Chapter 5 Components of the Project

5-1 Components of the Project

Based on the results of the first field survey, UETCL and the Team confirmed that the candidate components of the Project are shown in Table 5-1.1.

Table 5-1.1 Outline of the components of the Project

	Main component	Outline	Contents
Substation	**1. Buloba Substation**		
	(1) 220 / 132 kV Transformer	125 MVA×2units	
	(2) 132 / 33 kV Transformer	40 MVA×2units	
	(3) 220 kV Switchgear	1 lot	New Construction
	(4) 132 kV Switchgear	1 lot	
	(5) 33 kV Switchgear	1 lot	
	(6) Control building	1 lot	
	2. New Mukono Substation		
	(1) 220 / 132 / 33 kV Transformer	125 MVA×3units	
	(2) 220 kV Gas Insulated Switchgear	1 lot	
	(3) 132 kV Gas Insulated Switchgear	1 lot	New Construction
	(4) Control building	1 lot	
	(5) 132 kV transmission line (New Mukono Substation - Mukono Substation)	Approx. 0.3 km×2cct	
	3. Kawaala Substation		
	(1) 132 / 33 kV Transformer	40 MVA×3units	
	(2) 132 / 11 kV Transformer	20 MVA×1unit	
	(3) 132 kV Gas Insulated Switchgear (Direct connection type to transformers)	1 lot	Renovation
	(4) 33 kV Switchgear	1 lot	
	(5) 11 kV Switchgear	1 lot	
	(6) Control building	1 lot	
	4. Bujagali Substation		
	(1) 220 / 132 / 33 kV Transformer	250 MVA×1unit	Upgrade
	(2) 220 kV Switchgear	1 lot	
	(3) 132 kV Switchgear	1 lot	
	5. Mutundwe Substation		Upgrade
	(1) 132 kV Switchgear	1 lot	
	6. Mobile substation (132/33 - 11 kV)	20 MVA×2units	Procurement
Transmission	**7. 220 kV Transmission Line**		
	(1) Buloba branch point - Buloba Substation	Approx. 0.9 km×4cct	New Construction
	(2) New Mukono branch point - New Mukono Substation (including the modification of 132 kV transmission line betweenNo.77 and No.78)	Approx. 4.2 km×4cct	New Construction
	8. 132 kV Transmission Line		
	(1) Buloba branch point-Buloba Substation	Approx.0.8 km×2cct	New Construction
	(2) New Mukono Substation - New Mukono branch point (Southern trunk line)	Approx.0.4 km×2cct	New Construction
	(3) Mukono branch point (Northern trunk line) - Kampala North Substation	Approx.25.4 km×1cct	Re-conductoring
	(4) Kampala North Substation - Mutundwe Substation	Approx.10.2 km×2cct	Re-conductoring
	(5) Kampala North Substation - Lugogo Substation	Approx. 5.3 km×2cct	Re-conductoring
	(6) Kawaala branch point - Kawaala Substation	Approx.0.1 km×2cct	Cabling

Source: JICA Study Team

5-2 Natural Conditions

(1) Location, Features and Topography of the Planned Area

1) Buloba Substation

The planned site of Buloba Substation is situated close to Paris Palais St. Lawrence College around 1 kilometer from the Masaka - Kampala road slightly off the central Kampala. It is twenty kilometers away from Lake Victoria at 1,200 meters above sea level or more than 50meters higher than the lake at 1,134 meters above sea level. The site is a farm land which includes plantation of banana and coffee which is located at Wakiso district.

2) New Mukono Substation

The planned site of New Mukono Substation is approximately thirty kilometers from the central Kampala. The proposed site area is 0.85 kilometers from the Jinja - Kampala road between Mbalala - Namataba town. It is located at 1,100 meters above sea level. The site is a farm land which includes plantation of sugarcane and located inside the Nada forestry.

3) Kawaala Substation

The planned site of Kawaala Substation is situated in a residential area located between the main road of Northern bypass, Namungoona Road, Masiro Road and Sentema Road. It is within the central Kampala. It is twenty kilometers away from Lake Victoria at 1,100 meters above sea level or more than 60 meters higher than the lake at 1,200 meters above sea level.

4) Bujagali Substation

The planned site of Bujagali Substation is around the Bujagali dam besides Nile river which is located at 8 kilometers from the Jinja - Kampala road. The site is approximately 70 kilometers from the central Kampala.

5) Mutundwe Substation

Mutundwe Substation is one of the 4 most important substations and located within central Kampala. This substation has a wide range of scope from southern part of central Kampala extending to Entebbe district which the international Airport is located. Mutundwe substation is extremely important because it is the only substation that can distribute power supply around this area.

(2) Site Area

The premises of the planned substation covers a rectangular area of approximately 142,400 square meters for the Buloba Substation, approximately 11,700 square meters for the Kawaala Substation and approximately 395,900 square meters for the Mukono Substation.

(3) Temperature, Rainfall, Humidity, Atmospheric Pressure

Greater Metro Kampala Area has tropical rainforest climate. January to April is hot, on these months the highest temperature even exceeds 35 degrees Celsius. June to August is relatively cool, minimum temperature (Average Low) is around 17 degrees Celsius and the record low is about 12 degrees Celsius. There are two annual wet seasons; there is a long rainy season from March to May and a short rainy season from November to December but you can recognize the general rainy season from March to May. April is typically seeing the heaviest amount of precipitation at an average of around 170mm of rain. The atmospheric pressure recorded in Greater Metro Kampala Area is follows, minimum is 977hPa, maximum is 1016hPa and the average is 1009hPa.

The Temperature, Rainfall, Humidity and Atmospheric Pressure within Greater Kampala Area varied less, so we assumed the surrounding areas of Kampala city having the same climate with the Kampala city itself. Shown in Table 5-2.1 is a data from the World Meteorological Organization (Kampala Area) and the necessity of Uganda National Meteorological Authority (UNMA) data will be decided in the 2nd part of the Survey.

Table 5-2.1 Metrological Data of Kampala

Climate data for Kampala													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high ° C (° F)	33 (91)	36 (97)	33 (91)	33 (91)	29 (84)	29 (84)	29 (84)	29 (84)	31 (88)	32 (90)	32 (90)	32 (90)	36 (97)
Average high ° C (° F)	28.6 (83.5)	29.3 (84.7)	28.7 (83.7)	27.7 (81.9)	27.3 (81.1)	27.1 (80.8)	26.9 (80.4)	27.2 (81)	27.9 (82.2)	27.7 (81.9)	27.4 (81.3)	27.9 (82.2)	27.8 (82)
Daily mean ° C (° F)	23.2 (73.8)	23.7 (74.7)	23.4 (74.1)	22.9 (73.2)	22.6 (72.7)	22.4 (72.3)	22.0 (71.6)	22.2 (72)	22.6 (72.7)	22.6 (72.7)	22.5 (72.5)	22.7 (72.9)	22.73 (72.93)
Average low ° C (° F)	17.7 (63.9)	18.0 (64.4)	18.1 (64.6)	18.0 (64.4)	17.9 (64.2)	17.6 (63.7)	17.1 (62.8)	17.1 (62.8)	17.2 (63)	17.4 (63.3)	17.5 (63.5)	17.5 (63.5)	17.6 (63.7)
Record low ° C (° F)	12 (54)	14 (57)	13 (55)	14 (57)	15 (59)	12 (54)	12 (54)	12 (54)	13 (55)	13 (55)	14 (57)	12 (54)	12 (54)
Average rainfall mm (inches)	68 (2.68)	63 (2.48)	132 (5.2)	169 (6.65)	118 (4.65)	69 (2.72)	63 (2.48)	96 (3.78)	108 (4.25)	138 (5.43)	149 (5.87)	92 (3.62)	1,265 (49.8)
Average rainy days (≥ 1 mm)	5	5	10	12	11	6	5	7	9	9	8	7	94
Average relative humidity (%)	66	68.5	73	78.5	80.5	78.5	77.5	77.5	75.5	73.5	73	71.5	74.5
Mean monthly sunshine hours	155	170	155	120	124	180	186	155	150	155	150	124	1,824
Air Pressure (hPa)	1010	977	1007	1011	1014	1014	1016	1012	1013	1010	1014	1013	1009
Source 1: World Meteorological Organization, Climate-Data.org for mean temperatures													
Source 2: BBC Weather													
Source 3: Weather Underground, Climatevo													
Remarks: ①Record high °C (°F): The highest temperature ever recorded. ②Average high °C (°F): The average of highest temperature in a day. ③Daily mean °C (°F): The average of mean temperature in a day. ④Average low °C (°F): The average of low temperature. ⑤Record low °C (°F): The lowest temperature ever recorded.													

(4) Wind Speed

Kampala and Entebbe meteorological stations of Uganda were measured, shown in Table 5-2.2~5-2.3 the maximum wind speed. The figure shows the maximum monthly value of 2005 to 2014 is 25m/s in Kampala and 15m/s in Entebbe. The instrument is measured in 5-minute average wind speed at the height of 2.0 meters and the location where the wind flows freely and is not influenced by nearby objects.

Table 5-2.2 Maximum wind velocity in a month (m/s)：Kampala

Month / Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2005	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	15	10	11	8	10	9	9	10	10	10	10	10
2008	8	10	14	8	12	8	10	16	10	8	-	12
2009	12	14	12	11	12	10	8	8	8	8	15	6
2010	15	6	8	10	8	8	8	10	10	10	12	10
2011	10	10	10	-	-	-	-	8	10	10	10	12
2012	15	20	20	15	15	16	15	20	10	15	20	20
2013	20	25	10	19	20	20	20	20	5	15	14	10
2014	15	15	19	15	13	10	18	15	8	20	12	15

Source: Uganda National Meteorological Authority (UNMA)

Table 5-2.3 Maximum wind velocity in a month (m/s)：Entebbe

Month / Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2005	6	7	6	6	5	7.5	6	5.5	5	5	5.5	6
2006	7	6.5	5	7	5.5	6.5	7.5	6.5	7	8.5	6	5
2007	5.5	6	10	5.5	5	5.5	6	5	7	7	7	6
2008	12	10	13	12	13	15	14	10	13	13	14	14
2009	15	15	15	14	15	14	14	13	14	12	12	12
2010	7.5	5.5	-	6	6	7.5	7.5	7	7	6.5	6.5	6.5
2011	8	8	7	6.5	7	7.5	6.5	8.5	7	6.5	5	6
2012	7	-	7	7	6.5	8	6.5	8.5	7	6.5	8.5	7.5
2013	7	7.5	6.5	7.5	7.5	7	7.5	7	7.5	8.5	6	6.5
2014	6	-	8	-	7.5	7.5	7	7	9	7	6.5	6

Source: Uganda National Meteorological Authority (UNMA)

(5) Thunderstorm (Lightning)

Kampala and Entebbe meteorological stations of Uganda were measured, shown in Table 5-2.4~5-2.5 the frequency of thunderstorms per month. The table shows more numbers of thunderstorms is occurring between the dry season and short rainy season from August to December.

According to NASA's Optical Transient Detector and TRMM's Lightning Imaging Sensor, Uganda has 70 average annual number of lightning flashes per square kilometer. And based on the data from 'The World Survey of Climatology', Elsevier Publishing Comp., Kampala,Uganda has 242 thunderstorm days per year.

Table 5-2.4 Total frequency of thunderstorm per month (No of days) : Kampala

Month / Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly Average
2005	8	5	8	4	3	3	7	8	11	12	12	2	83
2006	6	11	7	11	12	4	12	8	2	4	16	8	101
2007	7	5	7	6	8	7	9	12	12	11	11	3	98
2008	5	5	9	17	6	2	4	4	11	11	15	9	98
2009	7	11	6	7	7	2	3	10	12	7	8	8	88
2010	7	13	11	8	7	7	3	10	7	19	14	10	116
2011	2	4	9	X	X	9	3	11	17	14	17	11	97
2012	2	7	7	3	5	3	13	5	9	11	8	8	81
2013	10	6	8	13	11	4	3	9	12	11	14	7	108
2014	12	2	6	17	18	10	3	11	11	11	17	4	122

Source: Uganda National Meteorological Authority (UNMA)

Table 5-2.5 Total frequency of thunderstorm per month (No of days) : Entebbe

Month / Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly Average
2005	14	6	21	23	29	14	15	8	17	26	21	11	205
2006	10	12	23	25	23	19	12	-	18	19	25	17	203
2007	13	12	13	23	24	16	14	16	15	18	16	13	193
2008	18	13	24	24	23	12	15	20	16	28	17	16	226
2009	16	17	20	23	21	13	10	13	13	23	15	20	204
2010	14	15	-	17	17	13	8	14	15	13	19	16	161
2011	9	8	14	16	19	-	9	12	17	12	17	14	147
2012	1	6	7	14	10	14	1	6	9	8	14	14	104
2013	12	7	14	10	9	2	5	5	10	6	7	1	88
2014	4	12	18	10	11	19	19	21	21	14	-	3	152

Source: Uganda National Meteorological Authority (UNMA)

(6) Soil investigation

The geological investigation was conducted based on the D420 standard of the American Society for Testing and Materials (ASTM). The investigation comprised in-situ survey conducted on the sites and indoor testing on samples taken from boring holes. Representative values at each strata were sought through implementing the standard penetration test based

on ASTM1586. The indoor testing was implemented based on ASTM4220 and entailed seeking the physical and dynamic characteristics of ground from stirred samples.

Generally speaking, the engineering properties of strata having thickness of 5 meters or more are not uniform. In order to appropriately forecast and capture the engineering characteristics of soil bearing capacity, settlement, etc., which are preconditions for facilities planning, it is necessary to obtain basic data for confirming geological conditions by implementing unconfined compressive strength testing, tri-axial testing, consolidation testing, etc. on multiple samples that have been acquired along the length of the boring holes.

From these indoor tests (unconfined compressive strength testing, tri-axial testing, consolidation testing, etc.), the soil bearing capacity, settlement, etc. are calculated and used as preconditions for planning facilities. The soil bearing capacity, which is sought from unconfined compressive strength testing and tri-axial testing is compared against the soil bearing capacity sought from the standard penetration test to give the permissible bearing capacity corresponding to the actual soil. Results of the standard penetration test correlate to the engineering characteristics and soil bearing capacity of soil, however, the correlation may be weak under certain soil conditions; in particular, it has been confirmed that the correlation is weak in coarse gravel, rock, soft clay, silt and mixed soil of these types. Since there is no pre-existing geological data for the surrounding area, in order to forecast and capture the engineering characteristics of the soil, it will be essential for the facilities planning to obtain multiple samples at various depths and evaluate the soil characteristics by means of indoor testing.

Generally speaking, since the engineering properties of soil strata having thickness of 5 meters or more tend not to be uniform or homogenous, evaluation was conducted upon taking samples at 5-meter intervals.

1) Buloba Substation

At Buloba Substation, considering the current conditions where marshland and steep slopes are confirmed in the surrounding area, it is guessed that geological conditions vary greatly over the site. Accordingly, samples for the standard penetration test and indoor tests were obtained from the planned substation site and along the routes of the transmission lines. Concerning the substation site, since there is an elevation difference of around 14 meters, samples were taken from a high point and a low point on the site.

The results of the standard penetration testing and indoor tests are shown in Tables 1-1 through 1-11 at the beginning of Appendix-9 Results of Geological Investigation.

According to the results of the geological investigation on the substation site, the ground comprises organic soil down to around 1.0 meter from the surface, clayey gravel from there down to around 5.5 meters, and silt at deeper levels.

Table 5-2.6 shows the allowable bearing capacity of each strata calculated from the results of indoor tri-axial testing based on the following expression according to the Ministry of Land, Infrastructure and Transport Notification 1113 of 2001.

Allowable bearing capacity: qa [kPa] = (1/3) x ($\alpha \cdot C \cdot Nc + \beta \cdot \gamma_1 \cdot B \cdot N\gamma + \gamma_2 \cdot Df \cdot Nq$)

B:	Width of footing (Building foundation area: 18m x 42m, steel tower foundation area: 6m x 6m)
α, β:	Shape coefficient (coefficient determined from the internal friction angle)
Df:	Depth of footing (design depth = approx. 3.0m)
C:	Cohesion of soil (calculated from tri-axial testing)
Nc, Nγ, Nq:	Bearing capacity factor (calculated from the typical bearing capacity factors)
φ:	Internal friction angle (calculated from tri-axial testing)

As is shown in Table 5-2.6, as a result of the calculations, bearing capacity of around 125 kPa (BH02) and 250 kPa (BH04) is secured at GL-3.0m, which is thought to be in the vicinity of the foundation plates on the substation site.

Table 5-2.6 Bearing capacity of Buloba Substation（calculated by laboratory test）

Test method		Notification No. 111 METI, Japan 2002	
		Bearing capacity qa (kPa)	
Borehole No.		North of substation (BH2)	South of substation (BH4)
Depth (m)	GL-1.0~6.0m	125	250
	GL-6.0~11.0m	200	140
	GL-11.0~16.0m	180	970
	GL-16.0~21.0m	200	210
	GL-21.0~26.0m	340	290
	GL-26.0~30.0m	340	280

Source: Detail Geotechnical Report (Appendix-9)

Also, it is necessary to evaluate the anticipated subsidence when planning facilities. The consolidation subsidence is calculated with the following expression using the results of indoor compression testing and consolidation testing as base data.

Instantaneous consolidation subsidence　$\rho dc = (1/E) i \cdot \Delta\sigma \cdot Ho$

- E: Young's modulus (calculated from the results of triaxial testing)
- i: Influence coefficient (assumed to be 0.45)
- Δσ: Mean stress (assumed to be 200 kpa)
- Ho: Thickness of clay (calculated from the boring investigation)

Initial consolidation subsidence:　$\rho pc = Ho \cdot mv \cdot \Delta\sigma z$

Mv: Elastic modulus (calculated from the results of consolidation testing)

Δσz: Stress increase (assumed to be 0.45Δσ)

Ho: Thickness of clay (calculated from the boring investigation)

Secondary consolidation subsidence (25 years, 50 years): ρsc=(Ho/1+ep)Cα log(t/tp)

C: Secondary consolidation subsidence coefficient (assumed to be [1/1+ep]Cα ＝0.003)

t: Time required for secondary consolidation (calculated from the results of consolidation testing)

tp: Time required for initial consolidation (calculated from the results of consolidation testing)

Ho: Thickness of clay (calculated from the boring investigation)

Table 5-2.7 shows the calculated instantaneous consolidation subsidence, initial consolidation subsidence, and secondary consolidation subsidence (25 years, 50 years). In light of these results, since there was confirmed to be a risk of consolidation subsidence arising, in the case of adopting mat foundations, subsidence of around 185 millimeters will be taken into account at point BH02 on the north side of the substation site, and 50-year subsidence of around 215 millimeters will be taken into account at point BH04 on the south side of the site. Since the confirmed subsidence is less than the maximum value of 300 millimeters given in the Structural Design Guidelines for Building Foundations (Architectural Institute of Japan), there is not deemed to be any problem. In consideration of these points, general mat foundation shall be adopted in the facilities plan for the substation equipment and buildings on the substation site.

Table 5-2.7 Settlement analysis of Buloba Substation (calculated by laboratory test)

Item	North of substation (BH2)	South of substation (BH4)
Time required for the primary consolidation settlement (Year)	2.5	5.4
Primary consolidation settlement at 200 kPa	126.0	162.0
Immediate or elastic compression at 200 kPa	20.0	22.5
Secondary consolidation settlement at 200kPa during 25 years	30.0	20.2
Secondary consolidation settlement at 200kPa during 50 years	39.0	29.2
Total vertical settlement at 200 kPa during 25 years	176.0	204.7
Total vertical settlement at 200 kPa during 50 years	185.03	214

Source: Detail Geotechnical Report (Appendix-9)

The result of the laboratory test for Buloba Substation sites is shown in Table 5-2.8 to 5-2.15 below.

Table 5-2.8 Moisture content at Buloba Substation site (based on the laboratory test)

Test method		ASTM D4959	
		Moisture content (%)	
Borehole number.		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	34.5	19.2
	GL-10.5~11.0m	37.3	22.1
	GL-15.5~16.0m	35.9	24.4
	GL-20.5~21.0m	29.5	29.7
	GL-25.5~26.0m	28.3	27.1
	GL-28.5~29.0m	22.6	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	22.7

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.9 Liquid limit at Buloba Substation site (based on the laboratory test)

Test method		ASTM D4318	
		Liquid limit (%)	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	65.6	53.9
	GL-10.5~11.0m	68.0	61.9
	GL-15.5~16.0m	61.3	66.0
	GL-20.5~21.0m	65.1	59.9
	GL-25.5~26.0m	62.6	54.8
	GL-28.5~29.0m	59.7	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	54.3

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.10 Plastic limit at Buloba Substation site (based on the laboratory test)

Test method		ASTM D4318	
		Plastic limit (%)	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	44.6	20.1
	GL-10.5~11.0m	38.6	34.1
	GL-15.5~16.0m	42.6	32.0
	GL-20.5~21.0m	44.0	40.4
	GL-25.5~26.0m	41.7	33.9
	GL-28.5~29.0m	36.5	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	34.6

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.11 Specific gravity at Buloba Substation site (based on the laboratory test)

Test method		ASTM D854	
		Specific gravity	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	2.732	2.795
	GL-10.5~11.0m	2.744	2.639
	GL-15.5~16.0m	2.713	2.694
	GL-20.5~21.0m	2.662	2.716
	GL-25.5~26.0m	2.691	2.682
	GL-28.5~29.0m	2.721	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	2.638

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.12 Bulk density at Buloba Substation site (based on the laboratory test)

Test method		ASTM D2937	
		Bulk density (Mg/m^3)	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	1.80	1.97
	GL-10.5~11.0m	1.70	2.01
	GL-15.5~16.0m	1.74	1.81
	GL-20.5~21.0m	1.82	1.79
	GL-25.5~26.0m	1.86	1.86
	GL-28.5~29.0m	1.71	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	1.93

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.13 Uniaxial compression test at Buloba Substation site (based on the laboratory test)

Test method		ASTM D2166	
		Adhesive cohesion Cu (kPa)	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-1.5~2.0m	-	70
	GL-3.0~4.0m	33	-
	GL-5.5~6.0m	23	-
	GL-7.5~8.0m	-	-
	GL-10.5~11.0m	20	38
	GL-11.5~12.0m	-	20
	GL-15.5~16.0m	30	-
	GL-18.5~19.0m	-	-
	GL-19.5~20.0m	-	25
	GL-23.5~24.0m	-	37
	GL-24.5~25.0m	41	-
	GL-25.5~26.0m	-	-
	GL-28.5~29.0m	46	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	19

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.14 Triaxial compression test at Buloba Substation site (based on the laboratory test)

Test method		ASTM D2850 and D4767	
		Adhesive cohesion Cu (kPa)	
Borehole number		Northern side of the site (BH2)	Southern side of the site (BH4)
Depth (m)	GL-5.5~6.0m	60	133
	GL-10.5~11.0m	40	34
	GL-15.5~16.0m	36	84
	GL-20.5~21.0m	29	31
	GL-25.5~26.0m	100	86
	GL-28.5~29.0m	66	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	60

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.15 Consolidation test at Buloba Substation site (based on the laboratory test)

Borehole No.:	Depth (m)	Pre-Consolidation pressure (kN/m^2)	Overburden Pressure (kN/m^2)	Compression Index, C_c	Coefficient of Volume Compressibility Mv (m^2/MN)			Coefficient of Consolidation C_v (cm^2/sec)			Permeability, k (m/s) $x10^{-9}$		
					Min	*Max*	*Ave*	*Min*	*Max*	*Ave*	*Min*	*Max*	*Ave*
BH 02	5.5-6.0	320.0	96.9883	0.469	0.085	0.395	0.165	0.003	0.010	0.006	0.257	1.493	0.857
	10.5-11.0	250.0	175.2315	0.108	0.036	0.200	0.123	0.012	0.018	0.015	0.410	3.172	1.895
	15.5-16.0	265.1	265.1	0.032	0.012	0.066	0.039	0.001	0.006	0.003	0.016	0.225	0.099
	20.5-21.0	366.4	366.3702	0.114	0.026	0.249	0.120	0.008	0.014	0.011	0.248	1.855	1.249
	25.5-26.0	465.5	465.5	0.108	0.039	0.239	0.133	0.009	0.016	0.012	0.329	3.855	1.783
	28.5-29.0	477.1	477.1	0.158	0.040	0.184	0.098	0.003	0.015	0.008	0.118	2.636	1.023
BH 04	5.5-6.0	260.0	106.4684	0.059	0.025	0.064	0.040	0.002	0.006	0.003	0.048	0.162	0.106
	10.5-11.0	260.0	206.5851	0.077	0.041	0.128	0.079	0.001	0.004	0.002	0.040	0.486	0.178
	15.5-16.0	274.8	274.8	0.138	0.062	0.217	0.147	0.003	0.007	0.005	0.382	0.816	0.602
	20.5-21.0	359.2	359.2	0.237	0.085	0.334	0.211	0.003	0.010	0.005	0.546	0.864	0.724
	25.5-26.0	464.2	464.2	0.182	0.095	0.537	0.287	0.002	0.003	0.002	0.268	1.143	0.627
	30.5-31.0	578.7	578.7	0.105	0.055	0.194	0.126	0.005	0.007	0.006	0.360	1.111	0.722

Source: Detail Geotechnical Report (Appendix-9)

Concerning transmission routes, since large undulations and marshland, etc. have been confirmed along the routes, geological investigation was implemented in one place on the 220 kV transmission line side (BH03) and one place on the 132 kV transmission line side (BH01). The results of the standard penetration testing and indoor tests are shown in Tables 1-1 through 1-11 at the beginning of Appendix-9 Results of Geological Investigation.

According to the findings on the 220 kV transmission line side (BH03), ground elevation was different from that in the test position on the substation site, however, the distribution of strata was almost the same as that on the substation site. According to the findings on the 132 kV transmission line side (BH01), it was confirmed that the ground consists of clayey sand down to 5.0 meters from the surface, and alternating layers of silt and clay at every 1 meter beyond that.

Table 5-2.8 shows the allowable bearing capacity of each strata calculated from the results of indoor tri-axial testing based on the following expression according to the Ministry of Land, Infrastructure and Transport Notification 1113 of 2001. As is shown in the table, as a result of the calculations, bearing capacity of around 150 kPa (BH01) and 315 kPa (BH03) is secured at GL-3.0m, which is thought to be in the vicinity of the foundation plates on the transmission line route.

Table 5-2.16 Bearing capacity of incoming line to Buloba Substation (calculated by laboratory test)

Test method		Notification No. 111 METI, Japan 2002	
		Bearing capacity qa (kPa)	
Borehole No.		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-1.0~6.0m	150	315
	GL-6.0~11.0m	130	200
	GL-11.0~16.0m	140	500
	GL-16.0~21.0m	260	210
	GL-21.0~26.0m	-	-
	GL-26.0~30.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

The consolidation subsidence is calculated from the previously indicated expression assuming the results of indoor compressive testing and consolidation testing, etc. to be base data. Table 5-2.17 shows the calculated instantaneous consolidation subsidence, initial consolidation subsidence, and secondary consolidation subsidence (25 years, 50 years). Subsidence on the 132 kV transmission site (BH01) and 220 kV transmission line side (BH03) is roughly 200 - 290 millimeters, which is almost the same level as inside the substation site, and this is not considered to be a problem because it is less than the maximum value of 300 millimeters given in the Structural Design Guidelines for Building Foundations (Architectural Institute of Japan). However, as is shown in the table, according to the test results on the 132 kV transmission line side (BH01), subsidence of around 200 - 290 millimeters is presumed due to the influence of the intermediate clay strata. At this point, it is planned to adopt pile foundations for the transmission steel tower on the 132 kV side.

Table 5-2.17 Settlement analysis of incoming line to Buloba Substation (calculated by laboratory test)

Item	132 kVside (BH1)	220 kVside (BH3)
Time required for the primary consolidation settlement (Year)	10	1.7
Primary consolidation settlement at 200 kPa	229.5	144.0
Immediate or elastic compression at 200 kPa	30.0	21.0
Secondary consolidation settlement at 200kPa During 25 years	18.0	35.0
Secondary consolidation settlement at 200kPa During 50 years	31.4	44.0
Total vertical settlement at 200 kPa during 25 years	277.4	200.0
Total vertical settlement at 200 kPa during 50 years	291.0	209.0

Source: Detail Geotechnical Report (Appendix-9)

The result of the laboratory test for Buloba Substation transmission line route is shown in Table 5-2.18 - 5-2.25.

Table 5-2.18 Moisture content of the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D4959	
		Moisture content (%)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	23.0	25.8
	GL-10.5~11.0m	24.5	31.0
	GL-15.5~16.0m	26.5	30.9
	GL-20.5~21.0m	28.9	29.2
	GL-25.5~26.0m	-	26.5
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	25.9
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.19 Liquid limit of the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D4318	
		Liquid limit (%)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	47.4	64.9
	GL-10.5~11.0m	44.7	41.2
	GL-15.5~16.0m	44.8	59.9
	GL-20.5~21.0m	49.9	56.5
	GL-25.5~26.0m	-	57.7
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	61.3
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.20 Plastic limit of the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D4318	
		Plastic limit (%)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	24.4	39.8
	GL-10.5~11.0m	28.8	22.6
	GL-15.5~16.0m	28.0	33.7
	GL-20.5~21.0m	28.8	40.1
	GL-25.5~26.0m	-	36.6
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	36.3
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.21 Specific gravity at the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D854	
		Specific gravity	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	2.595	2.650
	GL-10.5~11.0m	2.636	2.649
	GL-15.5~16.0m	2.599	2.637
	GL-20.5~21.0m	2.749	2.684
	GL-25.5~26.0m	-	2.693
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	2.592
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.22 Bulk density at the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D2937	
		Bulk density (Mg/m^3)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	1.89	1.92
	GL-10.5~11.0m	2.00	1.83
	GL-15.5~16.0m	1.86	1.86
	GL-20.5~21.0m	1.94	1.88
	GL-25.5~26.0m	-	1.93
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	1.93
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.23 Uniaxial compression test at the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D2166	
		Adhesive cohision Cu (kPa)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-1.5~2.0m	-	44
	GL-3.0~4.0m	-	-
	GL-5.5~6.0m	23.4	-
	GL-7.5~8.0m	-	35
	GL-10.5~11.0m	14	-
	GL-11.5~12.0m	-	-
	GL-15.5~16.0m	26	-
	GL-18.5~19.0m	-	31
	GL-19.5~20.0m	-	-
	GL-23.5~24.0m	-	-
	GL-24.5~25.0m	-	-
	GL-25.5~26.0m	-	44
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	24
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.24 Triaxial compression test at the transmission line routes to Buloba Substation (calculated by laboratory test)

Test method		ASTM D2850and D4767	
		Adhesive cohesion Cu (kPa)	
Borehole number		132 kV side (BH1)	220 kV side (BH3)
Depth (m)	GL-5.5~6.0m	68	118
	GL-10.5~11.0m	28	73
	GL-15.5~16.0m	31	55
	GL-20.5~21.0m	74	51
	GL-25.5~26.0m	-	-
	GL-28.5~29.0m	-	-
	GL-29.5~30.0m	-	-
	GL-30.5~31.0m	-	-

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.25 Consolidation test at the transmission line routes to Buloba Substation (calculated by laboratory test)

Borehole No.:	Depth (m)	Pre-Consolidation pressure (kN/m^2)	Overburden Pressure (kN/m^2)	Compression Index, C_c	Coefficient of Volume Compressibility Mv (m^2/MN)			Coefficient of Consolidation C_v (cm^2/sec)			Permeability, k (m/s) $x10^{-9}$		
					Min	*Max*	*Ave*	*Min*	*Max*	*Ave*	*Min*	*Max*	*Ave*
BH 01	5.5-6.0	200.0	101.9231	0.106	0.054	0.218	0.122	0.005	0.01	0.009	0.260	2.111	1.184
	10.5-11.0	210.0	206.4796	0.123	0.048	0.428	0.211	0.004	0.01	0.006	0.309	1.888	1.190
	15.5-16.0	282.11	282.1073	0.077	0.018	0.334	0.150	0.002	0.020	0.013	0.035	6.712	2.547
	20.5-21.0	390.6	390.6	0.153	0.056	0.123	0.079	0.001	0.003	0.002	0.108	0.225	0.169
BH 03	5.5-6.0	200.0	103.484	0.075	0.036	0.095	0.060	0.0012	0.0015	0.0014	0.050	0.137	0.083
	10.5-11.0	205.0	188.0236	0.077	0.028	0.186	0.098	0.009	0.022	0.017	0.238	4.018	1.915
	15.5-16.0	283.3	283.3	0.103	0.042	0.306	0.145	0.016	0.021	0.017	0.852	4.730	2.301
	20.5-21.0	377.7	377.7	0.159	0.056	0.356	0.173	0.012	0.020	0.016	0.638	5.764	2.740
	25.5-26.0	483.1	483.1	0.212	0.079	0.251	0.135	0.004	0.007	0.006	0.490	0.913	0.671
	29.5-30.0	558.5	558.5	0.114	0.055	0.092	0.075	0.006	0.016	0.010	0.422	1.064	0.732

Source: Detail Geotechnical Report (Appendix-9)

2) Kawaala Substation

Concerning Kawaala Substation, it is planned to construct a large-capacity substation that utilizes gas-insulated switchgear upon removing the existing equipment and buildings. It is planned to change the system inter-connection of this substation from a T-branch to open-pi connection. In line with this, it will be necessary to upgrade the existing single line lead-in to a double-line lead-in, however, because not enough land can be secured for two overhead lines, it is planned to install an underground line for around 50 meters. Because the substation site and cable pit route are adjacent to each other, soil samples for the standard penetration test and indoor tests were taken from one place on the planned substation site. The results of the standard penetration testing and indoor tests are shown in Tables 2-1 through 2-8 at the beginning of Apppendix-9 Results of Geological Investigation.

As a result of the standard penetration testing, it was confirmed that the ground consists of gravel down to around 2.0 meters from the surface, sandy clay from there to around 10.0 meters, clayey sand from there to around 15.0 meters, sandy silt from there to around 28 meters, and soft rock from there to around 30.5 meters.

Table 5-2.26 shows the allowable bearing capacity of each strata calculated from the results

of indoor tri-axial testing based on the following expression according to the Ministry of Land, Infrastructure and Transport Notification 1113 of 2001. As is shown in the table, as a result of the calculations, bearing capacity of around 150 kPa (BH01) and 400 kPa (BH01) is secured at GL-3.0m, which is thought to be in the vicinity of the foundation plates.

Table 5-2.26 Bearing capacity of Kawaala Substation (calculated by laboratory test)

Test method		Notification No. 111 METI, Japan 2002
		Bearing capacity qa (kPa)
Borehole No.		BH1(Building, Tower and cable pit)
Depth (m)	GL-1.0~5.0m	400
	GL-5.0~10.0m	390
	GL-10.0~15.0m	230
	GL-15.0~20.0m	430
	GL-20.0~25.0m	530
	GL-25.0~30.0m	570

Source: Detail Geotechnical Report (Appendix 8)

The consolidation subsidence is calculated from the previously indicated expression assuming the results of indoor compressive testing and consolidation testing, etc. to be base data. Table 5-2.27 shows the calculated instantaneous consolidation subsidence, initial consolidation subsidence, and secondary consolidation subsidence (25 years, 50 years). In light of these findings, in the case where mat foundations are adopted, subsidence of around 300 millimeters is considered. Since this is equivalent to the maximum value of 300 millimeters given in the Structural Design Guidelines for Building Foundations (Architectural Institute of Japan), it is deemed there will be no problem if the GF level of construction is raised. In view of the above results, general mat foundations will be adopted in the facilities plan for Kawaala Substation and the surrounding area.

Table 5-2.27 Settlement analysis of Kawala Substation (calculated by laboratory test)

Parameters	**BH1**
Time required for the primary consolidation settlement (Year)	13.5
Primary consolidation settlement at 200 kPa	247.5
Immediate or elastic compression at 200 kPa	34
Secondary consolidation settlement at 200kPa During 25 years	9
Secondary consolidation settlement at 200kPa During 50 years	19
Total vertical settlement at 200 kPa during 25 years	290
Total vertical settlement at 200 kPa during 50 years	300

Source: Detail Geotechnical Report (Appendix-9)

The result of the laboratory test at Kawaala Substation is shown in Table 5-2.28 to Table 5-2.35.

Table 5-2.28 Moisture content at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D4959
		Moisture content (%)
Borehole number.		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-3.0 m	26.2
	GL-5.0 m	22.0
	GL-6.0 m	22.7
	GL-10.0 m	19.0
	GL-11.0 m	21.5
	GL-12.0 m	10.9
	GL-15.0 m	19.3
	GL-16.0 m	25.8
	GL-18.0 m	24.2
	GL-20.0 m	25.8
	GL-24.0 m	22.6
	GL-25.0 m	20.7
	GL-27.0 m	22.0
	GL-30.0 m	17.6

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.29 Liquid limit at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D4318
		Liquid limit (%)
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	53.9
	GL-10.0 m	57.7
	GL-11.0 m	57.5
	GL-15.0 m	53.2
	GL-20.0 m	57.1
	GL-30.0 m	42.1

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.30 Plastic limit at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D4318
		Plastic limit (%)
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	26.4
	GL-10.0 m	31.6
	GL-11.0 m	29.6
	GL-15.0 m	31.3
	GL-20.0 m	35.9
	GL-30.0 m	24.1

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.31 Specific gravity at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D854
		Specific gravity
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	2.45
	GL-10.0 m	2.48
	GL-11.0 m	2.65
	GL-15.0 m	2.61
	GL-20.0 m	2.62
	GL-30.0 m	2.55

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.32 Bulk density at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D2937
		Bulk density (kg/m^3)
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	1903.0
	GL-10.0 m	1903.0
	GL-11.0 m	1969.6
	GL-15.0 m	1972.7
	GL-20.0 m	1856.9

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.33 Uniaxial compression test at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D2166
		Adhesive cohesion Cu (kPa)
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	24
	GL-10.0 m	10
	GL-11.0 m	54
	GL-15.0 m	42.7
	GL-20.0 m	33

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.34 Triaxial compression test at Kawaala Substation site (based on the laboratory test)

Test method		ASTM D2166
		Adhesive cohesion Cu (kPa)
Borehole number		BH1 (Control building, gantry and cable pit)
Depth (m)	GL-5.0 m	53
	GL-10.0 m	76
	GL-15.0 m	14
	GL-20.0 m	8
	GL-25.0 m	22
	GL-30.0 m	25

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.35 Consolidation test at Kawaala Substation site (based on the laboratory test)

Sample Source	Depth (m)	Pre-Consolidation pressure (kN/m²)	Overburden Pressure (kN/m²)	Compression Index, C_c	Coefficient of Volume Compressibility mv (m²/MN)			Coefficient of Consolidation C_v (cm²/sec)			Permeability, k (m/s) x10⁻⁹		
					Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
BH 1	5	150	92.2	0.195	0.072	4.057	0.8934	0.0010	0.0036	0.0018	7E-11	1.5E-09	2.83E-09
	10	180	172.1	0.201	0.070	1.846	0.502	0.0011	0.0042	0.0028	7.6E-11	6.5E-09	1.67E-09
	15		276.6	0.036	0.020	0.16	0.074	0.0032	0.0154	0.0083	1.12E-09	2.25E-09	9.25E-10
	20		368.8	0.029	0.016	0.16	0.07	0.0026	0.0081	0.0049	4.2E-09	1.12E-09	4.88E-10
	30		553.2	0.037	0.030	0.098	0.053	0.0020	0.0055	0.0035	8.76E-11	1.97E-10	1.5E-10

Source: Detail Geotechnical Report (Appendix-9)

3) New Mukono Substation

Concerning the 220/132 kV New Mukono Substation, it is planned to build on vacant land on the site of 132/33 kV Mukono Substation, where land acquisition procedures are already being advanced under assistance from the Chinese Exim Bank. Since it is planned to link this substation to the power system based on double-pi connection, concerning lead-in of the 220 kV transmission lines, it is planned to construct four overhead lines over around 4 kilometers parallel to the 132 kV lead-in line for Mukono Substation being installed under assistance from the Chinese Exim Bank. Unlike Buloba Substation, since no marshland has been confirmed on the transmission route, the rough design was implemented at one point on the substation premises. The results of the standard penetration testing and indoor tests are shown in Tables 3-1 through 3-8 at the beginning of Appendix-9 Results of Geological Investigation.

As a result of the standard penetration testing, it was confirmed that the ground consists of sandy silt down to around 9.0 meters from the surface, gravely sand from there to around 18.0 meters, and silty clay from there to around 28.5 meters.

Table 5-2.36 shows the allowable bearing capacity of each strata calculated from the results of indoor tri-axial testing based on the following expression according to the Ministry of Land, Infrastructure and Transport Notification 1113 of 2001. As is shown in the table, as a result of the calculations, bearing capacity of around 105 kPa (BH01) is secured at GL-3.0m, which is thought to be in the vicinity of the foundation plates.

Table 5-2.36 Bearing capacity of New Mukono Substation (BH01)

Test method		Notification No. 111 METI, Japan 2002	
		Bearing capacity qa (kPa)	
Borehole No.		BH1	
		Building	Tower
Depth (m)	GL-1.0~4.5m	105	115
	GL-4.5~6.0m	130	140
	GL-6.0~10.5m	260	275

Source: Detail Geotechnical Report (Appendix-9)

The consolidation subsidence is calculated from the previously indicated expression

assuming the results of indoor compressive testing and consolidation testing, etc. to be base data. Table 5-2.37 shows the calculated instantaneous consolidation subsidence, initial consolidation subsidence, and secondary consolidation subsidence (25 years, 50 years). As is shown in the table, there is less subsidence than at Buloba and Kawaala. Subsidence of around 167 millimeters is considered in the case of adopting mat foundations. The confirmed subsidence is equivalent to the maximum value of 300 millimeters given in the Structural Design Guidelines for Building Foundations (Architectural Institute of Japan), and it is deemed there will be no problem if the GF level of building is raised. In view of the above results, general mat foundations will be adopted in the facilities plan for New Mukono Substation.

Table 5-2.37 Settlement analysis of New Mukono Substation (BH01)

Parameters	BH1
Time required for the primary consolidation settlement (Year)	13.5
Primary consolidation settlement at 200 kPa	126
Immediate or elastic compression at 200 kPa	20
Secondary consolidation settlement at 200kPa During 25 years	12
Secondary consolidation settlement at 200kPa During 50 years	21
Total vertical settlement at 200 kPa during 25 years	158
Total vertical settlement at 200 kPa during 50 years	167

Source: Detail Geotechnical Report (Appendix-9)

The result of the laboratory test at New Mukono Substation is shown in Table 5-2.38 to Table 5-2.45.

Table 5-2.38 Moisture content at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D4959
		Moisture content (%)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-1.5 m	27.7
	GL-3.0 m	26.8
	GL-4.5 m	30.7
	GL-6.0 m	30.9
	GL-7.5 m	13.2
	GL-9.0 m	15.5
	GL-10.5 m	22.4
	GL-12.0 m	5.5
	GL-13.5 m	11.3
	GL-15.0 m	9.3
	GL-16.5 m	16.1
	GL-18.0 m	9.4
	GL-19.5 m	17.9
	GL-27.0 m	19.5
	GL-28.5 m	22.2

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.39 Liquid limit at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D4318
		Liquid limit (%)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	51.8
	GL-6.0 m	45.8
	GL-10.5 m	41.2
	GL-28.5 m	35.3

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.40 Plastic limit at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D4318
		Plastic limit (%)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	30.3
	GL-6.0 m	28.3
	GL-10.5 m	30.5
	GL-28.5 m	25.7

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.41 Specific gravity at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D854
		Specific gravity
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	2.573
	GL-6.0 m	2.571
	GL-10.5 m	2.704
	GL-28.5 m	2.722

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.42 Bulk density at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D2937
		Bulk density (kg/m^3)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	1900
	GL-6.0 m	1867
	GL-10.5 m	1698
	GL-28.5 m	1929

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.43 Uniaxial compression test at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D2166
		Adhesive cohesion Cu (kPa)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	19
	GL-6.0 m	7
	GL-10.5 m	40

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.44 Triaxial compression test at New Mukono Substation site (based on the laboratory test)

Test method		ASTM D2166
		Adhesive cohesion Cu (kPa)
Borehole number		BH1 (Control building and tower)
Depth (m)	GL-4.5 m	43
	GL-6.0 m	54
	GL-10.5 m	71

Source: Detail Geotechnical Report (Appendix-9)

Table 5-2.45 Consolidation test at New Mukono Substation site (based on the laboratory test)

Borehole No.:	Depth (m)	Pre-Consolidation pressure (kN/m^2)	Overburden Pressure (kN/m^2)	Compression Index, C_c	Coefficient of Volume Compressibility Mv (m^2/MN)			Coefficient of Consolidation C_v (cm^2/sec)			Permeability, k (m/s) $x10^{-9}$		
					Min	*Max*	*Ave*	*Min*	*Max*	*Ave*	*Min*	*Max*	*Ave*
BH 01	4.5	140.0	83.86	0.197	0.070	0.3219	0.1617	0.0001	0.0003	0.0001	0.007	0.041	0.020
	6.0	200.0	109.90	0.104	0.053	0.179	0.099	0.001	0.002	0.001	0.091	0.185	0.120
	10.5	220.00	174.94	0.137	0.062	0.297	0.162	0.001	0.002	0.002	0.105	0.396	0.241
	28.5	539.4	539.4	0.061	0.031	0.135	0.085	0.003	0.006	0.004	0.096	0.403	0.281

Source: Detail Geotechnical Report (Appendix-9)

(7) Topographic survey

Concerning the Project components of construction of the 220/132 kV New Mukono Substation and Buloba Substation, installation of associated transmission lines, and installation of underground 132 kV line to Kawaala Substation, since these will entail land acquisition and resettlement of some residents, it will be necessary to compile a basic resident resettlement plan that also includes access routes to the target sites. Concerning the resident resettlement plan, it is essential to conduct a survey based on positional confirmation maps (strip maps) of owners and structures on the transmission line routes and substation sites. Since quantity surveying maps are needed based on these basic materials, it was decided to implement quantity surveying as part of the natural conditions survey according to the following specifications in consideration of local conditions around the above component sites.

Concerning Buloba Substation, since it is necessary to construct a large-scale retaining wall when preparing the site due to the existence of a large slope that was confirmed in the site survey, it is possible the works will not be finished by the target year of 2020. Accordingly, a site preparation method that allows the work to be completed by 2020 will be examined based on the results of quantity surveying.

Incidentally, Appendix-8 shows the quantity surveying maps that were outsourced.

1) Kawaala Substation

Concerning the cable route (around 50 meters) leading in to Kawaala Substation, since the route is short and there are densely concentrated houses in the surrounding area, quantity surveying was implemented at 5-meter intervals.

2) Buloba Substation

Since the site for Buloba Substation has large grade difference and contains some houses, in order to confirm the planned scope and positional relationships, quantity surveying was implemented at 5-meter intervals over the scope of the target area (around 900 meters for the 220 kV line and 132 kV line).

3) New Mukono Substation

Concerning New Mukono Substation, since hardly any structures were confirmed on the route, and the route is longer than the others, quantity surveying was implemented at 30-meter intervals (over a distance of around 5 kilometers).

General procedure to survey and design the transmission line route is shown in Table 5-2.46. Since this preparatory survey is a feasibility study level, the item 1 to 3 will be conducted.

Table 5-2.46 Summary of the basic procedure of the transmission line route design

No.	Contents
1	Route zone design
	➢ Based on the nature and environment related regulations, necessary information will be collected. (Desk research)
2	Selection of outline route
	➢ Land use, natural environment and biological data will be collected and field survey will be conducted. ➢ Soil survey and topographic survey will be conducted to identify the tower position and the outline longitudinal drawing will be prepared.
3	Analysis of optional route and identification of the candidate route
	➢ Outline design of transmission equipment will be conducted to the candidate route.
4	Selection of the basic route
	➢ Existing facilities, main rivers, roads, existing transmission lines will be highlighted in the drawing map. ➢ Detail drawing map and longitudinal drawing will be prepared by aerial survey. Accordingly, most appropriate longitudinal design will be conducted.
5	Selection of the detail route
	➢ Proposed tower position is identified by the field survey and it will be indicated. Accordingly, the longitudinal measurement will be carried out.

Source: Prepared by JICA Study Team base on the report on the grid facilities in respect of the use of renewable energy, 2013 (Ministry of the Environment) (URL: http://www.env.go.jp/earth/report/h27-02/index.html)

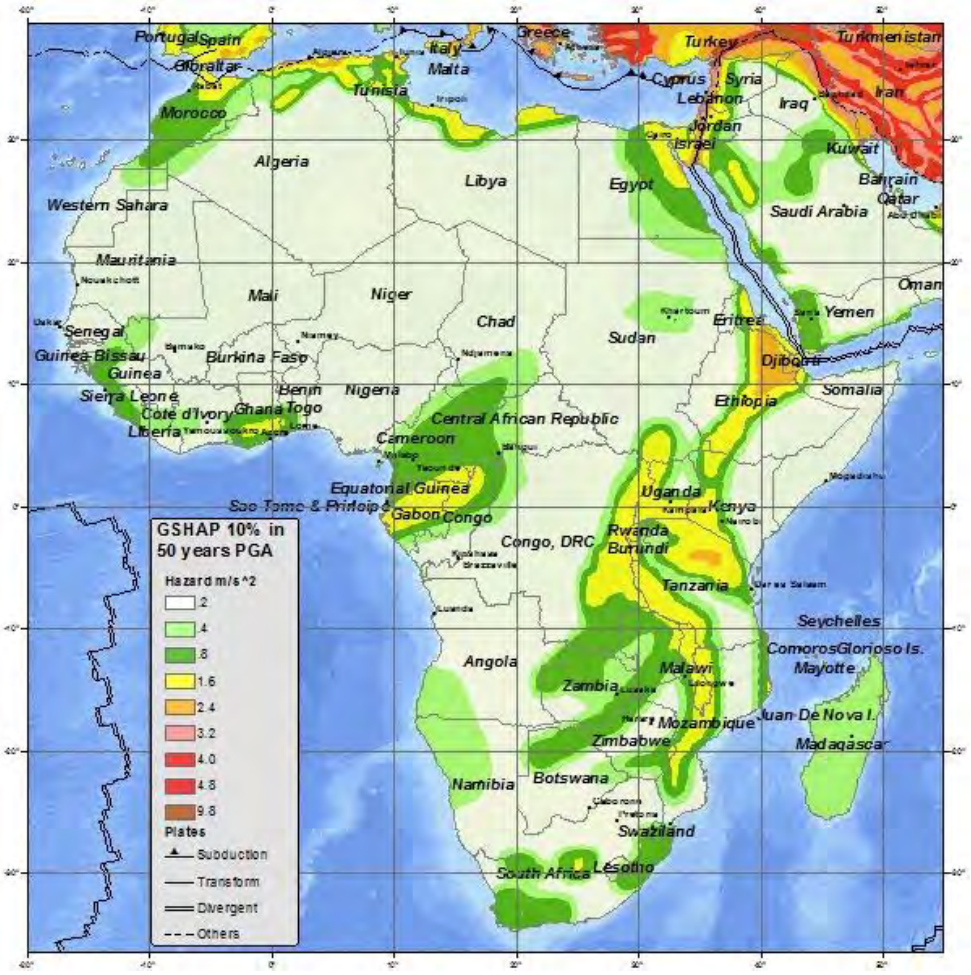
In the procedure of 'Selection of the line route' (No.2), the land shape and slope needs to be analyzed based on the altitude data. In this survey, the topographic survey was conducted Concerning the results of topographical and quantity surveying (every five-meter interval), there were not found to be any problematic fault lines, landslides, broken terrain, or steep slopes with gradient of more than 10 degrees on the 220 kV transmission line route of New Mukono Substation. Next, based on the survey data, the longitudinal drawing and section drawing are prepared and the outline route was reviewed in respect of the swinging overhead conductors, clearance of the land and vegetation, towers' position, height and insulators

shapes. The drawing is shown in Appendix-10. Based on the drawing, it was confirmed that the conductor of the lowest position shall secure the sufficient distance.

(8) Earthquakes

UETCL reported an earthquake as recent as 1996.

As the estimated seismic intensity value, the locally used 0.15 will be used in the interest of safety. Figure 5-2.1 shows the earthquake hazard map of the African Continent.



Remarks: :
・GSHAP : Global Seismic Hazard Assessment Program
・PGA : Peak Ground Acceleration (1g=9.81 m/s^2=981Gal)

Source: Home Page of U.S. Geological Survey

Figure 5-2.1 USGS African Hazard Map

5-3 Outline Design of the Project

5-3-1 Substation Plan

The Project components regarding the substation planning in Kampala metropolitan area are discussed as follows.

(1) Construction of Buloba Substation

This component is to construct Buloba 220/132/33 kV Substation at approx. 25 km away to the western direction from the central area of Kampala. Through this substation, it is expected to improve the stabilization of power transmission to Kampala metropolitan area. Furthermore, power distribution to Masaka, Mpigi Sentema and Mityana (60 km away from the central area of Kampala) which is currently connected from Mutundwe Substation through 33 kV feeders is expected to be improved. Table 5-3-1.1 indicates the primary data of Buloba Substation. 220 kV incoming feeders will be connected to 220 kV transmission line (2 circuits) currently under construction by the World Bank with double pi method (4 circuits). Also, two feeders will be connected to existing 132 kV transmission line (1 circuit) from Mutundwe to Kabulasoke by pi branch.

Table 5-3-1.1 Primary data of Buloba Substation

Specification	Quantity
220 kV Incoming feeders	4 feeders
220/132 kV Power Transformers (125 MVA)	2 units
132 kV Incoming feeders	2 feeders
132/33 kV Power Transformers (40 MVA)	2 units
33 kV Outgoing feeders	7 feeders

Source: JICA Study Team

The expansion of 33 kV distribution network to be connected to this substation will be the out of scope of the Project component, and it is considered to be coordinated by the Ugandan side. It is considered to be more reasonable to optimize the existing 33 kV feeders network to minimize the extent of 33 kV feeder line construction work to be borne by the Ugandan side. In this regard, it is considered to be technically feasible to split the existing 33 kV distribution line (between Mutundwe Substation and Mitfyana area) to split at one point and construct pi branch line to this substation. This method of connection work of 33 kV distribution lines can be applied to the other 33 kV distribution line (between Mutundwe Substation and Masaka area)

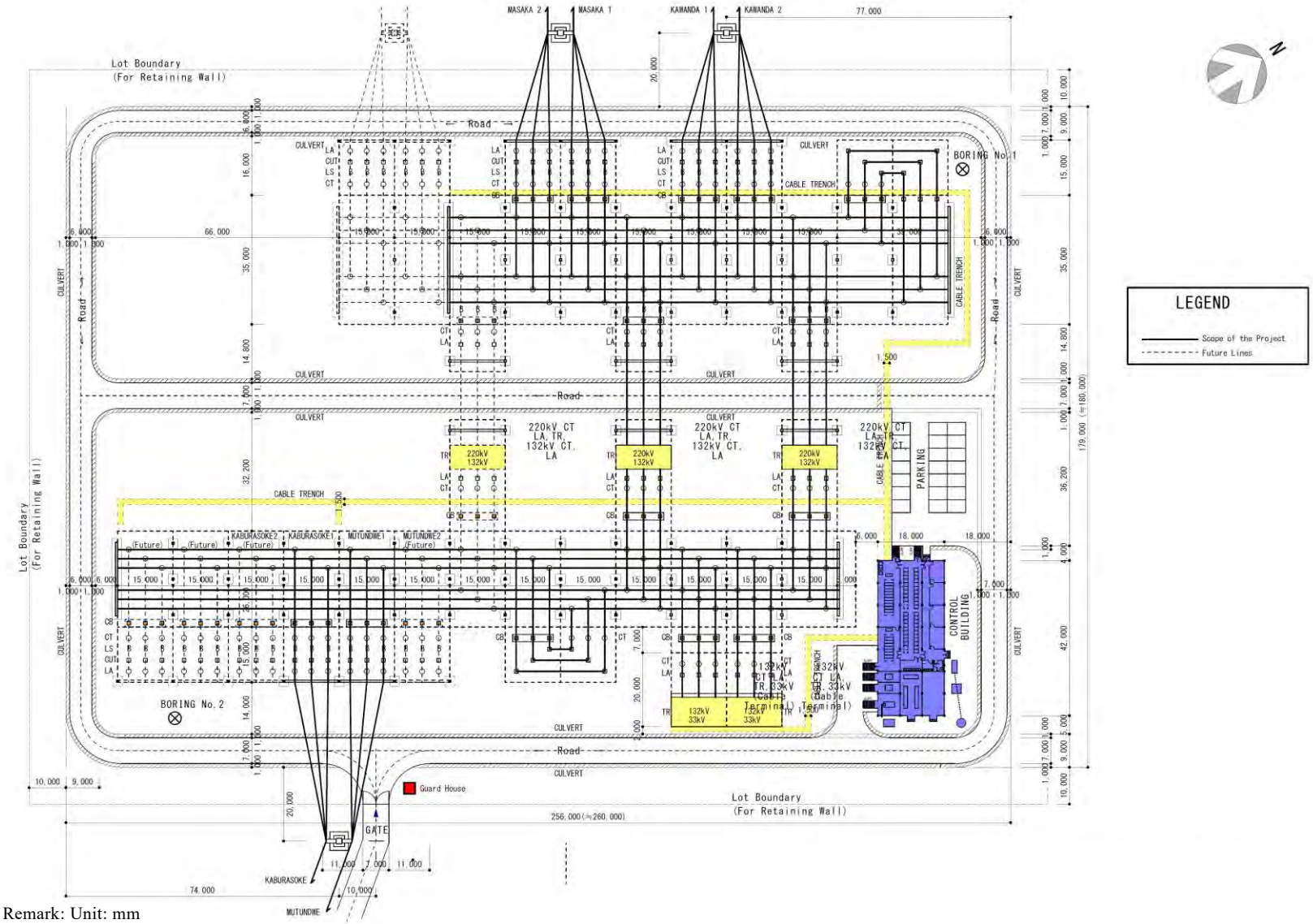
On the other hand, the distribution line to Sentema area is planned to be newly constructed. Additionally, the dedicated 33 kV distribution line to the Oil Pipeline Terminal to be constructed at Buloba area is planned to be constructed. The Table 5-3-1.2 indicates the proposed 33 kV feeder names and the line lengths.

Table 5-3-1.2 33 kV distribution feeder and line lengths

No.	Feeder name	Line length [km]
1	Mitfyana area	4.8
2	Sentema area	23
3	Masaka area	6.3
4	Oil Pipeline Terminal Dedicated line	3.0
5	Mutundwe Substation1	7
6	Mutundwe Substation 2	7
7	Spare	-

Source: UMEME

The substation is surrounded by gentle hills and swamp areas. The location is considered to be typical suburban area. Therefore, since the land acquisition of the substation is relatively easy, it is considered that the application of air insulated switchgears to 220 kV and 132 kV facilities are technically and economically appropriate. On the other hand, UETCL requests to utilize 33 kV gas insulated switchgears (GIS) which is the standard insulation type in Uganda. When considering the diagram of 33 kV voltage class, the busbars to be operated and maintained by UETCL and UMEME shall be sectioned so that each entity will conduct their own work independently. Figure 5-3-1.1 shows the proposed layout of Buloba Substation (proposed). The upper busbars are for 220 kV and the bottom busbars are for 132 kV voltage class respectively. 220 kV switchyard has the space for the future expansion of busbars covering five bays. This space will be used for the temporary store yard during the installation work period.



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Source: JICA Study Team

Figure 5-3-1.1 Buloba Substation Layout (Proposed)

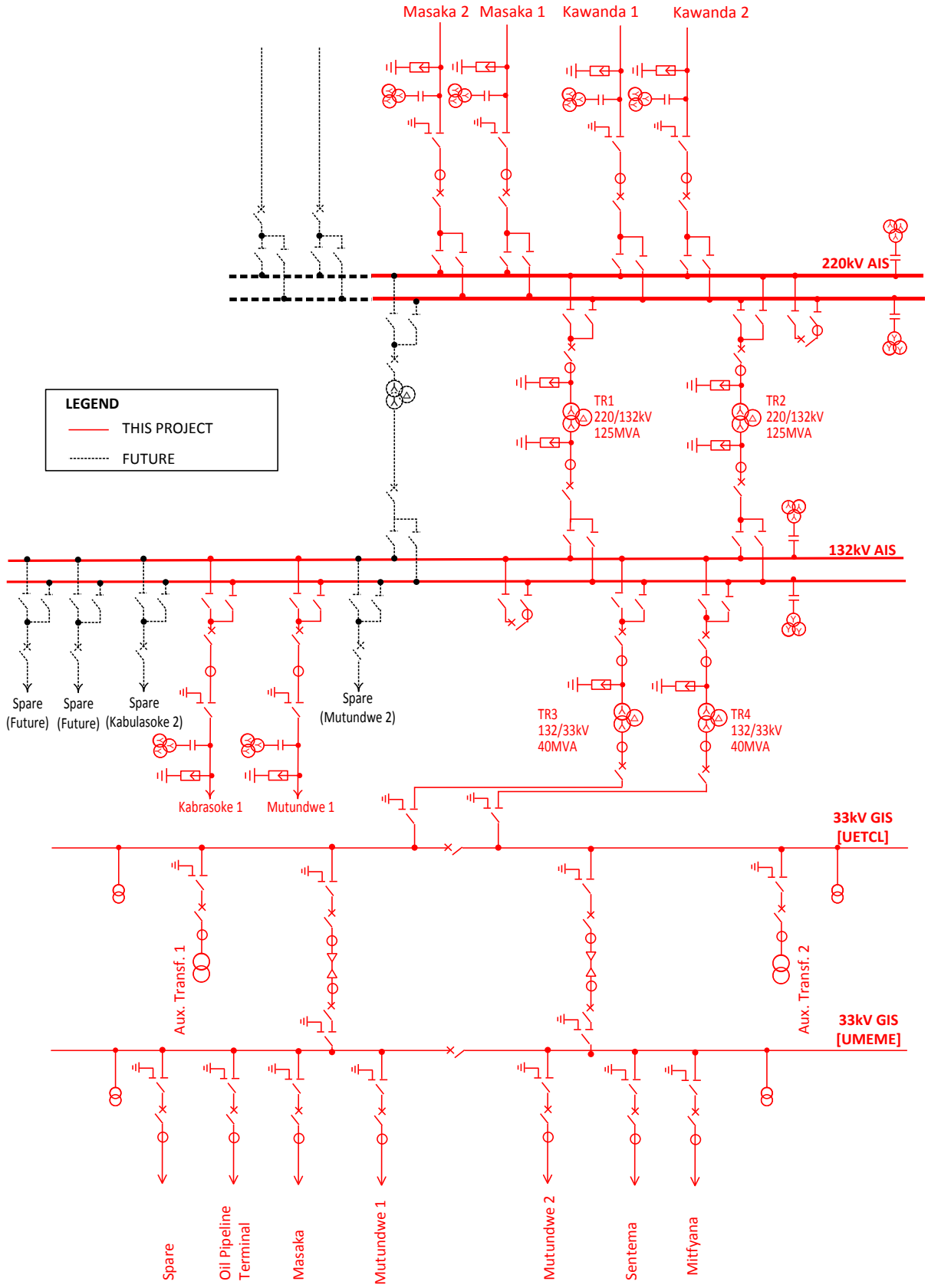


Figure 5-3-1.2 Buloba Substation Single line diagram (Proposed)

Proposed site for the construction of Buloba Substation is located on the slope area and it is forecasted to require a certain period for the land leveling work. Therefore, based on the result of the topographic and site surveys, the following land leveling work was designed to be applied to complete and commission the components by 2020.

Based on the result of topographic survey as shown in the Figure 5-3-1.2, it was confirmed that the land has a slope of approx. 15 m from north-east to south west direction. When the point of the land leveling is designed at the middle of the difference of the land level, 15 m, approx. 200,000 m^3 of soil will be generated for the mobilization. Also, since the slope of this site is large, the retaining wall work or gabion construction work will be necessary for the protection of the cliff against the erosion of the soil. Considering the planned commissioning year, 2020, the gabion construction work, which will require shorter work period, is going to be applied. (In case of retaining wall work, the work period is longer due to concrete frame work, concrete work etc.)

Based on the scale of soil mobilization and the slope protection work identified by the topographic survey, approx. four months is required. This will not affect the commissioning scheduled in 2020.

In addition to the substation site leveling work, the access road site preparation work has to be carried out. The slop of the access road will be generated 15 m height for 200 m of the horizontal distance. As for the protection of the surface, the gabion fixing work shall be applied as well as the site preparation work for the substation. Both of site preparation work and gabion construction work will require approx. two months and these works will be carried out in parallel with the substation preparation work. Therefore, the works will be completed within 4 months for the substation site preparation work and thus it will not influence the overall implementation period.

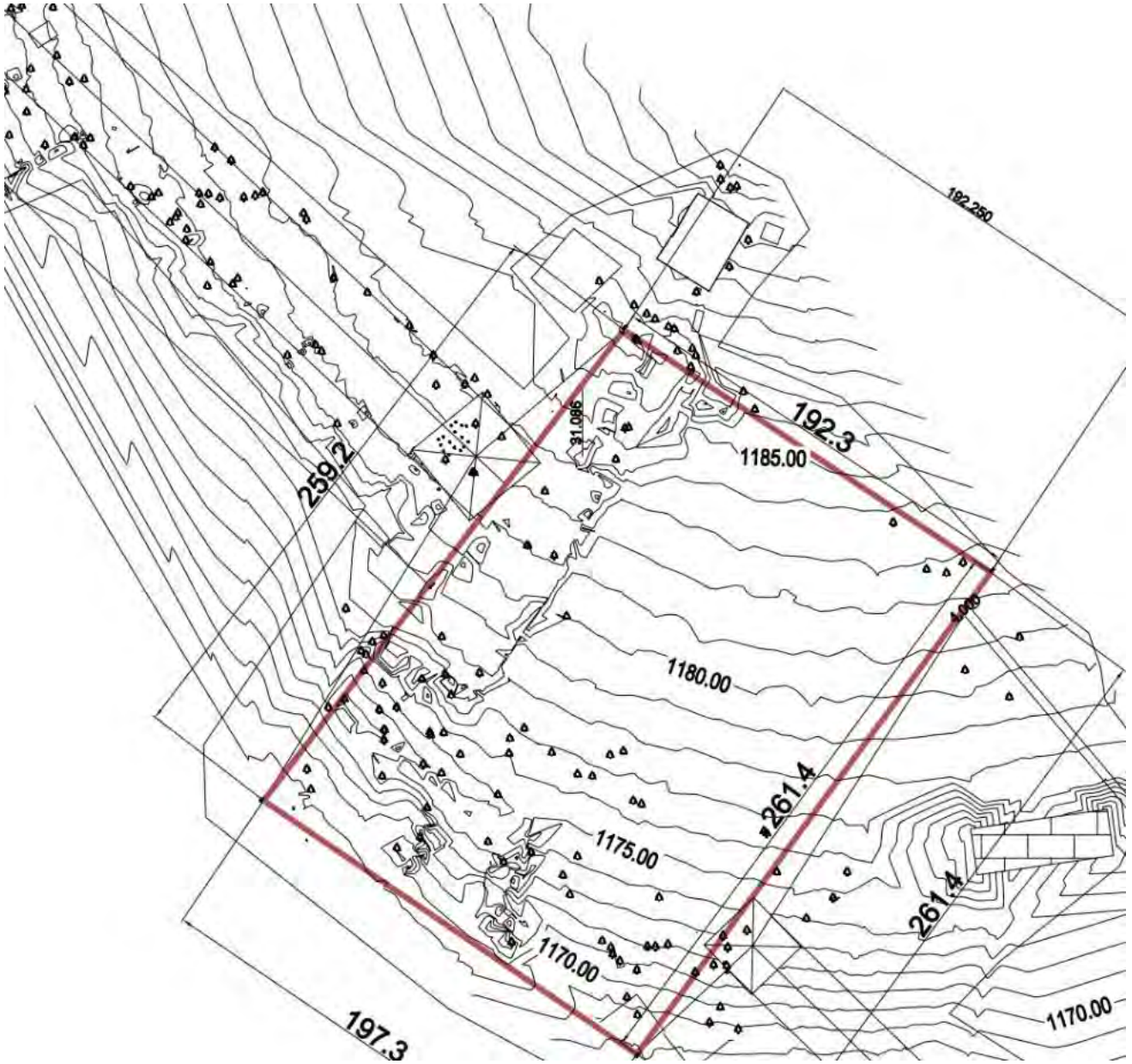


Figure 5-3-1.3 Topographic map at Buloba Substation site

(2) Upgrading of Kawaala Substation

Kawaala Substation, located at the north-west area in the central area of Kampala, has one 20 MVA of 132/11 kV power transformer and distributes power through three 11 kV feeders. Considering the remarkable power load increase at neighboring primary substations: Kampala North Substation and Mutundwe Substation, Kawaala Substation will be required not only to satisfy the power demand increase in its current power distribution area, but also to equalize the power demands among three substations (Mutundwe, Kampala North and Kawaala) for the more stable power supplies in the range from the north to the west in Kampala metropolitan area.

Main specification of Kawaala substation is shown in Table 5-3-1.3. According to UMEME, it plans to expand 33 kV distribution network rather than 11 kV network in principle in the future. Also, considering the power demand on 11 kV distribution feeders from this substation will be 12 MW in 2030, this Project will procure and install one unit of 132/11 kV power transformer (20 MVA) to replace the existing aged 20 MVA transformer at the substation.

According to the power demand of 33 kV distribution feeders from this substation as of 2030 will reach 75 MW, 2 units of 40 MVA power transformers will need to be procured for the satisfaction of the power load, In addition, since the access road to this substation is narrow and heavily hilly, the access of mobile substations to this substation is quite difficult. Due to this reason, additional one unit of 40 MVA transformer will be installed for the tentative use during the maintenance. In total, 120 MVA substation capacity will be required. However, the size of this substation is approx. 2,400 m^2 (40 m x 60 m) and its size is small considering its substation capacity (140 MVA in total). Therefore, 132 kV gas insulated switchgear (GIS) will be applied. Moreover, the direct connection from this GIS to the transformer through the duct will be applied for the further limitation of the required land.

Furthermore, 132/33 kV power transformer whose total capacity will be 120 MVA will be procured as a result of future power demand up to 2030. Considering the land limitation of existing Kawaala Substation and the stable operation of transmission operation, it was discussed between UETCL and the Team that three units of 40 MVA transformers shall be installed.

Therefore, it is technically feasible to install three units of 132/33 kV power transformer. However, considering the fact that currently this substation steps down to 11 kV and connects to three 11 kV feeders, the installation of one 132/11 kV power transformer is considered to be appropriate for the prompt connection and prompt resumption of distribution work.

Six 33 kV feeders are considered to be connected to the substation after the completion of the Project by the Ugandan side. Two circuits will be connected t Kampala North Substation and the other two feeders are to be connected to Mutundwe Substation as standby interconnectors.

The rest of two feeders will be newly constructed to Kasubi area and Kakiri area, the north-west direction with approx. 20 km of length.

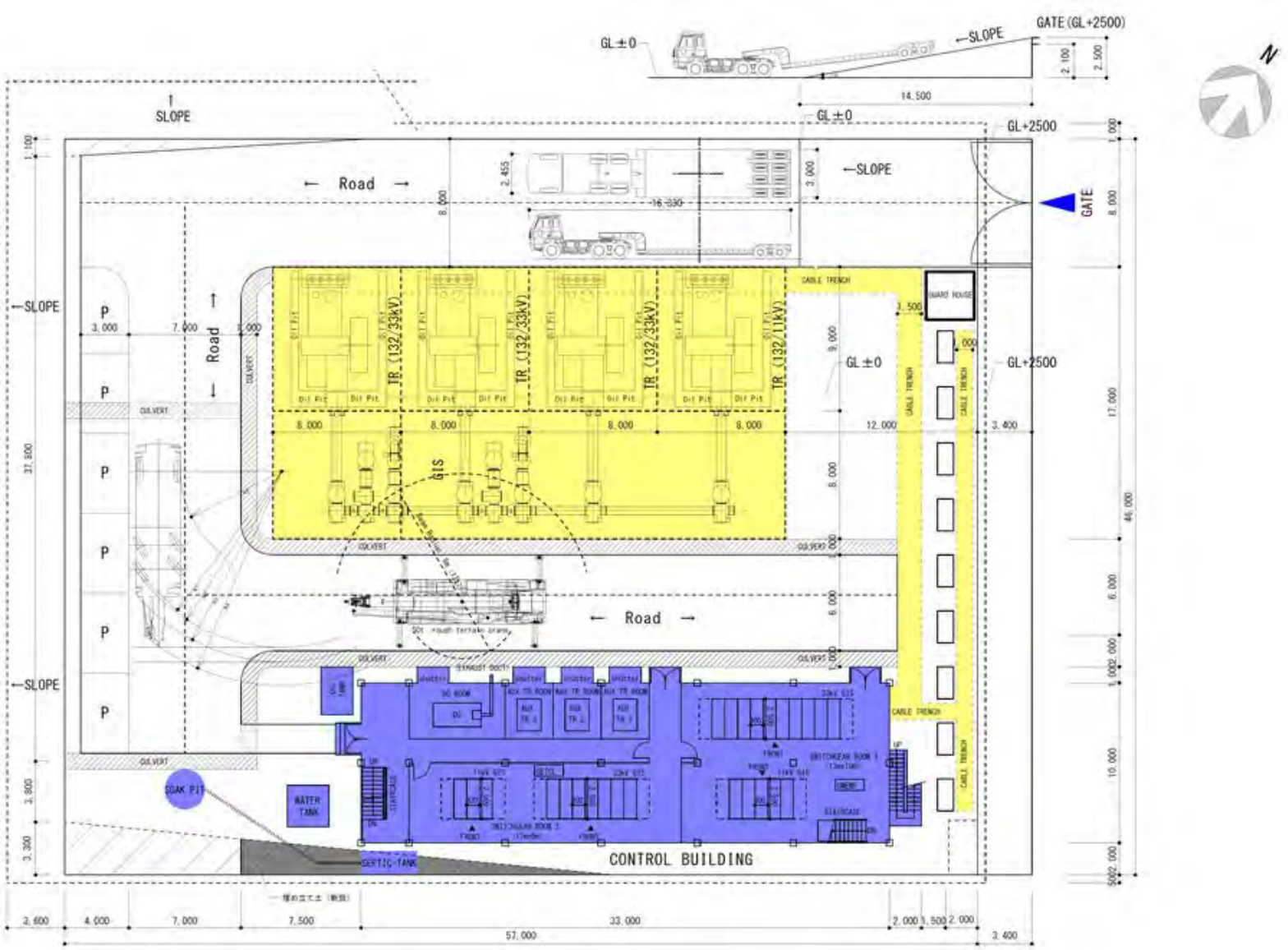
Table 5-3-1.3 Primary data of Kawaala Substation (Proposed)

Specification	Quantity
132 kV incoming feeders	2 feeders
132/11 kV power transformer (20 MVA)	1 unit
132/33 kV power transformer (40 MVA)	3 units
11 kV outgoing feeders	3 feeders
33 kV outgoing feeders	6 feeders

Source: JICA Study Team

The substation size is a rectangle-shape (60 m x 40 m). The area is approx. 2,400 mm sq and it is relatively narrow compared to other substations whose capacity and specification are similar with this substation. Therefore, 132 kV gas insulated switchgear is considered as equipment for the narrow area. Additionally, the direct connection by ducts between the transformers and 132 kV GIS are thought to be technically appropriate.

Three-direction of the substation site is surrounded by residential area. Thus, the distribution feeders can be extended only to the one direction, facing the access road. Hence, it is examined to install gantries for 33 kV feeders along the road on the site to facilitate the connection work of new 33 kV feeders to the new Kawaala Substation smoothly. As for 11 kV feeders, since they are connected to existing Kawaala Substation by underground cables, it seems to be technically unnecessary to construct gantries. Figure 5-3-1.3 illustrates the proposed layout of Kawaala Substation.



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Source: JICA Study Team

Figure 5-3-1.4 Kawaala Substation Layout (Proposed)

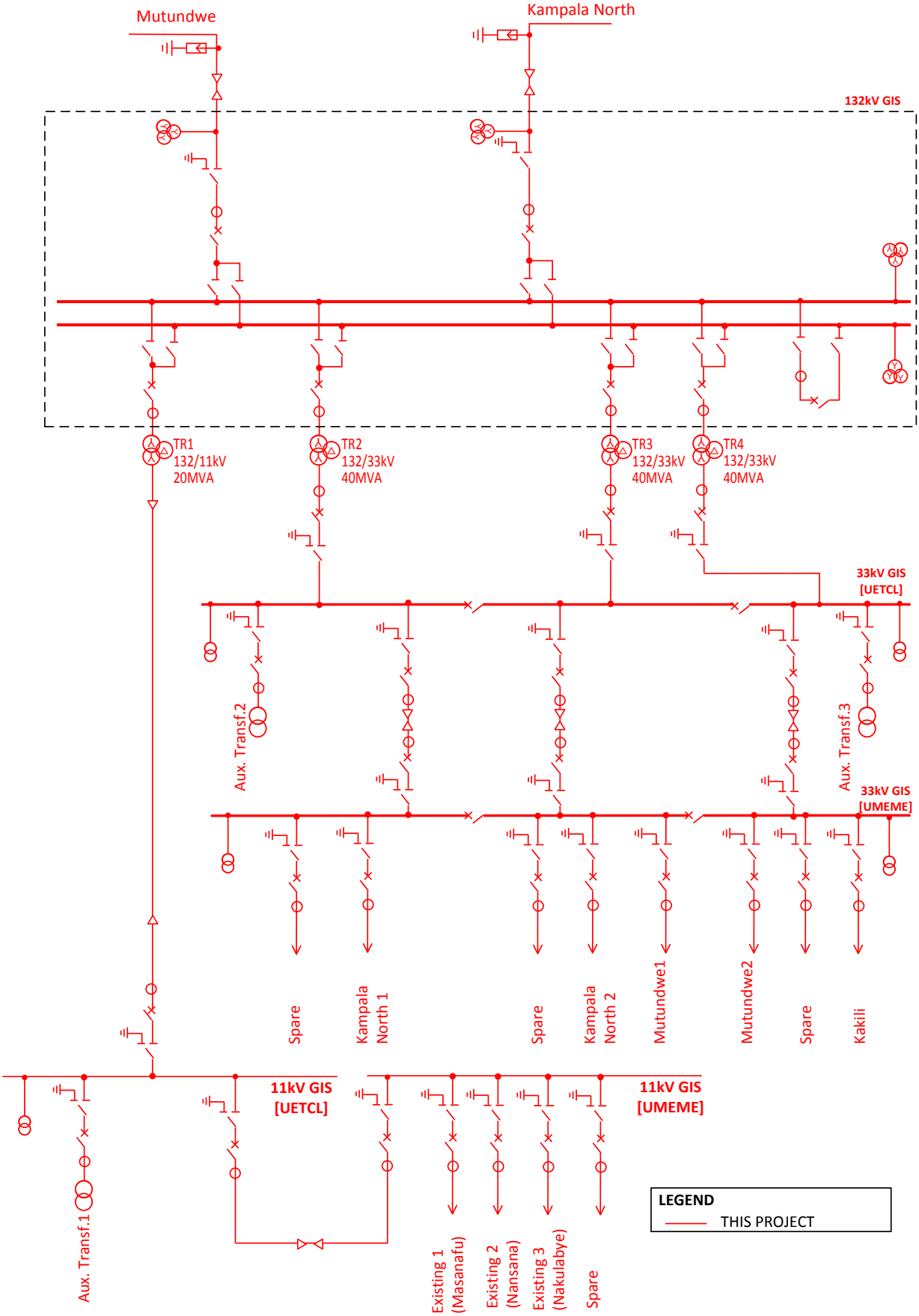


Figure 5-3-1.5 Kawaala Substation Single line diagram (Proposed)

(3) Construction of New Mukono Substation

UETCL, together with other donor, plans to construct 132/33 kV substations equipped with GIS at the eastern area of Kampala metropolitan area (Namely, Namanve South Substation, Luzira Substation and Mukono Substation and they are planned to be commissioned in 2017. This Project plans to construct the new substation which will function as 220/132 kV substation, called New Mukono Substation, neighboring to Mukono Substation. At present, one of 2 circuits of 220 kV transmission lines between Bujagali Substation and Kawanda Substation shall be double pi-off and thus four circuits will be connected to the substation. After stepped down to 132 kV power, it will be supplied to the Mukono Substation (2 circuits) and two circuits of 132 kV transmission lines will be connected to one circuit of 132 kV transmission lines from Nalubale Substation to Lugogo Substation (Southern Trunk Line).

It is designed to apply gas insulated switchgears to 220 KV switchgears and 132 kV switchgears at this substation based on the following two reasons: one is the limitation of the plot and the other is the high energy security as this substation shall cover 220 kV voltage class.

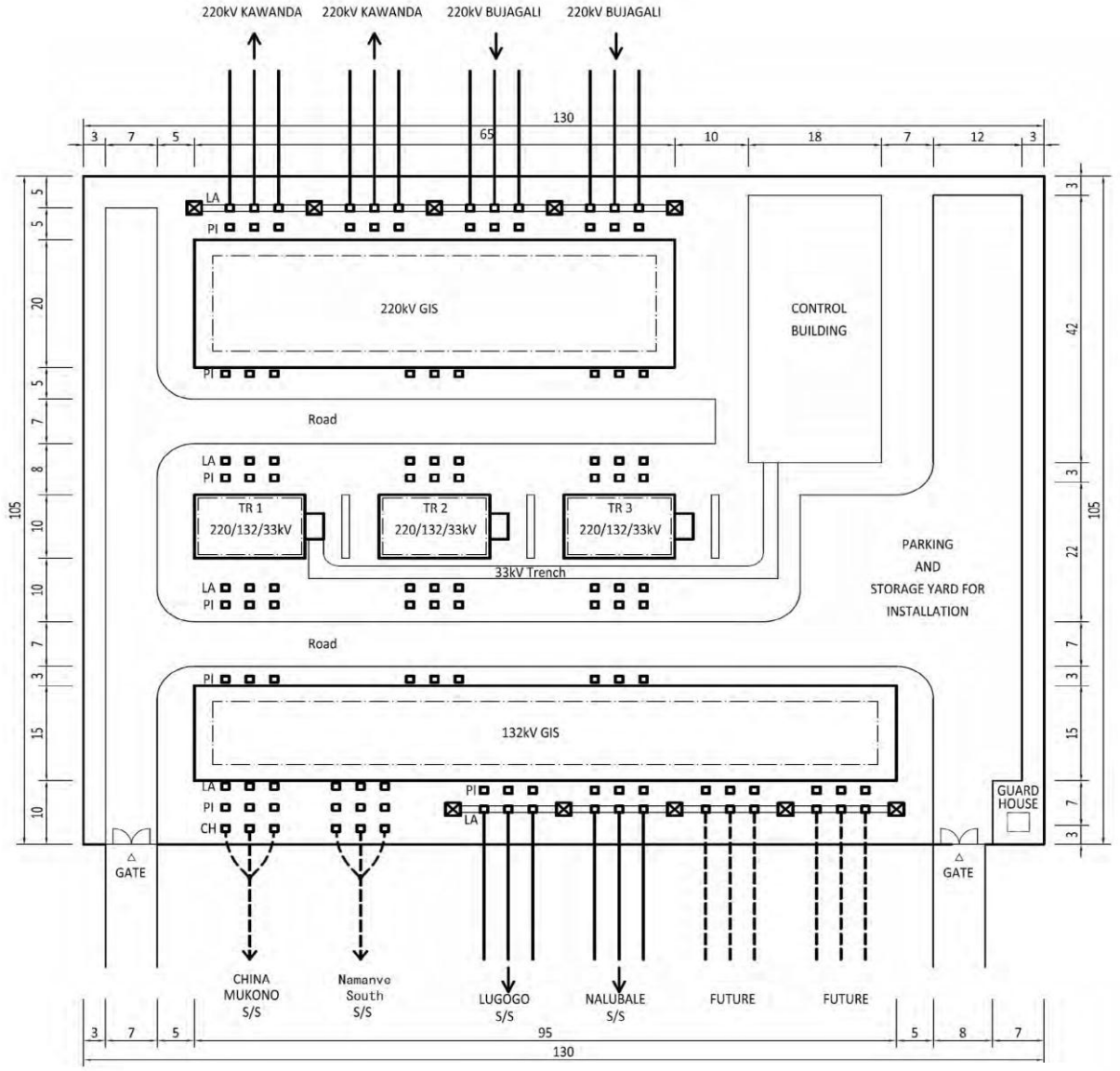
Considering the limitation of 16 acres land owned by UETCL (approx. 64,000 m^2) and the land will be used for both Mukono Substation (China) and this substation, the land for this substation will be limited. Moreover, substations to be constructed at the eastern area of Kampala Metropolitan Area (such as existing Namanve Substation and new Namanve South Substation, Luzira Substation and Mukono Substation, neighbor of this substation) will apply substation equipment which are durable against air pollution since this area is designed to be developed as the industrial area, the same design principle needs to be applied as well. Based on the above ideas, the application of gas insulated switchgears for both 220 kV and 132 kV switchgears was designed.

Table 5-3-1.4 shows the main components and the Figure 5-3-1.4 shows the proposed layout.

Table 5-3-1.4 Primary data of New Mukono Substation (Proposed)

Specification	Quantity
220 kV incoming feeders	4 feeders
220 kV GIS	7 feeders
220/132/33 kV power transformer (125 MVA)	3 units
132 kV GIS	9 feeders
132 kV outgoing feeders (including two spare feeders)	6 feeders

Source: JICA Study Team



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Source: JICA Study Team

Figure 5-3-1.6 New Mukono Substation layout (Proposed)

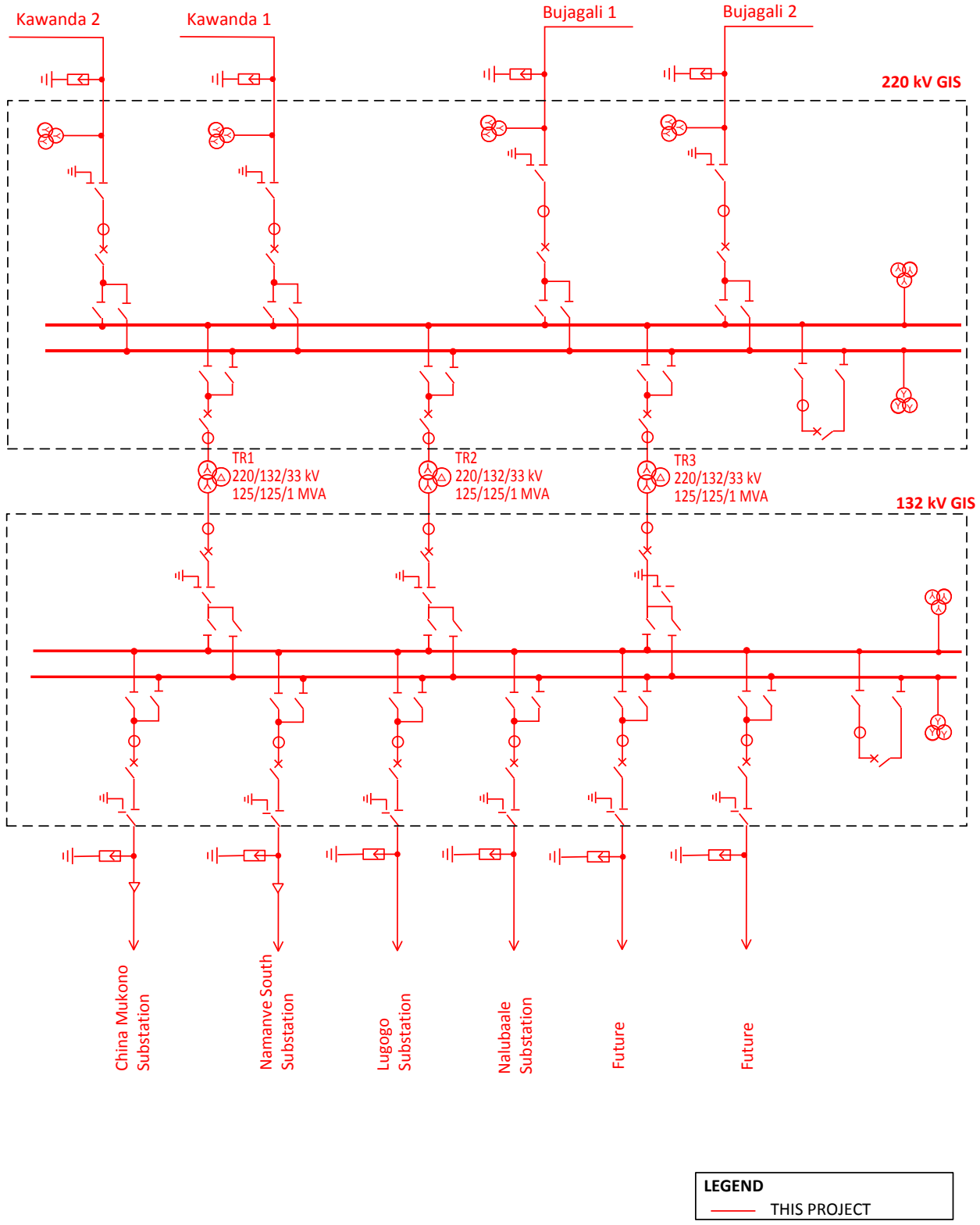


Figure 5-3-1.7 New Mukono Substation Single line diagram (Proposed)

(4) Upgrading of Bujagali Substation

Bujagali Substation is located in Bujagali Hydropower Plant. The generated power is stepped up to132 kV and connected to this substation. This substation functions as interconnection substation. The 132 kV power is furthermore to be stepped up to 220 kV and planned to be connected to Kawanda Substation and Tororo Substation and Isimba Substation in the future. Two units of 220/132/33 kV power transformer (250 MVA) are under installation and they will be commissioned by the end of 2016. At present, 132 kV substation equipment is under operation.

Since it is projected that the 2 units of 220/132/33 kV power transformer (Total capacity: 500 MVA) will be overloaded by 2030, partly due to the additional 183 MW to be generated from Isimba power station and connected to this substation at 132 kV, this Project designs to install additional one unit of the transformer (250 MVA).

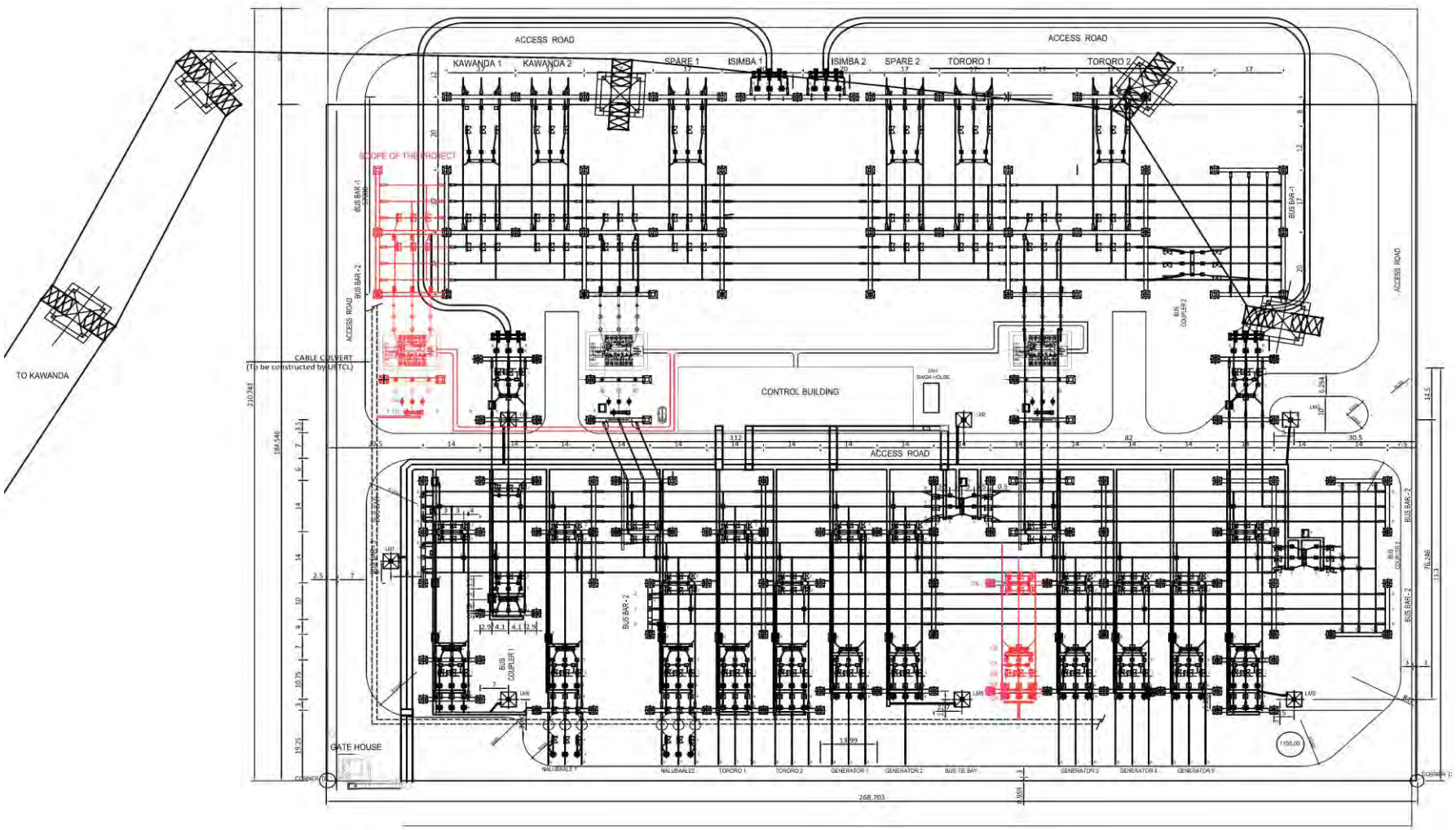
In addition, UETCL plans to distribute power to the neighboring areas from the tertiary winding (transformer capacity: 50 MVA) of these transformers and Umeme has a plan to construct the distribution substation just outside of Bujagali Substation. Considering this context, it was confirmed that 220/132/33 kV transformer whose specification is similar with the existing ones and one lot of 33 kV gas insulated switchgears which will be connected to the existing 33 kV switchgears will be procured under the Project. Table 5-3-1.5 shows the main equipment to be procured to Bujagali Substation.

Table 5-3-1.5 Primary data of Bujagali Substation (Proposed)

Specification	Quantity
220/132/33 kV power transformer (250 MVA)	1
33 kV gas insulated switchgear (GIS)	6 feeders

Source: JICA Study Team

Figure 5-3-1.5 shows the proposed equipment layout at Bujagali Substation. Since this substation was not planned to install the additional transformer, the spare space for the transformer was not identified. Thus, the 220 kV busbar shall be extended under the Project to secure the space. Also, the cable head will be installed to 132 kV switchyard to connect from 132 kV busbars to the transformer through the underground cable.



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Source: JICA Study Team

Figure 5-3-1.8 Equipment layout of Bujagali Substation (Proposed)

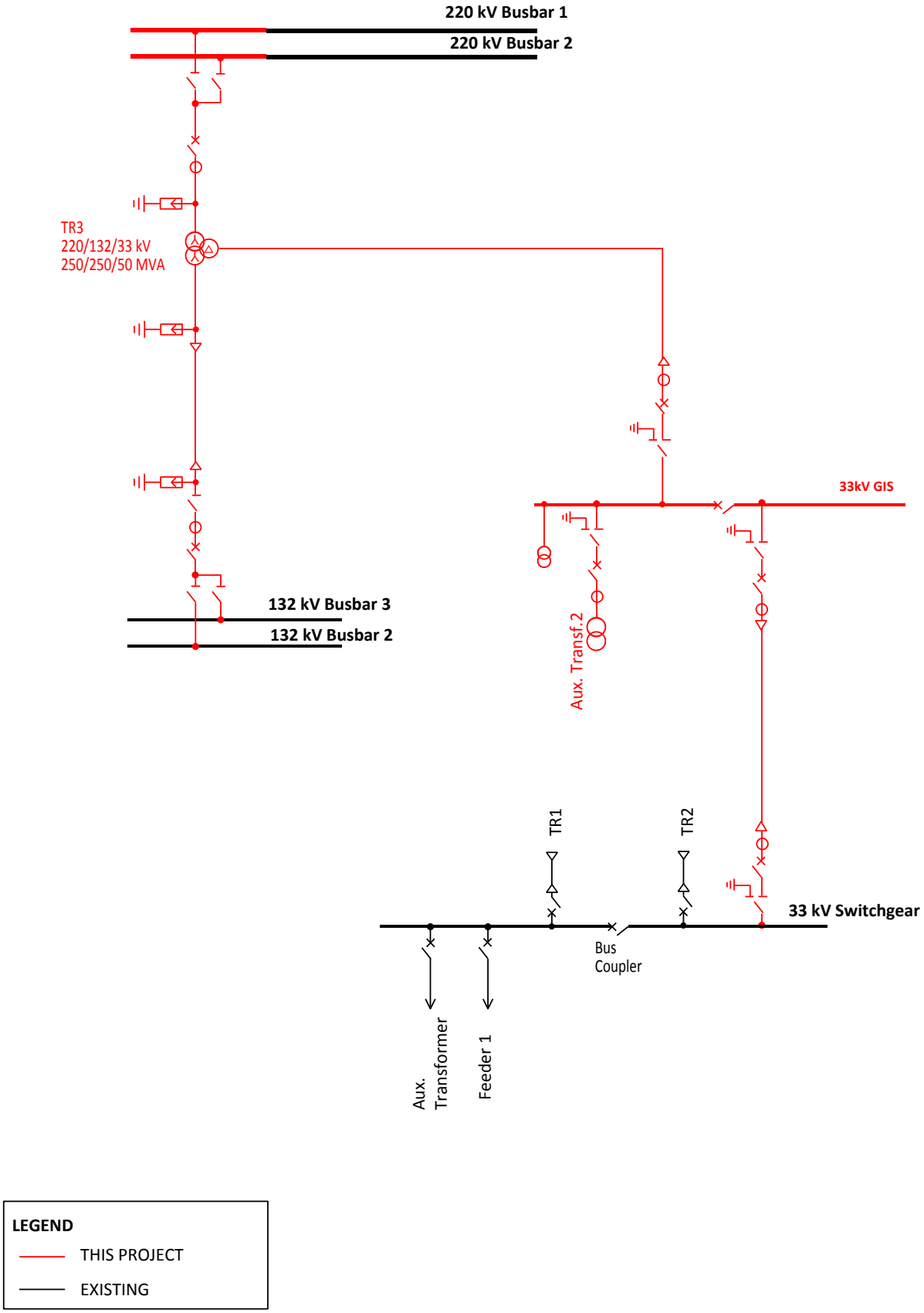
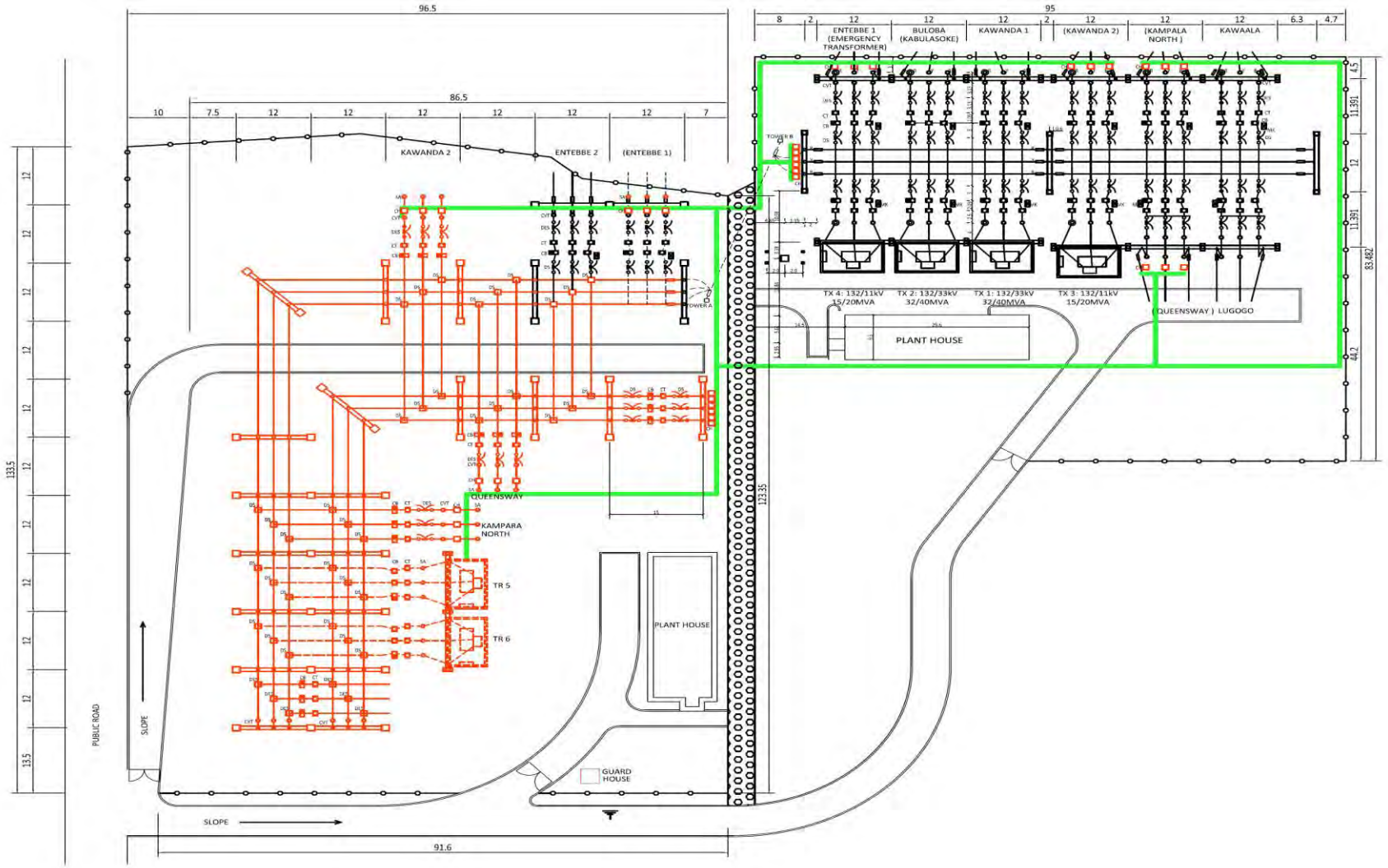


Figure 5-3-1.9 Bujagali Substation Single line diagram (Proposed)

(5) Upgrading of Mutundwe Substation

Mutundwe Substation is the substation supplying power to the southern area in Kampala, including Entebbe. Since this substation is the sole substation in charge of power supply to these areas, the importance of this substation is significant. This project will construct the new 132 kV double busbar at the vacant site of this substation to increase the stability of power supply. Figure 5-3-1.6 shows the general layout of Mutundwe Substation.



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Source: JICA Study Team

Figure 5-3-1.10 Layout of double busbar at Mutundwe Substation (Proposed)

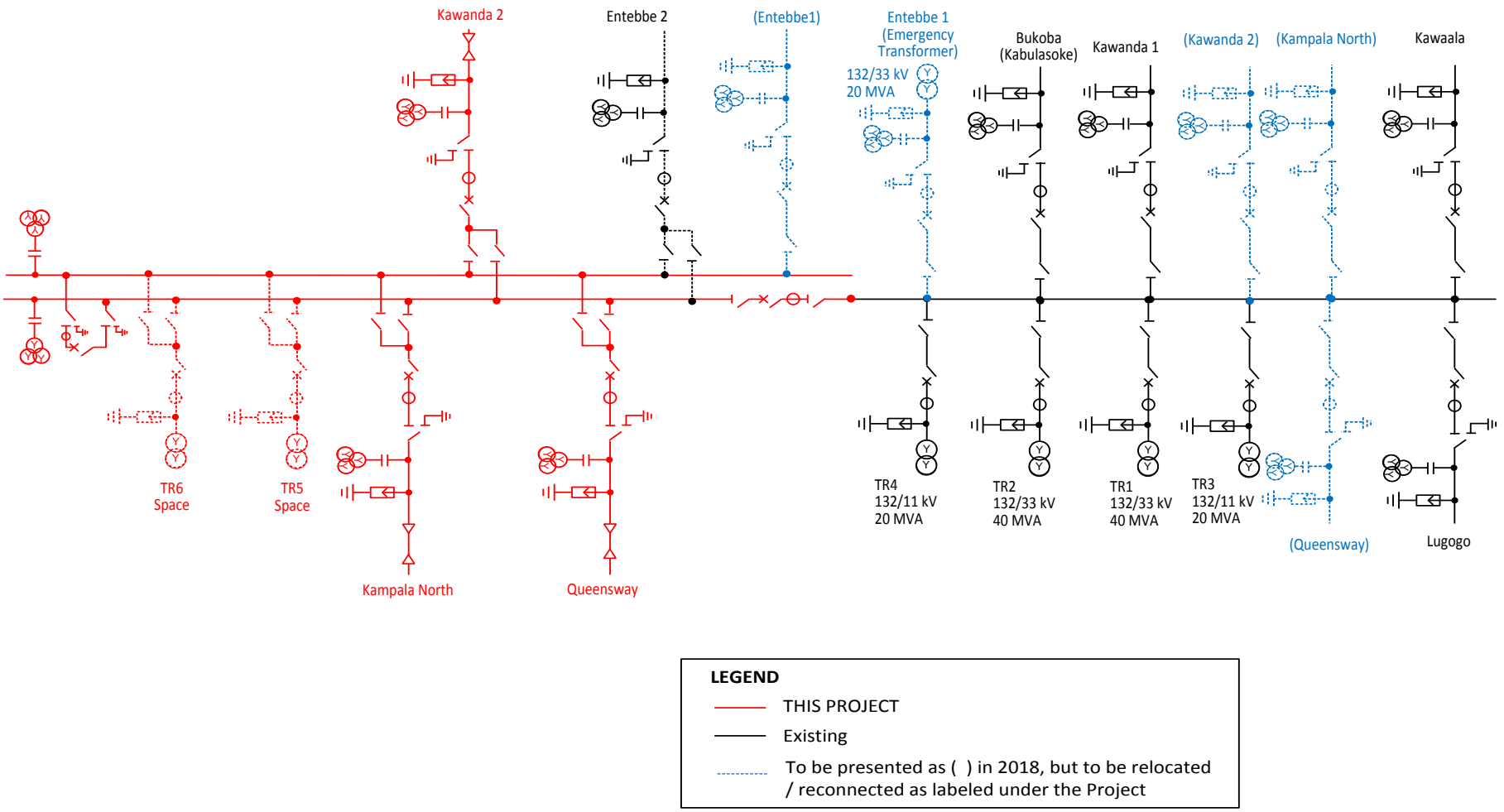


Figure 5-3-1.11 Mutundwe Substation Single line diagram (Proposed)

(6) Procurement of mobile substation

1) Design of the general specification of the mobile substation

UETCL needs to procure mobile substations due to following reasons:

(i) To use as an alternative transformer when the existing substation is faulty

(ii) To use as an emergency substation, when the commissioning and/or construction of new substations is delaying

(iii) Temporary use during the maintenance of substations

Among above purposes, when the mobile substation is used for the purpose a., it is necessary to analyze the mobility to access to existing substations with achieving the sufficient substation capacity. Thus, the mobility of the mobile substation was studied with the consideration of the access to UETCL substations located within Kampala, which requires severe road conditions.

As a result of the study of the mobile substation access route, it was confirmed that if the mobile substation satisfies the requirement in Table 5-3-1.6, it can access to each substation.

Table 5-3-1.6 Required specification for the mobility

Description	Specification
Maximum gradient	12%
Turning radius	To be capable of entering into road with the width of 7.5 meters from the vertically crossing main road with its width of 15 meters.

Source: JICA Study Team

To achieve the high mobility with high substation capacity, it is effective to divide main equipment such as primary voltage switchgear, main transformer, secondary voltage transformer, panels etc. into different trailers to equalize and minimize weights and sizes of each unit. Based on this design policy, the specification of the main transformer of the mobile substation which satisfies the mobility indicated in Table 5-3-1.6 shall be as follow.

- Capacity 20 MVA
- Primary voltage 132 kV
- Secondary voltage 33 - 11 kV
- On load tap changer (OLTC) OLTC shall be furnished in the primary side and its range is +5%~-12.5% (17 taps)
- Cooling system ODAF
- Vector group Y-Y-Δ (Delta winding shall be connected to the auxiliary transformer)

Since the distribution network in Uganda consists of either 33 kV or 11 kV, the secondary voltage shall b selectable type secondary voltage, 33 kV or 11 kV was adopted. Figure

5-3-1.12 shows the image of the mobile transformer unit

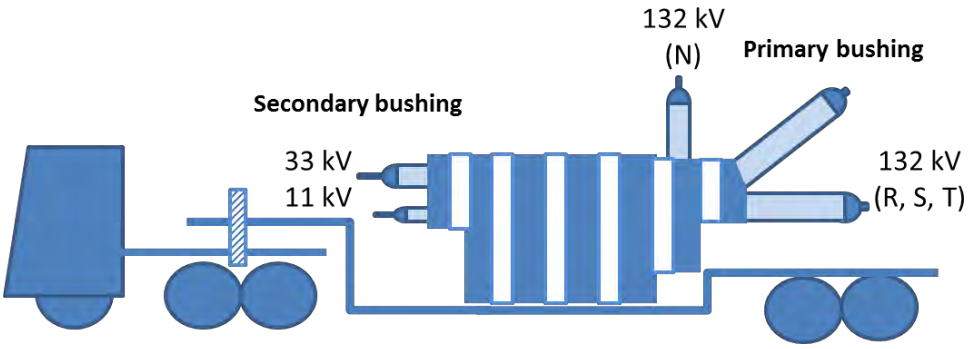


Figure 5-3-1.12 Image of mobile transformer

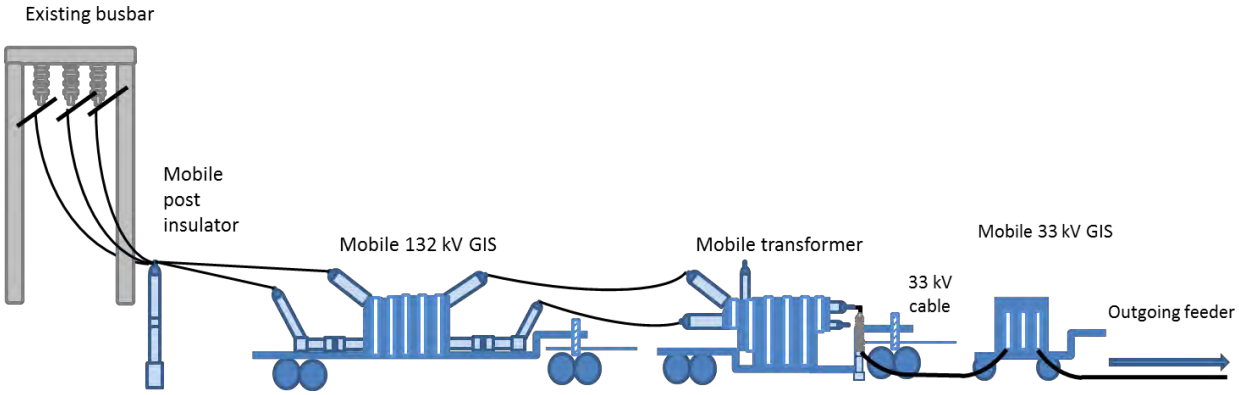
The specification of main equipment other than the mobile transformer is stated as follow.

➢ Primary switchgear and secondary switchgear	For the consideration of transportation and assembling at site, gas insulated switchgear shall be applied. 33 kV gas insulated switchgear (cubicle type) shall be used for both 33 kV and 11 kV voltage classes. The CT and VT shall be included in it.
➢ Primary side overhead line (Existing facility - Primary switchgear) and Primary switchgear - Transformer)	Hard-drawn aluminum stranded conductor
➢ Secondary side power cable (Transformer - secondary switchgear)	CV cable (200 mm^2)

2) Connection methods at substation

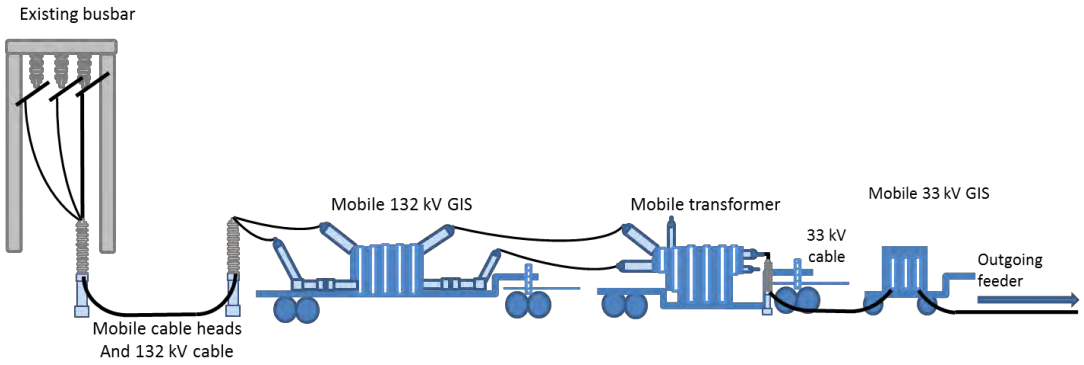
At substation where the air insulated switchgears are used such as Lugogo Substation, Mutundwe Substation and Kampala North Substation, the mobile substation shall be connected to the existing busbar.

If the spare bay is available the busbar is connected to the primary switchgear through overhead conductors. The conductors shall be supported by mobile post insulators. If there is no enough space nearby the existing busbars, the busbar will be connected to the primary GIS through power cables. As for the connection between the main transformer and the secondary switchgear, the power cables will be used. Figure 5-3-1.13 shows the image of the connection through overhead conductors and Figure 5-3-1.14 shows the connection through the cable.



Source: JICA study team

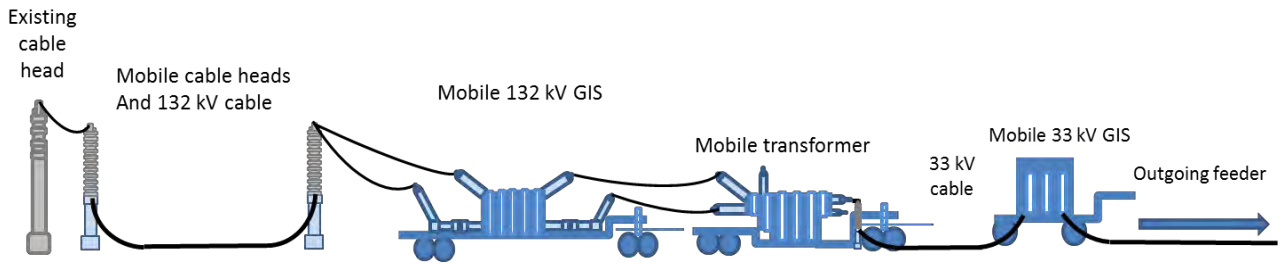
Figure 5-3-1.13 Image of the connection to the busbar through overhead conductors



Source: JICA study team

Figure 5-3-1.14 Image of the connection to the busbar through power cables

On the other hand, it is not feasible to connect to the mobile substation from busbar at substations applying GIS, such as Queensway Substation (To be commissioned in 2017) and Kawaala Substation (GIS shall be applied by this Project), the cable head located at the outside of these substation will be used as an interconnection point and shall be connected to the primary switchgear through the overhead conductors.. In this case the secondary voltage could be connected to either the distribution network directly or the in-coming switchgear. Figure 5-3-1.15 shows the image of the connection to GIS substations.



Source: JICA study team

Figure 5-3-1.15 Image of the connection to the busbar (GIS applied substations)

5-3-2 Transmission Plan

Based on the needs of UETCL and the result of the first field survey, JICA study team has concluded the renovation plan for transmission lines shown as Table 5-3-2.1 is necessary in this project.

The replacement of conductors between Kampala North substation and Mutundwe substation also became out of the scope because the existing conductors have enough capacity as the result of the power flow analysis.

The replacement of the conductors between Nalubaale substation and Namanve substation became one of the components based on the power flow analysis and UETCL's demand.

T-branch line to Kawaala substation also became one of the components based on the UETCL's demand.

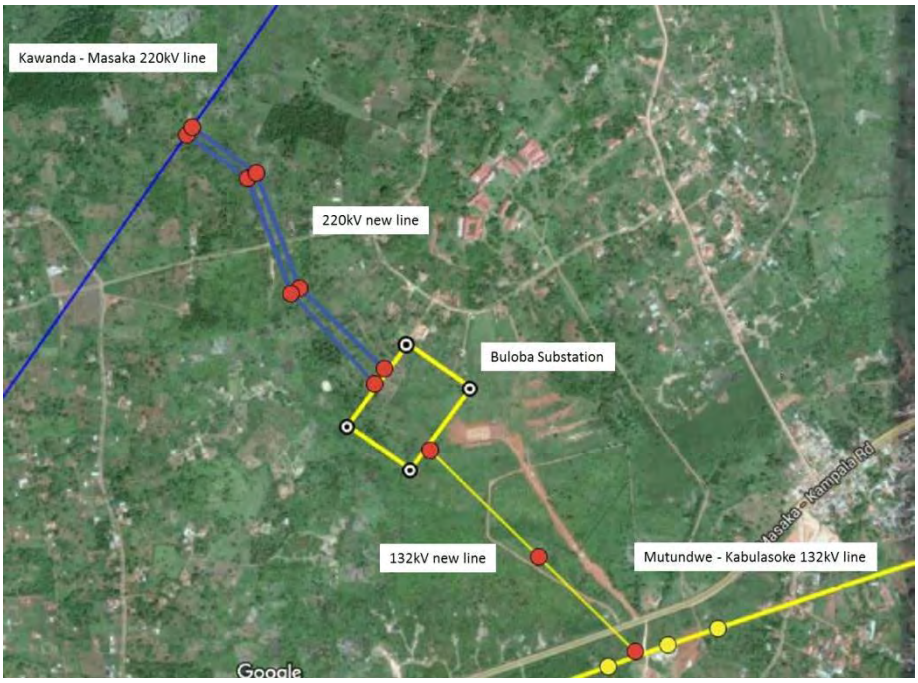
Table 5-3-2.1 Outline of transmission line components

	Main component	Specifications and quantity	Contents
Procurement and installation of transmission facilities	**220 kV transmission line**		
	(1) Separation point between Kawanda and Masaka substation - Buloba substation	1.8 km (4cct)	Construction
	(2) Separation point between Bujagali and Kawanda substation - New Mukono substation	8.4 km (4cct)	Construction
	132 kV transmission line		
	(1) Buloba substation - Separation point between Mutundwe and Kabulasoke substation	0.8 km (2cct)	Construction
	(2) New Mukono substation - Separation point between Nalubaale and Lugogo substation		
	(3) Separation point between Nalubaale and Lugogo substation - Mukono substation	0.4 km (2cct)	Construction
	(4) Kampala North - Mutundwe substation	25.4 km (1cct)	Reinforcement
	(5) Lugogo - Kampala North substation		
	(6) Separation point between Kampala North and Mutundwe substation - Kawaala substation	10.2 km (2cct) 5.3 km (2cct) 0.1 km (2cct)	Reinforcement Reinforcement Cable

Source: JICA study team

(1) 220 kV Transmission line from separation point between Kawanda substation and Masaka substation to Buloba substation

This transmission line is from the separation point between Kawanda substation and Masaka substation to Buloba substation and has two routes. The operation voltage is 220 kV and the number of circuit is four. The total route length is 1.8 km (0.9 km, 2 routes). The route is shown at Figure 5-3-2.1.



Source: JICA study team

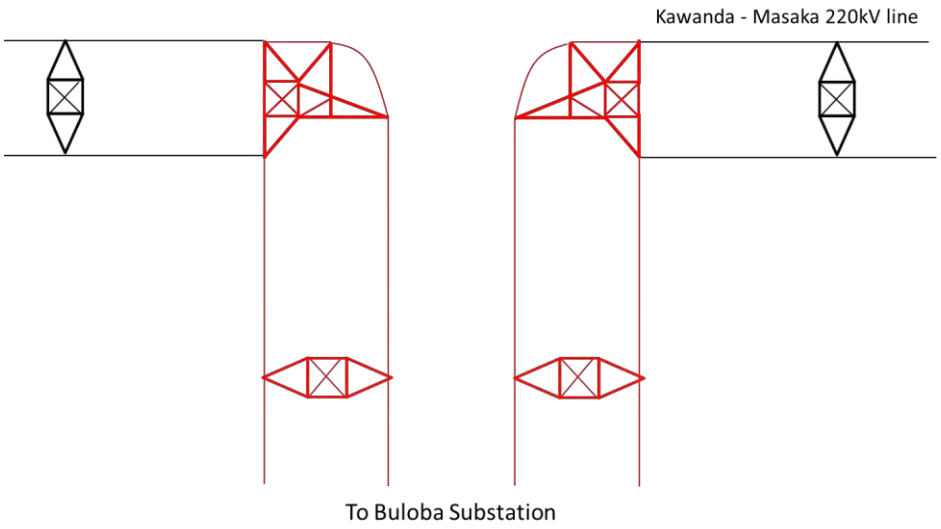
Figure 5-3-2.1 Route map of 220 kV, 132 kV transmission lines to Buloba substation

The shortest and straight route to the substation was selected based on the consideration of technical and environmental aspect. The distance between the two routes is set for 35 m in consideration of electrical clearance and necessary soil quantity.

Regarding the position of separation towers, as the tower points of Kawanda - Masaka line near the separation towers have not been decided by the consultant of the Kawanda - Masaka line, JICA study team had a discussion with the consultant about the position of separation towers. As a result, JICA study team and the consultant came to the conclusion that JICA study team can first decide the position of separation towers and after that the consultant shall reflect the position to the design of the Kawanda - Masaka line.

The separation method from Kawanda - Masaka line to Buloba substation is shown at Figure 5-3-2.2. In the case that two circuits of Kawanda - Masaka line cannot be de-energized, a tentative tower for bypassing the separation point is built in order to continue to supply power by the line while separation towers are being constructed. And the examination of the strength of the towers of Kawanda - Masaka line is required because the design condition of

the line is changed with the installation of the separation towers.



Source: JICA study team

Figure 5-3-2.2 Separation method

Regarding the basic design, the design is basically same as that of the line between Kawanda substation and Masaka substation by collecting the design condition of the line.

Corridor is used as a temporary haul road in the construction.

1) Setup of climatic conditions

Climatic conditions are set shown as Table 5-3-2.2 based on the conditions of Kawanda - Masaka transmission line because this new line is connected to Kawanda - Masaka line.

Table 5-3-2.2 Climatic Conditions

Items	Value
Temperature	Maximum 45℃
	Minimum 5℃
	Average 35℃
Rainfall	1,100mm/year
Isokeraunic Level	180
Maximum wind velocity	31m/s
Relative Humidity	90%
Altitude above mean sea level	1500m
Pollution level	Medium Category II

Source: JICA study team

2) Selection of conductor and ground wires

AAAC 240 mm sq (double) and AC 55 mm sq are selected as the conductor and the ground wire of the line because they are the same as the conductor and the ground wire of the line

between Kawanda substation and Masaka substation. OPGW 55 mm sq is selected in order to fit the size of another ground wire. Technical characteristics of conductor and ground wires are shown in Table 5-3-2.3 and 5-3-2.4.

Table 5-3-2.3 Technical Characteristics of Conductor

Type of Conductor	AAAC 240 sq mm (Double)
Component of stranded wires	61/2.25
Total area of conductor	240 mm^2
Total diameter	20.25 mm
Weight	669 kg/km
Ultimate Tensile strength	67,740 N
Modulus of elasticity	53,950 N/mm^2
Coefficient of linear expansion	23×10^{-6} /°C
DC resistance at 20°C	0.1383 ohm/km

Source: JICA study team

Table 5-3-2.4 Technical Characteristics of Ground Wires

Type of Conductor	AC 55 sq mm	OPGW 55 sq mm
Component of stranded wires	7×3.2 mm	AC 6×3.23 mm
Total area of conductor	56.29 mm^2	62.71 mm^2
Total diameter	9.6 mm	9.6 mm
Weight	356.5 kg/km	354.6 kg/km
Ultimate Tensile strength	64,300 N	54,400 N
Modulus of elasticity	149,100 N/mm^2	149,100 N/mm^2
Coefficient of linear expansion	12.9×10-6 /°C	12.9×10-6 /°C
DC resistance at 20°C	1.34 ohm/km	1.54 ohm/km

Source: JICA study team

3) Setup of clearance conditions

Clearance conditions are set shown as Table 5-3-2.5 based on the conditions of Kawanda - Masaka transmission line and other transmission line project in Uganda.

Table 5-3-2.5 Clearance (220 kV)

Among bare conductors and supporting structures, arms and so on	No less than 1.4 m
Ground	7.0 m
Road	8.0 m
Trees	3.9 m

Source: JICA study team

4) Setup of wire conditions

① Maximum working tension of conductor

The maximum working tension of the conductor is decided taking into account of the

following two factors.

- The maximum tension of the conductor must not exceed 40 percent of the ultimate Strength Tensile (UTS) of the conductor.
- Every Day Stress (EDS: Tension at 28°C with no wind) is less than 25 percent of the ultimate strength tensile of the conductor.

② Maximum working tension of ground wire

The maximum working tension of the ground wire is generally set up like "the sag of the ground wire under EDS condition is below 80% of the conductor's sag at the standard span length (350m)". Maximum working tension and EDS of conductor and ground wires are shown in Table 5-3-2.6.

Table 5-3-2.6 Maximum Working Tension and EDS

Type	Ultimate Strength	Maximum Working Tension	Every Day Stress
AAAC 240 sq mm	67,740 N	24,500 N (MWT/UTS=36%)	13,430 N (EDS/UTS=20%)
AC 55 sq mm	64,880 N	14,210 N (MWT/UTS=22%)	10,490 N (EDS/UTS=16%)
OPGW 55 sq mm	54,000 N	14,210 N (MWT/UTS=26%)	10,880 N (EDS/UTS=20%)

Source: JICA study team

③ Sag of conductor

The outline calculation result of sag by span length is shown in Table 5-3-2.7.

Table 5-3-2.7 Sag of Conductor (at 75°C)

Span length	Sag
250 m	5.8 m
300 m	7.7 m
350 m	10.1 m
400 m	12.7 m
450 m	15.7 m

Source: JICA study team

5) Selection of insulator set, supporting structure, and the foundation

① Insulator set

The ball socket type suspension insulator which shall comply with IEC60120 and 60305 or equivalent is used for an insulator set. Safety factor of insulator set is 3.0 or more. Example of insulator is shown in Table 5-3-2.8. Minimum creepage distance is 4,900 mm according to pollution levels.

Table 5-3-2.8 Example of insulator

Type	Height	Diameter	R.U.S	Number
U120B	146mm	255mm	120kN	17
U160BS	146mm	280mm	160kN	16

Source: JICA study team

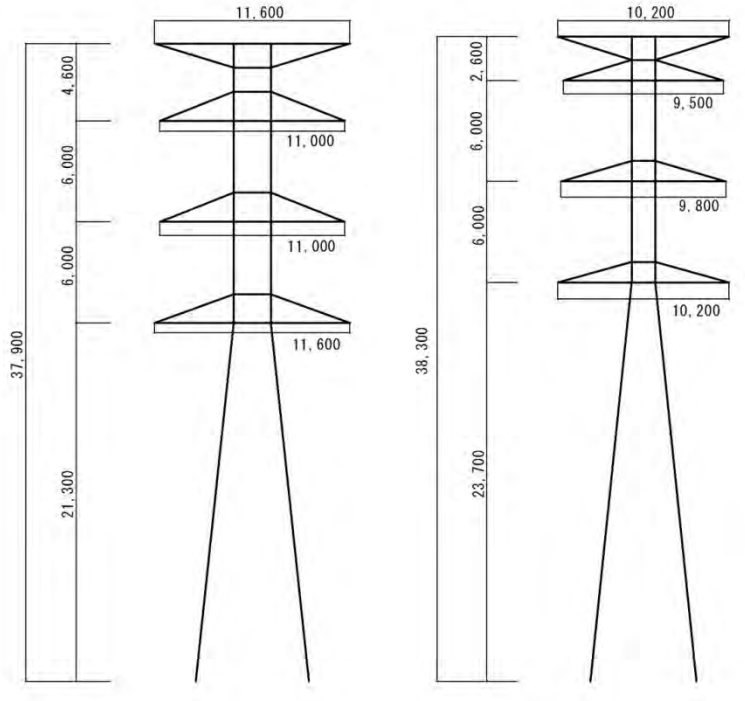
② Supporting structure

Fundamental steel tower types are four models (A ~ D) shown in Table 5-3-2.9. The type of members of steel tower is angle steel commonly used in 220 kV tower and it is used for tower design. Example of tower types is shown at Figure 5-3-2.3.

Table 5-3-2.9 Fundamental Steel Tower Type

Tower Type	Insulator String	Horizontal Angle of Line
A	Suspension	0°～ 3°
B	Tension	0°～ 30°
C	Tension	0°～ 60°
D	Tension	Dead end tower

Source: JICA study team



Source: JICA study team

Figure 5-3-2.3 Steel Tower's Example (Left: Tension type, Right: Suspension type)

③ Foundation

The area around Buloba Substation, where it is thought the groundwater flows towards

Lake Kioga, comprises a large marshy belt. In examining the foundations of steel towers for transmission lines, since there is concern over soft ground and the high groundwater level as was described in section 4-2 Natural Conditions, geological investigation was implemented at two points, i.e. one point on the 220 kV transmission line side (BH03) and one point on the 132 kV transmission line side (BH01). Moreover, since there is an elevation difference of around 14 meters and geological conditions are thought to differ on the site, geological investigation was implemented on the higher north side and on the lower south side. The measurement point on the north side (BH02) is the part where the 220 kV transmission line leads in to the substation, while the measurement point on the south side (BH04) is where the 132 kV transmission line leads in to the substation. Therefore, measurement points BH02 and BH03 show geological data on the 220 kV transmission route, and measurement points BH01 and BH03 show data on the 132 kV transmission route. Since both the 220 kV transmission route and the 132 kV transmission route are short sections of around 1 kilometer, the geological data from the measurement points shall be applied to the routes.

Appendix-9 Tables 1-1 through 1-4 outline the results of the standard penetration testing. If ground consists of clayey soil and bearing ground of N = 20 or higher is found to exist at a depth of 10 meters or less from the surface, general inverted T-shaped foundations can be adopted. Table 5-3-2.10 shows the bearing ground on the 220 kV transmission route based on the results at BH02 shown in Appendix-9 Table 1-2 and BH03 shown in Table 1-3. As can be gathered from the table, the bearing ground is located at depth of 8~10 meters.

Table 5-3-2.10 Results of Geological Survey (Buloba Substation)

Position*	Bearing Ground
BH02	10m underground (clayey soil, N ≧20)
BH03	8m underground (clayey soil, N ≧20)

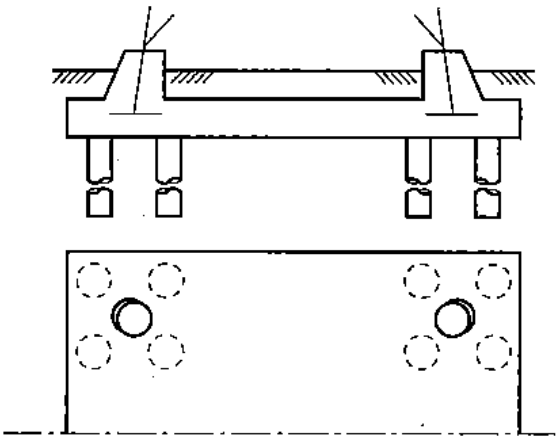
Note *Concerning the positions of BH02 and BH03, see the results of the geological survey.
Source: Appendix-9

The groundwater that was cause for concern was not confirmed at BH02, but it was confirmed at a depth of 9.0 meters at BH03. Moreover, on conducting geological classifications based on grain size testing and liquid limit and plastic limit testing, it was confirmed that the bearing ground at BH02 and BH03 comprises silty soil with high water content. There is concern that subsidence will arise due to rise of the groundwater level and the soil quality of the bearing ground. Moreover, concerning ground liquefaction, because the bearing ground at BH02 and BH03 mainly comprises clay and silt (35% or more) with high plasticity index (15% or higher), the chances of liquefaction occurring are thought to be low. According to the results of indoor tests, as was indicated in section 5-2 Natural Conditions, relatively large-scale subsidence is envisaged.

Accordingly, the amount of subsidence was sought from the compression index Cc obtained in consolidation testing using the load placed on steel tower legs (73t※safety factor 2) and foundation load (inverted T-shaped, height 7 meters, floor plates 7.1 meter square, 20t ※value obtained by deducting the weight of soil occupied by foundations from the weight of foundations) taken from design data, etc. of existing 132 kV steel towers in Uganda. As a result, the subsidence was found to be 21 millimeters at BH03 and 11 millimeters at BH02. Accordingly, since BH03 has large subsidence and high groundwater level, there is concern over the occurrence of uneven subsidence. Concerning BH02, the subsidence was found to be small and no rise in groundwater level was confirmed, however, as is described later, at BH04 which is located 250 meters away from BH02, large subsidence and rising groundwater level have been confirmed. Because the elevation of BH02 is 12 meters higher than BH04, it is possible that a large subsidence layer like at BH04 exists under the bearing ground. Accordingly, there is concern about uneven subsidence at BH02 too.

Concerning the results of topographical and quantity surveying shown in Appendix-9, there were not found to be any problematic fault lines, landslides, broken terrain, or steep slopes with gradient of more than 10 degrees on the 220 kV transmission line route of Buloba.

Accordingly, since there is concern over large subsidence and uneven subsidence if inverted T-shaped foundations are adopted at BH02 and BH03, mat type foundations will be adopted. Mat-type pile foundation will be adopted because the bearing ground is deep (8 m to 9 m), Moreover, because chemical analysis of soil found the ground to be corrosive (sulfides 1-3 %, chlorides 0.1-0.4 %), since steel pipe piles would be prone to corrosion, PC piles and so on will need to be examined. Figure 5-3-2.4 shows an example of Mat-type pile foundation.

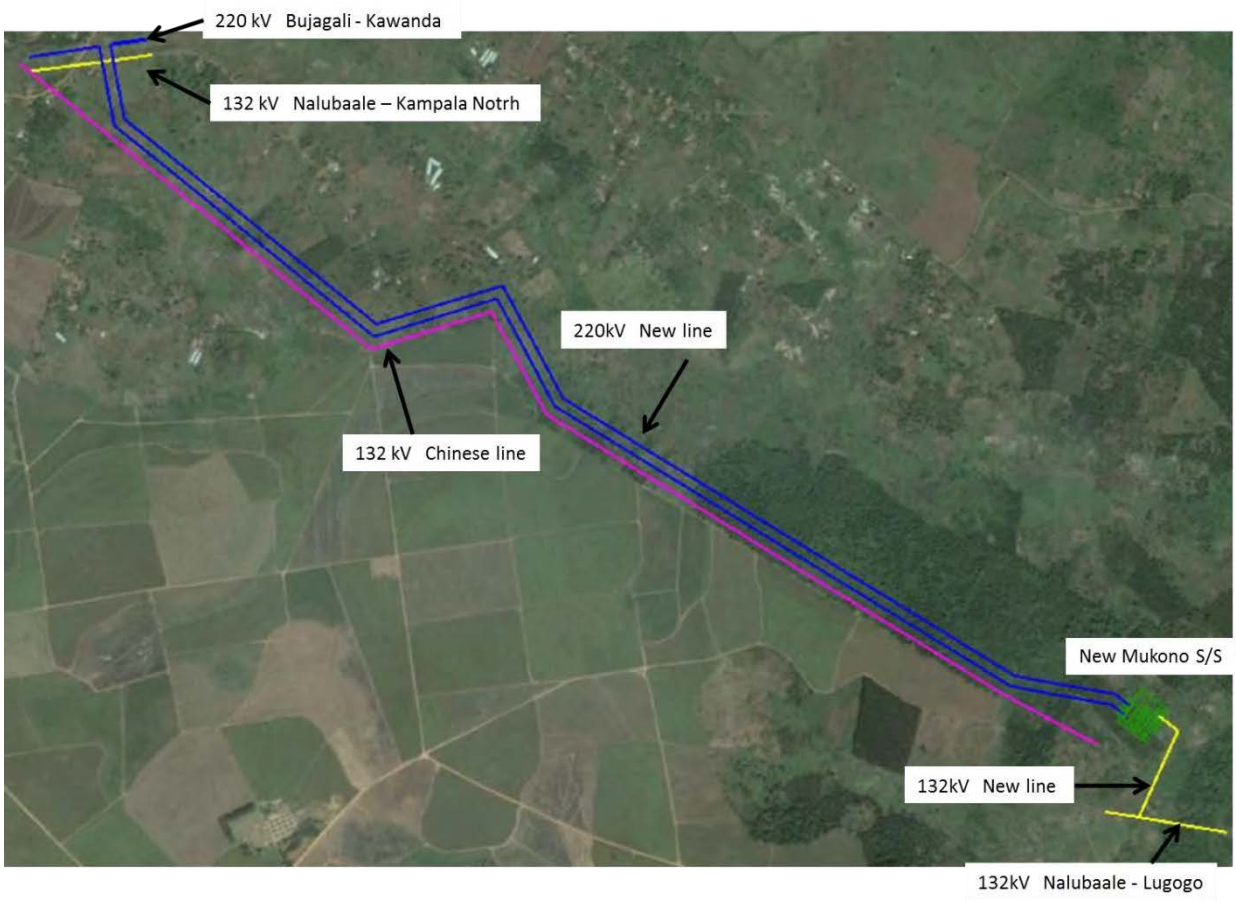


Source: Denki kyodo kenkyukai 58-3

Figure 5-3-2.4 Mat-type pile foundation

(2) Separation point between Bujagali and Kawanda substation - New Mukono substation

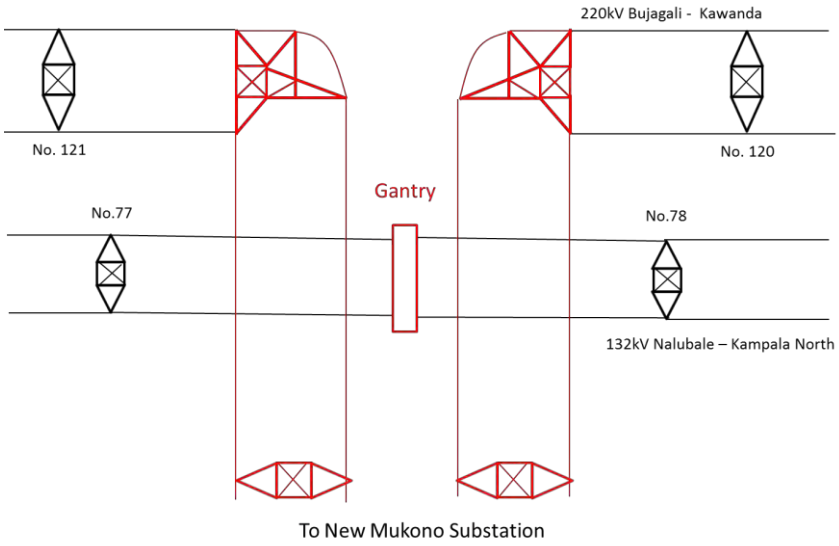
This transmission line is from the separation point between Bujagali substation and Kawanda substation to New Mukono substation and has two routes. The operation voltage is 220 kV and the number of circuit is four. The total route length is 8.4 km (4.2 km, 2 routes). The route is shown at Figure 5-3-2.5.



Source: JICA study team

Figure 5-3-2.5 Route map of 220 kV, 132 kV transmission lines to New Mukono substation

In order for this line to go over 132 kV Nalubaale Kampala North lien, a gantry is built between the No.77 and No.78 of the 132 kV line. The separation method from Bujagali - Kawanda line to New Mukono substation is shown at Figure 5-3-2.6. In the case that two circuits of Bujagali - Kawanda line cannot be de-energized, a tentative tower for bypassing the separation point is built in order to continue to supply power by the line while separation towers are being constructed. And the examination of the strength of the towers of Bujagali - Kawanda line is required because the design condition of the line is changed with the installation of the separation towers.



Source: JICA study team

Figure 5-3-2.6 Separation method

The shortest and straight route to the substation was selected based on the consideration of technical and environmental aspect. The distance between the two routes is set for 25 m except for angle points in consideration of electrical clearance and necessary soil quantity.

Corridor is used as a temporary haul road in the construction.

1) Setup of climatic conditions

Climatic conditions are set shown in Table 5-3-2.2 same as (1).

2) Selection of conductor and ground wires

AAAC 240 mm sq (double) and AC 55 mm sq are selected as the conductor and the ground wire of the line because they are the same as the conductor and the ground wire of the line between Bujagali substation and Kawanda substation. OPGW 55 mm sq is selected in order to fit the size of another ground wire. Technical characteristics of conductor and ground wires are shown in Table 5-3-2.3 and 5-3-2.4 same as (1).

3) Setup of clearance conditions

Clearance conditions are set shown in Table 5-3-2.5 same as (1).

4) Setup of wire conditions

Setup of wire conditions is same as (1). Maximum Working Tension and EDS of conductor and ground wire is shown in Table 5-3-2.6.

5) Selection of insulator set, supporting structure, and the foundation

① Insulator set

The insulator set is selected same as (1).

② Supporting structure

Supporting structure is shown at Figure 5-3-2.3 same as (1).

③ Foundations

Concerning the land around New Mukono Substation, as was described in section 5-2 Natural Conditions, unlike the case of Buloba Substation, no marshy land and so on was confirmed. Therefore, geological investigation was implemented at one representative point on the substation site.

Appendix-9 Table 1-3 outlines the results of the standard penetration testing. If ground consists of sandy soil and bearing ground of N = 30 or higher is found to exist at a depth less than 10 meters from the surface, general inverted T-shaped foundations can be adopted. Table 5-3-2.11 shows the bearing ground based on the results shown in Appendix-9 Table 3-1. As can be gathered from the table, the bearing ground is located at depth of 19.5 meters.

Table 5-3-2.11 Results of Geological Survey

Position	Bearing Ground
Mukono Substation	10 m underground (sandy soil, N≧30)

Source: Appendix-9

Since no groundwater was confirmed down to 28.5 meters, there is little possibility the groundwater level will rise. Therefore, it is thought that there is little possibility of foundations being uplifted, bearing capacity being reduced and liquefaction of sandy ground being caused by rising groundwater. Concerning the geological strata, on conducting geological classifications based on grain size testing and liquid limit and plastic limit testing, the ground was found to comprise soft silt with low water content down to a depth of 7.5 meters, compacted gravel down to 13.5 meters, loose gravel down to 18 meters, and dense silty sand down to 28.5 meters. Because the loose gravel down to 18 meters is sandy ground not subject to compression, there is little chance of subsidence (rough subsidence of sandy ground according to the De. Beer method[1]: approximately 5 millimeters). Moreover, since water content testing found the water content of ground at

1 Total settlement = immediate settlement + consolidation settlement
Condition: 8m depth, Footing foundation (floor width 7.1m), Loaded weight 93t (132kV tower between Tororo - Owen falls as reference), Thickness of layer 20m, calculation by compression index Co

10 meters and deeper to be no higher than 30% (5~23%), there is not thought to be a major issue in terms of subsidence.

Concerning the results of topographical and quantity surveying shown in Appendix-9, there were not found to be any problematic fault lines, landslides, broken terrain, or steep slopes with gradient of more than 10 degrees on the 220 kV transmission line route of Mukono.

In consideration of the above points, Inverted T-shaped foundation will be adopted from the viewpoint of ease of execution and economy.

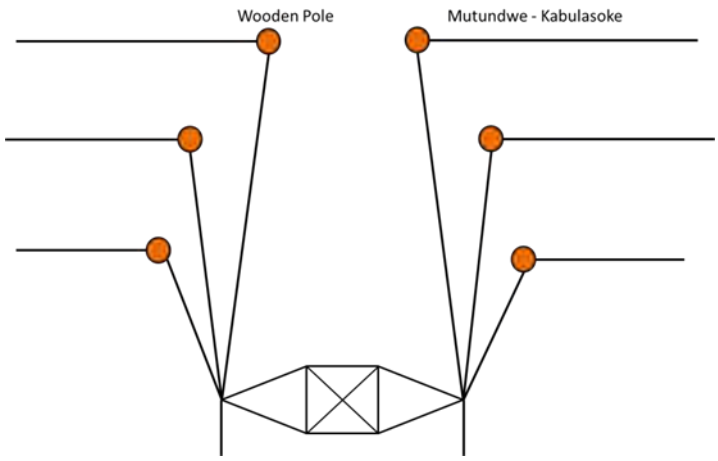
(3) 132 kV Transmission line from separation point between Mutundwe substation and Kabulasoke substation to Buloba substation

This transmission line is from the separation point between Mutundwe substation and Kabulasoke substation to Buloba substation. The operation voltage is 132 kV. The total route length is 0.8 km. The route is shown at Figure 5-3-2.1.

The shortest and straight route to the substation was selected based on the consideration of technical and environmental aspect.

There is a plan that UETCL will rebuild the transmission line between Mutundwe and Kabulasoke, which is one circuit, to two circuits line in the future. As the result, the line from Buloba to Mutundwe will be two circuits and the line from Buloba to Kabulasoke will also be two circuits. The number of circuit of the line from the separation point to Buloba substation is therefore four.

Regarding the separation method of the line between Mutundwe and Kabulasoke, the line is diverged to Buloba substation by inserting wooden poles in the line as a temporary measure shown at Figure 5-3-2.7.



Source: JICA study team

Figure 5-3-2.7 Separation method of Mutundwe - Kabulasoke line

Regarding the basic design, the design is basically same as that of the line between Kawanda substation and Masaka substation by collecting the design condition of the line.

Corridor is used as a temporary haul road in the construction.

1) Setup of climatic conditions

Climatic conditions are set shown as Table 5-3-2.2 based on the conditions of Kawanda - Masaka transmission line because this new line is connected to Kawanda - Masaka line.

2) Selection of conductor and ground wires

As the result of power system analysis, the necessary capacity of this line is 102 MVA in 2030. The conductor of the line between Mutundwe - Kabulasoke is AAAC 200 mm sq, but it cannot meet the capacity above. AAAC 240 mm sq (double) is, therefore, selected for the conductor of this line. AC 55 mm sq is selected as the ground wire of the line which is the same as the ground wire of the line between Kawanda substation and Masaka substation. OPGW 55 mm sq is selected in order to fit the size of another ground wire. Technical characteristics of conductor and ground wires are shown in Table 5-3-2.12 and 5-3-2.13.

Table 5-3-2.12 Technical Characteristics of Conductor

Type of Conductor	AAAC 240 sq mm (Double)
Component of stranded wires	61/2.25
Total area of conductor	240 mm^2
Total diameter	20.25 mm
Weight	669 kg/km
Ultimate Tensile strength	67,740 N
Modulus of elasticity	53,950 N/mm^2
Coefficient of linear expansion	23×10-6 /°C
DC resistance at 20°C	0.1383 ohm/km

Source: JICA study team

Table 5-3-2.13 Technical Characteristics of Ground Wires

Type of Conductor	AC 55 sq mm	OPGW 55 sq mm
Component of stranded wires	7×3.2 mm	AC 6×3.23 mm
Total area of conductor	56.29 mm^2	62.71 mm^2
Total diameter	9.6 mm	9.6 mm
Weight	356.5 kg/km	354.6 kg/km
Ultimate Tensile strength	64,300 N	54,400 N
Modulus of elasticity	149,100 N/mm^2	149,100 N/mm^2
Coefficient of linear expansion	12.9×10-6 /°C	12.9×10-6 /°C
DC resistance at 20°C	1.34 ohm/km	1.54 ohm/km

Source: JICA study team

3) Setup of clearance conditions

Clearance conditions are set shown in Table 5-3-2.14 based on the conditions of Kawanda - Masaka transmission line and other transmission line project in Uganda.

Table 5-3-2.14 Clearance (132 kV)

Among bare conductors and supporting structures, arms and so on	No less than 1.0 m
Ground	6.5 m
Road	7.5 m
Trees	2.7 m

Source: JICA study team

4) Setup of wire conditions

① Maximum working tension of conductor

The maximum working tension of the conductor is decided taking into account of the following two factors.

- The maximum tension of the conductor must not exceed 40 percent of the ultimate Strength Tensile (UTS) of the conductor.
- Every Day Stress (EDS: Tension at 28°C with no wind) is less than 25 percent of the ultimate strength tensile of the conductor.

② Maximum working tension of ground wire

The maximum working tension of the ground wire is generally set up like “the sag of the ground wire under EDS condition is below 80% of the conductor’s sag at the standard span length (350m)”. Maximum working tension and EDS of conductor and ground wires are shown in Table 5-3-2.15.

Table 5-3-2.15 Maximum Working Tension and EDS

Type	Ultimate Strength	Maximum Working Tension	Every Day Stress
AAAC 240 sq mm	67,740 N	24,500 N (MWT/UTS=36%)	13,430 N (EDS/UTS=20%)
AC 55 sq mm	64,880 N	14,210 N (MWT/UTS=22%)	10,490 N (EDS/UTS=16%)
OPGW 55 sq mm	54,000 N	14,210 N (MWT/UTS=26%)	10,880 N (EDS/UTS=20%)

Source: JICA study team

③ Sag of conductor

The outline calculation result of sag by span length is shown in Table 5-3-2.16.

Table 5-3-2.16 Sag of Conductor (at 75°C)

Span length	Sag
250 m	5.8 m
300 m	7.7 m
350 m	10.1 m
400 m	12.7 m
450 m	15.7 m

Source: JICA study team

5) Selection of insulator set, supporting structure, and the foundation

① Insulator set

The ball socket type suspension insulator which shall comply with IEC60120 and 60305 or equivalent is used for an insulator set. Safety factor of insulator set is 2.5 or more. Example of insulator is shown in Table 5-3-2.17. Minimum creepage distance is 2,900 mm according to pollution levels.

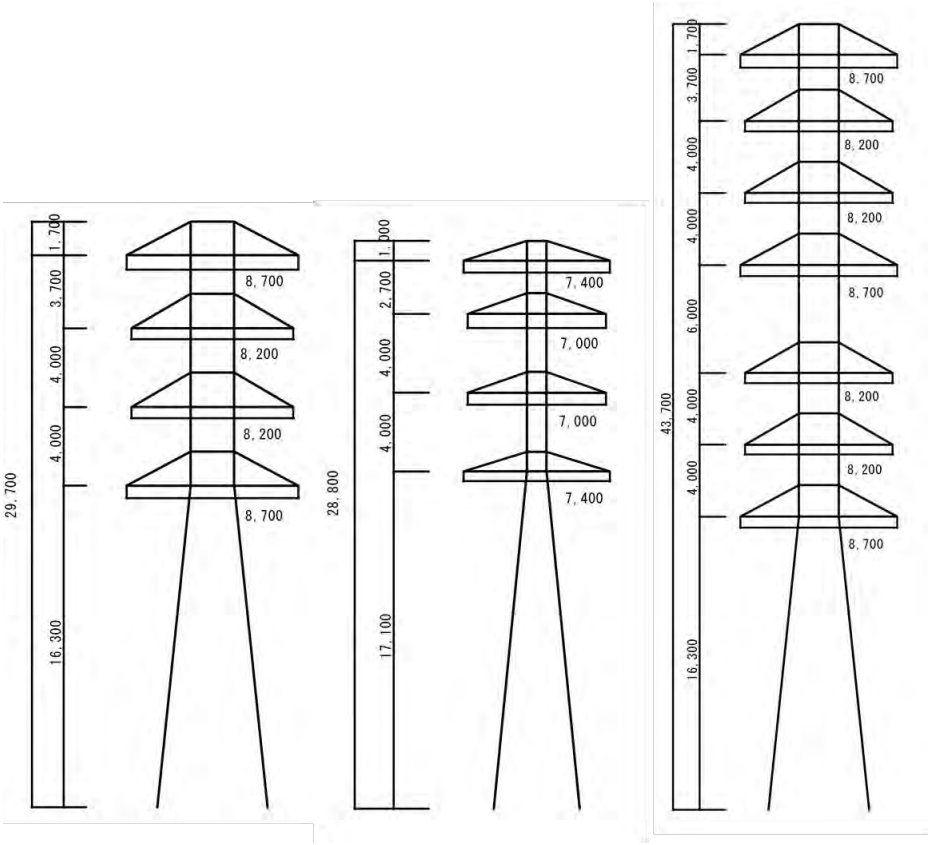
Table 5-3-2.17 Example of Insulator

Type	Height	Diameter	R.U.S	Number
U120B	146mm	255mm	120kN	12

Source: JICA study team

② Supporting structure

Fundamental steel tower types are four models (A ~ D) shown in Table 5-3-2.9. The type of members of steel tower is angle steel. Example of tower types is shown at Figure 5-3-2.8.



Source: JICA study team

Figure 5-3-2.8 Steel Tower's Example (Left: Tension type, Center: Suspension type, Right: 4 cct.)

③ Foundation

Since there is a large marshy belt around the transmission route, in examining the foundations of steel towers for transmission lines, since there is concern over soft ground and high groundwater level, geological investigation was implemented at two points on the 132 kV transmission route, i.e. BH01 and BH04.

Appendix-9 Tables 1-1 through 1-4 outline the results of the standard penetration testing. If ground consists of clayey soil and bearing ground of N = 20 or higher is found to exist at a depth of 10 meters or less from the surface, general inverted T-shaped foundations can be adopted. Table 5-3-2.18 shows the bearing ground on the 132 kV transmission route based on the results at BH01 shown in Appendix-9 Table 1-1 and the results at BH04 shown in Appendix-9 Table 1-4. As can be gathered from the table, the bearing ground is located at depth of 9 meters at BH01 and 14 meters at BH04.

Table 5-3-2.18 Results of Geological Survey (Buloba Substation, 132 kV Transmission Route)

Position*	Bearing Ground
BH01	9m underground (clayey soil, N ≧20)
BH04	14m underground (clayey soil, N ≧20)

Source: Appendix-9

The groundwater that was cause for concern was confirmed at a depth of 0.4 meters at BH01 and at a depth of 3.8 meters at BH04. Moreover, on conducting geological classifications based on grain size testing and liquid limit and plastic limit testing, it was confirmed that the bearing ground at BH01 comprises clayey soil and the bearing ground at BH04 comprises salty soil with high water content. There is concern that subsidence will arise due to rise of the groundwater level and the soil quality of the bearing ground. Moreover, concerning ground liquefaction, because the bearing ground at BH02 and BH03 mainly comprises clay and silt (35% or more) with high plasticity index (15% or higher), the chances of liquefaction occurring are thought to be low. According to the results of indoor tests, as was indicated in section 5-2 Natural Conditions, relatively large-scale subsidence is envisaged. Accordingly, the amount of subsidence sought from the compression index Cc obtained in consolidation testing was found to be 24 millimeters at BH01 and 21 millimeters at BH04. Accordingly, since there is large subsidence and high groundwater level, there is concern over the occurrence of uneven subsidence.

Concerning the results of topographical and quantity surveying shown in Appendix-9, there were not found to be any problematic fault lines, landslides, broken terrain, or steep slopes with gradient of more than 10 degrees on the 132 kV transmission line route of Buloba.

Accordingly, since there is concern over uneven subsidence if inverted T-shaped foundations are adopted, mat foundations will be adopted. Because the bearing ground is deep at 14 meters, it has been decided to adopt mat-type pile foundations. Moreover, because chemical analysis of soil found the ground to be corrosive (sulfides 1~4%, chlorides 0.3~0.9%), since steel pipe piles would be prone to corrosion, PC piles and so on will need to be examined.

(4) New Mukono substation - Separation point between Nalubaale and Lugogo substation

This transmission line is from New Mukono substation to the separation point between Nalubaale and Lugogo substation. The operation voltage is 132 kV. The total route length is 0.4 km. The route is shown at Figure 5-3-2.5 same as (3).

The separation method from Nalubaale - Lugogo line to New Mukono substation is shown at Figure 5-3-2.9. As this new line will be 4 circuits in the future, two separation towers are inserted in advance. In the case that two circuits of Nalubaale - Lugogo line cannot be de-energized, a tentative tower for bypassing the separation point is built in order to continue to supply power by the line while separation towers are being constructed. And the examination of the strength of the towers of Nalubaale - Lugogo line is required because the design condition of the line is changed with the installation of the separation towers.

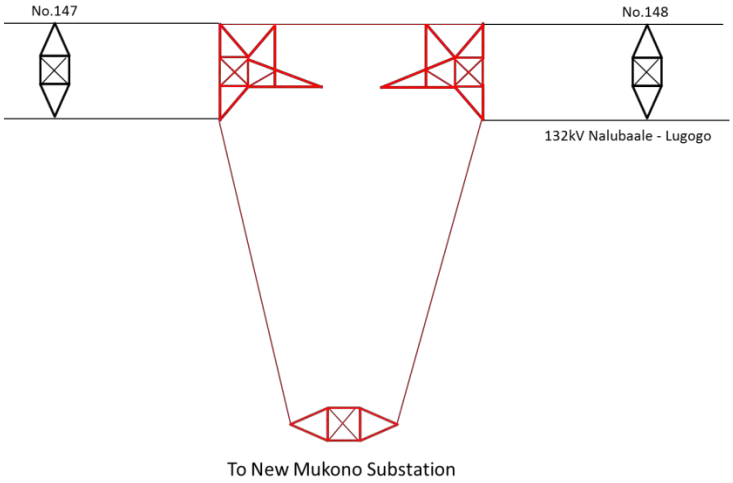


Figure 5-3-2.9 Separation method

The shortest and straight route to the substation was selected based on the consideration of technical and environmental aspect.

Corridor is used as a temporary haul road in the construction.

1) Setup of climatic conditions

Climatic conditions are set shown in Table 5-3-2.2 same as (1).

2) Selection of conductor and ground wires

ACSR Starling and GSW 55 mm sq are selected as the conductor and the ground wire of the line because they are the same as the conductor and the ground wire of the line between Nalubaale substation and Lugogo substation. Regarding communication line, ground-wire wrapped fiber system is selected because the system is adopted in Nalubaale - Lugogo line. Technical characteristics of conductor and ground wires are shown in Table 5-3-2.19 and 5-3-2.20.

Table 5-3-2.19 Technical Characteristics of Conductor

Type of Conductor	ACSR Starling
Component of stranded wires	26/7
Total area of conductor	421.08 mm^2
Total diameter	26.7 mm
Weight	1,467 kg/km
Ultimate Tensile strength	124,000 N
Modulus of elasticity	77,100 N/mm^2
Coefficient of linear expansion	19.36×10^{-6} /°C
DC resistance at 20°C	0.08 ohm/km

Table 5-3-2.20 Technical Characteristics of Ground Wire

Type of Conductor	GSW 55 sq mm
Component of stranded wires	7×3.2 mm
Total area of conductor	56.29 mm^2
Total diameter	9.6 mm
Weight	446 kg/km
Ultimate Tensile strength	63,700 N
Modulus of elasticity	205,900 N/mm^2
Coefficient of linear expansion	11.5×10^{-6} /°C
DC resistance at 20°C	2.15 ohm/km

3) Setup of clearance conditions

Clearance conditions are set shown in Table 5-3-2.5 same as (3).

4) Setup of wire conditions

Setup of wire conditions is same as (3). Maximum Working Tension and EDS of conductor and ground wire is shown in Table 5-3-2.21.

Table 5-3-2.21 Maximum Working Tension and EDS

Type	Ultimate Strength	Maximum Working Tension	Every Day Stress
ACSR Starling	124,000 N	34,300 N (MWT/UTS=28%)	23,800 N (EDS/UTS=19%)
GSW 55 sq mm	63,700 N	15,680 N (MWT/UTS=25%)	11,860 N (EDS/UTS=19%)

5) Selection of insulator set, supporting structure, and the foundation

① Insulator set

The insulator set is selected same as (1).

② Supporting structure

Supporting structure is the style for 2 circuit shown at Figure 5-3-2.8 same as (3).

③ Foundation

Since this transmission route is situated close to geological investigation point BH01(within 300 meters) described in section (2)-5)-c) above, based on the results of geological investigation for BH01, pile foundations will be adopted. Moreover, based on the results of topographical and quantity surveying shown in Appendix-9, there were not found to be any problematic fault lines, landslides, broken terrain, steep slopes with gradient of more than 10 degrees, extensive marshland, flood plain or soft ground on the

132 kV transmission line route of Mukono.

Table 5-3-2.22 Results of Geological Survey
(New Mukono Substation 132 kV Transmission Route)

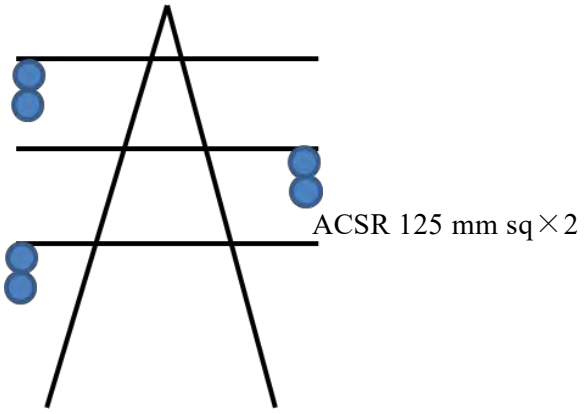
Position*	Bearing Ground
New Mukono Substation	19.5m underground (sandy soil, N≧30)

Source: Appendix-9

(5) Reinforcement of transmission lines between Mukono substation and Kampala North substation

As described in Chapter 3, the supports such as steel members, tower foundations are in good condition and there is no deterioration by passage. It is therefore estimated that these supports will have approximately the same lifespan as new conductors to be replaced.

Originally the type of conductors of the line was ACSR 175 mm sq (Lynx) and the number of circuit was 2. In about 1998, the line was needed to be reinforced according to the construction of a power station (50 MW) near Namanve substation. First, one of the circuits was reinforced by installing Bundled-ACSR 125 mm sq as the configuration shown at Figure 5-3-2.10. And then the other circuit was planned to be reinforced, but the plan was canceled. Since then the configuration of conductors has not been changed from the figure 5-3-2.10.



Source: JICA study team

Figure 5-3-2.10 Configuration of conductors

UETCL concerned the huge cost for redesign and remodeling accompanied by the replacement of conductors, but the redesign and remodeling of tower are minimized if there is no need to do the examination of tower strength if the high capacity low-sag conductor whose specification is close to ACSR 175 mm sq can be applied because the conductor of the line was ACSR 175 mm sq at the time of construction.

As the result of the power analysis in 2030, it found that the conductor that can accept 1,010 amperes is needed for the line between Mukono substation and Kampala North substation.

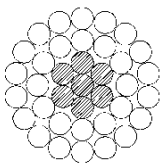
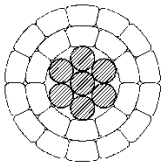
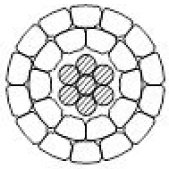
As the result of the investigation for the high capacity low-sag conductor whose specification is close to ACSR 175 mm sq, it was found that single Invar conductor (XTACIR) or single Gap type conductor can accept the required amperes and minimize a decrease of the ground clearance of existing conductors by increase capacity.

One of the single conductors is, therefore, installed for the line as the existing configuration.

The resistance of GAP conductor is slightly different Invar conductor and the power loss of GAP conductor is about 4 % smaller than Invar conductor.

Technical characteristics of Invar conductor and GAP conductor close to ACSR 175 mm sq (Lynx) is shown in Table 5-3-2.23.

Table 5-3-2.23 Technical characteristics of Invar conductor and GAP

Description		Unit	ACSR Lynx	Invar Conductor ZTACIR 201mm^2	Gap Conductor GZTACSR 208mm^2
Construction		Nos/mm	30/2.79-AL 7/2.79-ST	16/TW*1- ZTAL*2 12/TW*1-ZTAL*2 7/3.45- Invar	14/TW*1 - ZTAL*2 10/TW*1 - ZTAL*2 7/2.4 - Est*3
Nominal Diameter		mm	19.5	19.55	19.0
Min. breaking load		kN	79.6	99.4	86.2
Cross sectional area	AL	mm^2	183.4	201.0	207.9
	Core (ST, Invar, Est)		42.8	65.44	31.67
	Total		226.0	266.4	239.6
Nominal weight		kg/km	842	1024	844.8
DC Resistance at 20 deg. C		Ohm/km	0.1576	0.1364	0.1421
Modulus of electricity	Conductor	Gpa	81.0	84.0	80.8
	Core		-	152	205.9
Co-efficient of linear expansion	Conductor	/℃	17.0 x 10^{-6}	14.4 x 10^{-6}	19.1 x 10^{-6}
	Core		-	3.7 x 10^{-6}	11.5 x 10^{-6}
Allowable continuous operation Temp.		Deg. C	75	210	210
Sag of 300m span		m	6.3 at 75℃ (6.5 at 80℃)	7.0 at 185.5℃	6.7 at 195.5℃
Current capacity		A	457 at 75℃	1010 at 185.5℃	1010 at 195.5℃
Cross sectional view		-			

Notes:
*1: TW: Trapezoid wire
*2: ZTAL: Super thermal resistant aluminum alloy
*3: Est: Extra high strength steel

○Sag-Tension calculation
(1) Everyday tension: Not exceeding 25% of UTS
+ Temperature of the everyday condition: 26℃ (No Wind)
(2) Maximum working tension: Not exceeding 62.5% of UTS or 49750N
+ Temperature of the worst condition: 8℃
+ Wind pressure: 510Pa

○Current Capacity calculation
+ Ambient temperature: 35℃
+ Wind velocity: 0.6m/s
+ Wind direction: 0 degrees
+ Solar radiation: 0.1W/cm2
+ Emissivity of conductor surface: 0.6
+ Elevation above sea level: 1200m
+ Frequency: 50Hz

Source: JICA study team

Figure 5-3-2.11 shows the power system diagram on this reinforcement. Mukono substation doesn't exist at present, but it will construct in the near future and the system will consist of multiple lines.

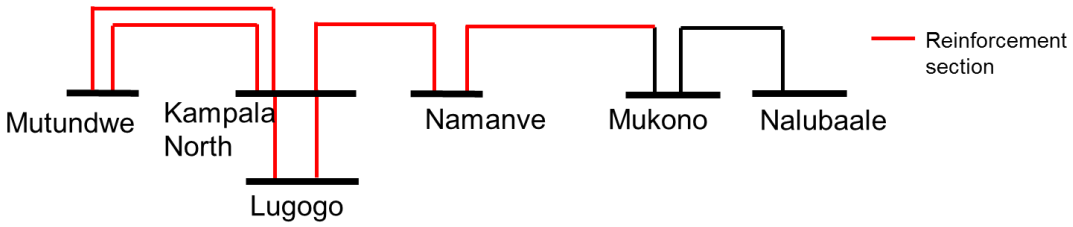
In construction, the construction span between Nalubaale substation and Kampala North substation is separated into two sections (Mukono - Namanve, Namanve - Kampala North).

By switching the power system, long time outage of substations is not required because power sources are supplied both sides of each section while the power outage of the line between substations in each section is required.

The length of construction span in each section is 3 - 4 km and engine space to reel conductor and durum space to send conductor are required in each section.

Construction method of stringing is Tension Stringing which is commonly used and easy.

Corridor is used for the conveyance of equipment and materials during the construction.



Source: JICA study team

Figure 5-3-2.11 Power system diagram between Nalubaale substation and Mutundwe substation

(6) Reinforcement of transmission lines between Kampala North substation and Mutundwe substation

As described in Chapter 3, the supports such as steel members, tower foundations are in good condition and there is no deterioration by passage. It is therefore estimated that these supports will have approximately the same lifespan as new conductors to be replaced.

The type of conductors has been ACSR 175 mm sq (Lynx) since the line was constructed. The number of circuit is 2.

As the result of the power analysis, it found that the conductor that can accept 140 MVA is needed for the line between Kampala North substation and Mutundwe substation.

JICA study team therefore considers the adoption of high capacity low-sag conductor because the conductor can accept the capacity and the examination of tower strength and remodeling of towers can be avoided.

Construction method of stringing is Tension Stringing.

Corridor is used for the conveyance of equipment and materials during the construction.

(7) Reinforcement of transmission lines between Kampala North substation and Lugogo substation

As described in Chapter 3, the supports such as steel members, tower foundations are in good condition and there is no deterioration by passage. It is therefore estimated that these supports will have approximately the same lifespan as new conductors to be replaced.

The type of conductors has been ACSR 175 mm sq (Lynx) since the line was constructed. The number of circuit is 2.

As the result of the power analysis, it found that the conductor that can accept 140 MVA is needed for the line between Kampala North substation and Mutundwe substation.

JICA study team therefore considers the adoption of high capacity low-sag conductor because the conductor can accept the capacity and the examination of tower strength and remodeling of towers can be avoided.

Construction method of stringing is Tension Stringing.

Corridor is used for the conveyance of equipment and materials during the construction.

(8) 132 kV Transmission line from separation point between Kampala North substation and Mutundwe substation to Kawaala substation

This line is T-branch line and consists of wooden poles. In order to improve the reliability of Kawaala substation, the connecting method to the substation is required to be changed from T-branch to Open-pi. Figure 5-3-2.12 shows the current situation of the route to Kawaala substation.

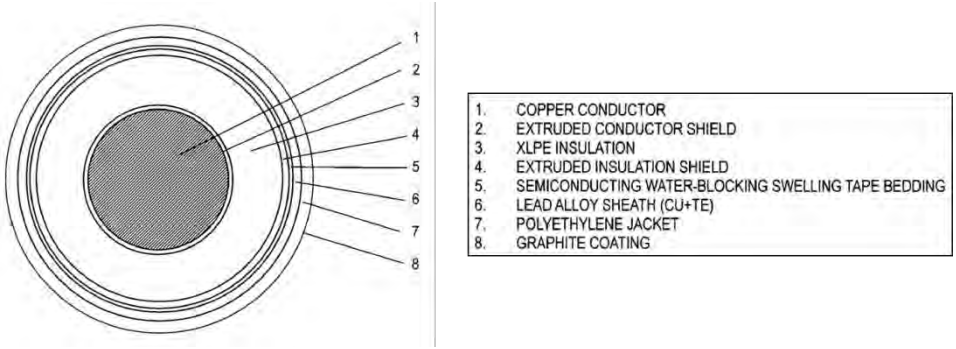
Source: JICA study team

Figure 5-3-2.12 Current situation of the route to Kawaala substation

Two circuits of underground cables are adopted for this line in consideration of environmental impact.

1) Selection of cable

As the result of the power analysis in 2030, it found that the cable that can accept 612 amperes is needed for the line. The size of the cable therefore seems to be 630 mm sq because the size can meet the capacity. Example of cross-section drawing of the cable is shown as Figure 5-3-2.13.

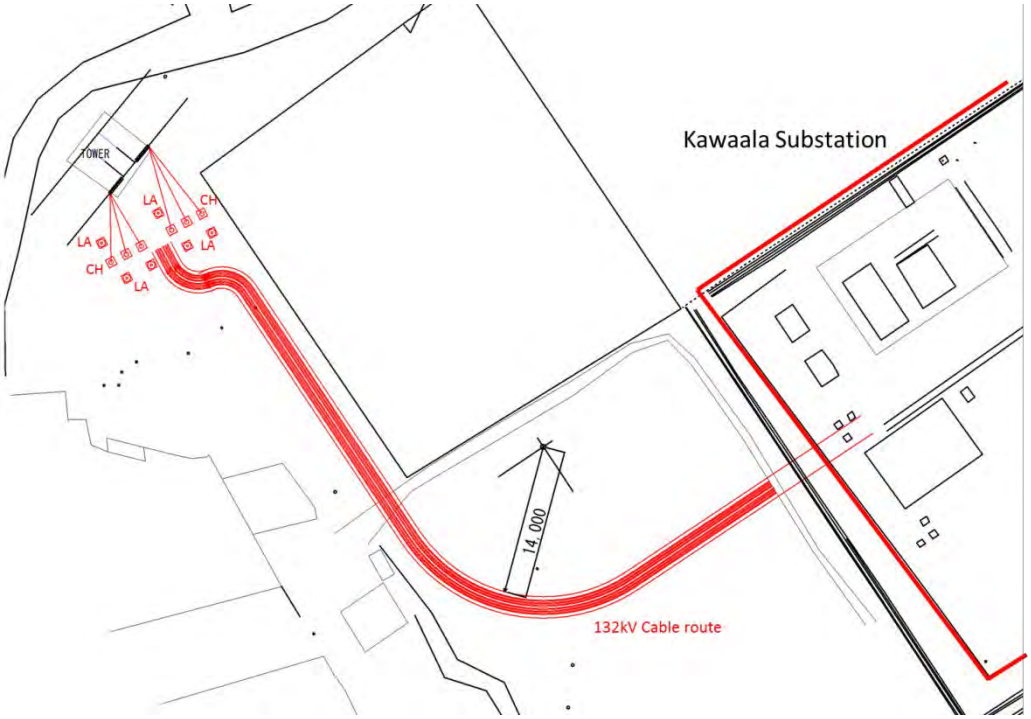


Source: JICA study team

Figure 5-3-2.13 Example of cross-section drawing of the cable

Regarding the connection method from separation tower (No.470) to the cable, platforms for connecting conductors to cables are built right beside No.470 and the conductors are directly connected to the aerial terminations (CH) on the platforms. And then the cables are connected to gas-immersed terminations of Gas Insulated Switchgear (GIS) at Kawaala substation.

In order to avoid the damage of cables caused by lightning, arresters (LA) are installed next to the aerial terminations. Cable route is shown at Figure 5-3-2.14.



Source: JICA study team

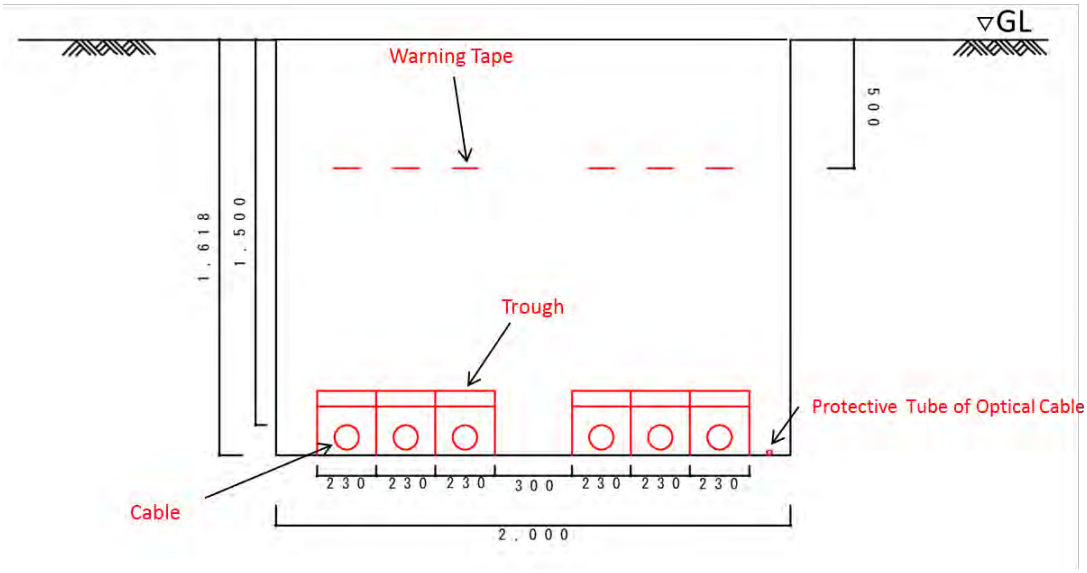
Figure 5-3-2.14 Cable route

2) Installation method

Direct burying method or conduit method could be selected as the burying method of the cables. The allowable current of a cable by direct burying method is more than that by conduit method. The construction cost of direct burying method is cheaper than that of conduit method. Direct burying method is therefore adopted.

Troughs that store the cables are made of concrete. Sand is stuffed in the troughs with the cables and then the troughs are buried.

In consideration of soil erosion by raining, the depth of burial of the cables is 1.5 m. Burying method is shown at Figure 5-3-2.15.



Source: JICA study team

Figure 5-3-2.15 Burying method of Cable

Long time outage is available for the construction and therefore existing wooden poles can be removed. The space that is secured by removing wooden poles is used for work space.

(9) Recommendations Based on the Study

On implementation of this project, matters which are revealed in association with studies considered in5-3-2 are as follows.

1) Size of overhead ground wire

The size of overhead ground wire for existing 220 kV transmission line is around 55 mm2. It is considered that the size cannot secure the capacity for accommodating instantaneous current in the case of contingencies such as ground fault.

However JICA study team selects the size for the new line built on this project because the new transmission lines built on this project are separated from existing lines and route length of the new lines are very short compared to the existing lines.

Therefore if the bigger size of ground wire is selected in that short part, it cannot make an effect on the rest of the existing line.

If there is a chance to replace overhead ground wire, we recommend UETCL to adopt the ground wire whose size is approximately 150 mm2 which can fully accommodate the fault current.

2) Standard of clearance

As the result of checking the technical specifications of existing lines, the value of clearance

is not standardized because each consultant sets each value.

Therefor JICA study team recommends UETCL to prepare UETCL's own standard of clearance and apply it to the transmission line design in the future.

5-3-3 Facility Planning

(1) Design Conditions for the Substation Facilities

The design conditions for the substation facilities are shown in the following Table 5-3-3.1~2.

Table 5-3-3.1 Basic Conditions for the Facility Design of the Project in Kawaala Substation

Items		Values
Altitude	Kawaala	1195 m
Ambient Temperature	Maximum	36 Degrees Centigrade
	Minimum	12 Degrees Centigrade
	Mean	23 Degrees Centigrade
Maximum Wind Velocity		30 m/s
Annual Rain Fall		1,265 mm/year
Seismic Force		Horizontal 0.15 G
Soil Bearing Capacity	Kawaala	120 KN/m^2 at GL-3.5m

Source: JICA Study Team

Table 5-3-3.2 Basic Conditions for the Facility Design of the Project in Buloba Substation

Items		Values
Altitude	Buloba	1185 m
Ambient Temperature	Maximum	36 Degrees Centigrade
	Minimum	12-Degrees Centigrade
	Mean	23 Degrees Centigrade
Maximum Wind Velocity		30 m/s
Annual Rain Fall		1,265-mm/year
Seismic Force		Horizontal 0.15 G
Soil Bearing Capacity	Buloba	150 KN/m^2 at GL-2.0m

Source: JICA Study Team

(2) Requirements for the Substation Facilities

Design ground level should be raised up by 1.0 m from existing ground level to avoid flood. The retaining wall around the project site should be constructed.

1) Outline of Control Building

The Outline of Control Building is shown in Table 5-3-3.3 and Table 5-3-3.4

Ground floor level should be +1.0 m from the design ground level to secure the height of Cable Culvert and Cable Pit.

Table 5-3-3.3 Outline of the Control Building in Buloba Substation

Items	Contents	Details
Structure	Reinforced Concrete Rahmen Structure	
Height of story	2 stories BFL-GFL=2.65 m GFL-RFL=4.0 m	BF: Cable Maintenance Pit, Water Tank 4ton, Pump unit, Submersible pump GF: Office, Switchgear Room, Entrance, Generator Room, Auxiliary Transformer Room, Battery Room, Toilet, Shower, Pantry, Corridor, Control Room
Total Floor Area	Approx. 1120 m^2(≒1116 m^2)	-
Building Area	Approx. 756 m^2	-
Exterior	Wall Finishing	Concrete with Urethane Exterior Paint Concrete Louver with Urethane Exterior Paint
	Roof Finishing	Concrete Plate t=80 wire-mesh @200 Urethane joint @2000 each Insulation t=50 Asphalt Membrane 3 Layer Water Proofing
Interior	Wall Finishing	Paint on Mortar iron trowel
	Floor Finishing	Free Access Floor h=300 mm Ceramic Tile 300 x 300
	Ceiling	System Ceiling with Gypsum Board t=12 mm Paint Finishing

Table 5-3-3.4 Outline of the Control Building in Kawaala Substation

Items	Contents	Details
Structure	Reinforced Concrete Rahmen Structure	
Height of story	3 stories BFL-GFL=2.65 m GFL-1FL=4.0 m 1FL-RFL=4.0 m	BF: Cable Maintenance Pit, Water Tank 4ton, Pump unit, Submersible pump 1F: Office, Switchgear Room, Entrance, Generator Room, Auxiliary Transformer Room, Battery Room, Corridor, Stair Case 2F: Control Room, Corridor, Stair Case, Toilet, Shower, Pantry Emergency Balcony: Evacuation Exit
Total Floor Area	Approx. 1000m^2 (≒990 m^2)	-
Building Area	Approx. 330m^2	-
Exterior	Wall Finishing	Concrete with Urethane Exterior Paint Concrete Louver with Urethane Exterior Paint
	Roof Finishing	Concrete Plate t=80 wire-mesh @200 Urethane joint @2000 each Insulation t=50 Asphalt Membrane 3 Layer Water Proofing

Items	Contents	Details
Interior	Wall Finishing	Paint on Mortar iron trowel
	Floor Finishing	Free Access Floor h=300 mm Ceramic Tile 300 x 300
	Ceiling	System Ceiling with Gypsum Board t=12 mm Paint Finishing

2) Foundation of Transformers

The Outline of the Foundation of transformers is shown in Table 5-3-3.5 to Table 5-3-3.6.

Ground floor level should be +1.0 m from the design ground level.

Table 5-3-3.5 Outline of the Foundations of 220/132kVx 2 and 132/33kVx2 transformers at Buloba Substation

Items	Contents	Details
Structure	Reinforced Concrete Mat Foundation	2 units of 125 MVA and 2 units of 40 MVA transformer
Auxiliary Facilities	Firewall	Firewall: Concrete wall H=7.5 m, L=9.0 m, t=250 Total number = 1
	Oil Pit	Oil pit: Around Transformer Foundation D=1.5 m filled with gravel, overflow piping connected to the oil-water separator set west-beside the foundation
	Cable Culvert	500mm x 900mm
Total Floor Area	Approx. 132 m^2	-
Note	In order to avoid the flooding of the equipment at the time of heavy rainfall, ground floor level should be raised +1.0m from the design ground level.	

Source: JICA Study Team

Table 5-3-3.6 Outline of the Foundations of 132/33kVx 3 and 132/11kVx1 transformers at Kawaala Substation

Items	Contents	Details
Structure	Reinforced Concrete Mat Foundation	3 units of 40 MVA and 1 unit of 20 MVA transformer
Auxiliary Facilities	Firewall	Firewall: Concrete wall H=7.5 m, L=9.0 m, t=250 Total number = 3
	Oil Pit	Oil pit: Around Transformer Foundation D=1.5 m filled with gravel, overflow piping connected to the oil-water separator set west-beside the foundation
	Cable Culvert	500mm x 900mm
Total Floor Area	Approx. 72 m^2	-
Note	In order to avoid the flooding of the equipment at the time of heavy rainfall, ground floor level should be raised +1.0m from the design ground level.	

Source: JICA Study Team

3) Foundations of Gas Insulated Switch (GISs)

The Outline of the foundations of Gas Insulated Switch (GISs) is shown in Table 5-3-3.7.

Ground floor level should be +1.0 m from the design ground level.

Table 5-3-3.7 Outline of the Foundations of Gas Insulated Switch (GISs) at Kawaala Substation

Items	Contents	Details
Structure	Reinforced Concrete Mat Foundation	1 unit of 132kV GIS
Auxiliary Facilities	Cable Pit	132 kV Cable Pit
Total Floor Area	Approx. 50 m^2	-
Note	In order to avoid the flooding of the equipment at the time of heavy rainfall, ground floor level should be raised +1.0m from the design ground level.	

Source: JICA Study Team

4) Cable Culvert

The Outline of the Cable Culvert is shown in Table 5-3-3.8.

Table 5-3-3.8 Outline of the Foundations of Gas Insulated Switch (GISs) at Kawaala Substation

Items	Contents
Cable Culvert From 40 MVA and 20 MVA transformers to Control Building.	Reinforced Concrete Box Culvert Approx. 26 m^2 (W=1.7 m, H=2.0m with Cable Rack)

Source: JICA Study Team

5) Foundations for Towers of a transmission lines

The Outline of the foundations for transmission line towers is shown in Table 5-3-3.9 and Table 5-3-3.10.

Table 5-3-3.9 Outline of the Foundations of transmission line Towers in Kawaala

Items	Contents	Details
Structure	Reinforced Concrete Foundation	2 cct, 132kV Cable, 1 Unit

Source: JICA Study Team

Table 5-3-3.10 Outline of the Foundations of transmission line Towers in Buloba

Items	Contents	Details
Structure	Reinforced Concrete Foundation	2 cct, 220kV Tower H= 40 m, 4 Units
		2 cct, 132kV Tower H= 40 m, 3 Unit

Source: JICA Study Team

Note: H=Height of Tower

5-3-4 Advantage of Japan's technologies and the possibility of its utilization for the Project

This project aims to upgrade the power system at Kampala Metropolitan Area and the equipment for substation and transmission needs to satisfy the following specifications.

(i) Substation equipment

- At Kawaala Substation, the equipment for 140 MVA capacity in total needs to be furnished to the same location, where the substation capacity is 20 MVA at present. Therefore, the 132 kV gas insulated switchgear for the direct connection to the power transformers needs to be applied to minimize the land use.
- At New Mukono Substation, the land use needs to be limited and the durability against air pollution needs to be considered. Therefore, gas insulated switchgears will be applied to both 220 kV and 132 kV voltage class.
- While substations are rehabilitated and a spare transformer is required, the mobile substations will be highly required. This mobile substation has to have mobility as well as suitable transformer capacity.

(ii) Transmission equipment

- At Kampala Metropolitan Area, transmission capacity has to satisfy the increasing power demand, but due to its high population density, the acquisition of new transmission lines will be difficult. Thus, the high temperature low sag conductors (HTLS) which has the similar construction with the existing overhead conductors, but have higher transmission capacity should be utilized to continue to use the existing towers.

Based on the above points to be considered, the draft requirements for the equipment on the prequalification and tender documents are considered as follow.

(1) Mobile substation

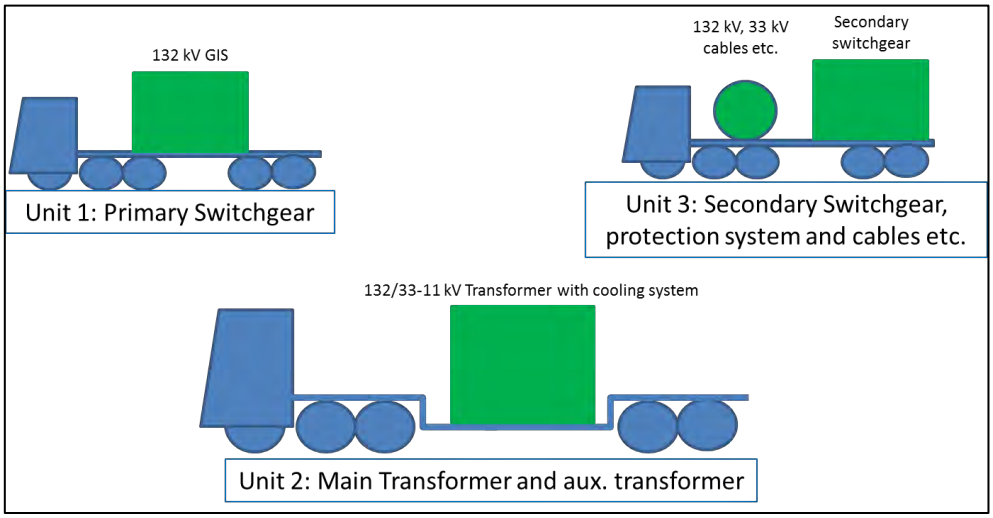
1) Basic policy for the selection of the equipment

This project aims to upgrade and improve the power system facilities at Kampala metropolitan area and it is highly required to design the specification of the equipment after the consideration of the characteristics of the environment.

In Japan, the road regulation regarding the transportation is strict as the total weight of vehicle needs to be maintained no more than 22 tons. Against such background, Japan has developed sophisticated techniques to compact the size of the mobile substation, securing the high transformer capacity.

The mobile substation is planned to be used throughout Uganda, including the urban area. Thus the required specification to the vehicles is severely limited by the road condition and the regulation of the Uganda National Road Authority (UNRA) restricts the weight and size.

Therefore, through the application of separate type mobile substation, high substation capacity will be secured with available mobility. Figure 5-3-4.1 shows the proposed mobile substation plan and Table 5-3-4.1 shows the technical specifications.



Source: Prepared by JICA Study Team based on the discussion with Japan's manufacture

Figure 5-3-4.1 Mobile substation system plan

2) Draft requirement for prequalification

To have experience (s) of the procurement of the mobile substation whose primary voltage is 132 kV or above is indispensable. Therefore, the following is considered as a requirement for the prequalification.

- To have at least five experiences to procure high voltage mobile substations (Primary voltage: at least 66 kV and at least one shall be 132 kV or above).
- To have at least fifteen years of transformer manufacturing experience (132kV or above)
- To submit the procurement certificates for the five experiences of the mobile substations supplied
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

3) Draft tender specification

Key specifications are stated below.

- Mobile substation equipment which includes the 20MVA 132/33 - 11kV transformer, switchgear facility and substation facilities in different trailers to secure both mobility enough to move within Uganda.
- Capability of moving on 12% of the uphill and turning which enable to enter into the road

with its width of 7.5 m.

- Low noise (70 dB or less)

Table 5-3-4.1 Specification of the mobile substation

No.	Description	Specification
<Common specification>		
(1)	Standard	IEC or equivalent
(2)	Composition	Considering the road condition of Kampala Metropolitan Area, it shall be a separate type comprising of primary side mobile switchgear, mobile transformer and secondary side switchgear
(3)	Operation condition	At the commissioning, the equipment shall be fully ready to be available at any necessary sites. (To be mobilized with fully equipped)
(4)	Connection method	Connection between existing busbars and primary side mobile GIS shall be done by either cable or overhead conductors.
(5)	SCADA system	SCADA terminal unit shall be equipped
(6)	Local monitoring system	Equipment for the monitor and control of the operation (V, I f, active power, energy, etc.) shall be equipped.
(7)	Altitude	Between 1,000 m and 1,500 m
(8)	Accessories	Mobile post insulators, mobile cable head, lightning arrestor power cable etc. to be connected between the switchgear and transformer etc.
(9)	Tolerable vibration in operation	0.3G (Resonance sine wave 3)
(10)	Tolerable vibration during transportation	3G (Marrum road)
(11)	Other	Vibration recorder shall be furnished for the mobile transformer.
<Mobile transformer>		
(1)	Capacity	20 MVA
(2)	Rated voltage	Primary: 132 kV Secondary: 33 - 11 kV
(3)	Tap position	Primary
(4)	Tap range	132 kV +5%/-12.5%
(5)	Tap number	17 taps (+4 taps/-15 taps)
(6)	Grounding system	Primary: Neutral direct grounding Secondary: Direct grounding
(7)	Auxiliary transformer	
	- Primary	33 or 11 kV
	- Secondary	0.4 kV
	- Capacity	100 kVA
(8)	Cooling system	ODAF
(9)	Impedance	To be informed by the detailed design
(10)	Insulation oil tank	To endure abnormal internal pressure when the three-phase short circuit fault happens.
(11)	Others	Each parts of mobile substation shall endure against electro-magnetic power caused by three phase short circuit faults and vibration during transportation

No.	Description	Specification
<Mobile switchgear>		
(1)	Voltage	132 kV (Primary), 33 - 11 kV (Secondary)
(2)	Breaking method	Gas insulated switchgear (GIS)
(3)	Insulation mode	SF_6
(4)	Secondary feeder number	2
(5)	Gas pressure during the transportation	0.15 MPa or less
(6)	Gas leakage rate	0.1%/year or less
(7)	Other	Secondary voltage switchgear shall be equipped into one separated trailer or together into mobile transformer
<Vehicle>		
(1)	Maximum gradient	12%
(2)	Turning radius	To be capable of entering into road with the width of 7.5 m.
(3)	Gross Vehicle Weight (GVW)	GVW limitation is 56 ton.
(4)	Number of axle	Manufacturer standard Maximum axle load is 8 ton or less

(2) Gas Insulated Switchgear (GIS)

1) Basic policy for the selection of the equipment

It is forecasted that Kampala metropolitan area shall require continuous development of power network facilities as the power demand increases. However, since it is a densely populated area, the land acquisition remains as a big challenge. Gas insulated switchgear (GIS) applies high pressure SF6 gas into the sealed partition to reduce the insulation distance. By applying this switchgear, the required land acquisition will be reduced.

Moreover, through the application of direct connection between GIS and power transformer by ducts, the required capacity of transformers will be installed to Kawaala Substation.

GIS has a structure that the energized part is sealed, it is more durable than air insulated switchgears (AIS) against environmental factors, it is necessary to be applied to New Mukono Substation where the high power supply reliability is required. Therefore, manufactures of the GIS should pass the type test and factory test before shipment whose criteria are higher than IEC standard to secure the high quality. Furthermore, the improvement of gas leakage ratio can reduce the frequency of maintenance. Since GIS requires high cost and labor for the maintenance compared to AIS, the use of GIS manufactured by Japan can contribute to the reduction of maintenance cost

Therefore, the requirement for the prequalification and the tender specification are proposed as follow.

2) Draft requirement for prequalification

- To have records of manufacturing GIS, which satisfies the technical specifications on

Table 5-3-4.2 and Table 5-3-4.3 beyond 15 years

- To submit five procurement certificates from electric power companies
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

3) Draft tender specification

Key specifications are stated below.

- The equipment is able to be directly connected to power transformer (applied to Kawaala Substation)

Table 5-3-4.2 Specification of 132 kV Gas Insulated Switchgear

No.	Description	Specification
(1)	Standards	IEC, JEC or equivalent
(2)	Model	Outdoor
(3)	Busbar	Double bus
(4)	Gas leakage rate	0.1% or lower per year
(5)	Rated voltage	145 kV
(6)	Rated current	To be informed by the detailed design
(7)	Rated interrupting current	31.5 kA
(8)	Rated short-time withstand current (short time)	31.5 kA (3 sec.)
(9)	Rated basic impulse withstand voltage	650 kV
(10)	Rated power frequency withstand voltage (1 min.)	275 kV
(11)	Auto-reclosing	Three phase bundle
(12)	Operating sequence	O-0.3 sec.-CO-3 min.-CO
(13)	Current transformer	6 CTs/phase
(14)	Voltage transformer	3 CVTs/phase
(15)	Tolerable vibration	0.3G (Resonance sine wave 3)
(16)	Tolerable vibration during transportation	3G
(17)	Other	To be accessible to the local panel without using ladder.

Table 5-3-4.3 Specification of 220 kV Gas Insulated Switchgear

No.	Description	Specification
(1)	Standards	IEC, JEC or equivalent
(2)	Model	Outdoor
(3)	Busbar	Double bus
(4)	Gas leakage rate	0.1% or lower per year
(5)	Rated voltage	245 kV
(6)	Rated current	To be informed by detailed design
(7)	Rated interrupting current	40.0 kA
(8)	Rated short-time withstand current (short time)	40kA kA (3 sec.)
(9)	Rated basic impulse withstand voltage	To be informed by detailed design
(10)	Rated power frequency withstand voltage (1 min.)	To be informed by detailed design

(11)	Auto-reclosing	Three phase bundle
(12)	Operating sequence	O-0.3 sec.-CO-3 min.-CO
(13)	Current transformer	6 CTs/phase
(14)	Voltage transformer	3 CVTs/phase
(15)	Tolerable vibration	0.3G (Resonance sine wave 3)
(16)	Tolerable vibration during transportation	3G
(17)	Other	To be accessible to the local panel without using ladder.

(3) Transformer

1) Basic policy for the selection of the equipment

Transformers which can be directly connected to gas insulated switchgears shall be required for the upgrading of the transformer at Kawaala Substation which has a limited area. Also, the transformer has to tolerate against earthquakes in Uganda and inland transportation over 1,000km from Mombasa Port to sites.

2) Draft requirement for prequalification

- To have at least five experiences to procure power transformers (Primary voltage: 132 kV or more).
- To have at least fifteen years of manufacturing experience
- To submit five procurement certificates from electric power companies
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

3) Draft tender specification

Key specifications are stated below.

- Low noise (70 dB or less)

Table 5-3-4.4 Specification of the transformer

No.	Description	Specification
(1)	Standard	IEC, BS or equivalent
(2)	Capacity	(To be specified depending on project site)
(3)	Rated voltage	(To be specified depending on project site)
(4)	Tap position	Primary
(5)	Tap range	+5%/-12.5%
(6)	Tap number	17 taps (+4 taps/-15 taps)
(7)	Grounding system	Primary: Neutral direct grounding Secondary: Direct grounding
(8)	Auxiliary transformer	
	- Primary	33 kV
	- Secondary	0.4 kV
	- Capacity	100 kVA

No.	Description	Specification
(9)	Cooling system	ONAN / ONAF
(10)	Impedance	(To be specified depending on project site)
(11)	Tolerable vibration	0.3G (Resonance sine wave 3)
(12)	Tolerable vibration during transportation	3G
(13)	Altitude	Between 1,000 m and 1,500 m

(4) High Temperature Low Sag conductors

1) Basic policy for the selection of the materials

When the transmission capacity needs to be increased, transmission towers are usually reconstructed first of all. However in case of this project which will be taken place at Kampala Metropolitan area, it is a big challenge to acquire the land for these transmission towers, due to its densely populated areas. As a result of the survey, it was confirmed that the reconstruction of towers with the acquisition of land will be difficult since the transmission lines where the project aims to increase the transmission capacity passed over densely residential areas. The specification of HTLS conductors which this project proposes to use shall minimize a decrease of ground clearance of the existing conductors by increase capacity, it is expected to enable the transmission capacity to increase and minimize the modification of the existing towers. In conclusion, this project considers using HTLS conductors to increase the transmission capacity with avoiding the negative social impact to the project area which may be caused by the long-term power outage during the work period.

2) Draft requirement for prequalification

Shown in Table 5-3-4.5 (10), (11)

3) Tender specifications

The items of the specifications which should be well noted are stated as follows:

- When 230 MVA (1010 A) of power, which is assumed to be required under the condition of N-1 accident, the sag shall be maximum sag of Lynx + 0.8 m (300 m span) or less.
- The maximum working tension in case of the worst condition (maximum wind pressure and minimum conductor temperature) shall be less than 30 % of Lynx UTS (76.8 kN) or equal, and EDS is less than 20 % of Lynx or equal.

Table 5-3-4.5 Specification of High Temperature Low Sag conductors

No.	Item	Specification
(1)	Applicable standards	IEC and JEC or equivalent standard
(2)	Type	Gap conductor or Invar conductor
(3)	Definition	Gap conductor: The core is Ultra high strength galvanized steel. The conductor is Super thermal-resistant aluminum alloy, designated "AT3" in accordance with IEC 62004. It

No.	Item	Specification
		offers excellent low sag and current-carrying characteristics at a high conductor temperature. Invar conductor: The core is Aluminum clad invar alloy. The conductor is Extra thermal-resistant aluminum alloy, designated "AT4" in accordance with IEC 62004. It offers excellent low sag and current-carrying characteristics at a high conductor temperature.
(4)	Material	Gap conductor: Core: Ultra high strength galvanized steel Conductor: Super thermal-resistant aluminum alloy (AT3) Grease: Thermal-resistant grease Invar conductor: Core: Aluminum clad invar alloy Conductor: Extra thermal-resistant aluminum alloy (AT4)
(5)	Nominal diameter	Equivalent to Lynx
(6)	Ultimate tensile strength (UTS)	UTS which Maximum working tension becomes less than 30% of Lynx UTS (79.8kN) or equal when condition changes from condition 1 to condition 2. Condition 1: Everyday stress (EDS) EDS: Less than 20% of Lynx UTS or equal Conductor temperature: 26 ºC Wind pressure: 0 Pa Condition 2: Worst case Maximum working tension: Less than 30% of Lynx UTS (79.8kN) or equal Conductor temperature: 8 ºC Wind pressure: 510 Pa
(7)	Current-carrying capacity at maximum operating temperature	Greater than 1010 A or equal ***Calculation Condition*** 1. Ambient temperature: 35 ºC 2. Wind velocity: 0.6 m/s 3. Wind direction: 0° 4. Solar radiation: 0.1 W/m^2 5. Emissivity of conductor surface: 0.6 6. Elevation above sea level: 1,200 m 7. Frequency: 50 Hz
(8)	Sag condition (Span: 300 m)	1) Maximum working tension is less than 30% of Lynx UTS (79.8kN) or equal when condition changes from condition 1 to condition 2. 2) Sag is less than maximum sag of Lynx + 0.8 m (8.4 m at the span of 300 m) or equal when condition changes from condition 1 to condition 3. Condition 1: Everyday stress (EDS) EDS: Less than 20% of Lynx UTS or equal Conductor temperature: 26 ºC Wind pressure: 0 Pa Condition 2: Worst case Maximum working tension: Less than 30% of Lynx UTS (79.8kN) or equal Conductor temperature: 8 ºC Wind pressure: 510 Pa

No.	Item	Specification
		Condition 3: Maximum sag Conductor temperature: 1. HTLS: Temperature at 1010 A 2. Lynx: 75 ºC Wind pressure: 0 Pa
(9)	Strength soundness of tower after replacing conductor	To check insufficient strength by the follows and to reinforce tower so that the tower ensures soundness of tower as support of transmission line after replacing conductor. ① Design change of conductor from the existing design ② Steel corrosion of existing tower ③ Unequal displacement of tower foundation and displacement of tower member ④ Strength poverty by aging of tower material
(10)	Supply performance	Greater than 15 years or equal
(11)	Special tools/training by supervisor	Gap conductor requires special tools and training by supervisor.

Note: If there are some defects on the existing towers, repair work shall be carried out by UETCL.

Chapter 6 Institutional Arrangement for Implementation and Operation and Maintenance of the Project

6-1 Project Implementing Organization

In the case where the Project is adopted, UETCL will be the implementing agency. The UETCL planning and investment department will engage in the outline design, which will be implemented from the preparatory study stage until signing of the contract with the EPC operator, and the basic design. After that, the UETCL Project implementation department will take charge of the implementation stage from contract signing to detailed design, installation work, trial operation and handover of equipment. After equipment has been handed over from the EPC contractor to UETCL, responsibility will transfer from the UETCL Project implementation department to the operation and maintenance department for Operation; and to the Finance, Accounts and Sales department will own the asset.

Authority to implement the Project will be given to UETCL after the loan agreement has been signed between the two governments. After the MD/CEO of UETCL has obtained approval from the UETCL Board of Directors on the procurements (depending on the contract amount), he will sign contracts on behalf of UETCL with the consultant and EPC operator. As the person with ultimate responsibility of UETCL, the MD/CEO will approve the Project implementation plans, equipment design and so on.

The MD/CEO will entrust the responsibility to manage the project implementation with the Manager Projects implementation department of UETCL. The manager Projects Implementation will then nominate, assign and designate one of the staff of the projects implementation department as a Project Manager, who will execute the works schedule management, checking of approved drawings, coordination with related agencies, reporting to the MD/CEO and so on. Moreover, to ensure the smooth operation of Project implementation, UETCL will appoint engineers from each department and form the Project Implementation Unit based around the Project Manager as shown in Table 6-1.1.

Concerning management of funds and payments, after the Project Manager has confirmed the situation regarding preparation of the necessary documents stipulated in the contracts, the decision to make payments will be received from the MD/CEO and the request to make payments will be made to the Ministry of Finance, Planning and Economic Development. Incidentally, the agency in charge of approving environmental procedures is NEMA, and applications for official Project approval to related agencies such as this will be made by the Project Manager while receiving clearance from the MD/CEO.

Table 6-1.1 Project team compositions according to implementation of this project

Personnel	Department
① Project Manager	Project Implementation Department
② Civil engineers	Project Implementation Department
③ Electrical engineers	Project Implementation Department
④ Environmental and social considerations team	Project Implementation Department
⑤ Design team	Project Implementation Department
⑥ Maintenance engineer (if necessary)	Project Implementation Department or Planning and Investment Department
⑦ IT technician (if necessary)	Maintenance Department

Source: JICA Study Team based on the hearing from UETCL

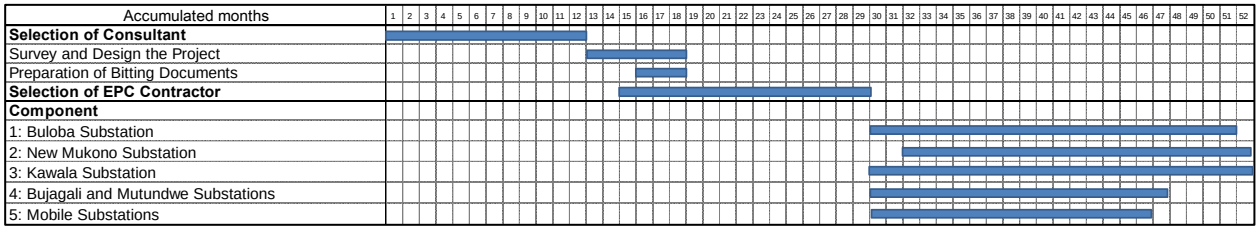
6-2 Project Implementation Schedule

6-2-1 Schedule until the EPC Contract

In case that this project is approved, the consultant in charge of detail design will be selected and EPC contractor will be selected. The overall schedule from the selection of the consultant to the commissioning is shown in Table 6-2-1.1.

Firstly, the Ugandan side shall commence the 12-month procedure of the overseas consultant selection. After the selection, two months will be spent for the review of the power system plan. 15 months procedure of the selection of EPC (E: Engineering, P: Procurement, and C: Construction) shall be commenced. During the selection of the EPC contractor, the prequalification (P/Q) is planned to be conducted. As a result, it will take 29 months after the commencement of the consultant selection up to the selection of the EPC contractor. After the selection of the EPC contractor it will require 23 months to carry out the actual construction work (including procurement-manufacture and construction works of substation and transmission equipment) (hereinafter called as 'the Work'), the overall project period will be 52 months.

Table 6-2-1.1 Overall Work Schedule



Source: JICA Study Team

6-2-2 Work Schedule

(1) Outline of the procurement component

This project formulate in total five procurement components as stated below, considering associated contents and their similarities.

- Component1: Construction of 220/132/33 kV Buloba Substation and the construction of 220 kV and 132 kV transmission lines connecting to

this substation.

- Component 2: Construction of 220/132/33 kV New Mukono Substation (GIS) and the construction of 220 kV and 132 kV transmission lines connecting to this substation.

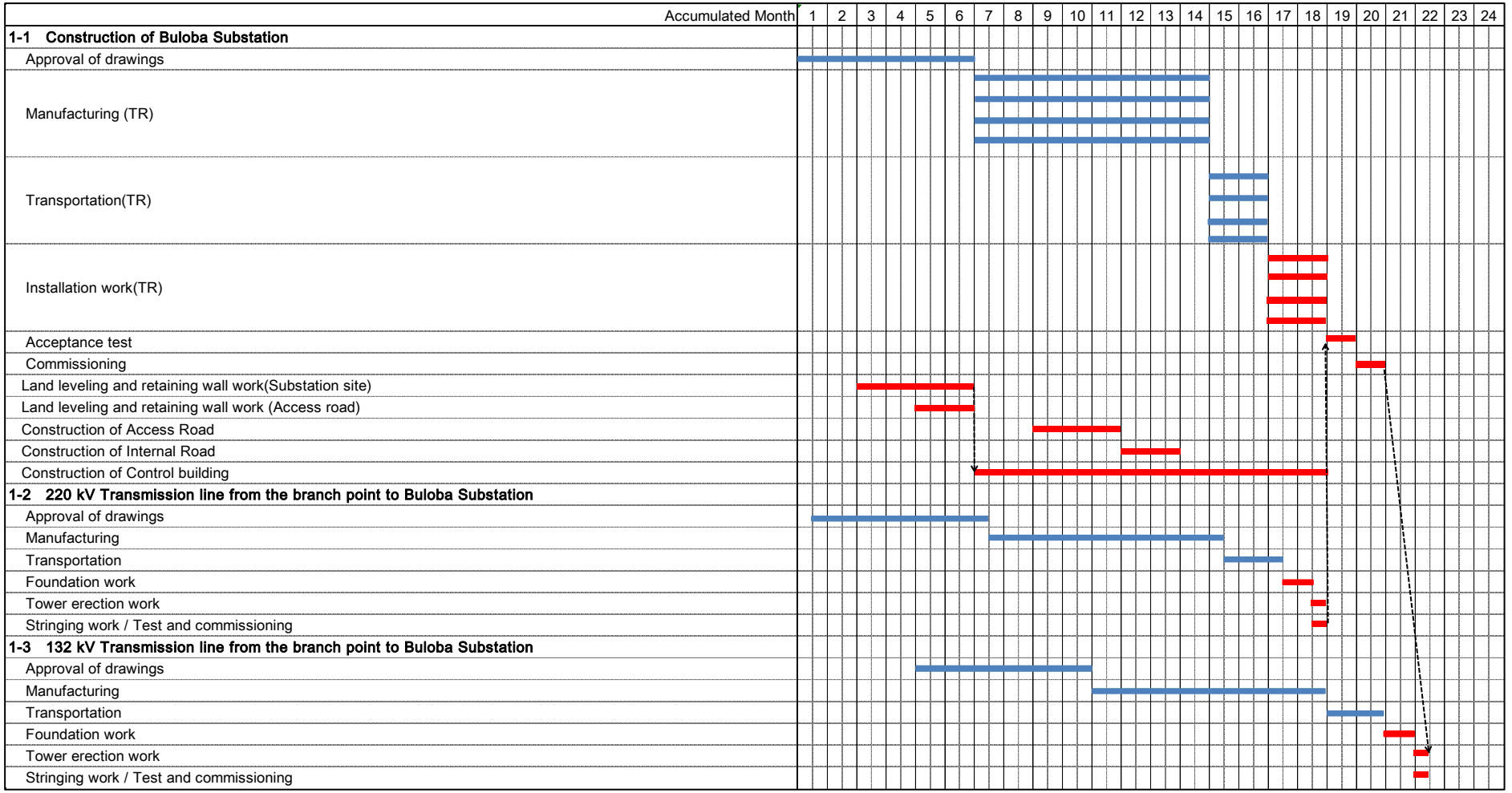
- Component 3: Rehabilitation of existing Kawaala Substation and re-conductoring of HTLS conductors in Kampala metropolitan area

- Component 4: Upgrading of existing Bujagali Substation and Mutundwe Substation.

- Component 5: Procurement of mobile substations

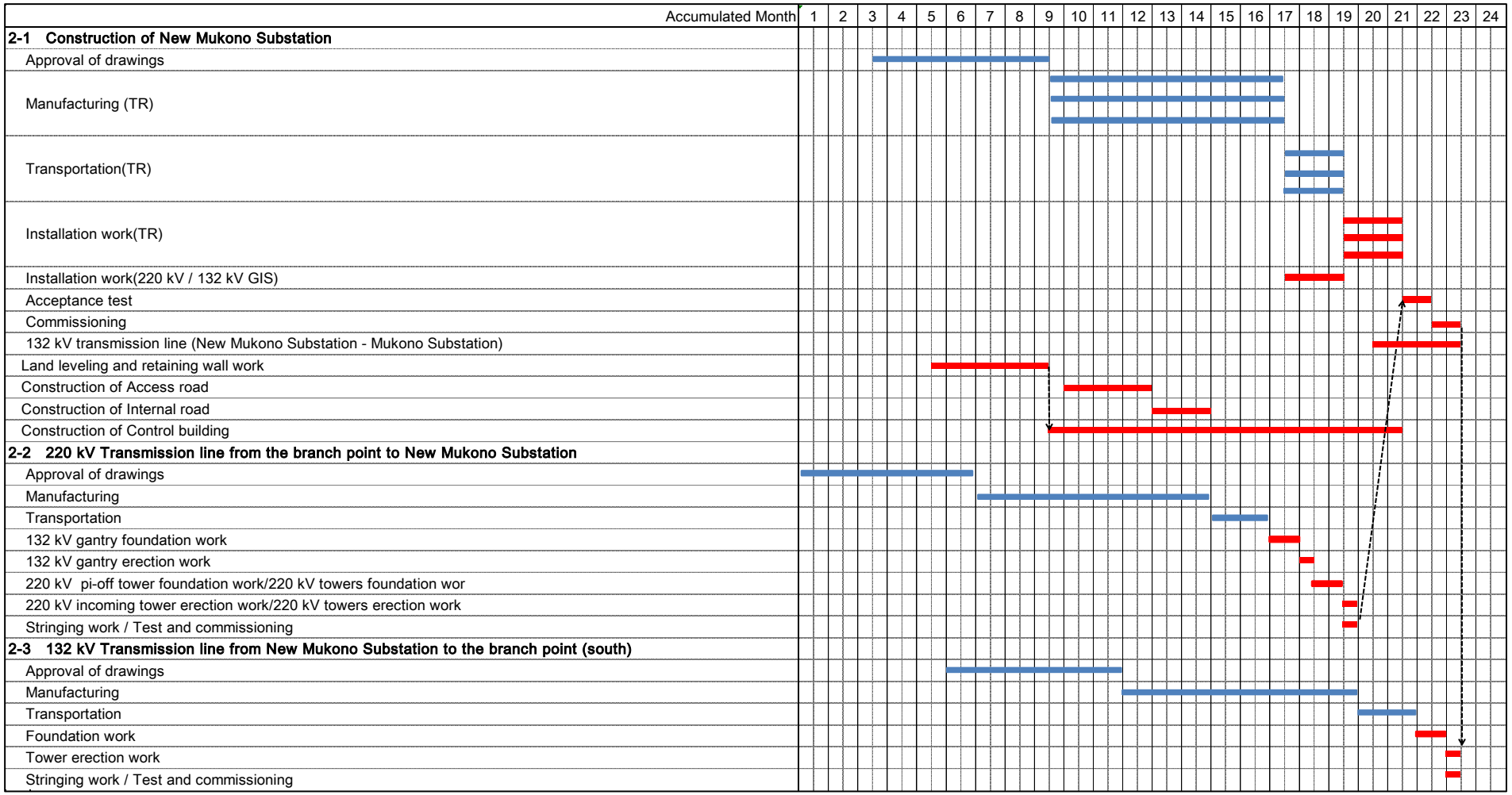
It will take 23 months since the detail design to the commission of Kawaala Substation (Lot 3), which considered to take the largest period. Table 6-2-2.1 to Table 6-2-2.5 shows the Work implementation plan by each component. Blue line shows overseas works and red line shows works to be carried out in Uganda. The Work plan is formulated considering the similar loan project carried out in Uganda.

Table 6-2-2.1 Work Schedule (Component 1)



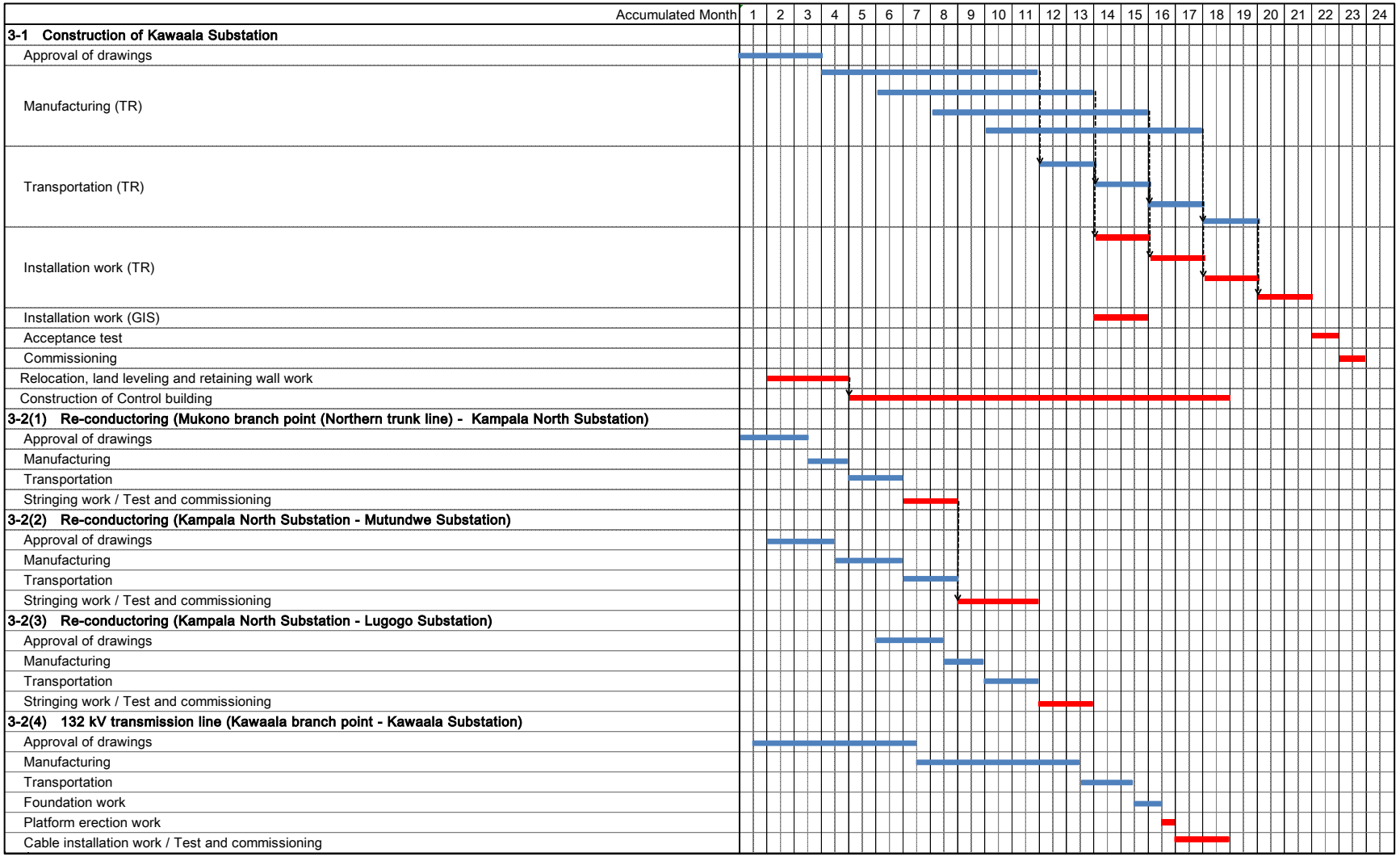
Source: JICA Study Team

Table 6-2-2.2 Work Schedule (Component 2)



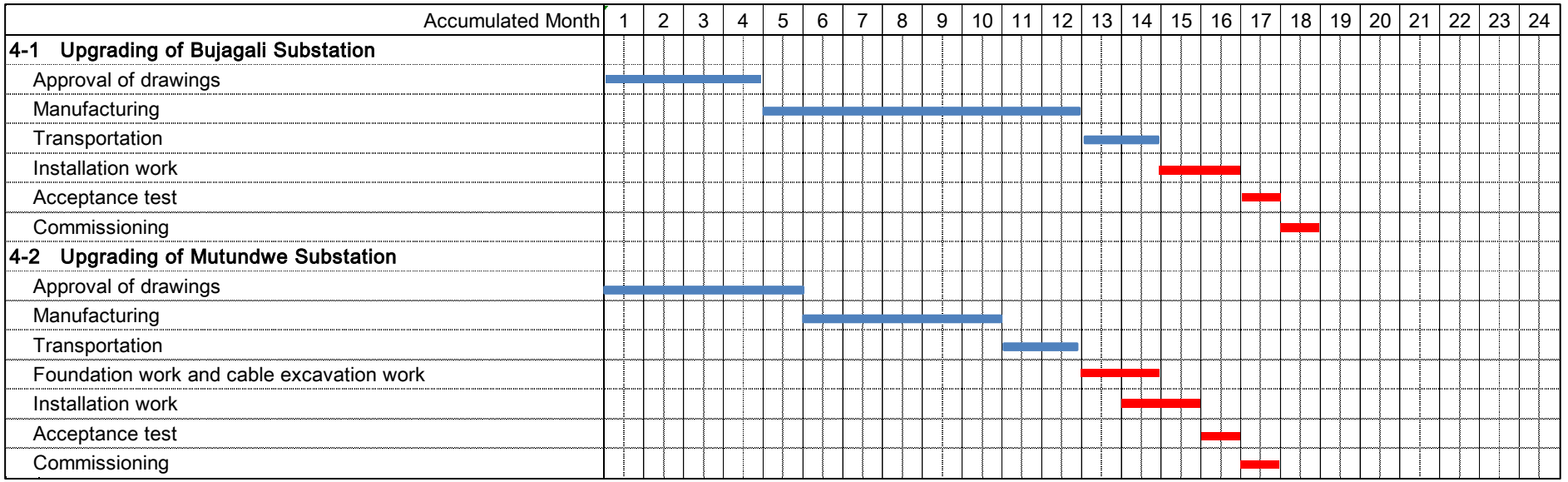
Source: JICA Study Team

Table 6-2-2.3 Work Schedule (Component 3)



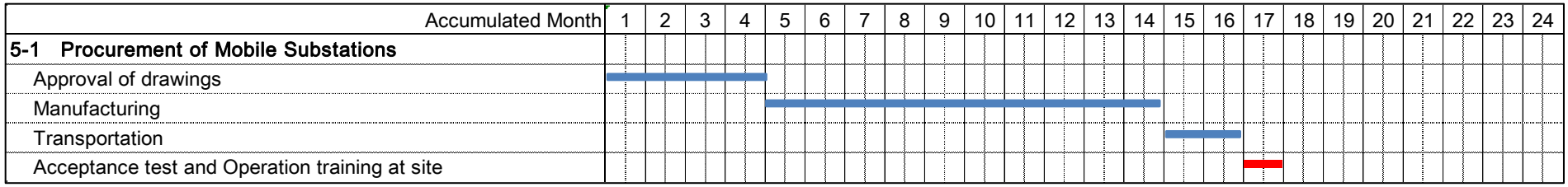
Source: JICA Study Team

Table 6-2-2.4 Work Schedule (Component 4)



Source: JICA Study Team

Table 6-2-2.5 Work Schedule (Component 5)



Source: JICA Study Team

(2) Tactics to minimize the power outage during the Work

The Work schedules were formulated to minimize the power outage area by avoiding the works such as re-conductoring works and erection works of new towers accompanying with the construction of new substation and upgrading works of substations will be taken place simultaneously. Two types of power outage will be conducted: the one is the long power outage period (0.5 months or longer) during the construction works and the other is the relatively short power outage period (a few hours up to a couple days). The short power outage period shall be required for the interconnection of the new equipment to the existing transmission network. The following chapter describes the required power outage area and its period. In this chapter, 'power outage' of the certain area is defined to open circuit breakers of stated feeders at the two substations.

1) Power outage plan of component 1

The component 1, construction of the new Buloba Substation shall require the least power outage to the existing transmission network. The total power outage, which means 24-hour consecutive power outage, will be required during the erection work of 220 kV and 132 kV pi-off towers (0.5 months each: in total 1 month). During the planned outage, the power load on these lines will be distributed to the neighbouring transmission lines such as Kawanda Substation - Mutundwe Substation Transmission line. Considering the power demand and transmission capacity, the power supply will be able to be continued. However, when the power demand beyond the power demand forecast occurs, the utilization of bypass towers during the construction to ease the planned outage is considered.

To minimize the power outage period, the tower foundation works will be carried out by man-power only, avoiding heavy vehicles to allow the transmission line to be kept energized during the work. The table 6-2-2.6 shows the area of the power outage.

Table 6-2-2.6 Power outage plan (Component 1)

Power outage area \ Month lapsed after the EPC Contract	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 . Substation																								
N/A																								
2 . 220 kV Transmission Line																								
Kawanda Substation—Masaka Substation (1)																		▬						
Kawanda Substation—Masaka Substation (2)																		▬						
3 . 132 kV Transmission Line																								
Mutundwe Substation—Kaburasoke Substation																						▬		

[Legend] ▬ : Power outgage (24-hour)

2) Power outage plan of component 2

Since 220 kV transmission lines will be pi-off from Bujagali - Kawanda 220 kV transmission lines, 0.5 month of total power outage period will be required for the pi-off tower erection and connection work. During the planned outage, Karuma Hydropower Plant will be able to conduct power supply. Prior to this work, 0.5 month of total power outage period will be also

required at Nalubale - Kampala North 132 kV transmission line next to the 220 kV transmission lines during the construction of the gantry. The same contents of the power outage shall be required to Nalubale - Lugogo 132 kV transmission line (southern trunk line) during the pi-off tower erection work. Based on the power demand, existing 132 kV transmission lines (north trunk line and southern trunk line) has sufficient transmission capacity and the power transmission to the metropolitan area will be negligible. However, the power outage method will be subject to the actual power demand during the construction period and the use of bypass towers can be applied. Table 6-2-2.7 shows the power outage plan of lot 2.

Table 6-2-2.7 Power outage plan (Component 2)

Power outage area \ Month lapsed after the EPC Contract	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 . Substation																								
N/A																								
2 . 220 kV Transmission Line																								
Bujagali Substation—Kawanda Substation (1)																			▬					
Bujagali Substation—Kawanda Substation (2)																			▬					
3 . 132 kV Transmission Line																								
Nalubale Substation—Mukono Substation																		▬						
Nalubale Substation—Lugogo Substation																							▬	

[Legend] ▬ : Power outgage (24-hour)

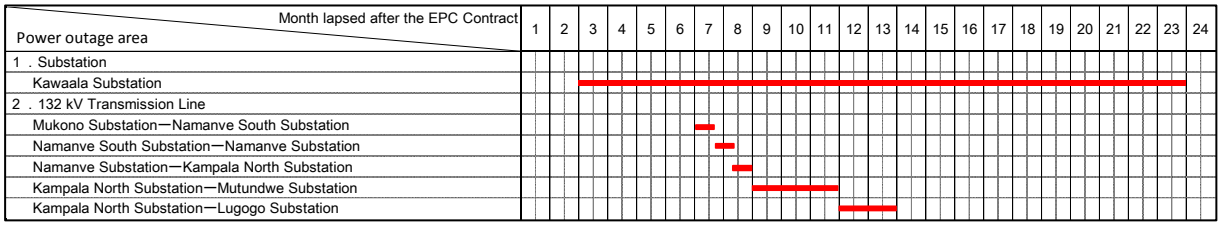
3) Power outage plan of component 3

Re-conductoring area from Mukono branch point to Kampala North Substation on the Northern trunk line includes the connection points to Namanve Substation and Namanve South Substation. The re-conductoring work of this area shall be divided into three areas: (i) Mukono Substation - Namanve South Substation, (ii) Namanve South Substation - Namanve Substation, and (iii) Namanve Substation to Kampala North Substation so that the power supply to these substations will be continued without power outage. The re-conductoring work will be carried out by two groups to reduce the work period. However, since the re-conducoting work will be carried out by the tension stringing method, consecutive 24-hour power outage shall be required as Table 6-2-2.8 indicates.

For re-conductoring works between Kampala North Substation - Mutundwe Substation and between Kampala North Substation to Lugogo Substation, suspension block method shall be applied, considering that the area is located in the centre of Kampala. Consecutive 24-hour power outage during the work period will be necessary as well.

During the rehabilitation work of Kawaala Substation, the total power outage up to 21-month from the decommission of the existing equipment to the commission of the substation will be required. Prior to the work, existing distribution feeders from Kawaala Substation need to be connected to neighbouring distribution substations of UETCL prior to the commencement of the rehabilitation work, and UMEME confirmed that it would be done in due course.

Table 6-2-2.8 Power outage plan (Component 3)



[Legend] : Power outgage (24-hour)

4) Power outage plan of component 4

During the 132 kV busbar extension work at Mutundwe Substation, the connection of these 132 kV feeders shall be rearranged as Table 6-2-2.9 indicates. In this table, two feeders to Entebbe Substation to be commissioned in 2018 is defined as a part of new busbars as of time before the project, since the structure of the extended busbar (new busbars) shall be integrated to these two feeders.

Table 6-2-2.9 Arrangement of 132 kV feeders at Mutundwe Substation

Feeder name	Origin (Feeders from/to)	Before the arrangement	After the arrangement
Kawaala	Kampala North	Existing busbar	Existing busbar
Kampala North		Existing busbar	New Busbar
Kawanda (1)	Kawanda	Existing busbar	Existing busbar
Kawanda (2)		Existing busbar	New Busbar
Kabulasoke	N/A	Existing busbar	Existing busbar
Emergency Substation	N/A	Existing busbar	Decommission
Lugogo	Lugogo	Existing busbar	Existing busbar
Queensway		Existing busbar	New Busbar
Entebbe (1)	Entebbe	New Busbar	Existing busbar
Entebbe (2)		New Busbar	New Busbar

Source: Prepared by JICA Study Team

As Table 6-2-2.9 indicates, two sets of feeders which are originated from the same substation shall be connected to existing busbar and new busbar respectively to improve the stabilization of the network. To minimize the power outage of affected 132kV feeders, the connection work shall be carried out in the order stated below:

[1] Foundation work for the busbar and cable excavation work will be carried out. During these works, the feeder connection work (which means the power outage caused by the arrangement of feeders) will not be carried out. However, since the construction of cable heads will be carried out to the 132 kV feeder bays to be reconnected to the new busbar, these feeder bays needs to undergo the power outage in a short period, during the utilization of heavy vehicles. (1.5 months)

[2] Entebbe (1) feeder shall be relocated from the new busbar to the existing busbar and start to be operated after the acceptance test and commissioning prior to the other feeders to be rearranged. (0.5 month)

[3] Entebbe (2) feeder shall be disconnected from the new busbar and the construction of new busbar shall be completed. (1.0 month)

[4] After the acceptance test and commissioning of new busbar and switchgears (1.0 month), the four feeders to be connected to the new busbar shall be connected and the acceptance test shall be carried out. (0.5 month)

[5] New busbar, together with the rearranged four feeders shall be commissioned. (0.5 month)

Table 6-2-2.10 shows the power outage plan of lot 4. Although four feeders need to undergo the power outage in the latter period of the 17th month, it is confirmed that the rest of feeders can maintain the power supply to the affected areas.

Table 6-2-2.10 Power outage plan (Component 4)

Power outage area \ Month lapsed after the EPC Contract	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 . Substation																								
N/A																								
2 . 132 kV Transmission Line																								
Kawanda Substation—Mutundwe Substation (2)																△								
Mutundwe Substation—Kampala North Substation																△								
Mutundwe Substation—Entebbe Substation (1)													△											
Mutundwe Substation—Entebbe Substation (2)																								
Mutundwe Substation—Queensway Substation																△								

[Legend] : Power outgage (24-hour) △ : Short period power outage

6-2-3 Works to be borne by the Ugandan side

The scope of the Project involves not only the construction of new substation/transmission lines but also the rehabilitation works of existing substation and transmission facilities. Therefore, for the smooth implementation of the Project, it is necessary that the works to be borne by the Ugandan side will be carried out without delaying, which shall include the following items:

To demolish and relocate the existing substation facilities at Kawaala Substation.

- To make arrangement with Umeme Limited to connect the existing 11 kV distribution feeders to the other distribution substation in advance to continue the power distribution service during the Work before the decommissioning of the existing equipment at Kawaala Substation by the EPC contractor,
- Temporary storage yard for Kawaala Substation shall be secured on the Kampala North Substation site.
- Resettlement Action Plan to be required for the implementation of component 1, component 2 and component 3 will be completed before the conclusion of EPC contract

6-3 Procurement Plan (Country of Origin of Equipment and Transportation Plan)

6-3-1 Procurement country

Since major equipment required for the construction/rehabilitation of substation and transmission equipment are not manufactured in Uganda, it is planned that these equipment will be procured from abroad.

Since materials required for the construction work such as cement, gravel, steel, concrete block, brick, reinforcing steel, timber, gasoline diesel, construction vehicle, crane, trailer and other materials are accessible in Uganda, it is planned that these materials will be procured in Uganda.

Table 6-3-1.1 shows the procurement plan of the necessary equipment and materials.

Table 6-3-1.1 Procurement Plan

Equipment/Material	Procurement country	
	Uganda	Overseas
Power Transformer	×	○
Air Insulated Switchgear	×	○
Gas Insulated Switchgear	×	○
Auxiliary Transformer	×	○
Diesel Engine Generator	×	○
Steel Structure	×	○
Overhead line	×	○
Control and relay panels	×	○
Construction materials	○	○

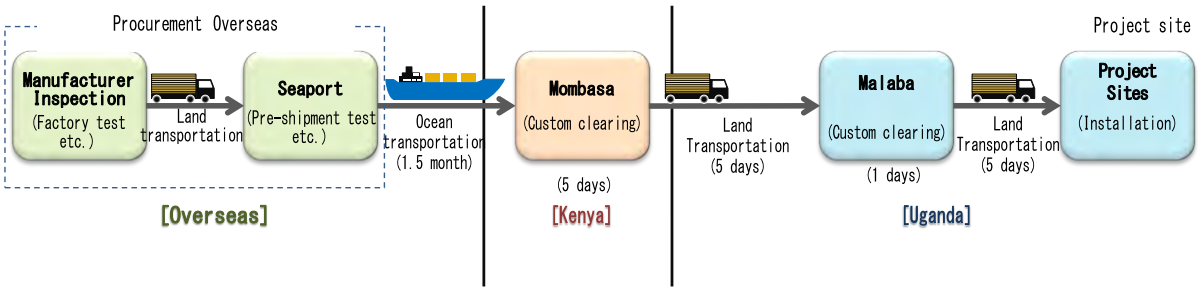
Remark: ○: Procured, △: Possible to be procured, ×: Not procured
Source: JICA Study Team

6-3-2 Transportation plan

In general, materials transported by ocean are off-loaded at Mombasa Seaport in Kenya. After the custom clearance at the port, these materials will be directly transported to each project sites after the custom clearance will be conducted by the Ugandan side at Malaba (border).

Assuming the materials are transported from Japan, it will take approx. 1.5 months to arrive at Mombasa Seaport, Kenya. It will take approx. 10 days for the inland transportation in Kenya up to the border of Uganda. And finally, it will require 5 days at least for the custom clearance and inland transportation in Uganda.

Therefore, it will take approx. 2 months from the loading overseas to each project site in Uganda. The road condition from Mombasa Seaport to each site in Kampala metropolitan area are paved and in a good condition thus major difficulties are not predicted. Figure 6-3-2.1 illustrates the equipment and materials procurement plan from overseas.



Source: JICA Study team

Figure 6-3-2.1 Equipment procurement plan from overseas

This project plans that the major equipment such as power transformer, GIS (220 kV, 132 kV and 33 kV), tower materials etc. will be manufactured overseas and transported to Uganda. Since the proposed transportation routes in Kampala cross some flyovers, the limitation of height was studied as 5 m in maximum. Thus, as long as the height of transportation vehicles, including cargos are within 5 m, it is considered that the transportation will not face problems. Also, as a result of the field survey at Kawaala Substation with an engineer of the leading transportation company in Uganda, it was studied that the surface condition and the width of the access road from the main road to the substation site are satisfactory and the construction work of the access roads will not be required. However, the construction of access roads to Buloba Substation and New Mukono Substation to be newly constructed under the project will be indispensable. Thus, component 1 and component 2 shall include the construction of 8 meter width of access roads from the main road as a work to be borne by the EPC contractor.

Source: JICA Study Team

Photo 6-3-2.1 Typical flyovers crossing on the proposed transportation routes

6-4 Institutional Arrangement for Operation and Maintenance

As stated in chapter 3-2-1 (1), UETCL consists of eight departments, namely, 'Human Resource & administration', 'Finance, accounts & sales', 'Projects implementation', 'Planning & investments', 'Operations & maintenance', 'Information & communications technology', 'Corporate services', and 'Manager, internal audit' (Refer to Figure 3-2-1.1). Among them, Operation & maintenance department is comprised of four sections, 'General affairs & administration division', 'Control section', 'Protection section' and 'Maintenance section' (Refer to Figure 3-2-1.4). The number of staffs is 2 at General affairs & administration division, 20 at the control section, 7 at the protection section and 103 at the maintenance section.

This project will be conducted by the project implementation department and the operation and maintenance after the commissioning will be conducted by the operation & maintenance department.

UETCL has a certain level of technical capacity in system operations and have steadily handled operation and maintenance for power transmission network in Uganda.

The monitoring and control for the existing substations and power transmission lines of the whole country have been carried out in a central monitoring room in Lugogo substation of UETCL. The new and substation in this Project shall be monitored and controlled by Lugogo substation. UETCL allocates staffs to the only selected substations. Under this project, Buloba Substation and New

Mukono Substation will be newly constructed, but the allocation of permanent staffs is not planned.

In this Project, the gas insulated switchgear which is a relatively new technique shall be included. However, UETCL currently operates the gas insulated substation and maintained properly so that it is not the thing which produces a trouble on the operation and maintenance.

6-5 Technical Assistance and Transfer

In this Project, the gas insulated substation which is a relatively new technique shall be included, however the gas insulated substation already had been operated in Uganda. The technique to be necessary in an operation method, a system protection function, maintenance of the gas insulated substation shall not be the thing which largely exceeds the technique of the conventional substations applied in Uganda.

About the mobile substation, it does not require a special technique in principle because a conventional substation is mounted on a trailer. However, the training for the utilization (installation) and cable connection will be carried out in Uganda. Also, the technical transfer on the operation (protection) and maintenance method will be carried out during the factory witness test before shipment.

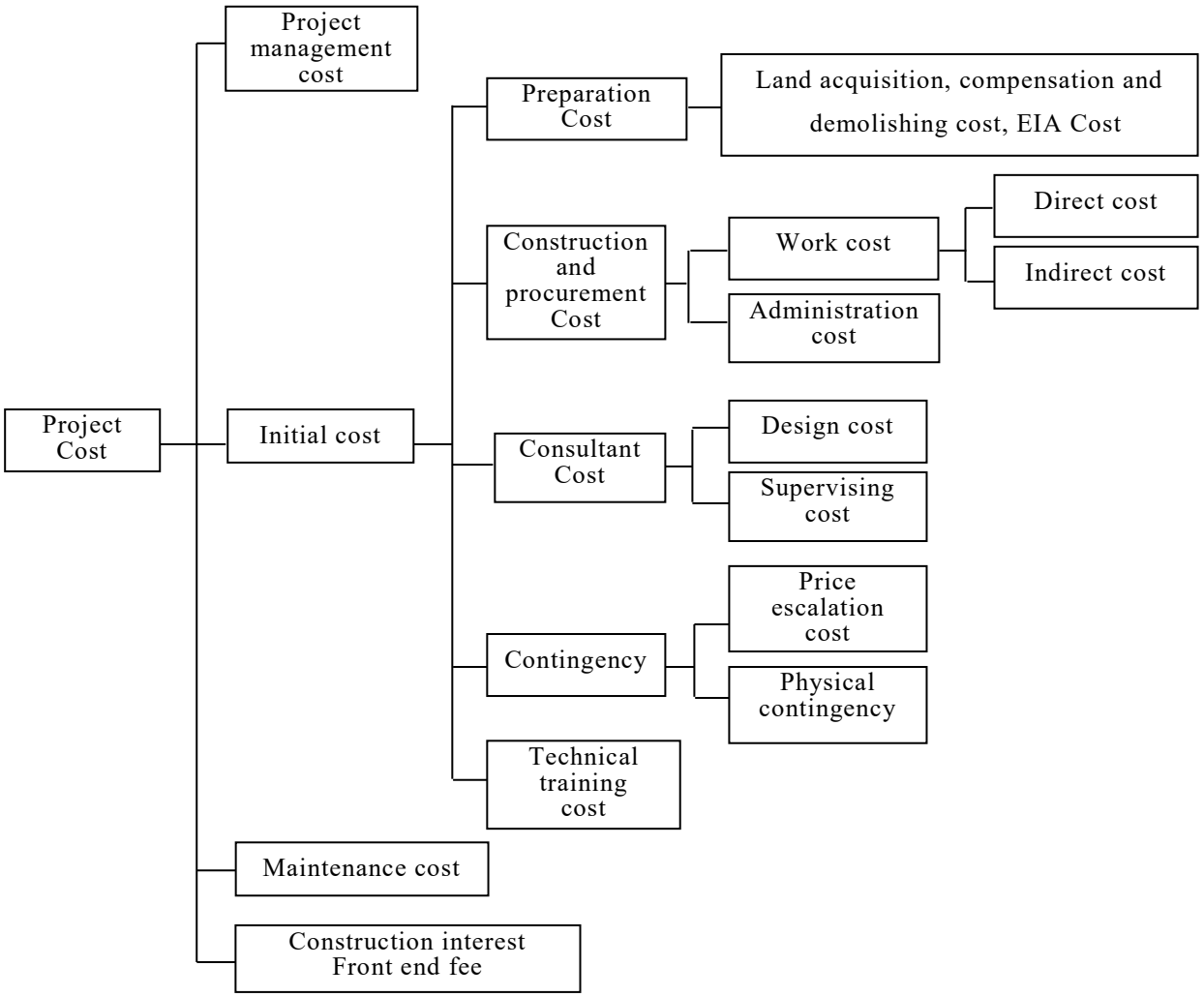
Chapter 7 Cost Estimation and Financial Plan of the Project

7-1 Guidelines for the Project cost estimation

The employment of consultants and procurement of materials and work will be conducted based on the 'Guidelines for the Employment of Consultants under Japanese ODA Loans' and 'Guidelines for Procurement under Japanese ODA Loans'.

7-2 Components of the project cost

The cost estimation will be conducted with reference to the 'Preparatory Survey Manual for design and cost estimation (Trial Edition) March 2009'. General components of the project cost are indicated in Figure 7-2.1.



Source: JICA Study team

Figure 7-2.1 General structure of the project cost

7-3 Cost estimation precondition

The cost estimation was conducted based on Draft Kyotsu Shinsa Jiko for Uganda (16 March

2016) as stated below:

(1) Exchange rate
   1) JPY/USD USD 1 = 115.0 JPY
   2) UGX/USD USD 1 = 3435.1 UGX
   3) JPY/UGX UGX 1 = 0.03348 JPY

(2) Price escalation ratio
   1) Foreign Currency (FC) 1.6%/year
   2) Local Currency (LC) 1.7%/year

(3) Physical contingency
   5.0%

(4) Cost estimation year and month
   March, 2016

(5) Interest during construction
   0.01%

(6) Front end fee
   0.0% (not considered)

(7) Others
   Interest during construction shall be included to the total project cost.

7-4 Cost estimation of the project cost

The project cost consists of the Work cost (construction cost), consultant cost (design and supervision), contingency, project administration cost and interest. Each cost is broken down to the foreign currency portion and local currency portion. Table 7-4.1 shows the cost estimate of the project.

Table 7-4.1 Project cost estimate

Unit: Mill. JPY

No.	Item	Type	Amount
[1]	The Work cost (construction cost)	Direct cost	10,750
[2]	Consultant cost		
		(1) Design cost	1,247
		(2) Supervision cost	
[3]	Contingency cost		1,655
		(1) Price escalation	527
		(2) Physical contingency	1,128
[4]	Administration cost		775
[5]	Land acquisition		1,849
[6]	VAT		2,457
[7]	Interest		7
		(1) Interest during construction	7
		(2) Front End Fee	0
[8]	Total		18,741

Remark: The Work Cost was calculated based on the application of invar conductor as HTLS.
Source: JICA Study Team

Each item was calculated based on the following policy.

(1) The Work Cost (Construction cost)

The cost estimation for the Work cost (construction cost) was based on the construction unit price method and composite construction unit price method and, in principle, the estimation price and actual construction work prices obtained in Uganda were adopted. As for equipment considered to be procured from Japan the cost estimation was obtained by Japanese manufactures.

The breakdown of the Work cost is shown in Table 7-4.2

Table 7-4.2 Breakdown of the Work cost

Item	Foreign Currency (Mill. JPY)	Local Currency (Mill. UGX)	Total (Mill. JPY)	Remark
(1) Construction of substation and transmission equipment	**9,038**	**51,142**	**10,750**	**Base Cost**
Component 1	1,559	16,294	2,105	
Component 2	3,416	15,847	3,946	
Component 3	2,177	7,983	2,444	
Component 4	1,043	11,018	1,412	
Component 5	843	0	843	
(2) Price Escalation	**441**	**2,661**	**530**	
(3) Contingency	**948**	**5,380**	**1,128**	
Total	**10,424**	**59,154**	**12,405**	

Source: JICA Study Team

(2) Design/Supervision cost

In principle, 3,049,000 JPY/MM for Japanese consultant and 25,000,000 UGX/MM for a local

Consultant were applied and calculated based on the work schedule. Finally, price escalation and contingency were added.

The breakdown of design and supervision costs are shown in Table 7-4.3

Table 7-4.3 Design and supervision costs

Item	Foreign Currency (Mill. JPY)	Local Currency (Mill. UGX)	Total (Mill. JPY)	Remark
Design and supervision	**616**	**14,380**	**1,098**	**Base Cost**
Price escalation	**19**	**495**	**36**	
Contingency	**64**	**1,487**	**113**	
Total	**699**	**16,362**	**1,247**	

Source: JICA Study Team

(3) Contingency

5% of physical contingency was calculated to the subtotal of the Work (construction) cost and the price escalation cost.

(4) Administration cost

5% was applied.

(5) Preparation cost

1,849 million JPY will be required for the land acquisition and land compensation for the project sites.

(6) VAT

The Value Added Tax (VAT) and custom tax shall be borne by the Ugandan side and it will amount to 2,457 million JPY.

(7) Interest

0.01% was applied as the interest during the construction for the Work (construction) cost and design/supervisor costs.

7-5 Work scope

Procurement component and the work scope were planned as Table 7-5.1.

7-6 Consulting services implementation plan

Consulting services shall be utilized for the smooth and effective implementation of the Project with the coordination among implementing agency, EPC contractor, JICA, and overseas/local stakeholders. Hence, the selection of the consultant who possesses sufficient qualification and experiences should be carried out in conformity with JICA consultant selection guidelines fairly and promptly. The consulting services shall include the followings:

- Project supervision
- Review of power system planning
- Review of the design and preparation for the tender documents
- Assist to the tender
- Construction supervision
- Supervision of the implementation of Environment Management Plan (EMP), Environment Monitoring Plan (EMoP), Resettlement Action Plan (RAP)
- Technical transfer

Table 7-5.1 Procurement components and work scope

Component	Main contents	Specification	Contents
Component 1 Construction of Buloba Substation	**1-1 Buloba Substation**		
	(1) 220 / 132 kV Transformer	125 MVA×2 units	Construction
	(2) 132 / 33 kV Transformer	40 MVA×2 units	
	(3) 220 kV Switchgear	1 lot	
	(4) 132 kV Switchgear	1 lot	
	(5) 33 kV Switchgear	1 lot	
	(6) Control building	1 building	
	1-2 220 kV Transmission Line		
	(1) Buloba branch point - Buloba Substation	Approx. 0.9 km×4cct	Construction
	1-3 132 kV Transmission Line		
	(1) Buloba branch point - Buloba Substation	Approx. 0.8 km×2cct	Construction
Component 2 Construction of New Mukono Substation	**2-1 New Mukono Substation**		
	(1) 220 / 132 / 33 kV Transformer	125 MVA×3 units	Construction
	(2) 220 kV Gas Insulated Switchgear	1 lot	
	(3) 132 kV Gas Insulated Switchgear	1 lot	
	(4) Control building	1 building	
	(5) 132 kV transmission line (New Mukono Substation - Mukono Substation)	Approx. 0.3 km×2cct	
	2-2 220 kV Transmission Line		
	(1) New Mukono branch point - New Mukono Substation (including the modification of 132 kV transmission line between No.77 and No.78)	Approx. 4.2 km×4cct	Construction
	2-3 132 kV Transmission Line		
	(1) New Mukono Substation - New Mukono branch point (Southern trunk line)	Approx. 0.4 km×2cct	Construction
Component 3 Upgrading of Kawaala Substation and reconductoring of 132 kV Lines	**3-1 Kawaala Substation**		
	(1) 132 / 33 kV Transformer	40 MVA×3 units	Renovation
	(2) 132 / 11 kV Transformer	20 MVA×1 unit	
	(3) 132 kV Gas Insulated Switchgear (Direct connection type to transformers)	1 lot	
	(4) 33 kV Switchgear	1 lot	
	(5) 11 kV Switchgear	1 lot	
	(6) Control building	1 building	
	3-2 132 kV Transmission Line		
	(1) Mukono branch point (Northern trunk line) - Kampala North Substation	Approx. 25.4 km×1cct	Re-conductoring
	(2) Kampala North Substation - Mutundwe Substation	Approx. 10.2 km×2cct	Re-conductoring
	(3) Kampala North Substation - Lugogo Substation	Approx. 5.3 km×2cct	Re-conductoring
	(4) Kawaala branch point - Kawaala Substation	Approx. 0.1 km×2cct	Cabling
Component 4 Upgrading of Bujagali Substation and Mutundwe Substation	**4-1 Bujagali Substation**		
	(1) 220 / 132 / 33 kV Transformer	250 MVA×1 unit	Upgrading
	(2) 220 kV Switchgear	1 lot	
	(3) 132 kV Switchgear	1 lot	
	4-2 Mutundwe Substation		Upgrading
	(1) 132 kV Switchgear	1 lot	
Component 5 Procurement of Mobile Substation	**5-1 Mobile Substation (132 / 33 - 11 kV)**	Approx. 20 MVA×2 units	Procurement

Source: JICA Study team

Chapter 8 Financial and Economical Evaluation of the Project

8-1 Financial Evaluation and Sensitivity Analysis

8-1-1 Objective and Evaluation Indicators of Financial Analysis

(1) Objective

Financial analysis is carried out in order to verify financial sustainability of the project. From a standpoint of project planning, it is essential to examine whether UETCL is able to ensure sufficient cost recovery of the investment for this project, as well as to check and identify risk factors which strongly affect financial sustainability of this project.

(2) Methods and Evaluation Index of Financial Evaluation

Financial analysis is an evaluation of project profitability based on evaluation index. The evaluation indexes used in the financial analysis are "Net Present Value (NPV)," "Benefit-Cost Ratio (B / C Ratio)" and "Financial Internal Rate of Return (FIRR)".

Table 8-1-1.1 Financial Evaluation Index, Definition and Calculation Formula

Financial Evaluation Index	Definition and Calculation Formula
Financial Internal Rate of Return（FIRR)	FIRR is the discount rate which makes FNPV zero
Financial Net Present Value(FNPV)	FNPV＝(Sum of the present value of financial revenue)－(Sum of the present value of finacial cost)
Benefit-Cost Ratio (B/C Ratio)	B/C＝(Sum of the present value of financial revenue)／(Sum of the present value of finacial cost)

Source: Prepared by JICA Study team

With the reference to evaluation of the calculated FIRR, due considerations will be given in the light of the implementing agency' position and characters, financial and economic situation in the country, and so on. It must be examine whether UETCL will be able to overcome those foreseen risks.

FNPV is calculated by the financial discount rate. Financial discount rate is a weighted average of capital cost (WACC). WACC is calculated, based on the composition of capital (fund to be procured). FNPV must turn at least positive. As many unexpected risk might affect the project feasibility in future, FNPV will have to ensure the project feasibility by bearing up such financial risk. Also Benefit-Cost Ratio must be more than 1, at least. The sum of financial revenue must exceed the sum of financial cost.

8-1-2 The Underlying Assumptions of Financial Analysis

(1) Introductory Explanation

Before looking into each underlying assumptions, we overview the composition of assumption items and explain the flow and order.

First of all, let's define the project life of this project.

Secondly, let's explain about how we have set up financial discount rate, with which we will calculate financial net present value.

Thirdly, let's look into the matter of "cost reflective policy", as well as into the basic structure of profit and loss for UETCL. We should take note that ERA's management policy for electricity tariff rate determination has been basically changed in recent years, since it is noteworthy to consider about it before conducting financial calculation.

Fourthly, let's look at the past and current trend of UETCL's bulk sale tariff (BST) rate and then set up the BST price for these financial calculations.

Fifthly, let's take a look at UETCL's purchase price from electricity generation companies. It is the most important item as far as UETCL's cost is concerned.

Sixthly, let's look into the matter of the profit margin (price gap) between BST and the purchase price.

Seventhly, let's check the contribution rate of this project to the UETCL's transmission business. UETCL has already been doing transmission business and it already owns the existing transmission equipment. In addition, the other future projects will be implemented under the other donors' assistance. This project will constitute a part of UETCL's transmission business, but not the whole. UETCL is a single transmission company in Uganda, and there is no other transmission business company. UETCL has been operating transmission not only in Kampala Metropolitan Area but also in Uganda as a whole. In this context, it is necessary to specify the contribution rate of this project as compared with the whole business of UETCL. We should set up some underlying assumptions in consultation with the technical members of the JICA Study Team, in order to specify the contribution rate. However, it is impossible to set up such underlying assumptions with full logical evidence. Some underlying assumptions are set up as a sort of target figures.

Eighthly, let's take a look at the projection of transmission loss/ distribution loss for the project life from 2021 up to 2060. It is also a sort of target figures which are set up assumingly, based on the technical assessment of JICA Study Team.

Ninthly, we will make projection on the BST volume/ BST revenue as well as purchase volume/ purchase cost of UETCL, which correspond to the contribution by this project.

Tenthly, the explanation on the projection on the operation and maintenance cost is shown.

Finally, the explanation on the administration cost is shown.

The followings are respective explanation.

(2) Project Life

For financial analysis and economic evaluation, the project life is generally defined as the operation period when the equipment / facilities which are constructed by the project. The project life does not include the construction period. The construction period for this project is from the commencement of the construction (2017) up to the completion of the construction (2021). In terms of the operation of this project, the project starts to generate revenue from 2021.

The project life span is defined as 40 years starting from 2021. Also, in Uganda depreciation period is set as 40 years. Other donors financing transmission facilities of UETCL typically adopt 50, 40 or 35 years as project life cycle. Usually in Uganda and Japan, transmission facilities are used over 40 years in many cases. Accordingly, the period of 40 years from 2021 to 2060 is defined as the project life. The following shows the summary.

- Construction (Implementation) start year : 2017
- Construction (Implementation) end year : 2021
- Starting year of revenue generation by this project: 2021 (The project shall complete in 2021 and the operation shall start in the same year. Therefore, the starting year of revenue generation is same as the construction end year.)
- Completion year of project evaluation: 2060

(3) Weighted Average of Cost of Capital (WACC), Financial Discounted Rate

The discount rate is set as the weighted average cost of capital (WACC). As shown in the table, WACC for Uganda under this project is calculated to be 7.0%.

Table 8-1-2.1 Calculation of WACC (Financial Discount Rate)

	Item	Debt(Japan)	GoU (UETCL) Equity
A	Weight	0.728	0.272
B	Nominal Cost	0.0844	0.1921
C	Tax	0.18	0.18
D	Tax Adjusted Nominal Cost: B × (1−C)	0.069208	0.157522
E	Inflation Rate	0.0079	0.0579
F	Real Cost = (1+D) / (1+E) −1	0.0608	0.0942
G	Weighted Compact	0.0443	0.0256
	WACC	0.070	

Source: Prepared by JICA Study team

Note: The in-detail calculation process is as follows:

D (Tax Adjusted Nominal Cost): 0.0844 ×(1-0.18) = 0.069208

0.192×(1-0.18) = 0.157522

F (Real Cost): (1+0.069208)/ (1+0.0079)-1=0.0608

	(1+0.157522)/(1+0.0579)-1=0.0942
G (Weighted Compact) :	0.0608×0.728 = 0.0443
	0.0349 ×0.272 = 0.0256
H (WACC) :	0.0443+0.025 = 0.070

Remark: With reference to the prerequisite of cost estimation, 18% of tax is applied to both debt and GoU equity.

The total cost of the project is 18.741 billion JPY. According to the current plan, within this total amount, 13.659 billion JPY (72.5%) is financed by Yen (JICA finance) and the rest, 5.082 billion JPY (27.5%) should be financed by Uganda Shilling.

It is calculated on the assumption that (a) nominal cost of equity is 19.2% (the interest rate of 15-year Treasury Bond of Uganda)[1] and nominal cost of debt (Japanese Yen Credit) is 8.44%. As a matter of fact, although Japanese Yen Credit is 0.01% in case of lending to LDC, Japanese Yen is assumed to be appreciated over Uganda Shilling at the annual rate of 8.43% for the 25 years from 1990 to 2015[2]. Therefore, Yen loan could become heavy burden like high interest rate. (8.44% is the sum of 0.01% and 8.43%)

Over 20 years, Uganda Shilling is depreciated against USD at the rate of 5.3%. Considering this factor, the nominal opportunity cost is calculated as 5.3%. Also, considering the factor shown in the Table 8-1-2.1 7.0% of discount rate is applied when calculating net present value.

(4) Cost Reflective Policy by ERA and the profit and loss structure of UETCL

At first, the Cost Reflective Policy adopted by ERA is reviewed before conducting the financial analysis. The purpose of the policy is to provide management direction for each power company and set their tariff.

ERA pays attention both to keep the sound business management of electricity companies, and maintain appropriate electricity price for end-users. There is no policy to provide subsidy in order to keep low electricity price, which was the case before. Currently, the basic policy of ERA is to achieve necessary cost recovery by setting appropriate tariff by generation and transmission companies under market rule. In case of sudden drop of exchange rate, it should avoid drastic change in the tariff. Yet, as a basic policy, all the cost should be recovered by collecting tariff as a financially sustainable business practice. This is called “cost reflective policy”.

Therefore, there is no subsidy provided except Capacity Charge. In other words, the price

[1] Uganda has seven types of Treasury bond: 91-day, 182-day, 2-year, 5-year, 10-year and 15-year. The longest period, 15-year, was selected.

2 In the economic financial analysis, the relative relationship between the Uganda Shilling - Japanese Yen in consideration of the interest rate and foreign exchange losses is important. It was analyzed on the basis of the annual average terms of 25-year in order to show the comprehensive relative relationship. It should be noted that, the term of 25-year, is a historical exchange rate statistics to be published in the Bank of Uganda.

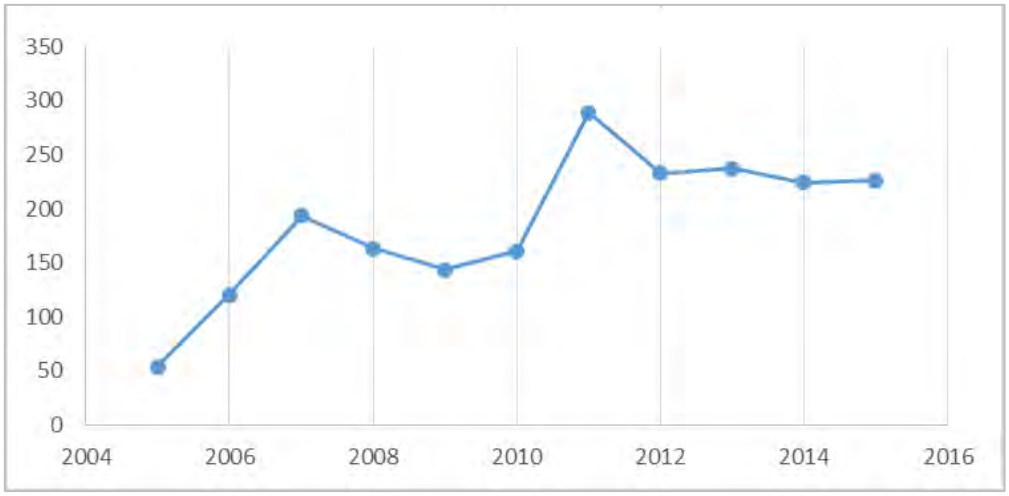
should be set to cover all the necessary cost and ensure self-reliant business of all generation, transmits and distribution companies. In the case of this project, the net revenue of UETCL is the difference of Bulk Sale to distributors, and the purchase cost paid to generators (Bulk Sale - Generation Payment = the Revenue of UETCL). Although they need to make large invest in infrastructure in the future, they have to recover the investment by this net revenue. UETCL has to be sustainable without receiving subsidy from the Government.

Based on the understanding as shown above, let's overview the profit and loss structure of UETCL. In terms of the cost for UETCL, the electricity purchase amount that UETCL buys from the generation companies is overwhelmingly large (88%) of the total cost. On the other hand, in terms of revenue, BST revenue is by far large. It constitutes 85% of the total revenue. So, it can be said that UETCL's profit and loss structure is very simple. It depends substantially on the difference between the BST revenue and the purchase cost from electricity generation companies. Fundamentally, the cost recovery for such large investment for transmission equipment will have to be done, based on the net-income of the BST revenue minus the electricity purchase cost from the electricity generation companies.

The UETCL's Bulk Sale Tariff (BST) is 226.3 UGX / kWh in 2015. In the 1st quarter of 2016, however, the BST was substantially raised to 279.6 UGX, this is 24% increase in such a short period.

(5) The current Bulk Sale Tariff of UETCL (BST) and unit price based on the financial analysis

Looking at the trend of the last 10-year trend of BST, it largely fluctuates year by year. It became 4 times as much as 10 years ago. In particular, there was a sharp rise from 226.3 UGX / kWh (2015) to 279.6 UGX / kWh in the 1st quarter of 2016. Although it can be recognized as the exact implementation result of the cost reflective policy, we can say that it was a very painful price increase to consumers.



Note: Unit: UGX / kWh
Source: Prepared by JICA Study team, based on the data obtained from finance and accounting department of UETCL

Figure 8-1-2.1 The trend of BST from UETCL to UMEME (2005 - 2015)

Table 8-1-2.2 The trend of BST from UETCL to UMEME (2005 - 2015)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
The average price to sell UMEME (Ush/kWh)	54	120.3	193.8	163.26	143.49	160.97	289.3	233.1	237.2	224.6	226.3
The ratio (As the 2005 Value is 100)	100	223	359	302	266	298	536	432	439	416	419

Source: Prepared by JICA Study team, based on the data obtained from finance and accounting department of UETCL

Overviewing the past trend which has fluctuated largely, it is so difficult to foresee the 5-year later price of BST for the year 2021, when the operation of this project will commence. It is, however, likely to be substantially higher than the current price, because the BST price has been on the upsurge trend in the long term.

As already mentioned in the item (3), the ERA's fundamental policy of the Uganda Government for the power sector is to realize the self-sustained business, not relying on subsidy. Basically, all the cost must be recovered from the price to be imposed on end user. For UETCL, the cost incurred for UETCL's business must be recovered from the BST revenue.

Based on the result of the financial analysis conducted for this project, UETCL will be likely to secure FIRR in the sustainable range, even in case of using the current price level. So, from the conservative standpoint of view, we will conduct financial calculation simulation study on the basis of using the current BST price (the 1st quarter of 2016).

(6) UETCL's purchase price from the electricity generating companies

As shown above (5), we have overviewed the past price trend of BST, which constitutes the almost whole revenue for UETCL's transmission business. In this item (6), we will look into the other side: the cost. The 5 year trend of unit purchase price of UETCL is

shown in the following table.

Table 8-1-2.3 The Average Purchase Price from the Electricity Generating Companies

Year	2010	2011	2012	2013	2014
UETCL's purchase price (UGX / kWh)	246.0	319.5	187.9	207.7	199.3

Source: Prepared by JICA Study team, based on the data obtained from finance and accounting department of UETCL

As written in 3-2-1 (2) in Chapter 3, hydro electricity generation recently became dominant in the share of electricity generation. This is beneficial for power sector in Uganda, since electricity generation cost was largely affected by unstable oil price in the past. As of 2011, thermal power generation occupied 36.9% and hydro generation came to occupy 59.2%. Then, the share of hydropower generation suddenly increased, and it came to occupy 89.6% and that of thermal power generation was only 2.7% in 2014. For the same period, UETCL's electricity purchase cost dramatically decreased from 830.3 billion UGX (2011) to 638.5 billion UGX (2014), while the purchase volume increased from 2,599 GWh (2011) to 3,203 GWh (2014). In view of controlling the electricity generation price near the current level, hydropower generation must be strengthened furthermore. However, the share of hydropower generation is already considerably high, there is not so much big room for the more reduction of purchase price. From the viewpoint of energy security in future, Uganda must not rely on only hydropower. As the oil resource development is expected in NDP II, it is expected that the development of thermal power plant by using heavy oil as fuel will be promoted in future. Considering about these current situations, it is not so probable that furthermore cost reduction in power generation will take place in near future. Presuming that cost reduction factor will be offset against cost increase factor, we assume that UETCL's electricity purchase price will be kept as the same level as the current price level.

(7) Price gap between UETCL's BST price and the purchase price from the electricity generating companies

The electricity tariff level of Uganda is already substantially high as compared with the other Africa countries, as we overviewed in 3-2-3 (2) 2) Chapter 3. The cost recovery rate has already reached almost 1. It means that the cost recovery is already done as a whole of the power sector of Uganda. However, it does not lead to the presumption that cost recovery is fully attained within each three sub-sector of power. As already known, the split into the three sub-sectors of power generation, transmission and distribution has already taken place in Uganda. We may assume that cost recovery in generation and distribution has already been achieved, but presumably not in transmission, because private concession has not occurred in transmission but in generation and distribution. The profit pursue by UETCL for the sub-sector of transmission might not be fully

achieved.

In Uganda, the price gap between UTECL's BST and purchase price from the electricity generating companies is only 32.6 UGX / kWh (at the average price of 2014), which is only 7.6% of the end user price. While private operators came to dominant in the generation and distribution sub-sectors, it is not necessarily beneficial for transmission sub-sectors to keep the large revenue. This is probably a political decision/consideration for private companies to newly enter the electricity market. The transmission company, UETCL is a public entity as well as the "single-buyer", its revenue level is kept minimum necessary for its operation, for this political reasons.

Since the profit margin for UETCL which stems from the price gap between BST and the purchase price occupies only 7.6%, we may think that there will remain room for expansion of profit margin for UETCL. In such cases that purchase cost increase should happen in future, UETCL will be able to start negotiation to secure larger share of the profit margin.

(8) Contribution of the project to expanding transmission network in the Kampala metropolitan area

In the Kampala metropolitan area, there are the existing transmission network and newly planned networks financed by other donors such as the Export-Import Bank of China. Therefore, it is necessary to specify the contribution ratio of our project among UETCL's net cash flow.

Power transmission system of Kampala metropolitan area, there are two voltage classes of transmission network: 220 kV and 132 kV. When the transmission loss is ignored as this figure is nominal compared to the amount of power supply, the amount of power that flows at each voltage class is approximately equal. Therefore, the proportion of each class is 50%.

In addition, the substation equipment is considered to be twice important than transmission equipment as the equipment connects a plurality of power transmission lines. In addition, it is necessary for the substation equipment to consider the additional features such as system protection. As a result, the substation equipment is concluded to be twice important of transmission lines and adding 5% of the ratio of the transmission facilities. Therefore, the ratio of substation facility is 35% and that of transmission line is 15%.

For example, as of 2030, the total electricity flow of 220 / 132 kV substation is 1,139 MW whilst the substation to be constructed by the project provides flow of 462 MW. Based on this, by applying the conversion ratio of 0.35, the contribution rate is calculated as below.

(462 MW / 1,139 MW) × 0.35 = 0.14 (14%)

Meantime no transmission network of 220 kV is planned in the JICA project. Therefore, the contribution ratio is 0%. Regarding 132kV substations, demand project is made for each substation in this report and these figures are used for this analysis. The newly planned Kawala substation and Buloba substation, all of the projected demand is considered as contribution. However, regarding Mutundwe substation, it is only rehabilitation. In this case, it contributes to stability and reliability of the related facility. Therefore, the contribution is only 10% of the total projected demand.

As for the mobile substations, since this equipment is proposed to be used during the emergency and maintenance period, the operation rate is assumed to be lower than the normal substations. The planed mobile substations have capacity of 40 MVA. According to the projection, the operation rate of mobile substation will be 10% in 2021. The operation rate is expected to increase up to 20% by 2030 considering that the elapse of 10-year shall increase the occurrence of faulty of existing facilities due to aging, which can respond to 8 MW demand.

Based on the above analysis, the contribution rate for 40 years between 2021 and 2060 are shown in the following table.

Table 8-1-2.4 The contribution rate of the project to the transmission network in Kampala metropolitan area for 40 years (2021 and 2060)

Year	220kV Transforming Equipment Contribution Rate	220kV Trasmission Line Contribution Rate	220kV Level Contribution Rate	132kV Transforming Equipment Contribution Rate	132kV Trasmission Line Contribution Rate	132kV Level Contribution Rate	Mobile Sub-Station Contribution Rate	Total	Year	220kV Transforming Equipment Contribution Rate	220kV Trasmission Line Contribution Rate	220kV Level Contribution Rate	132kV Transforming Equipment Contribution Rate	132kV Trasmission Line Contribution Rate	132kV Level Contribution Rate	Mobile Sub-Station Contribution Rate	Total
2021	12%	0%	12%	5%	5%	11%	1%	24%	2041	14%	0%	14%	5%	5%	10%	1%	25%
2022	13%	0%	13%	5%	5%	11%	1%	25%	2042	14%	0%	14%	5%	5%	10%	1%	25%
2023	14%	0%	14%	5%	5%	11%	1%	25%	2043	14%	0%	14%	5%	5%	10%	1%	25%
2024	14%	0%	14%	5%	5%	11%	1%	26%	2044	14%	0%	14%	5%	5%	10%	1%	25%
2025	14%	0%	14%	5%	5%	11%	1%	26%	2045	14%	0%	14%	5%	5%	10%	1%	25%
2026	14%	0%	14%	5%	5%	11%	1%	26%	2046	14%	0%	14%	5%	5%	10%	1%	25%
2027	15%	0%	15%	5%	5%	11%	1%	26%	2047	14%	0%	14%	5%	5%	10%	1%	25%
2028	15%	0%	15%	5%	5%	11%	1%	26%	2048	14%	0%	14%	5%	5%	10%	1%	25%
2029	15%	0%	15%	5%	5%	10%	1%	26%	2049	14%	0%	14%	5%	5%	10%	1%	25%
2030	14%	0%	14%	5%	5%	10%	1%	25%	2050	14%	0%	14%	5%	5%	10%	1%	25%
2031	14%	0%	14%	5%	5%	10%	1%	25%	2051	14%	0%	14%	5%	5%	10%	1%	25%
2032	14%	0%	14%	5%	5%	10%	1%	25%	2052	14%	0%	14%	5%	5%	10%	1%	25%
2033	14%	0%	14%	5%	5%	10%	1%	25%	2053	14%	0%	14%	5%	5%	10%	1%	25%
2034	14%	0%	14%	5%	5%	10%	1%	25%	2054	14%	0%	14%	5%	5%	10%	1%	25%
2035	14%	0%	14%	5%	5%	10%	1%	25%	2055	14%	0%	14%	5%	5%	10%	1%	25%
2036	14%	0%	14%	5%	5%	10%	1%	25%	2056	14%	0%	14%	5%	5%	10%	1%	25%
2037	14%	0%	14%	5%	5%	10%	1%	25%	2057	14%	0%	14%	5%	5%	10%	1%	25%
2038	14%	0%	14%	5%	5%	10%	1%	25%	2058	14%	0%	14%	5%	5%	10%	1%	25%
2039	14%	0%	14%	5%	5%	10%	1%	25%	2059	14%	0%	14%	5%	5%	10%	1%	25%
2040	14%	0%	14%	5%	5%	10%	1%	25%	2060	14%	0%	14%	5%	5%	10%	1%	25%
2041	14%	0%	14%	5%	5%	10%	1%	25%									
2042	14%	0%	14%	5%	5%	10%	1%	25%									
2043	14%	0%	14%	5%	5%	10%	1%	25%									
2044	14%	0%	14%	5%	5%	10%	1%	25%									
2045	14%	0%	14%	5%	5%	10%	1%	25%									
2046	14%	0%	14%	5%	5%	10%	1%	25%									
2047	14%	0%	14%	5%	5%	10%	1%	25%									
2048	14%	0%	14%	5%	5%	10%	1%	25%									
2049	14%	0%	14%	5%	5%	10%	1%	25%									
2050	14%	0%	14%	5%	5%	10%	1%	25%									
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2056	14%	0%	14%	5%	5%	10%	1%	25%									
2057	14%	0%	14%	5%	5%	10%	1%	25%									
2058	14%	0%	14%	5%	5%	10%	1%	25%									
2059	14%	0%	14%	5%	5%	10%	1%	25%									
2060	14%	0%	14%	5%	5%	10%	1%	25%									

Source: Analyzed and Prepared by JICA Study Team

(9) Improvement of loss during transmission and distribution

Transmission loss of distribution companies is 17% in 2016. Power distribution through the voltage class of 33 kV, which is carried out by this project will contribute to improve the distribution loss forecast stated on the 'Grid Development Plan 2014-2030'. Installed capacity of distribution transformers whose secondary side is 33 kV by the project is going to increase approximately 4% in the metropolitan area (from 73.6% to 77.5%) Multiplying 75% of load factor to 4%, 3% is considered to contribute to the improvement beyond the assumption of UETCL. Therefore, it improved up to 11% with respect to that assumption of UETCL is 14% in 2030. Assuming the same trend of distribution loss will be realized, that will become 4% by 2060. The transmission loss from power stations through the transmission lines of UETCL would be gradually decreased from 3% in 2016, to 2% in 2030, and furthermore to 1% in 2060.

Based on the above-mentioned assumption, the power loss during transmission and distribution is as shown in the following table[3].

Table 8-1-2.5 Expected Change of Electricity Loss during Transmission and Distribution in 2021 through 2060

Year	Distribution Loss	Transmission Loss	Year	Distribution Loss	Transmission Loss	Year	Distribution Loss	Transmission Loss	Year	Distribution Loss	Transmission Loss
2021	17.0%	3.0%	2031	10.8%	2.0%	2041	8.4%	1.6%	2051	6.1%	1.3%
2022	16.3%	2.9%	2032	10.5%	1.9%	2042	8.2%	1.6%	2052	5.9%	1.3%
2023	15.7%	2.8%	2033	10.3%	1.9%	2043	8.0%	1.6%	2053	5.6%	1.2%
2024	15.0%	2.7%	2034	10.1%	1.9%	2044	7.7%	1.5%	2054	5.4%	1.2%
2025	14.3%	2.6%	2035	9.8%	1.8%	2045	7.5%	1.5%	2055	5.2%	1.2%
2026	13.7%	2.4%	2036	9.6%	1.8%	2046	7.3%	1.5%	2056	4.9%	1.1%
2027	13.0%	2.3%	2037	9.4%	1.8%	2047	7.0%	1.4%	2057	4.7%	1.1%
2028	12.3%	2.2%	2038	9.1%	1.7%	2048	6.8%	1.4%	2058	4.5%	1.1%
2029	11.7%	2.1%	2039	8.9%	1.7%	2049	6.6%	1.4%	2059	4.2%	1.0%
2030	11.0%	2.0%	2040	8.7%	1.7%	2050	6.3%	1.3%	2060	4.0%	1.0%

Source: Analyzed and Prepared by JICA Study Team

(10) The revenue generated by JICA project in BST revenue and the electricity purchase cost from the generators

The revenue generated by JICA project in BST can be calculated by BST level which is projected in the above section (4). Also the electricity loss should be taken into consideration. For example, assumingly, 100 GWh electricity is generated in one year with 10% of distribution loss. In such case,

100GWh×{（1÷(1-0.1)）

is the final amount for sales to distributors.

[3] UETCL predicts the amount of power sold to distribution companies considering the distribution loss and the demand forecast of final consumers.

At the same time, transmission loss also should be taken into consideration when UETCL purchase electricity from the generators. If we assume the loss is 5%, for example, the total amount purchased by UETCL should be 100GWh×{（1÷(1-0.1)）×{（1÷(1-0.05)）.

Based on the demand forecast shown in the section 4-1, projected amount of BST sales and amount of electricity purchase from generators are shown in Table 8-1-2.6 and Table 8-1-2.7.

Table 8-1-2.6 BST contributed by the JICA project and its revenue and the purchase cost (2021 - 2060)

Year	UETCL Purchase		Year	UETCL Purchase		Year	UETCL Purchase	
	GWh	(Million USD)		GWh	(Million USD)		GWh	(Million USD)
2021	1,172	97.86	2036	2,080	173.65	2051	2,002	167.17
2022	1,258	105.01	2037	2,074	173.20	2052	1,997	166.76
2023	1,356	113.24	2038	2,069	172.75	2053	1,992	166.35
2024	1,466	122.43	2039	2,064	172.31	2054	1,987	165.94
2025	1,571	131.16	2040	2,059	171.87	2055	1,983	165.53
2026	1,683	140.48	2041	2,053	171.43	2056	1,978	165.12
2027	1,781	148.70	2042	2,048	171.00	2057	1,973	164.72
2028	1,889	157.72	2043	2,043	170.56	2058	1,968	164.31
2029	1,994	166.50	2044	2,038	170.13	2059	1,963	163.91
2030	2,113	176.38	2045	2,033	169.70	2060	1,959	163.52
2031	2,107	175.92	2046	2,027	169.28			
2032	2,102	175.46	2047	2,022	168.85			
2033	2,096	175.00	2048	2,017	168.43			
2034	2,091	174.55	2049	2,012	168.01			
2035	2,085	174.09	2050	2,007	167.59			

Source: Analyzed and Prepared by JICA Study Team)

Table 8-1-2.7 UETCL's Electricity purchase amount required for the JICA project and the cost (2021 - 2060)

Year	UETCL Purchase		Year	UETCL Purchase		Year	UETCL Purchase	
	GWh	Million USD		GWh	Million USD		GWh	Million USD
2021	1,208	70.11	2036	2,118	122.88	2051	2,029	117.70
2022	1,295	75.15	2037	2,112	122.53	2052	2,023	117.37
2023	1,395	80.94	2038	2,106	122.17	2053	2,017	117.04
2024	1,507	87.41	2039	2,100	121.82	2054	2,012	116.72
2025	1,612	93.54	2040	2,093	121.46	2055	2,006	116.39
2026	1,725	100.07	2041	2,087	121.11	2056	2,000	116.06
2027	1,824	105.80	2042	2,081	120.76	2057	1,995	115.74
2028	1,932	112.09	2043	2,075	120.42	2058	1,989	115.42
2029	2,037	118.20	2044	2,069	120.07	2059	1,984	115.10
2030	2,156	125.07	2045	2,064	119.73	2060	1,978	114.78
2031	2,149	124.70	2046	2,058	119.39			
2032	2,143	124.34	2047	2,052	119.05			
2033	2,137	123.97	2048	2,046	118.71			
2034	2,130	123.61	2049	2,040	118.37			
2035	2,124	123.24	2050	2,034	118.04			

Source: Analyzed and Prepared by JICA Study Team

(11) Operation and maintenance cost

The operation and maintenance cost is assumed to be 2% of the total investment which is

approximately 7.2 billion JPY (foreign currency, portion is 6.06 billion yen and JPY portion is 1.14 billion yen). It means $1.4million USD is needed every year for O&M.

(12) Administration cost

The administration cost of UETCL is 81,958 million UGX as of 2014. It is assumed the administration cost would be increased according to the scale of business, electricity demand and the increased contribution of JICA project in the future.

Table 8-1-2.8 Projected administration cost specific to the JICA project (2021 - 2060)

Year	Admini Cost	Year	Admini Cost	Year	Admini Cost
2021	6.04	2036	11.67	2051	11.67
2022	6.53	2037	11.67	2052	11.67
2023	7.12	2038	11.67	2053	11.67
2024	7.75	2039	11.67	2054	11.67
2025	8.38	2040	11.67	2055	11.67
2026	9.03	2041	11.67	2056	11.67
2027	9.65	2042	11.67	2057	11.67
2028	10.31	2043	11.67	2058	11.67
2029	10.97	2044	11.67	2059	11.67
2030	11.67	2045	11.67	2060	11.67
2031	11.67	2046	11.67		
2032	11.67	2047	11.67		
2033	11.67	2048	11.67		
2034	11.67	2049	11.67		
2035	11.67	2050	11.67		

Note: As the power demand forecast covers up to 2030, the administration cost after 2031 is considered to be constant.

Source: Analyzed and Prepared by JICA Study Team

(13) Other assumptions

1) Foreign exchange rate

- The exchange rate between US$ and Uganda Shilling: 3,348.9 UGX / USD
- The exchange rate between Japanese yen and USD: 109.2 JPY / USD

Note: The average exchange rate from November 2015 to February 2016 published by the Bank of Uganda. Four months is set to comply with the prerequisite of cost estimation.

2) Investment cost

The investment cost of this project is estimated in Chapter 6.

8-1-3 Result of Financial Evaluation

(1) FIRR, FNPV and B/C Ratio

The result of financial analysis is as follows:

- FIRR: 13.2%
- FNPV: 147.3 million USD
- B/C Ratio: 1.11

Table 8-1-3.1 Cash-flow by Financial Analysis

Year	Investment Cost	O&M Cost	Administration Cost	Purhcase Cost	Revenue	Net Cash Flow
2016	2.6					-2.6
2017	15.0					-15.0
2018	52.2					-52.2
2019	66.5					-66.5
2020	32.9					-32.9
2021	0.2	1.6	6.2	71.9	97.9	18.0
2022	3.6	1.6	6.7	77.1	105.0	16.0
2023	0.0	1.6	7.3	83.0	113.2	21.3
2024	0.0	1.6	8.0	89.7	122.4	23.2
2025	0.0	1.6	8.6	95.9	131.2	25.1
2026	0.0	1.6	9.3	102.6	140.5	27.0
2027	0.0	1.6	9.9	108.5	148.7	28.7
2028	0.0	1.6	10.6	115.0	157.7	30.6
2029	0.0	1.6	11.3	121.2	166.5	32.4
2030	0.0	1.6	12.0	128.3	176.4	34.5
2031	0.0	1.6	12.0	127.9	175.9	34.5
2032	0.0	1.6	12.0	127.5	175.5	34.4
2033	0.0	1.6	12.0	127.2	175.0	34.3
2034	0.0	1.6	12.0	126.8	174.5	34.2
2035	0.0	1.6	12.0	126.4	174.1	34.1
2036	0.0	1.6	12.0	126.0	173.6	34.1
2037	0.0	1.6	12.0	125.7	173.2	34.0
2038	0.0	1.6	12.0	125.3	172.8	33.9
2039	0.0	1.6	12.0	124.9	172.3	33.8
2040	0.0	1.6	12.0	124.6	171.9	33.7
2041	0.0	1.6	12.0	124.2	171.4	33.7
2042	0.0	1.6	12.0	123.9	171.0	33.6
2043	0.0	1.6	12.0	123.5	170.6	33.5
2044	0.0	1.6	12.0	123.2	170.1	33.4
2045	0.0	1.6	12.0	122.8	169.7	33.4
2046	0.0	1.6	12.0	122.5	169.3	33.3
2047	0.0	1.6	12.0	122.1	168.9	33.2
2048	0.0	1.6	12.0	121.8	168.4	33.1
2049	0.0	1.6	12.0	121.4	168.0	33.1
2050	0.0	1.6	12.0	121.1	167.6	33.0
2051	0.0	1.6	12.0	120.7	167.2	32.9
2052	0.0	1.6	12.0	120.4	166.8	32.8
2053	0.0	1.6	12.0	120.1	166.3	32.8
2054	0.0	1.6	12.0	119.7	165.9	32.7
2055	0.0	1.6	12.0	119.4	165.5	32.6
2056	0.0	1.6	12.0	119.0	165.1	32.5
2057	0.0	1.6	12.0	118.7	164.7	32.5
2058	0.0	1.6	12.0	118.4	164.3	32.4
2059	0.0	1.6	12.0	118.1	163.9	32.3
2060	0.0	1.6	12.0	117.7	163.5	32.2
Total	173	63	0.0	4,674	6,447	1,088

Source: Analyzed and prepared by JICA Study Team

(2) Sensitivity Test

There are two identified risk factors in Sensitivity analysis 1) the increase in investment cost; and 2) profit margin of UETCL (the gap between BST and electricity purchase cost from the generators). Especially the risk factor No.2 has more influence. Looking at the financial structure of UETCL, the major revenue comes from the factor 2. Even after the operation of the JICA project, it heavily affects its cash flow. Based on the past trend in the relevant electricity price, it is very difficult to predict future change. Regarding the risk factor 1, it is a major risk factor before the initiation of the operation. Both for donor side and Uganda side, the cost for construction materials and purchase cost of the facilities and machines should be closely monitored.

Looking at the permanent costs, the direct cost is much larger than indirect cost. Especially, the purchase cost of electricity from generators is quite notable. Compared to this, other costs such as administration and M&E cost does not have large influence on profitability.

Based on this profit structure, the following scenarios are set for Sensitivity Analysis. Please note that Scenario 3-5 is set to examine profitability according to the profit margin (hereafter "price gap")

Scenario 1: Increase in capital investment cost by 20%

Schenario2: Increase in administration cost by 20%

Increase in purchase cost by 20%

Schenario3: Decrease in "price gap" by 20%

Scenario 4: Decrease in "price gap" by 30%

Scenario 5: Decrease in "price gap" by 34.0%

Table 8-1-3.2 Result of Sensitivity Analysis

	Factor to worsen feasibility	FIRR	FNPV	B/C
Base Case	–	13.2%	US$147.3Million	1.11
Case 1	Investment cost 20% up	11.4%	US$121.3Million	1.09
Case 2	Current cost 20% up	12.4%	US$127.9Million	1.10
Case 3	Price gap margin 20% down (Price margin gap: Ushs64.2/kWh)	9.8%	US$63.5Million	1.05
Case 4	Price gap margin 30% down (Price margin gap: Ushs56.2/kWh)	7.8%	US$21.6Million	1.02
Case 5	Price gap margin 34.0% down (Price margin gap: Ushs52.8/kWh)	7.0%	US$4.9Million	1.00

Note: Case 2's current cost means the other cost (purchase cost, administration cost, maintenance cost), which are incurred every year during the operation period, excuding investment cost.

Source: Analyzed and Prepared by JICA Study Team

In the case of Scenario 1 and Scenario 2, the influence is limited. If the investment cost rises by 20%, FIRR is still 11.4%. If the purchase cost rises by 20%, FIRR is still 12.4%.

However, the change in “price gap” affects more heavily as it is the major pillar for the revenue in the UETCL business structure. Among the recurrent cost, the purchase cost of electricity is much larger, compared to the change of other costs such as O&M and administration. If BST decrease by 9.96% or purchase price from generators increase by 15%, FIRR will get down below the hurdle rate. If the BST If the current the “price gap” can be maintained (80.3 UGX per 1kWh), 14.9% of FIRR is ensured. If the “price gap” decreases by 34%, (“price gap” is 52.8UGX / kWh), FIRR is decreasing down to the hurdle rate. If the “price gap” decreases by 20% (“price gap” is 64.2 UGX / kWh), FIRR becomes 11.7%. In the case of 30 % decrease (“price gap” is 56.2 UGX / kWh), FIRR becomes 7.8%.

As we have overviewed the power sector of Uganda in Chapter 3, it is separated into three sub-sectors. In order to secure UETCL’s profit, the point is to procure electricity at cheap price from electricity generation companies as well as to sell electricity to generation companies at reasonably higher price. Looking into the level of end user who is the customers of distribution companies, the electricity price at the end user level is already substantially high. It can be presumed that there is not so much room for furthermore price upsurge for distribution companies.

For UETCL, BST price has been already increased by 24% in the 1st quarter of 2016 as well. For the time being from now, it seems to be difficult for UETCL to make BST price upsurge, since the sudden price hike by 24% at one time is a substantial rise.

8-2 Economical Evaluation and Sensitivity Analysis

8-2-1 Objective and Evaluation Index of Economic Analysis

(1) Objective

While financial analysis is conducted to examine profitability of business and possibility of sound business management, economic analysis is carried out to verify the appropriateness of investment in the project from the viewpoint of a national economy.

(2) Methods and Evaluation Index of Economic Evaluation

Economic analysis is an evaluation of the profitability in the context of the national economy using each evaluation index. The evaluation index used in the economic analysis are, "Economic Net Present Value (ENPV)," "Benefit-Cost Ratio (B / C Ratio)", and "Economic Internal Rate of Return (EIRR)".

Table 8-2-1.1 Evaluation Index and Evaluation Conditions of Economic Analysis

Economic Evaluation Index	Definition and Calculation Formula
Econoic Internal Rate of Return (EIRR)	EIRR is the discount rate which makes ENPV zero
Economic Net Present Value(ENPV)	ENPV＝(Sum of the present value of economic benefit)－(Sum of the present value of economic cost)
Benefit-Cost Ratio (B/C Ratio)	B/C＝(Sum of the present value of economic benefit)／(Sum of the present value of economic cost)

Source: Analyzed and prepared by JICA Study Team

8-2-2 Underlying Assumptions of Economic Analysis

(1) Project Life

The evaluation period is the same as financial analysis.

(2) Economic discount rate for economic analysis

The economic discount rate is usually 8% - 12% as the standard rate which are used by international financial institutions. In the past feasibility studies in Uganda, in some cases 10 % is adopted and 12 % is adopted for other cases. In this JICA project, 12 % is used from rather from a conservative point of view.

(3) Standard Conversion Factor (SCF)

Since the market mechanism in LDC (Less Developed Countries) tend to be distorted due to governmental intervention measures (subsidy, tax, monopoly price etc.), it is sometimes difficult to assess economic effect in those countries without the conversion to economic price. Thus the financial market prices need adjustment by using Standard Conversation Rate. For this study, Uganda's SCF is assumed to be one or 0.98 by referring to other feasibility studies of power projects in Uganda.

(4) Benefit calculation

1) Willingness-to-Pay (WTP)

The economic benefits of this JICA project is estimated based on the principle of by Willingness-to-Pay" (WTP). The basic formula is as follows; WTP = the electricity price ＋the consumer surplus. The Consumer surplus plus the revenue will equal the economic benefit of WTP, by definition. In 2012, UETCL contracted a study project on *"Electricity Affordability and Willingness-to-Pay Study (Part I and part II), Consulting Service for Mirama - Kabale 132kV Power Transmission Line and Related Sub-stations & Study on Affordability of Electricity Services in Uganda (December 2012)"* to a German consulting firm (FICHTNER). In 2007, another study was conducted regarding calculation of WTP, consumer surplus (CS) and cost of unserved energy (CUE) in Uganda in conjunction with Bujagali Power Project. The study name is "Bujagali II - Economic and Financial Evaluation Study (Feb. 2007), Power Planning Associates Ltd."

Based on the study result, we use more updated the data adjusted to the current situation. The WTP in 2012 are separately calculated for households and commerce/industry.

■ WTP for commercial and industrial sector

The study, *Electricity Affordability and Willingness-to-Pay*, calculates WTP by using diesel generators widely used in the commercial and industrial sector as unserved energy /alternative energy. In comparison with electricity tariff set for commercial and industrial sector, the consumer surplus is also calculated. For our study, the data is updated and set WTP for the commercial and industrial sector. Data updated for our study is; 1) price of diesel generators; 2) price of diesel oil. The lifetime of a typical diesel generator assumed to be 7 years. The World Bank study on Bujagali shows the same level as the cost of unserved energy（35.5US Cent / kWh）.

Table 8-2-2.1 Cost for Unserved Energy, WTP, Consumer Surplus in the commercial and industrial sector

Item	Value
A: Cost of diesel generator	USD 37,000
Y: Economic life of generator	10 years
R:Annual capital cost (Discount rate: 18%)	USD 6,548
B: Total kWh per year	87,600
C: Capital Cost	US Cents 7.47 /kWh
DF: Fuel price (diesel oil)	US Cents 79.0 per litter
E: Fuel consumption	0.3 litter/kWh
F: Fuel cost per kWh	US Cents 23.7 /kWh
G: Annual maintenance cost	USD 2,000 /year
H:Maintenance sot per kWh	US Cents 2.3 /kWh
CUE: Total cost of unserved energy	US Cents 33.47 /kWh
J: Average commercial/industrial sector tariff	UGX 479/kWh
EUP: Average commercial / industrial sector tariff	US Cents 14.01 /kWh
CS: Consumer surplus	US Cents 9.73 /kWh
WTP: Willingness to pay	US Cents 23.74 /kWh

Source: Analyzed and prepared by JICA Study Team

Note: The in-detail calculation is as follows:

1. R is calculated as (R= A/M)
2. M=(1-1/(1+0.12)^10)/0.12
3. C=R/B×100
4. F=D×E
5. H=G/B×100
6. CUE=C+F+H

The formula showing the relations among consumer surplus(CS) , End User Price (EUP) and Cost of Unserved Energy (CUE) is; CS={(CUE)-(EUP)}×1/2[4].

[4] With respect to the calculation of the consumer surplus (CS), as a result of application of the area calculation of triangle it is multiplied by 1/2.

In the calculation of the economic benefits, alternative material cost savings (diesel engine generator of energy replacement cost: CUE) is a part of demand in the current. With the difference between the part of the Project and Without Project refers to a benefit based on the additional market supply amount, consisting of Willingness to Pay (WTP) and the Consumer Surplus (CS). Thus, (Corporate WTP) = (CUE) – (CS) and it will amount to US Cents 23.74 / kWh.

With this calculation, WTP for the commercial and industrial sector is UScent23.74/kWh.

- WTP for residential household sector

The above-mentioned study, *Electricity Affordability and Willingness to Pay Study* (2012), conducted extensive survey with individual consumers about affordability and WTP for residential household sector. (916 sample households were chosen from throughout the country, covering the 5 areas, considering about the regional balance and the locational balance among urban area, suburb area and rural villages. The in-detail interview studies were conducted by visiting each household.

According to the study, *Electricity Affordability and Willingness to Pay Study*, which conducted extensive survey, WTP for household sector is 786 UGX / kWh（32.75 USD / kWh）. However, since 2012 the exchange rate has changed, so US cent based WTP should be used. (Uganda shilling has been depreciated by 28% against US$ for these four years (Feb. 2012 - Feb. 2016) (the annual average depreciation rate is 7.8%), based on the Monthly average exchange rate announced by the Central Bank of Uganda.) By reflecting the rise of consumer price (24% increase), current WTP becomes 975 UGX / kWh (28.4 US Cent / kWh).

In the financial analysis, the contribution of this JICA project is split into households (76%) and commerce & industry (24%) as of 2014. The same contribution can be applied to examine economic benefit.

2) Economic benefit as a result of improvement of transmission and distribution loss

Regarding the economic benefit as a result of improvement of transmission and distribution loss, it is calculated based on the assumption described in Section 8-1 (7). The following table show overall result of economic benefit.

Table 8-2-2.2 Economic benefit by the JICA project

Year	Metropolitan Area End User Power Consumption (GWh)	Contribution Rate of this Project (%)	Power consumption contributed by this Projects(Gwh)	Commerial & Industrial WTP Benefit(US$mill)	Residential Household WTP Benefit (US$mill)	WTP Bene Sub-total (US$mill)	Distribution Loss Improvement benefit (US$mill)	Transmission Loss Improvement Benefit (US$mill)	Total Economic Benefit (US$mill)
2016	1,805								
2017	1,989								
2018	2,037								
2019	2,146								
2020	2,300								
2021	2,374	23%	571	103.0	38.9	141.9	1.38	0.18	143.4
2022	2,510	23%	620	111.9	42.3	154.2	1.40	0.18	155.8
2023	2,672	24%	680	122.7	46.4	169.1	1.41	0.18	170.7
2024	2,851	25%	739	133.3	50.4	183.6	1.44	0.19	185.3
2025	3,048	25%	802	144.7	54.6	199.3	1.45	0.19	200.9
2026	3,267	25%	867	156.5	59.1	215.6	1.46	0.19	217.2
2027	3,495	25%	930	167.7	63.4	231.1	1.44	0.19	232.7
2028	3,741	25%	994	179.3	67.7	247.0	1.43	0.19	248.6
2029	4,016	25%	1,063	191.9	72.5	264.4	1.40	0.18	265.9
2030	4,323	25%	1,137	205.1	77.5	282.6	1.37	0.18	284.1
2031	4,323	25%	1,137	205.1	77.5	282.6	1.34	0.18	284.1
2032	4,323	25%	1,137	205.1	77.5	282.6	1.31	0.17	284.1
2033	4,323	25%	1,137	205.1	77.5	282.6	1.28	0.17	284.0
2034	4,323	25%	1,137	205.1	77.5	282.6	1.24	0.17	284.0
2035	4,323	25%	1,137	205.1	77.5	282.6	1.21	0.16	284.0
2036	4,323	25%	1,137	205.1	77.5	282.6	1.18	0.16	283.9
2037	4,323	25%	1,137	205.1	77.5	282.6	1.15	0.16	283.9
2038	4,323	25%	1,137	205.1	77.5	282.6	1.12	0.15	283.9
2039	4,323	25%	1,137	205.1	77.5	282.6	1.09	0.15	283.8
2040	4,323	25%	1,137	205.1	77.5	282.6	1.06	0.15	283.8
2041	4,323	25%	1,137	205.1	77.5	282.6	1.02	0.14	283.8
2042	4,323	25%	1,137	205.1	77.5	282.6	0.99	0.14	283.7
2043	4,323	25%	1,137	205.1	77.5	282.6	0.96	0.14	283.7
2044	4,323	25%	1,137	205.1	77.5	282.6	0.93	0.13	283.6
2045	4,323	25%	1,137	205.1	77.5	282.6	0.90	0.13	283.6
2046	4,323	25%	1,137	205.1	77.5	282.6	0.87	0.13	283.6
2047	4,323	25%	1,137	205.1	77.5	282.6	0.84	0.12	283.5
2048	4,323	25%	1,137	205.1	77.5	282.6	0.81	0.12	283.5
2049	4,323	25%	1,137	205.1	77.5	282.6	0.78	0.12	283.5
2050	4,323	25%	1,137	205.1	77.5	282.6	0.75	0.11	283.4
2051	4,323	25%	1,137	205.1	77.5	282.6	0.72	0.11	283.4
2052	4,323	25%	1,137	205.1	77.5	282.6	0.69	0.11	283.4
2053	4,323	25%	1,137	205.1	77.5	282.6	0.66	0.10	283.4
2054	4,323	25%	1,137	205.1	77.5	282.6	0.63	0.10	283.3
2055	4,323	25%	1,137	205.1	77.5	282.6	0.61	0.10	283.3
2056	4,323	25%	1,137	205.1	77.5	282.6	0.58	0.10	283.3
2057	4,323	25%	1,137	205.1	77.5	282.6	0.55	0.09	283.2
2058	4,323	25%	1,137	205.1	77.5	282.6	0.52	0.09	283.2
2059	4,323	25%	1,137	205.1	77.5	282.6	0.49	0.09	283.2
2060	4,323	25%	1,137	205.1	77.5	282.6	0.46	0.08	283.1

Notes: Distribution transformers are installed at Buloba Substation and Kawaala Substation. These transformers shall contribute to the shortening of the distribution line and improvement of voltage drop. Therefore, the distribution loss will be reduced.

Source: Analyzed and Prepared by JICA Study Team

8-2-3 The results of Economic Evaluation

(1) EIRR, ENPV and B/C Ratio

EIRR: 40.8%

ENPV: USD 550.2 million

B/C Ratio: 2.11

Table 8-2-3.1 The Cash-flow of the Economic Evaluation of the JICA project

Year	Investment cost	O&M cost	Purchase cost	Administration cost	Benefit	Net cash flow
2016						
2017	11.1					-11.1
2018	43.0					-43.0
2019	54.6					-54.6
2020	26.3	0.0				-26.3
2021	0.2	1.2	45.5	5.7	140.8	88.3
2022	0.0	1.2	49.3	6.2	153.6	96.9
2023	0.0	1.2	53.5	6.8	168.5	107.1
2024	0.0	1.2	57.4	7.4	182.7	116.7
2025	0.0	1.2	62.1	8.0	198.1	126.8
2026	0.0	1.2	67.4	8.6	214.0	136.8
2027	0.0	1.2	73.0	9.3	230.1	146.6
2028	0.0	1.2	79.1	10.0	246.9	156.5
2029	0.0	1.2	86.2	10.7	264.8	166.7
2030	0.0	1.2	86.6	11.5	283.6	184.3
2031	0.0	1.2	86.4	11.5	283.6	184.6
2032	0.0	1.2	86.1	11.5	283.6	184.8
2033	0.0	1.2	85.9	11.5	283.5	185.0
2034	0.0	1.2	85.6	11.5	283.5	185.2
2035	0.0	1.2	85.4	11.5	283.5	185.4
2036	0.0	1.2	85.1	11.5	283.5	185.7
2037	0.0	1.2	84.9	11.5	283.4	185.9
2038	0.0	1.2	84.6	11.5	283.4	186.1
2039	0.0	1.2	84.4	11.5	283.4	186.3
2040	0.0	1.2	84.1	11.5	283.3	186.5
2041	0.0	1.2	83.9	11.5	283.3	186.7
2042	0.0	1.2	83.7	11.5	283.3	186.9
2043	0.0	1.2	83.4	11.5	283.2	187.1
2044	0.0	1.2	83.2	11.5	283.2	187.4
2045	0.0	1.2	82.9	11.5	283.2	187.6
2046	0.0	1.2	82.7	11.5	283.1	187.8
2047	0.0	1.2	82.5	11.5	283.1	188.0
2048	0.0	1.2	82.2	11.5	283.1	188.2
2049	0.0	1.2	82.0	11.5	283.1	188.4
2050	0.0	1.2	81.8	11.5	283.0	188.6
2051	0.0	1.2	81.5	11.5	283.0	188.8
2052	0.0	1.2	81.3	11.5	283.0	189.0
2053	0.0	1.2	81.1	11.5	282.9	189.2
2054	0.0	1.2	80.9	11.5	282.9	189.4
2055	0.0	1.2	80.6	11.5	282.9	189.6
2056	0.0	1.2	80.4	11.5	282.8	189.8
2057	0.0	1.2	80.2	11.5	282.8	190.0
2058	0.0	1.2	80.0	11.5	282.8	190.2
2059	0.0	1.2	79.7	11.5	282.8	190.4
2060	0.0	1.2	79.5	11.5	282.7	190.5

Source: Analyzed and Prepared by JICA Study Team

(2) Sensitivity Analysis

Sensitivity analysis was conducted with the following scenario and three risk factors.

- Case1: Increase in capital investment cost by 20% compared to the original plan
- Case 2: Increase in capital investment cost by 20% compared to the original plan, and increase in the recurrent cost (administration, O&M, electricity purchase cost from generators)
- Case 3: Only 50% of unserved energy exists compared to the plan.
- Case 4: Fixing the tariff equal to WTP without considering unserved energy

Table 8-2-3.2 The Result of the Sensitivity Test on Economic Projection

Item	Risk factor	EIRR	ENPV (Million USD)	B/C
Base case	-	40.8%	550.2	2.11
Case 1	Investment cost 20% up	36.4%	528.0	2.02
Case 2	Investment cost 20% up and recurrent cost 20% up	33.5%	450.3	1.75
Case 3	Assuming the consumer surplus is a half of the Base case	31.1%	323.1	1.65
Case 4	Neglecting the consumer surplus (assuming the end user price is equivalent to WTP)	20.4%	121.6	1.24

Source: Analyzed and Prepared by JICA Study Team

In case of. 20% increase of capital investment, EIRR becomes 36.4 % (4.4% down from the plan). The overall influence is still limited. In the case of increase in capital investment cost by 20% and the recurrent cost, EIRR is still 33.5%.

However, if the tariff is fixed as WTP without considering unserved energy, EIRR sharply drops to 20.4% (case 4). If we assume 50% of unserved energy exists. EIRR become 31.1 %.

8-3 Summary of the results of financial analysis and economic evaluation

8-3-1 Summarized Results

The following points are the summary of the results of financial and economic analysis.

- As shown by the result of financial analysis, FIRR of basic case is 13.2%, which is 6.2% more than the hurdle rate (7.0%). It indicates that this project is feasible from a financial point of view. In the assumption, the electricity tariff would continue the same as of the first quarter of 2016. This is rather a conservative assumption. Actually, considering the recent upward trend of electricity tariff, BST is most likely to increase. In that case, the financial situation would be even better.

- However, even if FIRR is 13.2% as described above, it will be so difficult for private companies to carry out this project. This project needs a vast amount of investment, and it will need a long period for the investor companies to get return on investment. In addition, since UETCL has been positioned as the sole power transmission business utility in Uganda's power policy, it is not possible for private companies to enter the power transmission business.
- To fix the tariff and secure the revenue, UETCL should follow the Cost Reflective Policy of the Uganda Government. It is important to implement the policy and fix the appropriate tariff by reviewing the tariff level every 3 months to recover the cost.
- Economic Evaluation shows high feasibility and sustainability of the project. EIRR is beyond the hurdle rate, with the current consumer final price without considering unserved energy.
- However, the exchange rate can be a risk factor; Uganda often experience sudden depreciation of its currency, which can lead to inflation and enlargement of burden of external debt. This can affect stability of the project with JPY based loan.
- According to NDP II of Uganda, there are many infrastructure projects are to be implemented from now on. While this positively stimulates economy, the burden of external debt can be also notable. At this moment, the amount of external debt shows upward trend; it is more than 30% of GDP, compared to 22% in 2008. It is now 34.7% and expected to become even more in the future. Yet, the repayment period of yen loan of this project is 40% (10 year grace period) and so it does not add pressure to Uganda Government.

It is extremely difficult for private sector to conduct such a scale of the project considering the lending rate of private banks. On the other hand, utilization of public funds such as JICA loan scheme which includes ultra-long-term with ultra-low interest rates to implement the project is advantageous from Uganda's economic view, even if risk factors such as exchange rate fluctuations of the Uganda shilling are taken into consideration. Therefore, the implementation of this project from the point of view of economic financial analysis is concluded to be desirable for the country.

8-3-2 Monitoring Indicators

The following monitoring indicators can be proposed from a point of view of finance and economy.

(1) Management of UETCL

- ✓ Price level of BST (reflecting Cost Reflective Policy)
- ✓ Electricity purchase price from generation companies
- ✓ Ration between consumer price and electricity tariff

- ✓ Administration cost
- ✓ Percentage of transmission loss
- ✓ Percentage of distribution loss
- ✓ Maximum and average load factor of new substations
- ✓ Performance of rehabilitated substations comparing before and after (interview)
- ✓ Marketing income
- ✓ Cost
- ✓ Profit before tax

(2) Improvement of citizen life in Kampala Metropolitan Area

- ✓ The number of blackout and duration of blackout
- ✓ Satisfaction of commercial users
- ✓ Satisfaction of household users
- ✓ Maximum and average load factor of new substations

(3) Contribution to economy and external debt

- ✓ Economic Growth
- ✓ External debt (ratio against GDP and national revenue, and debt service ratio)

Chapter 9 Environmental and Social Considerations

9-1 Environmental Impact Assessment

9-1-1 Summary of the Project Components

The Project mainly consists of the following components:

- Construction of new substations and associated transmission lines at Buloba and Mukono
- Renovation of existing substation at Kawaala and cabling of associated transmission line
- Upgrade of existing substations at Mutundwe and Bujagali
- Reconductoring of existing transmission lines

Details of each project components are described in the ensuing sections.

(1) Construction of Buloba substation and associated transmission lines

The Buloba substation will be constructed in Mpigi District, approximately 25 km west of central Kampala. The substation will connect to the Kawanda–Masaka 220 kV Transmission Line (currently under construction) by constructing two 220 kV transmission lines of approximately 0.9 km length.

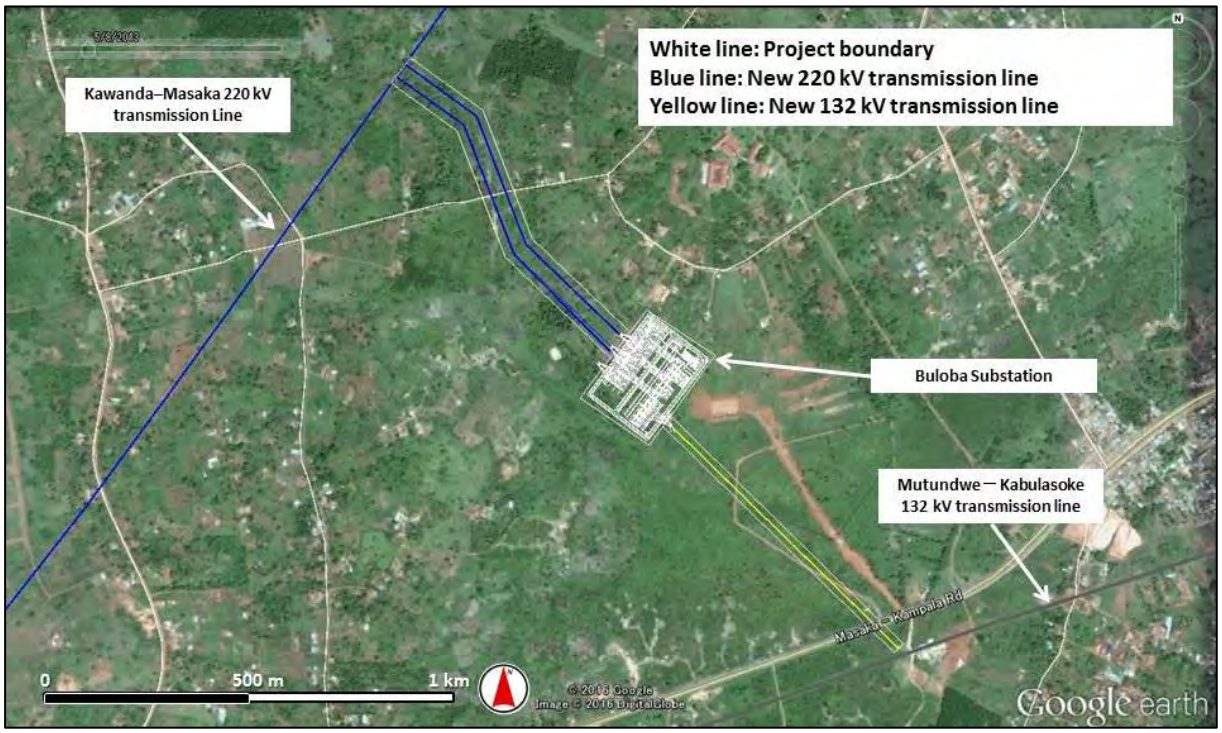
The Buloba substation will also be connected to the existing Mutundwe－Kabulasoke 132 kV transmission line located immediately south of Kampala‐Mityana Road, by constructing a 132 kV transmission line of approximately 0.8 km length. A new access road of approximately 750 m length (8 m width) will also be constructed within the corridor of the 132 kV transmission line, which will connect the new substation with Kampala–Mityana Road.

Table 9-1-1.1 shows the specifications of Buloba substation and associated transmission line. Figure 9-1-1.1 shows the layout of Buloba substation and associated transmission line.

Table 9-1-1.1 Specifications of Buloba substation and associated transmission line

Main component	Specification
Substation	Approx. area: 200 m x 260 m
220 / 132 kV Transformer	125 MVA×2units
132 / 33 kV Transformer	40 MVA×2units
220 kV Switchgear	1 lot
132 kV Switchgear	1 lot
33 kV Switchgear	1 lot
Control building	1 lot
220 kV Transmission Line	Approx. 0.9 km×4cct
132 kV Transmission Line	Approx.0.8 km×2cct
Access road	Approx. 8 m x 750 m

Source: JICA Study Team



Source: JICA Study Team

Figure 9-1-1.1 Layout of Buloba substation and associated transmission line

(2) Construction of Mukono substation and associated transmission lines

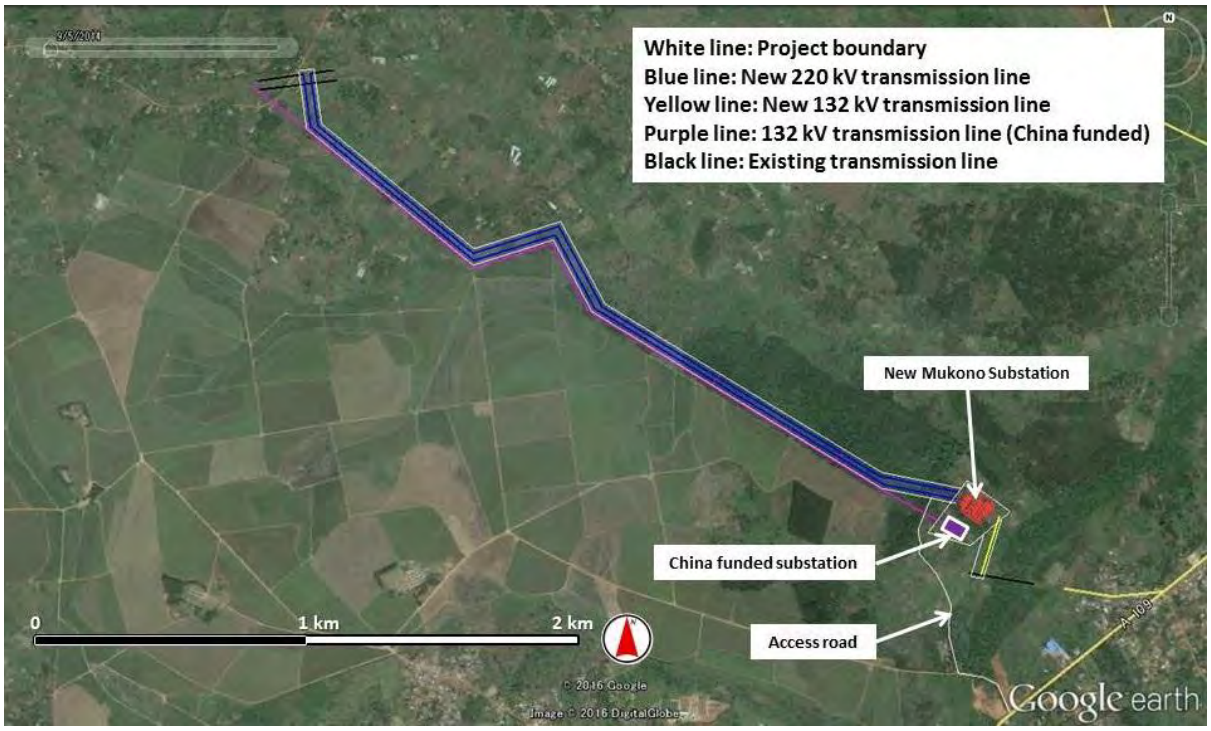
The Mukono substation will be constructed in Mukono District, approximately 25 km east of central Kampala. The substation will be constructed within the site boundary of the Chinese government funded 132 kV/33 kV substation, which is supposed to be completed prior to this Project. The substation will connect to the existing Bujagali–Kawanda 220 kV transmission line located north of the substation by constructing two 220 kV transmission lines (length of approx. 4.2 km). A 132 kV transmission line (length of approx. 0.4 km) will also be constructed, which will connect to the existing Kirra Nalubale－Lugogo 132 kV transmission line located south of the substation. A new access road of approximately 1,200 m (8 m width) length will be constructed over an existing dirt road running between the substation and main road (road A109).

Table 9-1-1.2 shows the specifications of Mukono substation and associated transmission line. Figure 9-1-1.2 shows the layout of Mukono substation and associated transmission line.

Table 9-1-1.2 Specifications of Mukono substation and associated transmission line

Main component	Specification
Substation	Approx. area: 130 m x 105 m
220 / 132 / 33 kV Transformer	125 MVA×3units
220 kV Gas Insulated Switchgear	1 lot
132 kV Gas Insulated Switchgear	1 lot
Control building	1 lot
220 kV Transmission Line	Approx. 4.2 km×4cct
132 kV Transmission Line	Approx. 0.4 km×2cct
Access road	Approx. 8 m x 1,200 m

Source: JICA Study Team



Source: JICA Study Team

Figure 9-1-1.2 Layout of Mukono substation and associated transmission line

(3) Renovation of Kawaala substation

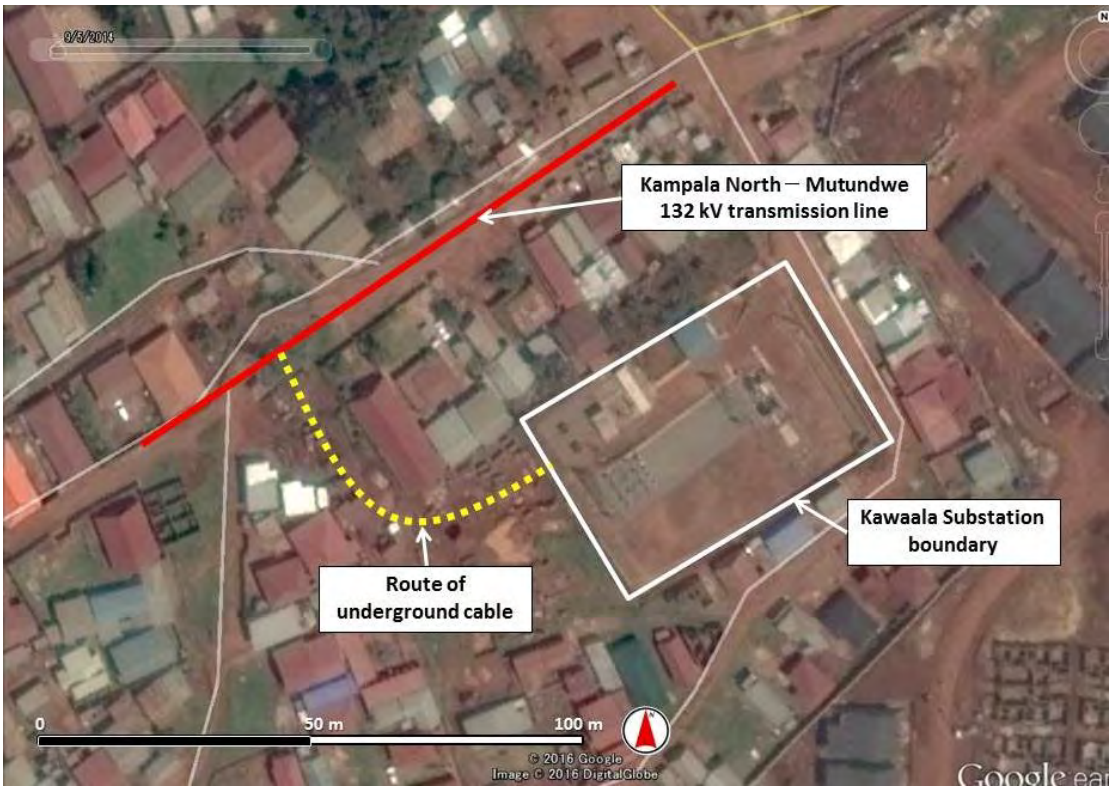
Kawaala substation is an existing substation located approximately 5 km the north-west area in the central area of Kampala, in Kampala District. The substation will be renovated by removing the existing facilities and replacement by new transformers, switchgears and control building. The existing overhead transmission line that connects to the Kampala North-Mutundwe 132 kV transmission line will also be replaced by installing new underground transmission line of approximately 100 m length.

Table 9-1-1.3 shows the specifications of Kawaala substation and associated transmission line. Figure 9-1-1.3 shows the layout of the existing Kawaala substation and route of the underground transmission line.

Table 9-1-1.3 Specifications of Kawaala substation and associated transmission line

Main component	Specification
Substation	
132/33 kV transformer	40 MVA×3
132/11 kV transformer	20 MVA×1
132 kV Gas Insulated Switchgear	1 lot
33 kV Switchgear	1 lot
11 kV Switchgear	1 lot
Control building	1 lot
132kV transmission line (underground)	Approx. 0.1 km×2cct

Source: JICA Study Team



Source: JICA Study Team

Figure 9-1-1.3 Layout of existing Kawaala substation and route of underground transmission line

(4) Upgrade of Bujagali substation

Bujagali substation is an existing substation located inside the Plot of Bujagali Hydroelectric Power Station. The substation will be upgraded by installing new transformers and switchgears inside available empty space. Table 9-1-1.4 shows the specifications of Bujagali substation. Figure 9-1-1.4 shows the existing layout of Bujagali substation and planned upgrade area.

Table 9-1-1.4 Specifications of Bujagali substation

Main component	Specification
Substation	
220/132/33 kV transformer	250 MVA×1
220 kV Switchgear	1 lot
132 kV Switchgear	1 lot

Source: JICA Study Team

Source: JICA Study Team

Figure 9-1-1.4 Layout of existing Bujagali substation and planned upgrade area

(5) Upgrade of Mutundwe substation

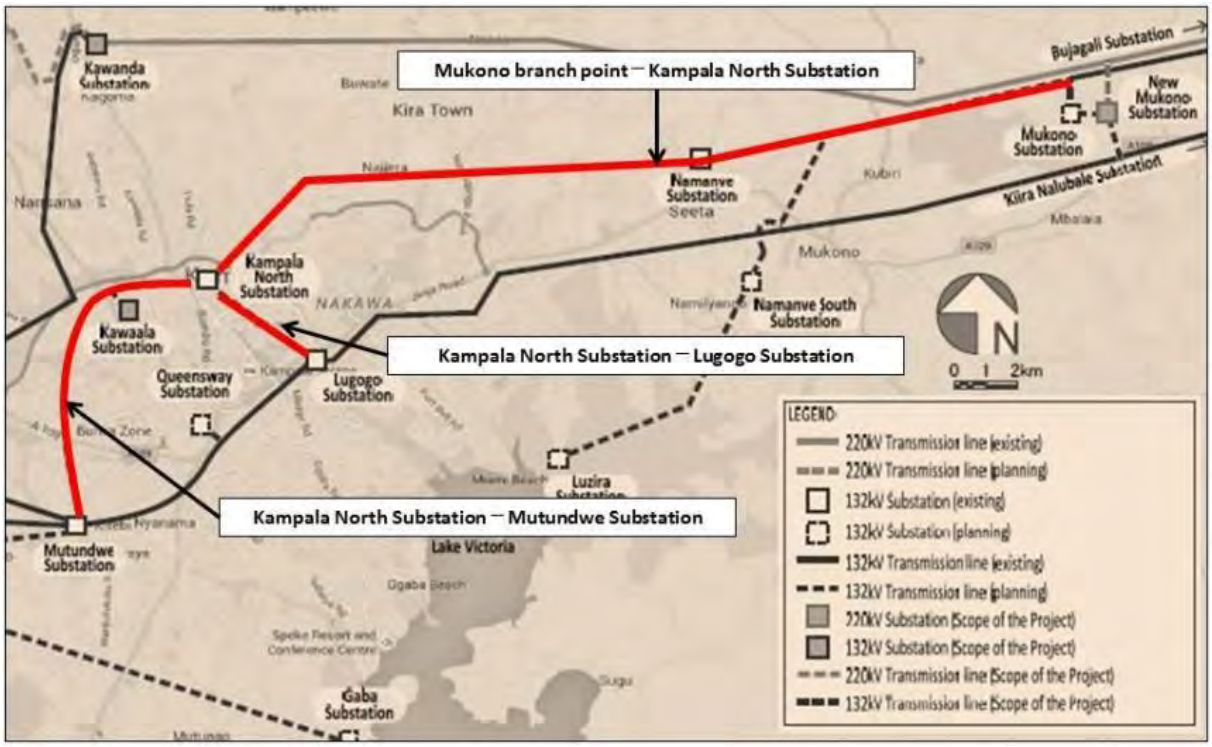
Mutundwe substation is an existing substation located in Lubaga Division, Kampala District. The substation will be upgraded by installing one unit of 132 kV switchgear.

(6) Reconductoring of existing transmission lines

Approximately 41 km of existing 132 kV transmission lines will be reconductored (removed and replaced by new higher capacity lines). The existing transmission towers will continue to be used. The transmissions that will be reconductored as part of this Project are:

- Mukono branch point (Northern trunkline)－Kampala North substation: Approx. 25.4 km x 1 cct
- Kampala North substation－Mutundwe substation: Approx. 10.2 km x 2 cct
- Kampala North substation－Lugogo substation: Approx. 5.3 km x 2 cct

Figure 9-1-1.5 shows the transmission lines subject to reconductoring works as indicated by the red line.



Source: JICA Study Team

Figure 9-1-1.5 Transmission lines subject to reconductoring works (red line)

9-1-2 Environment and Social Baseline Condition

(1) Air quality

Air quality survey was conducted in April 2016 at Buloba, Mukono, Kawaala, Bujagali and Mutundwe sites. Surveyed parameters were Total Suspended Particles (TSP), PM10 and PM2.5. Measurements were made using a portable meter (Casella Microdust Pro) for 10 minutes per site. The measurement sites were selected by taking into account sensitive receptors in the vicinity. Figures 9-1-2.1 to 9-1-2.5 shows the location of surveyed sites. Table 9-1-2.1 shows the results of the survey.

Source: JICA Study Team

Figure 9-1-2.1 Location of air quality survey sites (Buloba)

Source: JICA Study Team

Figure 9-1-2.2 Location of air quality survey sites (Mukono)

Source: JICA Study Team

Figure 9-1-2.3 Location of air quality survey sites (Kawaala)

Source: JICA Study Team

Figure 9-1-2.4 Location of air quality survey sites (Bujagali)

Source: JICA Study Team

Figure 9-1-2.5 Location of air quality survey sites (Mutundwe)

Table 9-1-2.1 Results of air quality survey

	Site	Location (UTM 36M)	TSP (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	Note
Buloba	1	432122E, 28384N	1	ND	ND	Substation
	2	432122E, 28581N	1	ND	ND	Nuns' residence
	3	432130E, 28709N	1	ND	ND	Nursery school
	4	431938E, 28977N	1	ND	ND	Homestead
	5	431873E, 28847N	1	ND	ND	Residential, kiosk
Mukono	1	480605E, 41823N	1	ND	ND	NFA camp
	2	480527E, 42663N	1	ND	ND	Substation perimeter
	3	478224E, 44127N	1	ND	ND	Homestead
	4	477419E, 44615N	1	ND	ND	Homestead
Kawaala	1	448764E, 37072N	3	ND	ND	Substation perimeter
	2	448725E, 37077N	1	ND	ND	Open land
	3	448785E, 37136N	8	1	ND	Medical clinic
Bujagali	1	514953E, 55448N	1	ND	ND	Construction office
	2	515039E, 55312N	1	ND	ND	Substation boundary
	3	515078E, 55445N	2	ND	ND	Control building
Mutundwe	1	448185E, 32427N	1	ND	ND	Homestead
	2	448208E, 32518N	5	1	1	Homestead
	3	448041E, 32484N	1	ND	ND	Homestead
	4	448060E, 32413N	1	ND	ND	Homestead

	Site	Location (UTM 36M)	TSP (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	Note
Draft Uganda national standard			300	-	-	24-hour average
WHO Guideline value				50	25	24-hour average

ND: Not detected

Source: Project EIA report

(2) Noise

Noise quality survey was conducted in April 2016 at Buloba, Mukono, Kawaala, Bujagali and Mutundwe sites. Noise level was measured using portable sound meter (Casella CEL-621C2) for 10 minutes per site (survey sites are same as air quality). Table 9-1-2.2 shows Uganda national noise standard stipulated under The National Environment (Noise Standards and Control) Regulations, 2003. Table 9-1-2.3 shows the results of the survey. According to the survey, noise levels were more or less within 45-55 dB, which are below the noise standard for "Mixed residential area". No sites exceeded noise standard for "Residential + industry".

Table 9-1-2.2 Uganda national noise standard

Column 1	Column 2	
Facility	Noise Limits B (A) (Leq)	
-	DAY	NIGHT
A. Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites.	45	35
B. Residential buildings	50	35
C. Mixed residential (with some commercial and entertainment)	55	45
D. Residential + industry or small scale production + commerce	60	50
E. Industrial	70	60

Source: The National Environment (Noise Standards and Control) Regulations, 2003.

Table 9-1-2.3 Results of noise survey

	Site	Location (UTM 36M)	Noise level dB(A)				Main noise source
			L_{Max}	L_{eq}	L_{90}	L_{50}	
Buloba	1	432122E, 28384N	62.5	46.2	40.5	42.5	Distant highway
	2	432122E, 28581N	71.5	50.8	38.0	41.5	Distant highway
	3	432130E, 28709N	78.8	58.4	41.0	52.5	Nursery school
	4	431938E, 28977N	64.6	43.9	37.5	40.0	Conversation
	5	431873E, 28847N	78.3	56.4	40.0	45.5	Conversation
Mukono	1	480605E, 41823N	60.6	49.1	45.5	48.5	Distant highway
	2	480527E, 42663N	67.0	45.2	34.5	38.5	Motorbike
	3	478224E, 44127N	72.3	47.2	34.5	38.0	Conversation
	4	477419E, 44615N	76.2	45.6	36.5	40.0	Motorbike
Kawaala	1	448764E, 37072N	68.2	47.8	41.0	44.0	Conversation
	2	448725E, 37077N	63.4	47.3	39.0	43.0	Conversation
	3	448785E, 37136N	77.2	56.6	48.5	51.5	Vehicles
Bujagali	1	514953E, 55448N	70.8	49.8	40.5	44.5	Conversation
	2	515039E, 55312N	60.6	45.7	41.5	44.5	Conversation
	3	515078E, 55445N	68.1	49.7	45.0	46.0	Vehicles
Mutundwe	1	448185E, 32427N	66.7	44.3	40.0	42.0	Vehicles
	2	448208E, 32518N	70.1	48.6	40.5	43.5	Conversation
	3	448041E, 32484N	66.2	50.8	47.5	48.5	Conversation
	4	448060E, 32413N	67.4	49.5	47.5	48.5	Vehicles

[Remark] ND: Not detected

Source: Project EIA report

(3) Water quality

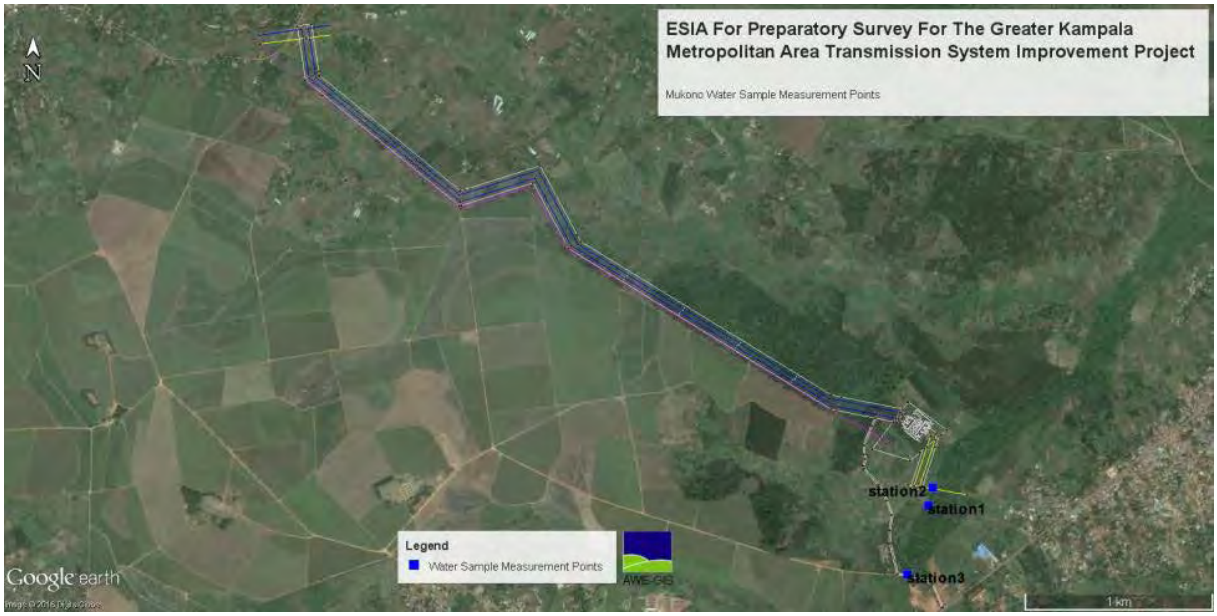
Water quality survey was conducted in April 2016 at Buloba and Mukono sites at adjacent water areas (e.g. streams, pond and borehole). Surveyed parameters were Water temperature, pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Nitrogen (T-N), Total Phosphorous (T-P), Suspended Solids (SS), Chemical Oxygen Demand (COD) and Oil. Water temperature, pH, EC and DO were measured *in-situ* using multi-water quality meter (HANNA HI 9828). Other parameters were analyzed at the laboratory of National Water and Sewerage Corporation (NWSC). Figures 9-1-2.6 and 9-1-2.7 show the location of the survey sites. Tables 9-1-2.4 and 9-1-2.5 show the survey results and Japanese standard for reference.

At Buloba, Stations 2 (spring) and 3 (pond) had low DO levels and relatively high COD levels, which probably is due to the limited water exchange that occurs at the sites. Station 1 (borehole) had relatively high levels of COD, SS and oil, which indicates that the water is not suitable for drinking.

At Mukono, Stations 2 and 3 had high levels of oil content, and COD was high at all the sites. Since there are no obvious pollution sources in the vicinity, these high levels may be due to inflow of domestic wastewater and agricultural runoff from upstream areas.

Source: Project EIA report

Figure 9-1-2.6 Location of water quality survey sites (Buloba)



Source: Project EIA report

Figure 9-1-2.7 Location of water quality survey sites (Mukono)

Table 9-1-2.4 Results of water quality survey (Buloba)

	Unit	St. 1 (Borehole)	St. 2 (Pond)	St. 3 (Spring)	Japanese water quality standard (lakes)
Water temp.	˚C	25	24	27	-
pH	-	6.3	5.94	7.3	6.5-8.5 (Class B)
EC	µS/cm	81	24	112	-
DO	mg/l	1.3	1.71	1.85	> 5.0 mg/l (Class B)
T-N	mg/l	0.9	1.3	1.2	< 1 mg/l (Class V)
T-P	mg/l	0.1	0.2	0.2	< 0.1 mg/l (Class V)
SS	mg/l	60	13	10	< 15 mg/l (Class B)
COD	mg/l	14	13	18	< 5 mg/l (Class B)
Oil	mg/l	0.8	0.3	5.3	-

Source: Project EIA report

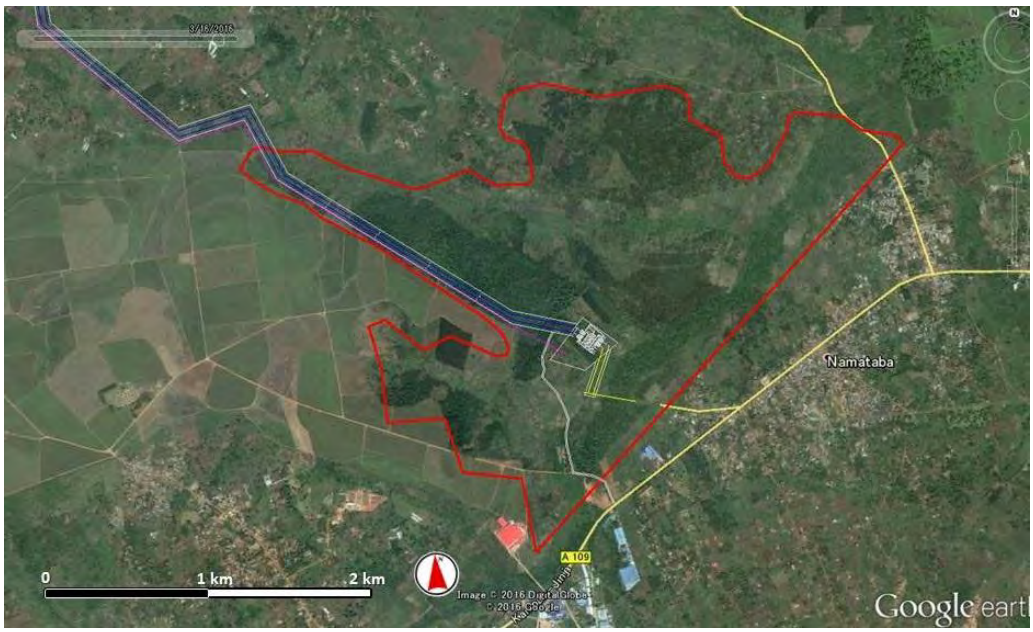
Table 9-1-2.5 Results of water quality survey (Mukono)

	Unit	St. 1 (Stream)	St. 2 (Stream)	St. 3 (Stream)	Japanese water quality standard (rivers)
Water temp.	˚C	22.50	22.58	22.86	-
pH	-	7.23	7.33	7.7	6.5-8.5 (Class C)
EC	µS/cm	126	126	144	-
DO	mg/l	4.74	4.96	4.90	> 5 mg/l (Class C)
T-N	mg/l	-	-	-	-
T-P	mg/l	2.2	0.8	0.4	-
SS	mg/l	15	17	27	< 50 mg/l (Class C)
COD	mg/l	39	27	23	-
Oil	mg/l	2	15	17	-

Source: Project EIA report

(4) Protected area

The Mukono substation and part of the transmission line will be constructed inside Nandagi Forest Reserve. Nandagi Forest Reserve was initially designated as a forest reserve in 1948 (LN No. 41 of 1948) with an area of 477 ha, mainly for protecting the catchment forest. In 1962, the area was expanded to 479 ha through LN No. 41 of 1948. Figure 9-1-2.7 shows the boundary of Nandagi Forest Reserve.



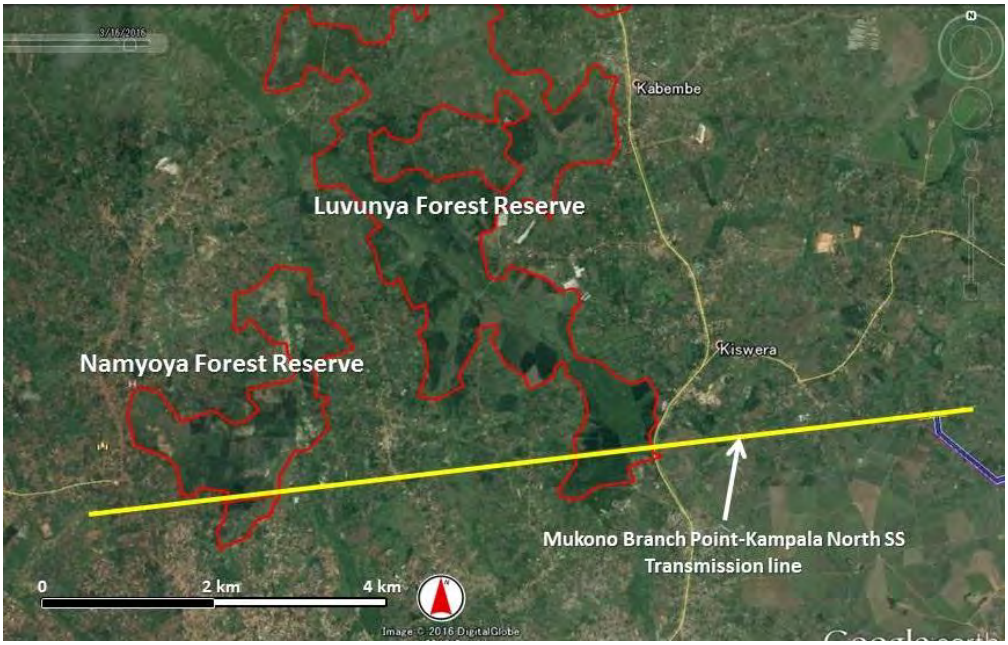
Source: JICA Study Team

Figure 9-1-2.8 Boundary of Nandagi Forest Reserve

The Nandagi Forest Reserve is managed by National Forestry Authority (NFA) under the National Forestry and Tree Planting Act 2003. While the Act prohibits activities such as tree cutting, grazing and crop cultivation inside the forest, activities such forestry is permitted providing that "License" is obtained from NFA. A large proportion of the forest has already been altered for forestry purposes, and currently there about 100 private forestry farmers in operation. An indigenous tree nursery facility is also operating inside the forest.

In order to implement the Mukono project, it is necessary to obtain License from NFA, which will be issued under the condition that UETCL compensates for the forest biomass and biodiversity that will be lost through the project (see Section 9-1-7 for more details).

The existing transmission line between Mukono branch point and Kampala north substation (approx. 25.4 km is planned for reconductoring works) passes through Luvunya Forest Reserve (844 ha) and Namyoya Forest Reserve (389 ha) over a distance of approximately 1km and 7 km respectively. No License is required for these lines as they have been acquired in the past when originally constructed. Figure 9-1-2.9 shows the boundary of Luvunya and Namyoya Forest Reserve and the route of the Mukono branch point－Kampala north substation transmission line.



Source: JICA Study Team

Figure 9-1-2.9 Boundary of Luvunya and Namyoya Forest Reserve and the route of the Mukono branch point－Kampala north substation transmission line

(5) Ecosystem

A two-day flora/fauna survey was conducted in Buloba and Mukono sites during April-May 2016. The survey covered vegetation, invertebrates, reptiles, amphibians, birds and mammals. During the survey, one tree species (*Jacaranda mimosifolia*) and two bird species (*Balearica regulorum*、*Psittacus erithacus*) were observed inside Nandagi Forest Reserve that are classified as threatened under the IUCN Red List (only one individual was observed for each of these species). Furthermore, three butterfly species (*Euphaedra rex*, *Neptis trigonophora*, *Caenides dacena*) observed inside Nandagi Forest Reserve are classified as threatened under the Uganda Red List published by Wildlife Conservation Society (WCS) in 2016. Tables 9-1-2.6 shows the threatened species observed inside Nandagi Forest Reserve and their threatened category.

Table 9-1-2.6 Threatened species observed inside Nandagi Forest Reserve and threatened category

	Scientific name	IUCN Red List	Uganda Red List*
Tree	*Jacaranda mimosifolia*	VU	Not listed
Bird	*Balearica regulorum*	EN	EN
	Psittacus erithacus	VU	VU
Butterfly	*Euphaedra rex*	Not listed	VU
	Neptis trigonophora	Not listed	VU
	Caenides dacena	Not listed	EN

*: The Red List if not legally binding.

Source: Project EIA report

(6) Hydrology

In Nandagi Forest Reserve, there are two tributaries (Kasala and Kisamba) of Sezibwa River. Figure

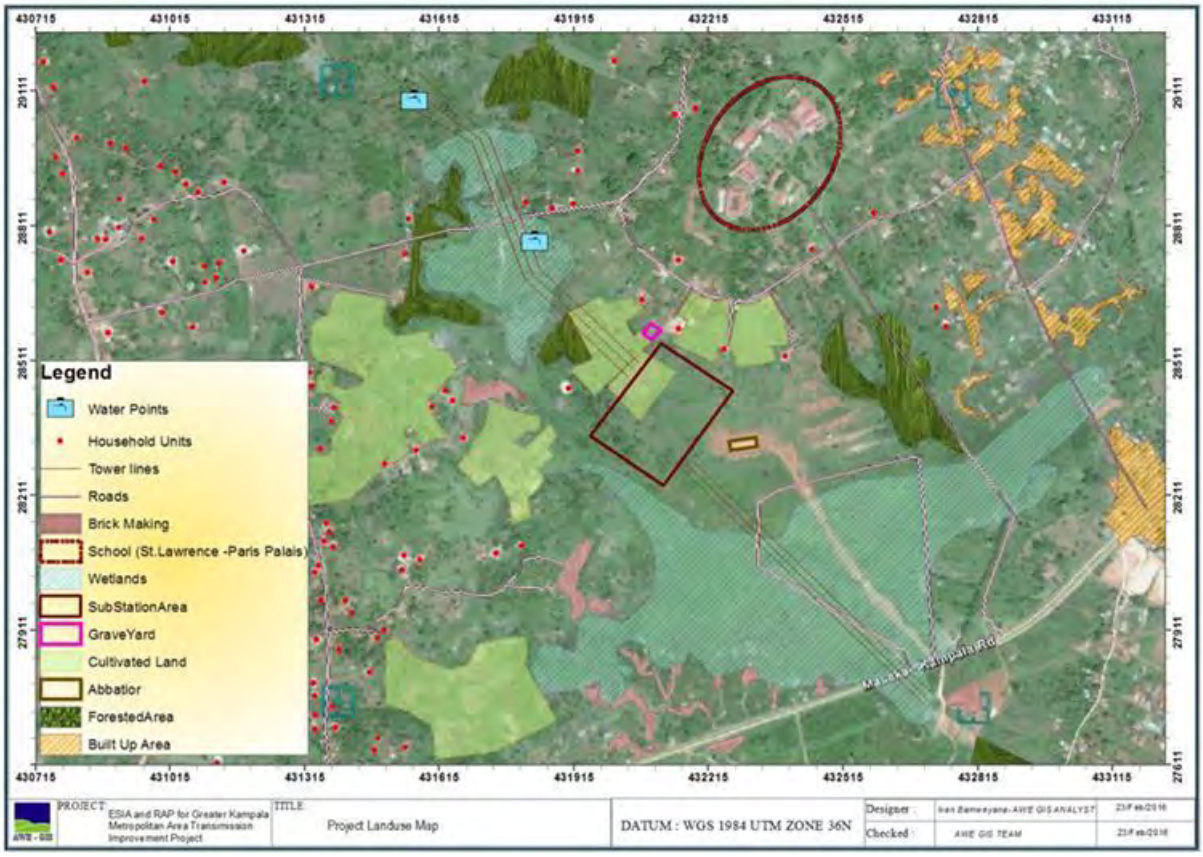
9-1-2.10 shows the flow path of Kasala and Kisamba tributaries.

Source: Project EIA report

Figure 9-1-2.10 Flow path of Kasala and Kisamba tributaries

(7) Land use

Most of the Buloba area is undeveloped land with some wetlands. Some areas are cultivated for crop farming. Residential houses are few. Some collect mud from the swampy areas for brick making. Figure 9-1-2.11 shows the main land use in the Buloba area.



Source: Project EIA report

Figure 9-1-2.11 Main land use in the Buloba area

Most of the Mukono area is developed for farmland and tree plantation. Figure 9-1-2.12 shows typical land use in the Mukono area.

Tree plantation

Maize farming

Cassava farming

Grazing

Source: Project EIA report

Figure 9-1-2.12 Typical land use in the Mukono area

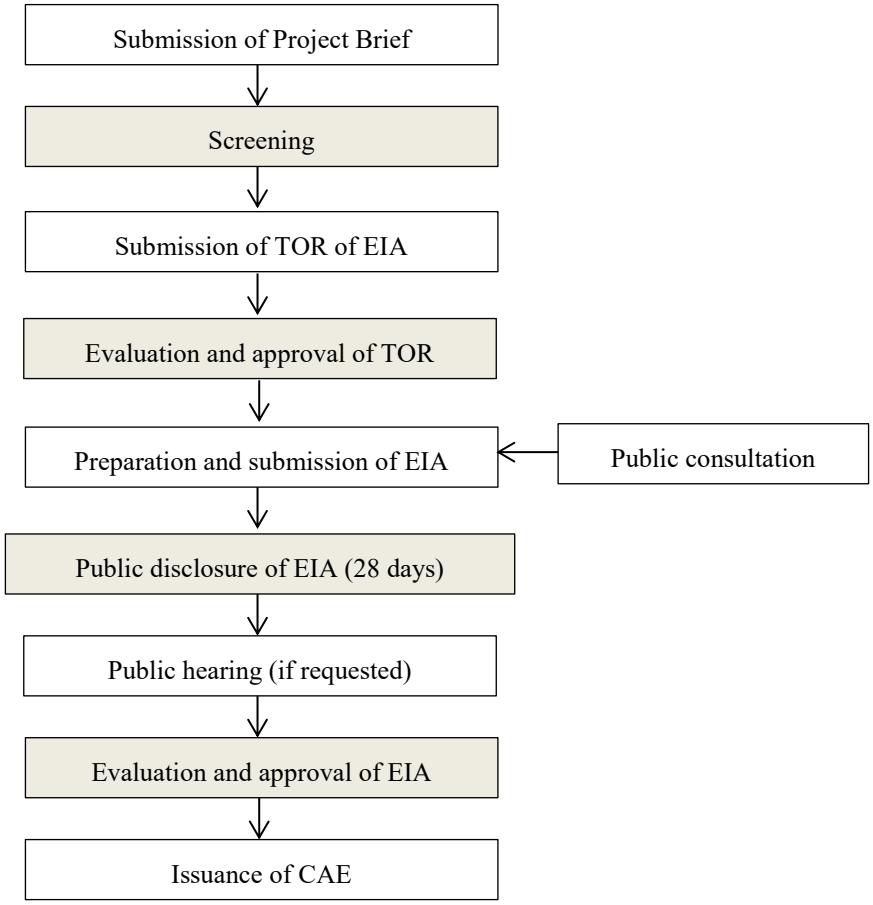
The Kawaala site is mainly surrounded by residential housing. Some empty spaces around the current substation are used for storing bricks.

9-1-3 Legal and Institutional Frameworks for Environmental and Social Considerations

(1) EIA system

Projects having potential environmental impacts are required to prepare an EIA as stipulated under the National Environment Act (1995). Substation and transmission line are prescribed under the Act as projects to be considered for EIA. The procedures and requirements of EIA are stipulated under the Environmental Impact Assessment Regulations No. 13/1998. EIA guidelines are also available such as Guidelines for Environmental Impact Assessment in Uganda 1997 and Environmental Impact Assessment Guidelines for the Energy Sector 2004.

The National Environment Management Authority (NEMA) is the approving agency and will issue "Certificate of Approval of Environment Impact Assessment: CAE" upon approval of the EIA. Figure 9-1-3.1 shows the main procedures of EIA.



[Remark] Grey box indicate NEMA's role

Source: JICA Study Team

Figure 9-1-3.1 Main procedures of EIA

No major gaps have been identified between Uganda EIA system and JICA environmental guideline as it includes among others important requirements such as alternative analysis, public participation and disclosure.

Since NEMA registered consultants are required to undertake EIA, the Project has subcontracted AWE for preparation of EIA. The EIA is planned to be submitted to NEMA within July and obtain CAE within around 3 month period.

(2) Other environment related laws and regulations

Table 9-1-3.1 is a list of Uganda's environment related laws and regulations relevant to this Project.

Table 9-1-3.1 Environment related laws and regulations of Uganda

	Name
Acts	Uganda Wildlife Act, 1996
	The National Forestry and Tree Planting Act, 2003
	Employment Act, 2006
	Occupational Safety and Health Act, 2006
	Historical Monument Act, 1967
Regulations	National Environment (Waste Management) Regulations, 1999
	National Environment (Noise Standards & Control) Regulations, 2003
	The National Environment (Wetlands, Riverbanks and Lakeshores Management) Regulations
	National Environment (Audit) Regulations, 2006
	National Environment (Minimum Standards for Management of Soil Quality) Regulations, 2001

Source: JICA Study Team

Apart from the EIA approval, following are environment-related permits/license that may be required prior to construction:

- Traffic Management Permit from Uganda National Roads Authority (UNRA)
- Waste transport and storage license from NEMA
- Wetland resource use permit from NEMA (if resource extraction from wetland is required)

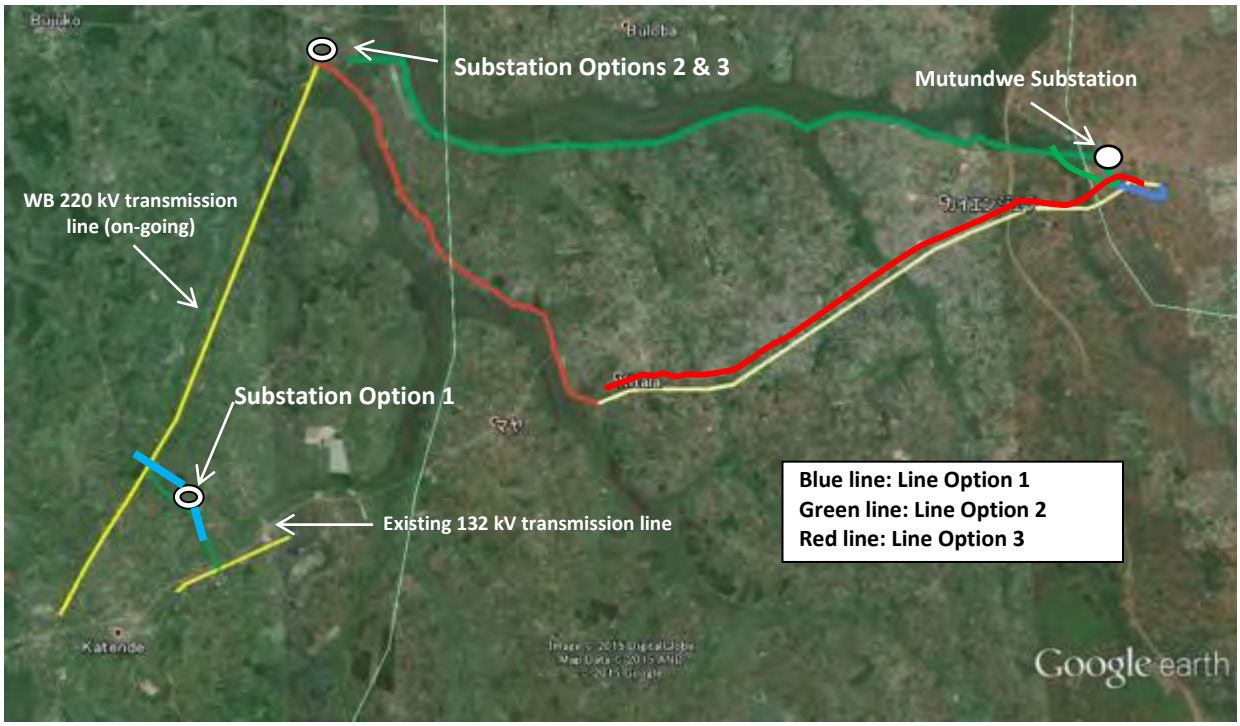
9-1-4 Analysis of Alternatives

(1) No development option

If the project is not implemented, there will be no major environment and social impacts such land acquisition and forest clearance. However, the numerous benefits of improved power supply in the Greater Kampala Metropolitan Area and the associated economic benefits would be foregone.

(2) Location alternatives of Buloba substation and associated transmission lines

Three alternatives were analyzed for the new Buloba substation site and transmission line route considering factors such as environment and social impacts and constriction cost. The locations of the alternatives are indicated in Figure 9-1-4.1. Table 9-1-4.1 shows the results of the alternative analysis. Alternative 1 was considered as the most feasible option due to less environment and social impacts and low cost.



Source: JICA Study Team

Figure 9-1-4.1 Location alternatives of Buloba substation and associated transmission lines

Table 9-1-4.1 Alternative analysis of Buloba substation

Item	Alternative 1	Alternative 2	Alternative 3
Substation location	Between World Bank (WB) 220kV transmission line and existing 132kV transmission line	Along the WB 220kV transmission line	Same as Option 2.
Start point of transmission line	Existing 132kV transmission line	Mutundwe substation	Mutundwe substation
End point of transmission line	The ongoing WB 220kV transmission line	New Buloba substation	New Buloba substation
Distance of transmission line	Overhead line of approx. 1.7 km	Underground line of approx. 3km＋overhead line of approx. 12 km	Overhead line of approx. 18 km
Environmental impacts	Impact low as the area is mostly farmland and shrubs.	Impact high as it requires construction of towers along marshland.	Impact high as it requires construction of towers along marshland.
Social impacts	Area of land acquisition less compared to other Options.	Area of land acquisition higher compared to Option 1.	Area of land acquisition highest compared to other Options.
Construction cost	Lowest, due to the shortest transmission line.	Highest due to the underground transmission line.	Higher than Option 1, due to the longer transmission line.
Overall assessment	Most recommended due to the lowest impacts on social and natural environments and lowest cost among all.	Not recommended due to the higher impacts on environments compared to Option 1. The cost is the highest among all.	Not recommended due to the highest impacts on social environment.

Source: JICA Study Team

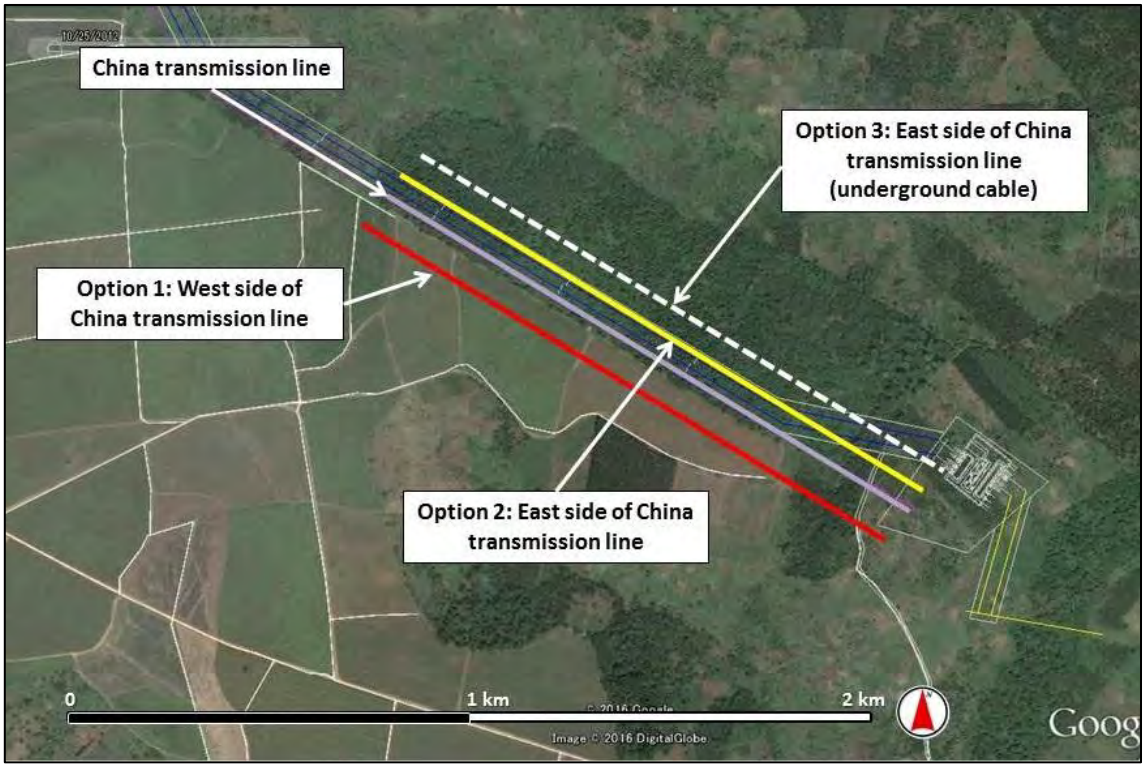
(3) Location alternatives of Mukono substation associated transmission line

Alternative routes of the new 220 kV transmission line were considered along the forest area near the new Mukono substation. Following are the options considered (see Figure 9-1-4.2):

Option 1: Routing of the new 220 kV transmission line west side of the China transmission line so to avoid the forest.

Option 2: Routing of the new 220 kV transmission line east side of the China transmission line.

Option 3: Routing of the new 220 kV transmission line east side of the China transmission line but with underground cable to minimize forest clearance.



Source: JICA Study Team

Figure 9-1-4.2 Route options considered for the new 220 kV transmission line

The viability of the three alternative route options was analyzed by considering environmental impacts, socioeconomic impacts and construction cost factors. Table 9-1-4.2 shows the results of the alternative analysis. In conclusion, Option 2 was considered as the most viable option mainly due to comparatively less socioeconomic impacts and low construction cost.

Table 9-1-4.2 Alternative analysis for the new 220 kV transmission line route

	Option 1	Option 2	Option 3
Environmental impacts	Impacts will be less than the other options as it will avoid the forest area.	Approximately 7 ha of forest area will need to be cleared.	Approximately 1 ha of forest area will need to be cleared.
Socioeconomic impacts	Land acquisition will be difficult as the route passes over a commercial sugar	Socioeconomic activity limited compared to Option 1. Will require	Socioeconomic activity limited compared to Option 1. Will require

	cane farm.	agreement of NFA, the landowner.	agreement of NFA, the landowner.
Construction cost	Same as Option 2	Same as Option 1	Approximately 6 times of Options 1 and 2.
Overall assessment	Although Option 1 will not require any forest clearance, it was considered unfeasible due to difficulty in land acquisition.	Although Option 2 will require the most amount of forest clearance, it was considered the most viable option mainly due to significantly lower construction cost than Option 3.	Although Option 3 will require less forest clearance than Option 2, it was considered unfeasible due to significantly higher construction cost than Option 2.

Source: JICA Study Team

9-1-5 Scoping and TOR of the environment and social consideration study

The potential environmental impacts of the project were identified initially through a scoping exercise, covering the construction and operation phases. The scoping process identifies the impacts that are likely to be of most importance and eliminates those that are of little concern.

Scoping was conducted by referring to JICA's "Guidelines for environmental and social considerations (2010)", which provides a list of items to be considered in the scoping process. The potential impacts of each scoping item were rated in accordance to the following criteria:

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
D: No impact is expected

Table 9-1-5.1 shows the results of the scoping including the rationale behind the rating. Note that the alleviating effects of mitigation measures were not considered in the evaluation.

Table 9-1-5.1 Results of scoping

	Item	Phase	Rating	Rationale
1	Air pollution	C	B-	Heavy construction works are potential sources of air pollution (e.g. dust and exhaust gases).
		O	D	There are no notable air pollution sources.
2	Water pollution	C	B-	・Runoff from the construction sites may pollute the surface waters nearby (e.g. New Mukono and Buloba). ・Uncontrolled discharge of concrete washwater.
		O	B-	Runoff from the transmission line corridor may pollute the surface waters nearby.
3	Soil pollution	C	B-	Soil may be contaminated through spills of hazardous substances.
		O	D	There are no notable soil pollution sources.
4	Waste	C	B-	Various types of construction wastes will be generated. (e.g. cleared vegetation, concrete debris, removed transmission cable and insulators, wood, waste oil)
		O	B-	Waste will be generated from maintenance activities (e.g. transmission oil).

	Item	Phase	Rating	Rationale
5	Noise/vibration	C	B-	Heavy construction works (e.g. grading works) are potential sources of noise pollution. There are no notable vibration sources.
		O	D	There are no notable noise/vibration pollution sources.
6	Ground subsidence	C, O	D	There are no activities that may cause ground subsidence.
7	Offensive odor	C, O	D	There are no notable odor sources.
8	Bottom sediment	C, O	D	There are no notable sediment pollution sources.
9	Conservation area	PC, C	B-	Part of the Nandagi Forest Reserve will be affected due to the construction of New Mukono substation and associated transmission lines.
		O	D	There are no activities that may have adverse impact on conservation areas.
10	Ecosystem, flora/fauna	PC, C	B-	Flora and fauna in the Nandagi Forest Reserve may be affected due to the construction of New Mukono substation and associated transmission lines. Flora and fauna in and around the Buloba substation and associated transmission lines may be affected.
		O	B-	There is a risk of bird collision with the new transmission lines.
11	Hydrology	C	B-	The new access road of New Mukono substation will cross over a small river. The flow of the river will be temporarily diverted during installation of culverts.
		O	D	There are no activities that may have adverse impacts.
12	Topography	C	B-	There will be some alteration of topography in the new substation sites (Buloba and New Mukono).
		O	D	There are no activities that may cause alteration of existing topography.
13	Involuntary resettlement	PC	B-	There will be some loss of land, crops, structures, etc. due to land acquisition for the new substations and transmission lines (Buloba, New Mukono and Kawaala). However, involuntary resettlement is likely to be small scale even if required.
14	Vulnerable social groups (poor, indigenous people etc.)	PC	C	Vulnerable social groups will be identified through ARAP study.
15	Livelihood, living environment	PC	B-	Land acquisition of the new substations and transmission lines (Buloba, New Mukono) will result in loss of farmland and plantations.
		C, O	B-	Livelihood and living standard of the PAPs may worsen if not appropriately compensated and rehabilitated.
16	Land use	PC, C, O	B-	Farmland and plantations in the new substations sites (Buloba, New Mukono) will be converted into substation land and transmission line corridor.
17	Local resource	C, O	D	There are no activities that may have adverse impacts on local resources.
18	Water use	C, O	D	There are no activities that may have adverse impacts on water use.
19	Social infrastructures and services	C	B-	The use of access road at the New Mukono site may be temporarily restricted.
		O	B+	The local community will have an improved access road at the New Mukono site.
20	Social institutions	C, O	D	There are no activities that may have adverse impacts on social institutions.
21	Misdistribution of benefit and losses	C, O	D	There are no activities that may cause misdistribution of benefit and losses.
22	Local conflicts of interest	C, O	D	There are no activities that may cause local conflicts of interest.

	Item	Phase	Rating	Rationale
23	Cultural heritage	C, O	D	There are no cultural heritages around the project area.
24	Landscape	C	B-	There will be slight changes to current landscape at the new substation sites (Buloba, New Mukono) and associated transmission lines.
		O	D	There are no activities that may affect the landscape.
25	Gender	C, O	D	There are no activities that may trigger gender issues.
26	Children's rights	C, O	D	There are no activities that may violate children's rights.
27	Infectious diseases (HIV/AIDS etc.)	C	B-	There may be risk of spreading infectious diseases due to influx of construction workers.
		O	D	The risk of spreading infectious diseases is low.
28	Occupational safety	C, O	B-	There is a moderate risk of occupational accidents (e.g. high-place work, electrocution).
29	Accidents	C	B-	Accidents may occur due to construction activities (e.g. truck movement).
		O	D	The risk of accidents is low.

PC: Pre-construction phase, C: Construction phase, O: Operation phase

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown.

D: No impact is expected

Source: JICA Study Team

Based on the scoping results, the TOR of the environment and social consideration study was prepared as shown in Table 9-1-5.2.

Table 9-1-5.2 TOR of the environment and social consideration study

	Item	TOR
1	Air pollution	・Implementation of air quality survey around the project sites ・Identification of sensitive receptors through field reconnaissance
2	Water pollution	・Implementation of water quality survey around Buloba and Mukono project sites
3	Soil pollution	・Field reconnaissance
4	Waste	・Confirmation of current waste treatment and disposal methods through interview surveys.
5	Noise/vibration	・Implementation of noise survey around the project sites ・Identification of sensitive receptors through field reconnaissance
6	Conservation area	・Confirmation of laws and regulations relevant to forest reserves ・Confirmation of necessary permissions and procedures for implementing the project inside Nadangi Forest Reserve. ・Confirmation of surface area and boundary of Nadangi Forest Reserve.
7	Ecosystem, flora/fauna	・Implementation of flora/fauna survey at Buloba and Mukono
8	Hydrology	・Confirmation through field reconnaissance
9	Topography	・Confirmation through field reconnaissance
10	Involuntary resettlement	・Preparation of ARAP (Buloba, Mukono and Kawaala) ・Confirmation through census survey, land/asset valuation survey and socioeconomic survey (Buloba, Mukono and Kawaala)
11	Vulnerable social groups (poor, indigenous people etc.)	・Confirmation through census survey and socioeconomic survey (Buloba, Mukono and Kawaala)
12	Livelihood, living environment	・Confirmation through census survey, land/asset valuation survey and socioeconomic survey (Buloba, Mukono and Kawaala)
13	Land use	・Confirmation through field reconnaissance

	Item	TOR
14	Social infrastructures and services	・Confirmation through field reconnaissance
15	Landscape	・Confirmation through field reconnaissance (e.g. scenic value)
16	Infectious diseases (HIV/AIDS etc.)	・Confirmation through socioeconomic survey
17	Occupational safety	・Confirmation of laws and regulations relevant to occupational safety ・Confirmation of occupational risks through interview survey
18	Accidents	・Confirmation of high risk areas through field reconnaissance

Source: JICA Study Team

9-1-6 Results of environment and social consideration study

Table 9-1-6.1 shows the main findings of the environment and social consideration study.

Table 9-1-6.1 Main findings of the environment and social consideration study

	Item	Main findings
1	Air pollution	Air quality (particulate matter) at all the sites were below draft national standards and WHO standards. The Kawaala area will be relatively susceptible to air pollution generated from construction works due to the proximity of residential houses.
2	Water pollution	Relatively high levels of organic matter and oil were found in surface waters around Buloba and Mukono. Appropriate mitigation measures should be considered to avoid inflow of pollutants into these surface waters.
3	Soil pollution	No notable soil pollution was identified during field reconnaissance. Risk of soil pollution should be minimized through prevention of oil leaks from construction vehicles, appropriate storage and handling of hazardous materials and so on.
4	Waste	Waste oil from substations are handled at UETCL's dedicated facility. PCB containing transformer oil is currently not in use. Appropriate waste management plan should be developed in particular for concrete debris, waste cable, waste oil and so on.
5	Noise/vibration	Noise levels at all the sites were more or less below national standards. The Kawaala area will be relatively susceptible to noise generated from construction works due to the proximity of residential houses.
6	Conservation area	In order implement the project in Nandagi Forest Reserve, a license must be acquired from National Forest Authority (NFA) in accordance to the National Forestry and Tree Planting Act, 2003. UETCL will also be required to compensate for the loss of forest and biodiversity. The surface area of Nandagi Forest Reserve was 479 ha.
7	Ecosystem, flora/fauna	One tree species and two bird species considered threatened under IUCN Red List were identified inside Nandagi Forest Reserve. The area however is unlikely to be a major habitat of these species as most of the area is developed for forestry.
8	Hydrology	The new access road in Mukono will crosses a small tributary and water channel. The water flow will be maintained by installing culverts. However, temporary diversion may be required during construction.
9	Topography	Cut and fill works may be required at Buloba and Mukono as the areas are in hilly terrain.
10	Involuntary resettlement	A total of 96 land owners and 11 structures (2 residential) have been identified in the land acquisition area. Resettlement is unlikely to be required as there is sufficient space to rebuild the structures within the owners land.
11	Vulnerable social groups (poor, indigenous people etc.)	A total of three vulnerable PAPs were identified, which may require additional assistance.
12	Livelihood, living environment	The project may affect the livelihood of farmers and foresters whose land be acquired through this project.

	Item	Main findings
13	Land use	Some of the farmland and forestry land will be converted into land for the substation and transmission line corridor.
14	Social infrastructures and services	The new access road in Mukono is currently used by the local community, which its use may be restricted during construction.
15	Landscape	Although Buloba and Mukono do not have any scenic value for tourism, semi-natural landscape remains.
16	Infectious diseases (HIV/AIDS etc.)	AIDS was one disease that is relatively common in the area.
17	Occupational safety	The main national law is Occupational Safety and Health Act, 2006. Occupational accident risks are mainly falling from high places and electric shock.
18	Accidents	Some of the roads that may be used for construction were narrow and run through local communities, hence have relatively high risks of accidents.

Source: JICA Study Team

9-1-7 Impact assessment and mitigation measures

Items that were rated as having potential negative impacts (e.g. A-, B-, C-) were assessed based on the environment and social consideration study. Table 9-1-7.1 shows the results of the impact assessment.

Table 9-1-7.1 Results of impact assessment

	Item	Rating of scoping		Rating after environment and social consideration study		Rationale
		PC, C	O	PC, C	O	
1	Air pollution	B-	D	B-	D	Since the Kawaala substation is located adjacent to residential area, the residents may be affected by air pollution (e.g. dust and exhaust gases) if appropriate mitigation measures are not implemented during construction works. Hence impact is rated as B-.
2	Water pollution	B-	B-	B-	B-	In the construction stage, surface waters (e.g. tributaries and ponds) near Buloba and Mukono sites may become polluted if concrete washwater and rainwater runoff from construction sites are discharged in an uncontrolled manner. Hence impact is rated as B-. In the operation stage, rainwater runoff from exposed surfaces along the transmission line corridor may pollute nearby surface water. Hence impact is rated as B-.
3	Soil pollution	B-	D	B-	D	In the construction stage, soil may become polluted if appropriate spill and leakage prevention measures of hazardous liquids (e.g. fuel and oil) are not implemented. Hence impact is rated as B-.
4	Waste	B-	B-	B-	B-	Inappropriate waste management may cause pollution for both the construction and operation stages. Hence impact is rated as B- for both stages.

	Item	Rating of scoping		Rating after environment and social consideration study		Rationale
		PC, C	O	PC, C	O	
5	Noise	B-	D	B-	D	Since the Kawaala substation is located adjacent to residential area, the residents may be affected by noise if appropriate mitigation measures are not implemented during construction works. Hence impact is rated as B-.
6	Conservation area	B-	D	B-	D	Approximately 15 ha of Nandagi Forest Reserve will be lost due to land acquisition for the Mukono transmission line. However, since this area is limited to around 3% of the total area, impact is rated as B-.
7	Ecosystem, flora/fauna	B-	B-	B-	B-	Three threatened species (1 tree and 2 bird species) were confirmed inside Nandagi Forest Reserve which may be affected by construction activities. However, since the majority of the forest reserve has been converted for forestry purpose, it is unlikely that the area is a major habitat for these threatened species. Hence impact is rated as B-. The new transmission line may cause bird collision. Hence impact is rated as B- for the operation stage.
8	Hydrology	B-	D	B-	D	The tributary and water channel that crosses the new Mukono access road will need to be temporary diverted during installation of culverts. Hence impact is rated as B-.
9	Topography	B-	D	D	D	Although the topography at Mukono and Buloba will alter due to construction of the substation, it is unlikely that such change will have any adverse impacts on the surrounding area. Hence impact is rated as D.
10	Involuntary resettlement	B-	D	B-	D	Although involuntary resettlement is unlikely to be required, there will be some loss of agriculture land, forestry land and structures. Hence impact is rated as B-.
11	Vulnerable social groups (poor, indigenous people etc.)	C	D	B-	D	A total of 3 vulnerable PAPs have been identified within the land acquisition area, which may be affected through land acquisition. Hence impact is rated as B-.
12	Livelihood, living environment	B-	B-	B-	B-	There will be some loss of agriculture and forestry land, which some PAPs depend for their livelihood. Since it may take some time for their livelihood to recover, impact is rated as B- for both the construction and operation stages.
13	Land use	B-	B-	B-	B-	Some of the agriculture and forestry land will be permanently converted to land for substation and transmission line. Hence impact is rated as B- for both the construction and operation stages.

	Item	Rating of scoping		Rating after environment and social consideration study		Rationale
		PC, C	O	PC, C	O	
14	Social infrastructures and services	B-	B+	B-	B+	The use of the Mukono community road may be restricted during the construction of the new access road. Hence impact is rated as B-.
15	Landscape	B-	D	B-	D	The semi-natural landscape at Buloba nd Mukono will be altered to a certain extent through construction of the substations. Hence impact is rated as B-.
16	Infectious diseases (HIV/AIDS etc.)	B-	D	B-	D	Infectious diseases such as HIV/AIDS exist in the area, and may spread further through influx of construction works. Hence impact is rated as B-.
17	Occupational safety	B-	B-	B-	D	There is a risk of occupational accidents during construction works such as falling from height and electric shock. Hence impact is rated as B-. While there are some risks of accidents during maintenance work, such risks are considered low as there will be no new maintenance works required and providing that standard safety measures are implemented. Hence impact is rated as D.
18	Accidents	B-	D	B-	D	Some of the roads that may be used for construction were narrow and run through local communities, hence have relatively high risks of accidents. Hence impact is rated as B-.

PC: Pre-construction phase, C: Construction phase, O: Operation phase

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown.

D: No impact is expected

Source: JICA Study Team

Mitigation measures are proposed in the ensuing sections for items that were rated as having negative impacts (e.g. A-, B-) in the above impact assessment.

(1) Pre-construction stage

1) Involuntary resettlement

New land acquisition will be required for the substation and transmission lines of Buloba (12 ha), Mukono (35 ha) and Kawaala (0.03 ha) sites. To minimize land acquisition, the corridor width of 220 kV transmission lines in Buloba and Mukono are reduced through corridor sharing. Residential areas were also avoided as much as possible during route selection.

Since no large scale resettlement was expected, an Abbreviated Resettlement Action Plan (ARAP) is been prepared by subcontracting a local consultant (AWE). According to the ARAP study, there will

be some loss of private land and associated crops and structures through land acquisition. However, resettlement is unlikely to be required as most of the project affected people (PAPs) have sufficient remaining land.

The Project will provide fair and adequate compensation and livelihood restoration assistance in accordance to Ugandan law and JICA environmental guideline, so that PAP's living and livelihood standard are restored at least to pre-project level. Special assistance will also be provided to the vulnerable people. Internal and external monitoring will also be conducted as well as establishment of grievance mechanism. (Please refer to Chapter 9-2 for more details on land acquisition impacts and planned compensation and livelihood restoration measures)

2) Vulnerable groups

A total of three vulnerable PAPs (2 are sick and one orphaned) have been identified within the land acquisition area of Mukono and Kawaala. These vulnerable people will be provided additional assistance in accordance to their needs.

3) Livelihood, living environment

Some PAPs in Buloba and Mukono will lose their farmland and forestry land, which are their source of livelihood. These PAPs will be provided compensation for the affected crops and trees as well as livelihood restoration assistance depending on their needs.

4) Land use

Some of the farmland and forestry land in Buloba and Mukono will be converted to land for substation and transmission line corridor. The affected PAPs will be provided compensation for the affected crops and trees as well as livelihood restoration assistance depending on their needs.

5) Protected area

The Mukono substation and part of the transmission lines are to be located inside Nandagi Forest Reserve. Approximately 15 ha of reserve forest area will need to be cleared to secure the 220 kV transmission line corridor, which is around 3 % of the total reserve area (479 ha). Forest clearance for the substation will not be required by this Project, as land is expected to be cleared by the Chinese funded project.

To implement the Project in Nandagi Forest Reserve, UETCL will need to obtain a "License" from NFA as per National Forestry and Tree Planting Act, 2003. As a condition of issuing the License, UETCL will compensate for the lost forest biomass and biodiversity, based on the "Forest Biomass and Biodiversity Valuation" undertaken by National Forest Authority (NFA). UETCL and NFA has signed a Memorandum of Understanding (MoU) dated July 19th, 2016, which shows NFA's basic agreement for implementing this project inside Nandagi Forest Reserve (see Appendix-10 foe the MoU). The License from NFA is expected to be obtained by the end of September 2016. The following measures are planned to be implemented with the received compensation:

- Forest restoration through tree planting
- Enhancement of forest management
- Enhancement of productivity of Nandagi Indigenous Tree Nursery

In addition, any threatened flora species (e.g. *Jacaranda mimosifolia*) that require cutting will be compensated by for example replanting its seed or seedling in a suitable alternative location.

The Project will also affect some of the private tree planting farmers (i.e. 6 licensed farmers) operating inside Nandagi Forest Reserve. They will be compensated for their lost trees and will also be provided livelihood restoration assistance if necessary. NFA shall also undertake awareness activities and guide tree farmers to continue with tree planting projects.

(2) Construction stage

1) Air pollution

Heavy construction works and construction vehicles are potential source of air pollution. The following measures will be implemented to minimize impacts:

- Keeping exposed soil surfaces and material stockpiles in damp condition by water spraying.
- Covering of material stockpiles when not in use.
- Use of well-maintained vehicles and machines. Vehicles and machines emitting excessive pollutants (e.g. black soot) to be removed until repaired.
- Use of closed/covered trucks when transporting dusty materials.
- Limiting the speed of construction vehicles when passing through communities.
- Switching off engines of construction vehicles and machines when not in use.

2) Water pollution

Concrete washwater

Large volume of concrete will be used for constructing foundations of transmission tower and substation. Concrete washwater may be generated during such works, which is highly alkaline and contain high sediment loads. Therefore, discharge of untreated concrete washwater to surface water and groundwater will be strictly prohibited, and to be discharged only at designated facilities (e.g. facilities with washwater treatment system).

Rainwater runoff

Rainwater runoff from construction sites may be high in sediment content which may pollute surrounding surface water areas. Such impacts will be minimized through the following measures:

- Avoid removing short vegetation and grass along the transmission line corridor as far as it does not hinder construction works.
- Implementation of temporary erosion control measures (e.g. silt fence, erosion mats) especially where construction sites are near surface water.

- Revegetation of exposed slopes immediately after construction is completed.
- Construction of retaining walls for exposed slope protection if necessary.
- Construction of temporary runoff drainage channel.
- Stockpiles and temporarily removed topsoil to be stored in a location and manner to prevent soil runoff into surface waters.

Other measures

- Spillage of hazardous liquids (e.g. oil) to be prevented by implementing spill prevention measures (see "Soil pollution" section below for details).
- Installation of portable toilets for construction workers.

3) Soil pollution

Spillage of hazardous liquids such as oil and fuel may contaminate the soil. Such risks will be minimized through the following measures:

- Regular inspection of vehicles and machines for oil and fuel leaks. Leaking vehicles and machines to be removed until repaired.
- Spill response kit (e.g. absorbents) to be readily available at the construction site.
- Hazardous substances to be stored only in specialized/labelled containers and designated storage facility.
- Storage facility to be located as far as possible from sensitive areas (e.g. groundwater wells, surface water) and well secured from the public.
- Storage and handling facilities of hazardous liquid to be bunded with an impermeable base.
- Posting of warning signs at the storage facility.
- Hazardous materials only to be handled by trained staff.

4) Noise

Noise from heavy construction works and construction vehicles are may become a nuisance to neighbors. Noise impacts will be minimized through the following measures:

- Vehicles and machinery to be equipped with exhaust mufflers and well maintained.
- Noisy equipment to be located as far as possible and aligned to be directed away from sensitive receptors.
- In principal, noisy construction works to be limited to normal working hours and no operation on Sundays and public holidays.
- Additional noise suppression measures (e.g. covering of noisy units) to be implemented if noise levels at nearest sensitive receptor consistently exceeds national noise standard or in case of consistent complaints.
- Construction workers to be provided with appropriate PPE such as ear plugs and ear muffs for protection against excessive noise.
- Construction machines and vehicles to be turned off when not in use.

5) Waste

Various types of construction wastes (e.g. cleared vegetation, concrete debris, old cables, waste oil) will be generated, and are potential sources of pollution if not handled appropriately. Following are the basic waste management policy:

- Maximization of reuse and recycling.
- Storage of wastes only in designated waste containers and areas.
- Storage of hazardous wastes in specialized/labelled containers and facility.
- Wastes to be handled and disposed only by NEMA-authorized waste management entities.
- Strict prohibition of littering and implementation of awareness programs for the construction workers.
- Daily clean-ups at the construction sites.

The Construction Contractor will be required to prepare a detailed Waste Management Plan, and submit to UETCL and other relevant organizations for approval.

6) Hydrology

The new access road in Mukono will crosses a small tributary and water channel. For these areas, culverts will be installed to prevent any disruption to the water flow. However, the flow will need to be temporary diverted during installation of culverts.

7) Social infrastructure

Restriction in road use

The new access road in Mukono will be constructed by expanding the existing community road. While the use of this road may be restricted during construction, such disturbances will be minimized by securing at least one-lane width so that vehicles can pass. Traffic control officers will be placed when necessary. The local community will also be informed beforehand if any restrictions occur.

Disruption of electricity supply

Construction works may temporarily disrupt the local electricity supply. Construction works will therefore be planned in manner to minimize duration of power outage, and if unavoidable, it will be communicated to the public and facilities (e.g. hospital) in advance.

8) Landscape

The natural landscape at Buloba and Mukono will change due to construction of new substations and transmission line. Landscape impacts will be minimized through revegetation and creation of green belt if necessary.

9) Infectious diseases

There is a risk of infectious diseases spreading due to influx of construction workers. Such risks will be minimized through the following measures:

- Holding of awareness programs for the construction workers.
- Preparation of Code of Conduct to be strictly followed by the workers.
- Contractor to undertake HIV/AIDS Management campaign including Training, distribution of quality Contraceptives and Voluntary Counseling and Testing among workers and adjacent communities and schools.

10) Occupational safety

The following measures will be implemented to minimize risks of occupational accidents:

- Compliance to JICA's "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects".
- Implementation of safety training programs for all workers.
- Provision of appropriate Personal Protective Equipment (PPE).
- Holding of regular tool box meeting to discuss safety.
- Lockout - tagout procedures to be clearly displayed on site and followed.
- Contractor to deploy an HSE Officer approved by UETCL.
- Contractor to provide appropriate safety signage at high risk locations (e.g. near fuel tanks) including ancillary work sites.
- The construction contractor will be required to submit an Occupational Health and Safety Plan (OHSP) to UETCL and other necessary organizations for approval.

11) Accidents

Construction vehicles may cause traffic accidents. The following measures will be implemented to minimize such risks of accidents:

- Strict compliance to speed limits.
- Holding of daily Tool Box Talks for workers.
- Avoid as far as practical of using roads with high risk of accidents.
- Vehicle motion alarm to be installed on all construction vehicles.
- Placement of traffic officers and appropriate safety/warning signs in high risk locations (e.g. 'Heavy Trucks Turning', 'Road Diverted', 'Half Road Closed', etc.).
- Maintain a Health and Accident register.
- The Contractor will be required to submit a Traffic Management Plan to UETCL and other necessary organizations for approval.
- Contractor to deploy a qualified Site Nurse and Doctor-On-Call.
- Contractor to set-up a Site Clinic for treatment of minor ailments. However, other cases shall be referred for specialized management.
- Contractor to provide a well-stocked First Aid Kit.

12) Ecosystem

Proliferation of invasive species

Invasive plant species may proliferate along exposed surfaces created through construction works such as cut and fill works (for example at Buloba and Mukono). Exposed surfaces will therefore be revegetated by native plant species immediately after works are completed to minimize chance of colonization by invasive species. If any growth of invasive species is observed they will be removed immediately.

Disturbance to flora and fauna

Construction works may have adverse impacts on flora and fauna especially at Buloba and Mukono where there is still some natural environment left. Impacts will be minimized through the flowing measures:

- Implementation of environmental awareness programs for the construction workers, with special focus on threatened species.
- Strictly prohibit hunting and poaching of wild life and cutting of trees.
- Prevention and minimization of pollution (e.g. noise, water) through strict implementation of planned pollution control measures.

Additional mitigation measures will be implemented if any important habitats of threatened species (e.g. bird nesting site) are newly identified in the future, under the guidance of experts.

(3) Operation stage

1) Water pollution

Rainwater runoff from transmission line corridors may be high in sediment content which may pollute surrounding surface water areas. Therefore, as far as possible, short trees and grasses along the transmission line corridor will be maintained, to the extent that it does not hinder maintenance works.

2) Waste

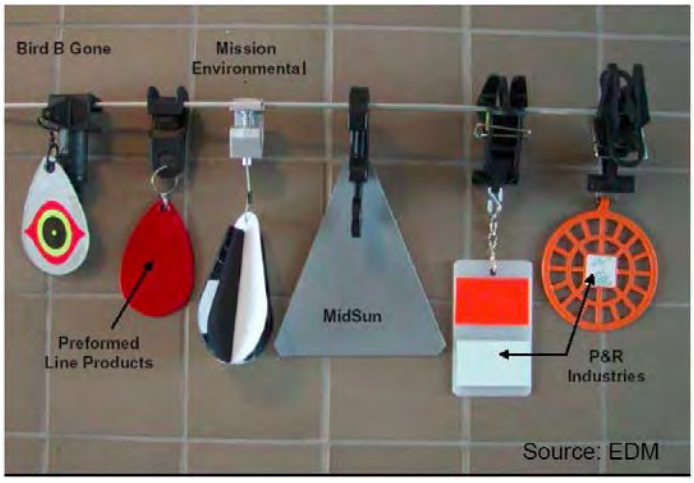
Wastes such old transformer oil and domestic wastes will be generated during the operation stage. Following are the basic waste management policy:

- Maximization of reuse and recycling.
- Wastes to be handled and disposed only by NEMA-authorized waste management entities.
- Waste disposal containers will be provided onsite for each waste category.
- Oil pit to be installed at substations to contain accidental spills during transformer oil exchange.
- Transformer oil will be free of PCBs.

- Waste oil to be recycled at UETCL facility for reuse. Residues to be disposed at oil companies.

3) Ecosystem

The new transmission lines will increase the risks of bird collision especially at Buloba and Mukono where there are many birds identified including threatened species. The risk of bird collision will be reduced by installing avian flight diverters (during construction) along the new transmission lines. Figure 9-1-7.1 shows some examples of avian flight diverters. The type and method of avian flight diverter installation will be further considered in the detailed design stage.



Source: Yee, Marcus L. (2007)

Figure 9-1-7.1 Examples of avian flight diverters

4) Livelihood, living standard

The living standard of PAPs may deteriorate if adequate compensation and assistance are not provided. The Project will therefore continue monitoring and provide livelihood restoration assistance until their livelihood and living standards are restored to pre-project levels.

5) Land use

Due to conversion of farmland and forestry land, the living standard of PAPs dependent on these lands may deteriorate if adequate compensation and assistance are not provided. The Project will therefore continue monitoring and provide livelihood restoration assistance until their livelihood and living standards are t restored to pre-project levels.

9-1-8 Environmental Management Plan and Monitoring Plan

Based on the environmental assessment, an Environmental Management Plan (EMP) is prepared to ensure that the Project is implemented with minimal environmental impacts. The EMP summarizes the planned mitigation measures against the anticipated environmental impacts, the responsibility for its

implementation and supervision, and estimated cost. An environmental monitoring plan is also included as part of the EMP to check the effectiveness of the mitigation measures. To ensure that the EMP is effectively implemented, a qualified and experienced environmental officer will be assigned on the contractors team and supervising consultant. Note that the EMP and monitoring plan are live documents and should be revised as necessary during the detailed design stage in line with the development of the construction plan. Table 9-1-8.1 is the EMP and Table 9-1-8.2 the environmental monitoring plan.

During the implementation stage, UETCL is required to regularly report the monitoring results to JICA using the Environmental Monitoring Form which a sample form is attached as Appendix-11.

Table 9-1-8.1 Environmental Management Plan

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
Preconstruction phase					
Involuntary resettlement	Loss of land, crops, structures, etc. due to land acquisition for the new substations and transmission lines (Buloba, Mukono and Kawaala).	• For the 2 x 220 kV transmission lines in Mukono and Buloba sites, the width of the transmission line corridors will be minimized through corridor sharing. • All PAPs will be provided fair and adequate compensation and assistance (e.g. allowances and livelihood restoration programs) until their livelihood and incomes are restored to at least pre-project levels, in accordance to the Project's ARAP. The ARAP will be based on Ugandan laws and in compliance to JICA Guidelines on Environmental and Social Consideration. • Additional assistance will be provided to vulnerable social groups if any. • Internal and external monitoring will be implemented and grievance mechanism established.	UETCL	Office of the Chief Government Valuer	To be estimated in ARAP
Conservation area	Partial loss of forest and biodiversity within Nandagi Forest Reserve due to land acquisition for the Mukono transmission lines.	• The loss of forest and associated biodiversity will be compensated (offset) based on the "Forest Biomass and Biodiversity Assessment" undertaken by National Forest Authority (NFA) in conjunction with UETCL. • Any threatened flora species (e.g. *Jacaranda mimosifolia*) that require cutting will be compensated by for example replanting its seed or seedling in a suitable alternative location. • NFA and UETCL shall undertake forest restoration and other activities that shall enhance the management of the remaining Central Forest Reserves. • Nandagi Indigenous Tree Nursery shall be supported to produce more seedlings for Forest restoration.	UETCL/NFA	NEMA, Ministry of Water and Environment	To be estimated through the Forest Biomass and Biodiversity Assessment
	Partial loss of NFA leased private tree planting farms within Nandagi Forest Reserve due to land acquisition for the Mukono transmission lines.	• Compensation to private farmers for the planted trees based on the ARAP valuation survey. • NFA shall undertake awareness activities and guide Licensee tree farmers to continue with Tree Planting projects. • Provision of livelihood restoration assistance to the affected private farmers if necessary.	UETCL	NFA	To be estimated in ARAP
Construction phase					

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
Air pollution	Fugitive dust emission from heavy construction works (e.g. grading works)	• Keeping exposed soil surfaces and material stockpiles in damp condition by water spraying. • Covering of material stockpiles when not in use.	Construction contractor	Supervising consultant, NEMA, UETCL	Included in construction base cost
	Dust and exhaust gas emissions from construction vehicles and machines	• Use of well-maintained vehicles and machines. Vehicles and machines emitting excessive pollutants (e.g. black soot) to be removed until repaired. • Use of closed/covered trucks when transporting dusty materials. • Limiting the speed of construction vehicles when passing through communities. • Switching off engines of construction vehicles and machines when not in use.	Construction contractor	Supervising consultant, NEMA, UETCL	Included in construction base cost
Water pollution	Discharge of concrete washwater.	• Discharge of untreated concrete washwater to surface water and groundwater to be strictly prohibited. • Concrete washwater (e.g. from concrete mixer and pump trucks) to be discharged only at designated facilities (e.g. facilities with washwater treatment system). • Recycling of washwater as far as practical.	Construction contractor	Supervising consultant, NEMA, UETCL	Included in construction base cost
	Soil erosion and runoff from construction site (Buloba and Mukono)	• Avoid removing short vegetation and grass along the transmission line corridor as far as it does not hinder construction works. • Implementation of temporary erosion control measures (e.g. silt fence, erosion mats) especially where construction sites are near surface water. • Revegetation of exposed slopes immediately after construction is completed. • Construction of retaining walls for exposed slope protection if necessary. • Construction of temporary runoff drainage channel. • Stockpiles and temporarily removed topsoil to be stored in a location and manner to prevent soil runoff into surface waters.	Construction contractor	Supervising consultant, NEMA, UETCL	Included in construction base cost
	Accidental spillage of hazardous liquids and discharge of human waste	• Spillage of hazardous liquids (e.g. oil) to be prevented by implementing spill prevention measures (see "Soil pollution" section below for details). • Installation of portable toilets for construction workers.	Construction contractor	Supervising consultant, NEMA, UETCL	Included in construction base cost
Soil pollution	Accidental spillage and	• Regular inspection of vehicles and machines for oil and fuel leaks.	Construction	Supervising	Included in

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
	leakage of hazardous liquids	Leaking vehicles and machines to be removed until repaired. • Spill response kit (e.g. absorbents) to be readily available at the construction site. • Hazardous substances to be stored only in specialized/labelled containers and designated storage facility. • Storage facility to be located as far as possible from sensitive areas (e.g. groundwater wells, surface water) and well secured from the public. • Storage and handling facilities of hazardous liquid to be bunded with an impermeable base. • Posting of warning signs at the storage facility. • Hazardous materials only to be handled by trained staff.	contractor	consultant, NEMA, UETCL	construction base cost
Noise	Noise from heavy construction works	• Vehicles and machinery to be equipped with exhaust mufflers and well maintained. • Noisy equipment to be located as far as possible and aligned to be directed away from sensitive receptors. • In principal, noisy construction works to be limited to normal working hours and no operation on Sundays and public holidays. • Additional noise suppression measures (e.g. covering of noisy units) to be implemented if noise levels at nearest sensitive receptor consistently exceeds national noise standard or in case of consistent complaints. • Construction workers to be provided with appropriate PPE such as ear plugs and ear muffs for protection against excessive noise. • Construction machines and vehicles to be turned off when not in use.	Construction contractor	Supervising consultant	Included in construction base cost
Waste	Generation of construction wastes (e.g. cleared vegetation, concrete debris, removed transmission cables, waste oil)	• Maximization of reuse and recycling. • Storage of wastes only in designated waste containers and areas. • Storage of hazardous wastes in specialized/labelled containers and facility. • Wastes to be handled and disposed only by NEMA-authorized waste management entities. • Strict prohibition of littering and implementation of awareness programs for the construction workers. • Daily clean-ups at the construction sites.	Construction contractor	Supervising consultant	Included in construction base cost

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
		• The construction contractor will be required to submit Construction Waste Management Plan (WMP) to UETCL and other necessary organizations for approval.			
Hydrology	Disruption of tributary and water channel flow due to construction of access road (Mukono)	• Culverts will be installed where the access road crosses the tributary and channel	Construction contractor	Supervising consultant	Included in construction base cost
Social infrastructures	Temporary restriction in the use of access road (Mukono)	• The access road will be constructed in manner to minimize disturbance to local users (e.g. secure of one-lane width). • Placement of traffic control officers if necessary. • Local community to be informed beforehand if any restrictions occur.	Construction contractor	Supervising consultant	Included in construction base cost
	Temporary disruption of electricity supply	• Construction works will be planned in manner to minimize duration of power outage. • If power outage is unavoidable, it will be communicated to the public and facilities (e.g. hospital) in advance. • Overhead line work to be designed and carried out in a way to avoid interference with existing power lines and maintaining safe separation distances from existing distribution lines.	Construction contractor, UETCL	Supervising consultant; UETCL	Included in construction base cost
Landscape	Change in landscape due to construction of new substations and transmission line (Buloba and Mukono).	• Site restoration (e.g. revegetation) to be implemented immediately after construction is completed. • Creation of green belt, if necessary.	Construction contractor	Supervising consultant	Included in construction base cost
Infectious diseases	Risk of spreading infectious diseases due to influx of construction workers	• Holding of awareness programs for the construction workers. • Preparation of Code of Conduct to be strictly followed by the workers. • Contractor to undertake HIV/AIDS Management campaign including Training, distribution of quality Contraceptives and Voluntary Counseling and Testing among workers and adjacent communities and schools.	Construction contractor	Supervising consultant	Included in construction base cost

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
Occupational safety	Occupational accidents (e.g. working at height)	• Compliance to JICA's "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects". • Implementation of safety training programs for all workers. • Provision of appropriate Personal Protective Equipment (PPE). • Holding of regular tool box meeting to discuss safety. • Lockout - tagout procedures to be clearly displayed on site and followed. • Contractor to deploy an HSE Officer approved by UETCL • Contractor to provide appropriate safety signage at high risk locations (e.g. near fuel tanks) including ancillary work sites. • The construction contractor will be required to submit an Occupational Health and Safety Plan (OHSP) to UETCL and other necessary organizations for approval.	Construction contractor	Supervising consultant	Included in construction base cost
Accidents	Traffic accidents and disruption due to construction-related traffic	• Strict compliance to speed limits. • Contractor to undertake daily Tool Box Talks for workers • Avoid as far as practical of using roads with high risk of accidents. • Vehicle motion alarm to be installed on all construction vehicles. • Placement of traffic officers and appropriate safety/warning signs in high risk locations (e.g. 'Heavy Trucks Turning', 'Road Diverted', 'Half Road Closed', etc.) • Contractor to maintain a Health and Accident register • The Contractor will be required to submit a Traffic Management Plan to UETCL and other necessary organizations for approval. • Contractor to Deploy a qualified Site Nurse and Doctor-On-Call • Contractor to set-up a Site Clinic for treatment of minor ailments. However, other cases shall be referred for specialized management • Contractor to provide a well-stocked First Aid Kit.	Construction contractor	Supervising consultant	Included in construction base cost
Ecosystem	Proliferation of invasive species (Buloba and Mukono)	• Revegetation of exposed surfaces (e.g. cut and fill slopes) to be done by native plant species only, and immediately after works are completed to minimize chance of colonization by invasive species. • Removal of invasive species if observed along the revegetation sites.	Construction contractor	NFA	Included in construction base cost

Item	Potential impacts	Mitigation measures	Implementation responsibility	Supervision responsibility	Estimated cost
	Disturbance to flora and fauna (Buloba and Mukono)	• Implementation of environmental awareness programs for the construction workers, with special focus on threatened species. • Strictly prohibit hunting and poaching of wild life and cutting of trees. • Prevention and minimization of pollution (e.g. noise, water) through strict implementation of planned pollution control measures.	Construction contractor	Supervising consultant	Included in construction base cost
Conflicts	There are potential conflicts among workers and between workers and adjacent communities	• Contractor to set-up a Conflict Redress Plan to be approved by UETCL • Contractor to set-up and operationalize a Conflict Redress Committee for approved by UETCL	Construction contractor	Supervising consultant, UETCL	US$ 2,000
Physical cultural resources	Loss of archeological, burial sites, sacred trees, shrines and other physical cultural resources	If such physical cultural resource are found: • Development of a Physical Cultural Resources Management Plan • Consultations to determine relocation costs • Relocation and replacement	UETCL, Contractor	DMM, MGLSD	US$20,000
Operation phase					
Water pollution	Pollution of surface water due to soil runoff from transmission line corridor and substations (Buloba and Mukono)	• Avoid removing short trees and grasses along the transmission line corridor as far as it does not hinder maintenance works.	UETCL	NEMA	-
Waste	Generation of operation waste (e.g. transformer oil)	• Wastes to be handled and disposed only by NEMA-authorized waste management entities. • Waste disposal containers will be provided onsite for each waste category. • Oil pit to be installed at substations to contain accidental spills during transformer oil exchange. • Transformer oil will be free of PCBs. • Waste oil to be recycled at UETCL facility for reuse. Residues to be disposed at oil companies.	UETCL	NEMA	Included in UETCL's operation and maintenance budget
Ecosystem	Bird collision with transmission line	• Installation of avian flight diverters (during construction) along the new transmission lines (Buloba and Mukono).	Construction contractor	NEMA/UWA	US$ 23,000 To be included in construction cost

Source: JICA Study Team

Table 9-1-8.2 Environmental Monitoring Plan

Category	Aim	Method	Frequency	Implementation responsibility	Estimated cost
Preconstruction phase					
Involuntary resettlement	To check the progress and effectiveness of ARAP implementation (Buloba, Mukono and Kawaala)	**[Internal monitoring]** ・Assessment of whether compensation and other entitlements are being delivered in line with the ARAP. ・Assessment of whether agreed measures to restore or enhance standards of living are being implemented. ・Assessment of whether agreed measures to restore or enhance livelihood and sources of income are being implemented. ・Identifying any conflicts or problems, issues, or cases of hardship resulting from the resettlement process.	・1/month during ARAP implementation ・Every 3 months during post resettlement for at least 2 years	UETCL	$275,000
		[External monitoring] ・Assessment of compliance with ARAP actions ・Assessment of pre- and post-resettlement socio-economic situation of the affected households ・Reviewing records of grievances and following up whether or not appropriate corrective actions have been undertaken and outcomes are satisfactory.	・2/year during ARAP implementation ・1/year during post resettlement for at least 2 years	Independent organization	$145,000
Conservation area	To check the progress and effectiveness of off-set programs at Nandagi Forest Reserve (Mukono)	Joint monitoring between UETCL and NFA. Detailed monitoring method to be determined between UETCL and NFA based on the Forest Biomass and Biodiversity Assessment.	・4/year for the first year ・1/year for at least 3 years post off-set establishment	UETCL/NFA	To be estimated through the Forest Biomass and Biodiversity Assessment
Construction phase					
Air pollution	To check whether excessive dust and exhaust gas are not emitted from the construction sites (Buloba, Mukono, Kawaala)	Visual inspection of: ・Fugitive dust emissions from construction sites ・Exhaust gas emissions from construction vehicles and equipment	・Daily	Construction supervisor	Part of supervision base cost
		Field measurement of air quality (PM_{10}, $PM_{2.5}$) at sensitive receptors near the substation sites. Results to be compared with WHO air quality guideline.	・1/week during heavy construction works	Construction supervisor (subcontract to local consultant)	$24,000
Water pollution	To check whether construction activities are	Field measurement of surface water quality (e.g. pH, EC, DO, SS, turbidity, TN, TP, oil & grease) at Buloba and Mukono.	・1/month	Construction supervisor	$36,000

Category	Aim	Method	Frequency	Implementation responsibility	Estimated cost
	not causing water pollution (Buloba and Mukono)	Results to be compared with baseline data.		(subcontract to local consultant)	
Soil pollution	To check of any leaks of hazardous liquids	Visual inspection of: ・Oil leaks from construction machines and vehicle. ・Leaks from storage and handling areas of hazardous liquids.	・1/week	Construction supervisor	Part of supervision base cost
Noise	To check whether excessive noise are not emitted from the construction sites (Buloba, Mukono, Kawaala)	Field measurement of noise level (LAeq) at sensitive receptors near the substation sites. Results to be compared with National Environment (Noise Standards And Control) Regulations, 2003.	・Daily during heavy construction works ・Daily/hourly on receipt of any complaints	Construction supervisor	Part of supervision base cost. Cost of portable sound meter: US$ 1,300
Waste	To check whether wastes are stored and handled in accordance to the contractor's Waste Management Plan (All sites)	Visual inspection of waste storage sites and construction sites.	・Daily	Construction supervisor	Part of supervision base cost
Occupational safety	To check whether safety procedures are implemented in accordance to OHSP (All sites)	Visual inspection of work safety procedures and equipment.	・Daily	Construction supervisor	Part of supervision base cost
Ecosystem	To check if construction activities are not causing any unnecessary disturbance to surrounding habitats and species (Buloba and Mukono)	Field surveys of sensitive habitats and flora/fauna around the project sites.	・1/month	Construction supervisor (subcontract to local consultant)	$24,000
Operation phase					
Water pollution	To check the growth status of revegetated areas and whether soil runoff is not polluting surface water (Buloba and Mukono)	Observation of growth status of revegetated areas and water quality measurements of adjacent surface water (SS, turbidity).	・3/year until regrowth is confirmed	UETCL (subcontract to local consultant)	$9,000
Waste	To check operation wastes are stored and handled in	Inspection of oil leakages and waste management practices at the substations.	・4/year	UETCL	Included in UETCL's operation

Category	Aim	Method	Frequency	Implementation responsibility	Estimated cost
	accordance to the Waste Management Plan (All sites)				and maintenance budget
Ecosystem	To check of any bird collision incidence along the transmission line corridor (Buloba and Mukono)	Field reconnaissance and community interview along the transmission line corridor.	・ 3/year for at least 2 years	UETCL	Included in UETCL's operation and maintenance budget

Source: JICA Study Team

9-1-9 Stakeholder Meeting

Stakeholder meetings were held with relevant government agencies and local communities during the EIA and ARAP preparation. Table 9-1-9.1 shows the organizations and communities consulted and objectives.

Table 9-1-9.1 List of organizations and communities consulted

Target	Date	Objective
National Forest Authority (NFA)	16th March 2016 4th April 2016	To discuss about project implementation in Nandagi Forest Reserve
Private tree farmers in Nandagi Forest Reserve	10th May 2016	・Explanation of project ・Explanation of RAP
Mukono communities	10th May 2016 30th April 2016	・Explanation of project ・Explanation of EIA and RAP
Buloba communities	27th January 2016 30th March 2016	
Kawaala communities	29th March 2016	

Source: JICA Study Team

Table 9-1-9.2 shows the main questions/comments raised during the meeting with NFA including responses from the Project side (see Appendix-12 for the minutes of the meeting). The results of the other meetings are described in Section 9-2 as the raised questions/comments were mostly related to RAP.

Table 9-1-9.2 Main questions/comments raised during the meeting with NFA

Questions/comments	Responses
・NFA needs to see the option selection reports showing the alternatives and why the forest reserve area was selected for the substation site.	・The relevant report will be submitted to NFA later.
・UETCL will need to pay an offset fee for the lost forest and biodiversity.	・Noted
・ The land of Nandagi Forest Reserve belongs to NFA, but the trees belong to individual farmers.	・Noted
・Biodiversity evaluation should be part of the ESIA study.	・A flora/fauna survey will be implemented as part of the EIA.

Source: JICA Study Team

9-1-10 Others

In order to resolve any conflicts that occur between workers or with workers and the local communities, the Construction Contractor will be required to develop a Conflict Redress Plan including establishment of Conflict Redress Committee, and obtain approval from UETCL for its plan.

9-2 Land Acquisition and Resettlement

9-2-1 Necessity of Land Acquisition and Resettlement

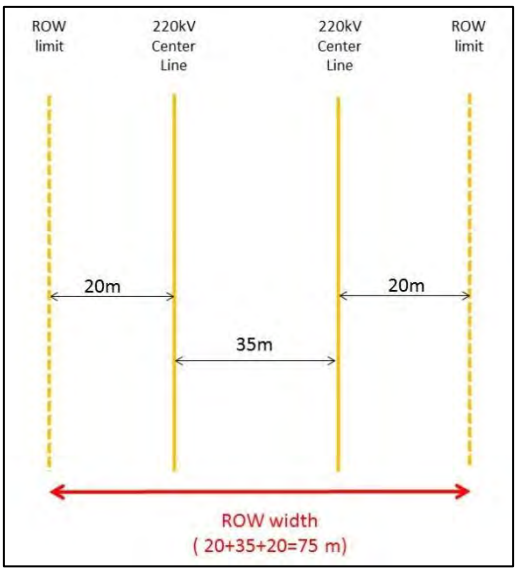
New land acquisition will be required at Buloba, Mukono and Kawaala project sites. Table 9-2-1.1 shows the project components that require new land acquisition and their total area.

Table 9-2-1.1 Project components that require new land acquisition and their total area

	Component	Land acquisition area (ha)
Buloba	・ Substation (approx. 200 m x 260 m) ・ 220 kV transmission line (approx. 0.9 km x ROW 75 m) ・ 132 kV transmission line (approx. 0.8 km x ROW 30 m)	Approx. 12
Mukono	・ 220 kV transmission line (approx. 4.2 km x ROW 75/55 m) ・ 132 kV transmission line (approx. 0.4 km x ROW 60 m) ・ Access road (approx. 1.2 km x ROW 8 m)	Approx. 35
Kawaala	・ Underground transmission line (approx. 0.1 km x ROW 5 m)	Approx. 0.03

Source: JICA Study Team

To avoid or minimize resettlement of local residents, the location of the substation and transmission line route were selected in a manner to avoid as far as possible residential areas. Furthermore, to minimize land acquisition for the transmission line, the two 220 kV transmission lines in Buloba and Mukono will be aligned as close together as possible and share their Right of Way (ROW). This will reduce the required ROW width to 75 m instead of 80 m if not shared. Figure 9-2-1.1 shows an image of the ROW sharing of two 220 kV transmission lines.



Source: JICA Study Team

Figure 9-2-1.1 Image of ROW sharing of two 220 kV transmission lines

In case of Mukono, the ROW of the two 220 kV transmission lines was further minimized to 55 m along sections where sufficient separation distance can be maintained between the transmission towers.

There is one residential structure each in Buloba and Mukono that is within the transmission line corridor. Resettlement is however unlikely to be required as the owner would be able to reconstruct their structures a small distance away within their land boundary.

9-2-2 Legal Framework on Land Acquisition and Resettlement

(1) Outline of Uganda's land acquisition and resettlement framework

1) Legal framework

The principal laws for land acquisition and resettlement in Uganda are as follows:

- The Constitution of the Republic of Uganda (1995)
- Land Act (1998)

Article 237 of the Constitution vests land in the citizens of Uganda and identifies four land tenure systems, namely: customary, freehold, mailo and leasehold. Article 26 of the Constitution recognizes rights to acquire land in the public interest providing that prompt payment of fair and adequate compensation, prior to the taking of possession or acquisition of the property.

Article 3 of the Land Act defines the four land tenure systems (customary, freehold, mailo and leasehold) identified in the Constitution. Following are brief explanations of the four land tenure systems:

- **Customary:** In this tenure, land is owned in perpetuity and tenure is governed by local customary regulation. "Kibanja" are a type of customary tenure which exists in some of the land acquisition area. Kibanja holders have full rights to own and use the land under an agreement made with the original land owner (i.e. mailo holder). However, since the original land owner still has certain landownership rights over the land, compensation is split between the Kibanja holder and land owner in accordance to Ugandan customs.
- **Freehold:** This tenure involves the holding of land in perpetuity or for a period less than fixed by a condition and enables the holder to exercise, subject to the law, full powers of ownership.
- **Mailo:** This tenure system is a feudal ownership introduced in Buganda by the British in 1900 under the Buganda Agreement. Land is hold in perpetuity and enables the holder to exercise, subject to the law, full powers of ownership. Mailo also permits the separation of ownership of land from ownership of developments on land made by a lawful or *bona fide* occupant.
- **Leasehold:** Lease tenure is a form of tenure under which the landlord or lessor grants the tenant or lessee exclusive possession of the land, usually for a defined period and in return for a rental fee. The tenant has security of tenure and a proprietary interest in the land.

Article 77 of the Land Act stipulates the payment of disturbance allowance on top of the computed compensation amount. The disturbance allowance will be 15% of compensation amount, and 30% if less than 6 month notice is given.

2) Land acquisition procedure

While there are no laws that specify the land acquisition procedure, the proponent is required to obtain approval from the Chief Government Valuer (CGV) of the Ministry of Lands, Housing and Urban Development regarding the calculated compensation for land and other assets. The main procedures are outlined below:

- The proponent submits an inception report to the CGV describing the valuation methods and valuer's qualification.
- The inception report is reviewed and approved by the CGV.
- The proponent implements land and asset valuation survey and submits the report to the CGV.
- The valuation report is reviewed and approved by the CGV.
- Once approved, the proponent pays the compensation to the owners.

This project has subcontracted a local consultant (AWE) to undertake the land and asset valuation survey and preparation of Abbreviated Resettlement Action Plan (ARAP). The reports of the land and asset valuation survey and ARAP have been submitted to UETCL in mid-July.

(2) Gap analysis of JICA guideline and Uganda law

Table 9-2-2.1 shows the gap analysis of JICA guideline and Uganda law and the project's policy to fill the gaps.

Table 9-2-2.1 Gap analysis of JICA guideline and Uganda law and the project's policy to fill the gaps

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	No specific provisions for exploring all viable alternatives	No specific provisions for exploring all viable alternatives	All viable alternatives including the design options will be explored to avoid or minimize involuntary resettlement and loss of means of livelihood
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Ugandan Constitution requires that prompt, fair and adequate compensation be paid prior to displacement (Article 26).	No gap	The Project will provide fair and adequate compensation to all project affected persons and implement effective measures to minimize impacts
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	There are no explicit provisions under resettlement or relocation laws for livelihood restoration assistance.	No provision for livelihood restoration assistance during resettlement process	The project will implement a strategy for enabling the PAPs to restore their livelihood and incomes to at least pre-project levels. This strategy will include implementation of a livelihood restoration programme such as poultry, piggery, or other such projects depending on the interests of the affected community.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Section 78 (1) of the Land Act provides that in assessing compensation rates, the following are taken into account: (a) in the case of a customary owner, the value of land shall be the open market value of the unimproved land; (b) the value of the buildings on the land, which shall be taken at open market value for urban areas and depreciated replacement cost for the rural areas; (c) the value of standing crops on the land, excluding annual crops which could be	No specific mention of full replacement cost	Project will provide compensation based on full replacement cost.

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
		harvested during the period of notice given to the tenant. Section 78(2) provides that in addition to the compensation assessed, there shall be paid as a disturbance allowance 15 percent or, if less than six months' notice to give up vacant possession is given, 30 percent of any sum assessed i.e. disturbance allowance of 15% or 30% depending on the notice period.		
5	Compensation and other kind of assistance must be provided prior to displacement. (JICA GL)	Section 42(7)(b) of the Land Act provides that no person from whom land is to be acquired shall be required to vacate until they receive full compensation.	No gap	Compensation and necessary assistance will be provided prior to displacement. The Project will implement a livelihood restoration programme such as poultry, piggery or any such similar projects depending on the interests of the affected community.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	The laws of Uganda provide for fair and adequate compensation (Art 26 of Constitution and Section 42(7) of the Land Act). The laws do not, however, provide for the preparation of resettlement action plans.	There is no equivalence on preparation of resettlement plans and making them available to the public.	Preparation of resettlement plans will be undertaken in a consultative manner and final RAP documents made available to the public through district local authorities, UETCL website and NEMA library.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	There are no explicit provisions for consultations and disclosure but there are guidelines issued by separate ministries (for example RAP Guide for roads).	Potential gap exists in regard to stakeholder involvement and information disclosure	Consultations will be held with the affected people and their communities based on sufficient information made available to them in advance
8	When consultations are held, explanations must be given in a form, manner and language understandable	There are no explicit provisions for consultations, but there are guidelines issued by separate ministries (for example	There are no explicit provisions for consultations	Information provided to PAPs during consultations will be in a form, manner and language that they

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
	to affected people. (JICA GL)	UETCL's Way Leaves Acquisition Manual and Way Leaves Policy).		understand. The consultation process will follow a top-down approach in which line ministries will be consulted, followed by District offices, sub-county offices and finally the communities/villages in the Project areas.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	There are no explicit provisions for consultations and disclosure, but there are guidelines issued by separate ministries (for example UETCL's Way Leaves Acquisition Manual and Way Leaves Policy).	While PAP participation is inherent in the ESIA/RAP process, it contains a number of differences with the requirements of JICA guidelines.	PAP involvement will be strongly encouraged and promoted throughout the ESIA/RAP preparation processes. Information about the project and it's impacts will be shared and views sought from the affected persons and communities.
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Section 77 of the Land Act, 1998 had provided for land tribunals to resolve all land related issues. However, since their suspension in 2007, the High Court handles all land-related cases as provided for in the Land Acquisition Act.	Potential gap exists in terms of accessibility and affordability by PAPs if the High Court must handle land-related grievances	Grievance Resolution Committee to be instituted but the procedure will not replace existing legal process in Uganda. Rather it seeks to resolve issues quickly so as to expedite receipt of entitlements and smooth resettlement without resorting to expensive and time-consuming legal action. If the grievance procedure fails to provide a settlement, complainants can still seek legal redress. Following are the main grievance steps: Step 1: Re-view and re-evaluation if the rates are not acceptable by the PAPs. Step 2: Establishment of a Grievance Resolution Committee in the village/ affected community which will

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
				comprise of an elder, an opinion leader and an LC 1 Chairperson. Step 3: Establishment of a Grievance Resolution Committee in the sub county (Sub County Review Committee) Step 4: Court of law
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefits. (WB OP4.12 Para.6)	The Ugandan law does not make specific provision for the process of identification of, or eligibility of project affected persons	Although PAPs are required to be identified and served notices, there is no explicit provision for baseline census and socioeconomic surveys as part of a RAP process	The project will conform to WB OP 4.12 and best practices during the preparation of the RAP. Some of the measures will include; ・Identification of PAPs through surveys and census ・Determination of compensation eligibility criteria using an eligibility matrix e.g. land owners (land owner, tenant, licensee, or sharecropper), owners of cultural resources or infrastructure, property owners (structures and crops), etc. ・Disclosure of cut-off date after valuation work has been done.
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Ugandan law does not make specific provision for squatters or illegal settlers and compensation is given to only legal occupants. The Land Act treats lawful occupants and bona fide occupants as statutory tenants of the registered owner. **Under Section 30 of the Land Act, "lawful occupant" means a person who entered the land with consent of the registered owner, and includes a purchaser; or a person who had**	Those without formal legal rights or claims to such lands are not entitled to be resettled or compensated	Dialogue with policy makers will be initiated to explore the possibility of giving compensation to those without formal legal rights or claims to such lands in order to conform to WB OP 4.12.

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
		occupied land as a customary tenant but whose tenancy was not disclosed or compensated for by the registered owner at the time of acquiring the leasehold certificate of title. **"Bona fide occupant" means a person who before the coming into force of the Constitution had occupied and utilized or developed any land unchallenged by the registered owner or agent of the registered owner for twelve years or more; or had been settled on land by the Government or an agent of the Government, which may include a local authority.** For the avoidance of doubt, a person on land on the basis of a license from the registered owner shall not be taken to be a lawful or bona fide occupant under this section. Any person who has purchased or otherwise acquired the interest of the person qualified to be a bona fide occupant under this section shall be taken to be a bona fide occupant for the purposes of this Act.		
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	The law is not explicit about land-based resettlement strategies	The law is not explicit about land-based resettlement strategies	Since land-based resettlement packages are difficult to be implemented, the project will ensure: ・ Adequate compensation at full replacement cost and disturbance allowance on top of that will be

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
				provided. ・ In addition, for orphaned land between two transmission lines, a 100% compensation rate will be applied. ・ If PAPs cannot continue current activities on remaining land as a result of the project land acquisition, the entire area will be bought.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	There are no equivalent provisions on transitional support	There are no provisions on transitional support	The project will provide support for the transition period.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	There is no distinction made on the basis of gender, age, or ethnic origin in Ugandan law during compensation.	There is no distinction made on the basis of gender, age, or ethnic origin in Ugandan law during compensation.	The project will conform to the requirements of WB OP 4.12 and best practices during the preparation of the RAP in regards to the needs of the vulnerable groups for example women and children, orphans, widows, and people with physical disabilities. In particular, the Project will implement a number of projects for the identified vulnerable people in the area. These will include provision of resettlement houses and livelihood restoration program such as poultry, piggery, etc.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people,	There is no explicit provision for abbreviated RAP in the Ugandan law.	There is no explicit provision for abbreviated RAP in the Ugandan law.	The project will conduct a RAP study and implement the recommendations in conformity with

No.	JICA Guidelines	Laws of Uganda	Gaps between JICA Guidelines and Laws of Uganda	Project policy
	abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)			JICA Guidelines and WB OP 4.12.

Source: Project ARAP report

(3) Project's policy on land acquisition and resettlement

The main gap between JICA guideline and Uganda law is that the Uganda law does not have any explicit provisions for livelihood restoration assistance. UETCL however recognizes the importance of livelihood restoration assistance and has voluntarily provided such assistance in other projects when necessary. UETCL also intends to provide necessary livelihood restoration assistance for this project until PAPs living standard and livelihood are restored to at least pre-project levels.

9-2-3 Scope of Land Acquisition and Resettlement

(1) Census survey

Census survey was implemented during May-June 2016 to understand the PAPs in the land acquisition areas. The survey identified a total of 96 PAPs (landowners) under 3 different land tenure types namely Mailo, Leaseholder and Kibanja. Table 9-2-3-.1 shows the number of PAPs by land tenure type.

Table 9-2-3.1 Number of PAPs by land tenure type

Item	Buloba	Mukono	Kawaala	Total
Land acquisition area (ha)	Approx. 12	Approx. 35	Approx. 0.03	Approx. 47
No. of PAPs (landowners)	58	31	7	96
Mailo	42	20	1	63
Leaseholder	2	0	0	2
Kibanja	14	11	6	31

Source: Project ARAP report

The cut-off-date was set when the census survey and land/asset valuation survey were completed.

(2) Land and asset valuation survey

Land and asset valuation survey was implemented at the same time of the census survey during May-June 2016. Initially, the project affected land, structures and crops were quantified at the site under the presence of the owner. The compensation rate for each asset was then calculated based on the method described in Section 9-2-4. Table 9-2-3.2 shows the number and type of affected structures. One residential structure was identified each within the transmission line corridor Buloba and Mukono. Other identified structures included incomplete structures, pit latrine and water tank. Since all these structures can be reconstructed a small distance away within the owners land boundary, resettlement is unlikely to be required.

Table 9-2-3.2 Number and type of affected structures

	Item		Note
Buloba	Residential	1	1 story, brick
	Common assets	0	
	Others	5	Incomplete structure, pit latrine, water tank
	Total	6	
Mukono	Residential	1	1 story, brick
	Common assets	0	
	Others	3	Incomplete structure, pit latrine
	Total	4	
Kawaala	Residential	0	
	Common assets	0	
	Others	1	Pit latrine
	Total	1	

Source: Project ARAP report

Table 9-2-3.3 shows the number and type of affected crops/trees, which occur only in Buloba and Mukono. The number of PAPs growing crops/trees were 7 and 20 in Buloba and Mukono respectively. The main crops were Matooke, sugar cane, coffee and avocado. While some PAPs are subsistence farmers, some also sell their crops in case of surplus yield. Hence loss of their farmland may result in less food supply for their household and income. While the project will compensate for the loss of crops, PAPs that are heavily dependent on farming are likely to require livelihood restoration assistance.

Table 9-2-3.3 Number and type of affected crops/trees

	PAPs	Crop/tree	Sub total	Total
Buloba	1	Matooke (4)	4	195
	2	Eucalyptus (2), Mango (7), Avocado (4), Matooke (10,000 m^2), Sugarcane (7), Muwafu (6), Ticka (14), Jackfruit (10)	50 (excluding Matooke)	
	3	Muwafu (1), Mango (1), Jambula (1), Matooke (4)	7	
	4	Matooke (100), Jackfruit (2), Coffee (2)	104	
	5	Pine (1)	1	
	6	Eucalyptus (2)	2	
	7	Eucalyptus (25), Jackfruit (2)	27	
Mukono	1	Matooke (30)	30	3,480
	2	Matooke (7)	7	
	3	Eucalyptus (576), Matooke (7), Mango (1)	584	
	4	Musizi (3), Jackfruit (1)	4	
	5	Matooke (204), Sugarcane (56)	260	
	6	Matooke (159), Coffee (10), Sugarcane (56)	225	
	7	Sugarcane (242)	242	
	8	Eucalyptus (1)	1	
	9	Eucalyptus (56), Coffee (40), Guava (6), Mvule (1)	103	
	10	Pine (11)	11	
	11	Matooke (250), Emiti (5)	255	
	12	Pine (60), Matooke (500), Avocado (4), Coffee (250), Jackfruit (3)	817	
	13	Coffee (380), Jackfruit (8), Mango (5)	393	
	14	Orange (10), Mango (4), Coffee (5), Pawpaw (5), Eucalyptus (5), Jackfruit (3)	32	
	15	Jackfruit (2), Mango (1), Emiti (2)	5	
	16	Coffee (5), Musizi (4), Jackfruit (4), Avocado (4)	17	
	17	Musizi (4), Kirundu (1), Coffee (5), Jackfruit (3), Mvule (1)	14	
	18	Avocado (126), Pawpaw (15), Orange (20), Eucalyptus (200), Mango (50)	411	
	19	Coffee (20), Musizi (6), Jackfruit (5), Eucalyptus (10), Matooke (15)	56	
	20	Eucalyptus (10), Musizi (1), Jackfruit (1), Umbrella (1)	13	

Note: Figures in brackets indicate the number of crops/trees counted.
Source: Project ARAP report

In addition, there are 6 NFA licensed private farmers that grow trees within the route of the Mukono 220 kV transmission line that traverse through Nandagi Forest Reserve. These farmers mainly grow forest products such as eucalyptus, pines and musizi. While the loss of trees will be compensated, they may also require livelihood restoration assistance as they will partially or fully lose their income source.

(3) Socioeconomic survey

A socioeconomic survey was implemented during May-June 2016 targeting the PAPs. The survey was conducted by interviewing the household heads. A total of 62 PAPs (Buloba: 33, Mukono: 23 and Kawaala: 6) were interviewed and the results are presented below:

1) Household composition

Table 9-2-3.4 shows the number of household members of the interviewed PAPs. Overall, over 30% of the PAPs had 9 and above household members, which was especially prominent in Buloba and Mukono. The next highest household composition was 3-4 members.

Table 9-2-3.4 PAPs household composition

		No. of household members					Total
		1-2	3-4	5-6	7-8	9 and above	
Buloba	Persons	1	9	7	7	9	33
	%	1.7	15	11.7	11.7	15	55
Mukono	Persons	2	5	3	4	9	23
	%	3.3	8.3	5	6.7	15	38.3
Kawaala	Persons	1	-	2	-	1	4
	%	1.7	-	3.3	-	1.7	6.7
Total	Persons	4	14	12	11	19	60
	%	6.7	23.3	20	18.3	31.7	100

Source: Project ARAP report

2) Livelihood

Table 9-2-3.5 shows the occupation of the interviewed PAPs. Overall, the ratio of teachers (27.4%) and farmers (22.6%) were high. Teachers were only from Buloba. Farmers were most prominent in Mukono. In Kawaala, most PAPs are involved in brick making.

Table 9-2-3.5 Occupation of PAPs

		Civil servant	**Cleric**	**Farmer**	**Formal employment**	**Nurse**	**Private formal employment**	**Private informal employment**	**Retail trade**	**Student**	**Teacher**	**Transport**	**Total**
Buloba	Persons	1	1	3	-	1	1	2	5	-	17	2	33
	%	1.6	1.6	4.8	-	1.6	1.6	3.2	8.1	-	27.4	3.2	53.2
Mukono	Persons	2	-	10	5	-	-	2	4	-	-	-	23
	%	3.2	-	16.1	8.1	-	-	3.2	6.5	-	-	-	37.1
Kawaala	Persons	-	-	1	-	-	1	3	-	1	-	-	6
	%	-	-	1.6	-	-	1.6	4.8	-	1.6	-	-	9.7
Total	Persons	3	1	14	5	1	2	7	9	1	17	2	62
	%	4.8	1.6	22.6	8.1	1.6	3.2	11.3	14.5	1.6	27.4	3.2	100

Source: Project ARAP report

3) Income

Around 90% of the interviewed PAPs have an annual income of over 1,500,000 UGX. However, the annual income of around 10% of the PAPs are within the range of 500,000-1,000,000 UGX, which is less than 1US$ per day. According to World Bank's 2012 statistics, around 40% of the Uganda population live at less than 1.25US$ per day.

4) Religion and tribe

Around 60% of the interviewed PAPs were Christians (Protestants: 29.0%, Catholics: 24.2%, Pentecostal: 6.5%) and remaining 40% Muslims. Around 90% of the PAPs were Muganda the most prevalent tribe in Uganda.

5) Water and energy sources

Around 60% of the interviewed PAPs were dependent on natural water sources such as spring water, borehole and rainwater. Around 40% of the PAPs were dependent on tap water. For energy, the majority of PAPs use charcoal and firewood. Other sources included electricity, kerosene, solar, gas and so on.

6) Education

Around 50% of the interviewed PAPs were university graduates and over 90% have attained primary education. Around 5% of the PAPs had never attained any level of education.

7) Health

The most common illness among the family of interviewed PAPs was malaria. Other illnesses included respiratory infections, typhoid, diabetes and so on.

(4) Vulnerable group

Three (3) vulnerable people were identified along the project area. Two were sick and one orphaned. These vulnerable people may require assistance in compensation payment procedures and also should have priority in livelihood restoration programs.

9-2-4 Compensation and livelihood restoration measures

(1) Compensation of losses

The project land acquisition will entail loss of land, structure and crops, which will be compensated in accordance to Uganda law before the project starts. The compensation method will differ depending on the type of land tenure. There will also be loss of income sources for land dependent PAPs such as farmers. Table 9-2-4.1 shows the compensation method for land, structure and crops.

Table 9-2-4.1 Compensation method for land, structure and crops

Type of loss		Entitled person	Compensation method
Land	Mailo	Owner	・ Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance. ・ Land-for-land compensation if such land is available.
	Leasehold	Leaseholder	・ Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance for the remaining leasehold interest in the land. ・ UETCL to acquire lease from the Registered Land owner upon expiry of the lease tenure of the Leaseholder. ・ Land-for-land compensation if such land is available.
	Kibanja	Owner	・ Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance. ・ Compensation will be split between the Bonafide/lawful occupant (Kibanja holder) and landowner in the ratio of 40% of above compensation paid to landlords and 60% to the Kibanja owner as the common practice in Uganda. ・ Land-for-land compensation if such land is available.
Structure		Owner including squatters	・ Compensation at full replacement value without depreciation and 30% disturbance allowance.
Crops (perennial)		Owner	・ Compensation at district rates and 30% disturbance allowance.
Crops (seasonal)		Owner	・ Ample time will be provided to enable the harvesting of seasonal crops.
Livelihood		Business owner, employee etc.	・ Compensation for loss of business and employment such as through provision of transition allowance. ・
Rental accommodation and business premises		Tenant	・ Compensation at full replacement value for fixed assets and 30% disturbance allowance.
Common property		Owner	・ Compensation as per approved valuer and 30% disturbance allowance.

Source: Project ARAP report

(2) Livelihood restoration

While the Uganda law does not have any provisions for livelihood restoration assistance, UETCL will voluntarily provide such assistance when necessary until PAPs living standard and livelihood are restored to at least pre-project levels. PAPs such as crop and tree farmers will likely require such assistance. Following are some livelihood restoration measures proposed in the ARAP:

- Provision of employment (e.g. Project construction worker)
- Provision of alternative income generating sources (e.g. poultry, piggery)
- Provision of training opportunities (e.g. farming skills, animal husbandry)

(3) Entitlement matrix

Table 9-2-4.2 is the entitlement matrix of this project, which shows the compensation and assistance measures and implementation responsibility.

Table 9-2-4.2 Entitlement matrix

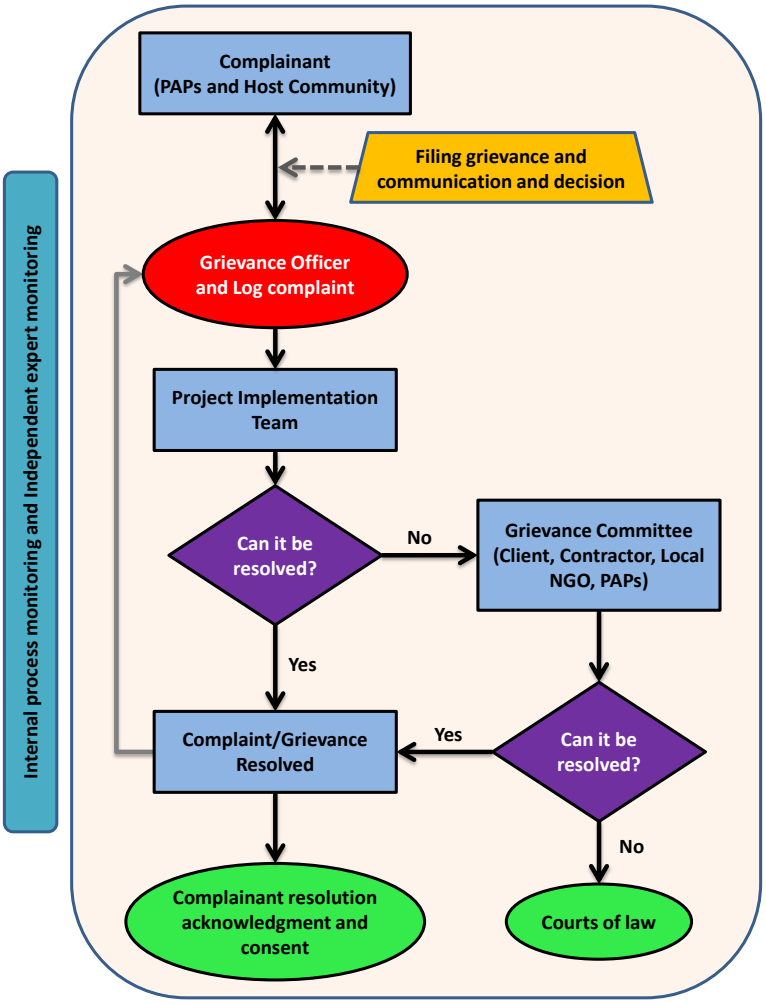
Type if impact	Entitled person	Primary entitlement measures	Other entitlement measures	Responsible organizations
Loss of land	Mailo or Freehold holder	・Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance for both property and land. ・Land-for-land compensation if such land is available.	・Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance) ・Support for transition period (e.g. livelihood restoration program, provision of employment) ・Additional assistance for vulnerable people (e.g. provision of resettlement house, priority for livelihood restoration program)	UETCL
	Leaseholder	・Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance for property. ・Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance for the remaining leasehold interest in the land. ・Land-for-land compensation if such land is available. ・UETCL to acquire lease from the Registered Land owner upon expiry of the lease tenure of the Leaseholder.	・Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance) ・Support for transition period (e.g. livelihood restoration program, provision of employment) ・Additional assistance for vulnerable people (e.g. provision of resettlement house, priority for livelihood restoration program)	UETCL
	Kibanja holder	・Cash compensation based on market value (equal to replacement value) and 30% disturbance allowance for property awarded to the Occupant. ・Compensation for Land will be split between the Bonafide/lawful occupant (Kibanja holder) and landowner in the ratio of 40% of above compensation paid to landlords and 60% to the Kibanja owner is the common practice in Uganda ・Land-for-land compensation if such land is available.	・Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance) ・Support for transition period (e.g. livelihood restoration program, provision of employment) ・Additional assistance for vulnerable people (e.g. provision of resettlement house, priority for livelihood restoration program)	UETCL
Loss of structure	Owners including Squatters	・Compensation at full replacement value without depreciation and 30% disturbance	・Building materials maybe salvaged from old housing to be utilized in new structures.	UETCL

Type if impact	Entitled person	Primary entitlement measures	Other entitlement measures	Responsible organizations
	occupiers	allowance.	· Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance). · Support for transition period (e.g. livelihood restoration program, provision of employment) · Additional assistance for vulnerable people (e.g. provision of resettlement house, priority for livelihood restoration program)	
Loss of rental accommodation and business premises	Tenants	· Compensation at full replacement value for fixed assets and 30% disturbance allowance.	· Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance).	UETCL
Loss of perennial crops	Owners	· Compensation at district rates and 30% disturbance allowance.	· Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance). · Support for transition period (e.g. livelihood restoration program, provision of employment)	UETCL
Loss of seasonal crops	Owners	· Ample time will be provided to enable the harvesting of seasonal crops.		
Loss of business and employment	Business owners	· Compensation for loss of business and employment such as through provision of transition allowance.	· Relocation assistance (e.g. assistance to identify new business and employment, transaction cost, transport allowance). · Support for transition period (e.g. livelihood restoration program, provision of employment)	UETCL
Loss of common property	Owners	· Compensation as per approved valuer and 30% disturbance allowance.	· Relocation assistance (e.g. assistance to identify new site, transaction cost, transport allowance).	UETCL

Source: Project ARAP report

9-2-5 Grievance Redress Mechanism

UETCL will establish a Grievance Committee comprised of representative of UETCL, local council and NGOs. Figure 9-2-5.1 shows the main steps of the grievance redress procedure.



Source: Project ARAP report

Figure 9-2-5.1 Main steps of the grievance redress procedure

9-2-6 Institutional Framework and Schedule

(1) Implementation structure

Implementation of ARAP will be the responsibility of UETCL's Project Implementation Department and Environment Section. This will include compensation payment, provision of livelihood restoration assistance, grievance redressal, monitoring and so on. Table 9-2-6.1 shows other organizations that are relevant to ARAP implementation including their roles.

Table 9-2-6.1 Organizations relevant to ARAP implementation and their roles (apart from UETCL)

Organization	Roles
Ministry of Gender, Labour & Social Development	Social development of affected communities.
Ministry of Lands, Housing and Urban Development	Approval of land and asset compensation rate.
District Land Boards	Management of land registration and transaction and setting of district compensation rate.
Local Council	Participation in Grievance Committee and overseeing ARAP implementation.

Source: Project ARAP report

(2) Implementation schedule

Implementation of ARAP is estimated to take around 6 months including CGV's approval process. Table 9-2-6.2 shows the tentative ARAP implementation schedule.

Table 9-2-6.2 ARAP implementation schedule (tentative)

Activity	1	2	3	4	5	6	7	8	9	10
ARAP approval and disclosure										
ARAP approval by CGV										
ARAP disclosure & display of valuation lists										
ARAP implementation										
Establishment of ARAP implementation structure and Grievance Committee										
Compensation payment										
Grievance management										
Land acquisition										
Start of construction										
Monitoring										

Source: Project ARAP report

9-2-7 Cost and Finance Source

Table 9-2-7.1 shows the estimated cost required for compensation of land and other assets. A disturbance allowance of 30% on top of the assessment value was awarded because the project is expected to commence as soon as compensation of the PAPs is completed.

Table 9-2-7.1 Estimated compensation cost for land and other assets (Ugandan shilling)

	Item	Assessed value	Disturbance allowance (30%)	Total (UGX)
Kawaala	Land	23,690,000	7,107,000	30,797,000
	Structure	1,332,000	399,600	1,731,600
	Kawaala total	25,022,000	7,506,600	32,528,600
Buloba	Land	972,239,000	291,671,700	1,263,910,700
	Structure	27,630,500	8,289,150	35,919,650
	Crops	77,707,500	23,312,250	101,019,750
	Buloba total	1,077,577,000	323,273,100	1,400,850,100
Mukono	Outside of Nandagi Forest Reserve			
	Land	471,814,000	141,544,200	613,358,200
	Structure	12,503,600	3,751,080	16,254,680
	Crops	35,382,000	10,614,600	45,996,600
	Total	519,699,600	155,909,880	675,609,480
	Inside of Nandagi Forest Reserve*			
	Land	1,030,959,000	309,287,700	1,340,246,700
	Tree	1,551,420,000	465,426,000	2,016,846,000
	Total	2,582,379,000	774,713,700	3,357,092,700
	Private farmers inside of Nandagi Forest Reserve			
	Tree	1,479,441,000	443,832,300	1,923,273,300
	Total	1,479,441,000	443,832,300	1,923,273,300
	Mukono total	4,581,519,600	1,374,455,880	5,955,975,480
Grand total		5,684,118,600	1,705,235,580	7,389,354,180

*: While the assessed values include land and trees, land will not be subject to compensation as it is government land. It was included in the table by UETCL's request. The compensation rates for trees are tentative values and the actual amount will be determined through the "Forest Biomass and biodiversity assessment".

Source: Project ARAP report

Table 9-2-7.2 shows the estimated overall cost required for ARAP implementation including livelihood restoration and monitoring.

Table 9-2-7.2 Estimated overall cost required for ARAP implementation (Ugandan shilling)

Item	Cost	Responsibility	Financial source
Compensation cost*	6,049,107,480	UETCL	GOU
Livelihood restoration	352,714,001	UETCL	GOU
Assistance to vulnerable households	60,491,074	UETCL	GOU
RAP implementation consultant	302,455,374	UETCL	GOU
Monitoring	151,227,687	UETCL	GOU
Contingency (10% of total)	604,910,748	UETCL	GOU
Total	**7,520,906,364**		

*: Does not include land compensation cost of Nandagi Forest Reserve included in Table 9-2-7.1.

Source: Project ARAP report

9-2-8 Monitoring

Internal and external monitoring will be implemented with this project. Details of each monitoring are described below.

(1) Internal monitoring

UETCL will assign a monitoring officer who will regularly monitor the progress of compensation

payment, effectiveness of assistance measures, grievances and issues, and report to the Project Implementation Department about once a month. (Appendix-13 is RAP monitoring form that can be used for reporting to JICA)

(2) External monitoring

UETCL will appoint an external monitoring agency to assess the status of ARAP implementation and its effectiveness. It will be undertaken twice a year during ARAP implementation and once a year (for at least 2 years) post ARAP implementation. The following points will be mainly confirmed through external monitoring: (Appendix-14 is draft TOR for external monitoring)

- Transparency of the implementation process.
- Adequacy of staff and capacity of the implementation agencies.
- Compliance of the resettlement process with Ugandan law.
- Effectiveness of the grievance process.
- Effectiveness of the internal monitoring mechanism.

9-2-9 Community consultation

Consultation meetings were held with the communities of Mukono, Buloba and Kawaala and private farmers operating inside Nandagi Forest Reserve. The objectives of consultations were to share Project information, to obtain baseline information, and to allow stakeholders the opportunity to make comments and express their views on the proposed Project's impacts and mitigation measures being proposed to address these impacts. Table 9-2-9.1 shows the outline of the consultation meetings.

Table 9-2-9.1 Outline of community consultation meetings

	Date	Location	Target community/village	Number of participants
Mukono	10th May 2016	Nandagi NFA Office	NFA private foresters in Nandagi Forest Reserve	34
	30th April 2016	Buyuki Trading Centre	Community members in villages of Nama II, Buyuki and Luwunga	27
	30th April 2016	Nandagi NFA Office	Community members in villages of Wanjeyo, Kivuvu and Bwefulumya villages	16
Buloba	27th January 2016	Grail Sisters Church, Kaggaba	Community members in villages of Kaggaba, Mabuye, and Nsujjuwe	16
	30th March 2016	Grail Sisters Church, Kaggaba	Community members in villages of Kaggaba, Mabuye, and Nsujjuwe	11
Kawaala	29th March 2016	Project site	Community members of Namungoona	16

Source: Project ARAP report

Table 9-2-9.2 shows some of the key issues raised by the participants and the responses made. None of the participants raised any objection to the Project. The minutes of the meetings are attached as Appendix-12.

Table 9-2-9.2 Key issues raised by the participants and responses by the project

	Issue	Response
Mukono	In some instances, PAPs' structures get old and collapse before compensation is done. How will these be handled if re-assessment is done subsequently?	In the event that a PAP's structure collapses before compensation, the PAP will get the compensation due him as his property information will have already been captured.
	Will PAPs be permitted to use the land after the project has been implemented?	The project proponent intends to fully compensate and acquire the project area and therefore no work or developments by PAPs will be allowed subsequent to project implementation.
	How will kibanja holders and title owners be compensated?	Kibanja owners and title holders will be equitably compensated in their individual holding capacities on pro rata basis.
	Who constitutes the grievance committee?	The grievance committee constitutes a member of the Local Council, a member of the project proponent organization and an identified NGO from the project area.
Buloba	How will the kibanja holders and title holders be catered for?	The compensation for such an area is split such that the kibanja holder receives 70% of the compensation sum while the title holder receives 30% of the compensation sum.
	Sometimes the Valuers don't give the right amount e.g. someone who deserves more money gets less, and vice versa.	The valuation process will be conducted in line with the laws of Uganda and the JICA Guidelines for Social and Environmental Considerations. In accordance with the Ugandan laws, the Valuation report will be submitted to the Chief Government Valuer for approval of the compensation values to be used for the Project.
	How will the Grievance Committee be selected and where could it be found?	The Grievance Committee will be composed of the area local chairpersons such as LC I and LC II. Aside from the local chairpersons, the Committee will also include an elder on the village, an opinion leader, as well as a representative from UETCL. The Committee's office shall be at the LC Chairperson's office, or another location that the PAPs agree upon as being the most convenient. UETCL also has officers that are dedicated to handling the RAP issues that arise from their various projects.
	If a young fruit tree has been valued, will the future prospects be catered for e.g. the jack fruit trees or oranges that would have been reaped from the fruit tree?	No, valuations are done on as as-is basis. Projections are not done during the valuation exercise.
	Sometimes the cut-off date is announced but the Project takes long to start, yet the people have been asked to hold off on developments.	If a Project takes more than 2 years after the cut-off date, a re-evaluation is done to take into consideration any changes.
Kawaala	Can one remove some of their property such as roof or doors even after they have been paid?	Yes, as long as the information has been captured by the Valuer. All additions or subtractions from property after the cut-off date are not considered during compensation.
	The cable, in some cases is passing through land that is undeveloped. Will such land owners be compensated?	Yes, all land owners will be compensated for their lost property. Developments on the land are also compensated for.

Source: Project ARAP report

9-3 Conclusion and recommendations

9-3-1 Conclusion and recommendations on EIA

The Environmental Management Plan (EMP) and monitoring plan should be adjusted in an adaptive manner in accordance to the approval conditions issued by NEMA. The EMP and monitoring plan were also prepared without any concrete construction plan, so they should be revised accordingly during the detailed design phase in line with the development of the detailed facility design and construction plan. Following are some important points that should be considered in the detailed design phase:

- Measures to prevent soil erosion and runoff from cut and fill surfaces of the substation (selection of appropriate revegetation species)
- Measures to minimize bird collision with transmission line (selection of appropriate bird collision prevention devices and consideration of installation method)
- Detailed waste management plan (especially for demolition waste, removed transmission cables and hazardous wastes)
- Environmental management measures of temporary facilities
- Duration, frequency, location and cost of environmental monitoring

Special attention should also be taken at Mukono site, where endangered species have been identified inside Nandagi Forest Reserve. If any important habitats (such as bird nesting area) of endangered species are identified in the ensuing stages, the Project should consider additional protection measures in consultation with experts. Assignment of an environmental expert is recommended in the detailed design study to undertake the above mentioned works.

9-3-2 Conclusion and recommendations on ARAP

Some of the PAPs within the land acquisition area are farmers and foresters who depend on their land for livelihood. There are also low income and vulnerable PAPs. The project therefore will need to provide appropriate livelihood restoration assistance in addition to payment of compensation, and a detailed livelihood restoration program should be established in the ensuing stages through consultation with the PAPs.

9-3-3 Environmental Checklist

The environment and social consideration of the project was summarized by using JICA's Environmental Checklist for Power Transmission and Distribution Lines. The Environmental Checklist is attached as Appendix-15.

Chapter 10 Project Evaluation

10-1 Preconditions

Preconditions for the Project include securing budget, land acquisition and compensation etc. in line with the Project implementation schedule. Also, after the detail design, UETCL has to consider modifying the evaluation for the environmental impact, resettlement action plan, if any changes occur.

In line with the implementation of the Project, there are particularly three preconditions for environment social consideration and coordination with the World Bank project and China Export-Import Bank project.

(1) Environment social consideration

Mainly three necessary procedures are identified under the environment and social consideration as stated below. The procedure of each is ongoing and it is least possible to hinder the Project implementation in the future.

1) Acquisition of the certificate of Approval of Environment impact assessment

UETCL plans to submit the EIA final report to NEMA by the end of July, 2016. After the submission, the certificate is expected to be issued in three months (by October-November, 2016).

2) Acquisition of the approval of ARAP

The land acquisition shall be required for the construction of transmission lines of this Project. Although the involuntary resettlement is not expected to be carried out, UETCL has to provide appropriate compensations to the residents based on the ARAP.

UETCL shall submit the ARAP final report, including the assessment report on the land and property, to the Chief Government Valuer (CGV) by the end of July 2016 and commence the discussion.

3) Acquisition of the NFA license

Since the transmission line route to New Mukono Substation passes some parts of the land of Nadagi forest reserve, the UETDL has to obtain the license from NFA, compensate for the land use and biodiversity. NFA is in the process of the calculation of the compensation amount. After its evaluation, the Minutes of Understanding (MoU) between UETCL and NFA is expected to be concluded and the license will be issued at the end of September, 2016.

(2) Coordination with the World Bank project

Although the route for the 220 kV transmission line between Kawanda Substation and

Masaka Substation has been identified, the basic and detail design has not been prepared yet. Accordingly, UETCL shall appropriately conduct coordination concerning arrangement of the connection point between the 220 kV transmission lines going to 220/132 kV Buloba Substation of the Project and the 220 kV transmission lines between Kawanda Substation and Masaka Substation, which will be constructed before the Project, so that the outline design of the Project is taken into account in the basic and detail design of the 220 kV transmission line between Kawanda Substation and Masaka Substation.

Since 220 / 132 kV Buloba Substation will be connected to the 220 kV transmission line between Kawanda Substation and Masaka Substation, it needs to be commissioned by 2018 as scheduled. UETCL is expected to carry out the project implementation with the World Bank smoothly to achieve the completion on schedule. In case of delaying, the impact to this Project is analyzed in Appendix-11.

(3) Coordination with China Export-Import Bank project

Since 220 / 132 kV New Mukono Substation of the Project and 132 / 33 kV Mukono Substation by China Export-Import bank are both planned within the plot of 16 acres where the procedures for land acquisition is in process by UETCL, UETCL shall appropriately coordinate both projects so that these two substations are maintained within the plot.

At the time of implementation of the Project, the construction work of 132 / 33 kV Mukono Substation and the related 132 kV incoming transmission lines, which will start in 2016, is expected to complete. Four circuits of the 220 kV incoming transmission lines to 220/132 kV New Mukono Substation of the Project is planned to install in two routes in parallel with the above mentioned 132 kV transmission lines with applying the concept of corridor share. Arrangement of the corridor share and the positions of towers planned in the outline design of the Project shall be examined at the stage of the basic design and detailed design stages in consideration of the actual installed condition of the above mentioned 132 kV incoming transmission lines.

10-2 Necessary Inputs by Recipient Country for Achieving the Overall Project Plan

(1) Prior to the Commencement of the Construction Work

- Prior to the commencement of the construction work, UETCL shall have completed the following items without delay. Also, to facilitate the smooth implementation of the Project, UETCL shall finish the cutting of trees, removal of buried objects, ground leveling and so on in the Project site without delay.
  - Compensation procedures for persons who conduct activities within the corridor of the transmission routes and plots for the substation of the Project
  - Implementation of resettlement based on Resettlement Action Plan

- In addition, prior to the commencement of the construction work, UETCL shall have completed the same procedures as above for the access roads.
- Prior to the commencement of the construction work, to ensure that the Project equipment and materials are delivered to the Project sites before the installation work without delay, UETCL shall have completed the preliminary procedures necessary for the tax exemption and customs clearance.
- Prior to the commencement of the construction work, concerning one of the two 132 kV transmission lines between Kampala North Substation and Mutundwe Substation, since it is planned to replace both lines on this section with HTLS conductor in the Project, UETCL shall have completed the reconnecting of switchgear, etc. to ensure that the lines can be operated as 132 kV transmission lines.
- Prior to the commencement of the construction work, as a part of operation and maintenance, UETCL shall have completed the minor repairs for the existing equipment directly related to the Project due to deterioration.
- Prior to the commencement of the construction work, since 220 / 132 kV New Mukono Substation of the Project is planned to connect with 132 / 33 kV Mukono Substation by another donor, UETCL shall have completed the construction work of 132 / 33 kV Mukono Substation in timely manner.
- Prior to the commencement of the construction work, UETCL shall have completed the reconnection, etc. of power distribution systems to maintain power supply during the rehabilitation of existing substations.
- Prior to the commencement of the construction work, UETCL shall have completed discussions with UEGCL and the concession operator (Bujagali Energy Corporation) to secure smooth implementation to install the additional transformers of the Project in Bujagali Power Station.

(2) During the Construction Work

- During the construction work, UETCL shall conduct the scheduled power outages required for the Project in conformity with the schedule agreed between UETCL and the Consultant in timely manner.
- During the construction work, UETCL shall conduct environmental and social impact monitoring based on the Monitoring Form prepared at the stage of the Preparatory Survey carefully.
- During the construction work, the Government of Uganda shall conduct budgetary allocation required for the Project including the cost covered by the Ugandan side without delay.

(3) After the Installation Work of the Project and Commencement of Operation

- After the installation work of the Project, UETCL shall conduct commissioning required for the function test or other related issues of the equipment of the Project without delay.
- After the installation work of the Project, UETCL shall conduct registration to the existing SCADA system at Lugogo Control Center so that the signals from the substations of the Project are displayed properly.
- After the installation work of the Project, UETCL shall hold discussions with UEDCL, the concession operator and other related parties so that the equipment of the Project is connected to the distribution system and the effects of the Project occur without delay.

10-3 External conditions

The followings are considered as the external conditions of the Project to achieve and sustain the effects.

(1) For the overall goal

As mentioned in the Chapter 2, National Development Plan II (NDP II) is considered as the upper level plan of the Project, and "Development of the infrastructures" is set as one of the priority issues of NDP II. In case that the policy of the Ugandan Government described in NDP II, consistency between the upper level plan and the Project cannot be maintained. In addition, stable political situation in Uganda is essential for smooth implementation of NDP II.

- The electric power development policy shall not be changed.
- The government and economy shall remain stable.

(2) For the project objectives

The Project aims to improve the conditions of power supply in the Kampala Metropolitan Area. Since the equipment on the transmission system functions as a network, not only the equipment of the Project but also the other related equipment on the transmission system shall be kept in the sound conditions by daily maintenance work. Moreover, security of the transmission facility shall be secured, since the power supply cannot continue if it is destroyed by wars or vandalism.

- Sustainable operation and maintenance shall be maintained properly.
- Security of the facilities shall be maintained.

(3) For the expected outcomes

One of the expected effects of the Project is to increase the actual power supply to the consumers. The power supply to the consumers is achieved through distribution network

connected to the transmission system. On the other hand, the transmission system is power-supplied from the generation equipment. Therefore, To achieve increase of the actual power supply to the consumers, the generation equipment located in the upper side and the distribution network located in the lower side of the transmission system shall be in the stable operational condition. In addition, since the equipment of the Project shall be also in stable operational condition, the maintenance work of the equipment of the Project shall be carried out properly in conformity with the maintenance schedule.

- Power generation facilities in the upper stream and power distribution facilities in the lower stream shall operate properly.
- Appropriate operation and maintenance shall be maintained properly.

10-4 Project Evaluation

10-4-1 Relevance

As shown below, relevance for this Project is considered to be high, as it will help to achieve Ugandan national energy and power policies and benefit the public facilities and residents including impoverished people in the target area.

(1) Relevance in terms of technical aspects

In Uganda, although development of power sources is proceeding based on the country's abundant hydropower resources, it is having difficulty developing the costly power distribution network in line with the growing demand for power. The Project is intended to strengthen transformation equipment in Kampala metropolitan area, where power shortages caused by the inadequate power distribution capacity are critical.

The Project components have been specified upon compiling the system plan having 2030 as the target year while securing consistency with the Grid Development Plan, which is Uganda's master plan of distribution equipment, and their relevance is as described in Chapter 3 System Planning. The following paragraphs specifically demonstrate to what degree the Project contributes to power distribution in Kampala metropolitan area in the respective cross sections of the Project evaluation target year (2023) and the Project system planning target year (2030), and assess its relevance according to its scale.

In 2030, transformation equipment in Kampala metropolitan area will comprise 220 kV transmission line, 220 / 132 kV transformation equipment, 132 kV transmission line, and transformation equipment for distribution (132 / 33 kV and 132 / 11 kV). The power that is received by the transmission department from the generation department will be distributed in order through the 220 kV transmission line, 220 / 132 kV transformation equipment, 132 kV transmission line, and transformation equipment for distribution, in the process being supplied from the transmission department to the distribution department. These facilities belonging to the transmission department form a spider's web network and contribute to

power distribution, and the Project components are ideally dispersed on the network as shown in Chapter 3 System Planning, thereby ensuring that the overall network functions most efficiently. Accordingly, the following paragraphs quantitatively demonstrate to what degree the Project contributes to the required capacity in each stage of the 220 kV transmission line, 220 / 132 kV transformation equipment, 132 kV transmission line, and transformation equipment in the respective cross sections of the Project evaluation target year (2023) and the Project system planning target year (2030).

The degree of contribution of the Project components concerning the 220 kV transmission line, 220 / 132 kV transformation equipment, 132 kV transmission line, and transformation equipment for distribution is shown according to the Project evaluation target year (2023) and the Project system planning target year (2030) in Table 10-4-1.1 and Table 10-4-1.2 respectively. In these tables, the new construction of 220 kV transmission line and 132 kV transmission line from the lead-in points to the Project component substations with the aim of leading-in to the substations is regarded as a part of transformation equipment and is excluded from the transmission line distribution capacity. In these tables, transmission capacity is defined as the sum of re-installation of HTLS lines between substations and other substations and power running through transmission lines over each section between substations.

Table 10-4-1.1 Degree of Contribution of the Project Component to Power Distribution in the Metropolitan Area in the Project Evaluation Target Year

Item	Necessary distributed capacity [MW]	Distributed capacity through the Project components [MW]
220 kV transmission lines	Approx. 806 MW	N / A
220 / 132 kV substations	Approx. 704 MW	Approx. 258 MW
132 kV transmission lines	Approx. 813 MW	Approx. 300 MW
132 / 33 or 11 kV substations	Approx. 567 MW	Approx. 133 MW

Source: Prepared by JICA Study Team

Table 10-4-1.2 Degree of Contribution of the Project Component to Power Distribution in the Metropolitan Area in the Project System Planning Year

Item	Necessary distributed capacity [MW]	Distributed capacity through the Project components [MW]
220 kV transmission lines	Approx. 938 MW	N / A
220 / 132 kV substations	Approx. 1,139 MW	Approx. 462 MW
132 kV transmission lines	Approx. 1,313 MW	Approx. 545 MW
132 / 33 or 11 kV substations	Approx. 987MW	Approx. 208 MW

Source: Prepared by JICA Study Team

(2) Relevance in terms of financial aspects

Examining the financial sustainability of the project with FIRR (Please check the Chapter 7 in reference to the investment cost estimate of this project), FIRR is projected to be as 13.2%, and confirmed to be financially sustainable. In this base case, it is assumed that the BST unit price and the purchase cost of electricity from generation companies.

While the net-cash-inflow for UETCL is, in short, the difference between the BST revenue to be generated from the UETCL's sales to distribution companies and the cost which is comprised of administration cost, grid O&M cost and UETCL's purchase cost of electricity from electricity generation companies. In particular, the purchase cost of electricity and the BST price are two major factors to give influence on the financial sustainability. ERA is the governmental body to determine on the electricity tariff. UETCL must get an approval on tariff schedule from ERA. In accordance with the cost reflective policy, ERA shall manage and determine the tariff structure and level, based on the financial performance and projection of power sector companies in view of sound management of power sector companies as well as securing fairness to the public.

Based on the sensitivity analysis result, the point of managing the UETCL's transmission business is turned out to be the subtle balance between BST price level and the electricity purchase price from generation companies. This is because the regime of electricity business is division of work between the three parties (electricity generation, transmission and distribution).The financial sustainability of UETCL's transmission business is very subject to change of tariff.

Another point to keep it in mind that Uganda shilling has a long-term tendency to be depreciated against major currency. Even if the nominal interest rate of the loan concerned may be very low, the financial discount rate (hurdle rate) will be substantially high as a matter of fact. In case of the BST price decrease from the current level by 10%, FIRR will be reduced to almost the hurdle rate (7.9%), and the financial net present value will be almost zero. Likewise in case of 14% upsurge in the purchase price from generation companies, the financial net present value will become almost zero.

With the reference to the electricity tariff which tends to be influential to financial feasibility of this project, ERA has revised the electricity tariff drastically, due to the drastic depreciation of Uganda Shilling in 2015 as well as in consideration of the inflation symptom strengthened. Not only the BST price but also the end user price has increased considerably in the 1st quarter of 2016. The BST price went up by 24%, reaching 279.6 Uganda Shillings/ kWh. The current price gap between the BST price and the purchase price is Uganda Shillings 80/ kWh and with this price level, FIRR is favorably projected to be 13.2%. Conducting sensitivity analysis with the use of the price gap as a variable factor, the critical price gap level will be 53 UGX / kWh. If the price gap may be below 53 UGX / kWh, FIRR

will fall below the hurdle rate. UETCL will have to constantly monitor the purchase price level as well as BST price level in order to manage appropriate price gap level. UETCL will have to make appropriate adjustment with ERA at each time of quarterly tariff adjustment.

Looking at the banking sector in Uganda, the lending rate of private commercial banks in Uganda is currently 24 - 25%, and it is far beyond the Base Case FIRR of 13.2%. Considering about the project life of this project is 4o years, it is fairly long from the viewpoint of private business. Based on these analyses, this project will not be feasible on commercial business basis.

Since power sector business is usually operated by public corporations, sudden electricity price change will be very painful to consumers. At present, Uganda's end-user tariff level is fairly high as compared with the other neighbor African countries. As far as the end user price is concerned, it is very difficult to make price upsurge at least for the time being. When it comes to the business of UETCL, the BST price will have to be kept as the same level for a while.

Even for commercial and industrial end-user, the 1st quarter sudden price increase seemed to be very drastic and painful. It is important to give consideration about economically weaker sections when determining electricity tariff. It is favorable for Umeme, which is an actual operator of distribution network, under the supervision of ERA to constantly check affordability for electricity tariff from the viewpoint of securing social fairness in power sector and share the information with the relevant stakeholders such as UETCL.

(3) Benefit in the Project Area

Electric power is absolutely essential as energy for the self-reliant, sustainable socioeconomic growth of a nation. Particularly in capital areas, which hold government agencies and head offices of the companies which support the national economy, power development projects are one of the most important economic infrastructure development to establish a secure, efficient power distribution network.

The Project aims to improve electric power distribution in the Kampala metropolitan area in Uganda as it faces a serious power system problem caused by supply capacity shortage due to recent rapid economic growth. The enhancement of supply capacity of power distribution facilities, which is currently insufficient, is a fundamental solution to the loss of opportunity gain due to disrupted supply and thus it is highly beneficial.

(4) Operation and Maintenance Capabilities

Despite its struggles with large-scale capital investments such as the current cooperation project, UETCL does have a certain level of technical capacity in system operations and has steadily handled O&M for the national power transmission network.

This Project includes such relatively new technologies as gas insulated switchgears and other equipment. As Uganda has already introduced them and the skills required for operation methods, system protection functionality and other O&M issues do not greatly exceed the technical levels for equipment used that has been used in the country, although internal structure of the switchgear and other equipment to be introduced may differ from that of traditional ones. As such, manufacturer technicians will be used for O&M technology transfers, offering guidance on initial and standard operation based on the characteristics, features and specifications of the equipment. Assuming that the technology transfer of differing operation methods for each delivering manufacturer goes smoothly, there should be no issues in terms of O&M capabilities on the Ugandan side for the delivered equipment.

Also, the mobile substation to be introduced in the Project is a relatively new technology for UETCL, and equipment will be designed for mounting on vehicles to secure mobility, however, the technology again will not greatly exceed the technical levels of conventional transformers and switchgear equipment in Uganda. As with the above gas insulated switchgear, assuming that the technology transfer of differing operation methods for each delivering manufacturer goes smoothly, there should be no issues in terms of O&M capabilities on the Ugandan side for the delivered equipment.

High-Temperature Low-Sag conductors (HTLS conductors) introduced in the Project is a new technology for UETCL. HTLS conductors can be Invar-type conductor or Gap-type conductor and so on, and although these conductor types entail different installation methods of support hardware from the ACSR and AAAC conductors that have been conventionally adopted by UETCL, the technical level is such that the technology can be transferred during the installation works period of the Project. Meanwhile, since key work processes such as stringing work and tension line work are the same as for conventional conductor types, the new technology will not exceed the technical levels of UETCL. Accordingly, assuming that the technology transfer regarding the differing methods of fitting support hardware goes smoothly, there should be no issues in terms of O&M capabilities on the Ugandan side.

In conclusion, there is deemed to be no problem in terms of O&M capabilities on the Ugandan side regarding the Project equipment.

UETCL basically is monitoring operational conditions of each substation from Lugogo Central Control Center, and does not locate the resident monitoring staffs at every substation in the Kampala Metropolitan Area (Currently, the resident monitoring staffs are located at Mutundwe Substation, Kawanda Substation and Namanve Substation). UETCL plans to monitor 220 / 132 kV New Mukono Substation and Buloba Substation of the Project from 132 / 33 kV Mukono Substation and Mutundwe Substation, respectively. Therefore, the additional staffs for operation and maintenance for the equipment of the Project are not expected.

On the other hand, the total of four member of security guards will be required for the substation of the Project, i.e.; two for Buloba Substation and two for New Mukono Substation (However, these for New Mukono Substation will also cover Mukono Substation). Approx. 96 million Ugandan shilling (Approx. 28,000 USD) per year is expected for these security guards. Since it is only 1.8% of the annual amounts for operation and maintenance cost of UETCL, it is expected that UETCL can allocate the required budget for the security guards without problems.

(5) Project to Contribute to Upper-Level Plans

Concerning upper-level plans, the master plan of power distribution in Uganda is the Grid Development Plan, and consistency between this and the network plan of the Project having 2030 as the target year has been secured through discussions conducted in the preparatory survey. From now on, assuming that UETCL advances the development of power distribution equipment based on plans that have been made consistent through the preparatory survey, it is anticipated that the Project will manifest the effectiveness described later and certainly contribute to the upper-level plan.

(6) Consistency with Japanese that have been

The Country Assistance Policy for Uganda says that Japan will assist its extensive-area infrastructure development (road and electricity) taking advantage of Japanese technologies and knowledge and promote development of the environment to help realize its economic growth.

The Project is intended to contribute to the reinforcement and rehabilitation of power distribution equipment as key social and economic infrastructure in the metropolitan area that supports the national society and economy, and it entirely complies with the assistance goal of “wide-area infrastructure development (electric power)” that is stipulated in the “Country-based Aid Policy for Uganda.” Moreover, as Japanese outstanding technologies that can be utilized for power distribution equipment, compact gas insulated switchgear, mobile substation and cable with high heat capacity and low slack can be considered, and these are being effectively introduced in compliance with the UETCL Grid Development Plan (upper-level plan). Thus, “project formation that utilizes Japanese technology and know-how” as stipulated in the “Country-based Aid Policy for Uganda” is also being furthered.

As shown above, the Project is deemed to be consistent with the Government of Japan’s aid policy for Uganda and to be highly relevant as a Japanese Grant Aid Project.

10-4-2 Effectiveness

The impacts expected from the implementation of the Project are as follows:

(1) Quantitative Impacts

The objectives of the Project is to improve transmission network in the Kampala metropolitan area and it is composed of 220 kV transmission lines, 220 / 132 kV substations, 132 kV transmission lines and 132 / 33 or 11 kV substations operated by UETCL, the implementation agency of the Project. In the Project, the equipment is enhanced.

The rate of the actual load to capacity of the equipment is defined as the utilization rates of the equipment, and the utilization rate of the equipment of the Project in the target years are applied as the operation indicator of the Project. On the other hand, energy carried by the equipment of the Project per year in the target years is applied as the effect indicator of the Project

< Operation Indicators of the Project >

Type of the equipment	Substation	Substation	Unit Capacity [MVA]	Number of Units and circuits	Capacity [MVA]	Length [km]	The target year of the Project evaluation (2022) [%]	The target year of the transmission system plan (2030) [%]
220/132kV Substation	Bujagali		250	1	250	N/A	48	50
220/132kV Substation	New Mukono		125	1	125	N/A	29	70
220/132kV Substation	New Mukono		125	1	125	N/A	29	70
220/132kV Substation	Buloba		125	1	125	N/A	28	64
220/132kV Substation	Buloba		125	1	125	N/A	28	64
132kV Lines	Mukono	Namanve South	240	1	240	26	44	69
132kV Lines	Namanve South	Luzira	147	1	147	10	14	14
132kV Lines	Namanve South	Luzira	147	1	147	10	14	14
132kV Lines	Namanve South	Namanve	240	1	240	5	7	4
132kV Lines	Namanve South	Kampala North	240	1	240	13	3	26
132kV Lines	Kampala North	Lugogo	240	1	240	6	11	21
132kV Lines	Kampala North	Lugogo	240	1	240	6	11	21
132kV Lines	Kampala North	Kawaala	240	1	240	5	4	4
132kV Lines	Kampala North	Mutundwe	240	1	240	10	5	24
132kV Lines	Kawaala	Mutundwe	240	1	240	6	12	41
132/11 Substation	Mutundwe		20	2	40	N/A	45	68
132/33 Substation	Mutundwe		40	2	80	N/A	45	66
132/11 Substation	Kawaala		20	1	20	N/A	25	60
132/33 Substation	Kawaala		40	3	120	N/A	28	63
132/33 Substation	Buloba		40	2	80	N/A	39	50

Source: JICA Study Team

Notes: Utilization rate of the equipment =
Load of the equipment [MW] / (Installed capacity of the Equipment [MW] * 0.95 [Power Factor])

< Effect Indicators of the Project >

Type of the equipment	Substation	Substation	Unit Capacity [MVA]	Number of Units and circuits	Capacity [MVA]	Length [km]	The target year of the Project evaluation (2022) [GWh]	The target year of the transmission system plan (2030) [GWh]
220/132kV Substation	Bujagali		250	1	250	N/A	781	827
220/132kV Substation	New Mukono		125	1	125	N/A	237	576
220/132kV Substation	New Mukono		125	1	125	N/A	237	576
220/132kV Substation	Buloba		125	1	125	N/A	233	528
220/132kV Substation	Buloba		125	1	125	N/A	233	528
132kV Lines	Mukono	Namanve South	240	1	240	26	694	1083
132kV Lines	Namanve South	Luzira	147	1	147	10	131	131
132kV Lines	Namanve South	Luzira	147	1	147	10	131	131
132kV Lines	Namanve South	Namanve	240	1	240	5	103	67
132kV Lines	Namanve South	Kampala North	240	1	240	13	49	416
132kV Lines	Kampala North	Lugogo	240	1	240	6	169	330
132kV Lines	Kampala North	Lugogo	240	1	240	6	169	330
132kV Lines	Kampala North	Kawaala	240	1	240	5	64	64
132kV Lines	Kampala North	Mutundwe	240	1	240	10	76	386
132kV Lines	Kawaala	Mutundwe	240	1	240	6	194	639
132/11 Substation	Mutundwe		20	2	40	N/A	118	177
132/33 Substation	Mutundwe		40	2	80	N/A	237	348
132/11 Substation	Kawaala		20	1	20	N/A	33	79
132/33 Substation	Kawaala		40	3	120	N/A	217	493
132/33 Substation	Buloba		40	2	80	N/A	204	263

Source: JICA Study Team

Notes: Energy carried by the equipment of the Project per year [MWh] =
Peak Load of the equipment [MW] * 8,760 [Hours] * Load Ratio 75%

(2) Qualitative Impacts

Effect Item	Project Countermeasures (Loan project)	Extent of Project Effects and Improvement (Current Conditions and Problems)
1. Accumulation of technology for enhancing flexibility of equipment planning and system operation	➢ Introduction of 132 kV gas insulated switchgear ➢ Introduction of High-Temperature Low-Sag (HTLS) conductors ➢ Introduction of mobile substation	➢ Through introducing gas insulated switchgear, which is a relative new technology in Uganda, the use of technology that utilizes such technology will be accumulated. ➢ Through introducing High-Temperature Low-Sag (HTLS) conductors which is largely unproven in Uganda, technology concerning power transmission planning that utilizes such technology will be accumulated. ➢ Through introducing mobile substation which is largely unproven in Uganda, it will be possible to take emergency steps in the event of substation accidents and thus sustain supply in service areas.

Effect Item	Project Countermeasures (Loan project)	Extent of Project Effects and Improvement (Current Conditions and Problems)
2. Promotion of utilization of 220 kV transmission lines for power supply in the metropolitan area	➢ Installation of 220 / 132 kV Buloba Substation (Total capacity: 250 MVA) ➢ Installation of 220 / 132 kV New Mukono Substation (Total capacity: 375 MVA)	It is planned to install 220 kV transmission line with the objective of reinforcing power distribution in Uganda, and 220 / 132 kV substation capacity will be greatly strengthened concerning supply to Kampala metropolitan area, which consumes a large proportion of power in the country. (Before the project) Total capacity (220 / 132 kV substations): 500 MVA (After the Project) Total capacity (220 / 132 kV substations): 1,125 MVA
3. Enhancement of supply reliability in the southwest system of the Kampala metropolitan area	➢ Application of double bus bar for Mutundwe Substation	Even though Mutundwe Substation is connected to the 220/132 kV Buloba Substation and new 220/132 kV Mukono Substation and is the most important substation in the southwest system, it still is not equipped with double bus lines. As a result, if bus accidents occur, the southwest system loses power supply and widespread power outages occur. Through introducing double bus line to this substation in the Project, supply reliability will be improved to such a level that bus accidents can be tolerated at this substation, even assuming the projected demand in the Project system planning target year (2030).
4. Introduction of technology for developing power transmission equipment that can reduce environmental and social impacts	➢ Introduction of 132 kV gas insulated switchgear ➢ Introduction of cable with high heat capacity and low slack ➢ Introduction of 4-line steel towers to 132 kV transmission lines ➢ Introduction of the concept of corridor sharing to transmission plans	Kampala metropolitan area will require ongoing development of power transmission equipment to respond to the growing demand for power. However, being such a densely populated area, there are great difficulties in securing site land in the metropolitan area. In the Project, in addition to gas insulated switchgear that has previously been proven in Uganda, the new technologies indicated on the left will be introduced. Through creating a track record for introducing these technologies, which are commonplace in other countries, it will become possible to develop power distribution equipment while mitigating the need for land acquisition.
5. Review of existing power transmission equipment master plan and realization of a project consistent with	➢ Review of the UETCL's Grid Development Plan (to be implemented in the preparatory survey stage and at the start of the main	In the preparatory survey of the Project, a system plan has been compiled based on review of the UETCL's Grid Development Plan with the objective of resolving fundamental issues in power distribution

Effect Item	Project Countermeasures (Loan project)	Extent of Project Effects and Improvement (Current Conditions and Problems)
that	body of work) ➢ Compilation and implementation of Project components in line with the above review	equipment development in Kampala metropolitan area. This specifically entails effectively utilizing 220 kV transmission lines, introducing gas insulated switchgear and overhead conductors with high heat capacity and low slack that reduces the need for land acquisition, adopting double bus line at Mutundwe Substation and so on. Since the components have been selected based on this, not only will Project implementation improve power supply in the areas around the Project equipment, but it will also improve the composition of the Kampala metropolitan area system so that it can respond to the optimum power transformation and transmission plans from the long-term perspective.
6. Securing of supply capability in the event of substation accidents in the metropolitan area	➢ Introduction of mobile substation	Since roads in Kampala metropolitan area are narrow and hilly, the usefulness of mobile substation comprising switchgear and transformation equipment mounted onto a single trailer will be severely restricted. In the Project, in consideration of road conditions in the metropolitan area, mobile substation that comprises switchgear and transformer equipment mounted onto separate trailers will be introduced, thereby securing mobile substation that can be utilized in the event of power transformation accidents in the metropolitan area.

(3) Estimation of Reduction of Emission of the Greenhouse Effect Gas

The Project aims to improve the transmission system in the Kampala Metropolitan Area, will realize effective use of the 220 kV transmission lines, and will bring about the reduction of transmission loss in the Kampala Metropolitan Area, which means rationalization of utilization of energy. Since reduction of transmission loss results in reduction of primary energy such as fossil fuel consumed by the power generation equipment, it will contribute to the reduction of emission of the greenhouse effect gas such as carbon di-oxide.

The transmission loss at the peak demand under condition of without and with the Project are estimated in Table 10-4-2.1

Table 10-4-2.1 Transmission loss at the peak load

	Peak Demand	Without Case	With Case
	MW	MW	MW
2020	518.0	27.3	17.9
2022	567.0	27.2	19.0
2030	987.0	44.0	29.7

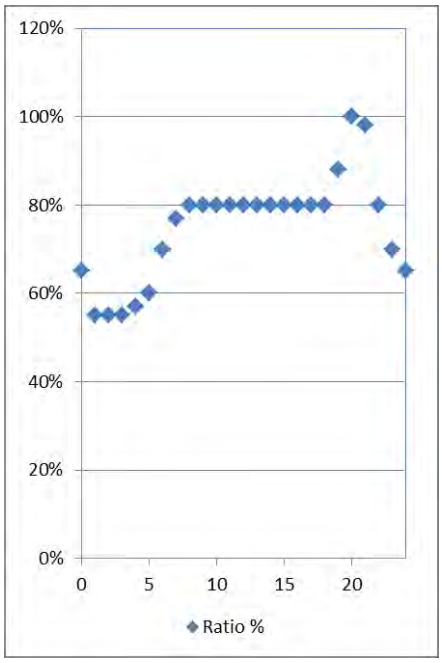
Source: JICA Study Team

In consideration of the trend of daily load curves and the load ratio of the power system, 75% in 2030 assumed the Grid Development Plan 2014 - 2030, the model of daily load curve is simulated as shown in the second column from the left of Table 10-4-2.2. Based on the model, the transmission loss at each hour without the Project is shown in in the fourth column, and the one with the Project is shown in the fifth column (the system voltage and power factor are assumed as the constant). The daily load curve shown in Table 10-4-2.2 is drawn in the Figure 10-4-2.1. In Table 10-4-2.2, the hour of the peak demand shown in Table 10-4-2.1 is assumed at 20:00 in conformity with the trend in the Grid Development Plan 2014 - 2030 (in the model, the average of the load factor results in 75%, which is assumed in the Grid Development Plan 2014 - 2030 as the average in 2030 in the). As shown in Table 10-4-2.2, the transmission loss in the system without the Project is 231 thousand MWH per year. On the other hand, that with the Project is 156 thousand MWh per year. It means that 75 thousand MWh of transmission loss will be reduced by the Project in a year.

Table 10-4-2.2 Transmission loss every hour

	Model	Model	Without Case	With Case
hour	Ratio	Factor	Transmission Loss	Transmission Loss
	%	=Load^2	MWh	MWh
0	65%	42%	18.59	12.55
1	55%	30%	13.31	8.98
2	55%	30%	13.31	8.98
3	55%	30%	13.31	8.98
4	57%	32%	14.30	9.65
5	60%	36%	15.84	10.69
6	70%	49%	21.56	14.55
7	77%	59%	26.09	17.61
8	80%	64%	28.16	19.01
9	80%	64%	28.16	19.01
10	80%	64%	28.16	19.01
11	80%	64%	28.16	19.01
12	80%	64%	28.16	19.01
13	80%	64%	28.16	19.01
14	80%	64%	28.16	19.01
15	80%	64%	28.16	19.01
16	80%	64%	28.16	19.01
17	80%	64%	28.16	19.01
18	80%	64%	28.16	19.01
19	88%	77%	34.07	23.00
20	100%	100%	44.00	29.70
21	98%	96%	42.26	28.52
22	80%	64%	28.16	19.01
23	70%	49%	21.56	14.55
24	65%	42%	18.59	12.55
Total	per Day		634.71	428.43
Total	per Year	365	231669	156377

Source: JICA Study Team



Source: JICA Study Team

Figure 10-4-2.1 Model of daily load curve

The thermal power plant consuming A heavy oil is located in Namanve, Uganda. The emission factors of some fuels are shown in Table 10-4-2.3. Based on the values for A heavy

oil, the carbon di-oxide emission factor is estimated as 0.6237 t CO2 / MWh, which is discharged in case of generation of 1 MWh of electric energy, under condition of 40% of thermal efficiency of the thermal power plant.

Table 10-4-2.3 Emission factor of each fuel

Type of Fuel	Unit Calorific Value	Emission Factor
General Coal	25.7 GJ/t	0.0247 tC/GJ
Light Oil	37.7 GJ/kl	0.0187 tC/GJ
A Heavy Oil	39.1 GJ/kl	0.0189 tC/GJ
Liquefied Natural Gas (LNG)	54.6 GJ/t	0.0135 tC/GJ

Source: Ministry of the Environment, "Manual for Calculation of GHG Emission Amount and Reporting (Ver.4.1)", Feb., 2016

$$0.6237 \text{ t CO2 / MWh} = 0.0189 \text{ tC/GJ} \times 3.6 \text{ GJ / MWh} \div 40\% \quad (4\text{-}1)$$

The reduction of emission of carbon di-oxide is estimated as shown in Table 10-4-2.4 under condition of carbon di-oxide factor 0.6237 t CO2 / MWh and the trend of the daily load curve shown in Table 10-4-2.2. Therefore, it can be said that reduction of emission of carbon di-oxide is 47 thousand t CO2 per year. On the other hand, since the main power source is the hydro-electric power generation, it is assumed that emission of 4.7 thousand t CO2 per year are reduced by the Project under condition of 10% share of the thermal power generation, which differs with respect to each year.

Table 10-4-2.4 Rationalization of utilization of energy by the Project evaluated based on reduction of emission of carbon di-oxide

	Estimated Value	Units
Reduction of carbon di-oxide emission per year	46,960	t CO_2 / year
Base line emission (Without Case)	144,492	t CO_2 / year
Power demand per year	6,484,590	MWh / year
Transmission loss per year	231,669	MWh / year
Carbon di-oxide emission per year	0.6237	t CO_2 / MWh
Project Emission (With Case)	97,532	t CO_2 / year
Transmission loss per year	156,377	MWh / year
Carbon di-oxide emission per year	0.6237	t CO_2 / MWh

Source: JICA Study Team

APPENDIX

Appendix-1 Member of the Team and Survey Period in Uganda

1. Member of the Team and survey period in Uganda

(1) First Field Survey

Name	Assignment	Survey Period in Uganda
Kazunari NOGAMI	Chief Consultant / Power System Planning	6th September to 10th October, 2015
Akira HIRANO	Power System Planning 2	6th to 25th September, 2015
Masayuki TAMAI	Substation Planning	6th September to 10th October, 2015
Atsushi FUKUGAICHI	Transmission Planning 1	6th September to 10th October, 2015
Shuichi MATSUBARA	Transmission Planning 2	6th September to 10th October, 2015
Chew Chong SIANG	Power Demand Forecast	6th September to 9th October, 2015
Yusuke HARADA	Economic and Financial / Institutional Framework Analysis	15th September to 10th October, 2015
Asami KABASAWA	Environmental and Social Consideration	6th September to 10th October, 2015
Jun HAYATSU	Natural Condition Survey / Facility Planning	6th September to 10th October, 2015
Kazuaki KONDO	Design and Procurement Planning	6th September to 10th October, 2015

(2) Second Field Survey

Name	Assignment	Survey Period in Uganda
Kazunari NOGAMI	Chief Consultant / Power System Planning	21st November to 19th December, 2015
Masatsugu KOMIYA	Deputy Chief Consultant / Substation Planning 2	22nd to 28th November, 2015
Akira HIRANO	Power System Planning 2	21st November to 19th December, 2015
Masayuki TAMAI	Substation Planning	8th November to 19th December, 2015
Atsushi FUKUGAICHI	Transmission Planning 1	15th November to 19th December, 2015
Yusuke HARADA	Economic and Financial / Institutional Framework Analysis	21st November to 19th December, 2015
Asami KABASAWA	Environmental and Social Consideration	8th November to 12th December, 2015
Jun HAYATSU	Natural Condition Survey / Facility Planning	8th November to 19th December, 2015
Kazuaki KONDO	Design and Procurement Planning	22nd November to 19th December, 2015
Naoto MIZUNO	Procurement / Fund Planning	6th to 19th December, 2015

(3) Supplemental Survey to the Second Field Survey

Name	Assignment	Survey Period in Uganda
Kenji TAKAHASHI	Economic and Financial / Institutional Framework Analysis	24th January to 3rd February, 2016

(4) Third Field Survey

Name	Assignment	Survey Period in Uganda
Kazunari NOGAMI	Chief Consultant / Power System Planning	27th February to 23rd March, 2016
Masatsugu KOMIYA	Deputy Chief Consultant / Substation Planning 2	27th February to 5th March, 2016
Masayuki TAMAI	Substation Planning	27th February to 24th March, 2016
Atsushi FUKUGAICHI	Transmission Planning 1	5th to 25th March, 2016
Kenji TAKAHASHI	Economic and Financial / Institutional Framework Analysis	16th March to 2nd April, 2016
Takeshi SATO	Environmental and Social Consideration	13th March to 7th April, 2016
Kazuaki KONDO	Design and Procurement Planning	27th February to 23rd March, 2016
Naoto MIZUNO	Procurement / Fund Planning	13th to 27th March, 2016
Satoshi SHISHIDO	Assistance for Transmission Planning	5th to 18th March, 2016

(5) Fourth Field Survey

Name	Assignment	Survey Period in Uganda
Masatsugu KOMIYA	Chief Consultant / Power System Planning	14th to 23rd June, 2016
Akira HIRANO	Power System Planning 2	14th to 23rd June, 2016
Kazuaki KONDO	Design and Procurement Planning	14th to 23rd June, 2016

Appendix-2 List of Parties Concerned in the Recipient Country

2. List of Parties Concerned in the Recipient Country

Organization	Title
Ministry of Finance, Planning and Economic Development (MOFPED)	
Mr. Tomohito Kanaizuka	ODA Loan Advisor
Mr. Denis Mugagga	Economist, Development Assistance & Regional Cooperation
Ministry of Energy and Mineral Development (MEMD)	
Hon. Eng. Simon D'Ujanga	Minister of State for Energy
Mr. Fred Kabagambe-Kaliisa	Permanent Secretary
Electricity Regulatory Authority(ERA)	
Dr. Geofrey Okobi	Director Economic Regulation
Mr. Ivan Karau Kisembo	Senior Projects Engineer-Development
Uganda Electricity Transmission Company Limited (UETCL)	
Mr. Eriasi Kiyemba	Managing Director / CEO
Mr. William K. Kiryahika	Deputy CEO
Mr. Buhanga Boneventura	Manager Planning and Investments
Ms. Rachel A. Baalessanvu	Senior Planning Engineer
Mr. Valentine K. Katabira	Manager – Operations & Maintenance
Mr. Frederick C. Zesooli	Manager - Human Resource & Administration
Mr. George Rwabajungu	Manager - Finance, Accounts and Sales
Mr. Mutyaba Christopher M.	Senior Maintenance Engineer – Substations
Mr. Jenkins Miiro Nelson	Senior Business Analyst
Ms. Pamela Kanyunyuzi	Business Analyst
Mr. Masereka Enos Bright	Planning Engineer
Ms. Diana Nakabugo	Planning Engineer
Mr. Mark Namungo	Senior Power Analyst
Mr. John Othieno	Principal Environment Officer
Mr. Herbert Opolot	Principal Procurement Officer
Mr. Mukasa Fred	Principal Development Engineer
Mr. Deride Luyima	Technical Engineer
Mr. Asen Habumugisha	Senior Surveyor
Mr. Kironde Jimmy	Senior Control Engineer
Mr. Andrew Geno Omalla	Technical Officer Projects

Mr. Mukwaya Paul Mathew	Technical Officer (Maintenance)
Mr. Muwambi Erisa	Surveyor
Mr. Ocom Justin	Drawing Office Supervisor
Mr. Kahororo Job	Draughtsman

Uganda Electricity Distribution Company Limited (UEDCL)

Mr. Laurn Bamanya	Projects Manager

Office of the Solicitor General

Mr. Christopher Gashirabake	Director Legal & Advisory Services

Uganda National Roads Authority

Mr. Ongom Justine	Manager of Maintenance

UMEME Corporation

Ms. Patricia Ocan	Asset Investment Planning Manager
Mr. Hiire Nicholas	Senior Planning Engineer

Embassy of Japan in Uganda

Mr. Kazuaki Kameda	Ambassador Extraordinary and Plenipotentiary
Mr. Yutaka Nakamura	Counselor
Mr. Naokazu Kanno	Second Secretary
Ms. Aiko Hino	Second Secretary
Mr. Kentaro Takada	Coordinator for Economic Cooperation
Ms. Naho Sakano	Special Researcher

JICA Uganda Office

Mr. Kyosuke Kawazumi	Chief Representative
Mr. Yasumichi Araki	Senior Representative
Mr. Ryoichi Kawabe	Representative
Mr. Yoshio Nakagawa	Project formulation Advisor

Appendix-3 Minutes of Discussions on the Draft Final Report

Minutes of Discussions
on the Preparatory Survey
for Greater Kampala Metropolitan Area Transmission System Improvement Project
between
Uganda Electricity Transmission Company Limited (UETCL)
and
JICA Preparatory Survey Team
(Draft Final Report Explanation: Fourth Field Survey)

Date: 21 June 2016

Kampala, Uganda

JICA Preparatory Survey Team (hereinafter referred to as "The Team") led by Mr. Masatsugu Komiya (Yachiyo Engineering Co., Ltd.) conducted the fourth field work on the preparatory survey for the Greater Kampala Metropolitan Area Transmission System Improvement Project (hereinafter referred to as "the Project") from 15th June to 22nd June, 2016 and had a series of discussion with the officials of UETCL regarding the draft final report. The First Preparatory survey commenced in August 2015.

Although the basic understanding and agreement on the project during the field survey is subject to change following further discussions during JICA's appraisal mission scheduled from the beginning to the middle of July, 2016, the both parties understand and agreed the following items.

1. Contents of Draft Final Report

The Team submitted the Draft Final Report to UETCL on 10th of June, 2016 and explained the contents of report during the field survey in Kampala.

In conclusion, UETCL agreed to the contents of the report in principle and the Team agreed to receive comments to be provided by UETCL and reflect them in the Final Report.

2. Required technical specifications for equipment

The Team explained that from the views stated below, technical requirement should be considered to key equipment, namely; mobile substation, Gas Insulated Switchgear (GIS), transformer (TR) and High-Tension Low-Sag (HTLS) conduetors.

No.	Consideration	Mobile substation	GIS	TR	HTLS conductors
1	Manufacturing experience, considering high quality and reliability	○	○	○	○
2	Criteria to type test reports for the quality assurance	○	○	○	○
3	Endurance of vibration, considering the occurrence of earthquakes in Uganda and during the transportation	○	○	○	
4	SF_6 gas sealing with the consideration of environment protection and maintenance	○	○		
5	GIS Equipment for mobile substation to be filled with SF_6 gas at normal working pressure before transportation to site, considering the public safety	○			
6	The mobility requirements on Ugandan Roads	○			

[Remark] Circle (○) shows equipment applicable to each consideration.

UETCL understood the necessity to observe these views and thus agreed to add to the specifications described in the Appendix-1.

3. Harmonization with the other donors projects

UETCL explained that the anticipated commissioning time of Kawanda-Masaka Line funded by the World Bank and Mukono Substation funded by China Export-Import Bank are as follows:

(i) Kawanda – Masaka Project: End of June, 2017

(ii) Mukono Substation Project: End of November, 2018 (Thirty months after Site Hand-over date which took place in June, 2016).

Therefore, both sides confirm that by the expected time for commencement of works for the Project, in January 2019, above-mentioned projects will be commissioned.

In case that the above-mentioned projects delay for any reason, UETCL agreed to make actions for the Project stated below with its own budget:

(i) 220 kV transmission lines connection work (Related to World Bank)

Since 220 kV transmission line branch towers are installed in the Project, UETCL is required to connect the 220 kV transmission line between the branch towers under the Project and the towers of Kawanda-Masaka Project (World Bank) and to carry out necessary work for setting the related protection system for the transmission line.

(ii) Final cabling work between GISs of New Mukono Substation (Japan) and Mukono Substation (China) (Related to New Mukono Substation)

The project is planned to lay 132 kV cables between New Mukono 220/132 kV Substation to Mukono 132/33kV Substation and cables to be connected to transmission line toward Namanve South Substation.

Even in the event of delay of Mukono 132/33 kV Substation, the Project will construct two cable heads (one is for sending to Namanve South Substation through 132 kV transmission line and the other is for sending to Mukono 132/33 kV Substation), and UETCL shall conduct the final connection work between the cable heads and overhead lines and necessary work for related protection system.

Both sides also confirmed the contents of Appendix-2, stating the impact of delaying other donors' constructions.

4. Further schedules of Environment Impact Assessment (EIA), Abbreviated Resettlement Action Plan and License from National Forestry Authority

UETCL agrees to conduct the further schedules as stated below:

(i) EIA Permit

EIA Draft Final Report will be submitted from AWE, which is hired by the Team, to UETCL

around 23rd June. After UETCL's review, the comments will be submitted to AWE. UETCL shall submit the Final Report to NEMA for the approval. After the submission of the report, AWE will respond to any comments from NEMA. The expected time of obtaining the EIA certificate will be the 15th of September, 2016. A copy of the certificate from NEMA will be sent to JICA by UETCL.

(ii) A-RAP (CGV's approval)

AWE shall submit the A-RAP Draft Final Report to UETCL and the Team on 24th of June. After that, UETCL and the Team shall commence the review and provide any comments to AWE. Based on these comments, AWE shall submit the A-RAP Final Report to UETCL and UETCL shall submit it to CGV accordingly.

The proposed time of UETCL's submission of A-RAP Final Report to CGV will be 11th of July. After the submission of the report, AWE will respond to any comments from CGV. A copy of the approval document will be sent to JICA by UETCL.

(iii) License from National Forest Authority (NFA)

UETCL informed the Team about tentative schedule of the NFA license as follows:

- ✧ NFA's survey: 2 months, from beginning of June to end of July, 2016
- ✧ Clarification meeting between UETCL and NFA on compensation fee: 1 month, from the end of July to the end of August, 2016.
- ✧ Disbursement of compensation fee by UETCL to NFA: by the end of September, 2016.

UETCL also confirmed to continue to make the necessity procedures as stated above for obtaining the license from NFA by the end of September, 2016 and report the result to JICA.

5. Requirement for mobile substations

UETCL requested the following features to the mobile substations to be procured under the Project. The Team agreed to reflect these specifications into the Final Report.

(i) UETCL requests to provide one trailer head to each set of mobile substations. The Team confirmed it.

(ii) UETCL proposed that mobile substations be designed for use at substation sites and two methods of connection to existing busbars are considered as below:

- ✧ Connection method 1: Cable

  Overhead conductor – mobile cable head – cable – mobile cable head – Overhead conductor – Bushing of primary voltage side of GIS
- ✧ Method 2: Overhead conductor

  Overhead conductor – Bushing of primary voltage side of GIS

Therefore, UETCL requested the project to provide equipment for above-mentioned two different connection methods for the connection to the existing busbars as accessories to each set of mobile substation. The Team confirmed it.

6. General layout plan and single line diagram of substation

UETCL agreed the substations to be rehabilitated / constructed by the Project are designed as Appendix-3 shows.

Appendix:

1. Technical specifications
2. The impacts of delay of other donor's constructions
3. General layout plan and single line diagram of the substations

Mr. Masatsugu Komiya
Chief Consultant
Yachiyo Engineering Co., Ltd.

Mr. Eriasi Kiyemba
Managing Director / CEO
Uganda Electricity Transmission Company Limited (UETCL)

Appendix-1 Technical specifications

(1) Mobile substation

1) Draft requirement for prequalification

- To have at least five experiences to procure high voltage mobile substations (Primary voltage: at least 66 kV and at least one shall be 132 kV or above).
- To have at least fifteen years of transformer manufacturing experience (132kV or above)
- To submit the procurement certificates for the five experiences of the mobile substations supplied
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

2) Draft tender specification

Key specifications are stated below.

- Mobile substation equipment which includes the 20MVA 132/33-11kV transformer, switchgear facility and substation facilities in different trailers to secure both mobility enough to move within Uganda.
- Capability of moving on 12% of the uphill and turning which enable to enter into the road with its width of 7.5 m.
- Low noise (70 dB or less)

Table 1 Main specification of the mobile substation

132 / 33 kV – 11 kV Multi ratio mobile substation		
No.	Description	Specification
<Common specification>		
(1)	Standard	IEC or equivalent
(2)	Composition	Considering the road condition of Kampala Metropolitan Area, it shall be a separate type comprising of primary side mobile switchgear, mobile transformer and secondary side switchgear
(3)	Operation condition	At the commissioning, the equipment shall be fully ready to be available at any necessary sites. (To be mobilized with fully equipped)
(4)	Connection method	Connection between existing busbars and primary side mobile GIS shall be done by either cable or overhead conductors.
(5)	SCADA system	SCADA terminal unit shall be equipped
(6)	Local monitoring system	Equipment for the monitor and control of the operation (V, I, active power, energy, etc.) shall be equipped.

Appendix-1 Technical specifications

132 / 33 kV – 11 kV Multi ratio mobile substation		
No.	Description	Specification
(7)	Altitude	Between 1,000 m and 1,500 m
(8)	Accessories	Mobile post insulators, mobile cable head, lightning arrestor power cable etc. to be connected between the switchgear and transformer etc.
(9)	Tolerable vibration in operation	0.3G (Resonance sine wave 3)
(10)	Tolerable vibration during transportation	3G (Marrum road)
(11)	Other	Vibration recorder shall be furnished for the mobile transformer.
<Mobile transformer>		
(1)	Capacity	20 MVA
(2)	Rated voltage	Primary: 132 kV Secondary: 33 – 11 kV
(3)	Tap position	Primary
(4)	Tap range	132 kV +5%/-12.5%
(5)	Tap number	17 taps (+4 taps/-15 taps)
(6)	Grounding system	Primary: Neutral direct grounding Secondary: Direct grounding
(7)	Auxiliary transformer	
	- Primary	33 or 11 kV
	- Secondary	0.4 kV
	- Capacity	100 kVA
(8)	Cooling system	ODAF
(9)	Impedance	To be informed by the detailed design
(10)	Insulation oil tank	To endure abnormal internal pressure when the three-phase short circuit fault happens.
(11)	Others	Each parts of mobile substation shall endure against electro-magnetic power caused by three phase short circuit faults and vibration during transportation
<Mobile switchgear>		
(1)	Voltage	132 kV (Primary), 33-11 kV (Secondary)
(2)	Breaking method	Gas insulated switchgear (GIS)
(3)	Insulation mode	SF_6
(4)	Secondary feeder number	2
(5)	Gas pressure during the transportation	0.15 MPa or less
(6)	Gas leakage rate	0.1%/year or less
(7)	Other	Secondary voltage switchgear shall be equipped into one separated trailer or together into mobile transformer
<Vehicle>		
(1)	Maximum gradient	12%
(2)	Turning radius	To be capable of entering into road with the width of 7.5 m.
(3)	Gross Vehicle Weight (GVW)	GVW limitation is 56 ton.
(4)	Number of axle	Manufacturer standard Maximum axle load is 8 ton or less

(2) Gas Insulated Switchgear (GIS)

1) Draft requirement for prequalification

- To have records of manufacturing GIS, which satisfies the technical specifications on Table 2 and Table 3 beyond 15 years
- To submit five procurement certificates from electric power companies
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

2) Draft tender specification

Key specifications are stated below.

- The equipment is able to be directly connected to power transformer (applied to Kawaala Substation)

Table 2 Specification of 132 kV Gas Insulated Switchgear

No.	Description	Specification
(1)	Standards	IEC, JEC or equivalent
(2)	Model	Outdoor
(3)	Busbar	Double bus
(4)	Gas leakage	0.1% or lower per year
(5)	Rated voltage	145 kV
(6)	Rated current	To be informed by the detailed design
(7)	Rated interrupting current	31.5 kA
(8)	Rated short-time withstand current (short time)	31.5 kA (3 sec.)
(9)	Rated basic impulse withstand voltage	650 kV
(10)	Rated power frequency withstand voltage (1 min.)	275 kV
(11)	Auto-reclosing	Three phase bundle
(12)	Operating sequence	O-0.3 sec.-CO-3 min.-CO
(13)	Current transformer	6 CTs/phase
(14)	Voltage transformer	3 CVTs/phase
(15)	Tolerable vibration	0.3G (Resonance sine wave 3)
(16)	Tolerable vibration during transportation	3G
(17)	Gas leakage rate	0.1%/year or less
(18)	Other	- To be accessible to the local panel without using ladder.

Table3 Specification of 220 kV Gas Insulated Switchgear

No.	Description	Specification
(1)	Standards	IEC, JEC or equivalent
(2)	Model	Outdoor
(3)	Busbar	Double bus
(4)	Gas leakage	0.1% or lower per year
(5)	Rated voltage	245 kV

(6)	Rated current	To be informed by detailed design
(7)	Rated interrupting current	40.0 kA
(8)	Rated short-time withstand current (short time)	40kA kA (3 sec.)
(9)	Rated basic impulse withstand voltage	To be informed by detailed design
(10)	Rated power frequency withstand voltage (1 min.)	To be informed by detailed design
(11)	Auto-reclosing	Three phase bundle
(12)	Operating sequence	O-0.3 sec.-CO-3 min.-CO
(13)	Current transformer	6 CTs/phase
(14)	Voltage transformer	3 CVTs/phase
(15)	Tolerable vibration	0.3G (Resonance sine wave 3)
(16)	Tolerable vibration during transportation	3G
(17)	Gas leakage rate	0.1%/year or less
(18)	Other	- To be accessible to the local panel without using ladder.

(3) Transformer

1) Draft requirement for prequalification

- To have at least five experiences to procure power transformers (Primary voltage: 132 kV or more).
- To have at least fifteen years of manufacturing experience
- To submit five procurement certificates from electric power companies
- To submit the type test report including lightning impulse test certified by laboratory satisfying ISO or equivalent

2) Draft tender specification

Key specifications are stated below.

- Low noise (70 dB or less)

Table 4 Specification of the transformer

No.	Description	Specification
(1)	Standard	IEC, BS or equivalent
(2)	Capacity	(To be specified depending on project site)
(3)	Rated voltage	(To be specified depending on project site)
(4)	Tap position	Primary
(5)	Tap range	+5%/-12.5%
(6)	Tap number	17 taps (+4 taps/-15 taps)
(7)	Grounding system	Primary: Neutral direct grounding Secondary: Direct grounding
(8)	Auxiliary transformer	
	- Primary	33 kV
	- Secondary	0.4 kV

No.	Description	Specification
	- Capacity	100 kVA
(9)	Cooling system	ONAN / ONAF
(10)	Impedance	(To be specified depending on project site)
(11)	Altitude	Between 1,000 m and 1,500 m

(4) High-Temperature Low-Sag (HTLS) conductors

1) Draft requirement for prequalification

Shown in Table 5 (10), (11)

2) Tender specifications

The items of the specifications which should be well noted are stated as follows:

- To carry out reconductoring without increasing load stress to existing towers.

Table 5 Specification of High Temperature Low Sag conductors

No.	Description	Specification
(1)	Applicable standards	IEC and JEC or equivalent standard
(2)	Type	Gap conductor or Invar conductor
(3)	Definition	Gap conductor: The core is Ultra high strength galvanized steel. The conductor is Super thermal-resistant aluminum alloy. It offers excellent low sag and current-carrying characteristics at a high conductor temperature. Invar conductor: The core is Aluminum clad invar alloy. The conductor is Super thermal-resistant aluminum alloy. It offers excellent low sag and current-carrying characteristics at a high conductor temperature.
(4)	Material	Gap conductor: Core: Ultra high strength galvanized steel Conductor: Super thermal-resistant aluminum alloy Grease: Thermal-resistant grease Invar conductor: Core: Aluminum clad invar alloy Conductor: Super thermal-resistant aluminum alloy
(5)	Nominal diameter	Equivalent to Lynx
(6)	Ultimate tensile strength (UTS)	UTS which Maximum working tension becomes less than 36% of Lynx UTS (79.8kN) or equal when condition changes from condition 1 to condition 2. Condition 1: Everyday stress (EDS) EDS: Less than 20% of HTLS UTS or equal Conductor temperature: 26 °C Wind pressure: 0 Pa Condition 2: Worst case Maximum working tension: Less than 36% of Lynx UTS (79.8kN) or equal Conductor temperature: 8 °C

Appendix-1 Technical specifications

No.	Description	Specification
		Wind pressure: 510 Pa
(7)	Current-carrying capacity at maximum operating temperature	Greater than 1010 A or equal ***Calculation Condition*** 1. Ambient temperature: 35 °C 2. Wind velocity: 0.6 m/s 3. Wind direction: 0° 4. Solar radiation: 0.1 W/m^2 5. Emissivity of conductor surface: 0.6 6. Elevation above sea level: 1,200 m 7. Frequency: 50 Hz
(8)	Sag condition (Span: 300 m)	1) Maximum working tension is less than 36% of Lynx UTS (79.8kN) or equal when condition changes from condition 1 to condition 2. 2) Sag is less than maximum sag of Lynx (7.6m at the span of 300 m) or equal when condition changes from condition 1 to condition 3. Condition 1: Everyday stress (EDS) EDS: Less than 20% of HTLS UTS or equal Conductor temperature: 26 °C Wind pressure: 0 Pa Condition 2: Worst case Maximum working tension: Less than 36% of Lynx UTS (79.8kN) or equal Conductor temperature: 8 °C Wind pressure: 510 Pa Condition 3: Maximum sag Conductor temperature: Temperature at 1010 A (HTLS) 75 °C (Lynx) Wind pressure: 0 Pa
(9)	Strength soundness of tower after replacing conductor	To check insufficient strength by the follows and to reinforce tower so that the tower ensures soundness of tower as support of transmission line after replacing conductor. ① Design change of conductor from the existing design ② Steel corrosion of existing tower ③ Unequal displacement of tower foundation and displacement of tower member ④ Quality of tower material
(10)	Supply record	More than 2,000 km
(11)	Manufacturing record	More than 15 years
(12)	Special tools/training by supervisor	Gap conductor requires special tools and training by supervisor.

Note: If there are some defects on the existing towers, repair work shall be carried out by UETCL.

Appendix-2

June 21, 2016

JICA Study Team

The Impacts of Delay of Construction Funded by Other Donors

Projects funded by other donors that are related to the Project are planned to be commissioned long before commissioning of the Project. In spite of low possibility, completion of these projects may be later than completion of the Project due to unexpected reasons. Therefore, the impacts of these cases have been summarized as part of the negative risk management as follows.

1. The impact of delay of construction funded by the China Export-Import Bank (construction of Mukono substation)

   Since contract of Mukono substation, Namanve south substation and Luzira substation have been made together, the following two cases of delay can be considered. However, operational problems will not occur in both cases.

   (Case 1) Only construction of Mukono substation will delay.

   Since New Mukono Substation cannot be connected to 132kV transmission line between Nalubaale Substation and Namanve substation, and power system configuration of 132kV transmission line between Nalubaale Substation and Namanve Substation is almost same as current power system configuration which components of the Project are not applied. Therefore, there are no problems when it is normal state, but 125% overload will occur at 132kV transmission line between Kampala North Substation and Lugogo Substation and 121% overload will occur at 132kV transmission line between Kawaala Substation and Mutundwe Substation when N-1 contingencies occur at 132kV transmission line between Nalubaale Substation and Mukono Substation in 2022 cross-section. However, since conductors of these overloaded transmission lines are supposed to be upgraded to HTLS conductors in the Project, actually overloads will not occur.

   (Case 2) Construction of Mukono Substation and the other substations will delay together.

   Since Mukono Substation, Namanve South Substation and Luzira Substation are installed for supplying to industrial parks mainly, delay of construction of the substations leads to reduction of electric load. Therefore, conditions of power flow will be improved compared to the Case 1.

[Conclusions]

Power System Operation:

Operational problems such as overload will not occur until 2022 cross-section.

Construction by the Project (JICA):

- Installation of 132kV power cables between 132kV busbar at New Mukono Substation and 132kV busbar at Mukono Substation, protection relay and communication lines.
- Installation of 132kV power cables between 132kV busbar at New Mukono Substation and 132kV transmission line for Namanve South Substation, protection relay and communication lines.

Construction funded by the China Export-Import Bank:

- Connection of cables described in Construction funded by JICA above, and alignment of protection relay.

2. The impact of delay of construction funded by the World Bank (220kV transmission line between Kawanda substation and Masaka substation)

Since 220kV equipment in Buloba Substation cannot be used, Buloba Substation can be used only as distribution substation (132/33kV, 40MVA*2) which is supplied from Mutundwe Substation with Kabulasoke Substation by 132kV 1cct transmission line (110MVA).

[Conclusions]

Power System Operation:

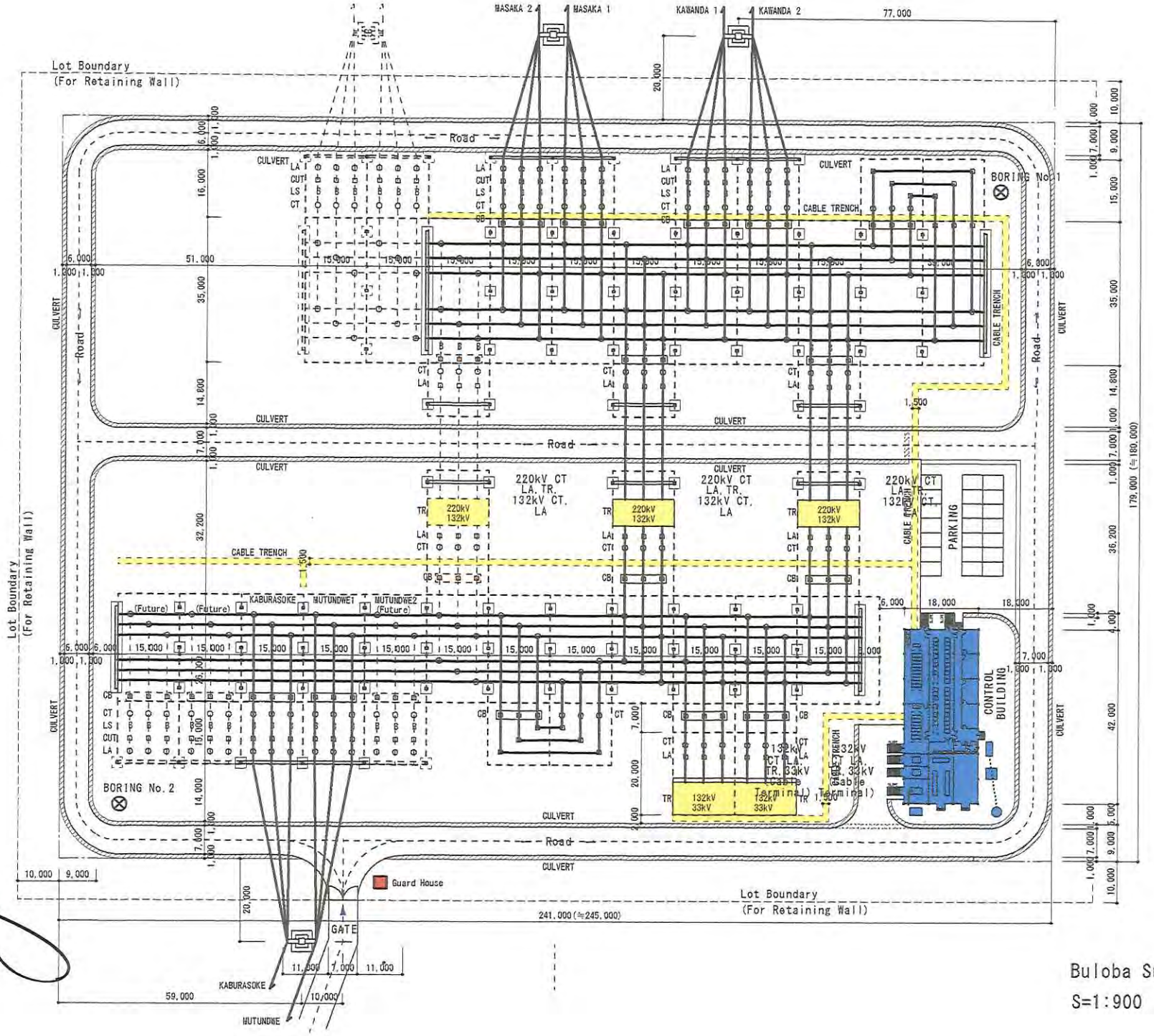
Operational problems such as overload will not occur until 2022 cross-section.

Construction by the Project (JICA):

- Installation of 220kV towers, conductors and OPGWs between Buloba Substation and 220kV branch towers.

Construction funded by the World Bank:

- Connection of conductors and OPGWs at 220kV branch towers.
- Implementation of works for commissioning such as changing settings for protection relay.



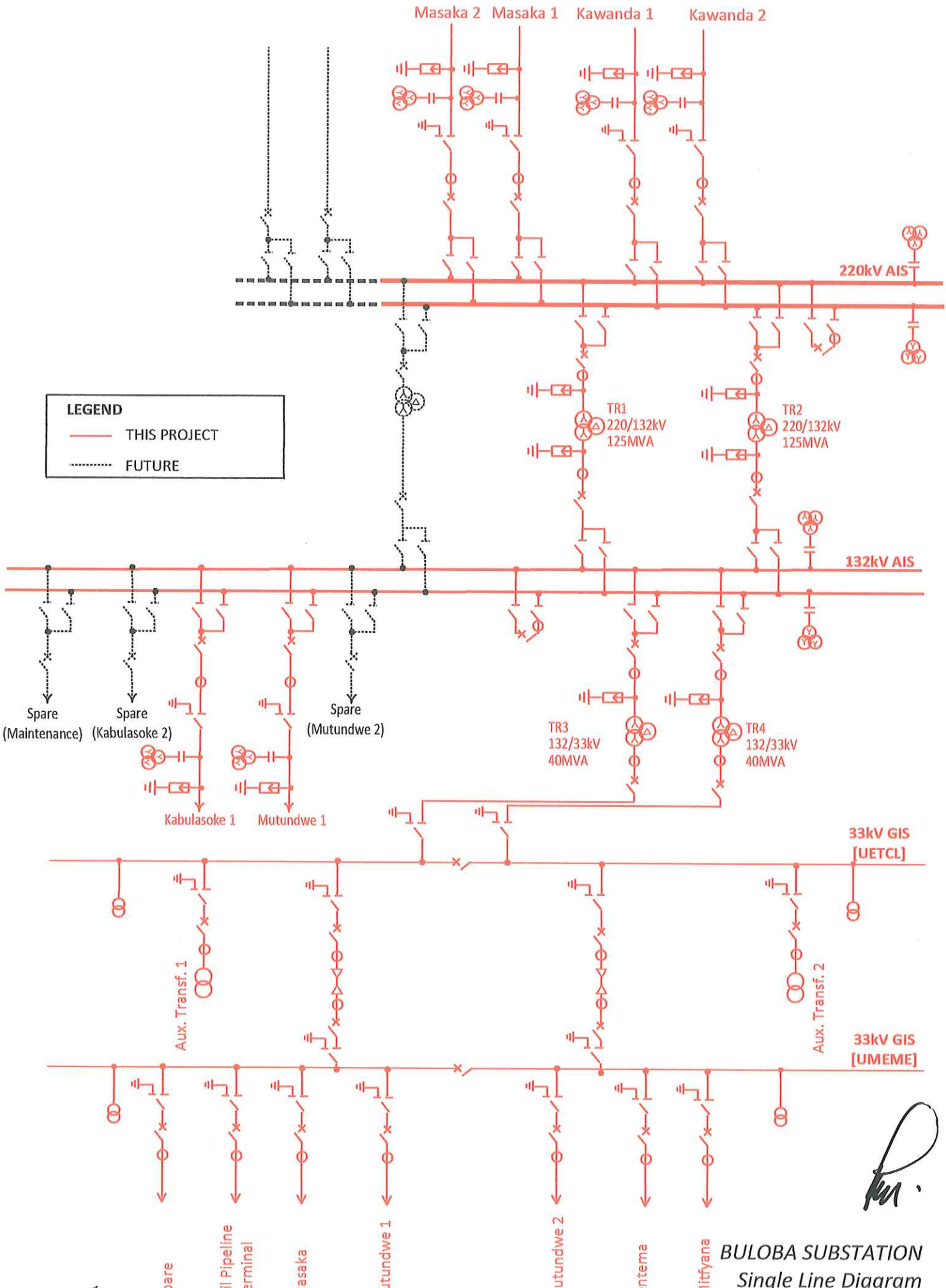
LEGEND

Scope of the Project

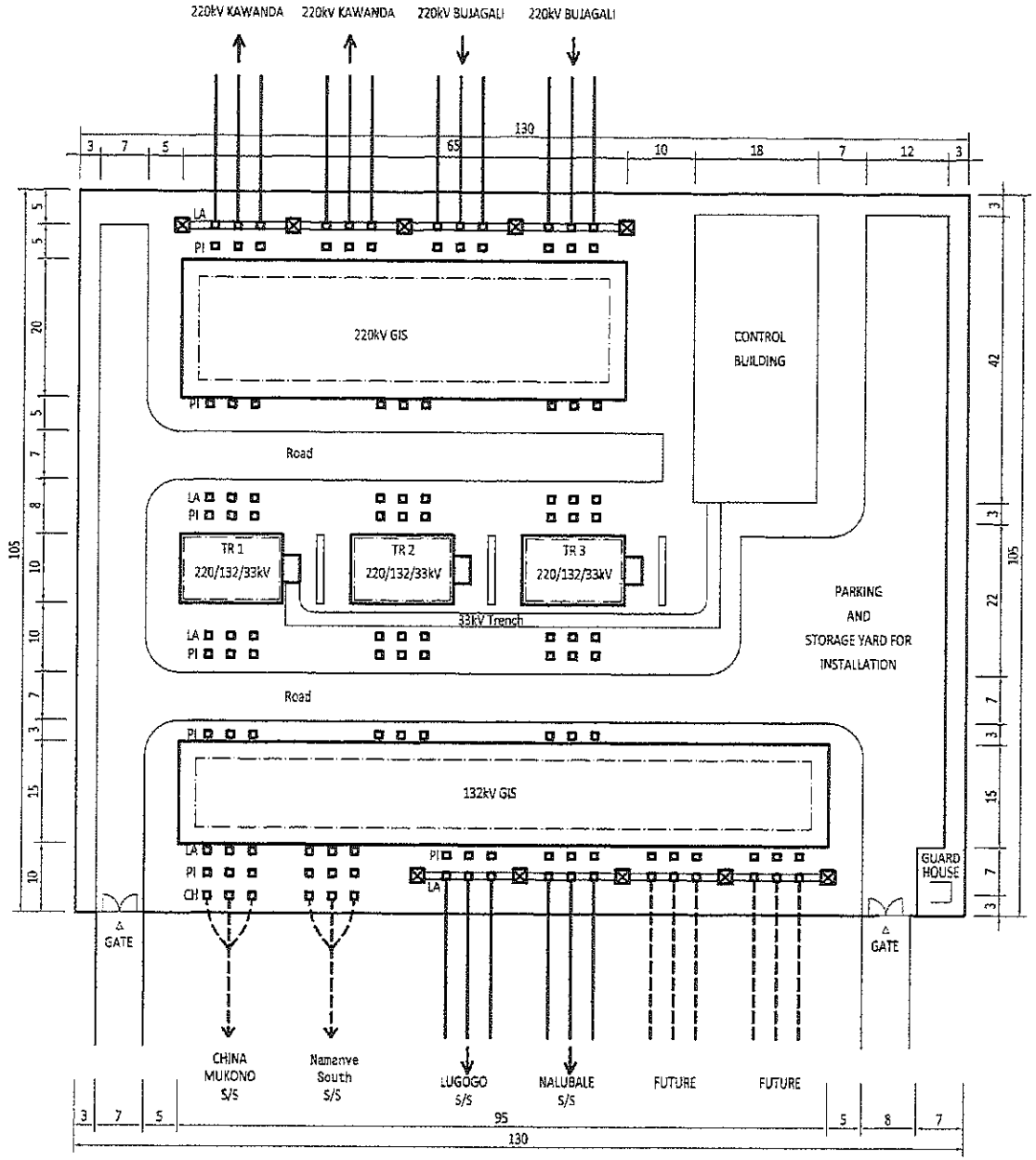
Future Lines

Buloba Substation Site Layout

S=1:900 (A3) 14 Mar. 2016



BULOBA SUBSTATION
Single Line Diagram

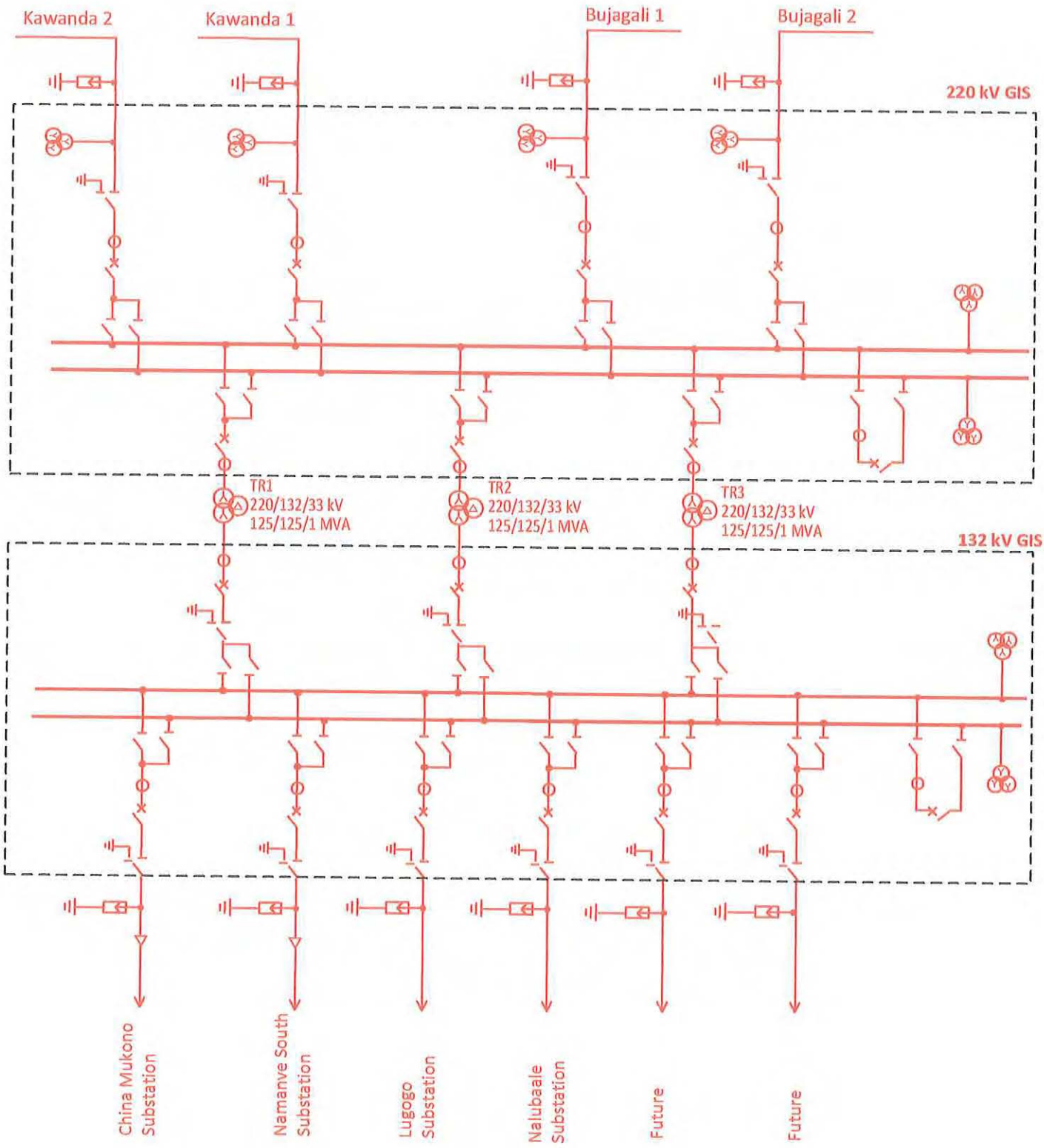


LEGEND

CH : Cable Head
GIS : Gas Insulated Switchgear
LA : Lightning Arrester
PI : Post Insulator
TR : Transformer

NEW MUKONO SUBSTATION SITE LAYOUT (GIS)

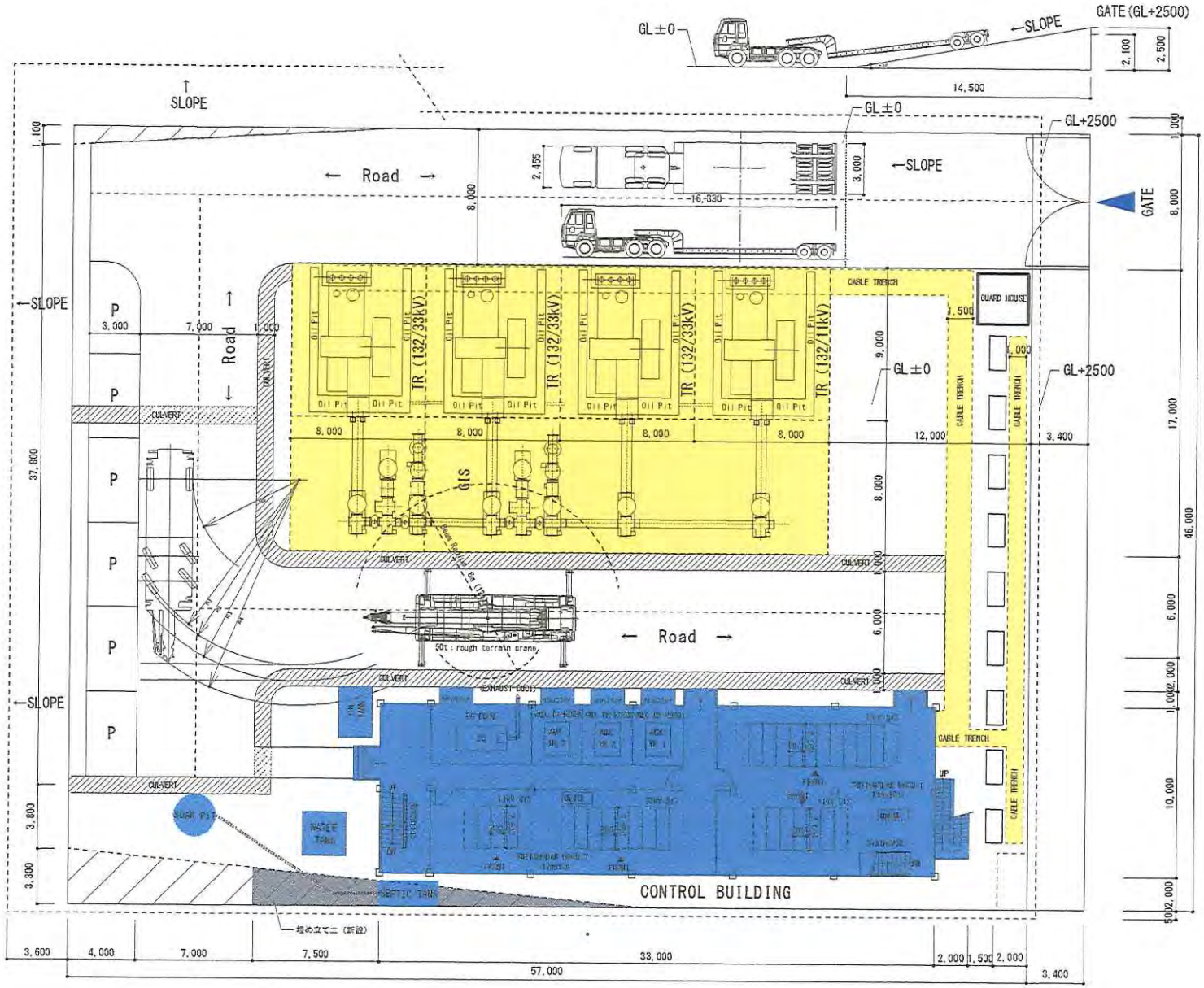
S=1:1000 (if only A4), UNIT=meter, 14 Mar., 2016



LEGEND

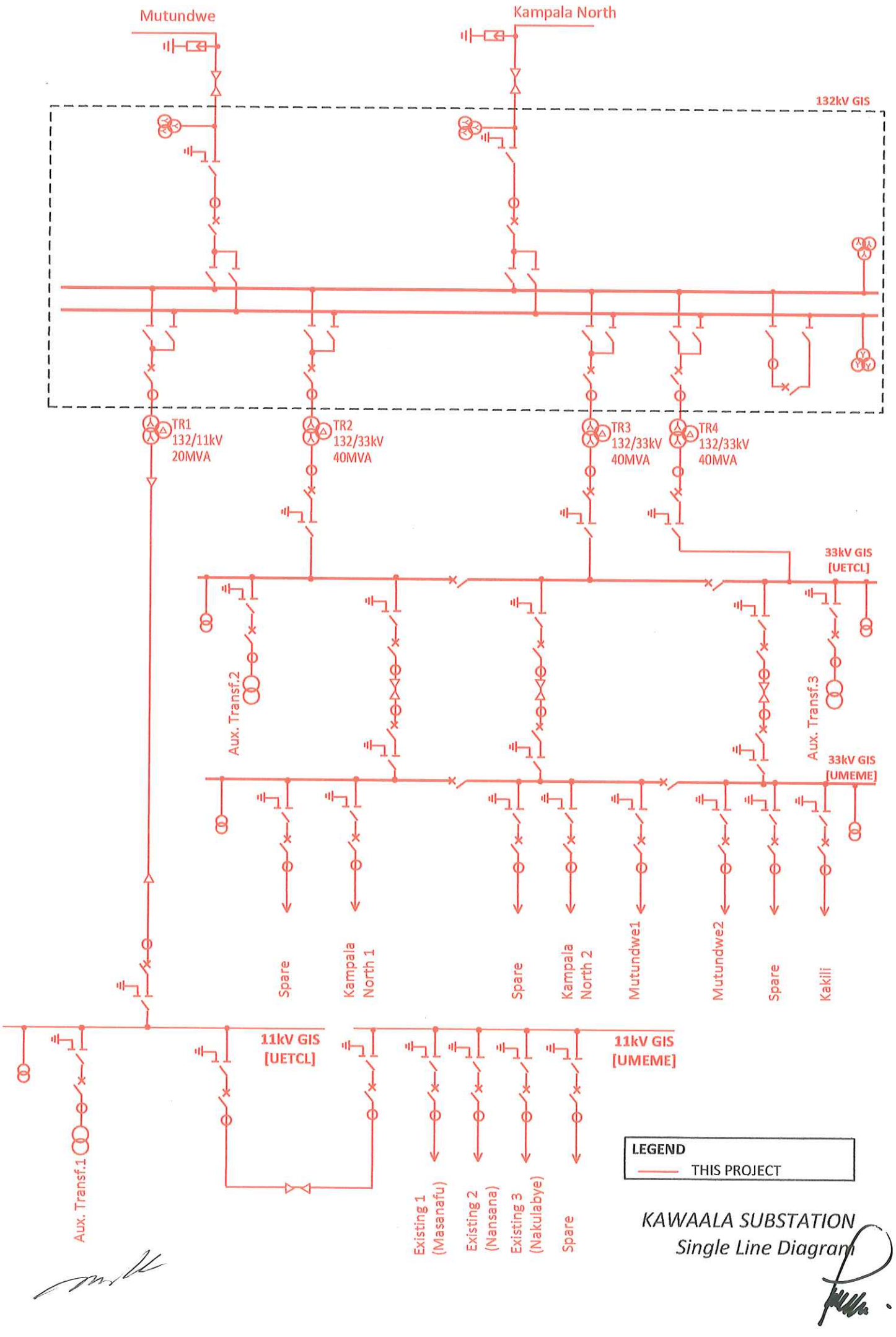
THIS PROJECT

New Mukono SUBSTATION
Single Line Diagram

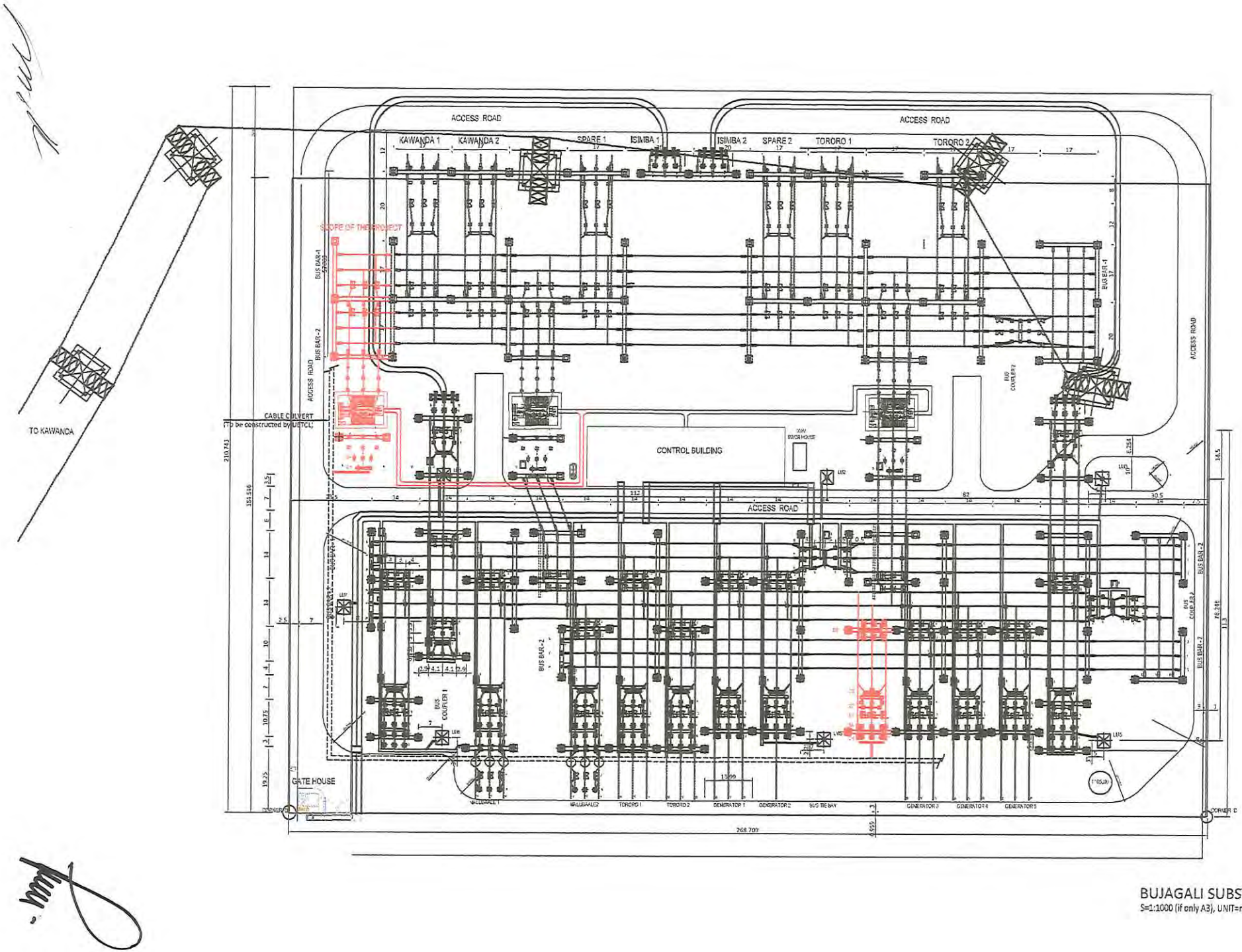


Kawaala Substation Site Layout

S=1:250 (A3) 14 Mar. 2016

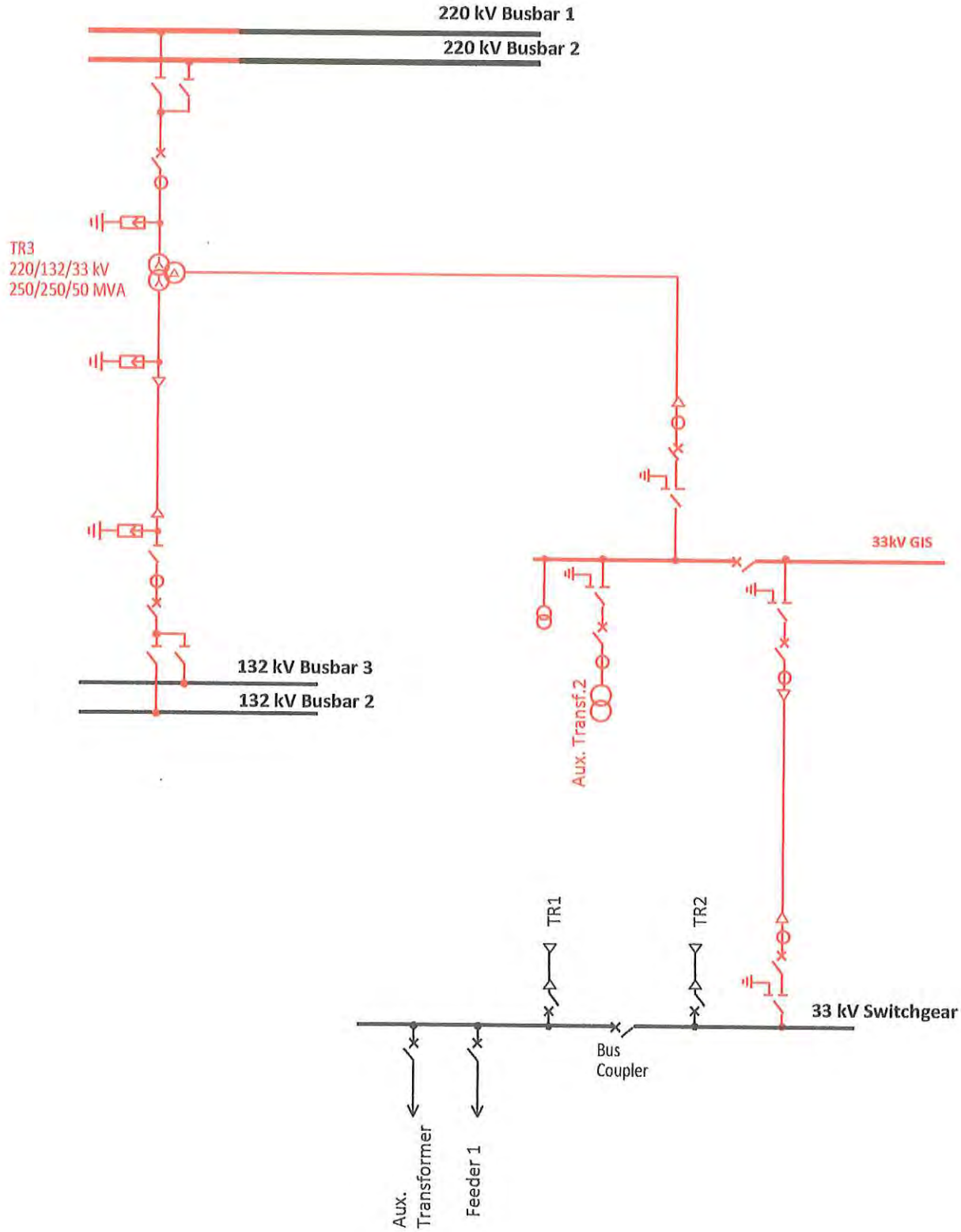


KAWAALA SUBSTATION
Single Line Diagram



BUJAGALI SUBSTATION SITE LAYOUT

S=1:1000 (if only A3), UNIT=meter, 15 Mar., 2016

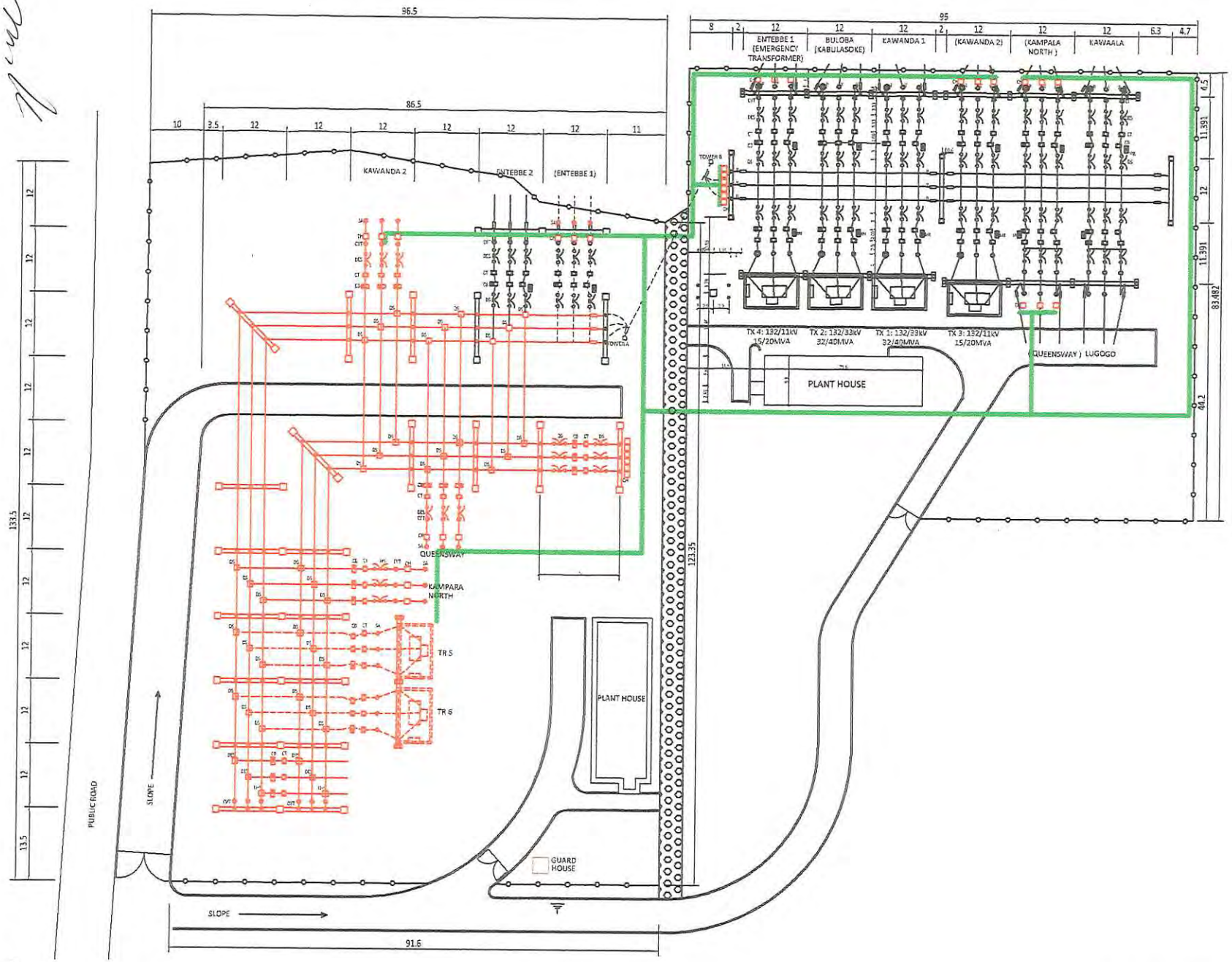


LEGEND

THIS PROJECT

EXISTING

BUJAGALI SUBSTATION
Single Line Diagram
(Scope of work only)



NOTES

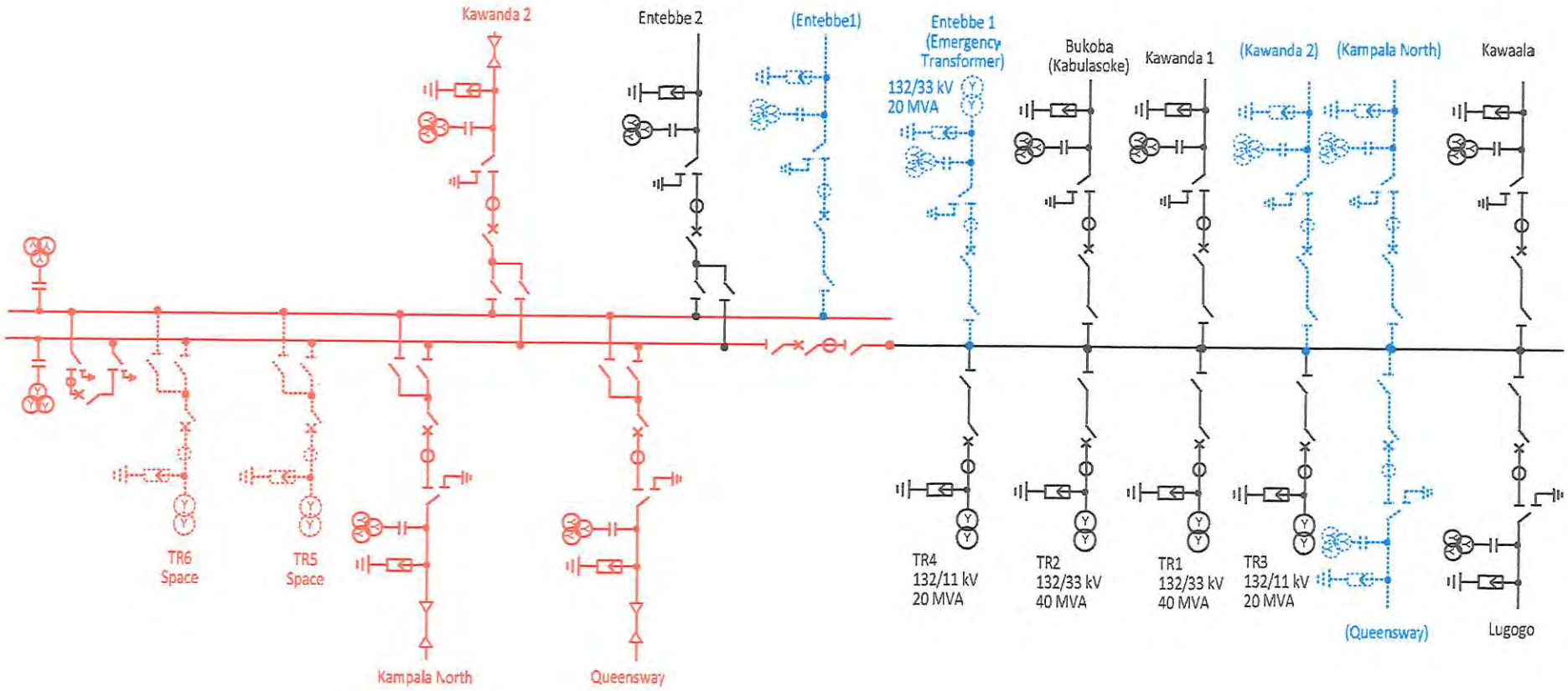
1) ALL DIMENSION ARE IN MILLIMETERS

LEGEND

SYMBOL	DESCRIPTION
SA	SURGE ARRESTOR
CVT	CAPACITIVE VOLTAGE TRANSFORMER
DES	DISCONNECTOR WITH EARTH SWITCH
CT	CURRENT TRANSFORMER
CB	CIRCUIT BREAKER
DS	DISCONNECTOR
MK	MARSHALING KIOSK
CH	CABLE HEAD
	132kV CABLE

MUTUNDWE SUBSTATION SITE LAYOUT

S=1:1000 (if only A4), UNIT=meter, 14 Mar., 2016



LEGEND

- THIS PROJECT
- Existing
- To be presented as ( ) in 2018, but to be relocated / reconnected as labeled under the Project

MUTUNDWE SUBSTATION
Single Line Diagram

Appendix-4 Minutes of Discussions on the Interim Report

Minutes of Discussions
on
the Preliminary Survey
for
Greater Kampala Metropolitan Area Transmission System Improvement Project
between
Uganda Electricity Transmission Company Limited (UETCL)
and
JICA Preliminary Survey Team

Date: 2nd March 2016
Kampala, Uganda

JICA Preliminary Survey Team (hereinafter referred to as "The Team") led by Mr. Kazunari Nogami (Yachiyo Engineering Co. Ltd.) started the preliminary survey for the Greater Kampala Metropolitan Area Transmission System Improvement Project (hereinafter referred to as "the Project") in September, 2015 and conducted tbe first field survey and second field survey from September to December, 2015.

In addition, Japan International Cooperation Agency (JICA) dispatched the Pre-fact Finding Mission in December, 2015 and agreed to the preliminary outline of the Project with the officials of Uganda Electricity Transmission Company Limited (hereinafter referred to as "UETCL") which is reflected on the Minutes of Discussions for the Pre-fact Finding Mission signed on 18th December, 2015 (hereinafter referred to as "M/D").

The Team has prepared an Interim Report on the project in conformity with the contents of the M/D and submitted a copy of the report to UETCL.

The Team shall have detailed discussions with officials of UETCL from 29th February, 2016 for the purpose of explanation of the content of the report, and will reflect any comments arising out of the discussions in the Draft Final Report.

(End)

Annex:

Annex-1: Summary of the Interim Report
Annex-2: Interim Report

Mr. Kazunari Nogami
Chief Consultant
Yachiyo Engineering Co., Ltd.

Mr. Eriasi Kiyemba
Managing Director / CEO
Uganda Electricity Transmission Company
Limited (UETCL)

Annex-1

The Preparatory Survey on the Project for
Greater Kampala Metropolitan Area Transmission System Improvement

Summary of the Interim Report

JICA Preliminary Survey Team (the Team) led by Mr. Kazunari NOGAMI, Yachiyo Engineering Co. Ltd. started the preliminary survey for the captioned Project (the Project) in September, 2015 and conducted the first field survey and second field survey from September to December, 2015.

In addition, Japan International Cooperation Agency (JICA) dispatched the Pre-fact Finding Mission in December, 2015 and agreed the outline of the Project with the official of Uganda Electricity Transmission Company Limited (UETCL) on the Minutes of Discussions (M/D) for the Pre-fact Finding Mission on 18th December, 2015 as attached to this summary of the Interim Report (the Summary) as per Attachment-1. The Team prepared the Interim Report in conformity with the contents of the M/D.

The summary is accompanying the following attachments.

Attachment-1:	Minutes of Discussions (M/D) for the Pre-fact Finding Mission sighned on 18th December, 2015
Attachment-2:	List of the components of Project
Attachment-3:	Location of the Project Site
Attachment-4:	Table of the contents of the Draft Final Report

1. Components of the Project

Based on the power system plan conducted in the preparatory survey, UETCL and the Team confirmed the components of the Project as shown in Attachment-2, and agreed on M/D for the Pre-Fact Finding Mission on 18th December, 2015 as shown in Attachment-1. However, in consideration of the discussion with UETCL, the following modification and addition of the components will be conducted for the components of the Project. The location of these Project sites are shown in Attachment-3.

- To improve reliability of 220 kV transmission network, 4 circuits of 220 kV transmission lines shall be led to 220 / 132 kV New Mukono Substation and 220 / 132 kV Buloba Substation of the Project instead of 2 circuits. The number of the 220 kV incoming lines to these substation will be modified from 2 circuits to 4 circuits in the components list in the Draft Final Report.
- As the result of power system planning in the preparatory survey, it is revealed that bus arrangement at the existing Mutundwe Substation shall be modified from single bus configuration to double bus configuration to improve power supply around the west-southern transmission network of the Kampala metropolitan area fundamentally. The modification work

of bus arrangement at Mutundwe Substation will be included in the components list in the Draft Final Report.

2. Background of selection of the components of the Project

The power system plan is formulated by repeated consultation with UETCL about ideal power system in Kampala metropolitan area in 2030, the target year of the power system plan, with reviewing Grid Development Plan of UETCL in consideration of the on-going projects as the background of selection of the components of the Project. Outline of the results of power system planning is described as follows. The power system configuration of the Kampala Metropolitan Area in 2030, the target year of the Project for power system plan is shown in Figure 1.

- The projects which have already been committed are included in the power system plan; i.e., Namanve South Substation, Luzira Substation and Mukono Substation which will be installed by another donor in 2018.
- To enhance eastern power system of Kampala metropolitan area through effective utilization of 220 kV transmission lines, 220/132kV New Mukono Substation is planned in power system plan.
- To enhance western power system of Kampala metropolitan area through effective utilization of the 220 kV transmission lines, 220/132kV Buloba Substation is planned in power system plan.
- Power supply to Gaba Substation is secured by effective utilization of 132 kV transmission line between Mutundwe Substation and Entebbe Substation currently under construction stage by another donor via Entebbe Highway Switching Station.
- Since strategic planning to reduce social impact is required in consideration that the components of the Project related to transmission lines are located in Kampala metropolitan area, High-Temperature Low-Sag wire (hereinafter referred to as "HTLS wire") is applied to the sections shown in Attachment-2.
- In power system plan, 2 circuits of transmission lines between Bujagali Power station and Nalubaale Substation are planned to be open operation under normal condition for effective use of transmission lines upgraded with HTLS conductors without high level of transmission losses.
- 220/132kV transformer, holding unit capacity of 250MVA, will be increased from 2 units to 3 units at Bujagali Substation in consideration of above mentioned open operation between Bujagali Substation and Nalubaale Substation.

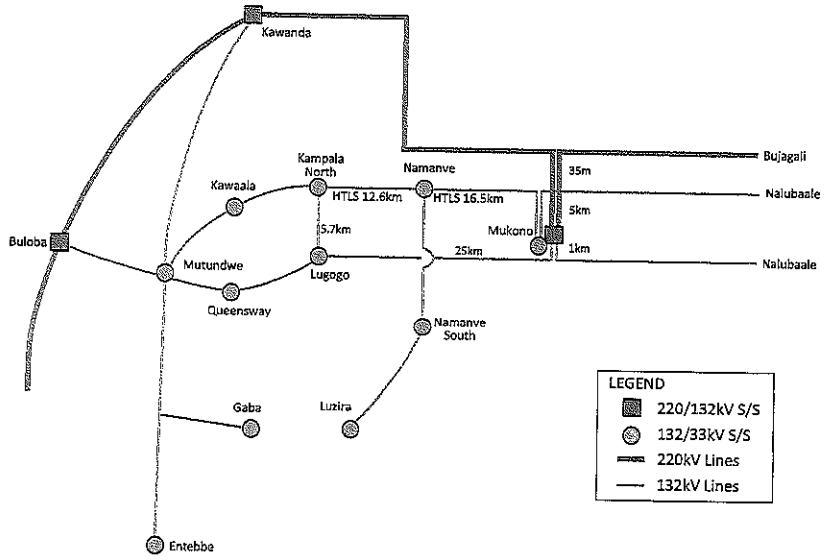


Figure 1 Power system configuration of the Kampala Metropolitan Area based on formulated power system plan in 2030

3. Submission of the Draft Final Report

The Team continues discussions with UETCL on the Project and the results of the discussions will be summed up to the Draft Final Report. The table of the contents of the Draft Final Report is shown in Atthachment-4. The black-colored sections in Atthachment-4 have been already confirmed in the Interim Report. The red-colored sections in Atthachment-4 will be discussed with UETCL, sorted in the Draft Final Report and submitted to UETCL for confirmation.

However, it is paid attention that the contents of the Draft Final Report will be reviewed by JICA and modification maybe conducted to form the Project in conformity with the concept of the Japanese Yen Loan Project.

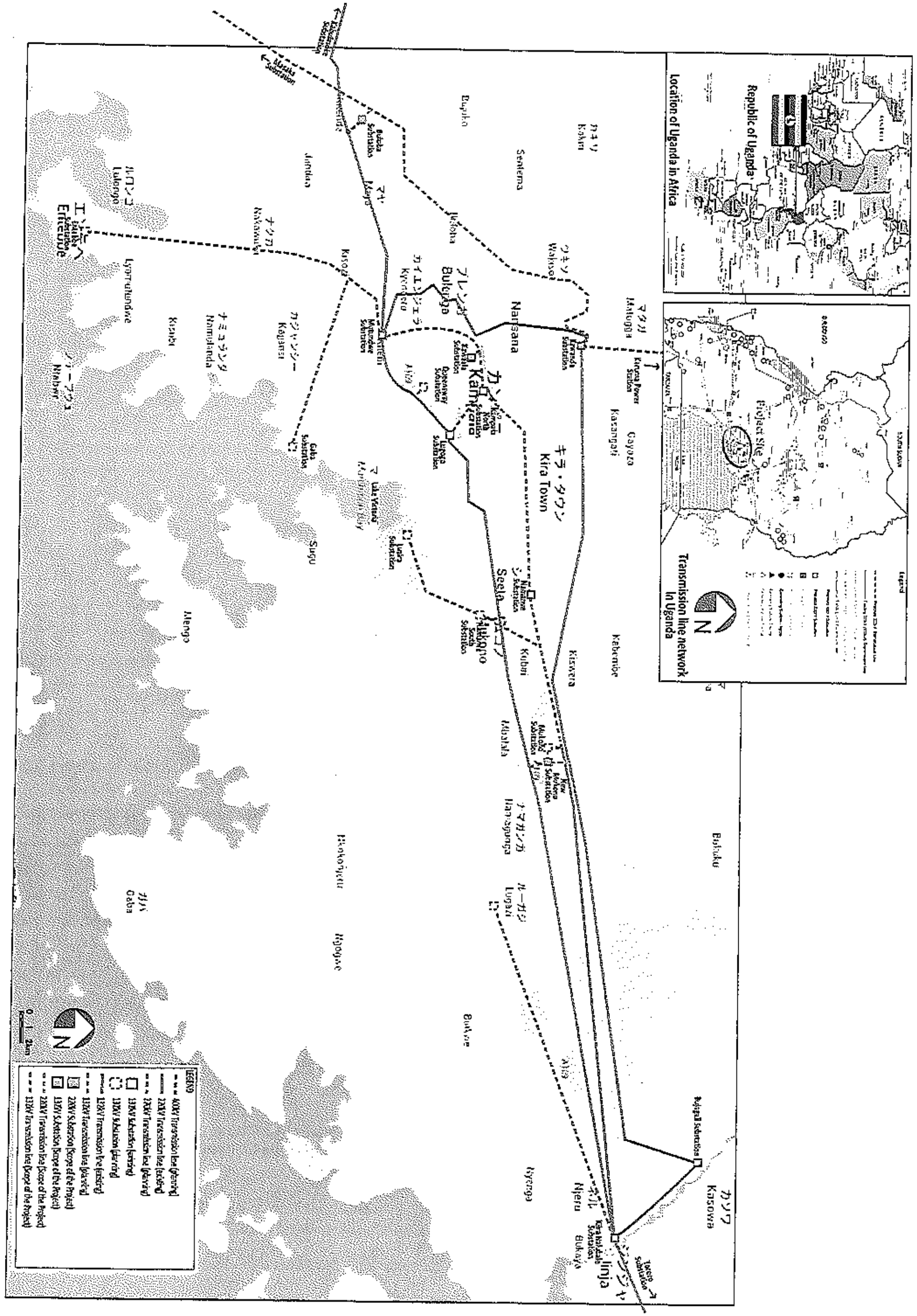
In addition, environmental and social consideration for the Project will be described in the Draft Final Report, based on the report prepared by the local consultant. The survey by the local consultant will be completed in the middle of 2016. Therefore, contents of environmental and social consideration for the Project will be added to the Draft Final Report after submission of the report by the local consultant.

- End -

List of the components of the Project

	Main component	Outline	Contents
Substation	**1. Buloba Substation**		
	(1) 220 / 132 kV Transformer	125 MVA×2units	New Construction
	(2) 132 / 33 kV Transformer	40 MVA×2units	
	(3) 220 kV Switchgear	1 lot	
	(4) 132 kV Switchgear	1 lot	
	(5) 33 kV Switchgear	1 lot	
	(6) Control building	1 lot	
	2. New Mukono Substation		
	(1) 220 / 132 kV Transformer	125 MVA×3units	New Construction
	(2) 220 kV Gas Insulated Switchgear	1 lot	
	(3) 132 kV Gas Insulated Switchgear	1 lot	
	(4) Control building	1 lot	
	3. Kawanda Substation		
	(1) 132 / 33 kV Transformer	60 MVA×1unit	Upgrade
	(2) 132 kV Switchgear	1 lot	
	(3) 33 kV Switchgear	1 lot	
	4. Kawaala Substation		
	(1) 132 / 33 kV Transformer	40 MVA×3units	Renovation
	(2) 132 / 11 kV Transformer	20 MVA×1unit	
	(3) 132 kV Gas Insulated Switchgear	1 lot	
	(4) 33 kV Switchgear	1 lot	
	(5) 11 kV Switchgear	1 lot	
	(6) Control building	1 lot	
	5. Bujagali Substation		
	(1) 220 / 132 / 33 kV Transformer	250 MVA×1unit	Upgrade
	(2) 220 kV Switchgear	1 lot	
	(3) 132 kV Switchgear	1 lot	
Transmission	**6. 220 kV Transmission Line**		
	(1) Branch point of Buloba Substation – Buloba Substation	Approx.0.9 km×2cct	New Construction
	(2) Branch point of New Mukono Substation – New Mukono Substation	Approx.5.0 km×2cct	New Construction
	7. 132 kV Transmission Line		
	(1) Buloba branch point-Buloba Substation	Approx.0.8 km×2cct	New Construction
	(2) New Mukono Substation -Mukono Substation	Approx.0.8 km×2cct	New Construction

	Main component	Outline	Contents
	(3) New Mukono Substation -New Mukono branch point (Southern Trunk Line)	Approx.0.5 km×2cct	New Construction
	(4) Mukono branch point (Northern Trunk Line) -Kampala North Substation	Approx.43.5 km×1cct	Re-conductoring
	(5) Kampala North Substation－ Mutundwe Substation	Approx.11.0 km×1cct	Re-conductoring
	(6) Kawaala branch point－Kawaala Substation	Approx.0.1 km×2cct	Cabling
	(7) Kampala North Substation－Lugogo Substation	Approx. 5.7 km ×2cct	Re-conductoring
Procurement	**8. Mobile substation**	1 lot	-



Kampala Metropolitan Area Transmission Network (2030)

The Project
for
Greater Kampala Metropolitan Area Transmission System Improvement Project

Draft final report

Contents

Annex-2

Appendix-5 Technical Memorandum

Technical Memorandum

on

the Preparatory Survey

for

Greater Kampala Metropolitan Area Transmission System Improvement Project

between

Uganda Electricity Transmission Company Limited (UETCL)

and

JICA Preparatory Survey Team

Date: 21 March 2016

Kampala, Uganda

JICA Preparatory Survey Team (hereinafter referred to as "The Team") led by Mr. Kazunari Nogami (Yachiyo Engineering Co. Ltd.) started the preparatory survey for the Greater Kampala Metropolitan Area Transmission System Improvement Project (hereinafter referred to as "the Project") in September, 2015 and conducted the first field survey and second field survey from September to December, 2015.

Although, the Ugandan side understands that no commitment is made from the Japanese side concerning the realization of the Project at the stage of preparatory survey, UETCL and the Team had a series of technical discussion on the basic design of the Project. In addition to the contents of the Interim Report submitted to UETCL on February, 2016, and comments received from UETCL that shall be addressed in the Draft Final Report, UETCL and the Team further agreed to the technical items stated below from the view of the technical adequacy. The both parties also understand that the project components, including the items stated below are subject to change during the period to be examined by JICA.

1. Substation design

(1) Design of the busbar extension at Mutundwe Substation

To improve reliability, UETCL and the Team confirmed necessity to include the modification work of the bus configuration from the single to double in the Project as shown in Attachment-1 and Attachment-2.

(2) Utilization of Gas Insulated Switchgears (GIS) to New Mukono Substation

To secure reliable supply, both parties confirmed to apply Gas Insulated Switchgears to both 220 kV and 132 kV sides at New Mukono Substation as the substations planned in the eastern area such as Namanve South Substation, Luzira Substation and Mukono Substation.

(3) Interconnection configuration in the 132 kV side of New Mukono Substation to Nalubale - Lugogo 132 kV Transmission Line

Based on power flow analysis, it is revealed that the double-pi interconnection shall be applied in the 132 kV side of New Mukono Substation of the Project in consideration of bus failure at Mutundwe Substation, in case that the bus-configuration at Mutundwe Substation kept in the single arrangement as the existing. However, the modification work of the bus configuration from the single to double at Mutundwe Substation is included as the components of the Project as mentioned above. It is revealed by power flow analysis under the condition that open-pi interconnection can be applied in the 132 kV side of New Mukono Substation even in consideration of the bus failure at Mutundwe Substation. Therefore, UETCL and the Team confirmed to apply open-pi interconnection in the 132 kV side of New Mukono Substation.

(4) Location of the access roads to Buloba Substation and New Mukono Substation

To avoid additional land acquisition, UETCL and the Team confirmed that the access road (8 meter-width) to Buloba Substation shall be located within the corridor of 132 kV outgoing lines from the substation, which is reaching the Masaka Road, as Attachment-3.

UETCL and the Team also confirmed that the access road to 220 / 132 kV New Mukono Substation shall be prepared in the Project by improving the existing road branching from Jinja Road up to the substation site.

(5) Technical requirements of mobile substations and Gas Insulated Switchgears (GIS)

To secure quality and reliability, UETCL and the Team confirmed in principle to apply the requirements of mobile substations and Gas Insulated Switchgears of the Project as described in Attachment-4. And also UETCL and the Team confirmed the cost estimation of the Project shall reflect the equipment which shall fulfill the requirement described in this attachment.

(6) Power outage plan

Both parties confirmed that power outage required for the implementation work of each components of the Project shall be minimized by shifting the period not to occur at the same time as much as possible. UETCL agreed to take appropriate countermeasures for unavoidable outage for implementation of the Project with notice in advance to the public by themselves.

2. Transmission design

(1) Installation of the 220 kV lines of the Project within Nadagi Forest Reserve

UETCL has submitted a request letter to NFA for approval to install 30 m-width corridor for 132 kV transmission lines planned under Mukono Industrial Park Substation within Nadagi Forest Reserve and received the respond letter describing that NFA has no objection to the installation work. UETCL explained to the Team that UETCL will take the same procedures for the 220 kV transmission lines to 220 / 132 kV New Mukono Substation of the Project, which is planned within Nadagi Forest Reserve, and make adjustment with NFA so that the 220 kV lines can be installed within the Nadagi Forest Reserve parallel with the 132 kV transmission lines under Mukono Industrial Park Substation.

(2) Arrangement of the corridor share within Nadagi Forest Reserve

To minimize the area for the above mentioned 220 kV incoming transmission lines to New Mukono Substation, the corridor share will be applied between the transmission routs installed within the Nadagi Forest Reserve in the dimensions described in Attachment-5.

(3) 220 kV branch tower at Buloba Substation

UETCL, the Team, and the consultant (Intec Group) and contractor (KEC) of the project for Kawanda – Masaka 220 kV lines held a meeting on coordination for the configuration of the branch point to Buloba Substation of the Project and reached to the following conclusions..

- Intec Group and KEC explained to the Team that the location of the branch towers to Buloba Substation of the Project will be taken into consideration their planning of Kawanda – Masaka 220 kV lines.
- UETCL explained to the Team that, if location of the branch towers modified from where the Team planned in the preparatory survey, the additional RAP Study for the small modification around the branch point will be carried out by UETCL, if necessary.
- The Team shall still include the cost for the branch towers to the Project cost.

(4) Technical requirements for High Temperature Low Sag conductors (HTLS)

UETCL confirmed to apply the requirements for prequalification and technical specifications for HTLS conductors as shown in Attachment-6.

Attachment:

1. General layout of Mutundwe Substation
2. Single line diagram of Mutundwe Substation
3. Access roads route map
4. Technical requirement for Mobile Substation and GIS
5. Arrangement of corridor share within Nadagi Forest Reserve.
6. Technical requirement for HTLS conductors

野上一成

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