available periods and percentage availability at corresponding gauging stations are explained separately under each meteorological parameter *(i.e. from 2.3 – 2.8 Sections*).

Table 2.1 Expected Details of Meteorological Parameters

Item	Data	Minimum Data Collection Period
Wind speed	Yearly wind data that based on hourly recorded wind data at a height of 10m at meteorological stations and/or point near transmission line	As long as possible
Wind direction	Yearly wind data that based on hourly recorded wind data at a height of 10m at meteorological stations and/or point near transmission line	3 years
Ambient temperature	Yearly ambient temperature data that based on hourly recorded temperature data at meteorological stations and/or point near transmission line	As long as possible
Humidity	Yearly humidity data that based on hourly recorded humidity data at meteorological stations and/or point near transmission line	1 years
Amount of precipitation	Yearly precipitation data that were recorded at meteorological stations and/or point near transmission line	5 years
Solar radiation	Yearly solar radiation data that were recorded at meteorological stations and/or point near transmission line	3 years
Thunder days	Yearly thunder days data that were recorded at meteorological stations and/or point near transmission line	3 years

2.3. Wind

2.3.1. Stations and Data Availability

Wind speed and directions were measured at Polonnaruwa [7.87^0, 81.05^0] and Trincomalee [8.58^0, 81.25^0] weather stations (*see Figure 2.2*). Even it is expected to collect hourly recorded wind data under the scope, wind speed and directions were recorded only at 8.30 am and 5.30 pm during each day at each station. Further, at each station, average daily wind speed was calculated and given as *Daily Average Wind Run*. Wind data available duration and percentage availability at Polonnaruwa and Trincomalee stations are given in *Table 2.2.*

Figure 2.2: Wind Measurements – Weather Stations

Table 2.2 Wind Data Measurements Duration and Availability

Met. Parameter	Daily Measurements	Data Availability (Period & Percentage)			
		Polonnaruwa		Trincomalee	
		Period	%	Period	%
Wind Speed	8.30 am, 5.30 pm, Avg. wind Run	*(5 Yrs.)* 2010 -2014	96.2	*(20 Yrs.)* 1994 -2014	78.7
Wind Direction	8.30 am, 5.30 pm, Avg. wind Run	*(5 Yrs.)* 2010 -2014	96.2	*(20 Yrs.)* 1994 -2014	*88.1*
				(5 Yrs.) 2010 -2014	*78.3*

Wind data explained in *Table 2.2* is given with enclosed CDROM in digital format *(i.e. 1.Wind.xlsx)*

2.3.2. Wind Speed

Maximum, minimum and average wind speed of each year at Polonnaruwa and Trincomalee weather stations are given in *Table 2.3.*

Table 2.3 Annual Maximum, Minimum and Mean Wind Speed at (a) Polonnaruwa and (b).Trincomalee Weather Stations

(a) Polonnaruwa

Year	Speed (m/s) (Annual)		
	Average	Maximum	Minimum
2010	1.3	6.4	0.0
2011	1.2	6.9	0.0
2012	1.4	8.4	0.0
2013	1.6	7.8	0.0
2014	1.6	8.9	0.0
Average	**1.4**	**7.7**	**0.0**

(b).Trincomalee

Year	Speed (m/s) (Annual)		
	Average	Maximum	Minimum
1994	1.0	3.5	0.0
1995	0.7	3.6	0.0
1996	1.1	9.0	0.0
1997	0.4	4.8	0.0
1998	0.8	7.3	0.0
1999	2.5	8.3	0.0
2000	1.8	9.6	0.0
2001	1.6	7.0	0.0
2002	2.2	7.2	0.0
2003	2.3	8.7	0.0
2004	2.1	7.6	0.0
2005	2.2	8.1	0.0
2006	2.1	8.5	0.0
2007	2.3	10.3	0.0
2008	2.0	6.2	0.0
2009	2.4	9.3	0.0
2010	1.8	4.6	0.0
2011	NA	NA	NA
2012	2.7	8.2	0.5
2013	2.3	6.3	0.0
2014	2.4	7.2	0.0
Average	**1.8**	**7.3**	**0.0**

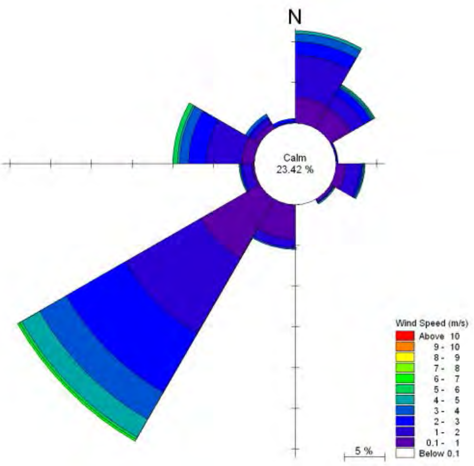
NA = Not Available

Maximum wind speed at Polonnaruwa and Trincomalee weather stations for the considered period are 8.9 m/s and 10.3 m/s respectively *(please note that wind data is not available at Trincomalee weather station for year 2011)*. According to average and maximum values of wind hazard susceptible map of Sri Lanka prepared by Disaster Management Center of Sri Lanka, average wind speed in Polonnaruwa varies between 8.2 m/s – 10.3 m/s. Further, for the same area, maximum wind speed varies between 12.7 m/s – 18.0 m/s (*see Appendix 1*). This analysis was carried out by "Weather Research and Forecasting (WRF)" model using NCEP/NCAR re-analysis data. The spatial resolution of the model is 10 X 10 km. Data between 1958 – 2009 period has been considered for the analysis. Comparing measured wind speeds and simulated wind speed, simulated values are higher than measured values. In case of measured wind data (by Meteorological Department in Sri Lanka), wind speed was recorded only at 8.30 am and 5.30 pm during each day. Our analysis includes only above values. So there is a possibility of not recording actual maximum wind speed of each day. Further, for the provided hazard map by *Disaster Management Center of Sri Lanka*, they have considered data from 1958 – 2009 period. However, for our analysis we have only considered 2010 – 2014 period considering the measured data availability in Polonnaruwa weather station. These reasons could cause the discrepancy between Meteorological Department recorded and WRF simulated values.

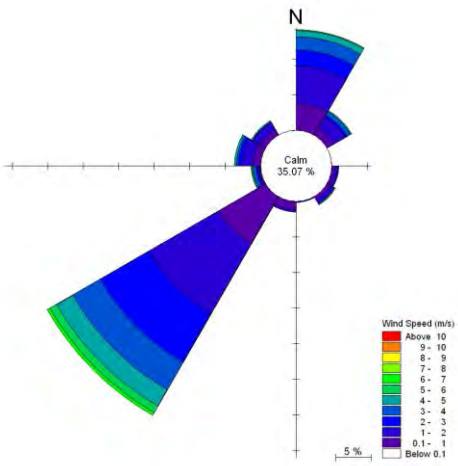
2.3.3. Wind Direction

Wind directions at Polonnaruwa and Trincomalee weather stations for the period of 2010 – 2014 are illustrated by wind rose diagrams (*Figure 2.3*). A wind rose is a graphic tool used by meteorologists to give a succinct view of how wind speed and direction are typically distributed at a particular location.

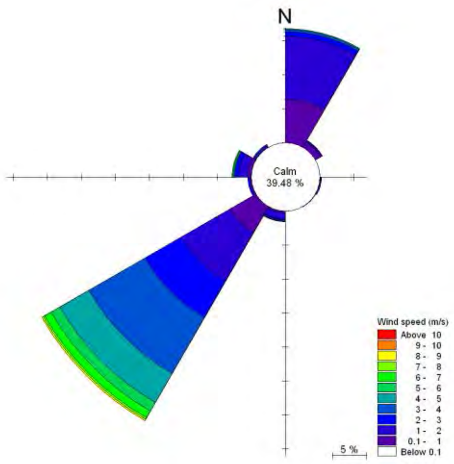
(a). Polonnaruwa



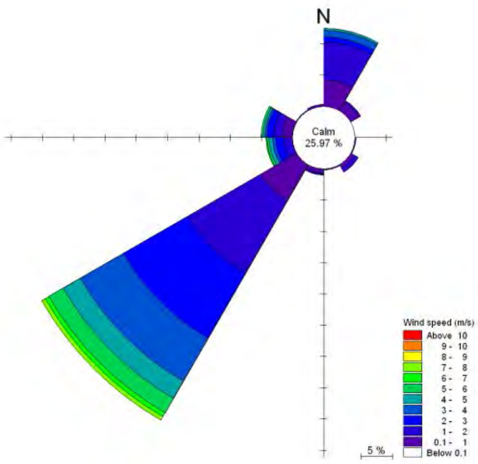
2010



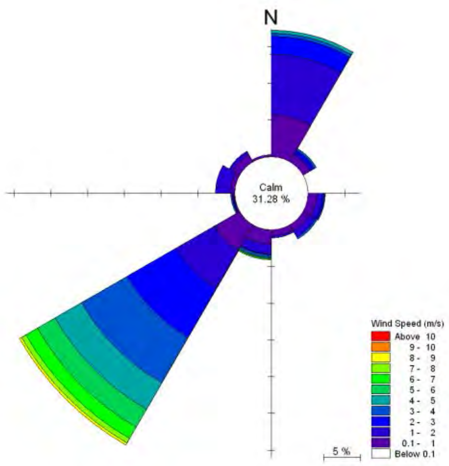
2011



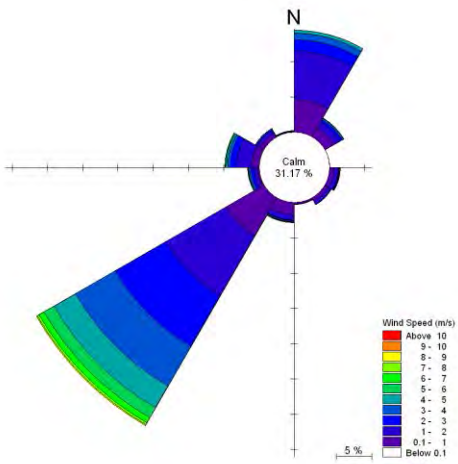
2012



2013



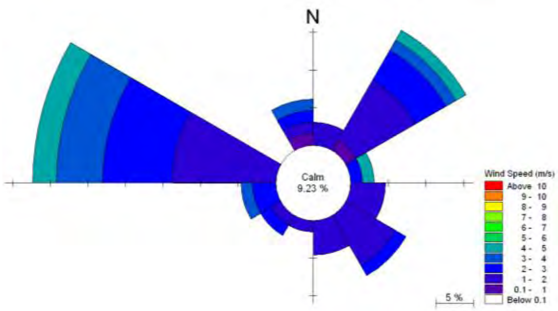
2014



All (2010-2014)

As seen in *Figure 2.3 (a),* it is clear that wind direction is dominant between 210^0 N – 240^0 N directions at Polonnaruwa weather station. Additionally, there is a considerable amount of wind has blown from 0^0 N – 30^0 N directions.

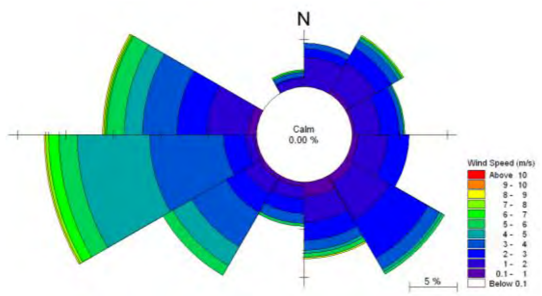
(b).Trincomalee



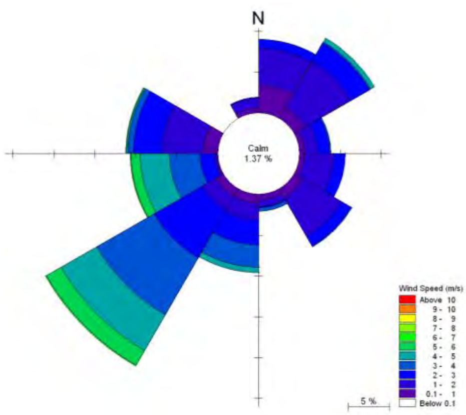
2010

Data - Not Available

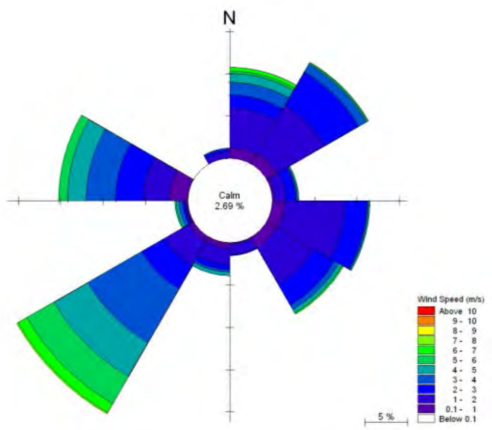
2011



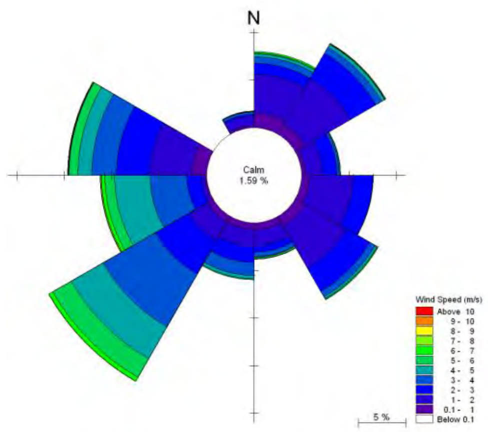
2012



2013



2014



All (2010 – 2014)

Figure 2.3: Wind Rose Diagrams for 2010 - 2014 Period at *(a).* Polonnaruwa *(b).* Trincomalee Weather Stations

As seen in *Figure 2.3 (b),* we can see that wind has blown from various directions at Trincomalee weather station. High percentage of wind has blown between 210^0 N – 300^0 N directions. Further, wind has come from 0^0 N – 150^0 N direction at Trincomalee weather station in each year. This could be resulted due to the effect of wind coming from sea side.

2.4. Ambient Temperature

2.4.1. Stations and Data Availability

Daily maximum and minimum temperature values were measured at Polonnaruwa [7.87^0, 81.05^0] and Trincomalee [8.58^0, 81.25^0] weather stations (*see Figure 2.4*). At each station, maximum and minimum temperature values were recorded during each day. Mean temperature was calculated by averaging maximum and minimum temperature values. Temperature data available duration and percentage availability at Polonnaruwa and Trincomalee stations are given in *Table 2.4.*

Table 2.4 Temperature Data Measurements Duration and Availability

Met. Parameter	Interval	Data Availability (Period & Percentage)			
		Polonnaruwa		Trincomalee	
		Period	%	Period	%
Ambient Temperature (Max.)	Daily	*(6 Yrs.)* 2009 -2014	98.6	*(21 Yrs.) 1994 -2014*	95.0
Ambient Temperature (Min.)	Daily	*(6Yrs.)* 2009 -2014	98.5	*(21 Yrs.) 1994 -2014*	95.6

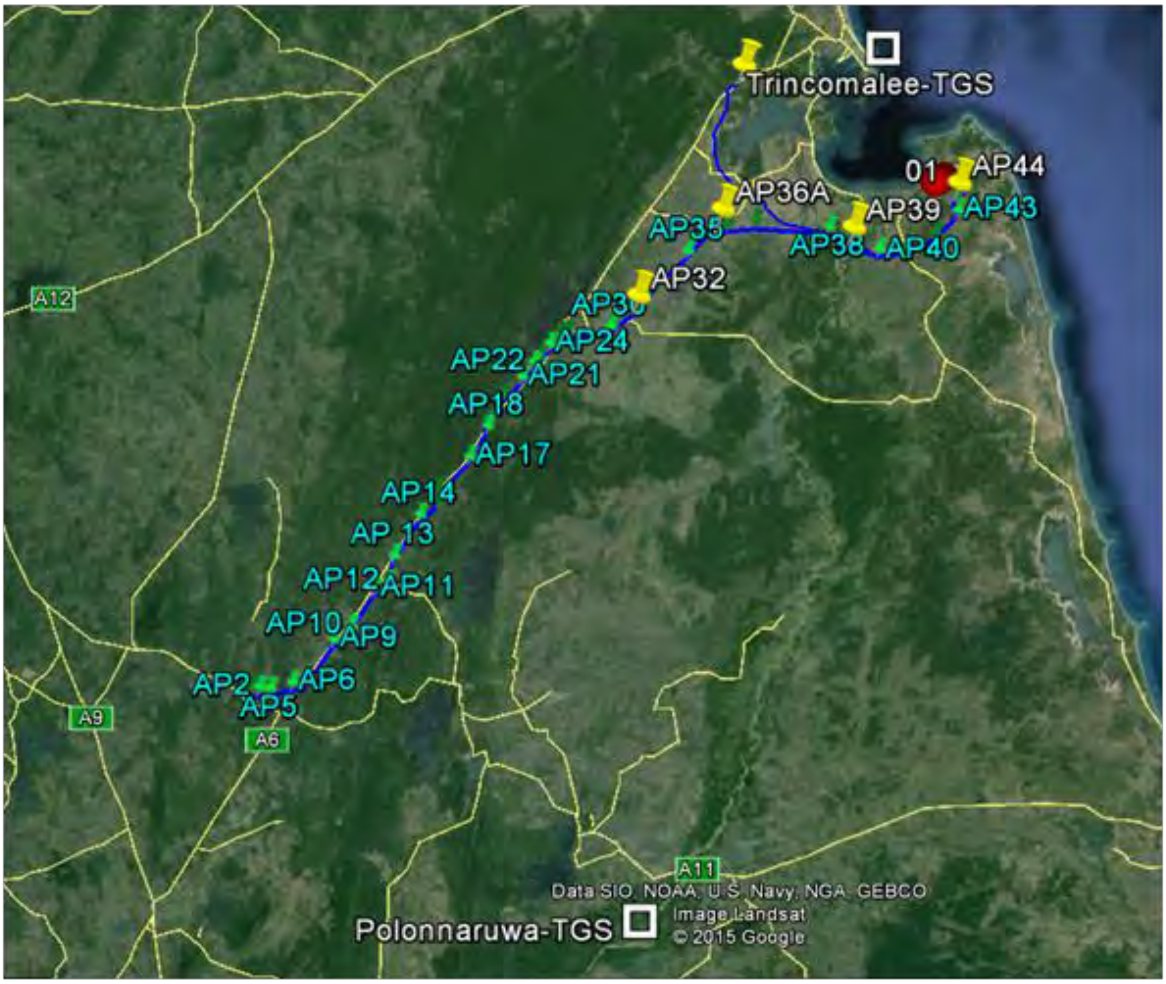


Figure 2.4: Ambient Temperature Measurements – Weather Stations

Temperature data explained in *Table 2.4* is given with enclosed CDROM in digital format *(i.e. 2.Temperature.xlsx)*

Annual maximum, minimum and mean temperature values for the available periods at Polonnaruwa and Trincomalee weather stations are given in *Table 2.5*.

Table 2.5 Annual Maximum, Minimum and Mean Temperatures at *(a)* Polonnaruwa and *(b).*Trincomalee Weather Stations

(a). Polonnaruwa

Polonnaruwa			
Year	Max. Temp (^{0}C)	Min. Temp (^{0}C)	Avg.Temp (^{0}C)
2009	38.5	14.4	28.5
2010	37.3	17.9	28.1
2011	38.3	16.5	28.3
2012	39.0	18.0	28.8
2013	38.2	18.2	28.6
2014	38.5	16.4	28.6
Average	**38.3**	**16.9**	**28.5**

(b).Trincomalee

Trincomalee			
Year	Max. Temp (^{0}C)	Min. Temp (^{0}C)	Avg.Temp (^{0}C)
1994	38.2	21.6	28.7
1995	37.8	22.1	28.9
1996	39.6	21.2	28.7
1997	39.0	20.1	28.2
1998	39.3	22.4	29.4
1999	39.3	20.8	28.7
2000	38.2	22.0	28.9
2001	39.0	20.7	28.9
2002	39.1	21.6	29.2
2003	38.4	21.9	29.0
2004	39.2	20.9	28.7
2005	38.2	20.0	28.9
2006	38.3	20.7	29.1
2007	38.2	19.0	28.7
2008	38.7	21.1	28.6
2009	38.4	19.6	28.9
2010	38.6	19.0	29.2
2011	37.4	23.4	30.0
2012	39.5	21.2	29.1
2013	38.3	20.6	28.5
2014	39.1	20.0	28.8
Average	**38.7**	**20.9**	**28.9**

From above analysis, it can be identified that maximum temperature at both stations has reached to 39^{0}C for the considered period. Also, it clear that minimum temperature at Trincomalee is higher than Polonnaruwa weather stations for the considered common period (*i.e. 2009 – 2014*).

2.5. Relative Humidity

2.5.1. Stations and Data Availability

Daily maximum relative humidity values were measured at Polonnaruwa [7.87^0, 81.05^0] and Trincomalee [8.58^0, 81.25^0] weather stations for year 2014 (*see Figure 2.5*). At each station, maximum and minimum relative humidity values were recorded during each day. Hourly recorded relative humidity data is not available at both stations. In line with the Scope of the Service, maximum values of relative humidity data were considered for the analysis. Relative humidity data available duration and percentage availability at Polonnaruwa and Trincomalee stations are given in *Table 2.6*.

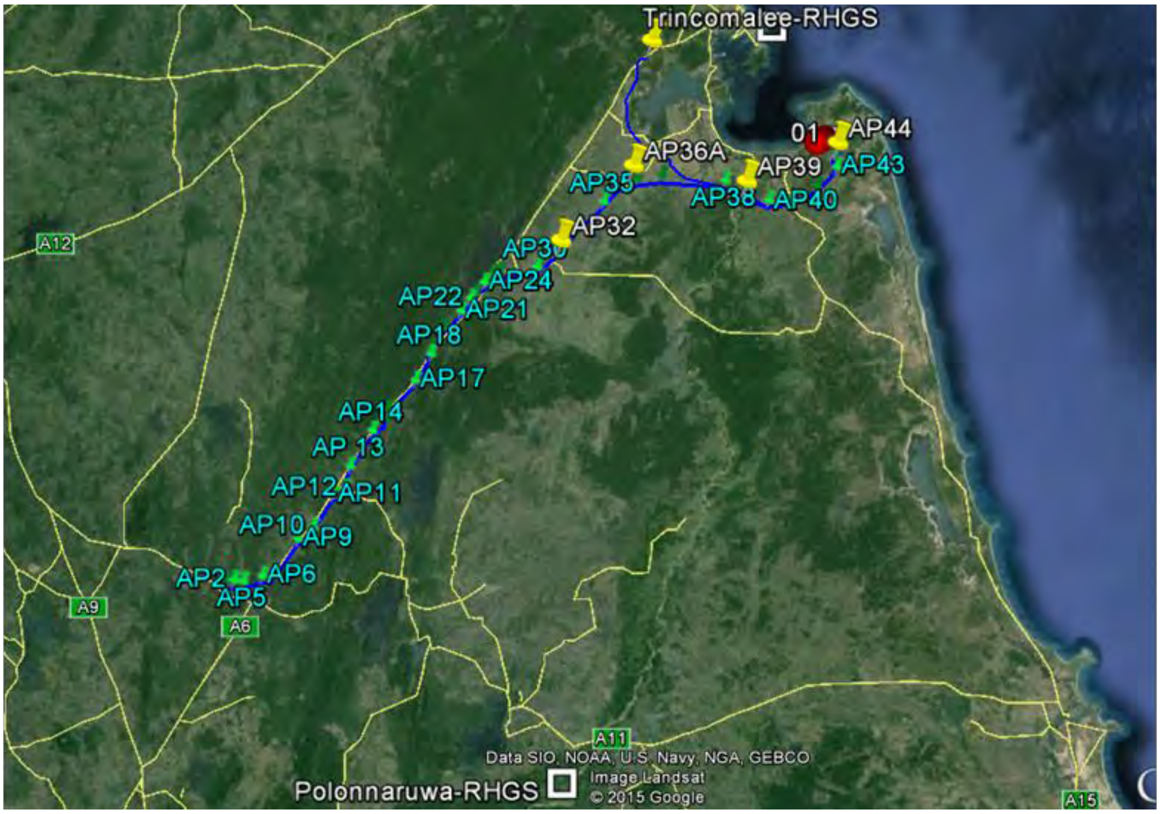


Figure 2.5: Relative Humidity Measurements – Weather Stations

Table 2.6 Relative Humidity Measurements Duration and Availability

Met. Parameter	Interval	Data Availability (Period & Percentage)			
		Polonnaruwa		Trincomalee	
		Period	%	Period	%
Relative Humidity (Max.)	Daily	*(1 Yrs.) 2014*	*83.3*	*(1 Yrs.) 2014*	*66.3*

Relative humidity data explained in Table 2.6 is given with enclosed CDROM in digital format *(i.e. 3.Relative Humidity.xlsx)*. Daily maximum relative humidity values for year 2014 at Polonnaruwa and Trincomalee weather stations are given in *Table 2.7* and *Table 2.8* respectively.

Table 2.7 Maximum Relative Humidity at Polonnaruwa in 2014

Year	Day	Daily Maximum Relative Humidity											
		January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
2014	1	96	91	96	92	97	84	67	68	*NA*	96	87	*NA*
2014	2	93	97	96	92	97	76	69	64	*NA*	96	88	*NA*
2014	3	92	96	94	93	95	82	68	64	*NA*	93	92	*NA*
2014	4	86	98	95	86	97	69	68	64	*NA*	95	92	*NA*
2014	5	92	97	95	89	92	71	65	64	*NA*	94	93	*NA*
2014	6	98	96	95	93	95	66	65	65	*NA*	75	93	*NA*
2014	7	94	97	95	90	89	66	67	81	*NA*	69	94	*NA*
2014	8	94	97	94	91	96	68	67	59	*NA*	89	95	*NA*
2014	9	93	95	96	88	96	64	66	64	*NA*	77	96	*NA*
2014	10	97	96	96	89	91	64	65	63	*NA*	59	96	*NA*
2014	11	96	95	96	90	92	68	64	65	*NA*	62	95	*NA*
2014	12	94	95	96	90	91	67	65	63	*NA*	61	98	*NA*
2014	13	97	97	97	91	88	67	64	63	*NA*	93	98	*NA*
2014	14	97	96	93	93	77	66	59	57	*NA*	92	97	*NA*
2014	15	100	93	97	90	81	72	63	79	*NA*	94	94	*NA*
2014	16	99	93	94	87	78	65	71	84	*NA*	96	97	*NA*
2014	17	96	97	94	92	85	70	64	94	*NA*	97	98	*NA*
2014	18	97	97	94	92	90	64	64	96	*NA*	98	97	*NA*
2014	19	98	95	97	90	90	68	63	96	*NA*	98	99	*NA*
2014	20	97	96	96	92	93	67	67	92	*NA*	99	99	*NA*
2014	21	96	94	96	93	68	68	65	96	*NA*	96	88	*NA*
2014	22	97	96	93	93	60	62	65	75	*NA*	95	99	*NA*
2014	23	98	97	96	94	72	65	67	72	*NA*	97	99	*NA*
2014	24	97	94	94	92	72	64	67	90	*NA*	98	98	*NA*
2014	25	95	94	97	87	89	66	68	89	*NA*	95	97	*NA*
2014	26	96	99	93	87	78	68	66	67	*NA*	96	99	*NA*
2014	27	96	100	95	88	97	79	67	79	*NA*	96	99	*NA*
2014	28	99	96	95	95	98	65	64	68	*NA*	95	95	*NA*
2014	29	99		96	97	96	64	68	67	*NA*	96	91	*NA*
2014	30	97		94	98	74	67	63	66	*NA*	95	98	*NA*
2014	31	97		90		75		64	66		92		*NA*
Average		**96**	**96**	**95**	**91**	**87**	**68**	**66**	**74**	**NA**	**90**	**95**	**NA**

NA = Not Available

Yearly Avarage = 86

Table 2.8 Maximum Relative Humidity at Trincomalee in 2014

Year	Day	Daily Maximum Relative Humidity											
		January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
2014	1	82	85	85	88	89	87	*NA*	*NA*	77	91	*NA*	*NA*
2014	2	88	84	86	91	90	81	*NA*	*NA*	73	97	*NA*	*NA*
2014	3	95	78	84	87	92	80	*NA*	*NA*	76	79	*NA*	*NA*
2014	4	97	76	83	86	96	80	*NA*	*NA*	81	0	*NA*	*NA*
2014	5	98	75	84	88	86	77	*NA*	*NA*	71	95	*NA*	*NA*
2014	6	98	73	84	86	87	77	*NA*	*NA*	0	80	*NA*	*NA*
2014	7	96	72	84	85	94	73	*NA*	*NA*	82	83	*NA*	*NA*
2014	8	95	72	79	86	93	73	*NA*	*NA*	74	83	*NA*	*NA*
2014	9	84	71	78	85	94	74	*NA*	*NA*	73	88	*NA*	*NA*
2014	10	88	81	75	86	86	75	*NA*	*NA*	73	64	*NA*	*NA*
2014	11	89	77	74	87	86	75	*NA*	*NA*	92	0	*NA*	*NA*
2014	12	92	89	78	88	88	75	*NA*	*NA*	97	87	*NA*	*NA*
2014	13	95	83	66	87	83	79	*NA*	*NA*	0	87	*NA*	*NA*
2014	14	93	86	72	86	84	78	*NA*	*NA*	83	89	*NA*	*NA*
2014	15	93	85	78	88	82	79	*NA*	*NA*	77	93	*NA*	*NA*
2014	16	89	89	82	81	76	75	*NA*	*NA*	70	94	*NA*	*NA*
2014	17	77	83	82	83	72	77	*NA*	*NA*	72	98	*NA*	*NA*
2014	18	92	84	88	88	79	76	*NA*	*NA*	73	0	*NA*	*NA*
2014	19	84	79	93	89	80	80	*NA*	*NA*	64	97	*NA*	*NA*
2014	20	87	74	90	87	83	78	*NA*	*NA*	0	94	*NA*	*NA*
2014	21	82	80	92	87	79	78	*NA*	*NA*	93	91	*NA*	*NA*
2014	22	88	84	89	90	74	78	*NA*	*NA*	86	91	*NA*	*NA*
2014	23	83	89	90	84	80	77	*NA*	*NA*	85	95	*NA*	*NA*
2014	24	76	86	89	83	83	76	*NA*	*NA*	85	87	*NA*	*NA*
2014	25	72	79	81	83	81	76	*NA*	*NA*	96	0	*NA*	*NA*
2014	26	75	97	82	86	78	73	*NA*	*NA*	98	93	*NA*	*NA*
2014	27	81	91	81	85	85	79	*NA*	*NA*	0	89	*NA*	*NA*
2014	28	86	76	90	89	88	79	*NA*	*NA*	98	94	*NA*	*NA*
2014	29	93		88	94	81	77	*NA*	*NA*	91	95	*NA*	*NA*
2014	30	95		88	90	82	80	*NA*	*NA*	92	93	*NA*	*NA*
2014	31	90		86		84		*NA*	*NA*		90		*NA*
Average		**88**	**81**	**83**	**87**	**84**	**77**	**NA**	**NA**	**71**	**78**	**NA**	**NA**

NA = Not Available

Yearly Avarage = 81

As seen in *Table 2.7* and *Table 2.8*, maximum relative humidity at Polonnaruwa and Trincomalee weather stations were recorded as 100 and 98 respectively. Also, yearly average value at Polonnaruwa and Trincomalee weather stations were calculated as 86 and 81 respectively. Generally, relative humidity at Polonnaruwa is higher than Trincomalee weather station.

2.6. Rainfall

2.6.1. Stations and Data Availability

Rainfall data at 6 gauging stations in the vicinity of the proposed transmission line were collected. Coordinates of selected Polonnaruwa, Trincomalee Habarana, Kaudulla, Kanthale and Palampoddiar gauging stations are [7.87^0, 81.05^0], [8.58^0, 81.25^0], [8.03^0, 80.75^0], [8.13^0, 80.93^0], [8.35^0, 80.98^0] and [8.55^0, 81.07^0] respectively (*see Figure 2.6*). At each station, daily rainfall was recorded. Rainfall data available duration and percentage availability at 6 gauging stations are given in *Table 2.9*.

Figure 2.6: Rainfall Measurements – Gauging Stations

Table 2.9 Rainfall Data Measurements Duration and Availability

Met. Parameter	Interval	Data Availability (Period & Percentage)		
		Station NM	Period	%
Rainfall	Daily	Polonnaruwa	*(6 Yrs.)* 2009 -2014	98.6
	Daily	Trincomalee	*(5 Yrs.)* 2010 -2014	100.0
	Daily	Palampoddiar RFGS	*(5 Yrs.)* 2010 -2014	91.7
	Daily	Kanthale RFGS	*(5 Yrs.)* 2010 -2014	95.0
	Daily	Kaudulla RFGS	*(5 Yrs.)* 2010 -2014	89.9
	Daily	Habarana RFGS	*(5 Yrs.)* 2010 -2014	95.0

Rainfall data explained in *Table 2.9* is given with enclosed CDROM in digital format (*i.e. 4.Rainfall.xlsx*). Monthly and annual total rainfall values for the considered periods at 6 gauging stations are tabulated in *Table 2.10*.

Table 2.10 Monthly and Annual Total Rainfall Values at 6 Gauging Stations

(a). Polonnaruwa

Year	Polonnaruwa-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual Tot.*
2009	-	1	161	247	21	0	35	80	20	105	301	544	**1515**
2010	123	29	103	247	242	0	91	92	245	183	334	81	**1770**
2011	663	560	45	151	2	0	39	81	7	735	519	360	**3160**
2012	7	239	24	63	0	0	67	4	32	550	249	661	**1896**
2013	390	162	207	44	108	0	12	68	12	39	143	228	**1414**
2014	270	62	5	58	138	0	0	51	101	319	508	1130	**2642**
Average	**291**	**175**	**91**	**135**	**85**	**0**	**41**	**62**	**70**	**322**	**343**	**500**	**2066**

(b). Trincomalee

Year	Trincomalee-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Ann. Tot.*
2010	48	4	3	2	42	19	23	96	197	71	292	622	**1419**
2011	817	481	44	197	1	1	34	80	32	548	352	320	**2907**
2012	13	156	21	13	1	0	16	4	231	597	181	590	**1823**
2013	200	355	239	3	132	1	65	93	2	35	177	190	**1493**
2014	164	83	5	2	57	5	25	120	108	160	430	532	**1691**
Average	**249**	**216**	**62**	**43**	**47**	**5**	**33**	**79**	**114**	**282**	**286**	**451**	**1867**

(c). Habarana

Year	Habarana-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual Tot.*
2010	45	65	44	89	72	0	19	74	171	62	350	355	**1346**
2011	617	441	132	162	0	0	6	10	8	400	470	303	**2548**
2012	-	179	58	99	4	11	0	2	3	509	133	550	**-**
2013	275	154	130	89	74	0	79	90	26	83	122	124	**1245**
2014	248	20	0	140	79	0	0	15	261	379	-	-	**-**
Average	**296**	**172**	**73**	**116**	**46**	**2**	**21**	**38**	**94**	**286**	**269**	**333**	**1713**

(d). Kaudulla

Year	Kaudulla-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual Tot.*
2010	7	47	34	126	107	0	70	100	165	224	339	418	**1637**
2011	671	437	66	81	0	0	86	0	0	621	451		**-**
2012	-	99	8	125	0	0	0	0	8	672	132	625	**-**
2013	413	177	166	58	146	25	25	14	0	246	57	114	**1440**
2014	140	69	-	102	113	0	0	24	201	-	-	-	**-**
Average	**308**	**166**	**68**	**98**	**73**	**5**	**36**	**28**	**75**	**441**	**245**	**386**	**1539**

(e). Kanthale

Year	Kanthale-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual Tot.*
2010	19	24	3	58	124	0	137	164	155	123	474	540	**1820**
2011	661	607	119	106	15	0	67	57	37	722	510	280	**3181**
2012	11	145	28	299	39	0	20	0	-	682	168	767	**-**
2013	239	288	221	111	154	0	5	34	0	104	190	158	**1503**
2014	225	63	0	29	267	0	0	118	140	385	-	-	**-**
Average	**231**	**226**	**74**	**120**	**120**	**0**	**46**	**75**	**83**	**403**	**335**	**437**	**2168**

(f). Palampoddiar

Year	Palampoddiar-Rainfall (mm)												
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual Tot.*
2010	44	32	70	-	202	13	87	196	334	118	462	804	**-**
2011	531	484	0	56	0	0	70	121	47	969	722	469	**3469**
2012	12	145	12	243	15	-	55	0	112	554	255	764	**-**
2013	201	369	196	28	107	-	1	21	1	53	154	187	**-**
2014	158	75	16	39	90	0	1	103	89	314	-	-	**-**
Average	**189**	**221**	**59**	**92**	**83**	**4**	**43**	**88**	**116**	**402**	**398**	**556**	**3469**

It is clear that highest rainfall has occurred during October to February period at all stations. This could be resulted due to the north-east and inter monsoon effects. Rainfall amount during June and July months are identified as lower than other months. Out of all stations, rainfall at Polonnaruwa and Kanthale stations are higher than other stations (*NB*: *Palampoddiar GS was excluded considering non data availability*). In 2011, comparatively high rainfall has occurred at all stations.

2.7. Solar Radiation

2.7.1. Stations and Data Availability

Solar radiation is radiant energy emitted by the sun. The solar radiation is expressed in watts per square meter (W/m^2) and the total amount of solar radiation is expressed in joules per square meter (J/m^2). Solar radiation values are available only at Polonnaruwa weather stations [7.87^0, 81.05^0] in the vicinity of the proposed transmission line (*see Figure 2.7*). For the period of July 2011 – September 2012, total solar radiation (e.g. hourly, monthly) was recorded by Meteorological Department. Solar radiation data available duration and percentage availability at Polonnaruwa station are given in *Table 2.11*.

Figure 2.7: Solar Radiation Measurements – Polonnaruwa Weather Station

Table 2.11 Solar Radiation Data Measurements Duration and Availability

Met. Parameter	Interval	Data Availability (Period & Percentage) at Polonnaruwa	
		Period	%
Solar Radiation Total/Max./Min.	Monthly/hourly	*(1 Yrs.)* 2011/7 - 2012/9	93.3

Solar radiation data explained in *Table 2.11* is given with enclosed CDROM in digital format *(i.e. 5.Solar Radiation.xlsx).*

Total solar radiation values for the considered periods at Polonnaruwa weather stations are given in *Table 2.12.* Generally, Meteorological Department records total solar radiation values (i.e. not an instantaneously values). In each hour, Meteorological Department records total solar radiation. Considering total of each day of each month, maximum and minimum daily total solar radiation is identified. Further, total monthly solar radiation is calculated (Table 2.12). Thus, considering the daily total, maximum solar radiation was identified as 27 MJ/m^2 for the considered period.

Table 2.12 Monthly/Daily Total Maximum and Minimum Solar Radiation

Year and Month	Solar Radiation(MJ/m^2)		
	Total (Monthly total) [1]	*Maximum (Daily total)* [2]	*Minimum (Daily total)* [2]
2011-07	553	25	0
2011-08	708	26	14
2011-09	680	26	13
2011-10	561	24	8
2011-11	430	21	3
2011-12	NA	NA	NA
2012-01	563	22	14
2012-02	476	23	4
2012-03	680	26	16
2012-04	612	27	14
2012-05	679	27	16
2012-06	648	25	13
2012-07	691	26	12
2012-08	710	26	16
2012-09	642	26	16
Average	**617**	**25**	**11**

Table 2.13 Hourly Maximum Total and Average Solar Radiation

Date	Hour of the Maximum Solar Radiation Received	Solar Radiation	
		(MJ/m^2) (Hourly Total)	*W/m^2*
7/20/2011	12-13hrs	3.45	958
8/23/2011	12-13hrs	3.54	983
9/17/2011	12-13hrs	3.60	1000
10/17/2011	11-12hrs	3.44	956
11/13/2011	10-11hrs	3.06	850
2011-12	*NA*	*NA*	*NA*
1/1/2012	12-13hrs	3.22	894
2/11/2012	11-12hrs	3.56	989
3/24/2012	12-13hrs	3.54	983
4/5/2012	12-13hrs	3.67	1019
5/3/2012	11-12hrs	3.62	1006
6/23/2012	11-12hrs	3.28	911
7/30/2012	11-12hrs	3.47	964
8/12/2012	12-13hrs	3.49	969
9/2/2012	12-13hrs	3.48	967
Average		**3.46**	**961**

In Table 2.12, MJ (Mega Joules) values refer to "Energy". To calculate solar radiation in W (Watt), referring "Power", it can be approximated by dividing MJ/m^2 values by corresponding time period. For this purpose, maximum "hourly" total solar radiation of each month in MJ/m^2 was used. Assuming constant solar radiation throughout the considered one hour of period, solar radiation was calculated in W/m^2, dividing MJ/m^2 by hour of time *(i.e. 60 x 60 Seconds) (See Table 2.13).*

2.8. Thunder Days

2.8.1. Stations and Data Availability

Thunder days were measured at Polonnaruwa [7.87^0, 81.05^0] and Trincomalee [8.58^0, 81.25^0] weather stations for 2011 – 2013 periods (*see Figure 2.8*). Thunder (or lightning) is counted during 24 hours of each day. If 1 or more thunder (or lightning) occurs during a day, that day is considered as a "Thunder Day". Thus, thunder days of each month was counted. Thunder days data available duration and percentage availability at Polonnaruwa and Trincomalee stations are given in *Table 2.13.*

Table 2.13 Thunder Day Data Measurements Duration and Availability

Met. Parameter	Interval	Data Availability *(Period & Percentage)*			
		Polonnaruwa		Trincomalee	
		Period	%	Period	%
Thunder Days	*Availability:* Monthly only	*(3 Yrs.)* 2011 - 2013	100.0	*(3 Yrs.)* 2011 - 2013	100.0

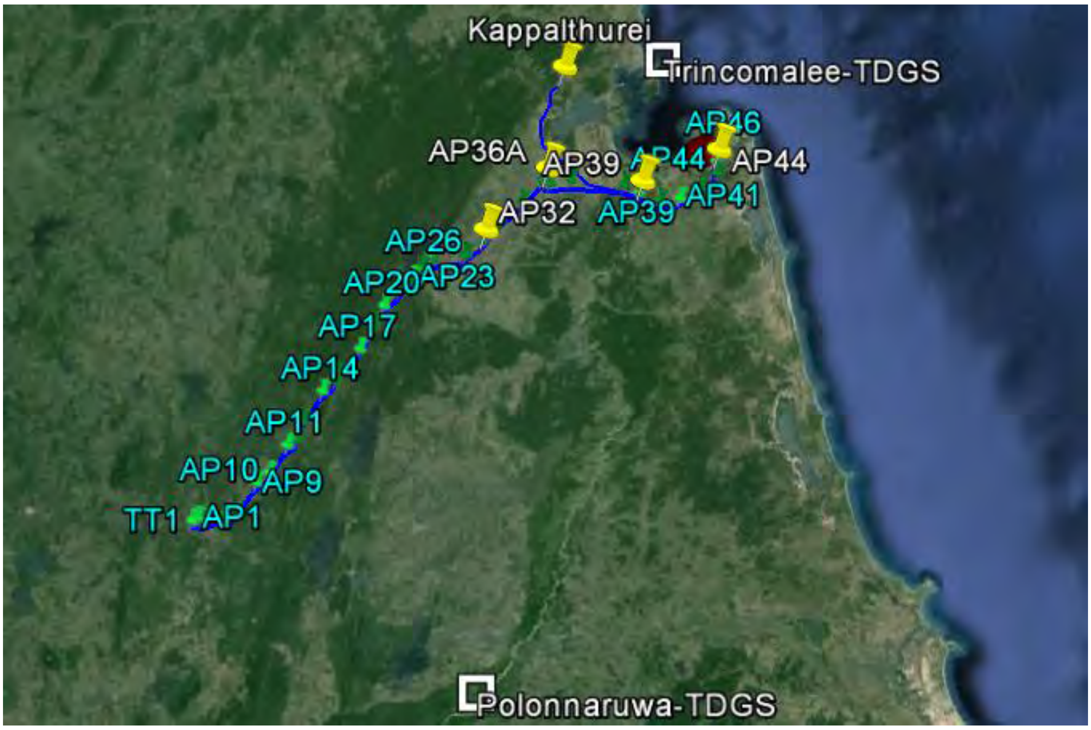


Figure 2.8: Thunder Day Measurements – Weather Station

Thunder days data explained in *Table 2.13* is given with enclosed CDROM in digital format *(6.Thunder days.xlsx).* Monthly thunder day values for 2011 - 2013 periods at Polonnaruwa and Trincomalee stations are given in *Table 2.14*. Except 2011, yearly average thunder days at both stations were calculated as 5. Further, number of thunder days at Polonnaruwa and Trincomalee during April and October months are higher than other months for 2011 – 2013 periods.

Table 2.14 Monthly Thunder Days at (a) Polonnaruwa and (b).Trincomalee Weather Stations

(a). Polonnaruwa

Month	Year			Monthly Average
	2011	2012	2013	
January	5	0	4	**3**
February	1	4	2	**2**
March	6	2	9	**6**
April	12	15	16	**14**
May	3	1	3	**2**
June	0	0	0	**0**
July	2	5	1	**3**
August	2	2	3	**2**
September	1	5	3	**3**
October	19	15	9	**14**
November	9	3	7	**6**
December	4	6	0	**3**
Average	**5**	**5**	**5**	**5**

(b). Trincomalee

Month	Year			Monthly Average
	2011	2012	2013	
January	NA	2	1	**2**
February	6	8	0	**5**
March	2	3	0	**2**
April	24	8	5	**12**
May	3	8	10	**7**
June	0	0	0	**0**
July	8	4	5	**6**
August	4	10	10	**8**
September	12	3	7	**7**
October	19	6	9	**11**
November	3	7	7	**6**
December	10	1	1	**4**
Average	**8**	**5**	**5**	**6**

NA = Not Available

CHAPTER 3
HYDROLOGICAL SURVEY AND INVESTIGATIONS

3.1. Measurement of Elevations at Points LP1- LP11

3.1.1. Details of Points

Details of the expected measurement points (i.e. *LP1 – LP 11*) are given in *Figure 3.1* and *Table 3.1.*

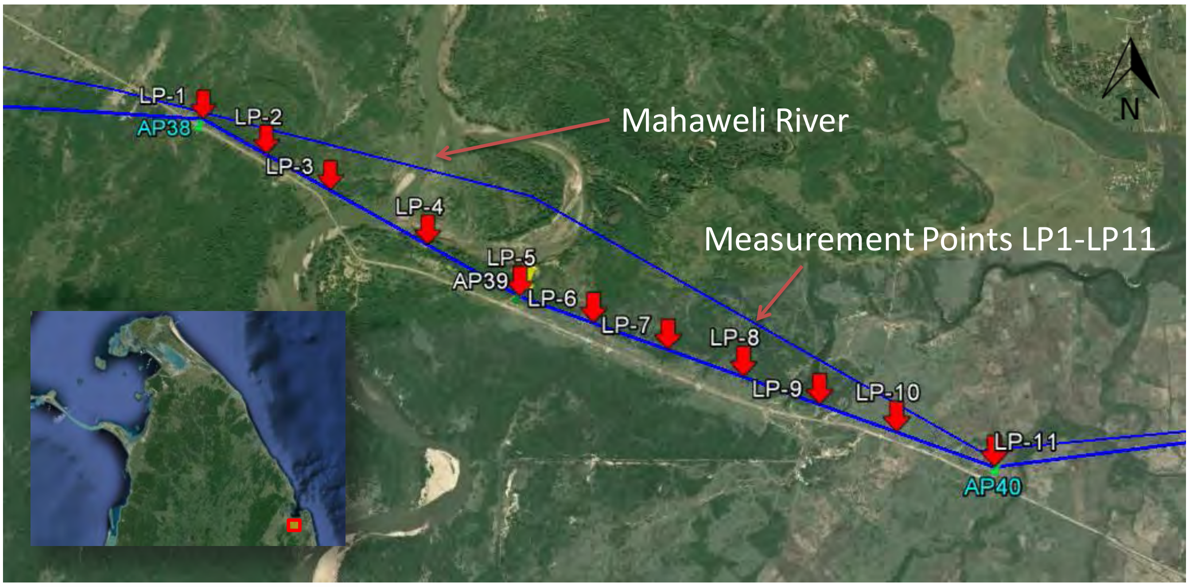


Figure 3.1: Measurement Points (L1 – L11)

Table 3.1 Coordinates of Measurement Points (L1 – L11)

Point	Coordinate(UTM)		Note
LP1	522446.43 m E	931697.93 m N	AP38
LP2	522836.37 m E	931475.79 m N	
LP3	523226.75 m E	931252.33 m N	
LP4	523809.56 m E	930918.48 m N	
LP5	524347.96 m E	930611.15 m N	AP39
LP6	524768.70 m E	930456.42 m N	
LP7	525190.93 m E	930300.70 m N	
LP8	525612.87 m E	930144.29 m N	
LP9	526033.98 m E	929987.60 m N	
LP10	526455.24 m E	929832.80 m N	
LP11	526982.92 m E	929639.64 m N	AP4

3.1.2. Surveying Elevations at Points LP1 - LP11

During 12th - 15th February in 2015, LHI survey team went to the site to measure elevations of specified points (*i.e. LP1 to LP11*). However, due to the flooding condition in study are (*i.e. around Mahaweli River*), it was difficult to reach to exact locations *(see Appendix 2 for site condition during 12 th -15 th of February in 2015).* During this period, LHI survey team used a control point established by Surveying Department (*i.e. SLGI02 = [531862.75 m E, 936608.09 m N*]) (*see Appendix 3*) for the present survey. Based on this control point, control points were established in site (*i.e. LHI 01 = [525532.00 m E, 930054.00 m N], and LHI 02 = [523214.00 m E, 931136.00 m N*] (*see Appendix 4)* to measure elevations of specified points.

During 13th - 15th March in 2015, LHI survey team measured elevations at specified location (*i.e. LP1 to LP11)*. This task was carried out by using DGPS, Auto Level and Total Station. To measure elevation points LP1 – LP6 and LP7 – LP11, previously established LHI 02 and LHI 01 control point were used respectively. Pictures of LP1 – LP11 points are shown in *Appendix 5.* Measured elevations are presented in *Table 3.2*.

Table 3.2 Elevation of LP1 – LP11 Points

Point	Coordinate(UTM)		Ground Level (above MSL in m)
LP1	522446.43 m E	931697.93 m N	2.515
LP2	522836.37 m E	931475.79 m N	2.999
LP3	523226.75 m E	931252.33 m N	2.923
LP4	523809.56 m E	930918.48 m N	3.115
LP5	524347.96 m E	930611.15 m N	2.505
LP6	524768.70 m E	930456.42 m N	2.969
LP7	525190.93 m E	930300.70 m N	2.408
LP8	525612.87 m E	930144.29 m N	2.072
LP9	526033.98 m E	929987.60 m N	2.229
LP10	526455.24 m E	929832.80 m N	2.131
LP11	526982.92 m E	929639.64 m N	2.023

3.2. Investigation of OHWL and MHWL

The ordinary high water level *(OHWL)* is a line on the bank or shore to which the high water ordinarily rises each year. It is the water ward limit of upland vegetation and soil. This line is not established based on the level to which the water rises during major floods. It is generally recognizable by a visible change in the soil and vegetation. OHWL is used to define the boundary of in-water work. Any work below the OHWL is considered to be in-water work and special measures must be taken to protect the water way. To investigate Ordinary High Water Level (OHWL) and Maximum High Water Level (MHWL), attempts were made with two approaches as follows.

3.2.1. Field Investigation to Identify High Water Levels

On 14th of March in 2015, field investigation was carried out in left and right banks of the Mahaweli River where transmission line crosses the river. As seen in *Figure 3.2*, natural features nearby river along LP3 – LP4 was considered.

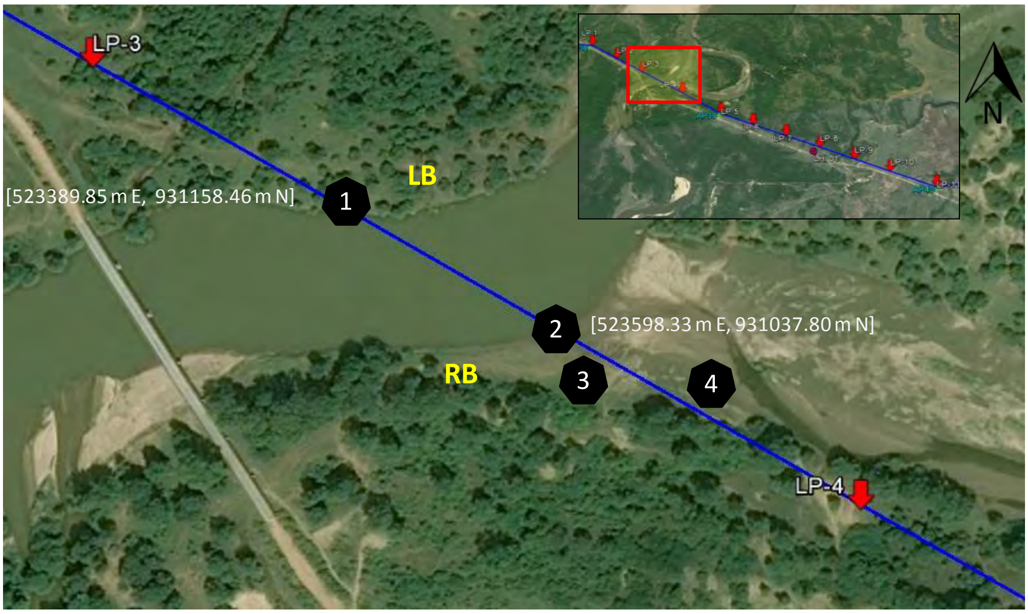


Figure 3.2: LB and RB Areas of River along the Transmission Line

Vegetation patterns and natural feature of points 1 – 4 along LP3 – LP4 line is further illustrated in *Figure 3.3*. As seen in Figure No. 1, erosion has occurred in left bank area. As a result, nearly vertical slope has formed in the collapsed left bank. Therefore, vegetation pattern in the left bank area is barely helpful to identify high water levels. Similarly, as seen in Figure No. 2 and 3, clay has deposited in the right bank side up to 2.67 m MSL. Hence, only considering vegetation pattern in right bank side, it is difficult to identify high water levels.


1
3.30 m MSL


2
2.67 m MSL

Figure 3.3: Natural Features of River Banks along the Transmission Line

River cross section survey was carried out along the transmission line during the same survey period. River cross selection along the transmission line is shown in *Figure 3.4 (NB: Vertical and horizontal scale are different)*.

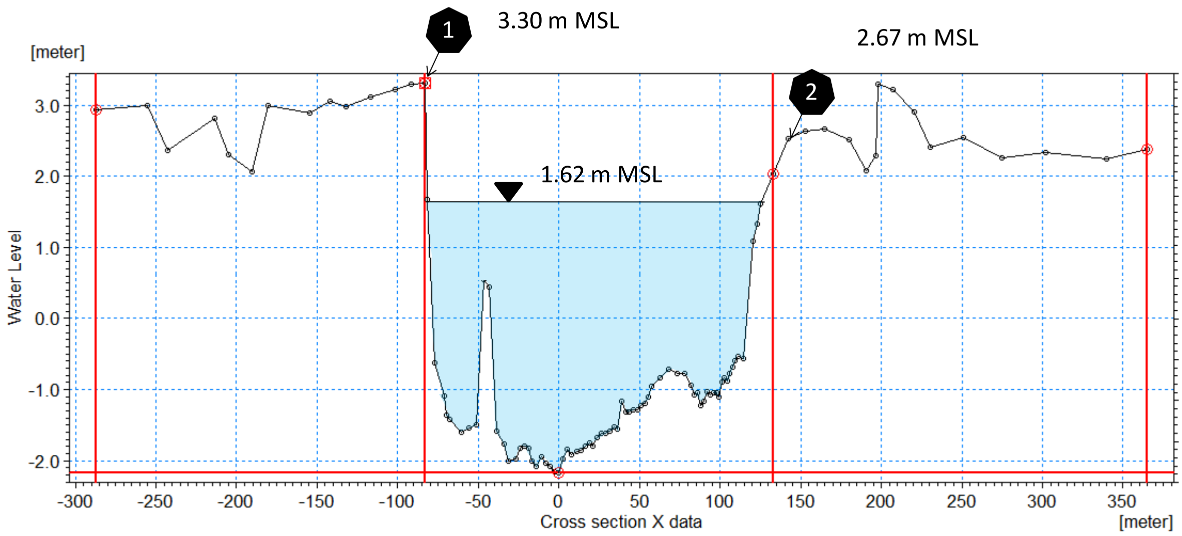


Figure 3.4: River Cross Section along the Transmission Line *(On 14th of March in 2015)*

According to *John Scherek and Glen Yakel (1993*), the OHWL is the elevation of the top of the bank of the channel for watercourses such as river. As seen in Figure No. 1 and Figure 3.4, the top level of collapsed river left bank is 3.30 m MSL. However, flooding level could be higher than 3.30 m MSL during the flooding time.

To further investigate about high water levels, numerical simulation was carried out.

3.2.2. Numerical Simulation to Identify High Water Levels

To identify high water levels, numerical model simulation was conducted by using MIKE 21 Hydrodynamic Model (*HD*). Hydrological characteristics required for the model was obtained from calibrated rainfall - runoff (*RR*) model of MIKE 11 modelling system.

MIKE 21 Hydrodynamic (HD) Model System

MIKE 21 HD is a modelling system for 2D free-surface flows and applicable to the simulation of hydraulic and environmental phenomena in lakes, estuaries, bays, coastal areas and seas in response to a variety of forcing functions including tide, wind, wave and river flow. It provides the hydrodynamic basis for the computations performed in the environmental hydraulics and sediment transport modules. MIKE 21 HD Model has the capability to simulate changes of depth (water level) and discharge along and across the river reaches with time. Further, computation of flow velocities and flow patterns are other important capabilities of the same model. Thus, water level at interested point was predicted by using the MIKE 21 HD model.

Model Set-up

The MIKE 21 HD (Flexible Mesh) was selected for the proposed study. By using flexible mesh, it is easy to model small areas with different grid resolutions. Thus, interested area can be defined with a high resolution. Further, model boundaries can be set up smoothly with flexible mesh of this model.

Bathymetry

Bathymetry was created in 2D plane to include the flood inundation areas. Since the flood plain spreads over few kilometers from the river, wider bathymetry was prepared rather than having only a narrow river path. Surveyed river cross sectional data, 1:50,000 topographic maps and Google Earth images were used for the preparation of bathymetry. *Figure 3.5* shows the bathymetry of the project area prepared for the model with flexible mesh.

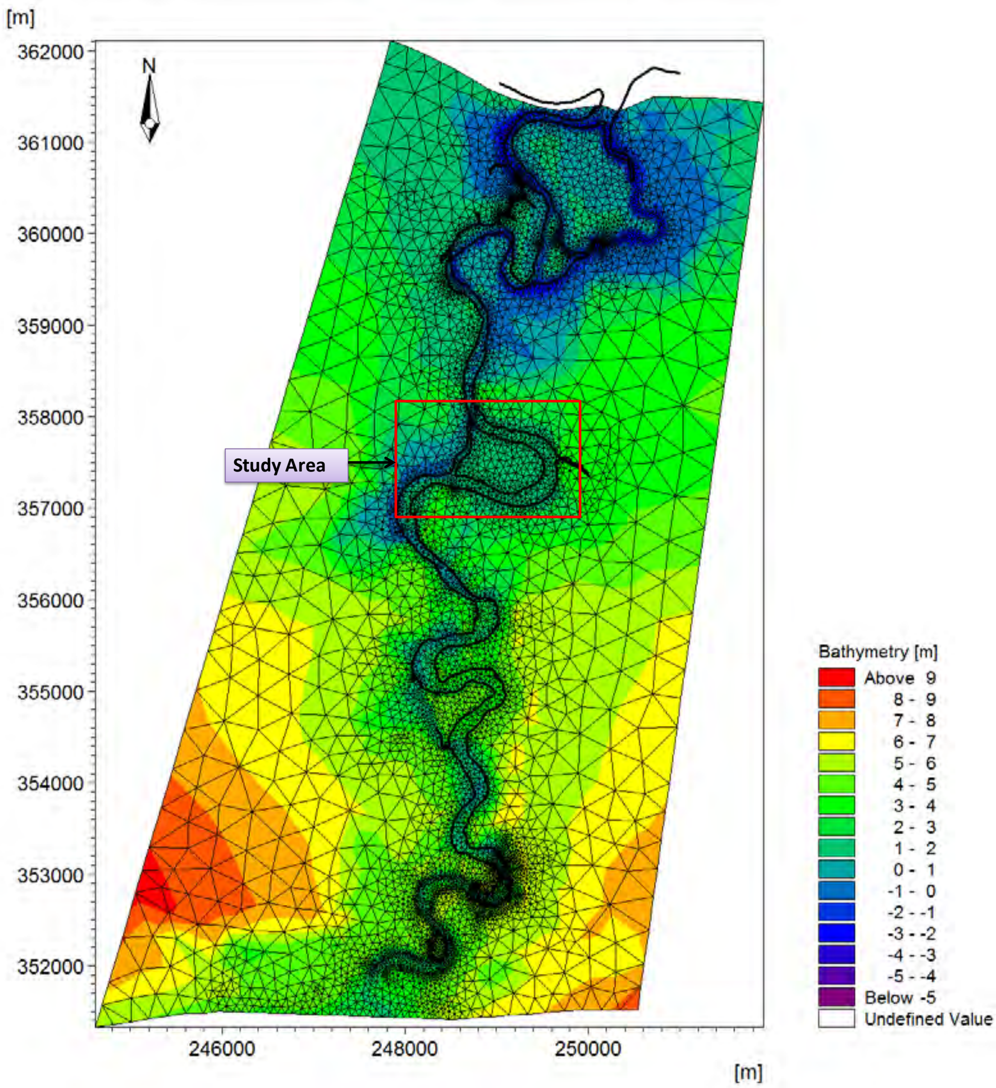


Figure 3.5: Bathymetry of the River Reach used for 2D Simulations

Boundary Conditions

Discharge and sea levels were used as upstream and downstream boundaries respectively. By using calibrated rainfall-runoff (RR) model, upstream boundary condition was provided for HD model. These flow values are corresponded to the selected return periods to simulate different flood situations. Constant water level boundary was applied for the downstream boundary (see *Figure 3.6 for* Schematic diagram of the established model).

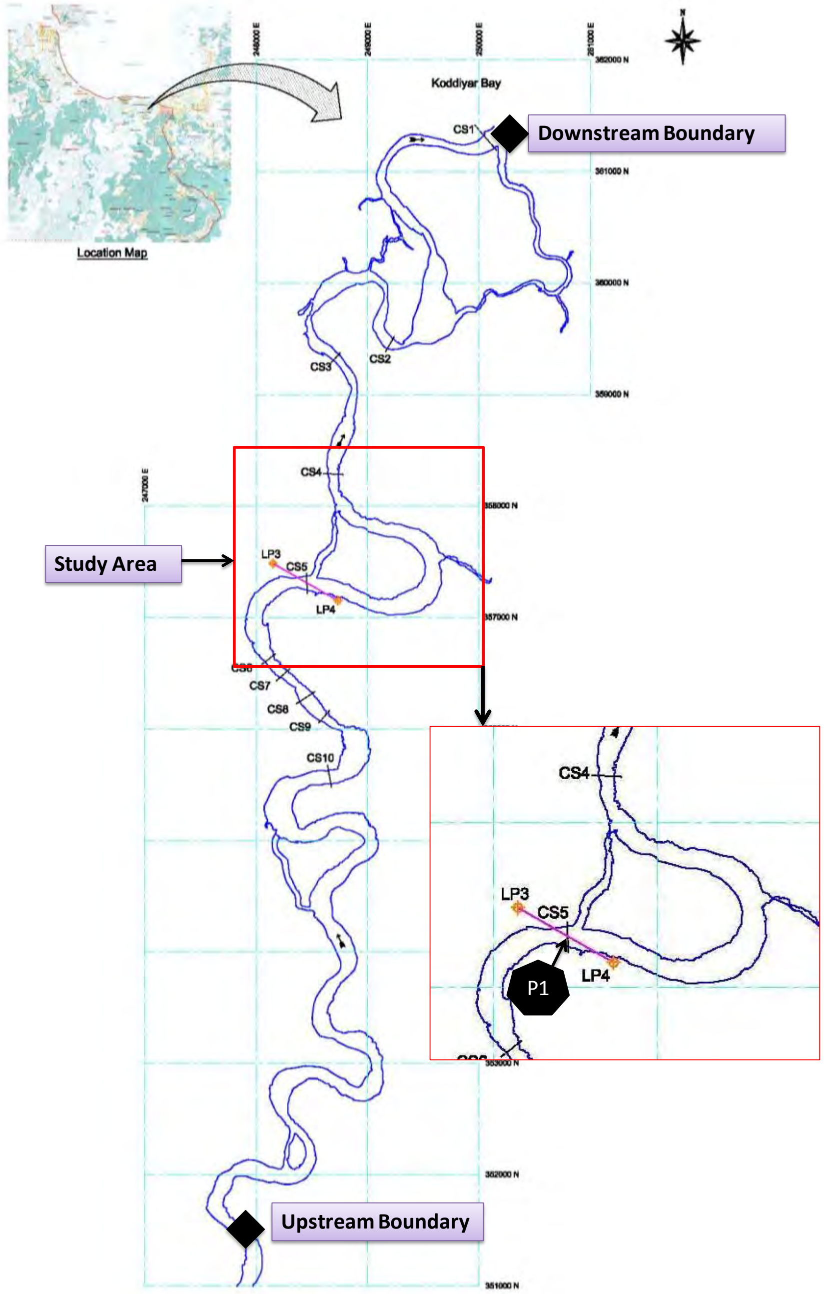


Figure 3.6: Schematic Diagram Used for MIKE 21 HD Model

Model Calibration

The hydrodynamic model was calibrated using measured discharges. The bed roughness was used as the calibration parameter and Manning's coefficient of 0.029 was identified as suitable value for river bed roughness when calibrating the model.

Model Simulation

By using MIKE21 HD model simulation, high flow analysis was conducted by taking different discharges for the upstream boundary of the model. For this purpose, extreme analysis was done for the discharge obtained from the calibrated RR model. Accordingly, *Gumbel* distribution was used to estimate discharges correspond to different return periods (i.e. 2, 5, 10, 25, 50 and 100 year). On the basis of discharges for different return periods, HWL identification was done at interested point (P1) by using simulated water level at point P1. 2D plot for the water level variation in the vicinity of LP3 – LP4 area for return period of 10 years is given in Figure 3.7.

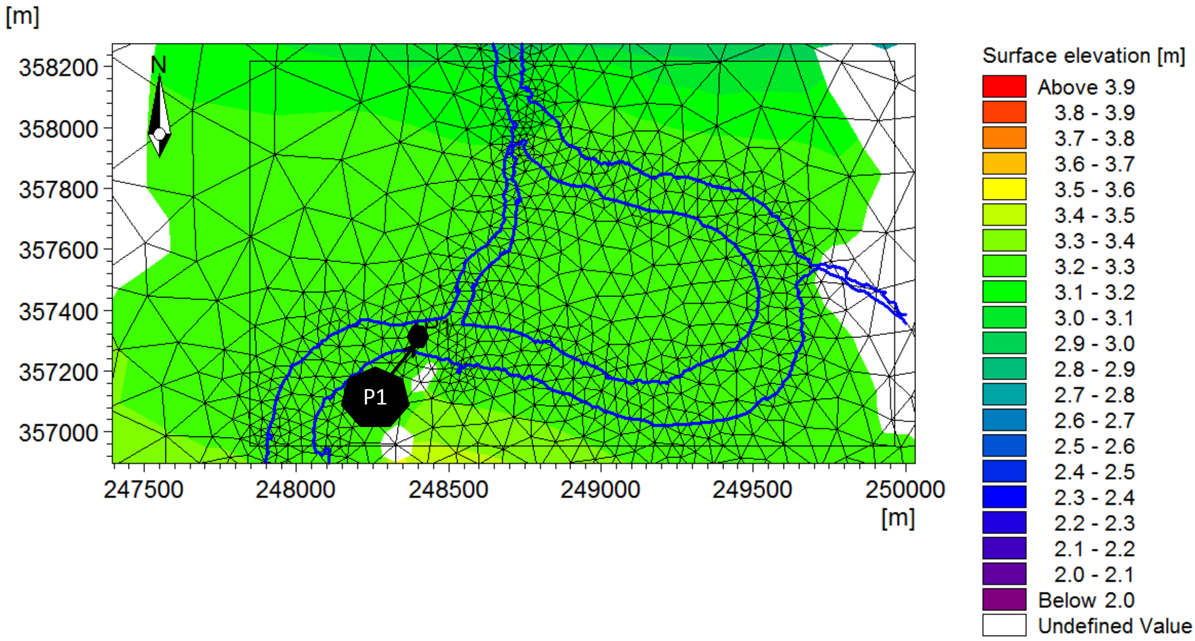


Figure 3.7. Water Level Variation in Study Area – MIKE21 HD Output (*Tr = 10 Years*)

Table 3.2 shows water level at point P1 for different return periods obtained by HD model.

Table 3.2 Water Levels at Point P1 for Different Return Period

Return Period (Tr)	Water Level m MSL	Remarks
2	2.92	
5	**3.13**	*Suggested OHWL*
10	3.26	
25	3.38	
50	3.45	
100	**3.52**	*Suggested MHWL*

According to *Robert and Shawn (2008),* 5 - year flood elevation was approximated as the OHWL for their project works. Thus, on the basis of numerical simulation results and above approximation, 3.13 m MSL can be suggested as OHWL. As mentioned in *Section 3.2.1*, field investigated OHWL is approximated to 3.30 m MSL. Therefore, appropriate OHWL is required to select considering the type of construction work in the study area.

In case of MHWL, 3.52 m MSL is suggested by assuming 100 years of return period. However, considering the design life of proposed construction, most suitable MHWL can be selected from Table 3.2.

References

J. Scherek and G. Yakel,1993,Guidelines for Ordinary High Water Level (OHWL) Determinations, Minnesota Department of Natural Resources Waters.

Lichvar, Robert W. and McColley, Shawn M., 2008, A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States, A delineation Manual; U.S. Army Corps of Engineers; p43.
http://www.santabarbaraca.gov/civicax/filebank/blobdload.aspx?BlobID=18319

DHI MIKE11 User Manual

DHI MIKE21 User Manual

APPENDIX - 1: WIND HAZARD SUSCEPTIBLE MAP OF SRI LANKA

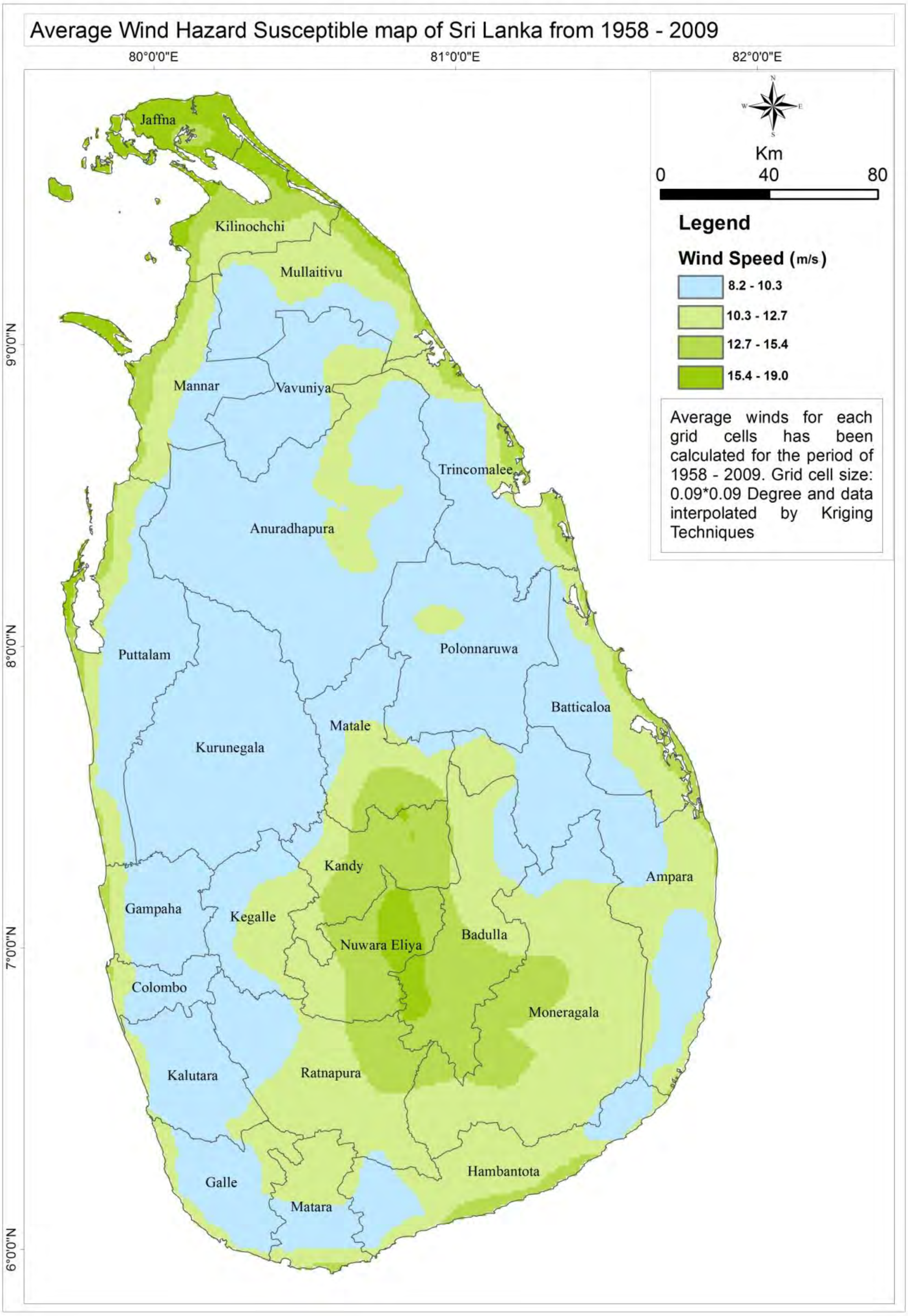


Figure A1-1: Average Values of Wind Hazard Susceptible Map of Sri Lanka
(Source: (http://www.dmc.gov.lk/hazard/hazard/Tropical_Cyclones.html)

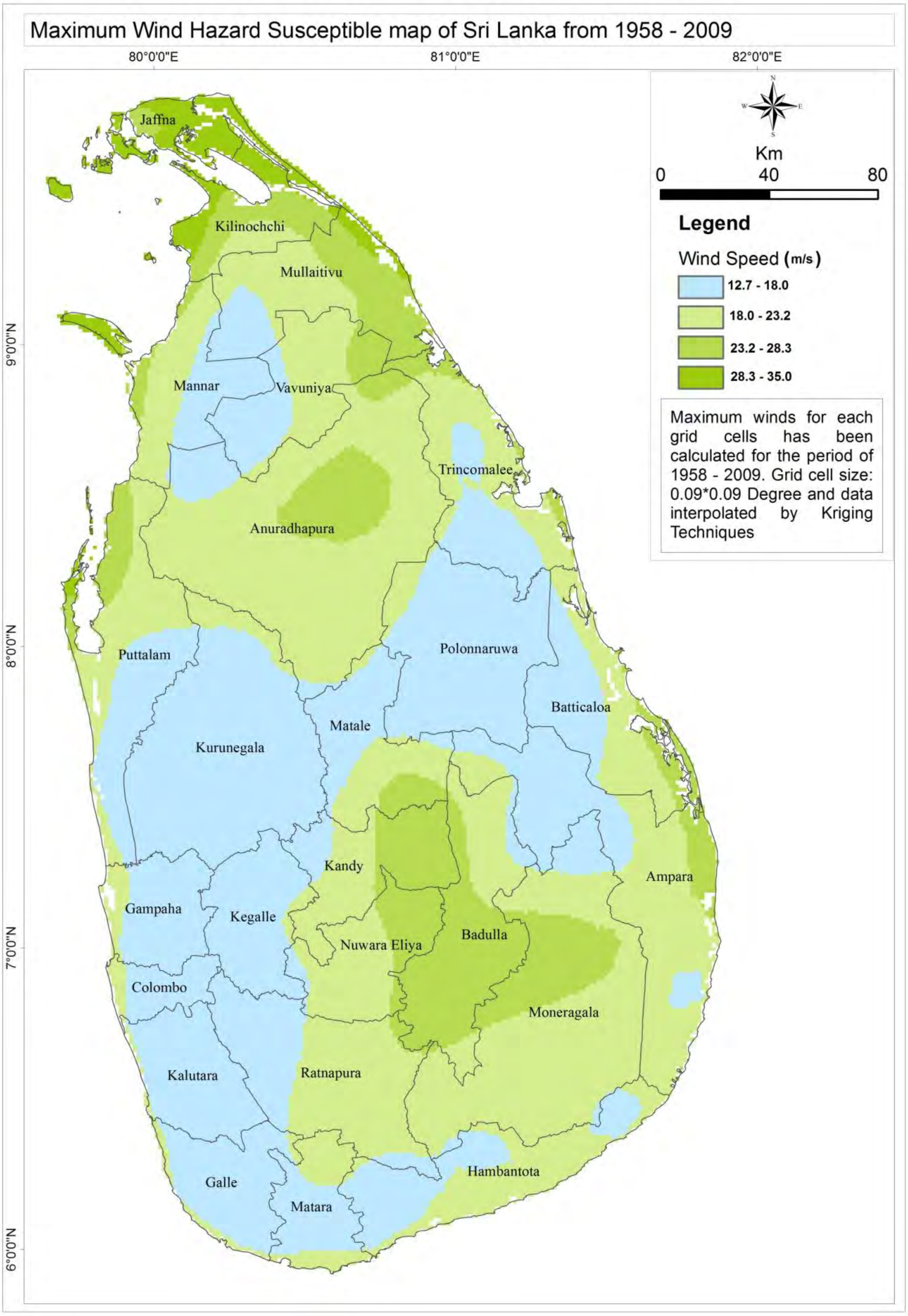


Figure A1-2: Maximum Values of Wind Hazard Susceptible Map of Sri Lanka

(Source: (http://www.dmc.gov.lk/hazard/hazard/Tropical_Cyclones.html)

APPENDIX - 2: SITE CONDITION DURING 12TH -15TH FEBRUARY 2015

Figure A2 - 1: Site Condition during 12th - 15th of February in 2015

APPENDIX - 3: CONTROL POINT ESTABLISHED BY SURVEYING DEPARTMENT

Figure A3 - 1: Control Point "SLGI02" Established by Surveying Department

Figure A3 - 2: GPS Observations at "SLGI02"

APPENDIX - 4: CONTROL POINTS ESTABLISHED BY LHI SURVEY TEAM

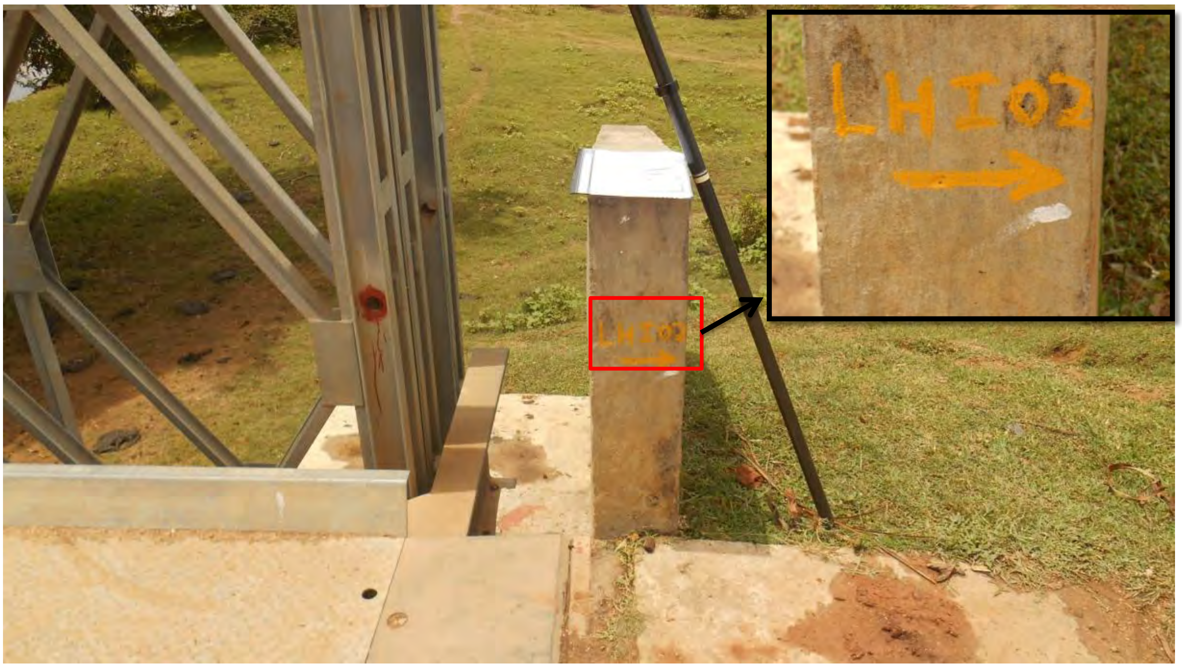
Figure A4 - 1: Control Point "LHI01" Established by LHI

Figure A4 - 2: Establishment of Control Point "LHI01"

Figure A4 - 3: Establishment of Control Point "LHI01"

Figure A4 - 4: Control Point "LHI02"

Figure A4 - 5: Establishment of Control Point "LHI02"



igure 220 **Figure A4 - 6: Mark nearby Control Point "LHI2"**

APPENDIX - 5: POINTS LP1 – LP11

Figure A5 - 1: Point LP1

Figure A5 - 2: Point LP2

Figure A5 - 3: Point LP3

Figure A5 - 4: Point LP4

Figure A5 - 5: Point LP5 and nearby CEB Mark

Figure A5 - 6: Point LP6

Figure A5 - 7: Point LP7

Figure A5 - 8: Point LP8

Figure A5 - 9: Point LP9

Figure A5 - 10: Point LP10

Figure A5 - 11: Point LP11

Insulator Pollution Details for the Sampoor Area (Lat 8.508923°, Lon 81.193291°)

Insulator Type - Glass, Standard Type, 120kN

Pollution Data with one month Interval

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	October	0.0204	NA	_
2	November	0.0054	NA	_
3	December	0.0134	NA	_
4	January	0.0108	NA	_
5	February	0.0025	NA	_
6	March	0.0025	0.0208	Very Light
7	April	0.0078	0.0813	Light
8	May	0.0082	0.0521	Light
9	June	0.0360	0.1167	Medium
10	July	0.0313	0.1313	Medium
11	August	0.0025	0.0271	Very Light
12	September	0.0026	0.0854	Very Light
13	October	0.0053	0.0042	Very Light
14	November	0.0000	0.0042	Very Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	October	0.0081	NA	_
2	November	0.0019	NA	_
3	December	0.0336	NA	_
4	January	0.0320	NA	_
5	February	0.0046	NA	_
6	March	0.0092	0.0094	Very Light
7	April	0.0075	0.0174	Very Light
8	May	0.0109	0.0334	Very Light
9	June	0.0738	0.2092	Medium
10	July	0.0593	0.1627	Medium
11	August	0.0027	0.0276	Very Light
12	September	0.0078	0.0523	Light
13	October	0.0028	0.0073	Very Light
14	November	0.0019	0.0276	Very Light

Data with 3 months interval

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	December	0.0134	NA	_
2	March	0.0025	0.0208	Very Light
3	June	0.0347	0.1229	Medium
4	September	0.0025	0.0521	Very Light

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	December	0.0337	NA	_
2	March	0.0121	0.0283	Very Light
3	June	0.0711	0.2367	Medium
4	September	0.0066	0.0712	Light

Data with 6 month interval

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	March	0.0051	0.0417	Very Light
2	September	0.0051	0.0688	Light

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	December	0.0123	0.0370	Medium
2	March	0.0056	0.0733	Light

Data with 12 month (yearly) interval

#	Month	ESDD	NSDD	Pollution

#	Month	ESDD	NSDD	Pollution

		(mg/cm2)	(mg/cm2)	Level
1	September	0.0052	0.0771	Light

		(mg/cm2)	(mg/cm2)	Level
1	December	0.0047	0.0763	Light

Insulator Type - Porcelain, Fog Type, 120kN

Pollution Data with one month Interval

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	August	0.0012	0.0227	Very Light
2	September	0.0013	0.0247	Very Light
3	October	0.0135	0.0021	Very Light
4	November	0.0012	0.0309	Very Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	August	0.0024	0.0114	Very Light
2	September	0.0057	0.0328	Very Light
3	October	0.0117	0.0082	Very Light
4	November	0.0032	0.0170	Very Light

Data with 3 months interval

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	October	0.0135	0.0062	Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	October	0.0160	0.0265	Light

No six month data and yearly data are available

Insulator Type - Composite (Hybrid), Standard, 120kN

Pollution Data with one month Interval

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	April	0.0100	0.0579	Light
2	May	0.0055	0.0377	Very Light
3	June	0.0298	0.1005	Medium
4	July	0.0223	0.0809	Medium
5	August	0.0009	0.0195	Very Light
6	September	0.0026	0.0433	Very Light
7	October	0.0028	0.0098	Very Light
8	November	0.0009	0.0181	Very Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	April	0.0081	0.0707	Light
2	May	0.0113	0.0464	Light
3	June	0.0625	0.1933	Medium
4	July	0.0524	0.1737	Light
5	August	0.0020	0.1737	Very Light
6	September	0.0101	0.0794	Light
7	October	0.0064	0.0212	Very Light
8	November	0.0061	0.0259	Very Light

Data with 3 months interval

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	June	0.0287	0.1403	Medium
2	September	0.0035	0.0670	Very Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	June	0.0602	0.2169	Medium
2	September	0.0101	0.1367	Light

Top Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	September	0.0044	0.0800	Light

Bottom Surface

#	Month	ESDD (mg/cm^2)	NSDD (mg/cm^2)	Pollution Level
1	September	0.0112	0.145	Light

No yearly data are available

Geotechnical Engineering Division

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GEOTECHNICAL INVESTIGATION REPORT

ELS SI 3592

PROJECT

Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)

CLIENT

Tokyo Electric Power Services Co. Ltd.

February 02, 2015.

ENGINEERING & LABORATORY SERVICES [PVT.] LTD.
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Email: soil@elslanka.com | Web: www.elslanka.com

452 CONCRETE PIPES

855 CEMENT BLOCKS

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ANNEXURE

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

1.0 Introduction

Tokyo Electric Power Services Co. Ltd. (TEPSCO) is a Tokyo based engineering/ consulting company. And will perform Japanese International Coorporation Agency's (JICA) preparatory study on National Transmission and Distribution Network Development and Efficiency Improvement Project (II) in Sri Lanka as JICA study team under JICA. Under the above project 400kV electricity transmission line is proposed from Sampoor, where a coal power project is proposed, to Habarana (95km). Geotechnical Investigation was carried out for some tower locating along above tower line in order to assess the geological conditions at required tower positions.

M/s. Engineering and Laboratory Services (Pvt) Ltd. was authorized by **M/s. Tokyo Electric Power Services Co. Ltd. (TEPSCO),** to carry out the soil investigation at the above site and prepare the soil investigation report with recommendations for foundation design.

2.0 Site Description

The boreholes were done along the proposed transmission line.

Table 1: Locations of the boreholes

Location	Coordinate (UTM)	
	Northing (m)	Easting (m)
TT-01	889756.50	469925.99
AP-09	894523.58	477707.07
AP-17	910993.46	489980.66
AP-20	916390.60	492864.38
AP-32	924330.82	504853.51
AP-36A	932097.78	513311.74
AP-38	931688.98	522443.44
AP-39	930607.46	524349.76
AP-44	934586.00	533906.00
TT-02	936689.06	534721.00

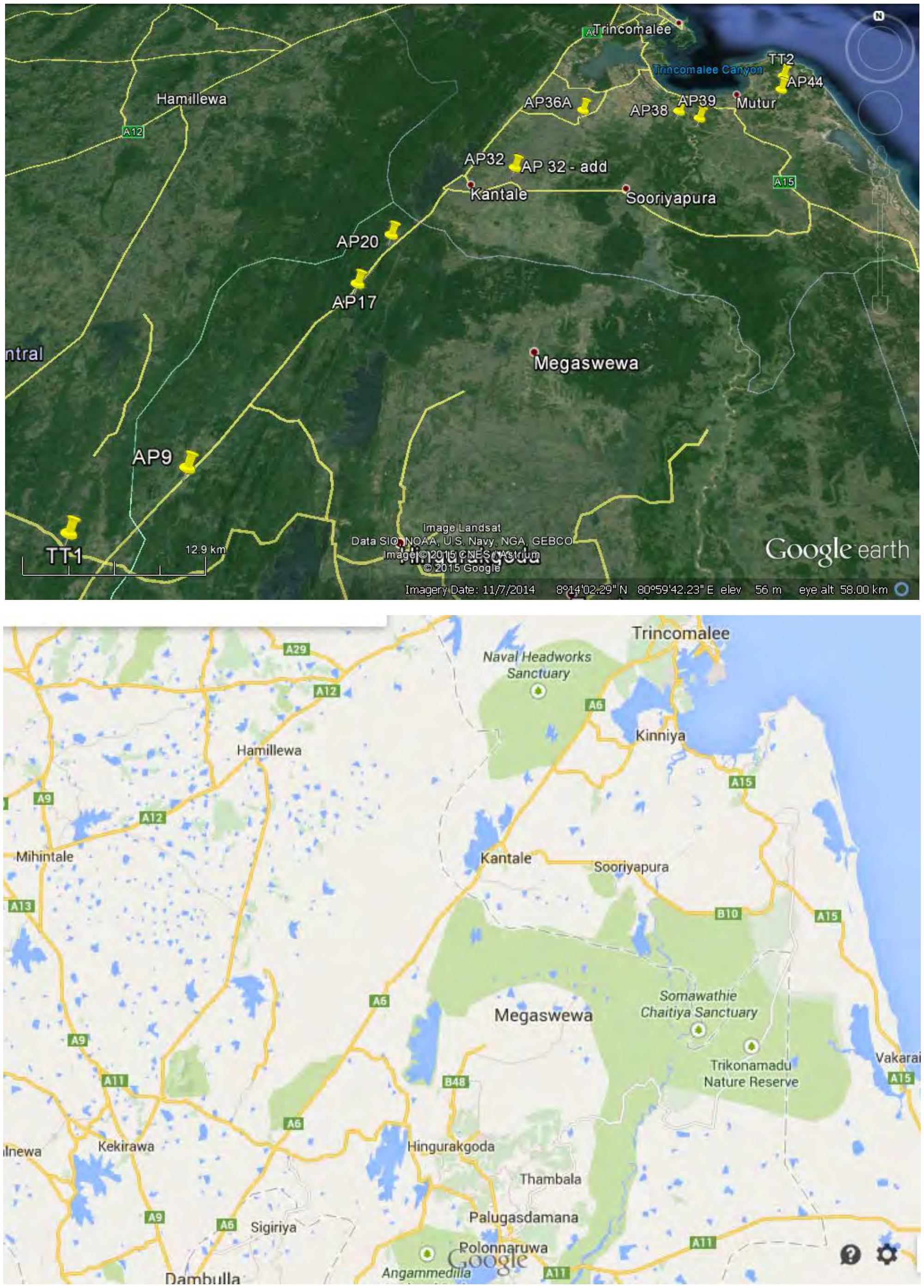


Figure 1: Proposed tower locations

3.0 Field Investigation

The field investigation was consisted of advancing 10 boreholes at the location marked as in Figure 1.

The boreholes were advanced by means of a rotary - drilling machine. The drilling was carried out with overburden cutting tools, and the wash boring process was adopted to remove the cuttings from the bottom of the borehole.

Standard Penetration Test (SPT) was carried out in regular intervals in the overburden. This test was carried out as specified in BS 1377.

Disturbed samples of soil were collected both from the SPT tube and the cuttings were collected from the washings.

Groundwater Level (GWL) was determined as the depth at which the water level stabilized inside the borehole.

The field investigation was commenced on 02nd January 2015 and completed on 31st January 2015.

4.0 Subsurface Conditions

The results of the borehole investigation are given in Annexure I.

The bed rock level at the area is generally varies 3.5m-10m depth from the surface level except AP-39 (near to river). Generally the water level along investigated line was noted as 0.6-2m depth from the surface level.

Using this, profiles of subsurface conditions across the boreholes have been constructed and these are shown in Figure 2(a) to 2(j).

4.1 Subsurface conditions across the borehole TT-01

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 0.25m at the time of investigation.

(ii) A medium dense to dense clayey sand layer was found up to the depth of 4.20m at the borehole TT-01

(iii) A completely weathered rock layer was encountered up to the rock level at the depth of 10.30m and borehole was terminated at that level

4.2 Subsurface conditions across the borehole AP-09

The results indicate that,

(i) The groundwater level (GWL) was not encountered at the time of investigation.

(ii) A sand layer was found up to the depth of 1.00m at the borehole AP-09.

(iii) A completely weathered rock layer was encountered up to the rock level at the depth of 4.40m and borehole was terminated at that level.

4.3 Subsurface conditions across the borehole AP-17

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 3.00m at the time of investigation.

(ii) Gravels layer was found up to the depth of 1.00m at the borehole AP-17.

(iii) Then completely weathered rock layer was encountered up to the rock level at the depth of 4.80m and borehole was terminated at that level.

4.4 Subsurface conditions across the borehole AP-20

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 1.10m at the time of investigation.

(ii) A sandy clay layer was found up to the depth of 0.80m at the borehole AP-20.

(iii) Then completely weathered rock layer was encountered up to the rock level at the depth of 8.85m and borehole was terminated at that level.

4.5 Subsurface conditions across the borehole AP-32

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 1.15m at the time of investigation.

(ii) A clayey sand layer was found up to the depth of 0.80m at the borehole AP-32.

(iii) Then firm to very stiff sandy clay layer was encountered up to the rock level at the depth of 7.30m and borehole was terminated at that level.

4.6 Subsurface conditions across the borehole AP-36A

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 0.60m at the time of investigation.

(ii) A loose sand layer was found up to the depth of 3.50m (the rock level) and borehole was terminated at that level.

4.7 Subsurface conditions across the borehole AP-38

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 1.40m at the time of investigation.

(ii) A stiff sandy clay layer was found up to the depth of 2.00m at the borehole AP-39.

(iii) Then medium dense sand layer was found up to the depth of 4.50m.

(iv) Very soft organic clay layer was found up to the depth of 7.50m.

(v) Then completely weathered rock layer was encountered up to the rock level at the depth of 8.80m and borehole was terminated at that level.

4.8 Subsurface conditions across the borehole AP-39

The results indicate that,

(i) The groundwater level (GWL) was encountered at the depth of 1.60m at the time of investigation.

(ii) A stiff sandy clay layer was found up to the depth of 2.00m at the borehole AP-39.

(iii) Then medium dense to loose sand layer was found up to the depth of 6.00m.

(iv) Very soft organic clay layer was found up to the depth of 9.00m.

(v) Then very loose clayey organic sand layer was found up to the depth of 10.50m.

(vi) Loose sand with organic clay layer was found up to the depth of 13.50m.

(vii) Firm to very soft organic clay/organic sandy clay layer was noticed up to the depth of 25.00m.

(viii) Loose clayey sand layer was found up to the depth 30.00m.

(ix) Then dense clayey sand layer was found up to the depth of 32.00m

(x) Then very dense to dense sand layer was encountered up to the rock level at the depth of 40.00m and borehole was terminated at that level.

4.9 Subsurface conditions across the borehole AP-44

The results indicate that,

(iii) The groundwater level (GWL) was encountered at the depth of 1.30m at the time of investigation.

(iv) A completely weathered rock was found up to the rock level at the depth of 2.80m and borehole was terminated at that level.

4.7 Subsurface conditions across the borehole TT-02

The results indicate that,

(vi) The groundwater level (GWL) was not encountered at the time of investigation.

(vii) A completely weathered rock layer was encountered up to the rock level at the depth of 2.60m and borehole was terminated at that level.

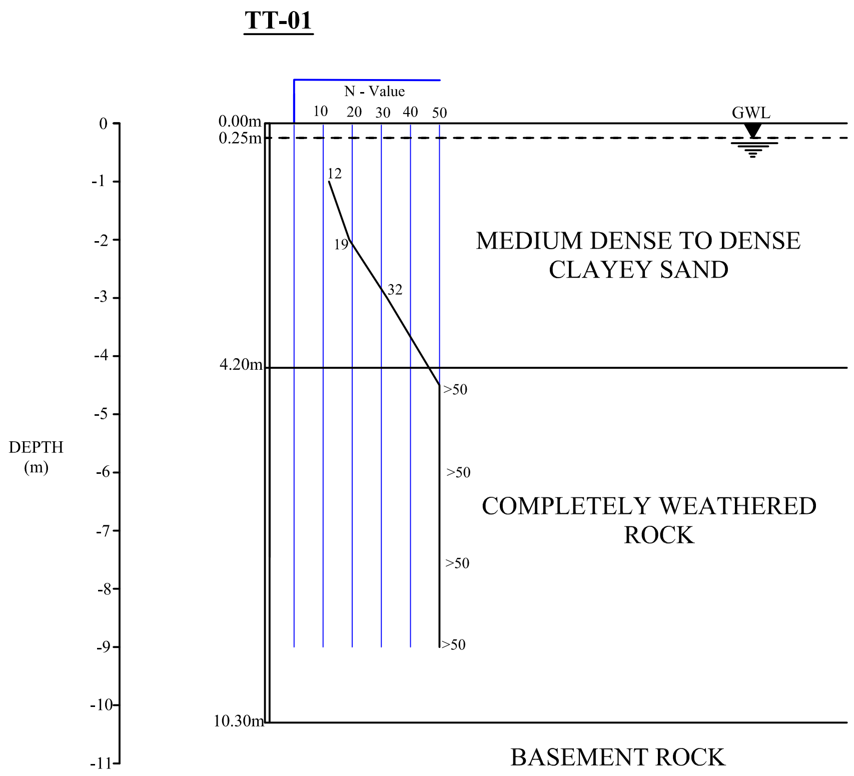


Figure 2(a): Possible Soil Profile at the borehole, BH-TT-01	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-09

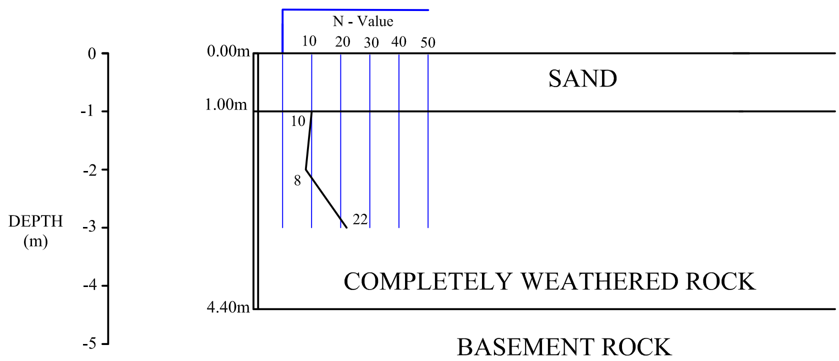


Figure 2(b): Possible Soil Profile at the borehole,AP-09	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-17

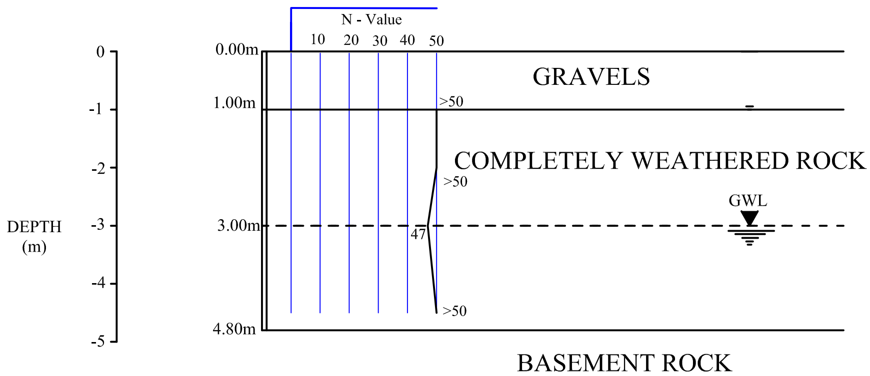


Figure 2(c): Possible Soil Profile at the borehole, AP-17	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

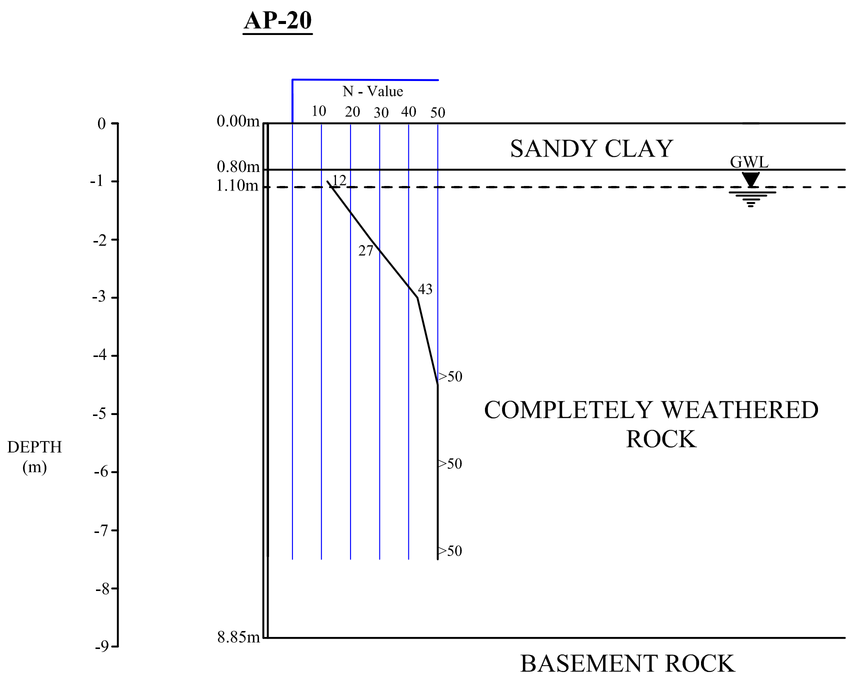


Figure 2(d): Possible Soil Profile at the borehole, AP-20	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

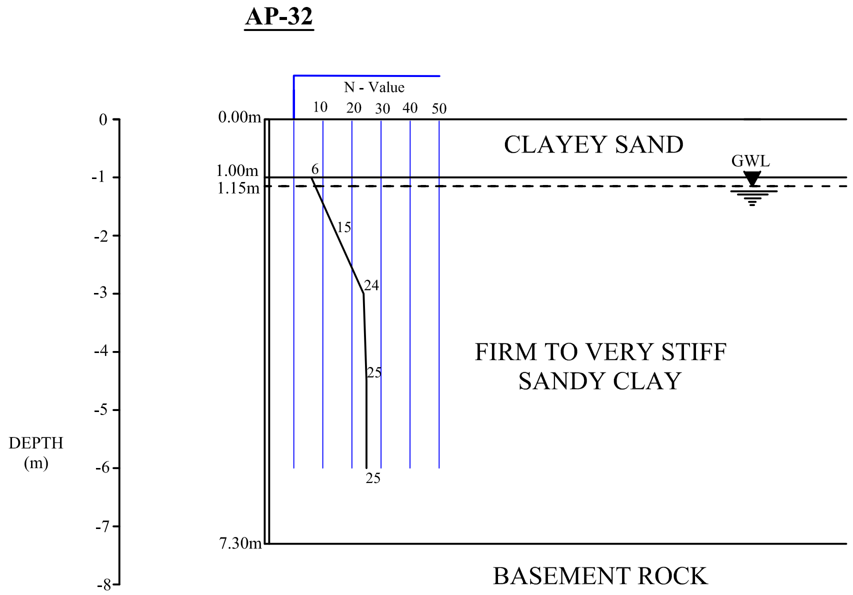


Figure 2(e): Possible Soil Profile at the borehole, AP-32	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-36A

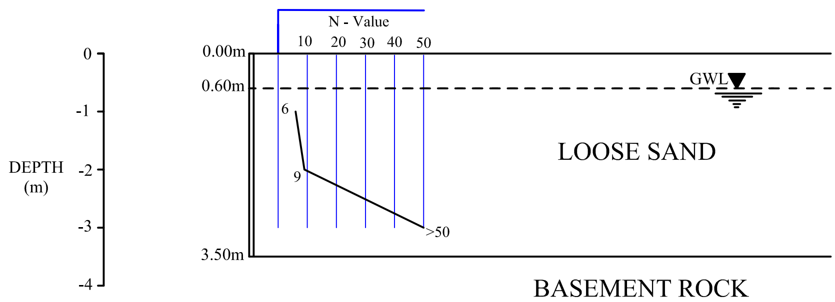


Figure 2(f): Possible Soil Profile at the borehole, AP-36A	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-38

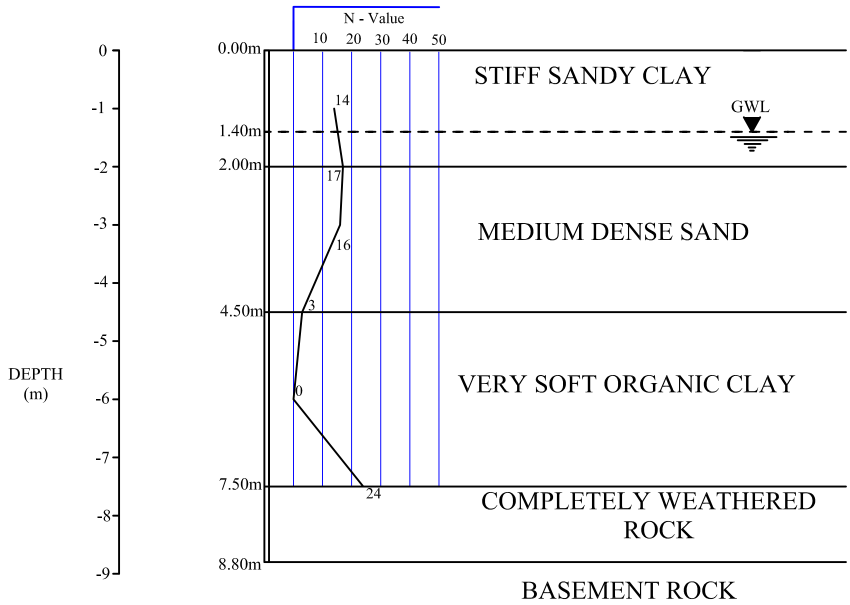


Figure 2(g): Possible Soil Profile at the borehole, AP-38	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-39

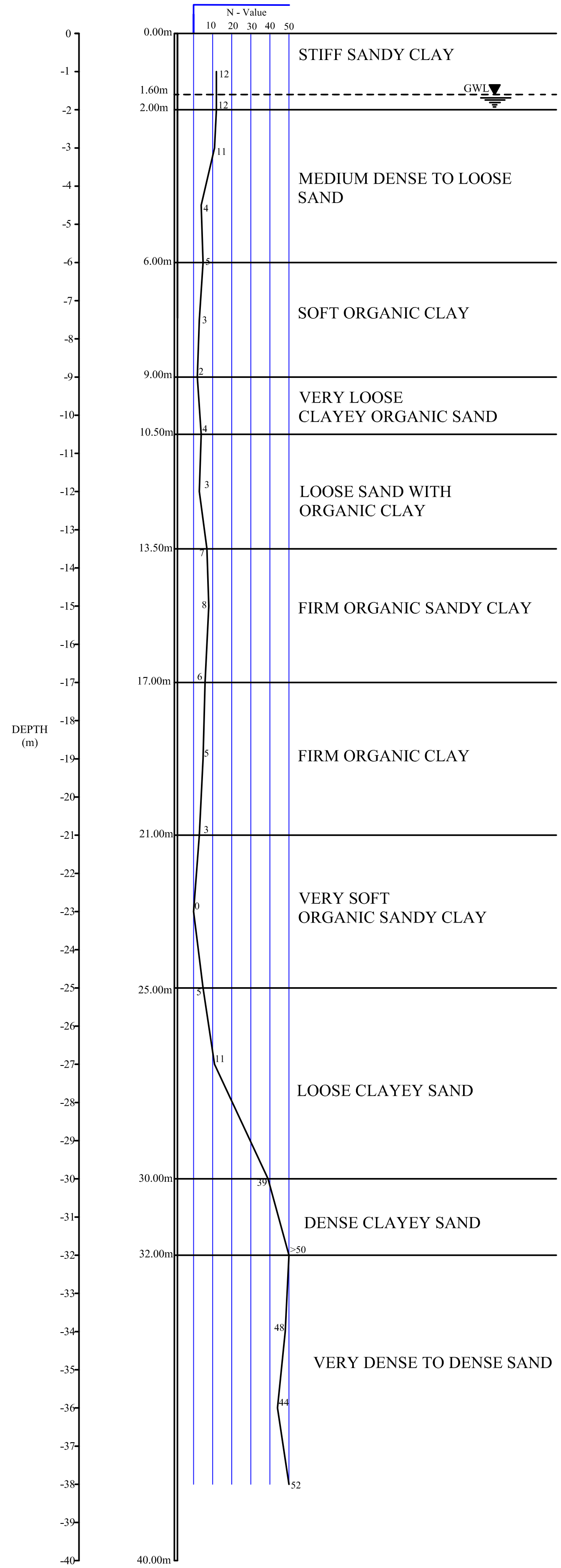


Figure 2(h): Possible Soil Profile at the borehole, AP-39	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:165

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

AP-44

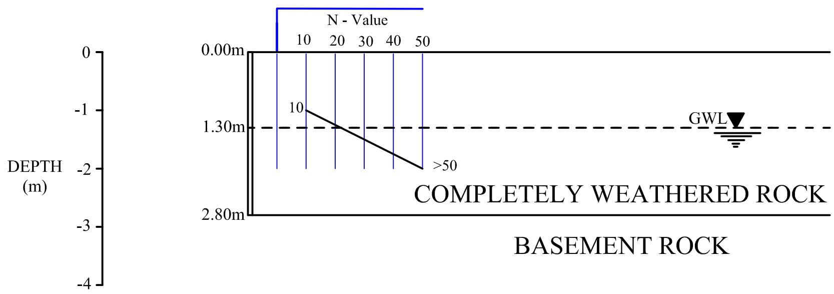


Figure 2(i): Possible Soil Profile at the borehole, AP-44	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

TT-02

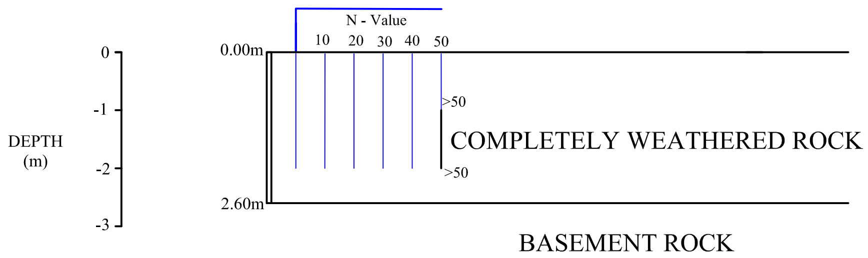


Figure 2(j): Possible Soil Profile at the borehole, TT-02	Project: Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)	Vertical scale 1:130

Note: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

Annexure I: Borehole Logs

ENGINEERING & LABORATORY SERVICES (PVT) LTD.
SITE INVESTIGATIONS DIVISION

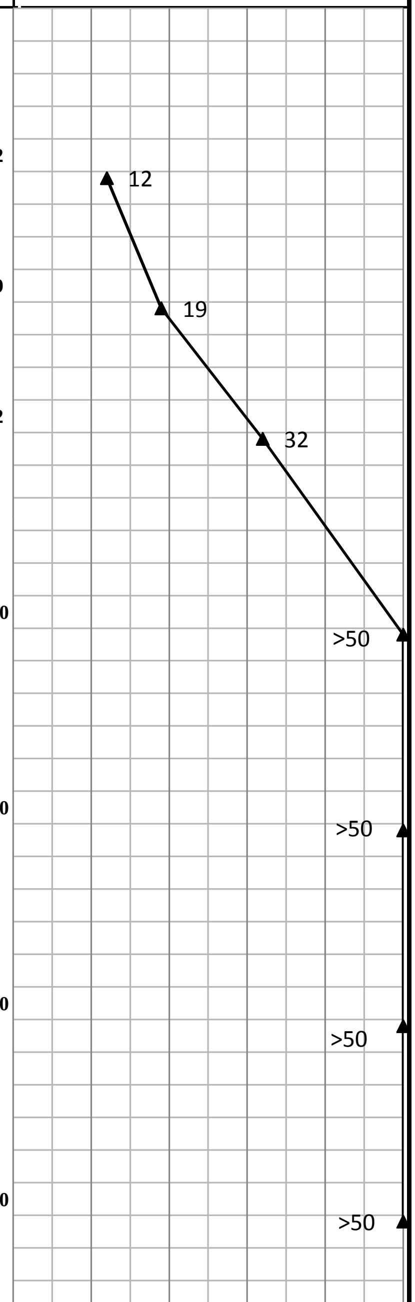
NO 62/3, Neelammahara Road,
Katuwawala, Sri Lanka.
Tel: 0114 309 494

Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	TT-01
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	1 of 2
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	0.25m
Date of Started	02.01.2015	Drilling Method	Wash	Casing depth	9.0m	Coordinates	8° 3' 0.67"N
Date of Finished	04.01.2015	Casing Diameter	76mm	Elevation (m)			80° 43' 37.39"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	☒	D1	DS	G.W.L at 0.25m	0.00	Sand/clay	Medium dense, yellowish brown, gray, fine to medium CLAYEY SAND with fine,sub rounded gravels				
1.00	☒	D2	SS					5	6	6	**12**
			WS								
2.00	☒	D3	SS					6	9	10	**19**
			WS								
3.00	☒	D4	SS		3.00	Sand/clay	Dense, brown, gray, fine to coarse CLAYEY SAND	5	12	20	**32**
4.00			WS								
					4.20	Completely Weathered Rock	Black, yellowish brown, fine to medium sand with small amount of clay and mica traces COMPLETELY WEATHERED ROCK				
5.00	☒	D5	SS					5	25/ 5cm	HB	**>50**
			WS								
6.00	☒	D6	SS				(6.00-6.45)m sample changed to; yellowish brown, gray, fine to coarse clayey sand with mica traces	30/ 5cm	HB		**>50**
7.00			WS								
8.00	☒	D7	SS				COMPLETELY WEATHERED ROCK	25	HB		**>50**
			WS								
9.00	☒	D8	SS					30	HB		**>50**
10.00			WS								

Moisture Content - %
Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90)
SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample	N - Natural Moisture Content	C - Consolidation
GWL : Ground Water Level observed inside the Borehole, after the saturation	SS -SPT Sample	L - Atterberg Limit Test	UCT-Unconfined Compression
NE Not Encountered	W - Water Sample	G - Grain Size Analysis	CU - Consolidated Undrained
HB -Hammer Bounce	WS-Wgrey Sample	SG -Specific Gravity Test	UU-Unconsolidated Undrained
FD - Free Down	UD- Undisturbed Sample	B - Bulk Density	pH - Chemical
	CS- Core Sample	V - Vane Shear Test	O - Organic content
	Cr - Core Recovery (%)		SO_4^{2-} - Sulphate Content
	RQD-Rock Quality Designation (%)		Cl⁻ - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By : Dimuthu
Supervised By: S.M.D..Samantha
Drilled By: W.L.Nimal

Legend: Made Ground, Silt, Gravel, Laterite Nodules, Completely Weathered Rock, Fresh Rock, Clay, Sand, Organic Matter, Silty Sand, Highly Weathered Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD.
SITE INVESTIGATIONS DIVISION
NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka.
Tel: 0114 309 494

Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	TT-01
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	2 of 2
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	0.25m
Date of Started	02.01.2015	Drilling Method	Wash	Casing depth	9.0m	Coordinates	8° 3' 0.67"N
Date of Finished	04.01.2015	Casing Diameter	76mm	Elevation (m)			80° 43' 37.39"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
10.00							Continue from Page 1				
							ROCK LEVEL				
					10.30		END OF THE BOREHOLE AT 10.30m DEPTH				
11.00											
12.00											
13.00											
14.00											
15.00											
16.00											
17.00											
18.00											
19.00											
20.00											

Field Records (SPT)

Moisture Content - %
Undrained Shear Strength - t/m^2: 10 20 30 40 50 60 70 80 90
SPT Resistance - Blows/ft: 5 10 15 20 25 30 35 40 45

Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks
Existing ground level considered as the zero level

Logged By : Dimuthu
Supervised By: S.M.D..Samantha
Drilled By: W.L.Nimal

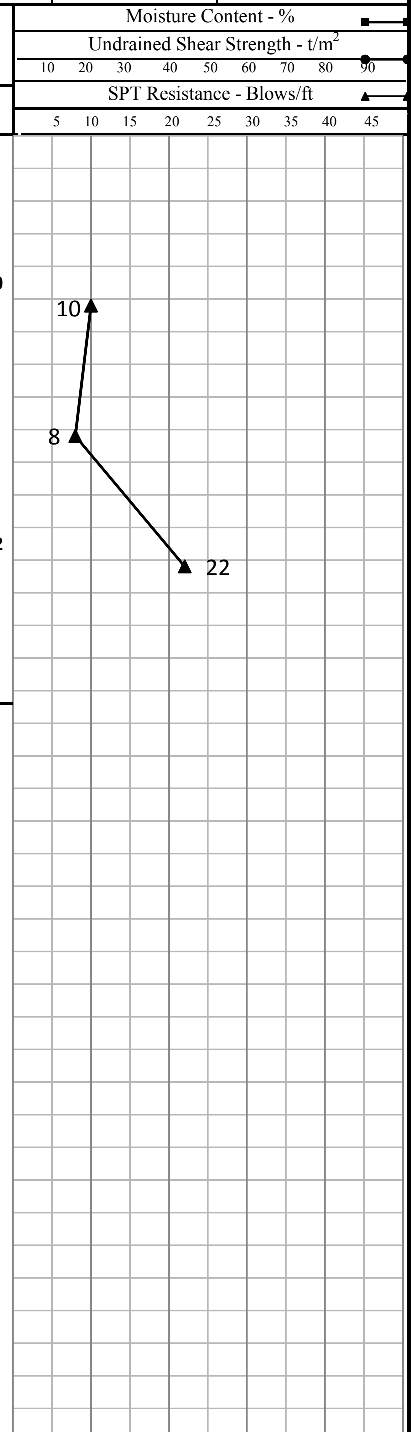
Made Ground | Silt | Gravel | Laterite Nodules | Completely Weathered Rock
Clay | Sand | Organic Matter | Silty Sand | Highly Weathered Rock | Fresh Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD. **SITE INVESTIGATIONS DIVISION**		NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka. Tel: 0114 309 494	Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	AP-09
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm
Date of Started	30.01.2015	Drilling Method	Wash	Casing depth	3.0m
Date of Finished	30.01.2015	Casing Diameter	76mm	Elevation (m)	

Ground Water level	
Coordinates	8° 5' 32.79"N
	80° 47' 51.57"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	☒	D1	DS		0.00	Sand	Brown, fine to medium, SAND				
1.00	☒	D2	SS		1.00	Completely Weathered Rock	Brown, yellowish brown, silty, fine to coarse sand with mica traces	2	3	7	**10**
			WS								
2.00	☒	D3	SS				COMPLETELY WEATHERED ROCK	3	3	5	**8**
			WS								
3.00	☒	D4	SS				(3.00-3.45)m sample changed; yellowish brown, brown, black, fine to coarse, silty sand	6	7	15	**22**
4.00			WS				COMPLETELY WEATHERED ROCK ROCK LEVEL				
					4.40		END OF THE BOREHOLE AT 4.40m				
5.00											
6.00											
7.00											
8.00											
9.00											
10.00											



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample	N - Natural Moisture Content	C - Consolidation	**Remarks**
GWL : Ground Water Level observed inside the Borehole, after the saturation	SS -SPT Sample	L - Atterberg Limit Test	UCT-Unconfined Compression	Existing ground level considered as the zero level
NE Not Encountered	W - Water Sample	G - Grain Size Analysis	CU - Consolidated Undrained	
HB -Hammer Bounce	WS-Wgrey Sample	SG -Specific Gravity Test	UU-Unconsolidated Undrained	
FD - Free Down	UD- Undisturbed Sample	B - Bulk Density	pH - Chemical	
	CS- Core Sample	V - Vane Shear Test	O - Organic content	
	Cr - Core Recovery (%)		SO_4^{2-} - Sulphate Content	
	RQD-Rock Quality Designation (%)		Cl^- - Cloride Content	

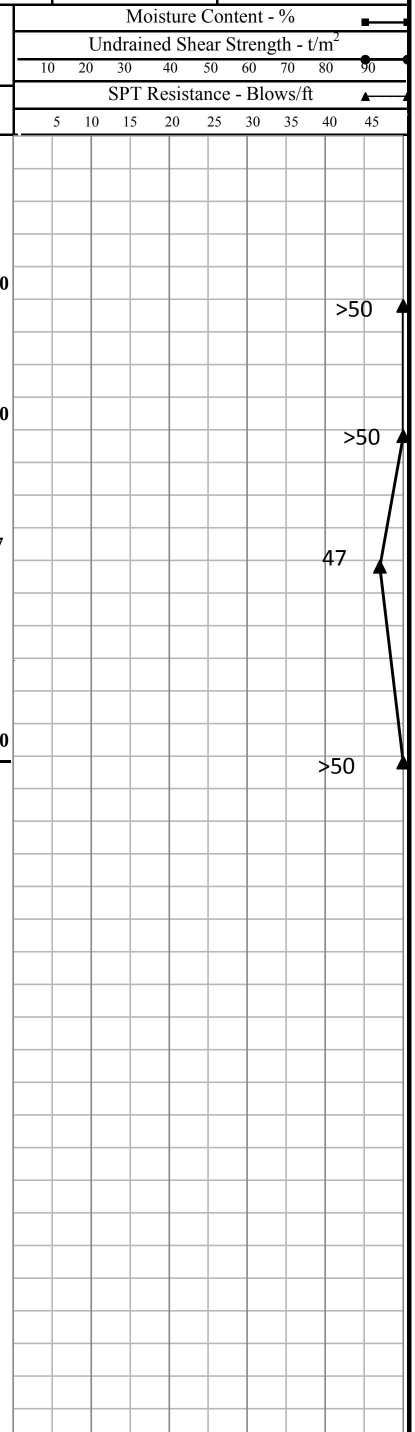
Logged By :	Dimuthu
Supervised By:	Indunil
Drilled By:	Sumathipala

Made Ground	Silt	Gravel	Laterite Nodules	Completely Weathered Rock	Fresh Rock
Clay	Sand	Organic Matter	Silty Sand	Highly Weathered Rock	

ELS	**ENGINEERING & LABORATORY SERVICES (PVT) LTD.** **SITE INVESTIGATIONS DIVISION**	NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka. Tel: 0114 309 494	Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	AP-17
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	3.0m
Date of Started	28.01.2015	Drilling Method	Wash	Casing depth	4.50m	Coordinates	8° 14' 29.26"N
Date of Finished	28.01.2015	Casing Diameter	76mm	Elevation (m)			80° 54' 32.47"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	☒	D1	DS		0.00	Gravel	Offwhite, fine to medium GRAVELS				
1.00	☒	D2	SS		1.00	Completely Weathered Rock	(1.45-2.00)m washed sample changed to; brown, fine to medium sand	2	HB		>50
			WS								
2.00	☒	D3	SS				COMPLETELY WEATHERED ROCK	9	HB		>50
			WS								
3.00	☒	D4	SS	G.W.L at 3.0m			(3.00-3.45)m sample changed; fine to coarse sand with fine to medium gravels	14	22	25	47
4.00			WS				COMPLETELY WEATHERED ROCK				
	☒	D5	SS				ROCK LEVEL	18	HB		>50
5.00					4.80		END OF THE BOREHOLE AT 4.80m DEPTH				
6.00											
7.00											
8.00											
9.00											
10.00											



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks
Existing ground level considered as the zero level

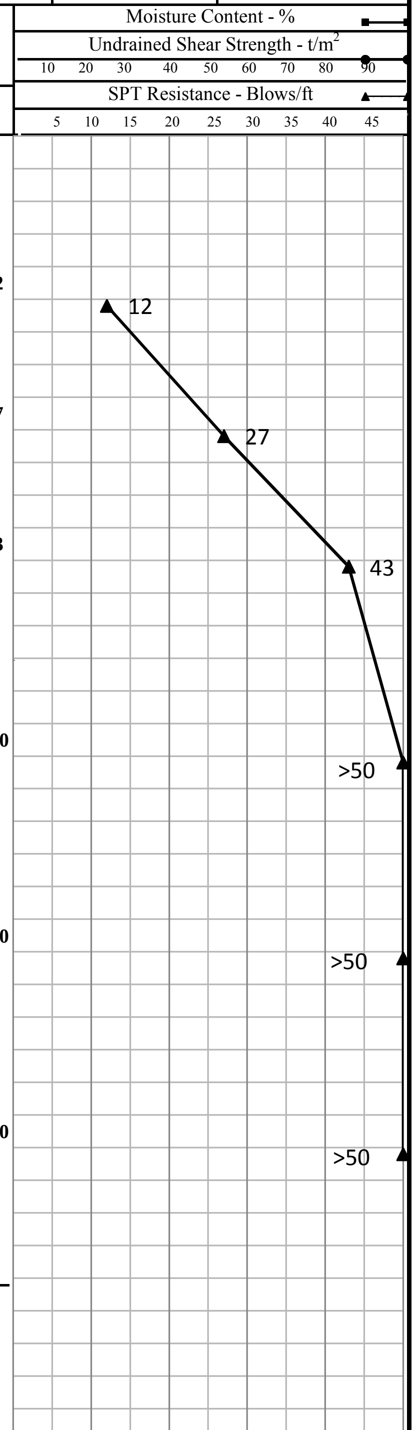
Logged By : Dimuthu
Supervised By: Indunil
Drilled By: Sumathipala

Made Ground	Silt	Gravel	Laterite Nodules	Completely Weathered Rock	
Clay	Sand	Organic Matter	Silty Sand	Highly Weathered Rock	Fresh Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD. SITE INVESTIGATIONS DIVISION		NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka. Tel: 0114 309 494	Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	AP-20
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	1.10m
Date of Started	05.01.2015	Drilling Method	Wash	Casing depth	7.5m	Coordinates	8° 17' 25.02"N
Date of Finished	05.01.2015	Casing Diameter	76mm	Elevation (m)			80° 56' 6.71"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	☒	D1	DS				Brown, fine to coarse SANDY CLAY				
1.00					0.80		Brown, fine to coarse sand with mica traces and small amount of clay				
	☒	D2	SS	G.W.L at 1.10m				2	4	8	**12**
			WS								
2.00	☒	D3	SS					8	10	17	**27**
			WS								
3.00	☒	D4	SS				COMPLETELY WEATHERED ROCK	2	14	29	**43**
4.00			WS								
	☒	D5	SS				(4.50-4.95)m sample changed to; brown, blackish brown, fine to coarse sand with weathered rock fragments	13	21/ 5cm	HB	**>50**
5.00			WS								
6.00	☒	D6	SS					12	25/ 5cm	HB	**>50**
7.00			WS				COMPLETELY WEATHERED ROCK				
	☒	D7	SS					25	HB		**>50**
8.00			WS				ROCK LEVEL				
9.00					8.85		END OF THE BOREHOLE AT 8.85m DEPTH				
10.00											



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample	N - Natural Moisture Content	C - Consolidation
GWL : Ground Water Level observed inside the Borehole, after the saturation	SS -SPT Sample	L - Atterberg Limit Test	UCT-Unconfined Compression
NE Not Encountered	W - Water Sample	G - Grain Size Analysis	CU - Consolidated Undrained
HB -Hammer Bounce	WS-Wgrey Sample	SG -Specific Gravity Test	UU-Unconsolidated Undrained
FD - Free Down	UD- Undisturbed Sample	B - Bulk Density	pH - Chemical
	CS- Core Sample	V - Vane Shear Test	O - Organic content
	Cr - Core Recovery (%)		SO_4^{2-} - Sulphate Content
	RQD-Rock Quality Designation (%)		Cl^- - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By : Dimuthu
Supervised By: S.M.D..Samantha
Drilled By: W.L.Nimal

Made Ground	Silt	Gravel	Laterite Nodules	Completely Weathered Rock	
Clay	Sand	Organic Matter	Silty Sand	Highly Weathered Rock	Fresh Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD.
SITE INVESTIGATIONS DIVISION

NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka. Tel: 0114 309 494

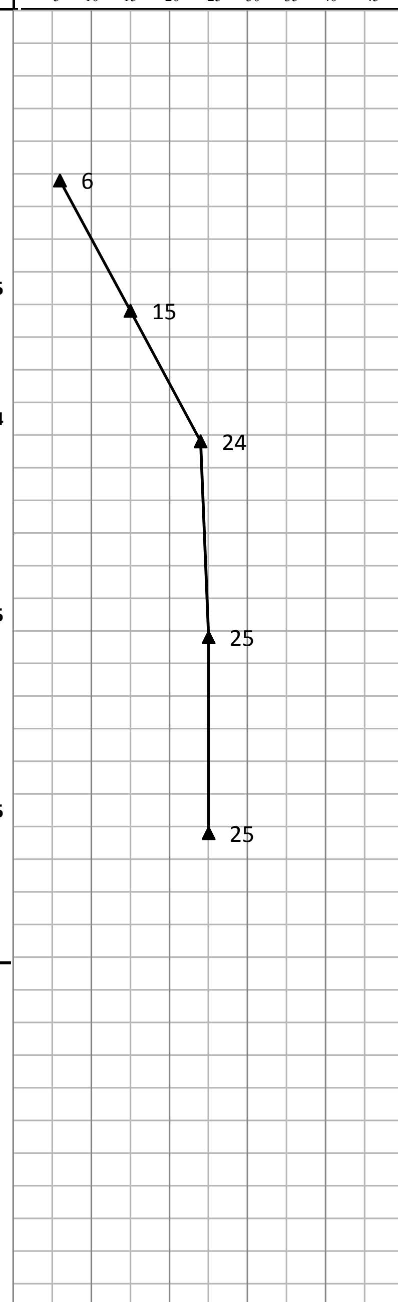
Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	AP-32
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	1.15m
Date of Started	16.01.2015	Drilling Method	Wash	Casing depth	6.0m	Coordinates	8° 21' 45.98"N
Date of Finished		Casing Diameter	76mm	Elevation (m)			81° 2' 38.72"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
		D1	DS		0.00		Brown, fine to coarse CLAYEY SAND with fine gravels with root fragments				
1.00		D2	SS	G.W.L at 1.15m	1.00		Firm to stiff, fine to coarse SANDY CLAY	3	3	3	6
			WS								
2.00		D3	SS					4	6	9	15
			WS								
3.00		D4	SS		3.00		Very stiff, brown, fine to medium SANDY CLAY with fine to medium gravels	8	10	14	24
4.00			WS								
		D5	SS					4	9	16	25
5.00			WS								
6.00		D6	SS					6	10	15	25
7.00							ROCK LEVEL				
					7.30		END OF THE BOREHOLE ATT 7.30m DEPTH				
8.00											
9.00											
10.00											

Field Records (SPT)

Moisture Content - %
Undrained Shear Strength - t/m^2
10 20 30 40 50 60 70 80 90
SPT Resistance - Blows/ft
5 10 15 20 25 30 35 40 45



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks
Existing ground level considered as the zero level

Logged By :
Supervised By: S.M.D..Samantha
Drilled By: W.L.Nimal

Made Ground · Silt · Gravel · Laterite Nodules · Completely Weathered Rock
Clay · Sand · Organic Matter · Silty Sand · Highly Weathered Rock · Fresh Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD.
SITE INVESTIGATIONS DIVISION

NO 62/3, Neelammahara Road, Katuwawala, Sri Lanka. Tel: 0114 309 494

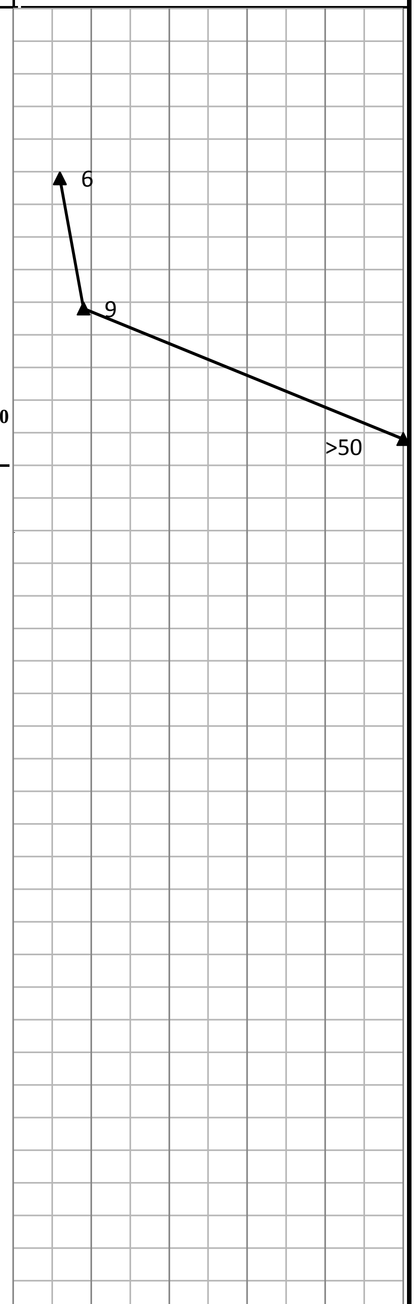
Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**	Borehole No	AP-36A
Client	**M/s. Tokyo Electric Power Services Co. Ltd**	Sheet	1 of 1

Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	0.60m
Date of Started	25.01.2013	Drilling Method	Wash	Casing depth	3.50m	Coordinates	8° 25' 58.86"N
Date of Finished	25.01.2013	Casing Diameter	76mm	Elevation (m)			81° 6.49' 46"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	☒	D1	DS		0.00	Sand					
1.00	☒	D2	SS	G.W.L at 0.6m		Sand	Loose, brown, fine to medium SAND with some clay and gravels	4	3	3	**6**
			WS								
2.00	☒	D3	SS			Sand		3	4	5	**9**
			WS								
3.00	☒	D4	SS			Sand	ROCK LEVEL	**HB**			**>50**
					3.50		END OF THE BOREHOLE AT 3.50m DEPTH				
4.00											
5.00											
6.00											
7.00											
8.00											
9.00											
10.00											

Moisture Content - %
Undrained Shear Strength - t/m²: 10 20 30 40 50 60 70 80 90
SPT Resistance - Blows/ft: 5 10 15 20 25 30 35 40 45



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By : Nishantha
Supervised By: Lahiru
Drilled By: Suranga

Made Ground | Silt | Gravel | Laterite Nodules | Completely Weathered Rock
Clay | Sand | Organic Matter | Silty Sand | Highly Weathered Rock | Fresh Rock

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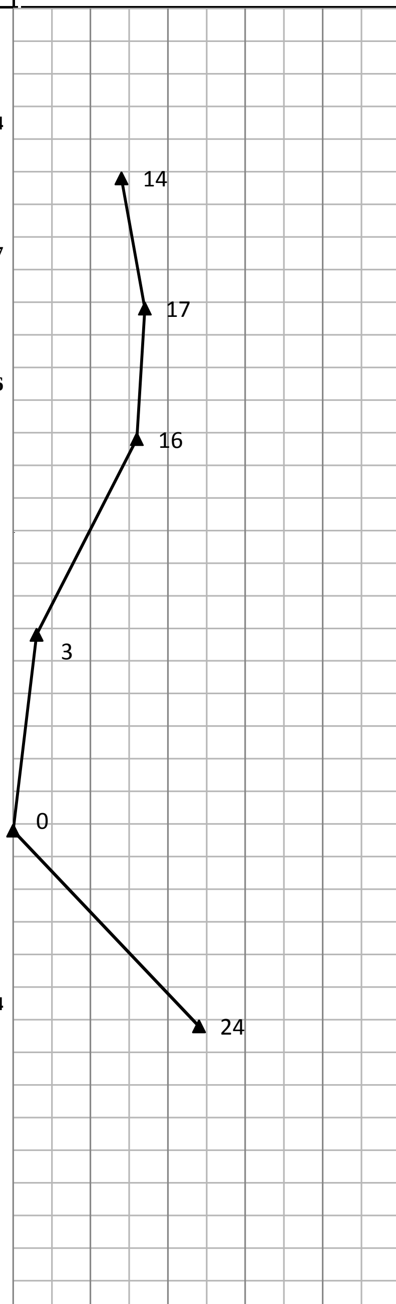
Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	AP-38
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	1 of 1
Location	Sampoor	Rig	TD	Core Diameter	54mm
Date of Started	23.01.2015	Drilling Method	Wash	Casing depth	7.50m
Date of Finished	14.01.2015	Casing Diameter	76mm	Elevation (m)	

Ground Water level: 1.40m
Coordinates: 8° 25' 43.01"N, 81° 12' 13.96"E

Depth (m)	Sa. NO.	Sa. Type	Reduced level	Depth (m)	Soil Description	15cm	15cm	15cm	N
0.00					Ground level				
	D1	DS		0.00	Stiff, brown, fine to medium SANDY CLAY with root fragments				
1.00						4	5	9	**14**
	D2	SS	G.W.L at 1.40m						
		WS							
2.00				1.00	Medium dense, yellowish brown, gray, fine to medium SAND	4	8	9	**17**
	D3	SS							
		WS							
3.00						8	8	8	**16**
	D4	SS							
4.00		WS							
	D5	SS		4.50	Very soft, black, gray, amorphous ORGANIC CLAY with fine to coarse sand	1	2	1	**3**
5.00									
		WS							
6.00						FD	FD	FD	**0**
	D6	SS							
7.00		WS							
	D7	SS		7.50	Greenish gray, fine to coarse sand with fine gravels COMPLETELY WEATHERED ROCK **ROCK LEVEL**	15	8	16	**24**
8.00									
		WS							
9.00				8.80	END OF THE BOREHOLE AT 8.80m DEPTH				
10.00									

Moisture Content - %
Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90)
SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks
Existing ground level considered as the zero level

Logged By : N.A.C Nishshanka
Supervised By: R.M.B.Sandaruwan
Drilled By: Sumathipala

Made Ground | Silt | Gravel | Laterite Nodules | Completely Weathered Rock
Clay | Sand | Organic Matter | Silty Sand | Highly Weathered Rock | Fresh Rock

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SITE INVESTIGATIONS DIVISION

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Katuwawala, Sri Lanka.
Tel: 0114 309 494

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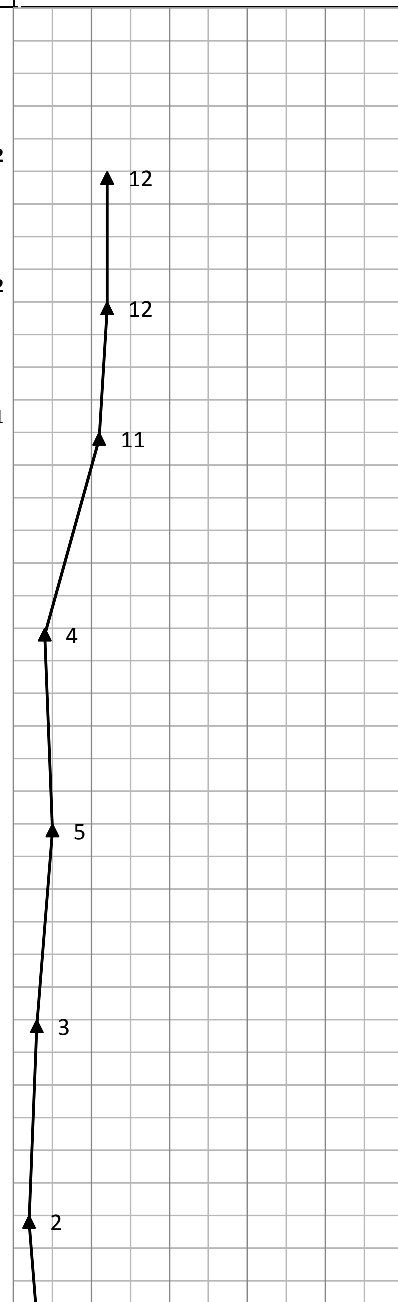
Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**	Borehole No	BH-39
Client	**M/s. Tokyo Electric Power Services Co. Ltd**	Sheet	1 of 4

Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	1.60m
Date of Started	16.01.2015	Drilling Method	Wash	Casing depth	40.00m	Coordinates	8° 25' 7.77"N
Date of Finished	22.01.2015	Casing Diameter	76mm	Elevation (m)			81° 13' 49.16.27"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	X	D1	DS		0.00	Sandy clay	Stiff, brown, fine to medium SANDY CLAY				
1.00	X	D2	SS					2	5	7	**12**
			WS	▼							
2.00	X	D3	SS	G.W.L at1.6m	2.00	Sand	Medium dense, brown, fine to medium SAND with mica traces	17	6	6	**12**
			WS								
3.00	X	D4	SS					14	5	6	**11**
4.00			WS								
	X	D5	SS		4.50	Sand	Washed sample; Loose, brown, fine to coarse sand with mica traces	8	2	2	**4**
5.00								No Sample			
			WS								
6.00	X	D6	SS		6.00	Organic clay	Soft, black, amorphous ORGANIC CLAY with fine to coarse sand and some gravels	1	2	3	**5**
7.00			WS								
	X	D7	SS					2	2	1	**3**
8.00			WS								
9.00	X	D8	SS		9.00	Clayey organic sand	Very loose, black, amorphous, fine to coarse, CLAYEY ORGANIC SAND	1	1	1	**2**
10.00			WS								

Moisture Content - %
Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90)
SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks
Existing ground level considered as the zero level

Logged By : Nishantha
Supervised By: Indunil
Drilled By: Sumathipala

Made Ground | Silt | Gravel | Laterite Nodules | Completely Weathered Rock | Fresh Rock
Clay | Sand | Organic Matter | Silty Sand | Highly Weathered Rock

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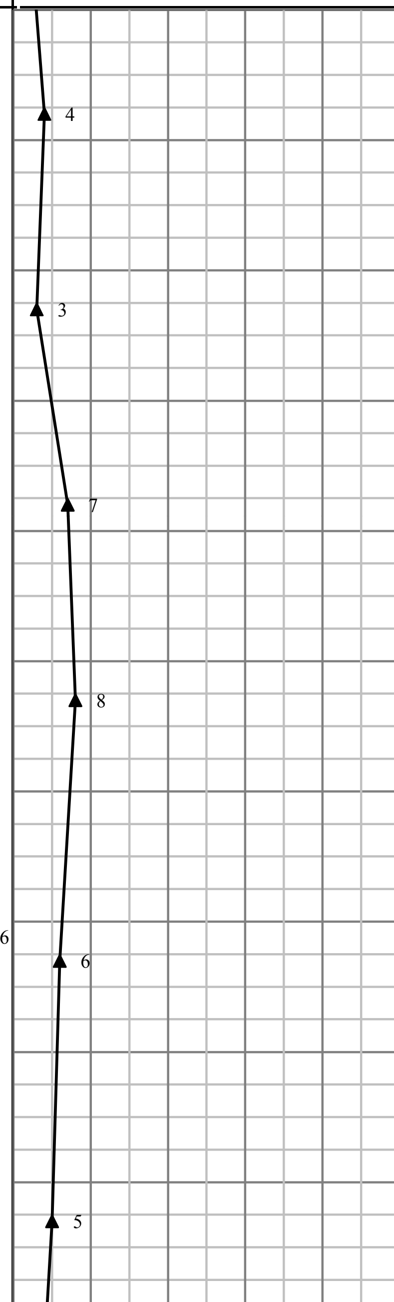
Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**					Borehole No	BH-39
Client	**M/s. Tokyo Electric Power Services Co. Ltd**					Sheet	2 of 4
Location	Sampoor	Rig	Joy	Core Diameter	54mm	Ground Water level	
Date of Started	16.01.2015	Drilling Method	Wash	Casing depth	40.00m	Coordinates	8° 25' 7.77"N
Date of Finished	22.01.2015	Casing Diameter	76mm	Elevation (m)			81° 13' 49.16.27"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Soil Description	Field Records (SPT) 15cm	15cm	15cm	N
10.00						Continue from Page 1				
						Same as previous description				
	X	D9	SS		10.50	Loose, black, fine to coarse SAND with small amount of ORGANIC CLAY	1	2	2	4
11.00			WS							
12.00	X	D10	SS				1	1	2	3
13.00			WS							
	X	D11	SS		13.50	Firm, black, amorphous ORGANIC fine SANDY CLAY	2	3	4	7
14.00			WS							
15.00	X	D12	SS				3	3	5	8
16.00			WS							
17.00	X	D13	SS		17.00	Firm, black, amorphous ORGANIC CLAY	2	3	3	6
18.00			WS							
19.00	X	D14	SS		19.00	Firm, black, amorphous ORGANIC CLAY with some fine sand	3	2	3	5
20.00										

Moisture Content - %
Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90)
SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample	N - Natural Moisture Content	C - Consolidation	**Remarks**
GWL : Ground Water Level observed inside the Borehole, after the saturation	SS -SPT Sample	L - Atterberg Limit Test	UCT-Unconfined Compression	Existing ground level considered as the zero level
NE Not Encountered	W - Water Sample	G - Grain Size Analysis	CU - Consolidated Undrained	
HB -Hammer Bounce	WS-Wgrey Sample	SG -Specific Gravity Test	UU-Unconsolidated Undrained	
FD - Free Down	UD- Undisturbed Sample	B - Bulk Density	pH - Chemical	
	CS- Core Sample	V - Vane Shear Test	O - Organic content	
	Cr - Core Recovery (%)		SO_4^{2-} - Sulphate Content	
	RQD-Rock Quality Designation (%)		Cl^- - Cloride Content	

Logged By : Nishantha
Supervised By: Indunil
Drilled By: Sumathipala

Legend: Made Ground, Clay, Silt, Sand, Gravel, Organic Matter, Laterite Nodules, Silty Sand, Completely Weathered Rock, Highly Weathered Rock, Fresh Rock

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Tel: 0114 309 494

Format No: ELS-SI-02

Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	BH-39
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	3 of 4
Location	Sampoor	Rig	Joy	Core Diameter	54mm
Date of Started	16.01.2015	Drilling Method	Wash	Casing depth	40.00m
Date of Finished	22.01.2015	Casing Diameter	76mm	Elevation (m)	

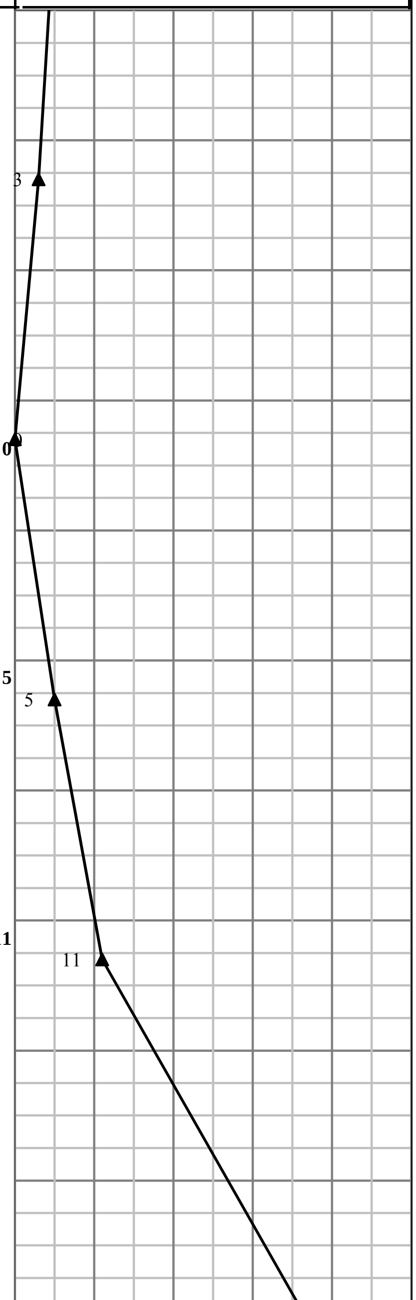
Ground Water level

Coordinates: 8° 25' 7.77"N, 81° 13' 49.16.27"E

Continue from Page 1

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Soil Description	15cm	15cm	15cm	N
20.00			WS			Same as previous description				
21.00	X	D15	SS		21.00	Very soft, black, amorphous ORGANIC fine SANDY CLAY	1	2	1	**3**
22.00			WS							
23.00	X	D16	SS				1	FD	FD	**0**
						No Sample				
24.00			WS							
25.00	X	D17	SS		25.00	Loose, brownish black, fine to coarse CLAYEY SAND with fine to medium gravels	3	2	3	**5**
26.00			WS							
27.00	X	D18	SS				6	4	7	**11**
28.00										
29.00			WS							
30.00										

Moisture Content - %
Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90)
SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
HB -Hammer Bounce
FD - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wgrey Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By: Nishantha
Supervised By: Indunil
Drilled By: Sumathipala

Made Ground, Silt, Gravel, Laterite Nodules, Completely Weathered Rock, Clay, Sand, Organic Matter, Silty Sand, Highly Weathered Rock, Fresh Rock

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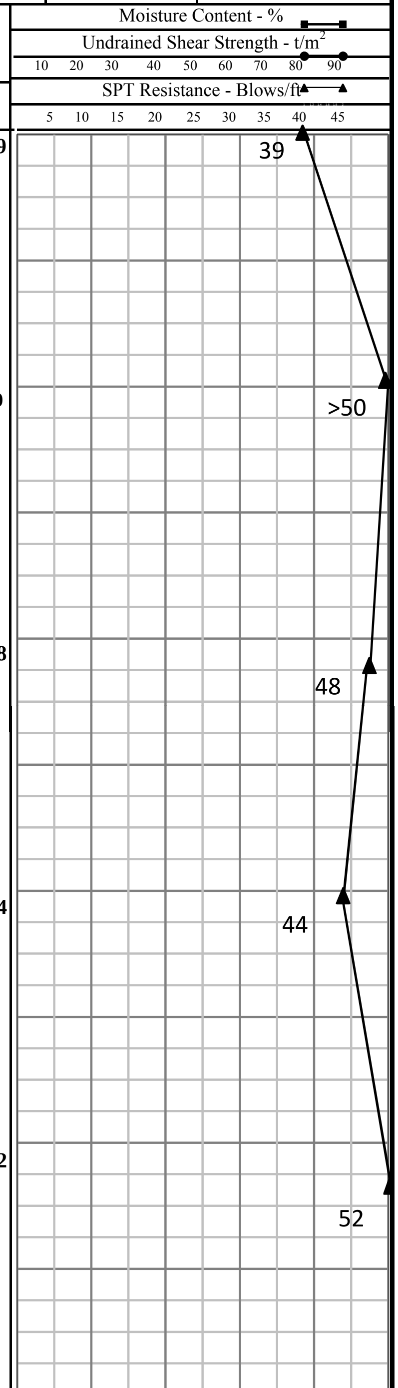
Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	BH-39
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	4 of 4
Location	Sampoor	Rig	Joy	Core Diameter	54mm
Date of Started	16.01.2015	Drilling Method	Wash	Casing depth	40.00m
Date of Finished	22.01.2015	Casing Diameter	76mm	Elevation (m)	

Ground Water level:

Coordinates: 8° 25’ 7.77”N, 81° 13’ 49.16.27”E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Soil Description	15cm	15cm	15cm	N
30.00						Continue from Page 1				
	X	D19	SS		30.00	Dense, yellowish brown, fine to medium CLAYEY SAND	12	17	22	**39**
31.00			WS							
32.00	X	D20	SS		32.00	Very dense, yellowish brown, gray, fine to coarse SAND	18	22	29	**>50**
33.00			WS							
34.00	X	D21	SS		34.00	Washed sample changed to;	16	23	25	**48**
							No sample			
35.00			WS							
36.00	X	D22	SS				12	19	25	**44**
37.00			WS			Dense, brown, gray, fine to medium sand with mica traces				
38.00	X	D23	SS				24	28	24	**52**
39.00										
40.00						END OF THE BOREHOLE AT 40.00m DEPTH				



Sample Key / Test Key

SPT : Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE : Not Encountered
HB : -Hammer Bounce
FD : - Free Down

D - Disturbed Sample
SS -SPT Sample
W - Water Sample
WS-Wash Sample
UD- Undisturbed Sample
CS- Core Sample
Cr - Core Recovery (%)
RQD-Rock Quality Designation (%)

N - Natural Moisture Content
L - Atterberg Limit Test
G - Grain Size Analysis
SG -Specific Gravity Test
B - Bulk Density
V - Vane Shear Test

C - Consolidation
UCT-Unconfined Compression
CU - Consolidated Undrained
UU-Unconsolidated Undrained
pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By : Nishantha
Supervised By: Indunil
Drilled By: Sumathipala

Legend: Made Ground, Clay, Silt, Sand, Gravel, Organic Matter, Laterite Nodules, Silty Sand, Completely Weathered Rock, Highly Weathered Rock, Fresh Rock

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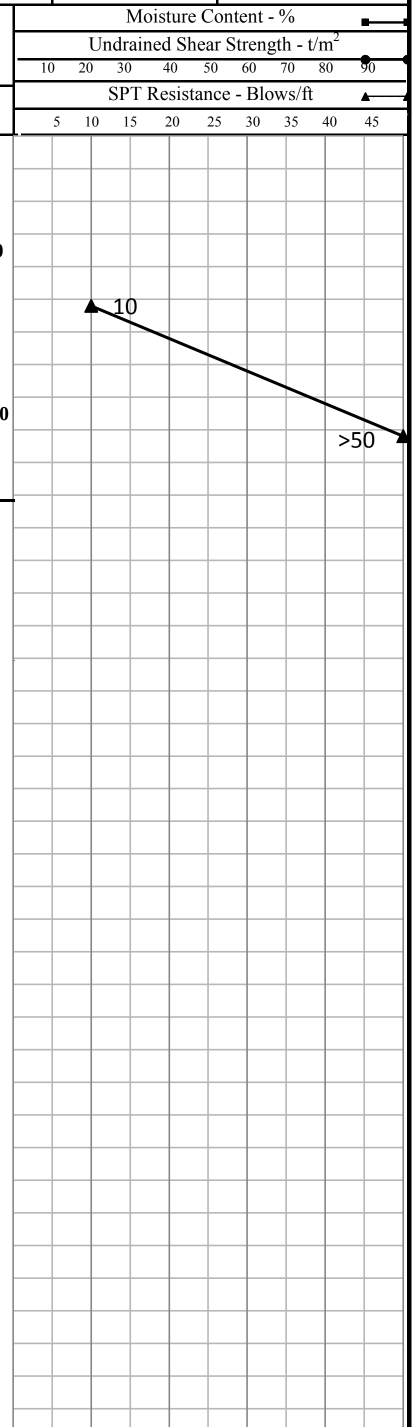
Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	AP-44
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm
Date of Started	27.01.2015	Drilling Method	Wash	Casing depth	2.0m
Date of Finished	27.01.2015	Casing Diameter	76mm	Elevation (m)	

Ground Water level: 1.30m

Coordinates: 8° 27' 17.13"N, 81° 18' 28.90"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N
0.00							Ground level				
	X	D1	DS		0.00	Completely Weathered Rock	Brown, light brown, fine sand with mica traces and root fragments COMPLETELY WEATHERED ROCK				
1.00								2	4	6	**10**
	X	D2	SS	G.W.L at 1.30m			(1.00-1.45)m sample changed to; brown, black, silty, fine to medium, sand with mica traces				
			WS								
2.00											
	X	D3	SS					14	17	HB	**>50**
							COMPLETELY WEATHERED ROCK ROCK LEVEL				
3.00					2.80		END OF THE BOREHOLE AT 2.80m DEPTH				
4.00											
5.00											
6.00											
7.00											
8.00											
9.00											
10.00											

Field Records (SPT)



Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample	N - Natural Moisture Content	C - Consolidation	
GWL : Ground Water Level observed inside the Borehole, after the saturation	SS -SPT Sample	L - Atterberg Limit Test	UCT-Unconfined Compression	
NE Not Encountered	W - Water Sample	G - Grain Size Analysis	CU - Consolidated Undrained	
HB -Hammer Bounce	WS-Wgrey Sample	SG -Specific Gravity Test	UU-Unconsolidated Undrained	
FD - Free Down	UD- Undisturbed Sample	B - Bulk Density	pH - Chemical	
	CS- Core Sample	V - Vane Shear Test	O - Organic content	
	Cr - Core Recovery (%)		SO_4^{2-} - Sulphate Content	
	RQD-Rock Quality Designation (%)		Cl^- - Cloride Content	

Remarks: Existing ground level considered as the zero level

Logged By: Dimuthu

Supervised By: Indunil

Drilled By: Sumathipala

Made Ground	Silt	Gravel	Laterite Nodules	Completely Weathered Rock	
Clay	Sand	Organic Matter	Silty Sand	Highly Weathered Rock	Fresh Rock

ENGINEERING & LABORATORY SERVICES (PVT) LTD.
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Project	**Geotechnical Investigation for National Transmission and Distribution Network Development and Efficiency Improvement Project (II)**			Borehole No	TT-02
Client	**M/s. Tokyo Electric Power Services Co. Ltd**			Sheet	1 of 1
Location	Sampoor	Rig	Joy	Core Diameter	54mm
Date of Started	25.01.2015	Drilling Method	Wash	Casing depth	2.0m
Date of Finished	25.01.2015	Casing Diameter	76mm	Elevation (m)	

Ground Water level: NE

Coordinates: 8° 28' 25.59"N, 81° 18' 55.61"E

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	15cm	15cm	15cm	N	SPT Resistance - Blows/ft
0.00							Ground level					
		D1	DS		0.00		Black, dark brown, fine sand					
1.00		D2	SS				COMPLETELY WEATHERED ROCK (1.00-1.45)m sample changed to; black, yellowish brown, offwhite, fine sand	8	8	HB	>50	>50
			WS				COMPLETELY WEATHERED ROCK (2.00-2.45)m sample changed to; black, light green, slightly silty sand					
2.00		D3	SS				COMPLETELY WEATHERED ROCK ROCK LEVEL	2	16	HB	>50	>50
			WS		2.60		END OF THE BOREHOLE AT 2.60m DEPTH					
3.00												
4.00												
5.00												
6.00												
7.00												
8.00												
9.00												
10.00												

Field Records (SPT)

Moisture Content - %; Undrained Shear Strength - t/m^2 (10 20 30 40 50 60 70 80 90); SPT Resistance - Blows/ft (5 10 15 20 25 30 35 40 45)

Sample Key / Test Key

SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)
GWL : Ground Water Level observed inside the Borehole, after the saturation
NE Not Encountered
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CU - Consolidated Undrained
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pH - Chemical
O - Organic content
SO_4^{2-} - Sulphate Content
Cl^- - Cloride Content

Remarks: Existing ground level considered as the zero level

Logged By: Dimuthu
Supervised By: Indunil
Drilled By: Sumathipala

Made Ground | Silt | Gravel | Laterite Nodules | Completely Weathered Rock
Clay | Sand | Organic Matter | Silty Sand | Highly Weathered Rock | Fresh Rock

Annexure II: Field Photographs

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

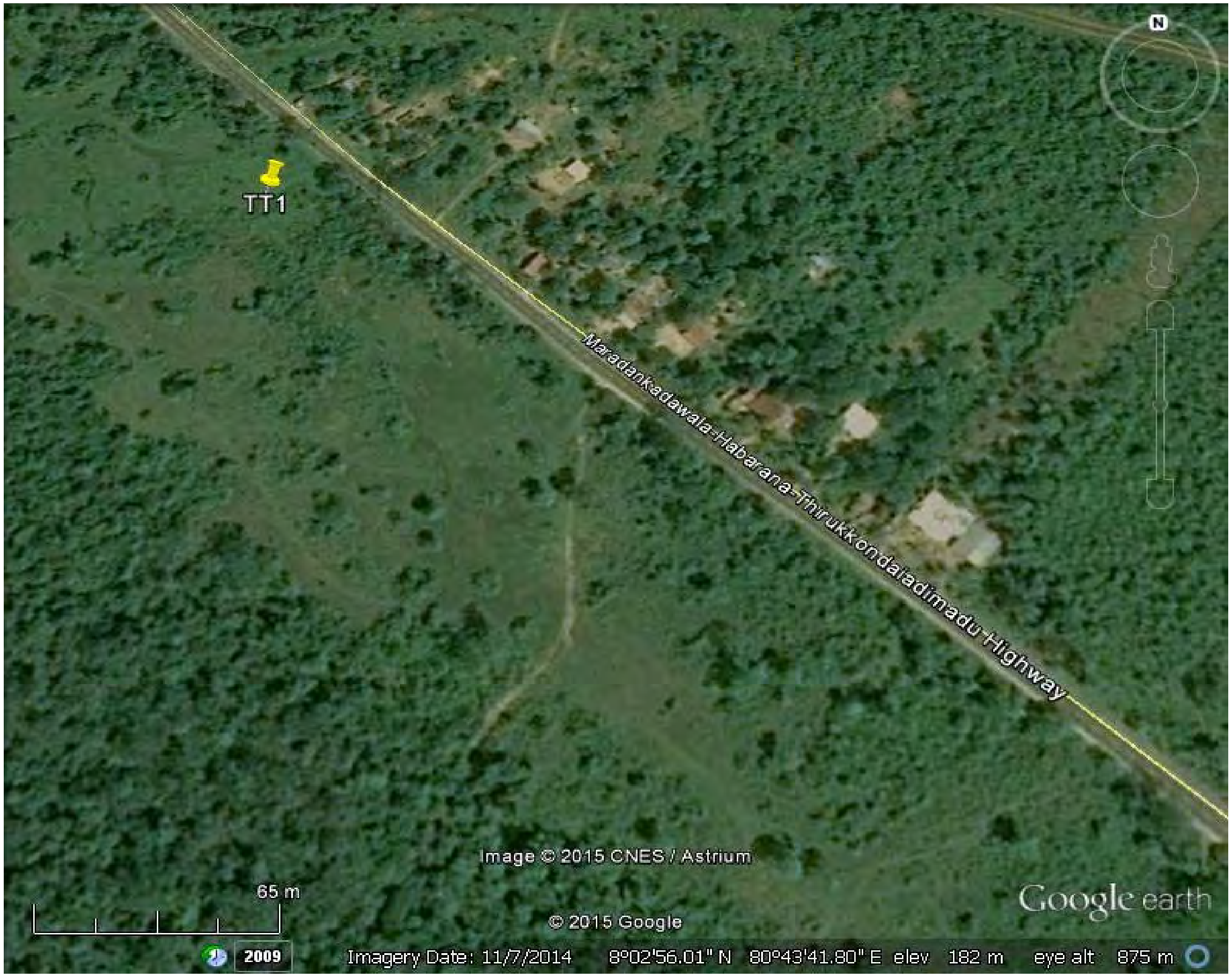
Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)

Engineering & Laboratory Services (Pvt) Ltd.

Annexure III: Borehole Locations

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)



Engineering & Laboratory Services (Pvt) Ltd.

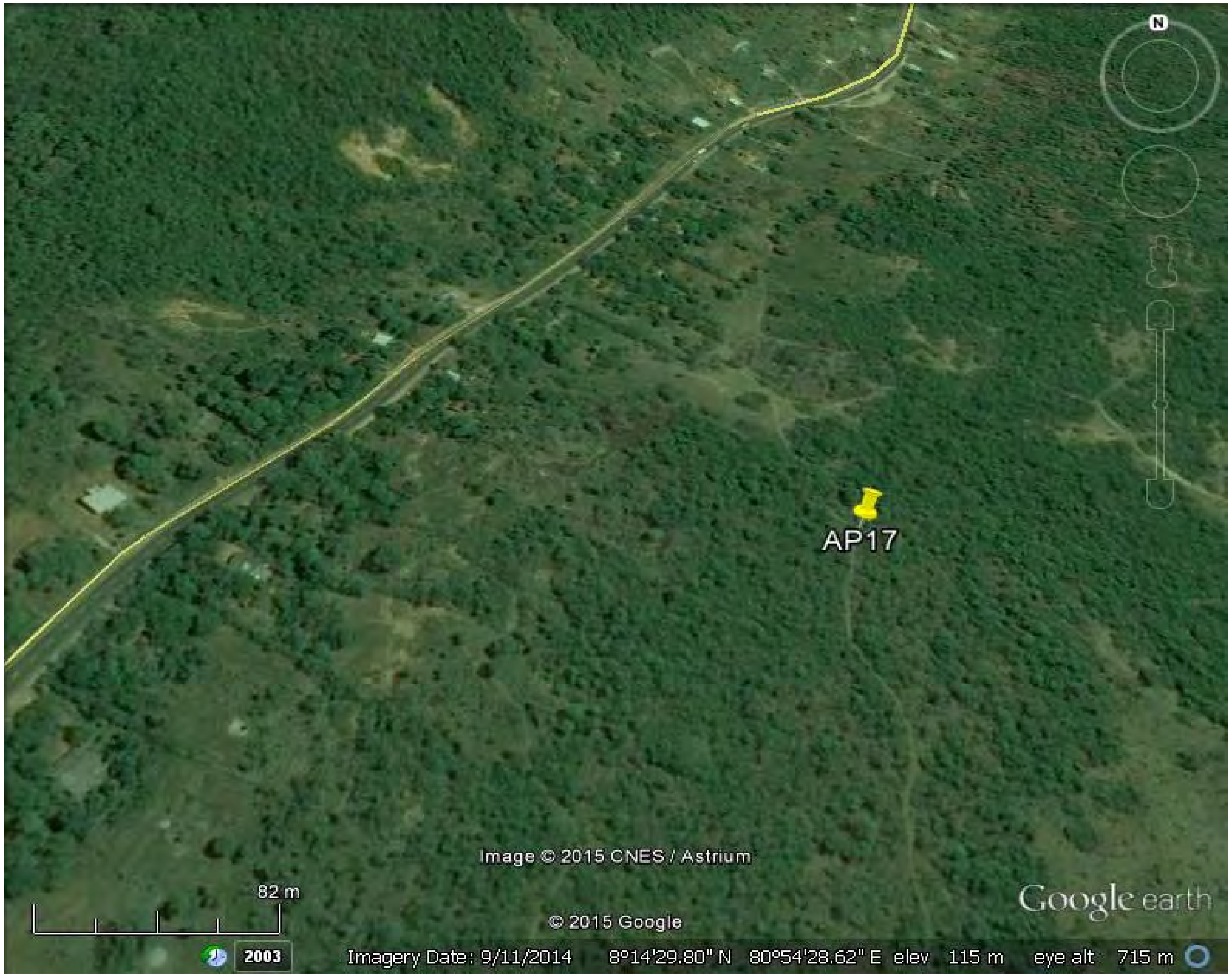
GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)

Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

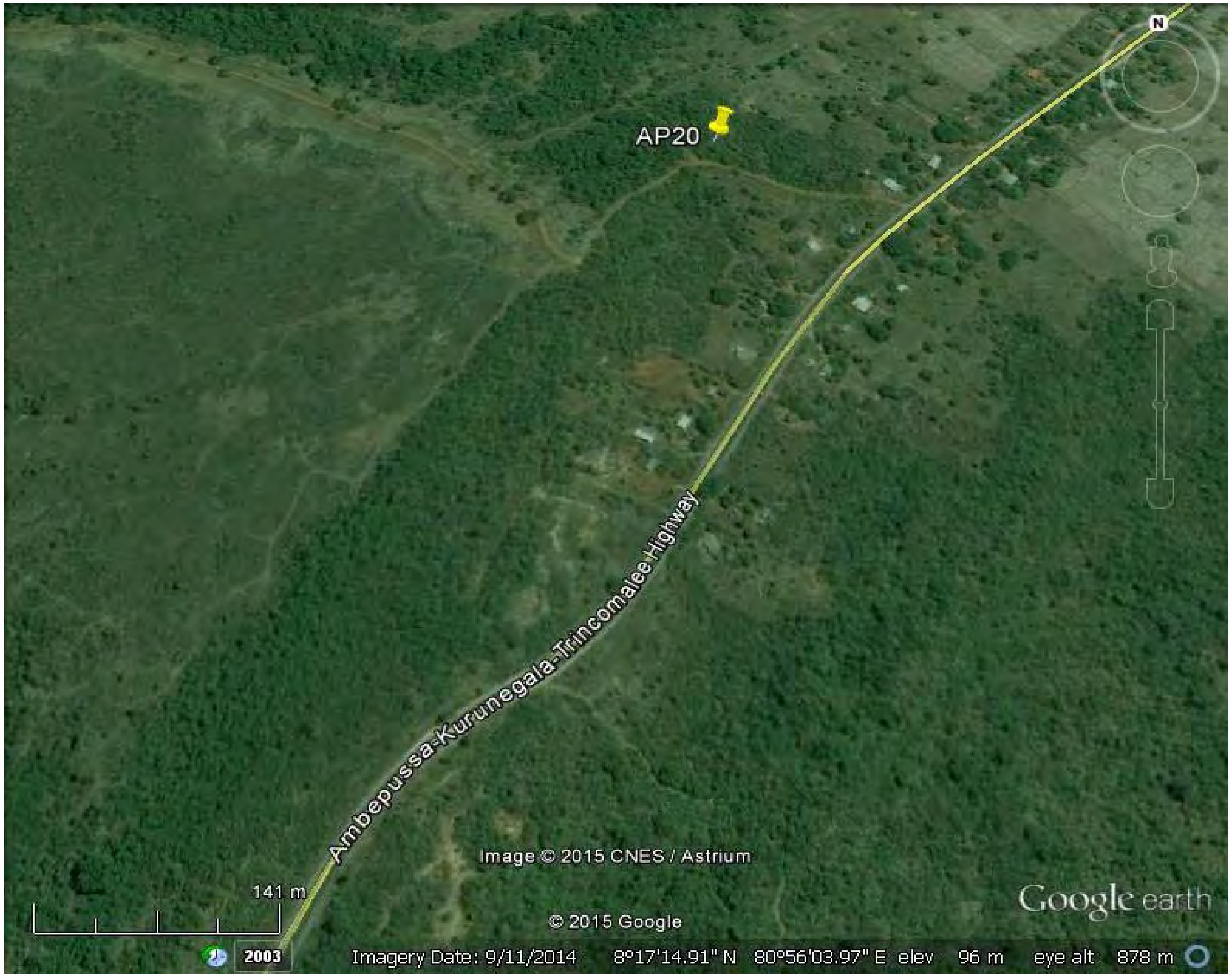
Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)



Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

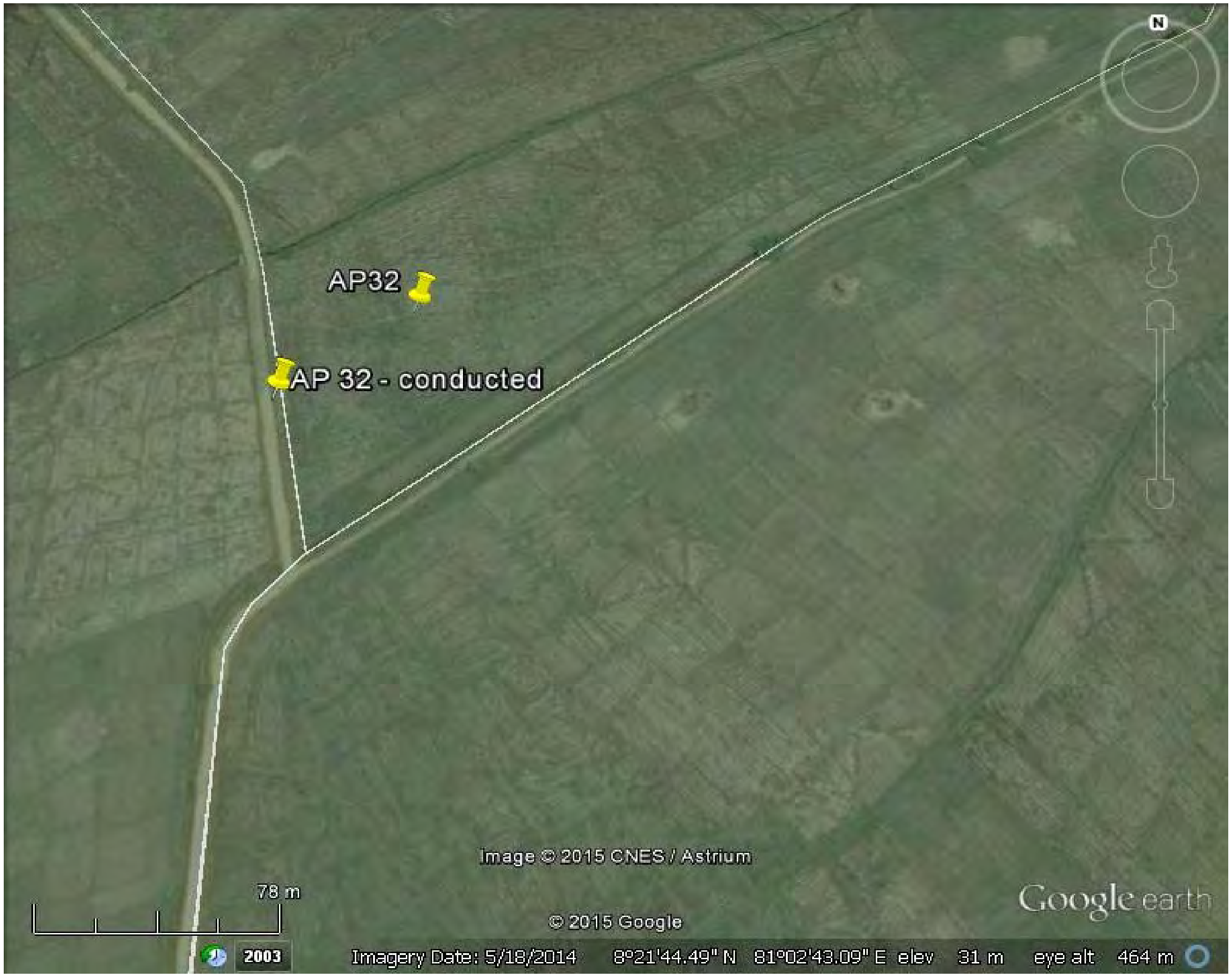
Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)



Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)



Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)

Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

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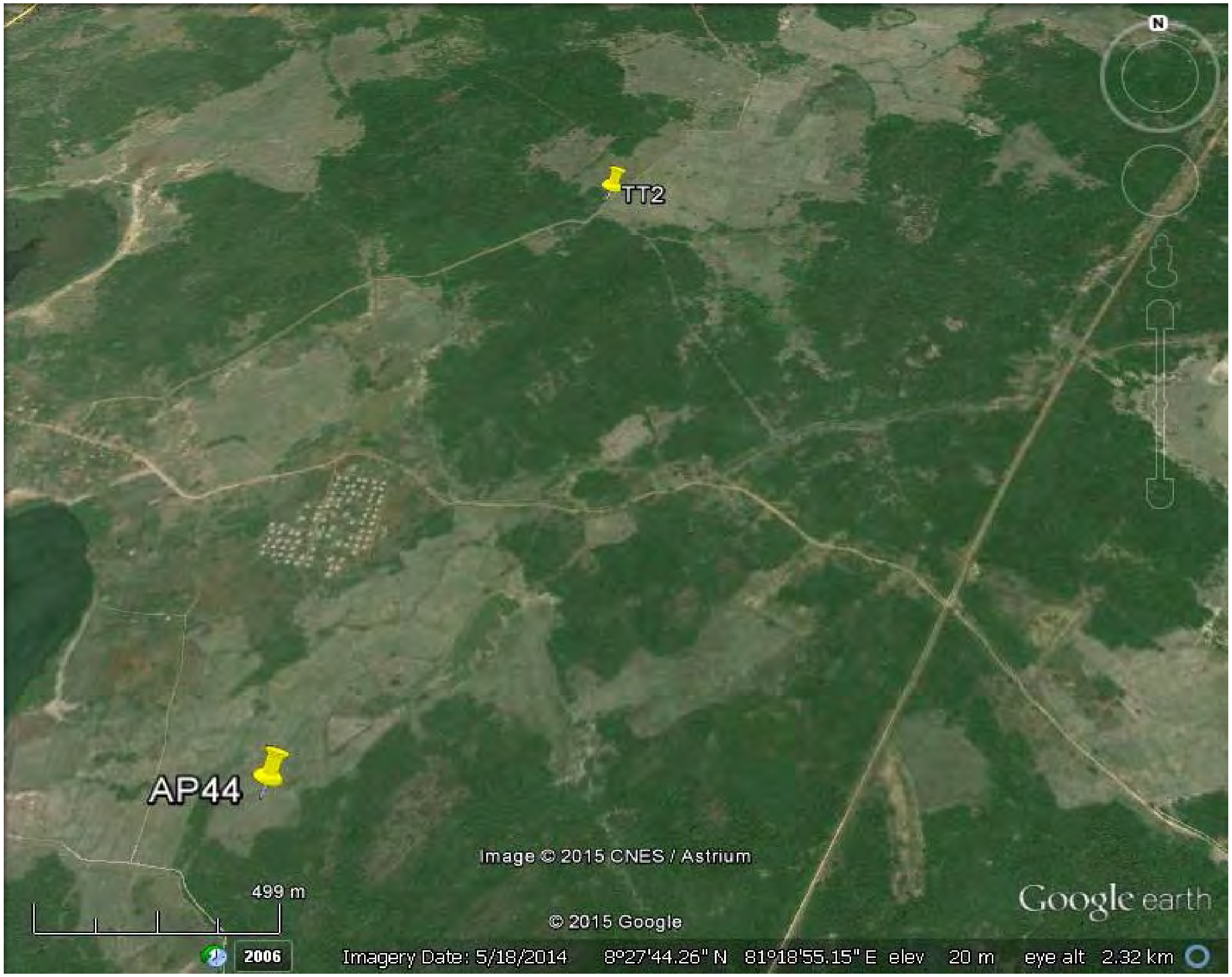
Engineering & Laboratory Services (Pvt) Ltd.

GEOTECHNICAL INVESTIGATION FOR NATIONAL TRANSMISSION AND DISTRIBUTION NETWORK DEVELOPMENT AND EFFICIENCY IMPROVEMENT PROJECT (II)

Client: Tokyo Electric Power Services Co. Ltd. (TEPSCO)



Engineering & Laboratory Services (Pvt) Ltd.

Loss Reduction Calculation of the 400kV Sampoor - New Habarana T/L

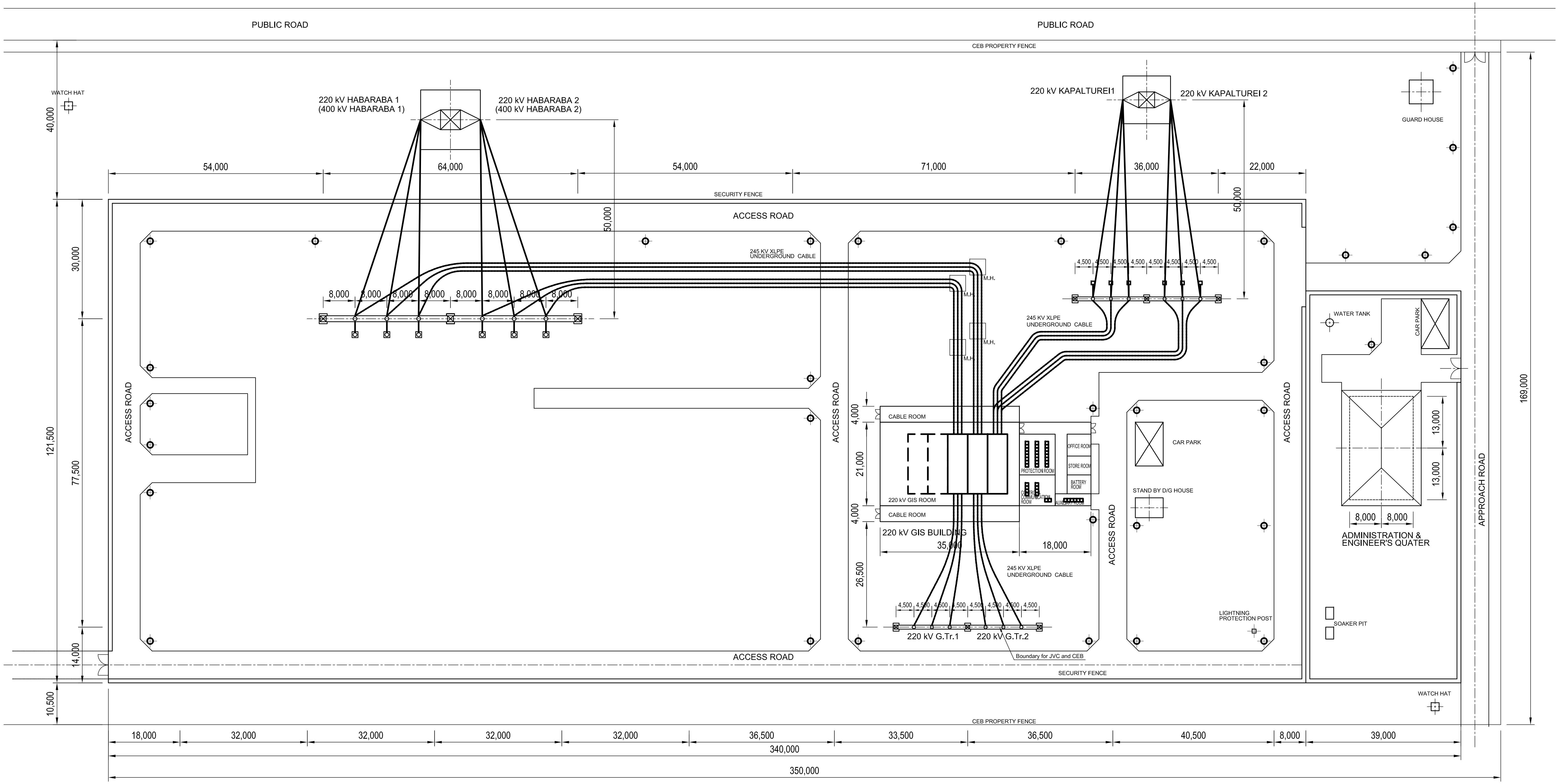
Power factor	0.85		Construction cost of 400kV Sampoor - New Habarana		
Load factor of 220kV	0.582		-ACSR Zebra	9284	M Rs
Conductor Resistance			-LL-ACSR/AW 550	10029	M Rs
- ACSR Zebra	0.0814	Ohm/km at 63 deg.	-Cost Difference	745	M Rs
- LL-ACSR/AC 550	0.0621	Ohm/km at 61 deg.			
Bundle	4	bundle	Rate	0.87	LKRs/yen
Length of S-H T/L	91.2	km			

	Year	Generation at Sampoor (GWh)	Operation Voltage of S-H T/L (kV)	Load of Kapparutlai (MW)	Energy to S-K T/L (GWh)	Energy to S-H T/L (GWh)	Sending per 1cct of S-H T/L (MW)	Load factor of S-H T/L	Load Loss Factor of S-H T/L	Current per conductor (A)	Annual losses on Zebra per cct (MWh/km)	Annual losses on LL per cct (MWh/km)	Annual loss reduction per cct (MWh/km)	Annual loss reduction (MWh)	Tariff (kWh/Y)	Loss reduction benefits equivalent Sales Amounts (M JPY)	Sum of Annual Benefit Amounts (M JPY)
1	2017																
2	2018																
3	2019																
4	2020	3360	220	85.2	434.4	2925.6	194.3	0.8594	0.7628	149.97	146.8	112.0	34.8	6348.8	15.62	99.17	99.17
5	2021	3381	220	85.2	434.4	2946.6	194.3	0.8656	0.7725	149.97	148.7	113.4	35.3	6429.9	15.62	100.44	199.61
6	2022	6621	400	88	448.7	6172.3	452.9	0.7779	0.6397	192.27	202.3	154.4	48.0	8750.3	15.62	136.68	336.29
7	2023	8053	400	88	448.7	7604.3	452.9	0.9584	0.9264	192.27	293.0	223.6	69.5	12673.1	15.62	197.95	534.24
8	2024	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	816.62
9	2025	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	1,099.00
10	2026	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	1,381.38
11	2027	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	1,663.76
12	2028	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	1,946.14
13	2029	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	2,228.52
14	2030	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	2,510.90
15	2031	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	2,793.28
16	2032	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	3,075.66
17	2033	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	3,358.04
18	2034	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	3,640.42
19	2035	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	3,922.80
20	2036	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	4,205.18
21	2037	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	4,487.56
22	2038	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	4,769.94
23	2039	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	5,052.32
24	2040	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	5,334.70
25	2041	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	5,617.08
26	2042	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	5,899.46
27	2043	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	6,181.84
28	2044	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	6,464.22
29	2045	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	6,746.60
30	2046	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	7,028.98
31	2047	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	7,311.36
32	2048	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	7,593.74
33	2049	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	7,876.12
34	2050	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	8,158.50
35	2051	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	8,440.88
36	2052	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	8,723.26
37	2053	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	9,005.64
38	2054	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	9,288.02
39	2055	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	9,570.40
40	2056	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	9,852.78
41	2057	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	10,135.16
42	2058	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	10,417.54
43	2059	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	10,699.92
44	2060	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	10,982.30
45	2061	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	11,264.68
46	2062	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	11,547.06
47	2063	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	11,829.44
48	2064	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	12,111.82
49	2065	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	12,394.20
50	2066	9343	400	114	581.2	8761.8	709.8	0.7046	0.5380	301.33	418.0	318.9	99.1	18078.4	15.62	282.38	12,676.58

Loss Reduction Calculation of the 220kV Sampoor - Kappalturai T/L

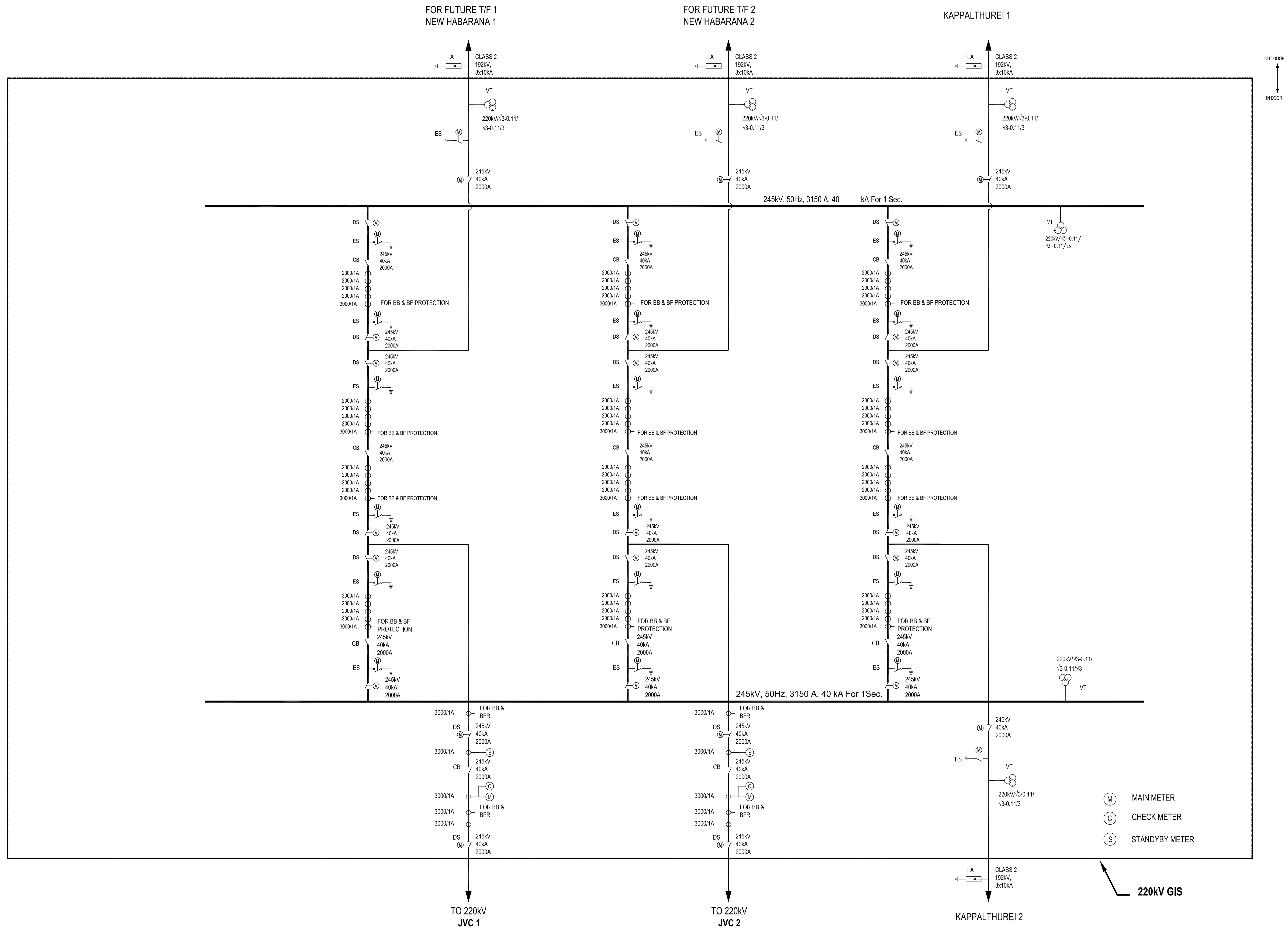
Power factor	0.85		Conductor cost		
Load factor of 220kV	0.582		- ACSR Zebra	770 JPY/m	670 LKRs/m
Conductor Resistance			- LL-ACSR/AC 550	1,079 JPY/m	939 LKRs/m
- ACSR Zebra	0.0814	Ohm/km at 63 deg.	Cost Difference per km	3,708,000 JPY/km	3,225,960 LKRs/km
- LL-ACSR/AC 550	0.0621	Ohm/km at 61 deg.			
Bundle	2	bundle	Rate	0.87 LKRs/yen	
Length of S-H T/L	45	km			

	Year	Generation at Sampoor (GWh)	Operation Voltage of S-H T/L (kV)	Sending per 1cct of S-K T/L (MW)	Load Loss Factor of S-K T/L	Current per conductor (A)	Annual losses on Zebra per cct (MWh/km)	Annual losses on LL per cct (MWh/km)	Annual Loss reduction per cct (MWh/km)	Annual Loss reduction (MWh/km)	Annual Loss reduction (MWh)	Tariff (kWh/Y)	Loss reduction benefits equivalent Sales Amounts (JPY/km)	Sum of Annual Benefit Amouints (JPY/km)
1	2017													
2	2018													
3	2019													
4	2020	3360	220	39.3	0.3874	60.67	6.1	4.7	1.4	2.9	130.2	15.62	45,184	45,184
5	2021	3381	220	39.3	0.3874	60.67	6.1	4.7	1.4	2.9	130.2	15.62	45,184	90,368
6	2022	6621	220	44.1	0.3874	68.08	7.7	5.9	1.8	3.6	163.9	15.62	56,895	147,263
7	2023	8053	220	44.1	0.3874	68.08	7.7	5.9	1.8	3.6	163.9	15.62	56,895	204,158
8	2024	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	299,540
9	2025	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	394,922
10	2026	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	490,304
11	2027	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	585,686
12	2028	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	681,068
13	2029	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	776,450
14	2030	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	871,832
15	2031	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	967,214
16	2032	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,062,596
17	2033	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,157,978
18	2034	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,253,360
19	2035	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,348,742
20	2036	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,444,124
21	2037	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,539,506
22	2038	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,634,888
23	2039	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,730,270
24	2040	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,825,652
25	2041	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	1,921,034
26	2042	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,016,416
27	2043	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,111,798
28	2044	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,207,180
29	2045	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,302,562
30	2046	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,397,944
31	2047	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,493,326
32	2048	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,588,708
33	2049	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,684,090
34	2050	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,779,472
35	2051	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,874,854
36	2052	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	2,970,236
37	2053	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,065,618
38	2054	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,161,000
39	2055	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,256,382
40	2056	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,351,764
41	2057	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,447,146
42	2058	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,542,528
43	2059	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,637,910
44	2060	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,733,292
45	2061	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,828,674
46	2062	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	3,924,056
47	2063	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	4,019,438
48	2064	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	4,114,820
49	2065	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	4,210,202
50	2066	9343	220	57.1	0.3874	88.15	12.9	9.8	3.1	6.1	274.8	15.62	95,382	4,305,584

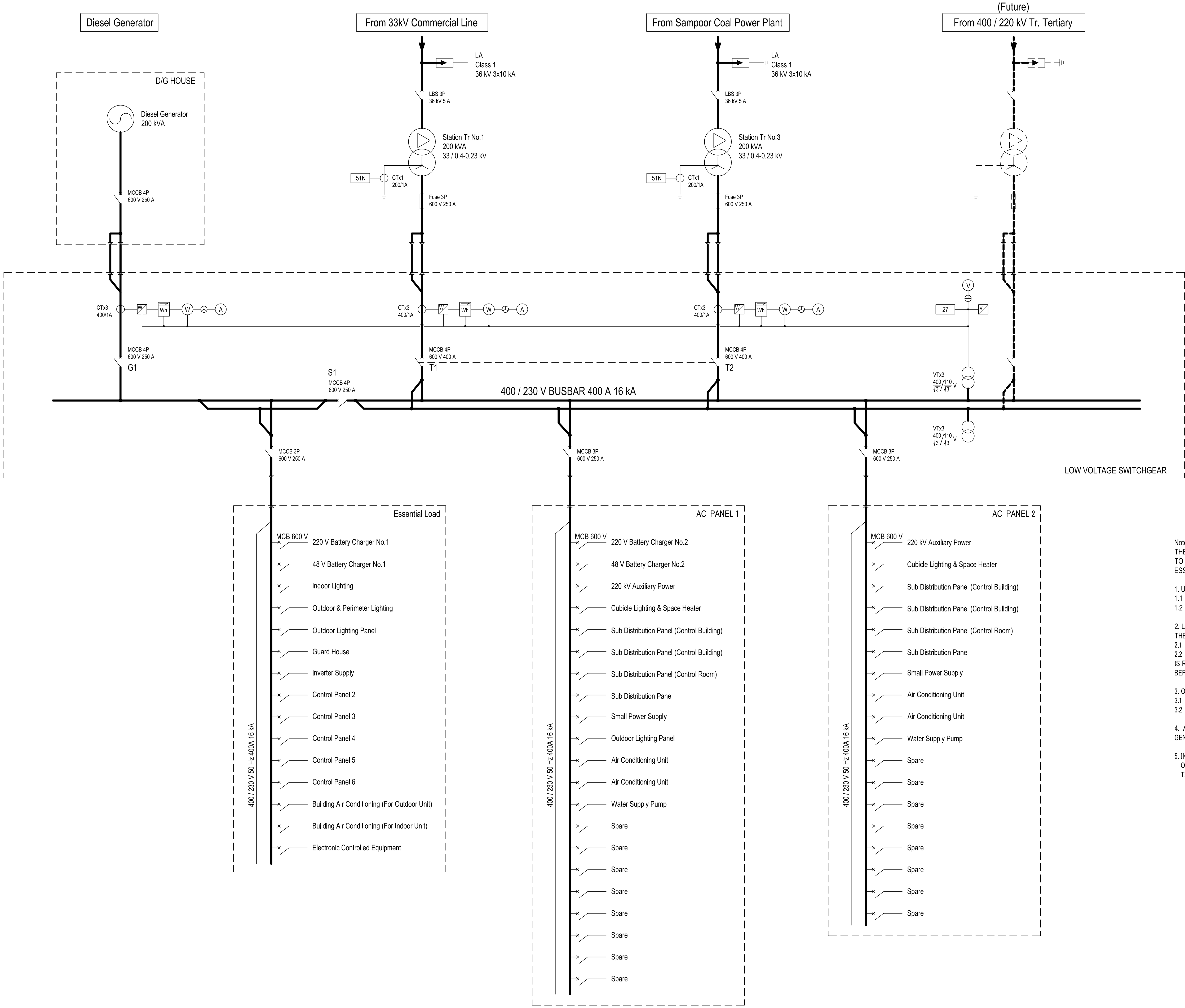


SL-SP SS-LY-001 : Layout Drawing for the Sampoor 220 kV Switching Station

Annex 5.3-1



SL-SP SS-SD-001 : Single Line Diagram for the Sampoor 220 kV Switching Station



Note:
THE MAIN SUPPLY IS TO BE AUTOMATICALLY SELECTED & INTERLOCKED TO PREVENT PARALLELING OF THE TWP SUPPLY & TP TO ALWAYS SUPPLY TJE ESSENTIAL SERVICES

1. UNDER NORMAL OPERATING CONDITIONS:
1.1 CIRCUIT BREAKER T1 OR T2 WILL BE CLOSED.
1.2 CIRCUIT BREAKER G2 WILL BE OPENED.

2. LOSS OF SUPPLY FROM 33 kV LINE SHALL AUTOMATICALLY INITIATE THE FOLLOWING OPERATIONS:
2.1 AFTER A SHORT TIME DELAY, THE DIESEL GENERATOR SHALL START.
2.2 CIRCUIT BREAKER G1 SHALL CLOSE AFTER THE GENERATOR VOLTAGE IS REACHED. CIRCUIT BREAKER T1, T2 AND S1 WILL BE OPENED SIMULTANEOUSLY BEFORE G1 CLOSED.

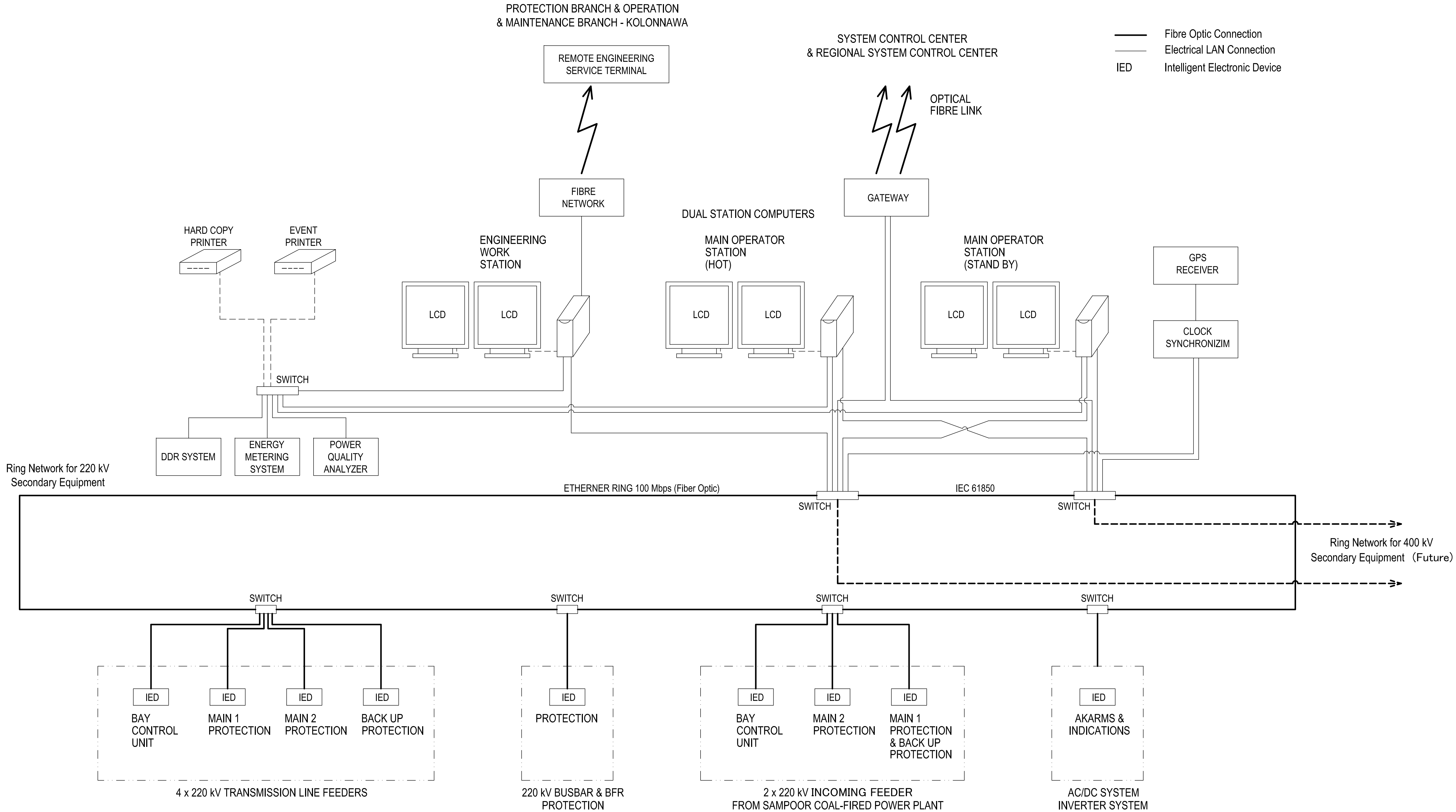
3. ON RESTORATION OF MAIN SUPPLY
3.1 CIRCUIT BREAKER G1 SHALL BE OPENED WITH A TIME DELAY.
3.2 CIRCUIT BREAKER T1 OR T2, & S1 SHALL BE CLOSED

4. AUTO CHANGE OVER FACILITY SHALL BE PROVIDED WITH GENERATOR SUPPLY & 33 kV LINE SUPPLIES.

5. INTERLOCKING REQUIREMENTS.
ONLY ONE OF THE BREAKERS G1, T1 AND T2 CAN BE IN CLOSED POSITION AT A TIME FOR ALL OPERATING CONDITIONS.

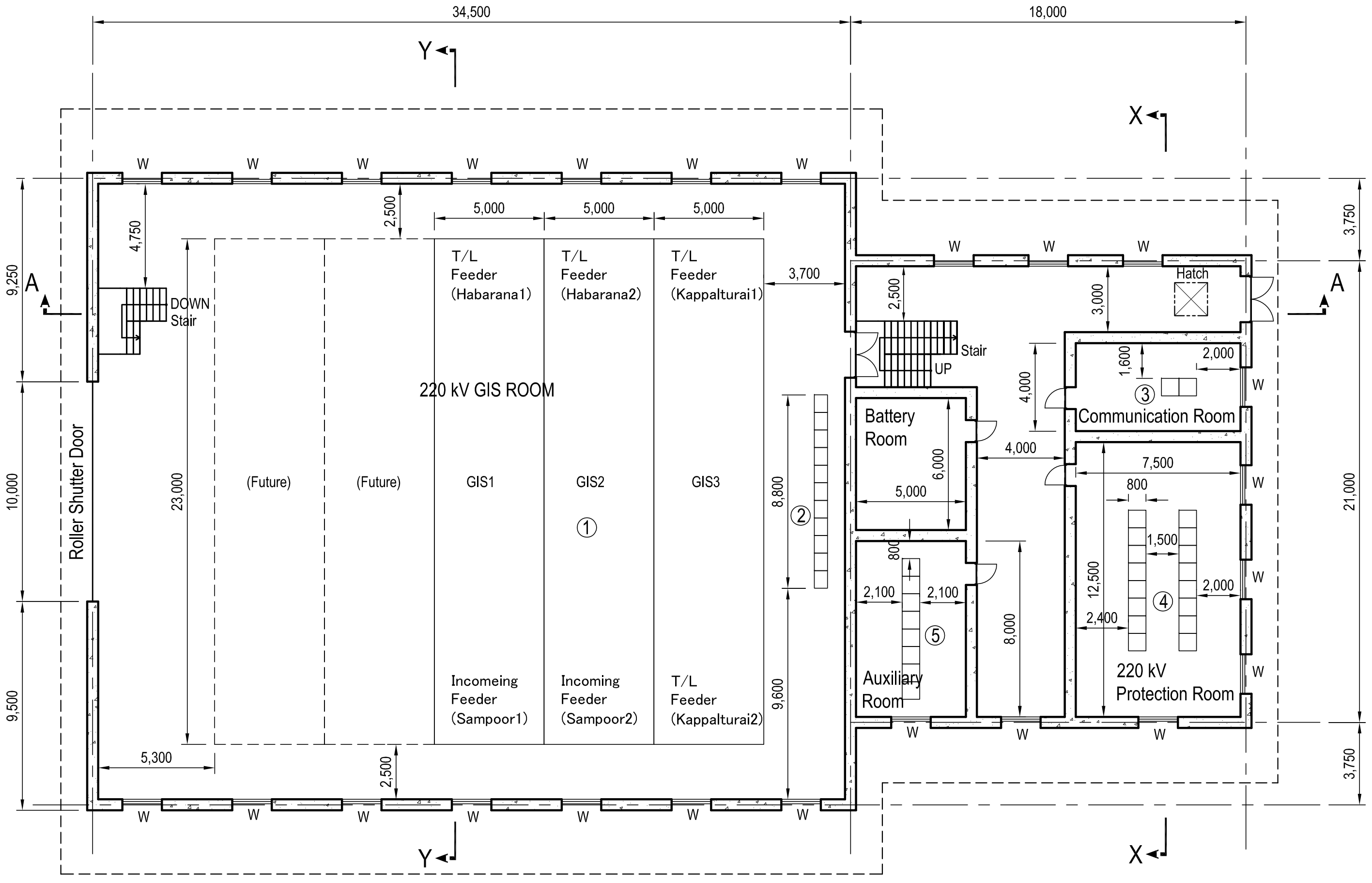
Annex 5.3-3

SL-SP SS-SD-002 :Station Service Circuit Diagram for the Sampoor 220 kV Switching Station



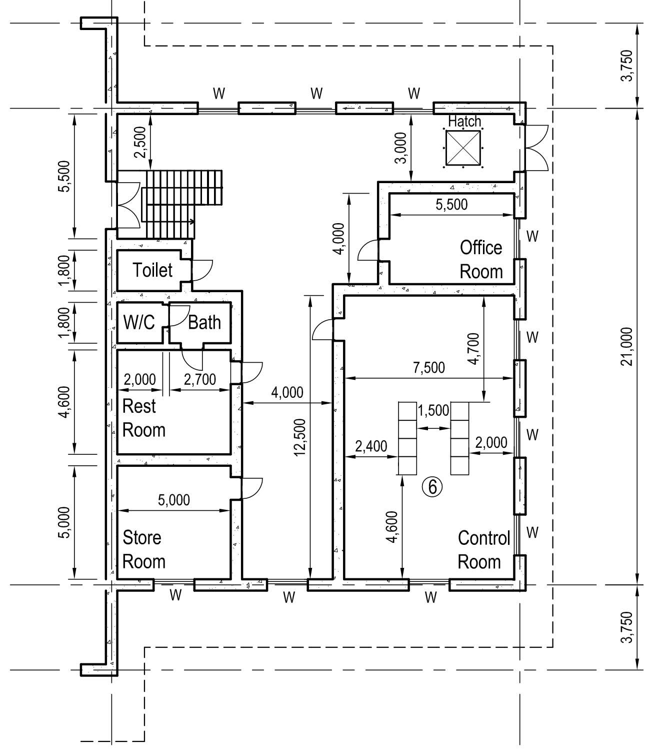
Annex 5.3-4

SL-SP SS-SD-003 :Supervisory Control System for the Sampoor 220 kV Switching Station



GROUND FLOOR PLAN

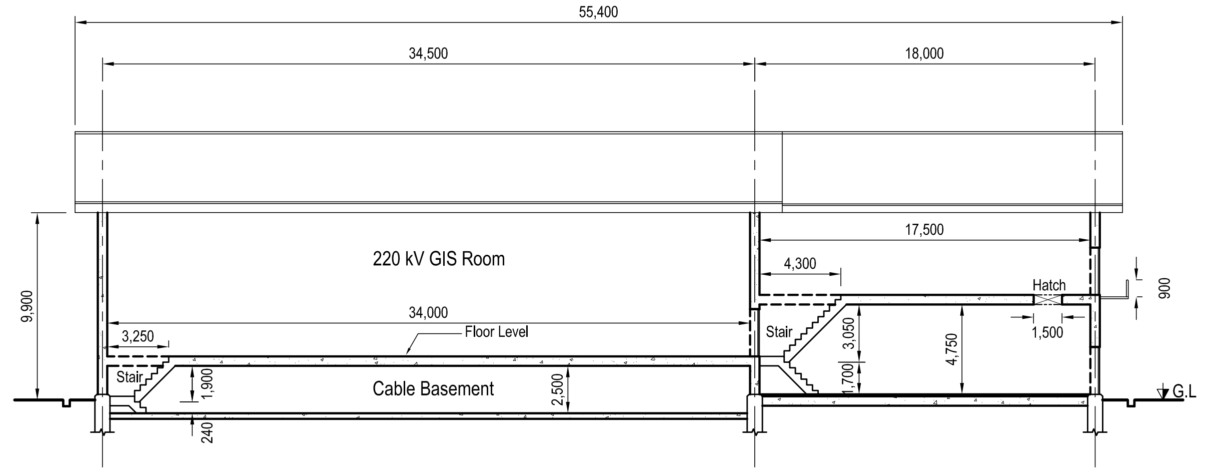
SCALE A



UPPER FLOOR PLAN

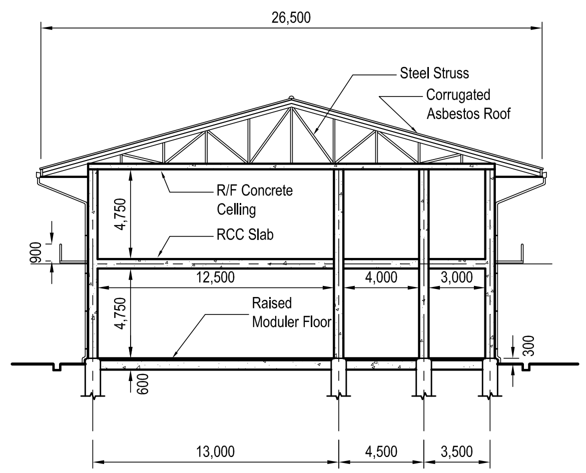
SCALE A

No.	Equipment
1	220 kV GIS (1+1/2 Circuit Breaker Scheme)
2	Local Control Board
3	Communication Equipment
4	220 kV Protection Panel
5	33 kV Distribution Board
6	Control Equipment (Micro SCADA)



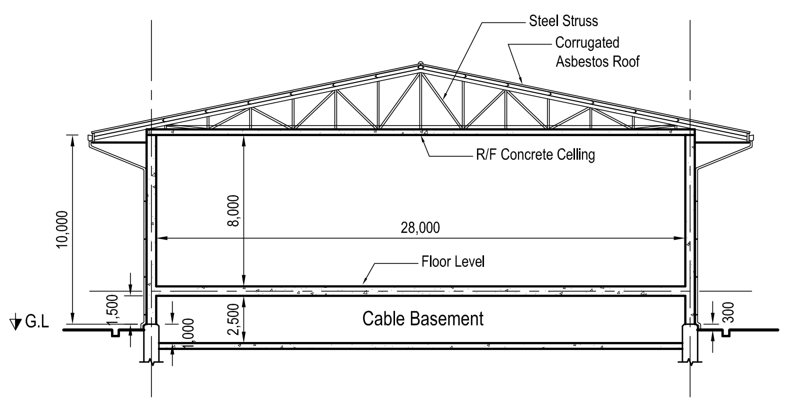
SECTION A-A

SCALE B



SECTION X-X

SCALE B



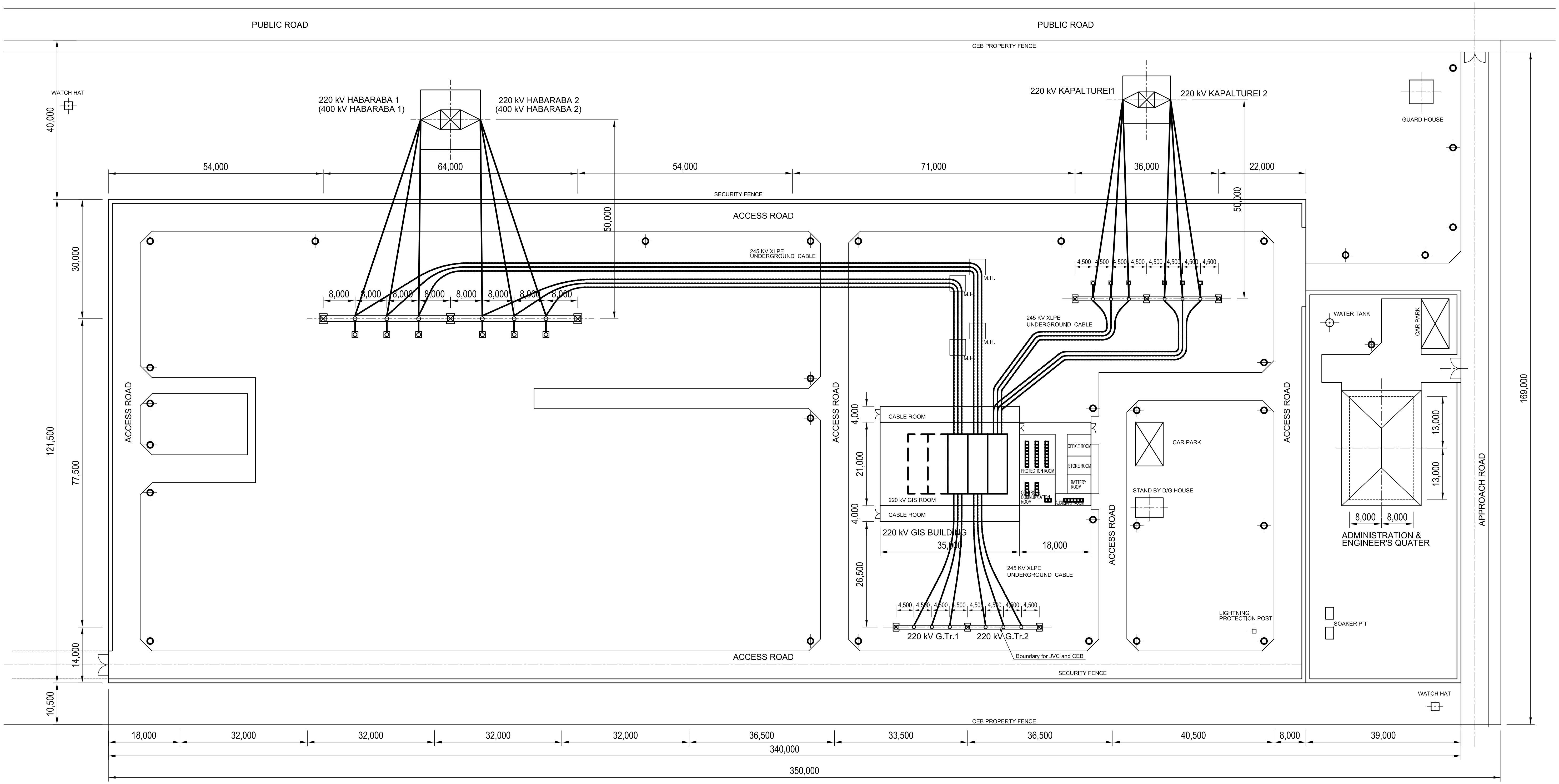
SECTION Y-Y

SCALE B

SCALE A 0 2.5 5.0 12.5 m

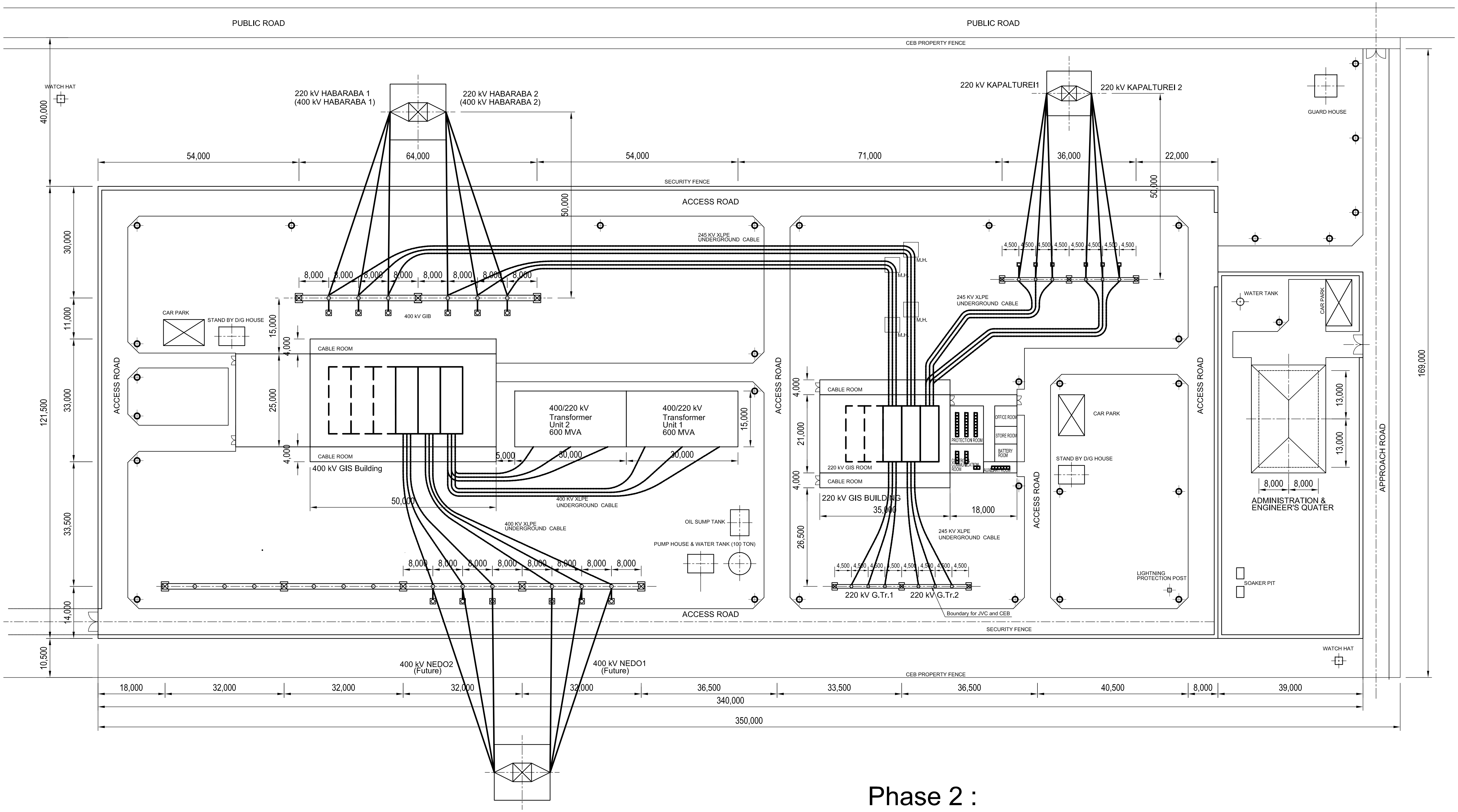
SCALE B 0 4.0 8.0 20.0 m

SL-SP SS-LY-002 : Control Building Layout for the Sampoor 220 kV SS

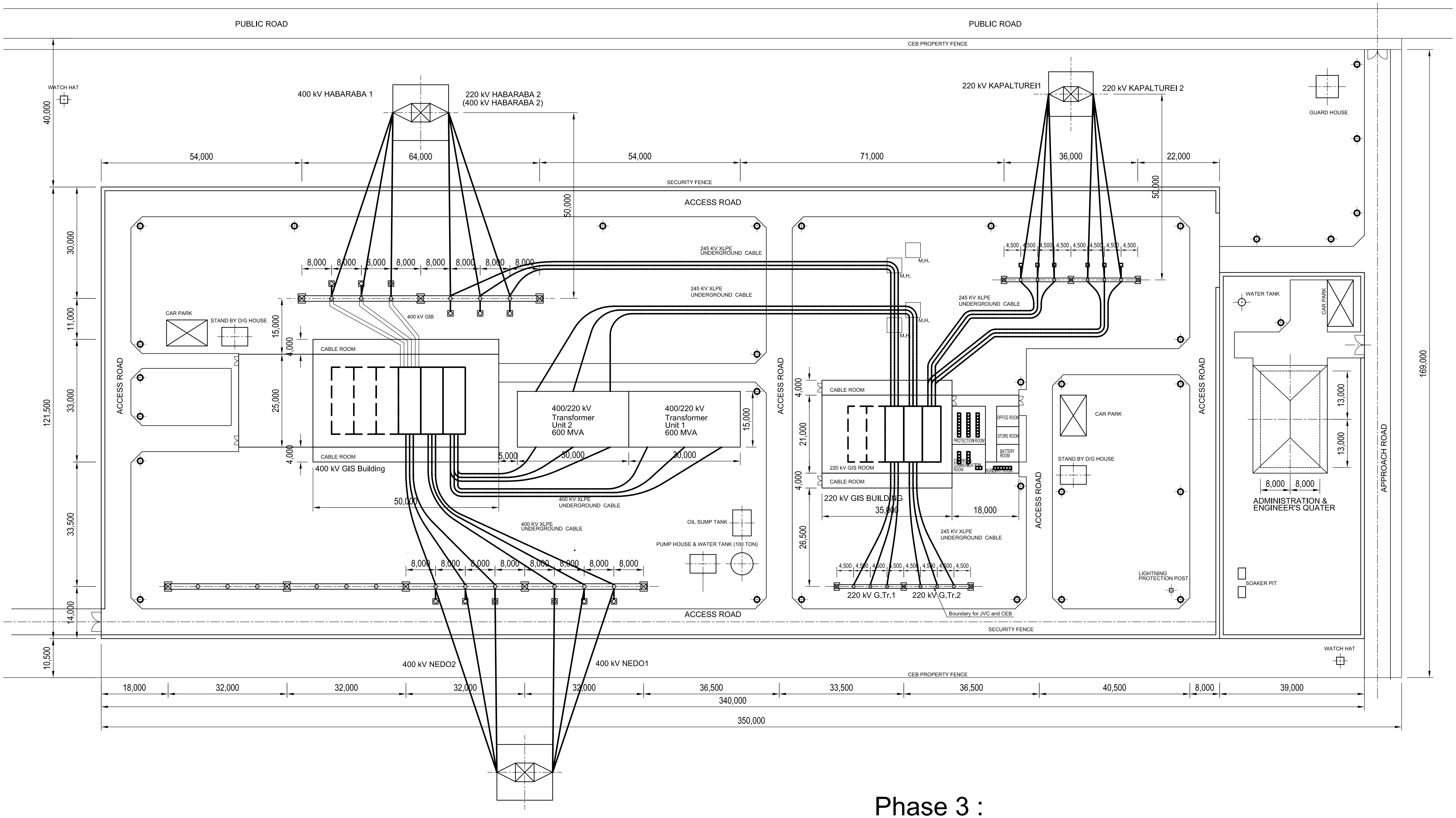


Phase 1 :
Layout for the Sampoor 220 kV Switching Station

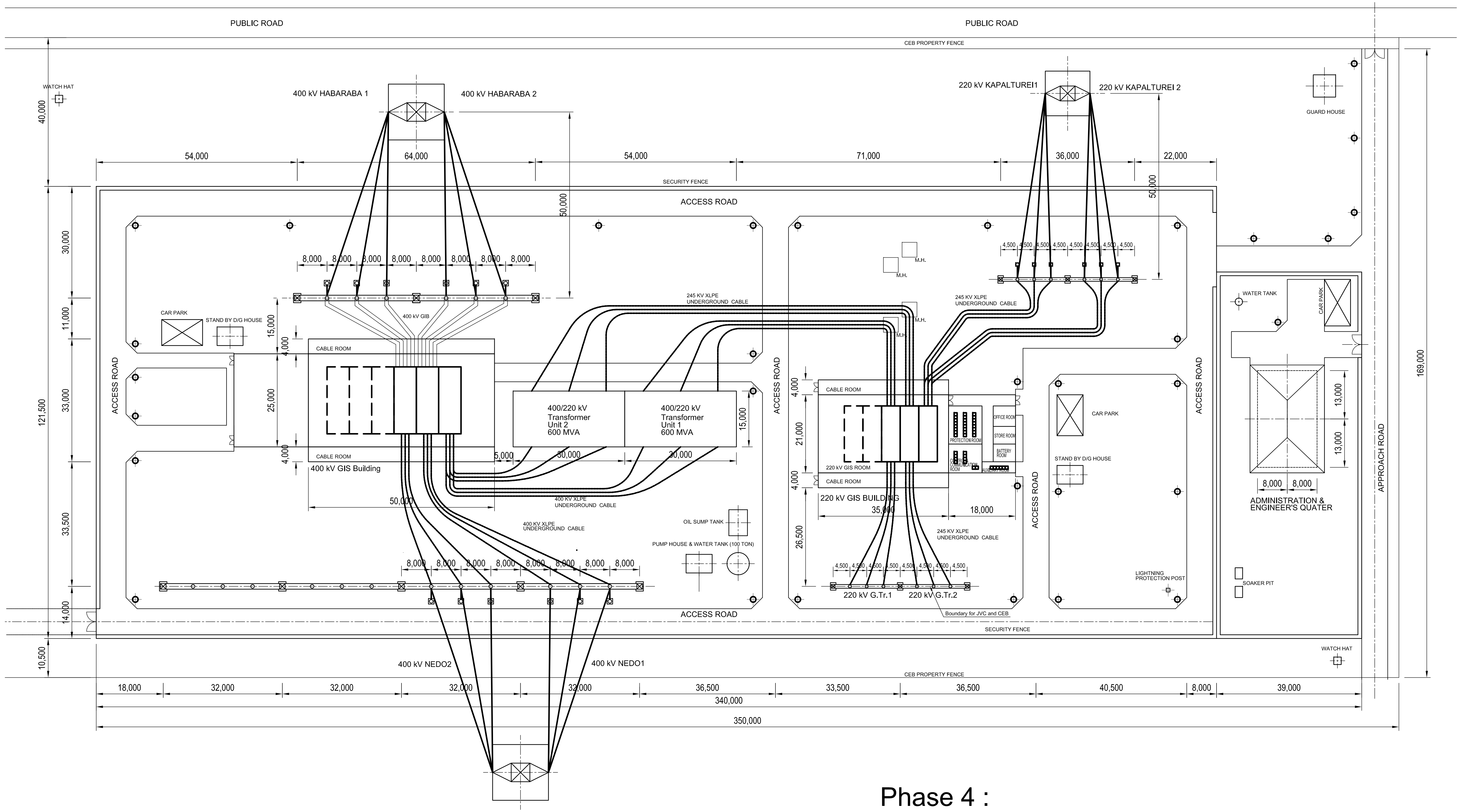
Annex 5.4-1



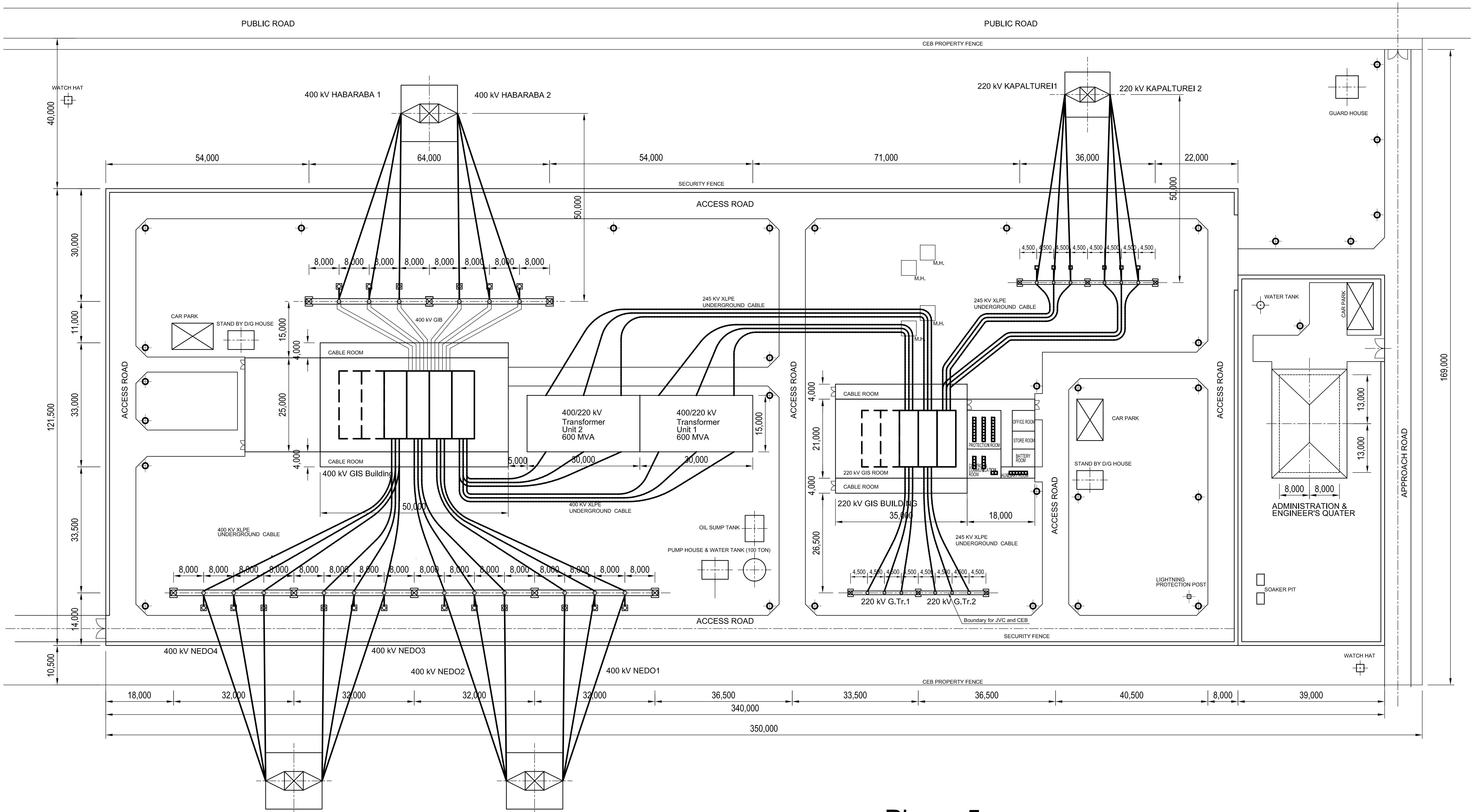
Phase 2 :
Preceding Construction for the 400 kV Substation



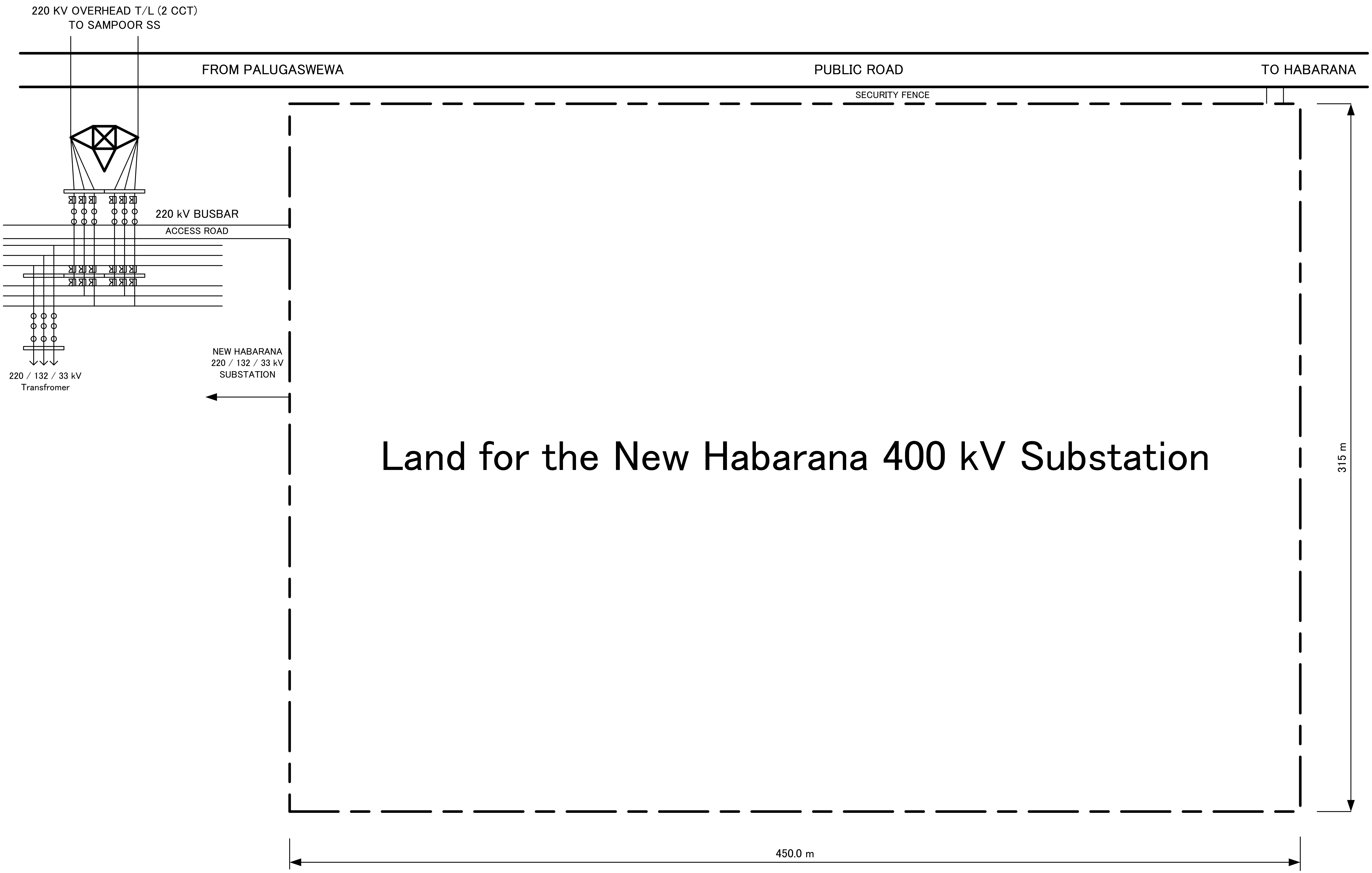
Phase 3 :
Layout for Sampoor the 220 kV Switching Station and 400 kV Substation (1 cct)



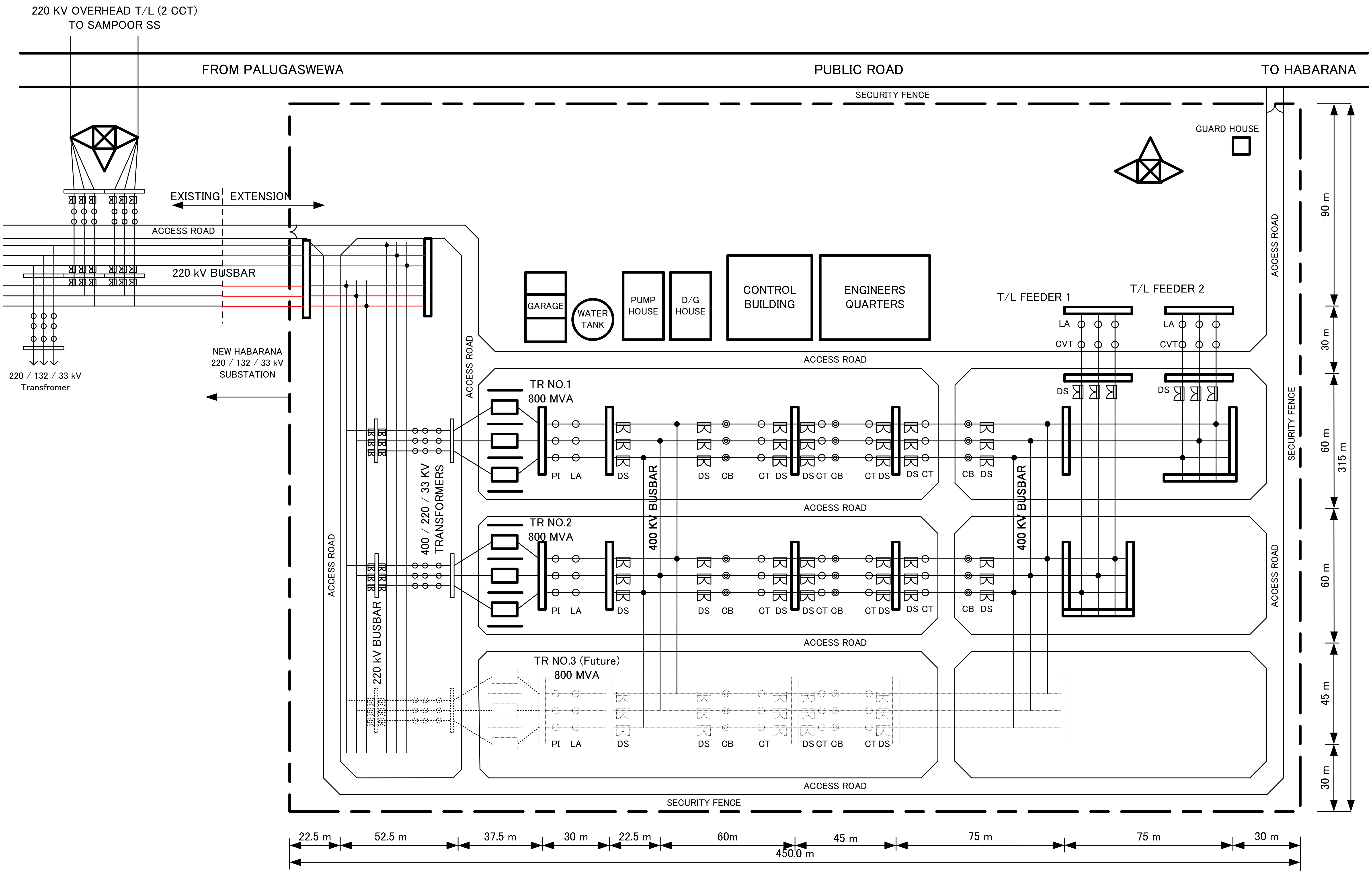
Phase 4 :
Layout for Sampoor the 400 kV Substation (2 cct)



Phase 5 :
Layout for the Sampoor 400 kV Substation (2 cct) Final Phase

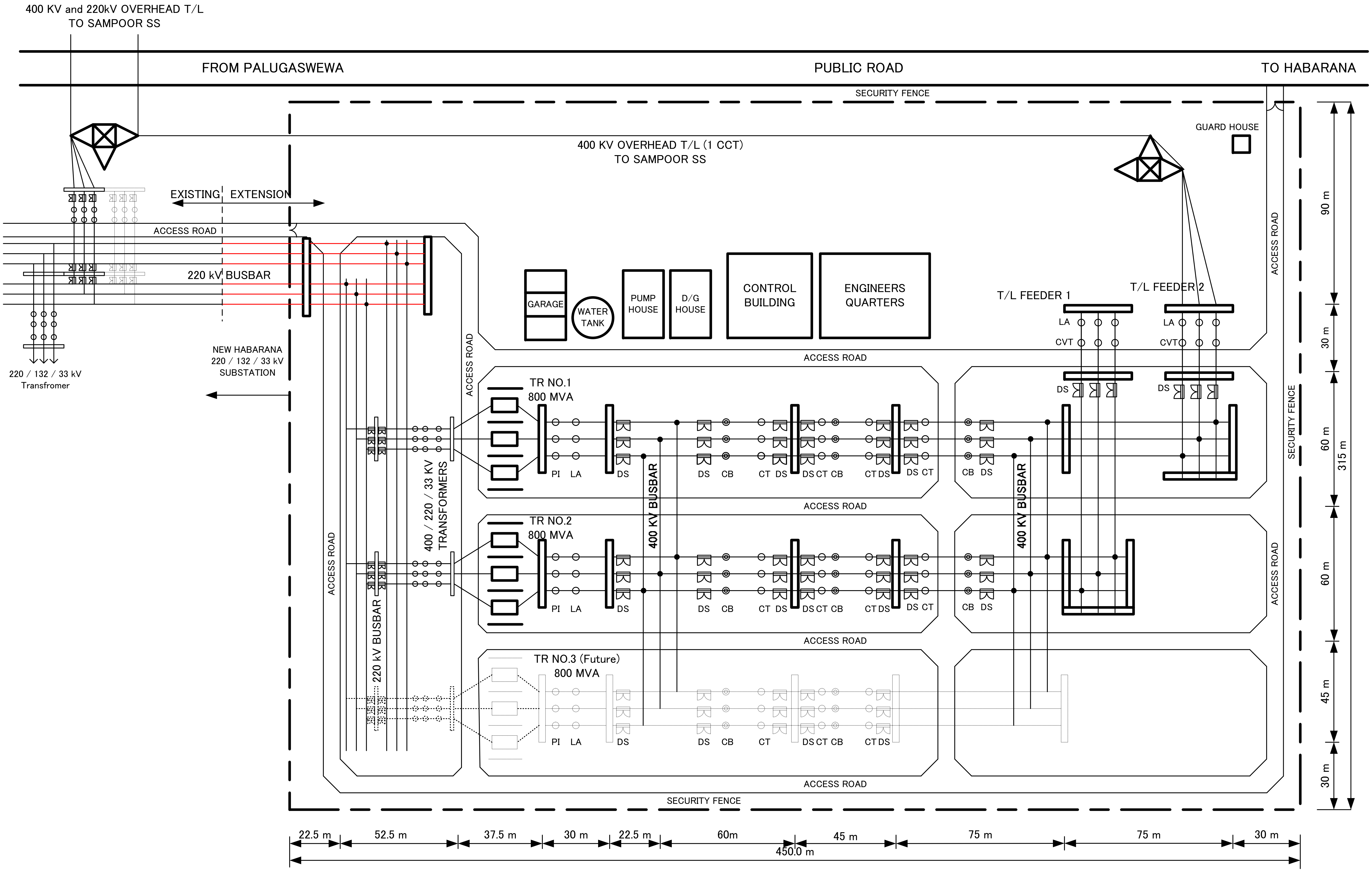


Phase 1 :
Layout for the New Habarana 220 KV Grid Substation



Phase 2 :

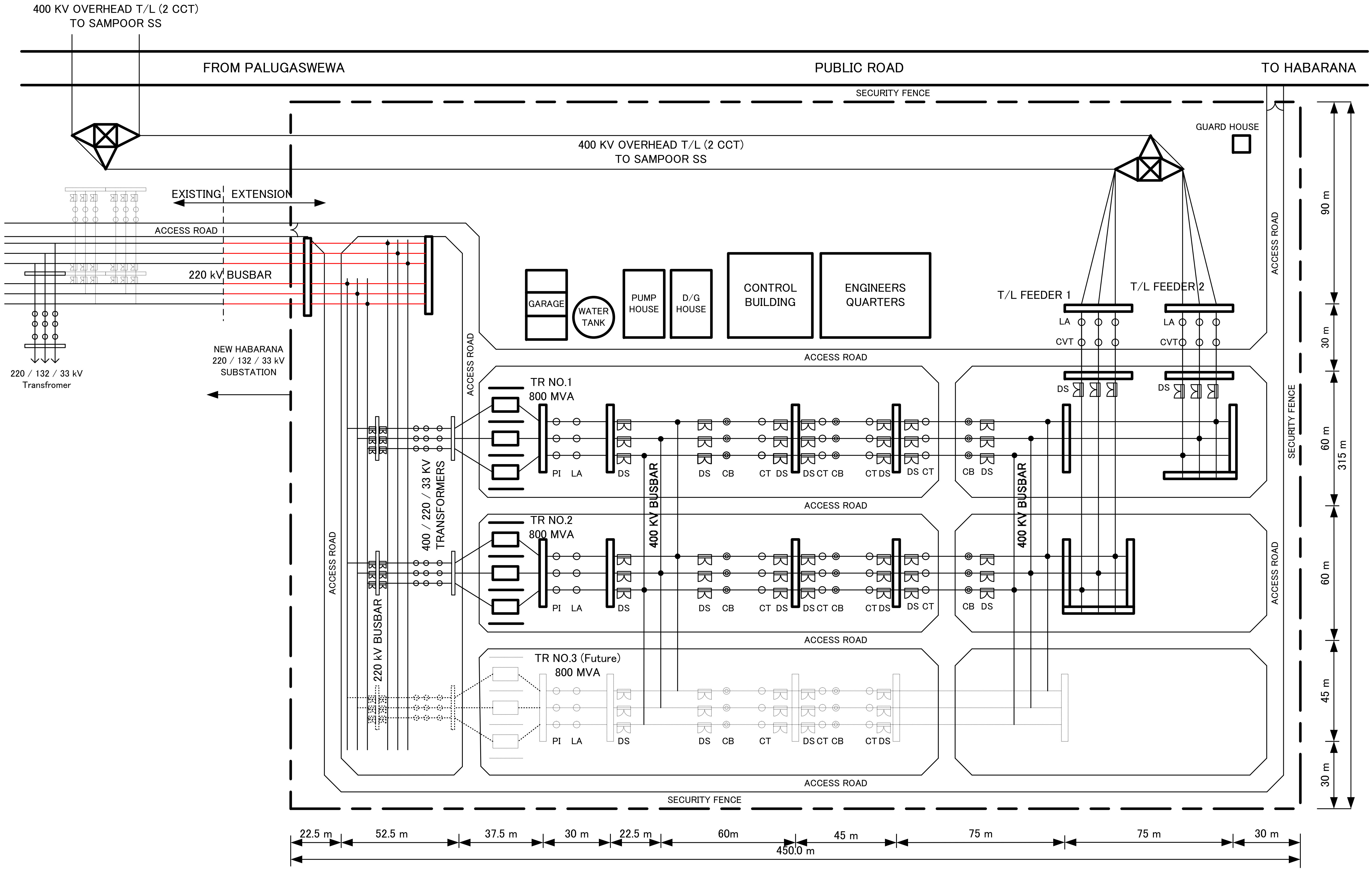
Preceding Construction for the 400 kV Grid Substation



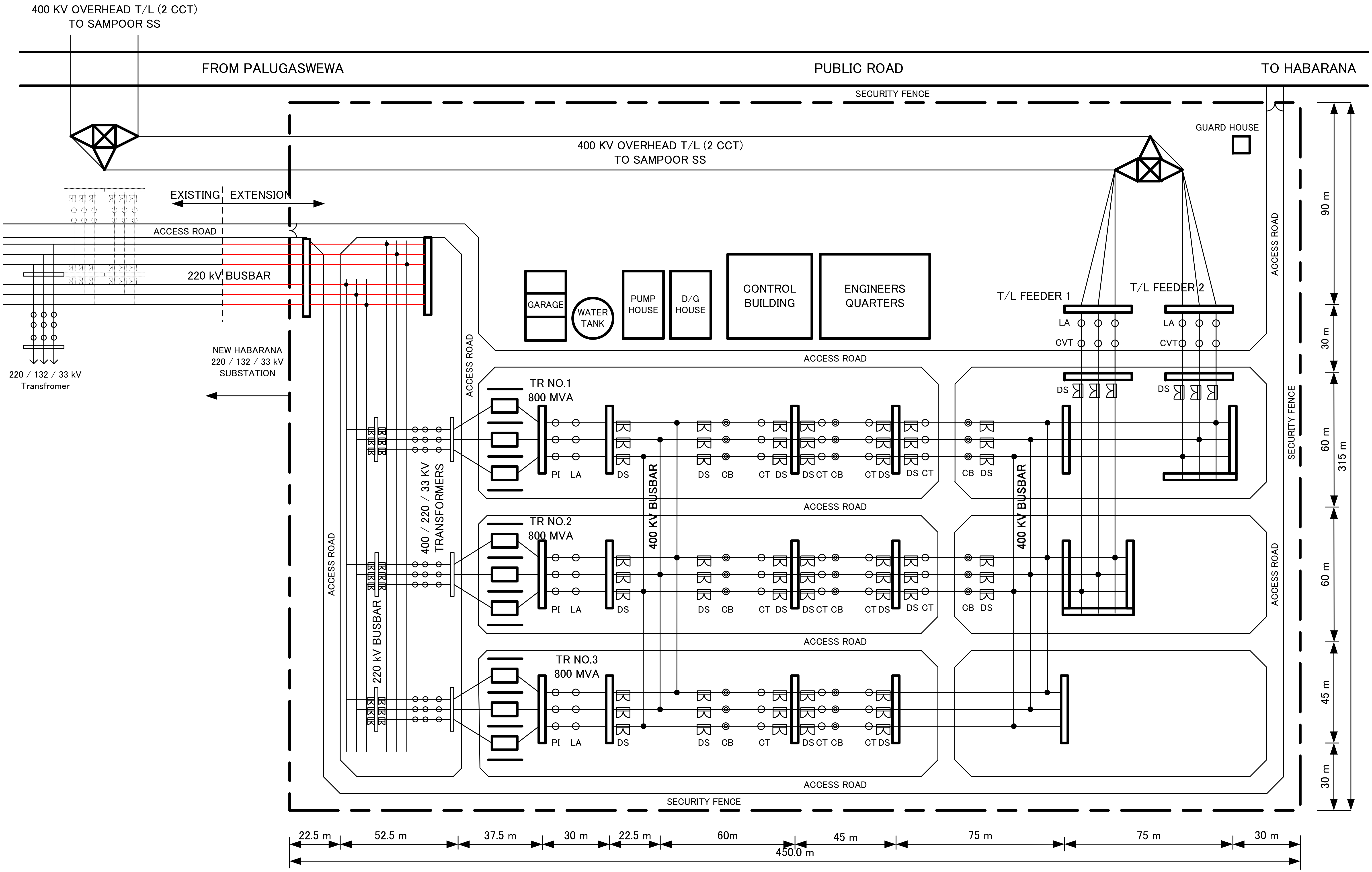
Phase 3 :

Layout for the New Habarana 220 KV Grid Substation (1 cct)

Layout for the 400 kV Grid Substation (1 cct)



Phase 4 :
Layout for the New Habarana 400 KV Grid Substation (2 cct)



Phase 5 :
Layout for the New Habarana 400 KV Grid Substation (2 cct)
Final Phase

Annex 5. 4-10

Terms of Reference for Supervision Consultant for the works under National Transmission and Distribution Network Development and Efficiency Improvement Project (II) in Democratic Socialist Republic of Sri Lanka (Draft)

Chapter 1. Background

(1) Sri Lanka has 2,970 MW electric power supply capability (2012) and 2,146 MW electricity peak demand (2012), and its power system is stable comparing with other South Asian countries However, the economy has had the annual average growth rate of 7%, and the economic growth has caused electricity demand increase at the annual average rate of 5-6% in recent years. Therefore, Government of Sri Lanka promotes the construction of large-scale coal-fired power plants based on the long term generation expansion plan in order to meet the rapid expansion of electricity demand and decrease the generation cost. On the other hand, transmission and distribution system loss rate is improved year by year (12.0% as of 2012). However, it is necessary to reduce the transmission and distribution system loss rate more and more by the introduction of high voltage transmission system, low-loss conductor, etc. in order to meet the power demand expansion. Ministry of Power and Energy (MOPE) published the electrical policy for steady power supply and energy efficiency as one of the important policies in national energy policy (2006), and considered to introduce high voltage transmission systems which had enough transmission capacity in parallel with the construction of the large-scale power station. In addition, introduction of low-loss conductor is promoted from the point of view of transmission loss reduction simultaneously. Component of "National Transmission and Distribution Network Development and Efficiency Improvement Project (II) (hereinafter referred to as 'the Project')" is to construct transmission lines from Sampoor coal-fired power plant (250 MW x 2) to New Habarana Substation (which locates between Sampoor coal-fired power plant and Colombo area) and Kappalturai substation in order to evacuate the electric power from Sampoor coal-fired power plant constructed by Trincomalee Power Company Limited (TPCL: special-purpose company by the co-funding of National Thermal Power Corporation (NTPC) in India and Ceylon Electricity Board (CEB)). In addition, related switching station/ substation are also included in the Project for the stable power supply. Another purpose of the Project is energy efficiency by the introduction of extra high voltage (400 kV) transmission facilities for the first time and low-loss conductor.

(2) Based on the above background, the Government of Sri Lank requested to receive a loan from the Japan International Cooperation Agency (hereinafter referred to as "JICA") to

finance the National Transmission and Distribution Network Development and Efficiency Improvement Project (II) which is to enhance transmission network system in Sri Lanka.

(3) The Project consists of the following components:

a) Construction of 400 kV designed Sampoor – New Habarana TL (220 kV operation)

b) Construction of 220 kV Sampoor – Kappalturai TL

c) Construction of 220 kV GIS at Sampoor SS

(4) The Government of Sri Lanka intends to use part of the proceeds of the loan for eligible payments for consulting services for which this ToR is issued.

(5) The Project is expected to be completed by the end of 2018.

(6) Location of the Project: See (3) of this Chapter

(7) Executing Agency: CEB (Ceylon Electricity Board)

Chapter 2. Objectives of Consulting Services

The consulting services shall be provided by an international consulting firm (or any other relevant entity) (hereinafter referred to as "the Consultant") selected in compliance with Guidelines for the Employment of Consultants under Japanese ODA Loans, April 2012.

The services to be rendered by the Consultant will cover construction supervision partially. Expected consulting services period is approximately 14 months.

Chapter 3. Scope of Consulting Services

3.1 Project Implementation Stage

The Consultant shall perform his duties during the construction period in accordance with the contracts to be executed between the Employer and the Contractors. FIDIC Plant and Design Build First Edition (1999) will be applied to the works of the Project.

The Consultant is requested to be (behave) "advisor".

In addition to roles of "Engineer" above, the Consultant shall also carry out the followings:

- To assist in review of the detailed design documents of 400 kV transmission line and 220 kV GIS prepared by the Contractors
- To assist in carrying out construction supervision of 400 kV transmission line and 220 kV GIS in view of quality control and scheduling control
- To assist in inspection of manufacturing and fabrications of 400 kV transmission line and 220 kV GIS at the site
- To assist in review and approval for testing procedure prepared by Contractors.
- To witness the testing and commissioning at site as well as factory acceptance tests.
- To check the as-built drawings and operation & maintenance manuals prepared by the Contractors.

3.2 Co-ordination

The Consultant will assist CEB to maintain proper co-ordination and communication between CEB/JICA and CEB/Contractors.

Chapter 4. Expected Time Schedule

The total duration of consulting services will be 24 months. The implementation schedule expected is as shown in Table 1.

Table 1: Implementation Schedule Tentative

Key activities	Data (FY)	Expected Duration in Months
Commencement of construction	January 2017	24
End of construction	December 2018	
Termination of Consulting Services	December 2018	24

Chapter 5. Staffing

Refer to the page **.

2 of Professional (A) consultants will be engaged, over 24 month's duration of consulting services, for a total of 40.0 man-months for Professional (A).

A detailed schedule of consulting services of person-months is shown in Attachment xx.

The qualification of key Team Members is shown in Table 2.

Table 2: Qualification of Key Team Members

Designation	Qualification
International Consultants (Pro-A)	
Transmission Line Engineer	Education: • Graduate in Electrical Engineering Experience: • In the power transmission system related field: 15 years or more • In design and/or construction supervision for transmission line projects: 10 years or more • In design and/or supervision of installation works for transmission line projects: 2 projects or more
Substation Engineer	Education: • Graduate in Electrical Engineering Experience: • In the power transmission system related field: 15 years or more • In design and/or construction supervision for substation (including GIS) projects: 10 years or more • In design and/or supervision of installation works for substation projects: 2 projects or more

Chapter 6. Meager Tasks and Duties of Team members

6.1 Transmission Line Engineer

- Assist in review of the detailed design documents of 400 kV transmission line prepared by the Contractors.
- Assist in carrying out construction supervision of 400 kV transmission line in view of quality control and scheduling control.
- Assist in inspection of manufacturing and fabrications of 400 kV transmission line at the site.
- Assist in review and approval for testing procedure prepared by Contractors.
- Witness the testing and commissioning at site as well as factory acceptance tests.
- Check the as-built drawings and operation & maintenance manuals prepared by the Contractors.

6.2 Substation Engineer

- Assist in review of the detailed design documents of 220 kV GIS prepared by the Contractors
- Assist in carrying out construction supervision of 220 kV GIS in view of quality control and scheduling control
- Assist in inspection of manufacturing and fabrications of GIS at the site
- Assist in review and approval for testing procedure prepared by Contractors.
- Witness the testing and commissioning at site as well as factory acceptance tests.
- Check the as-built drawings and operation & maintenance manuals prepared by the Contractors.

Chapter 7. Reports to be prepared by the Consultant

The Consultant shall prepare and submit to the Owner for the following reports:

- Site Work Report

Chapter 8. Obligation of the Executing Agency

The followings are assumed to be provided from the Executing Agency for the consulting services:

- To provide to the Consultants in an expeditious manner access to and copies of studies, plans, specifications, maps, drawings, criteria, and other information related to the Project, if available to CEB and necessary for the Consultants to perform the Services, at no expense to the Consultants.
- To assist the Consultants in obtaining customs clearance for materials or equipment brought into Sri Lanka for performance of the Services by the Consultants. CEB and/or

government of Sri Lanka shall directly pay the customs duties associated with materials or equipment reimbursable hereunder brought for the jobsite office only, which at completion of the Project will be delivered to CEB as CEB's property.

- To assist the Consultants, if required, in obtaining clearances, visas, and extensions; resident work permits; and any other documents relating to Expatriates of the Consultant, their accompanying dependents, and their personal effects assigned to perform the Services and shall use its best efforts to assist the Consultant, its Sub-consultants, and employees to obtain the benefit of all privileges, exemptions, and other favorable treatment, which are or may become lawfully available under any decisions, laws, regulations, or rules of Sri Lanka.
- To provide overall management, direction, and control of the Project. In addition, CEB intends to provide a dedicated CEB's team for the Project to coordinate with the Consultants' project team.
- To facilitate and expedite the Services, CEB shall approve or object to the Consultants' replies and/or recommendations within two weeks after receipt of such replies/recommendations made during the Project's implementation period and in accordance with the Project's milestone schedule. For the purposes of assuring continuity in the performance of the Consultants' Services, in the event approval or objection is not made within such two weeks period, the replies/recommendations shall be deemed approved unless otherwise agreed for a longer period.

Manning Schedule for the Consulting Services

		Position	Billing Rate		2015												2016												2017												2018												Total
			F/C JPY	LC/ LKR	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
		Engineering and Consulting Services																																																			
		International Consultants	0	0																																																	0
A	1	Transmission Line Engineer	2,895,000	0																									1	1	1	1	1		1	1	1	1	1			1	1	1	1		1	1	1	1	1	1	20
A	2	Substation Engineer	2,895,000	0																										1	1	1	1	1	1	1	1			1	1	1	1	1	1		1	1	1	1	1	1	20
			0	0																																																	0
			0	0																																																		0
		Local Consultants	0	0																																																	0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
		[Total of Pro-A]			**0**												**0**												**19**												**21**												**40**
		[Total of Pro-B]			**0**												**0**												**0**												**0**												**0**
		[Total of Pro-A+Pro-B]			0												0												19												21												40
		Total Cost of FC for Each Month(Pro-A)			0												0												55,005,000												60,795,000												115,800,000
		Total Cost of FC for Each Month(Pro-B)			0												0												0												0												0
		Total Cost of LC for Each Month(Pro-A)			0												0												0												0												0
		Total Cost of LC for Each Month(Pro-B)			0												0												0												0												0
			0	0																																																	0
C	1	Secretary	0	118,000																									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
			0	0																																																		0
		[Total of Supporting Staff]			**0**												**0**												**12**												**12**												**24**
		Total Cost of LC for Each Month(SS)			0												0												1,416,000												1,416,000												2,832,000
		Grand Total			**0**												**0**												**31**												**33**												**64**

Annex 10.2-1 Assumed Construction Cost of Transmission Lines

1. Assumed Construction Cost of 400 kV Sampoor - New Habarana Transmission Line

Rate= 130.2 LKR / USD

Item	Specification	Unit Wt[t]	No. of Tower	Tot. Wt[t]	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
			Sampoor - New Habarana							
					230,040 LKR/t	0 LKR/t				
Towers										
Suspension Tower (TDL)	Body extension +0m	49.1	22	1,080.2	248,489,208	0	248,489,208	1,908,519	0	1,908,519
Suspension Tower (TDL)	Body extension +3m	55.4	143	7,922.2	1,822,422,888	0	1,822,422,888	13,997,104	0	13,997,104
Suspension Tower (TDL)	Body extension +6m	94.4	3	283.2	65,147,328	0	65,147,328	500,364	0	500,364
Suspension Tower (TDL)	Body extension +9m	61.8	1	61.8	14,216,472	0	14,216,472	109,190	0	109,190
Tension Tower 0-10 (TD1)	Body extension +0m	45.5	6	273.2	62,851,989	0	62,851,989	482,734	0	482,734
Tension Tower 0-10 (TD1)	Body extension +3m	47.6	2	95.2	21,888,767	0	21,888,767	168,117	0	168,117
Tension Tower 0-10 (TD1)	Body extension +6m	54.3	2	108.6	24,990,166	0	24,990,166	191,937	0	191,937
Tension Tower 0-10 (TD1)	Body extension +9m	60.1	0	0.0	0	0	0	0	0	0
Tension Tower 10-30 (TD3)	Body extension +0m	56.2	17	954.7	219,619,879	0	219,619,879	1,686,789	0	1,686,789
Tension Tower 10-30 (TD3)	Body extension +3m	58.8	3	176.5	40,612,872	0	40,612,872	311,927	0	311,927
Tension Tower 10-30 (TD3)	Body extension +6m	64.8	2	129.5	29,794,321	0	29,794,321	228,835	0	228,835
Tension Tower 10-30 (TD3)	Body extension +9m	72.2	0	0.0	0	0	0	0	0	0
Tension Tower 30-60 (TD6)	Body extension +0m	67.7	10	677.3	155,812,994	0	155,812,994	1,196,720	0	1,196,720
Tension Tower 30-60 (TD6)	Body extension +3m	71.0	5	354.9	81,636,596	0	81,636,596	627,009	0	627,009
Tension Tower 30-60 (TD6)	Body extension +6m	77.7	2	155.4	35,738,555	0	35,738,555	274,490	0	274,490
Tension Tower 30-60 (TD6)	Body extension +9m	85.6	0	0.0	0	0	0	0	0	0
Terminal Tower (TDT)	Body extension +0m	151.9	1	151.9	34,935,485	0	34,935,485	268,322	0	268,322
Terminal Tower (TDT)	Body extension +3m	167.3	5	836.4	192,406,607	0	192,406,607	1,477,777	0	1,477,777
Terminal Tower (TDT)	Body extension +6m	184.3	0	0.0	0	0	0	0	0	0
Terminal Tower (TDT)	Body extension +9m	194.4	0	0.0	0	0	0	0	0	0
Total Tower			224	13,261.0	3,050,564,127	0	3,050,564,127	23,429,832	0	23,429,832
		[Unit]	Qty	Unit Price	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
Conductors										
LL-ACSR eq Zebra		[km]	0.0	1,079,000	0	0	0	0	0	0
Zebra/AS		[km]	2,188.8	770,000	1,685,376,000	0	1,685,376,000	12,944,516	0	12,944,516
Total Conductor			2,188.8		1,685,376,000	0	1,685,376,000	12,944,516	0	12,944,516
Earth Wires										
AS 110		[km]	91.2	243,000	22,161,600	0	22,161,600	170,212	0	170,212
OPGW 120		[km]	91.2	611,000	55,698,760	0	55,698,760	427,794	0	427,794
Total Earth wire			182.4		77,860,360	0	77,860,360	598,006	0	598,006
Insulators										
U160 BS	Suspension tower	[Nos.]	38,976	4,900	190,982,400	0	190,982,400	1,466,839	0	1,466,839
U160 BS	Tension tower	[Nos.]	54,432	4,900	266,716,800	0	266,716,800	2,048,516	0	2,048,516
U160 BLP (Anti-fog)	Suspension tower	[Nos.]	13,356	7,600	101,505,600	0	101,505,600	779,613	0	779,613
U160 BLP (Anti-fog)	Tension tower	[Nos.]	11,592	7,600	88,099,200	0	88,099,200	676,645	0	676,645
U70BL		[Nos.]	1,008	2,400	2,419,200	0	2,419,200	18,581	0	18,581
U70BLP (Anti-fog)		[Nos.]	252	4,700	1,184,400	0	1,184,400	9,097	0	9,097
Total Insulators			119,616		650,907,600	0	650,907,600	4,999,290	0	4,999,290
Spacer dumpers										
4 bundle spacer	LL-ACSR eq Zebra	[Nos.]	10,944	2,400	26,265,600	0	26,265,600	201,733	0	201,733
4-bundle jumper spacer	LL-ACSR eq Zebra	[Nos.]	330	2,400	792,000	0	792,000	6,083	0	6,083
Total Spacer dumpers			11,274		27,057,600	0	27,057,600	207,816	0	207,816
Insulator set										
Normal suspension insulator set	double-strings	[Sets]	696	140,000	97,440,000	0	97,440,000	748,387	0	748,387
Anti-fog suspension insulator set	double-strings	[Sets]	318	300,000	95,400,000	0	95,400,000	732,719	0	732,719
Normal tension insulator set	quad-strings	[Sets]	486	350,000	170,100,000	0	170,100,000	1,306,452	0	1,306,452
Anti-fog tension insulator set	quad-strings	[Sets]	138	800,000	110,400,000	0	110,400,000	847,926	0	847,926
Jumper suspension insulatror se	single-string including	[Sets]	0	120,000	0	0	0	0	0	0
Anti-fog Jumper suspension ins	single-string	[Sets]	0	300,000	0	0	0	0	0	0
Inverted type tension insulator s	quad-strings	[Sets]	0	300,000	0	0	0	0	0	0
Inverted type anti-fog tension ins	quad-strings	[Sets]	0	800,000	0	0	0	0	0	0
Light duty tension insulator set	single-string	[Sets]	36	150,000	5,400,000	0	5,400,000	41,475	0	41,475
Light duty anti-fog tension insulator set		[Sets]	12	320,000	3,840,000	0	3,840,000	29,493	0	29,493
Supension sets for earth wire	AS 110	[Sets]	169	5,000	845,000	0	845,000	6,490	0	6,490
Supension sets for earth wire	OPGW 120	[Sets]	169	6,400	1,081,600	0	1,081,600	8,307	0	8,307
Tension sets for earth wire	AS 110	[Sets]	112	4,100	459,200	0	459,200	3,527	0	3,527
Tension sets for earth wire	OPGW 120	[Sets]	112	6,000	672,000	0	672,000	5,161	0	5,161
Preformed amor rod	Zebra eq	[Sets]	4,056	3,600	14,601,600	0	14,601,600	112,147	0	112,147
Total Insulator set					500,239,400	0	500,239,400	3,842,085	0	3,842,085
Other supply										
Other supply	6% of total cost above		1	359,520,305	359,520,305	0	359,520,305	2,761,293	0	2,761,293
A. Total Supply					6,351,525,392	0	6,351,525,392	48,782,837	0	48,782,837

Item	[Unit]	Qty	Unit Price	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
Design and Drawings									
Design and liaison of works	[km]	91.2	180,000	0	16,416,000	16,416,000	0	126,083	126,083
Drawings and Documentation required for works	[km]	91.2	180,000	0	16,416,000	16,416,000	0	126,083	126,083
B. Total Design and Drawings				**0**	**32,832,000**	**32,832,000**	**0**	**252,166**	**252,166**

Item	Specification	[Unit]	Qty	Unit Price	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
Foundation Work										
TDL Tower foundation	Pad and chimney	[Units]	162	6,471,000	0	1,048,302,000	1,048,302,000	0	8,051,475	8,051,475
TD1 Tower foundation	Pad and chimney	[Units]	10	6,886,000	0	68,860,000	68,860,000	0	528,879	528,879
TD3 Tower foundation	Pad and chimney	[Units]	22	7,566,000	0	166,452,000	166,452,000	0	1,278,433	1,278,433
TD6 Tower foundation	Pad and chimney	[Units]	17	17,853,000	0	303,501,000	303,501,000	0	2,331,037	2,331,037
TDT Tower foundation	Pad and chimney	[Units]	6	31,437,000	0	188,622,000	188,622,000	0	1,448,710	1,448,710
TDL Tower foundation	pile foundation	[Units]	7	12,942,000	0	90,594,000	90,594,000	0	695,806	695,806
TD1 Tower foundation	pile foundation	[Units]	0	13,772,000	0	0	0	0	0	0
TD3 Tower foundation	pile foundation	[Units]	0	15,132,000	0	0	0	0	0	0
TD6 Tower foundation	pile foundation	[Units]	0	35,706,000	0	0	0	0	0	0
TDT Tower foundation	pile foundation	[Units]	0	62,874,000	0	0	0	0	0	0
Total Foundation Work					0	1,866,331,000	1,866,331,000	0	14,334,340	14,334,340
Tower Erection										
Suspension Tower (TDL)	Body extension +0m	[Unit]	22	1,136,000	0	24,992,000	24,992,000	0	191,951	191,951
Suspension Tower (TDL)	Body extension +3m	[Unit]	143	1,281,000	0	183,183,000	183,183,000	0	1,406,935	1,406,935
Suspension Tower (TDL)	Body extension +6m	[Unit]	3	1,429,000	0	4,287,000	4,287,000	0	32,926	32,926
Suspension Tower (TDL)	Body extension +9m	[Unit]	1	2,183,000	0	2,183,000	2,183,000	0	16,767	16,767
Tension Tower 0-10 (TD1)	Body extension +0m	[Unit]	6	1,053,000	0	6,318,000	6,318,000	0	48,525	48,525
Tension Tower 0-10 (TD1)	Body extension +3m	[Unit]	2	1,101,000	0	2,202,000	2,202,000	0	16,912	16,912
Tension Tower 0-10 (TD1)	Body extension +6m	[Unit]	2	1,256,000	0	2,512,000	2,512,000	0	19,293	19,293
Tension Tower 0-10 (TD1)	Body extension +9m	[Unit]	0	1,391,000	0	0	0	0	0	0
Tension Tower 10-30 (TD3)	Body extension +0m	[Unit]	17	1,299,000	0	22,083,000	22,083,000	0	169,608	169,608
Tension Tower 10-30 (TD3)	Body extension +3m	[Unit]	3	1,361,000	0	4,083,000	4,083,000	0	31,359	31,359
Tension Tower 10-30 (TD3)	Body extension +6m	[Unit]	2	1,498,000	0	2,996,000	2,996,000	0	23,011	23,011
Tension Tower 10-30 (TD3)	Body extension +9m	[Unit]	0	1,669,000	0	0	0	0	0	0
Tension Tower 30-60 (TD6)	Body extension +0m	[Unit]	10	1,567,000	0	15,670,000	15,670,000	0	120,353	120,353
Tension Tower 30-60 (TD6)	Body extension +3m	[Unit]	5	1,642,000	0	8,210,000	8,210,000	0	63,057	63,057
Tension Tower 30-60 (TD6)	Body extension +6m	[Unit]	2	1,797,000	0	3,594,000	3,594,000	0	27,604	27,604
Tension Tower 30-60 (TD6)	Body extension +9m	[Unit]	0	1,979,000	0	0	0	0	0	0
Terminal Tower (TDT)	Body extension +0m	[Unit]	1	3,512,000	0	3,512,000	3,512,000	0	26,974	26,974
Terminal Tower (TDT)	Body extension +3m	[Unit]	5	3,868,000	0	19,340,000	19,340,000	0	148,541	148,541
Terminal Tower (TDT)	Body extension +6m	[Unit]	0	4,262,000	0	0	0	0	0	0
Terminal Tower (TDT)	Body extension +9m	[Unit]	0	4,495,000	0	0	0	0	0	0
Total Tower Erection					0	305,165,000	305,165,000	0	2,343,817	2,343,817
Stringing										
Stringing	includes installation of insulator :	[km]	91.2	1,530,000	0	139,536,000	139,536,000	0	1,071,705	1,071,705
Total String					0	139,536,000	139,536,000	0	1,071,705	1,071,705
Other work										
Other work	10% of total cost above		1.0	231,103,200	0	231,103,200	231,103,200	0	1,774,986	1,774,986
C. Civil work					**0**	**2,542,135,200**	**2,542,135,200**	**0**	**19,524,848**	**19,524,848**

Item		[Unit]	Qty	Unit Price	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
Other services										
Other services	4% of total other cost		1.0	357,059,704	0	357,059,704	357,059,704	0	2,742,394	2,742,394
D. Total Other services					**0**	**357,059,704**	**357,059,704**	**0**	**2,742,394**	**2,742,394**

Cost estimate for 400kV Sanpoor - New Habarana Transmission Lin

Item	FC [LKR]	LC [LKR]	Total [LKR]	FC [USD]	LC [USD]	Total [USD]
A. Supply cost	6,351,525,392	0	6,351,525,392	48,782,837.30	0.00	48,782,837.30
B. Design and Drawing cos	0	32,832,000	32,832,000	0.00	252,165.90	252,165.90
C. Civil work cost	0	2,542,135,200	2,542,135,200	0.00	19,524,848.03	19,524,848.03
D. Other services cos	0	357,059,704	357,059,704	0.00	2,742,394.04	2,742,394.04
Total	6,351,525,392	2,932,026,904	9,283,552,296	48,782,837.30	22,519,407.97	71,302,245.27
Unit Price	69,643,919	32,149,418	101,793,337 LKR/km			781,822.86 USD/km

Rate 0.823 Yen/LKR

Item	FC [Yen]	LC [Yen]	Total [Yen]
Total in Yen	5,227,305,398	2,413,058,142	7,640,363,540
Unit Price	57,316,945	26,458,971	83,775,917 Yen/km

Length of Transmission Line		91.2	km	
Nos. of Tower	Suspension tower	169	towers	
	Tension tower	49	towers	
	Terminal Tower	6	towers	
	Substation gantry	2	gantrys	Sampoor S/S, New Habarana G/S
Anti-fog insulator using Towe	Suspension tower	53	towers	Anti-fog insulator will use the tower that are within 10km from coast lin
	Tension tower	11	towers	(No.160 to No.224 Towers will use anti-fog insulator
	Terminal Tower	1	towers	
	Substation gantry	1	gantry	

2. Assumed Construction Cost of 220 kV Sampoor - Kappalutrai Transmission Line

Escaretion rate

Foreign = 0.02 Local = 0.038 Rate: 0.823 Yen/LKR

Year	Length (km)	Unit cost		Total cost		Unit cost	Total cost
		FC (MLKRs)	LC (MLKRs)	FC (MLKRs)	LC (MLKRs)	M Yen/km	M Yen
2013	45	39.10	15.72	1759.50	707.4	45.12	2030.26
2014	45	39.88	16.32	1794.60	734.4	46.25	2081.37

CEB data base for construction cost in 2013

Transmission Line / Cable	Per km Cost (MLKR)	
	FC	LC
220kV 2xZebra double cct TL	39.10	15.72
400kV 4xZebra double cct TL	105.64	23.79
220kV Cu(XLPE) 1600mm2 cab	289.80	32.20

(Source:CEB database)

Cost Estimate for Dispute Board (Standing)

Construction Period 24 Months
Warranty Period 12 Months

Cost estimate for the regular Site visits is shown below:

Cost Category	For 1 DB member for calculation purpose				1-Person DB
Monthly Retainer Fee	Fee 3,000 USD	Const Period x 24 Months		=	USD **72,000**
Monthly Retainer during DNP	Fee 2,000 USD	Const Period x 12 Months		=	USD **24,000**
Daily fee for Site Visits (3 days for Site visit, 1 day x 2 for travel)	Fee 3,000 USD	Const Period x 5 Days (3+2)	x 6 Times (1Nos/4 months)	=	USD **90,000**
Site Visit Expenses (Air tickets, accommodation, etc.)	Fee 1,000 USD	Const Period x 6 Times (1Nos/4 months)		=	USD **6,000**
Sub-Total (1)					**192,000**

Cost estimate for the referrals is shown below:

Cost Category	For 1 DB member for calculation purpose				1-Person DB
Additional Daily Fee at Regular Site Visits	Fee 3,000 USD	Const Period x 1 Days	x 2 Times	=	USD 6,000
Reviewing Submission and Drafting Decision	Fee 3,000 USD	Const Period x 6 Days (3+3)	x 2 Times	=	USD 36,000
Sub-Total (2)					**42,000**

Total		**234,000**

Cost Estimate for Dispute Board (Ad hoc)

Construction Period 24 Months
Warranty Period 12 Months

Cost estimate for the referrals is shown below:

Cost Category	For 1 DB member for calculation purpose									1-Person DB
Daily Fee at Regular Site Visits	Fee 3,000	USD	x	Const Period 1	Days	x	2	Times	=	USD 6,000
Reviewing Submission and Drafting Decision	Fee 3,000	USD	x	Const Period 6	Days (3+3)	x	2	Times	=	USD 36,000
Total										**42,000**

Cost Breakdown for 220 kV Sampoor Switching Station

US$ 1 =	107.10	JPY
US$ 1 =	130.2	LKR
LKR 1 =	0.823	JPY

(1) Cost breakdown for "One-and-half circuit breaker line bay 220 kV for GIS"

	Items	Unit	Qty.	Unit Price		Foreign Portion	Local Portion	Total	Total
				FC (JPY)	LC (LKR)	(JPY)	(LKR)	(JPY)	(USD)
1	GIS & Local control panel/cabinet	[bay]	1	230,000,000	12,980,000	230,000,000	12,980,000	240,682,540	2,247,269
2	Supervisory service	[bay]	1	5,000,000	0	5,000,000	0	5,000,000	46,685
3	Special tools	[bay]	1	15,000,000	0	15,000,000	0	15,000,000	140,056
	Total					**250,000,000**	**12,980,000**	**260,682,540**	**2,434,011**

(2) Cost Breakdown for "Common Items - GIS"

	Items	Unit	Qty.	Unit Price		Foreign Portion	Local Portion	Total	Total
				FC (JPY)	LC (LKR)	(JPY)	(LKR)	(JPY)	(USD)
1	LVAC - 400 V Panel	[panel]	4	2,698,938	151,650	10,795,752	606,600	11,294,984	105,462
2	Battery Charger and Distribution Boards	[panel]	2	10,535,590	530,780	21,071,180	1,061,560	21,944,844	204,901
3	Lightning Arrester (Outdoor)	[unit]	12	499,182	78,020	5,990,184	936,240	6,760,710	63,125
4	Fiber Optic/SCADA	[unit]	1	17,932,920	606,610	17,932,920	606,610	18,432,160	172,102
5	Substation earthing	[lot]	1	10,904,059	1,516,520	10,904,059	1,516,520	12,152,155	113,465
6	Transformers (33/0.4-0.23 kV, 200 kVA)	[unit]	2	1,347,536	27,500	2,695,072	55,000	2,740,337	25,587
7	Cables and sealing ends	[lot]	1	122,655,260	14,739,660	122,655,260	14,739,660	134,786,000	1,258,506
8	Civil works	[lot]	1	18,143,015	212,549,014	18,143,015	212,549,014	193,070,853	1,802,716
9	Diesel Generator	[unit]	1	3,736,025	303,300	3,736,025	303,300	3,985,641	37,214
10	Digital Disturbance Recorder	[unit]	1	15,691,305	1,668,170	15,691,305	1,668,170	17,064,209	159,330
	Total					229,614,772	234,042,674	422,231,892	3,942,408
	Total (Round)					**229,610,000**	**234,040,000**	**422,230,000**	**3,940,000**

Note:

Cost Breakdown of Common Items were calculates as the following rules:

1) The original data as at 2013 was received by CEB,
2) The original data was modified the one as of 2015 in cosideration with price escalation.
3) The price of "4 Cables and seeling ends" was reviewd and modified in accordance with the length of cable estimated by basic drawings as follows:
4) Total price for "4 Cables and seeling ends" calculated in 3) is distributed by the original ratio of FC and LC.

A) Detail Breakdown for Cable price (incl. construction cost)

	Section	Unit	Qty.	Cable size	Unit Price (JPY)	Total Price (JPY)	Remarks
1	220 kV GIS to Gantry structure for Kappalthurei G/S	[m]	60	800 sq	33,600	12,096,000	2cct, 3phase
2	220 kV GIS to Gantry structure for Sampoor CFPP	[m]	50	2000 sq	65,300	19,590,000	2cct, 3phase
3	220 kV GIS to Gantry structure for New Habarana G/S	[m]	200	1600 sq	60,800	72,960,000	2cct, 3phase
					Total	104,646,000	

B) Detail Breakdown for Cable sealing end (incl. construction cost)

	Section	Unit	Qty.	Cable size	Unit Price (JPY)	Total Price (JPY)	Remarks
Cable Sealing End for AIS							
1	220 kV GIS to Gantry structure for Kappalthurei G/S	[set]	2	800 sq	1,960,000	3,920,000	2cct
2	220 kV GIS to Gantry structure for Sampoor CFPP	[set]	2	2000 sq	3,330,000	6,660,000	2cct
3	220 kV GIS to Gantry structure for New Habarana G/S	[set]	2	1600 sq	3,330,000	6,660,000	2cct
Cable Sealing End for GIS							
1	220 kV GIS to Gantry structure for Kappalthurei G/S	[set]	2	800 sq	1,510,000	3,020,000	2cct
2	220 kV GIS to Gantry structure for Sampoor CFPP	[set]	2	2000 sq	2,470,000	4,940,000	2cct
3	220 kV GIS to Gantry structure for New Habarana G/S	[set]	2	1600 sq	2,470,000	4,940,000	2cct
					Total	30,140,000	
					A+B	**134,786,000**	**JPY**

(3) Cost Breakdown of "5 Civil Works"

Items		Unit	Qty.	Unit Price		Foreign Portion	Local Portion	Total	Total
				FC (JPY)	LC (LKR)	(JPY)	(LKR)	(JPY)	(USD)
1	Preliminary work	[lot]	1	145,227	61,037	145,227	610,368	647,560	6,046
2	Site Cleaning	[m2]	59,150	51	30	3,019,376	1,766,272	4,473,018	41,765
3	Site formation & up keeping	[m2]	59,150	0	387	0	22,891,050	18,839,334	175,904
4	Cable trenches duct	[m]	310	0	21,062	0	6,529,220	5,373,548	50,173
5	Galvanized steel structures	[unit]	6	1,552,265	880,182	9,313,591	5,281,092	13,659,930	127,544
6	Foundations for switchgear & take-off structu	[lot]	1	0	12,468,735	0	12,468,735	10,261,769	95,815
7	Lightning protection system	[lot]	1	871,361	366,221	871,361	366,221	1,172,761	10,950
8	Miscellaneous work								
8-1	Room for diesel generator	[lot]	1	0	1,460,303	0	1,460,303	1,201,829	11,222
8-2	Shed for car parking	[unit]	2	0	1,002,954	0	2,005,908	1,650,862	15,414
8-3	Guard room and watch tower	[lot]	1	0	4,156,866	0	4,156,866	3,421,101	31,943
9	Water aupply and drainage	[lot]	1	0	3,811,228	0	3,811,228	3,136,641	29,287
10	Construction & maintenance road								
10-1	Approach road	[m]	169	0	50,452	0	8,526,388	7,017,217	65,520
10-2	Structures for approach road	[m]	169	0	18,329	0	3,097,601	2,549,326	23,803
10-3	Access roads & structures	[m]	1070	0	10,666	0	11,412,620	9,392,586	87,699
11	Fence	[m]	843	0	13,172	0	11,103,996	9,138,589	85,328
12	Miscellaneous work	[lot]	1	455,944	1,916,272	455,944	1,916,272	2,033,036	18,983
13	Substation building								
13-1	Sub-structures	[m2]	1361.25	0	23,383	0	31,830,109	26,196,180	244,596
13-2	Super structures	[m2]	1361.25	0	35,111	0	47,794,849	39,335,161	367,275
13-3	Door & windows	[unit]	24	0	109,197	0	2,620,728	2,156,859	20,139
13-4	Roof & ceiling	[lot]	1	0	9,461,153	0	9,461,153	7,786,529	72,703
13-5	Floor & trenchs	[m2]	1739.25	0	5,852	0	10,178,091	8,376,569	78,213
13-6	Finishes & fittings	[lot]	1	0	8,774,622	0	8,774,622	7,221,514	67,428
13-7	Curtaining & funiture	[lot]	1	0	1,448,954	0	1,448,954	1,192,489	11,134
13-8	Supplying & erection crane	[unit]	1	4,337,516	2,635,186	4,337,516	2,635,186	6,506,274	60,750
13-9	Miscellaneous building works	[lot]	1	0	401,182	0	401,182	330,173	3,083
14	Supplying & installation services								
14-1	A/C ventilation system	[lot]	1	3,131,968	890,624	3,131,968	890,624	3,864,952	36,087
14-2	Fire protection & detecting system	[lot]	1	1,049,772	5,349,093	1,049,772	5,349,093	5,452,076	50,906
14-3	Lighting & small poert supply work	[lot]	1	8,337,376	8,014,813	8,337,376	8,014,813	14,933,567	139,436
Total						**18,143,015**	**212,549,014**	**193,070,853**	**1,802,716**

Cost Breakdown for the Consulting Services

USD = JPY 107.1
LKR = JPY 0.823

	Unit	Qty.	Foreign Portion (JPY)		Local Portion LKR		Combined Total
			Rate	Amount ('000)	Rate	Amount ('000)	('000) JPY
A Remuneration							
1 Professional (A)	M/M	40	2,895,000	115,800	0	0	115,800
2 Professional (B)	M/M	0	0	0	0	0	0
3 Supporting Staffs	M/M	24	0	0	118,000	2,832	2,331
Subtotal of A				115,800		2,832	118,131
B Direct Cost							
1 International Airfare		7	510,000	3,570		0	3,570
2 Domestic Airfare		0		0		0	0
3 Domestic Travel		0		0		0	0
3 Accommodation Allowance (A)	Month	40	600,000	24,000		0	24,000
Accommodation Allowance (B)	Month	0		0	100,000	0	0
Accommodation Allowance (SS)	Month	24		0		0	0
4 Vehicle Rental	Month	40		0	280,000	11,200	9,218
5 Office Rental	M/M	0		0		0	0
6 International Communications	M/M	40	10,000	400		0	400
7 Domestic Communications	M/M	40		0	10,000	400	329
8 Office Supply	Set	1		0	100,000	100	82
9 Office Furniture and Equipment	M/M	0		0		0	0
10 Report Preparation	Set	1			20,000	20	16
Subtotal of B				27,970		11,720	37,616
Total				143,770		14,552	155,746

Annex 10. 5–1

Annual Fund Requirement

Base Year for Cost Estimation:	Apr, 2015				FC & Total:	million JPY
Exchange Rates	LKR = JPY		0.823		LC :	million LKR
Price Escalation:	FC:	2.0%	LC:	3.8%		
Physical Contingency	5%					
Physical Contingency for Consultant	5%					

Item	Total			2015			2016			2017			2018		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION															
I) Procurement / Construction	9,761	4,770	13,687	0	0	0	0	0	0	4,832	2,341	6,758	4,929	2,429	6,928
Package 01: Construction of Transmission Line	7,747	3,847	10,913	0	0	0	0	0	0	3,873	1,923	5,456	3,873	1,923	5,456
Package 02: Construction of Switching Station	1,100	291	1,339	0	0	0	0	0	0	550	145	670	550	145	670
Base cost for JICA financing	8,847	4,138	12,252	0	0	0	0	0	0	4,423	2,069	6,126	4,423	2,069	6,126
Price escalation	449	405	783	0	0	0	0	0	0	179	160	311	271	245	472
Physical contingency	465	227	652	0	0	0	0	0	0	230	111	322	235	116	330
II) Consulting services	159	17	173	0	0	0	0	0	0	75	8	81	84	9	91
Base cost	144	15	156	0	0	0	0	0	0	68	7	74	75	8	82
Price escalation	7	1	9	0	0	0	0	0	0	3	1	3	5	1	5
Physical contingency	8	1	8	0	0	0	0	0	0	4	0	4	4	0	4
Total (I + II)	9,920	4,787	13,859	0	0	0	0	0	0	4,907	2,348	6,839	5,013	2,438	7,020
B. NON ELIGIBLE PORTION															
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	428	352	0	27	23	0	341	281	0	59	49	0	0	0
Base cost	0	391	322	0	26	21	0	313	258	0	52	43	0	0	0
Price escalation	0	16	13	0	0	0	0	12	10	0	4	3	0	0	0
Physical contingency	0	20	17	0	1	1	0	16	13	0	3	2	0	0	0
c Administration cost	0	863	711	0	1	1	0	17	14	0	418	344	0	426	351
d VAT	0	2,021	1,663	0	0	0	0	0	0	0	997	821	0	1,024	842
e Import Tax	0	844	694	0	0	0	0	0	0	0	417	343	0	426	351
Total (a+b+c+d+e)	0	4,155	3,420	0	29	24	0	358	295	0	1,892	1,557	0	1,876	1,544
TOTAL (A+B)	9,920	8,942	17,279	0	29	24	0	358	295	4,907	4,241	8,397	5,013	4,315	8,564
C. Interest during Construction	61	0	61	0	0	0	0	0	0	20	0	20	41	0	41
Interest during Construction(Const.)	61	0	61	0	0	0	0	0	0	20	0	20	41	0	41
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	28	0	28	28	0	28	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	10,009	8,942	17,368	28	29	51	0	358	295	4,927	4,241	8,417	5,054	4,315	8,605
E. JICA finance portion incl. IDC (A + C + D)	10,009	4,787	13,948	28	0	28	0	0	0	4,927	2,348	6,860	5,054	2,438	7,061

Administration Cost = 5%
VAT= 12% of the expenditure in local currency of the eligible portion
Import Tax= 7%