

Existing Primary Substation Plans

Region	Name	Financer	Equipment	Year of Completion	Cost (1000US\$)
Accra	Dansoman	GEDAP	2X 20MVA, 33/11kV	2009	2,700
	Adabraka	GOG	2X 20MVA, 33/11kV	2009	2,700
	Nmai Djorn	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Sowutom	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Kwabanya	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Cantonments	GEDAP	2X 20MVA, 33/11kV	2010	2,700
	Trade Fair	GOG	2X 20MVA, 33/11kV	2009	2,700
	Darukuman	-	2X 20MVA, 33/11kV	2011	2,500
	Gbawe/Weiija	-	2X 20MVA, 33/11kV	2011	2,700
	T(Adenta)	GEDAP	Upgrade to 2*20MVA	2011	680
	3rd BSP	GOG	2X 20MVA, 33/11kV	2009	2,500
	Mallam BSP	GOG	Install 2X 20MVA, 33/11kV	2009	680
Tema	Dawhenya	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Santeo Adjei Kojo	-	2X 20MVA, 33/11kV	2011	2,700
	Afienea	-	2X 20MVA, 33/11kV	2011	2,500
	Community 25	-	2X 20MVA, 33/11kV	2011	2,700
	Kpone	-	2X 20MVA, 33/11kV	2011	2,700
Ashanti	2nd BSP	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Fawode	GEDAP	2X 20MVA, 33/11kV	2010	2,500
	Achiase/Kenyase	GEDAP	2X 20MVA, 33/11kV	2010	2,500
Central	Elmina	ECG	2X 10MVA, 33/11kV	2009	1,700
	Swedru	GOG	2X 10MVA, 33/11kV	2009	1,700
	Winneba	GOG	2X 15MVA, 33/11kV	2009	578
Western	Station A	GEDAP	Upgrade to 2*20MVA	2009	680
	Station B	GEDAP	Upgrade to 1*20MVA	2009	340
	Station C	GEDAP	Upgrade to 2*20MVA	2009	680
	Station D	LUTON	2X 10MVA, 33/11kV	2009	1,700
Eastern	Koforidua	-	2X 20MVA, 33/11kV	2010	2,500
Total					57,838

Existing Sub-transmission line Plans

Region	Section	Year of Completion	Line Type	Line Length (km)	Cost (1000US\$)
Accra	B-Dansoman	2009	3*630 Al XLPE	8.6	903
	Mallam-Dansoman	2009	265AAC 2cct	4.3	421
	V(old)-Dansoman	2009	3*630ALXLPE	6	630
	B-Darkuman	2011	3*630ALXLPE	8	840
	A-Darkuman	2011	3*630ALXLPE	14	1,470
	E-Adabraka	2009	3*630ALXLPE	3.8	399
	X-G	2011	3*630ALXLPE	8.5	893
	J-Sowutuom	2010	265AAC 2cct	10	980
	Sowutuom-Mallam	2010	265AAC 2cct	4.5	441
	J-C	2010	265AAC 2cct	5	490
	J-C	2010	3*630ALXLPE	6	630
	J-N	2010	265AAC 2cct	18.8	1,842
	Kwabinya-C	2010	3*630ALXLPE	14	1,470
	Kwabinya-T	2010	265AAC 2cct	14	1,372
	GwabeAJ-Mallam	2011	265AAC 2cct	4	392
	GwabeAJ-Z	2011	265AAC 2cct	10	980
	K-Cantonment	2010	3*630ALXLPE	5	525
	L-Cantonment	2010	3*630ALXLPE	5	525
	L-Trade Fair	2009	3*630ALXLPE	2.1	221
	L-Trade Fair	2009	265AAC 1cct	1	33
	Q-Trade Fair	2009	265AAC 1cct	3.2	106
	T-Dodowa	2009	265AAC 2cct	20	1,960
	Nmai Jorn- 3rd BSP	2010	400AAC 2cct	8	920
	H-M	2009	265AAC 2cct	7.5	735
	M-T	2009	265AAC 2cct	7	686
	Z-Tokuse	2011	265AAC 2cct	8.2	804
	3rd BSP-Y	2009	400AAC 2cct	3	345
Tema	H-Kpone	2011	400AAC 2cct	6	690
	Kpone-Community25	2011	400AAC 2cct	7	805
	Dawhenya-Community25	2011	400AAC 2cct	5	575
	Dawhenya-Afiinya	2011	265AAC 2cct	12	1,176
	Afiinya-Ashaiman	2011	265AAC 2cct	11	1,078
	B(Tema)-3rd BSP(Accra)	2009	400AAC 2cct	13	1,495
	Santeo Adjei Kojo-3rd BSP	2011	400AAC 2cct	8.7	1,001
	Ashiman-Santeo Adjei Kojo	2011	400AAC 2cct	7.3	840
Ashante	Fawode-C	2010	265AAC 2cct	9	882
	Fawode-Achiyase/Kenyase	2010	400AAC 2cct	7	805
	Achiyase/Kenyase-2nd BSP	2010	400AAC 2cct	10	1,150
Western	D-B	2009	3*630ALXLPE	6	630
				Total	32,138

Region	Substation Name	Capacity (MVA)	Maximum Demand (MVA)									
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tema	Asutuare	10	1.1 (11%)	1.1 (11%)	1.2 (12%)	1.3 (13%)	1.3 (13%)	1.4 (14%)	1.5 (15%)	1.6 (16%)	1.7 (17%)	1.8 (18%)
	Juapong	5	1.2 (24%)	1.3 (26%)	1.4 (27%)	1.4 (29%)	1.5 (31%)	1.6 (32%)	1.7 (34%)	1.8 (36%)	1.9 (39%)	2.0 (41%)
	Kpong	10	6.4 (64%)	6.8 (68%)	7.2 (72%)	7.6 (76%)	8.1 (81%)	8.6 (86%)	9.1 (91%)	9.6 (96%)	10.2 (102%)	10.8 (108%)
Ashanti	Obuasi	5	1.9 (37%)	1.9 (38%)	2.0 (39%)	2.0 (40%)	2.1 (41%)	2.1 (42%)	2.2 (44%)	2.2 (45%)	2.3 (46%)	2.4 (47%)
Western	Aboso	10	0.9 (9%)	1.0 (10%)	1.0 (10%)	1.1 (11%)	1.1 (11%)	1.1 (11%)	1.2 (12%)	1.2 (12%)	1.3 (13%)	1.3 (13%)
	Awaso	2.5	1.2 (47%)	1.2 (49%)	1.3 (51%)	1.3 (53%)	1.4 (55%)	1.4 (57%)	1.5 (60%)	1.5 (62%)	1.6 (64%)	1.7 (67%)
	Axim	2.5	2.0 (79%)	2.1 (82%)	2.1 (85%)	2.2 (89%)	2.3 (92%)	2.4 (96%)	2.5 (99%)	2.6 (103%)	2.7 (107%)	2.8 (111%)
	Atuabo	5	7.5 (150%)	7.8 (155%)	8.1 (161%)	8.4 (168%)	8.7 (174%)	9.0 (181%)	9.4 (188%)	9.7 (195%)	10.1 (202%)	10.5 (210%)
	Bibiani	5	2.6 (51%)	2.7 (53%)	2.8 (55%)	2.9 (57%)	3.0 (60%)	3.1 (62%)	3.2 (64%)	3.3 (67%)	3.5 (69%)	3.6 (72%)
	Bonsa	5	1.7 (34%)	1.7 (35%)	1.8 (36%)	1.9 (38%)	2.0 (39%)	2.0 (41%)	2.1 (42%)	2.2 (44%)	2.3 (45%)	2.4 (47%)
	Dwenasi	5	3.0 (61%)	3.1 (63%)	3.3 (65%)	3.4 (68%)	3.5 (70%)	3.7 (73%)	3.8 (76%)	3.9 (79%)	4.1 (82%)	4.3 (85%)
Eastern	Akwatia	10	3.3 (33%)	3.5 (35%)	3.7 (37%)	3.9 (39%)	4.1 (41%)	4.3 (43%)	4.6 (46%)	4.8 (48%)	5.1 (51%)	5.4 (54%)
	Koforidua	20	11.4 (57%)	11.7 (59%)	12.0 (60%)	12.3 (62%)	12.7 (63%)	13.0 (65%)	13.3 (67%)	13.7 (68%)	14.0 (70%)	14.4 (72%)
	Nkawkaw	10	5.7 (57%)	5.8 (58%)	6.0 (60%)	6.2 (62%)	6.3 (63%)	6.5 (65%)	6.7 (67%)	6.9 (69%)	7.0 (70%)	7.2 (72%)
	Oda	10	7.8 (78%)	8.4 (84%)	9.1 (91%)	9.9 (99%)	10.7 (107%)	11.6 (116%)	12.6 (126%)	13.6 (136%)	14.8 (148%)	16.0 (160%)
Central	Benso	5	1.4 (27%)	1.4 (28%)	1.4 (29%)	1.5 (30%)	1.5 (31%)	1.6 (32%)	1.6 (33%)	1.7 (34%)	1.7 (35%)	1.8 (36%)
	Cape Coast	10	8.6 (86%)	9.1 (91%)	9.7 (97%)	10.3 (103%)	10.9 (109%)	11.6 (116%)	12.2 (122%)	13.0 (130%)	13.8 (138%)	14.7 (147%)
	Saltpond	5	5.5 (110%)	5.8 (117%)	6.2 (123%)	6.5 (130%)	6.9 (138%)	7.3 (146%)	7.7 (154%)	8.2 (163%)	8.6 (173%)	9.1 (183%)
Volta	Aflao	10	3.3 (33%)	3.4 (34%)	3.6 (36%)	3.8 (38%)	4.0 (40%)	4.2 (42%)	4.4 (44%)	4.6 (46%)	4.8 (48%)	5.1 (51%)
	Anloga	2.5	0.5 (19%)	0.5 (20%)	0.5 (21%)	0.6 (22%)	0.6 (23%)	0.6 (25%)	0.6 (26%)	0.7 (27%)	0.7 (29%)	0.7 (30%)
	Hohoe	2.5	2.1 (84%)	2.2 (88%)	2.3 (93%)	2.4 (98%)	2.6 (102%)	2.7 (108%)	2.8 (113%)	3.0 (119%)	3.1 (125%)	3.3 (131%)
	Kpandu	5.0	2.7 (55%)	2.9 (58%)	3.0 (60%)	3.2 (64%)	3.3 (67%)	3.5 (70%)	3.7 (74%)	3.9 (78%)	4.1 (81%)	4.3 (86%)
	Kpeve	2.5	2.9 (114%)	3.0 (120%)	3.2 (126%)	3.3 (132%)	3.5 (139%)	3.6 (146%)	3.8 (153%)	4.0 (161%)	4.2 (169%)	4.4 (178%)
	Tsito	2.5	1.8 (72%)	1.9 (76%)	2.0 (80%)	2.1 (84%)	2.2 (88%)	2.3 (93%)	2.4 (97%)	2.6 (102%)	2.7 (107%)	2.8 (113%)

Analysis Result of primary substation	Substation Name	Capacity (MVA)	Maximum Demand (MVA)									
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
VRA-NED	Berekum	5	4.9 (97%)	5.0 (101%)	5.2 (104%)	5.4 (108%)	5.6 (112%)	5.8 (117%)	6.1 (121%)	6.3 (126%)	6.5 (131%)	6.8 (136%)
	Wa	5	4.3 (86%)	4.5 (90%)	4.7 (94%)	4.9 (98%)	5.1 (103%)	5.4 (107%)	5.6 (112%)	5.9 (117%)	6.1 (122%)	6.4 (128%)
	Navrongo	3	1.7 (56%)	1.8 (61%)	2.0 (65%)	2.1 (71%)	2.3 (76%)	2.5 (82%)	2.7 (89%)	2.9 (96%)	3.1 (103%)	3.3 (111%)
	Bawku	3	2.9 (98%)	3.2 (105%)	3.4 (112%)	3.6 (120%)	3.9 (128%)	4.1 (137%)	4.4 (147%)	4.7 (157%)	5.0 (168%)	5.4 (179%)
	Wenchi	3	1.1 (37%)	1.1 (38%)	1.2 (40%)	1.2 (41%)	1.3 (43%)	1.3 (45%)	1.4 (47%)	1.5 (48%)	1.5 (50%)	1.6 (52%)

Distribution reinforcement plans

Table 1 Results of reinforcement planning (ECG Accra East Office) (1/3)

(Legend)

① : New 33kV/11kV substation construction (including ancillary facilities such as 33kV distribution lines) ② : Installation of new distribution line ③ : Enlargement of lines (Overhead line) ④ : Enlargement of lines (Cable) ⑤ : Voltage increase ⑥ : Installation of Capacitor Bank and Condensor, or Booster ⑦ : Alleviation of load by construction of a switching station
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Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main F	F03(FD38), F15(FK02), F11(FD19), F04(FD48)	① Partial transfer of load after construction of the Adabraka substation	2009	GEDAP	
Main G	G013(G56), G07(G06), G11(G13), G19(G60), G12(G47), G02(G33), G06(G64), G04(G351), G21(G25)	① Partial shift of load after construction of the Adabraka substation	2009	GEDAP	
Main H	H02(H351)	④ Cable replacement (120 mm ² Al -> 185 mm ² Al, 15 km) and partial shift of load to the M01 feeder	2008	572	3,800
	H05(H06)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 13km)	2017	900	
	H10(H10)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 14km)	2017	969	
	H04(H07)	② * Installation of a new distribution line from the Main H substation, and partial shift of load (120mm ² AAC, 15km)	2011	320	
	H08(H24)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 15km)	2013	1,039	

Table 1 Results of reinforcement planning (ECG Accra East Office) (2/3)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main K	K03(K09)	① Installation of a new distribution line from the Trade Fair substation (to be constructed in 2009), and partial shift of load (120mm ² AAC, 8km)	2009	171	3,532
	K04(K10)	① Installation of a new distribution line from the Trade Fair substation, and partial shift of load (120mm ² AAC, 8km)	2009	171	
	K05(K150)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 18km)	2008	1,246	
	K13(K13)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 17km)	2014	1,177	
	K06(K60)	② Installation of a new distribution line from the Airport substation (already constructed), and partial shift of load (120mm ² AAC, 9km)	2011	192	
	K10(K61)	② Same as above (120mm ² AAC, 7km)	2017	149	
	K11(K06)	② Same as above (120mm ² AAC, 9km)	2009	192	
	K12(K07)	② Same as above (120mm ² AAC, 11km)	2011	235	
Main L	L11(L01)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 17km)	2017	1,177	2,456
	L10(L22)	① Installation of a new distribution line from the Trade Fair substation, and partial shift of load (120mm ² AAC, 6km)	2017	128	
	L06(L12)	④ Cable replacement (185mm ² Al → 240mm ² Cu, 12km)	2017	831	
	L04(L03)	① Installation of a new distribution line from the Trade Fair substation, and partial shift of load (120mm ² AAC, 6km)	2015	128	

	L03(L02)	①	Same as above (120mm ² AAC, 9km)	2010	192	
Main M	M05 (Old Legon 2)	①	Partial shift of load after construction of the Nmai Djorn substation	2010	GEDAP	1,172
	M01 (Old Legon 1)	④	Cable replacement (185mm ² Al → 240mm ² Cu, 16km)	2011	1,108	
	M07 (Madina)	①	Partial shift of load after construction of the Nmai Djorn substation	2010	GEDAP	
	M08 (Kwabenya)	①	Installation of a new distribution line from the Kwabenya substation (to be constructed in 2010 under the GEDAP), and partial shift of load (120mm ² AAC, 3km)	2010	GEDAP New distribution line installation cost: 64	

Table 1 Results of reinforcement planning (ECG Accra East Office) (3/3)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main Q	Q03 (Teshie 1)	② Installation of a new distribution line from the Main Q substation, and partial shift of load (120mm ² AAC, 5km)	2009	107	405
	Q06 (Teshie 3)	② Same as above (120mm ² AAC, 5km)	2015	107	
	Q01 (Old Spintex)	② Same as above (120mm ² AAC, 4km)	2008	85	
	Q07 (Teshie 2)	② Same as above (120mm ² AAC, 5km)	2014	107	
Main T	T03 (Adenta Est.1)	① Partial shift of load after construction of the Nmai Djorn substation	2010	GEDAP	363
	T09 (Agbogba)	① Installation of a new distribution line from the Kwabenya substation (to be constructed in 2010 under the GEDAP), and partial shift of load (120mm ² AAC, 7km)	2010	GEDAP New distribution line installation cost: 149	
	T11 (Pantang)	① Same as above (120mm ² AAC, 10km)	2010	213	
Main W	Peduse	⑥ Installation of a capacitor bank (tentatively 4,000 kVar) to improve voltage	2008	6	12
	"W03 (Akropong)"	⑥ Installation of a capacitor bank (tentatively 4,000 kVar) to improve voltage	2008	6	
Main Y	"Y04 (Johnson Wax)"	① Installation of a new distribution line from the Nami Djorn substation (to be constructed in 2010 under the GEDAP), and partial shift of load (120mm ² AAC, 5km)	2010	GEDAP New distribution line installation cost: 107	576
	"Y10 (Texpo)", "Y11 (Spintex)"	② Installation of a new distribution line from the Main Y substation, and partial shift of load (120mm ² AAC, 12km)	2008	256	
	"Y02 (Old Spintex)"	② Installation of a new distribution line from the Airport substation (already constructed), and partial shift of load (120mm ² AAC, 10km)	2013	213	

Table 2 Results of reinforcement planning (ECG Accra West Office) (1/2)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main A (Odorkor)	A120, A13, A01, A61	① Partial shift of load after construction of the Darkman substation (2011) and the Sowutuom substation (2010)	2011 2010	GEDAP	
Main B (Korie Bu)	B25, B27, B35, B15, B42, B24, B28, B19, B20	① Partial shift of load after construction of the New Dansoman substation	2009	GEDAP	
Main C (Achimota Village)	ABC	③ Aerial line replacement (35mm ² Cu → 120mm ² AAC, 20km)	2008	103	103
	C20, C60, C14, C13	① * Partial shift of load after construction of the Sowutuom substation	2010	GEDAP	
Main D (Avenor)	D150	④ Cable replacement (185mm ² Al → 240mm ² Cu, 2.2km)	2011	152	3,978
	D123	④ Cable replacement (185mm ² Al → 240mm ² Cu, 4.4km)	2010	305	
	D16	④ Cable replacement (185mm ² Al → 6x630mm ² Cu, 3.2km)	2008	2,032	
	D101	④ Cable replacement (185mm ² Al → 240mm ² Cu, 4.2km)	2008	291	
	D103	④ Cable replacement (185mm ² Al → 240mm ² Cu, 5.3km)	2008	367	
	D01	④ Cable replacement (185mm ² Al → 240mm ² Cu, 5.4km)	2011	374	
	D114	④ Cable replacement (185mm ² Al → 240mm ² Cu, 6.6km)	2008	457	

Main E (Tran-shipment)	E08, E07, EG14, E20, E150	①	Partial shift of load after construction of the Adabraka substation	2009	GEDAP
Main F (Koko-miemie)	F11, F10	①	Partial shift of load after construction of the Adabraka substation	2009	GEDAP

Table 2 Results of reinforcement planning (ECG Accra West Office) (2/2)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main G (Power House)	G25	② Installation of a new distribution line from the Main G substation, and partial shift of load (185mm ² Al cable, 10km)	2008	329	1,087
	G56	② Same as above (185mm ² Al cable, 10km)	2014	329	
	GE19	④ Cable replacement (185mm ² Al → 258mm ² Cu, 6.2km)	2014	429	
Main N (Nsawam)	Nsawam - Accra	① Partial shift of load after construction of the Ofankor substation	2008	Posting as new substation construction cost	320
	Adoagyiri -Coaltar	② Partial shift of load to a new feeder from Asamankese feeders	2008	320	
Main R (Ridge)	R12	④ Cable replacement (185mm ² Al → 240mm ² Cu, 4.9km)	2011	339	983
	R11	④ Cable replacement (185mm ² Al → 240mm ² Cu, 2.1km)	2010	145	
	R3	④ Cable replacement (185mm ² Al → 240mm ² Cu, 7.2km)	2017	499	
Main S (Kuwa-shieman)	S10	① Partial shift of load after construction of the Sowutuomr substation	2010	GEDAP	
Main V (Dansoman)	V02, V10, V11	① Partial shift of load after construction of the New Dansoman substation	2009	GEDAP	
Main Z (Tokuse)	RADIO	② Installation of a new distribution line from the Main Z substation, and partial shift of load (120mm ² AAC, 15km)	2008	320	640
	TUBA	② Installation of a new distribution line from the Main Z substation, and partial shift of load (120mm ² AAC, 15km)	2008	320	

Table 3 Results of reinforcement planning (ECG Tema Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Tema A	A31	④ Cable replacement (120mm ² Cu → 240mm ² Cu, 3km)	2009	213	213
Tema B	B111	① Installation of a new distribution line from the Adjei Kojo substation (to be constructed in 2010 under the GEDAP), and partial shift of load (120mm ² AAC, 3km)	2010	GEDAP Distribution line installation cost: 64	64
Tema C	LUBE OIL	④ Cable replacement (120mm ² Cu → 240mm ² Cu, 1.75km)	2012	124	369
	F/H#2	② Installation of a new distribution line toward PFC Tank and partial shift of load (240mm ² Cu ケーブル, 0.5km)	2010	32	
	AGRONA	④ Cable replacement (120mm ² Cu → 240mm ² Cu, 3km)	2010	213	
Tema E	E21	④ Cable replacement (120mm ² Cu → 240mm ² Cu, 1km)	2009	71	71
Tema H	Prampram	① Installation of a new distribution line from the Dawhenya substation (to be constructed in 2010 under the GEDAP), and partial shift of load (120mm ² AAC, 15km)	2010	GEDAP Distribution line installation cost: 320	1.089
	Western Castling	④ Cable replacement (185mm ² Al → 240mm ² Cu, 2km)	2011	139	
	H-B1	② Connection of the cable on the trunk portion of the existing H-B2 line to H-B1, for two lines on the trunk portion of H-B1, plus installation of a new cable (630 mm ² Al XLPE, 6 km) for H-B2	2010	630	
	H-B2				

Tema L (Lashibi)	Comm.20 (L91)	⑥	Installation of a capacitor bank (tentatively 300 kVar) to improve voltage	2013	1	1
Tema S (Ashiaman)	S31 (AFARIWA)	①	Partial shift of load after construction of the Mobole substation now under planning	2010	Construction of a new substation	
KPONG	Krobo Area	②	Installation of a new distribution line from the substation and partial shift of load (120mm ² AAC, 16km)	2013	341	341
Asutsuare	Asutsuare	③	Aerial line replacement (35mm ² Cu → 120mm ² AAC, 16km)	2008	358	358

Table 4 Results of reinforcement planning (ECG Ashanti East Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main C	NSUTA -KUWAWU	① Partial shift of load after construction of the Fawode and Achiase substations (both in 2010)	2010	GEDAP	213
	C21	② Installation of a new distribution line from the Main F substation and partial shift of load (completed)	2007	Already implemented	
	C41	② Partial shift of load to the KTI substation (120mm ² AAC, 10km)	2008	213	
	Airport 1	① Partial shift of load after construction of the Achiase substation (2010)	2010	GEDAP	
	Airport 2	① Partial shift of load after construction of the Fawode substation (2010), and partial shift of load to the distribution line from Main E	2010	GEDAP	
Main E	E21	① Partial shift of load after construction of the Fawode substation (2010), and partial shift of load to the distribution line from Main C	2010	GEDAP new distribution line installation cost: 213	
NSUTA	Mampong	③ Aerial line replacement (16mm ² Cu → 120mm ² AAC, 10.9km)	2008	67	67
AGONA	NSUTA	① Partial shift of load after construction of the Achiase substation (2010)	2010	GEDAP	
KONONGO	KONONGO	⑥ Installation of a capacitor bank (tentatively 4000 kVar) to improve voltage	2009	6	18
	AGOGO	⑥ Installation of a capacitor bank (tentatively 4000 kVar) to improve voltage	2010	6	
	ODUMASI	⑥ Installation of a capacitor bank (tentatively 4000 kVar) to improve voltage	2017	6	
EJISU	EJISU	⑥ Installation of a capacitor bank (tentatively 4000 kVar) to improve voltage	2009	6	6

Table 5 Results of reinforcement planning (ECG Ashanti West Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation units
Main A	OBR	② Partial shift of load to the Guinness 1 feeder completed; installation of four new distribution lines from the Amanform substation (already constructed) and partial shift of load (installation work already started; lengths of 0.1 km (three) and 1 km (one))	2007 2008	(Already implemented) distribution line installation cost: 28	129
	IND OHL	④ Cable replacement (35mm ² Cu → 185mm ² Al, 2.7km)	2008	92	
	LAKE ROAD	① Installation of a new distribution line from the KTI (Japckson Park) substation now under construction and partial shift of load, plus installation of three new distribution lines (each with 185 mm ² Al cable and a length of 0.1 km)	2008	10	
	POWER HOUSE 2				
Main B	B11	② Installation of a new distribution line from the Main E substation and partial shift of load (120mm ² AAC, 5km)	2009	107	533
	B21	② Installation of a new distribution line from the Main E substation and partial shift of load (120mm ² AAC, 5km)	2009	107	
	B61	② Installation of a new distribution line from the Abuakawa substation and partial shift of load (120mm ² AAC, 5km)	2008	107	
	B71	② Installation of a new distribution line from the Abuakawa substation and partial shift of load (120mm ² AAC, 5km)	2009	107	
	B81	② Installation of a new distribution line from the Abuakawa substation and partial shift of load (120mm ² AAC, 5km)	2009	107	
Main D	D21	① Plan for a partial shift of load to the Knust substation already constructed	2008	Substation already constructed	

	D31	①	Plan for a partial shift of load to the Knust substation already constructed	2008	Substation already constructed	
BEKWAI	KOKOFU	③	Aerial line replacement (16mm ² Cu → 120mm ² AAC, 1.9km)	2008	12	12
Dunkwa	DUNKWA	③	Aerial line and cable replacement (35mm ² Cu → 120mm ² AAC, 8.7km) (16mm ² Cu → 120mm ² AAC, 1.5km) (35mm ² Cu cable → 185mm ² Al XLPE, 2.7km)	2008	162	162

Table 6 Results of reinforcement planning (ECG Western Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation unit
Western A	A10	④ Cable replacement (120mm ² Cu PILC →185mm ² Cu PILC, 1.5km)	2017	74	637
	A31	④ Cable replacement (120mm ² Cu PILC →240mm ² Cu PILC, 4.3km) Partial shift of load from the existing distribution line A41 to A57	2008	304	
	A55	③ Aerial line replacement (150mm ² Al → 265mm ² Al, 7.6km)	2010	259	
Western B	B21	④ Cable replacement (185mm ² Cu PILC →240mm ² Cu PILC, 2.9km)	2012	205	453
	B71	④ Cable replacement (120mm ² Cu PILC →240mm ² Cu PILC, 3.5km)	2008	248	
Western C	C08	⑤ Voltage increase from 11 to 33 kV	2010	719	719
Bogoso	"Bogoso / Asanko"	⑦ Construction of a switching station and division of the existing distribution lines	2010	400	400
Atuabo	Aboso 1	③ Aerial line replacement (150mm ² AAC →240mm ² AAC, 38km)	2012	775	1,976
	Aboso 2	③ Aerial line replacement (150mm ² AAC →240mm ² AAC, 38.7km)	2012	789	
	Town 2	③ Aerial line replacement (70mm ² Cu→240mm ² AAC, 12km)	2013	100	
	Manganese	① Voltage increase from 11 to 33 kV and construction of a new 33/11-kV substation (5 MVA)	2008	312	
Asawinso	Awaso /Wiawso	③ Aerial line replacement (150mm ² AAC →200mm ² AAC, 15km)	2017	123	725
	Bibiani	③ Aerial line replacement (150mm ² AAC →400mm ² AAC, 29.5km)	2012	602	
Dwenase	Juaboso	③ Aerial line replacement (120mm ² AAC →240mm ² AAC, about 60km, Need for replacement of supporting structures as well)	2012	1,942	1,942

Table 7 Results of reinforcement planning (ECG Eastern Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation unit
Tafo	Kibi / Suhum	⑤ Voltage increase from 11 to 33 kV	2008	1,270	3,518
	Tafo	① Installation of a new 33-kV distribution line (240 mm ² AAC, 24 km) from the Tafo BSP, construction of a new 33/11-kV substation (10 MVA) ahead of it, and connection to the existing Tafo distribution line along the way	2008	1,743	
	Koforidua	② Installation of a new 33-kV distribution line (240 mm ² AAC, 17 km) from the Tafo BSP, and connection to the existing Tafo Koforidua distribution line	2008	505	
Akwatia	Akwatia	⑤ Voltage increase from 11 to 33 kV	2008	616	2,932
	Asamankese	① Installation of a new 33-kV distribution line (240 mm ² AAC, 25 km) from the Akwatia BSP, construction of a new 33/11-kV substation (5 MVA) ahead of it, and connection to the existing Asamkese distribution line along the way	2008	1,425	
	Oda	② Installation of a new 33-kV distribution line (240 mm ² AAC, 30 km) from the Akwatia BSP, and connection to the existing Oda distribution line	2008	891	
Nsawam	Adoagyiri	② Installation of a tie (11 kV, 120 mm ² AAC, 15 km) to the Adoagyiri distribution line from the existing Asamkese distribution line, and change of the load power flow	2008	320	320
Oda	Achiase	③ Aerial line replacement (35mm ² Cu →120mm ² AAC, 56km) (50mm ² AAC→120mm ² AAC, 4km)	2008	374	374
Nkawkaw	Mountains	① Aerial line replacement (16mm ² Cu→120mm ² AAC, 32km) Construction of a 33/11-kV substation (5 MVA) along the way, and partial shift of load on the existing Mountains distribution line to the Donkorkrom distribution line	2010	898	1,087
	Town	④ Cable replacement (95mm ² Al XLPE, 185mm ² Al XLPE →240mm ² Cu XLPE, 3km)	2008	189	

Table 8 Results of reinforcement planning (ECG Central Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)		
				Distributi on line units	Substati on unit	
WINNEBA	WINNEBA	②	Installation of a new distribution line (120 mm ² AAC, 4 km) and partial shift of load, or partial shift of load to the APAM distribution line	2010	85	86
	SWEDRU 1	①	Partial shift of load after construction of the Swedru substation	2009	GEDAP	
	SWEDRU 2	①	Partial shift of load after construction of the Swedru substation	2009	GEDAP	
	APAM	⑥	Installation of a condensor to increase voltage	2008	1	
SALTPOND	MANKESSIM	⑥	Installation of a condensor to increase voltage	2008	1	1
Cape Coast	SALTPOND	①	Partial shift of load after construction of the Elmina substation, and installation of a condensor to increase voltage	2009	GEDAP 1	2
	FOSU	①	Partial shift of load after construction of the Elmina substation, and installation of a condensor to increase voltage	2009	GEDAP 1	
	ELMINA	①	Partial shift of load after construction of the Elmina substation	2009	GEDAP	
	TOWN 2	①	Partial shift of load after construction of the Elmina substation	2009	GEDAP	

Table 9 Results of reinforcement planning (ECG Volta Office)

Substations (existing)	Distribution lines (existing)	Type of countermeasure		Year	Cost (USD1,000)	
					Distribution line units	Substation unit
KPANDO	HOHOE	⑥	Installation of a 33-kV booster station to increase voltage	2008	100	1,124
	"HOHOE-JASIKAN"	②	Installation of a new 11-kV distribution line (120mm ² AAC, 48km)	2009	1,024	
KPEVE	TOWNSHIP	②	Installation of a tie between the Tsibu Bethel and Agbate distribution lines to take in the existing Township load (120mm ² AAC, 5km)	2009	96	96
HO	TANYIGBE	②	Installation of a new 11-kV distribution line and division of the existing Tanyigbe load (120mm ² AAC, 4km)	2016	75	75
SOGAKOPE	"SOGA-AKATSI"	②	Installation of a new 33-kV distribution line and division of the Keta distribution line from Akatsi and Sogakope (120mm ² AAC, 12.5km)	2008	267	267
TSITO	PEKI	①	Construction of new 33/11-kV substations (10 MVA) at the center of the load distribution, installation of a new 33-kV distribution line (120 mm ² AAC, 2 km), and connection for division of the load	2010	343	343
Anloga	Keta	③	Replacement of aerial lines (16mm ² Cu → 120mm ² AAC, 3.5km) (35mm ² Cu → 120mm ² AAC, 14.4km) (70mm ² Cu → 120mm ² AAC, 2.4km)	2008	700	700

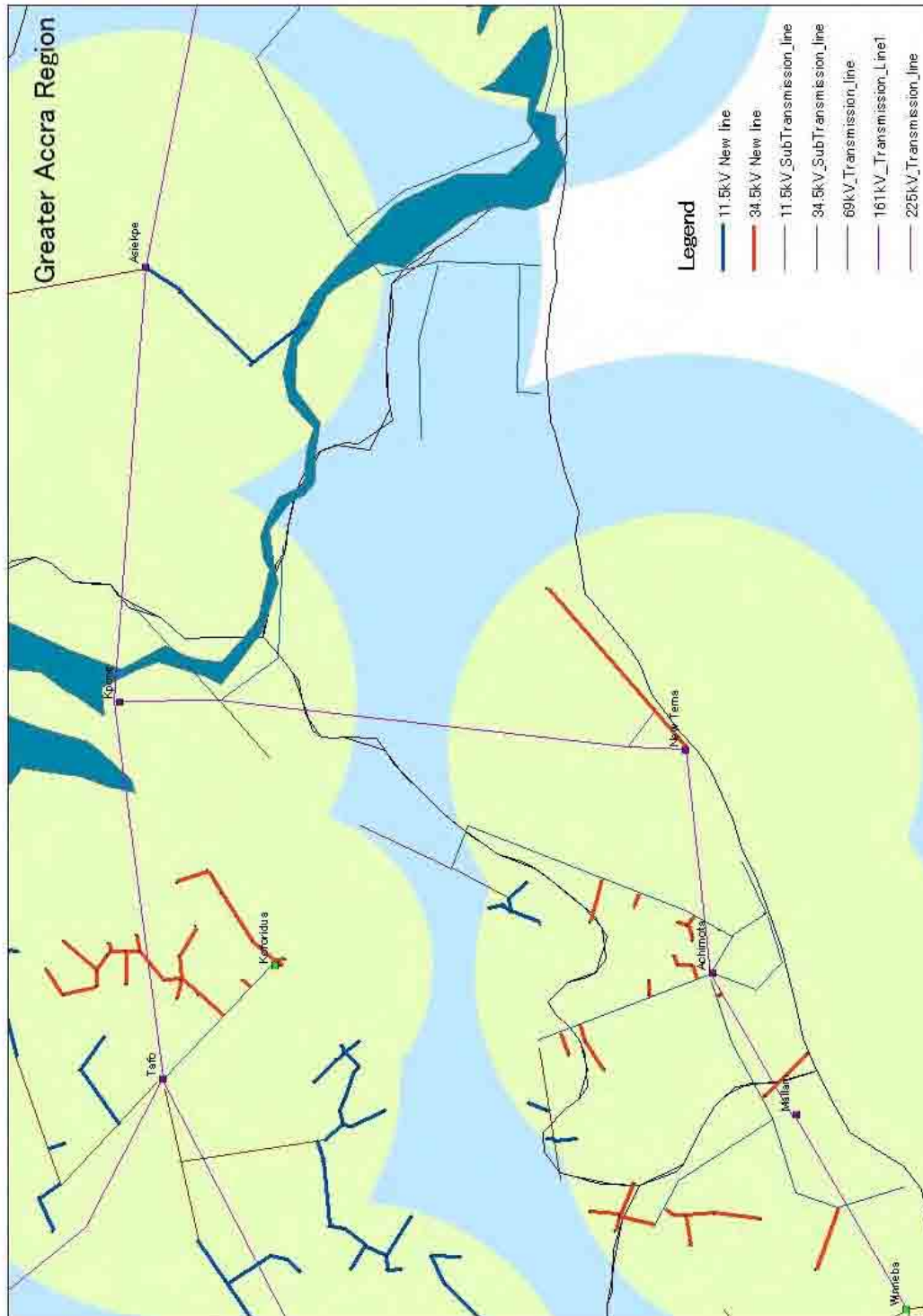
Table 10 Results of reinforcement planning (VRA-NED Area) (1/2)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation unit
Tamale	28F3B	① Installation of new 34.5-kV line (185 mm ² ALXLPE, 18 km) from the Tamale BSP, construction of a 34.5/11.5-kV substation (5 MVA) ahead of this line (near Tolon), and connection to the existing 28F3B distribution line along the way	2008	1,292	1,907
	28F4B	② Installation of a 11.5kV new line (185mm ² ALXLPE, 4km)	2009	131	
	28F6B	② Installation of a 11.5kV new line (185mm ² ALXLPE, 4km)	2008	131	
	28F7B	③ Aerial line replacement (100mm ² AAC → 240mm ² AAC, 8km)	2013	66	
	28F8B	③ Aerial line replacement (100mm ² AAC → 240mm ² AAC, 19km)	2009	156	
	28F9B	② Installation of a 11.5kV new line (185mm ² ALXLPE, 4km)	2010	131	
Brekum	Sunyani - Drobo (BRYF1)	③ Aerial line replacement (120mm ² AAC → 150mm ² AAC, 40km)	2009	279	1,141
	"Brekum - Dormaa (BRYF2)"	③ Aerial line replacement (120mm ² AAC → 150mm ² AAC, 31km)	2009	216	
	Brekum F1 (BRBF1)	⑤ Voltage increase from 11 to 34.5 kV, and aerial line replacement (35mm ² Cu, 50mm ² AAC → 200mm ² AAC, 23km)	2008	555	
	Brekum F2 (BRBF2)	③ Aerial line replacement (50mm ² AAC → 100mm ² AAC, 6km)	2008	42	
	Brekum F3 (BRBF3)	③ Aerial line replacement (16mm ² Cu, 50mm ² AAC → 100mm ² AAC, 8km)	2008	49	
Sunyani	Sunyani F3 (27F3B)	② Installation of a 11.5kV new line (120mm ² AAC, 13km)	2008	327	1,421
	Sunyani F7 (27F7B)	③ Aerial line replacement (35mm ² AAC → 100mm ² AAC, 7km)	2008	43	
	Sunyani F8 (27F8B)	① Installation of new 34.5-kV line (120 mm ² AAC, 14 km) from the Sunyani BSP, construction of a 34.5/11.5-kV substation (5 MVA) ahead of this line (near Chiraa), and connection to the existing 27F8B distribution line along the way	2008	1,045	

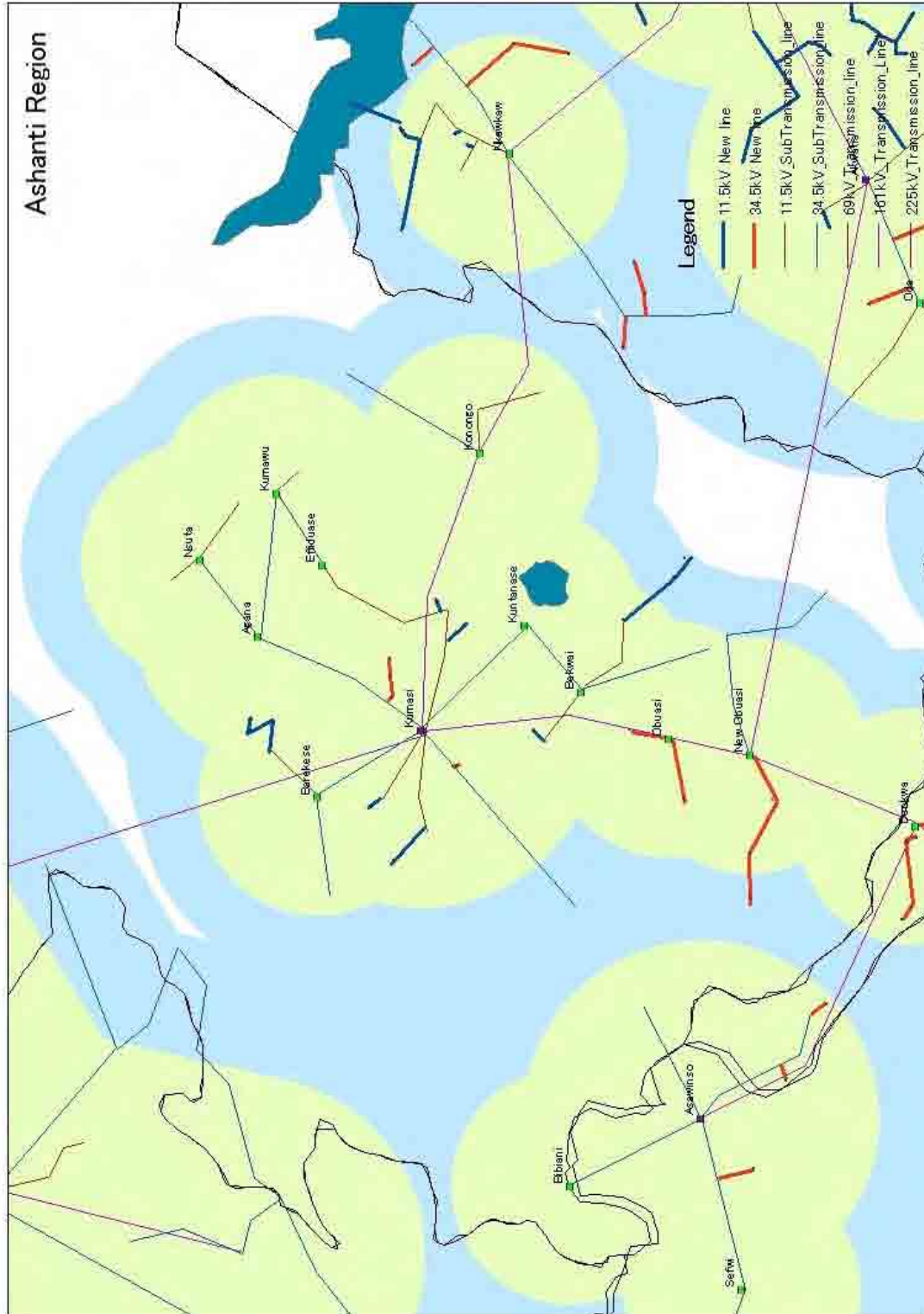
Table 10 Results of reinforcement planning (VRA-NED Area) (2/2)

Substations (existing)	Distribution lines (existing)	Type of countermeasure	Year	Cost (USD1,000)	
				Distribution line units	Substation unit
Sawla	Sawla-Wa (38YF6)	⑥ Installation of a capacitor bank (2,000 kVar) in the Mim switching station to improve voltage	2011	3	155
	Wa-Hamile (WAFY1)				
	Wa Township 1 (479BF1)	③ Replacement of the feeder cable in the starting section with 185 mm ² Al XLPE, and aerial line replacement (50mm ² AAC → 100mm ² AAC, 6km)	2009	37	
	Wa Township 2 (479BF2)	③ Aerial line replacement (100mm ² AAC, 120mm ² AAC → 150mm ² AAC, 12km)	2010	84	
	Wa Township 3 (479BF3)	③ Replacement of the feeder cable in the starting section with 185 mm ² Al XLPE, and aerial line replacement (50mm ² AAC → 100mm ² AAC, 5km)	2008	31	
Yendi	Bimbilla (35F5Y)	⑥ Installation of a 10-MVA booster station to improve voltage	2008	100	100
Bolgatanga	29F1B (BOLGA)	③ Replacement of the feeder cable in the starting section with 185 mm ² Al XLPE, and aerial line replacement (50mm ² AAC, 120mm ² AAC → 150mm ² AAC, 5km)	2010	168	1,486
	29F4B (BOLGA)	⑤ Voltage increase from 11 to 34.5 kV, and aerial line replacement (50mm ² AAC → 100mm ² AAC, 20km)	2008	649	
	29F6B (BOLGA)	⑤ Voltage increase from 11 to 34.5 kV, and aerial line replacement (50mm ² AAC → 100mm ² AAC, 8km)	2008	669	
Techiman	26F1B (TECHIMAN)	③ Replacement of the feeder cable in the starting section with 185 mm ² Al XLPE, and aerial line replacement (50mm ² AAC → 150mm ² AAC, 17km)	2008	125	319
	26F2B (TECHIMAN)	③ Aerial line replacement (50mm ² AAC → 120mm ² AAC, 8km)	2009	55	
	WHF2B (WENCHI)	③ Aerial line replacement (25mm ² AAC → 100mm ² AAC, 20km)	2008	139	

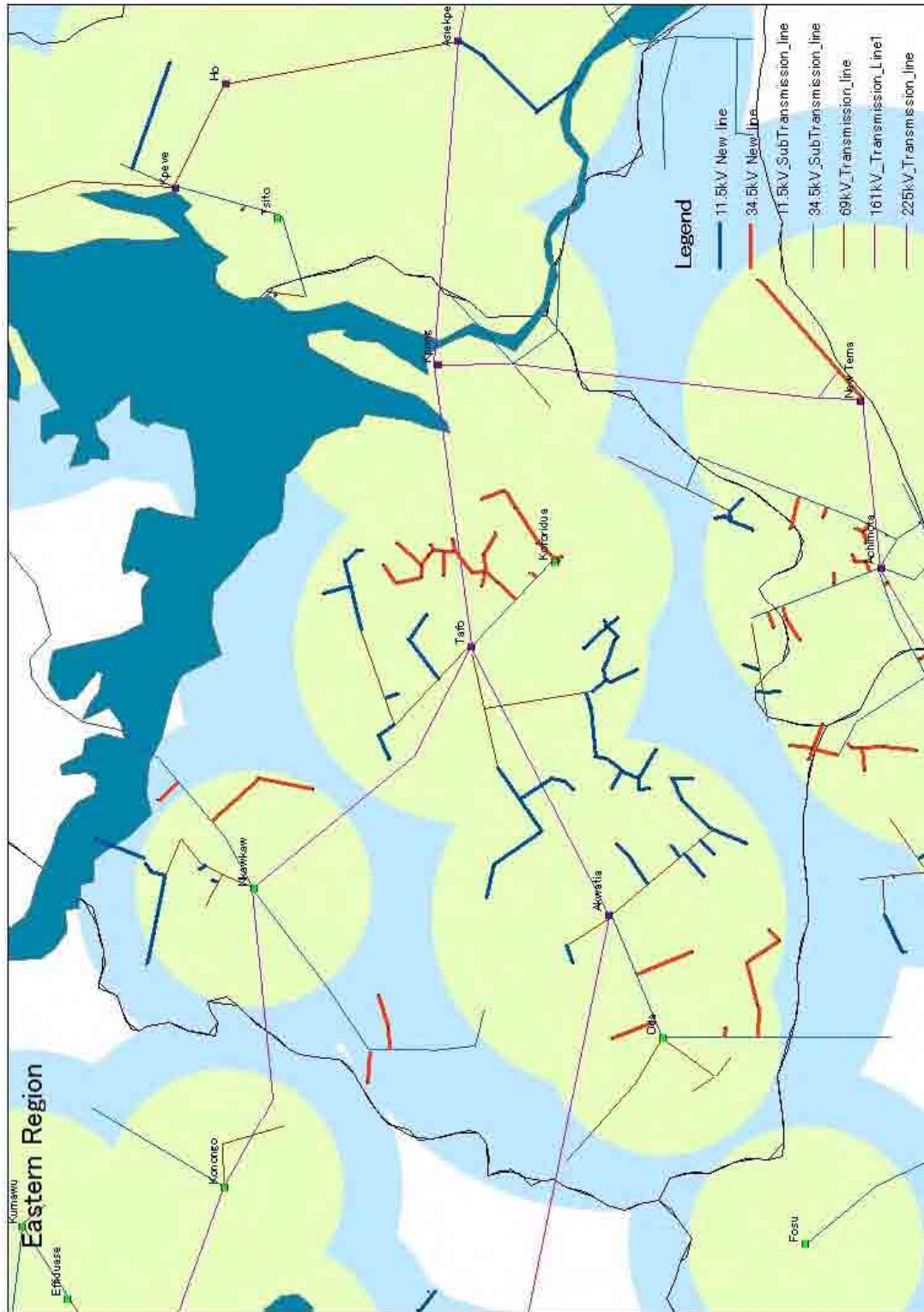
Extension Plan (Rural Electrification)
Great Accra Region



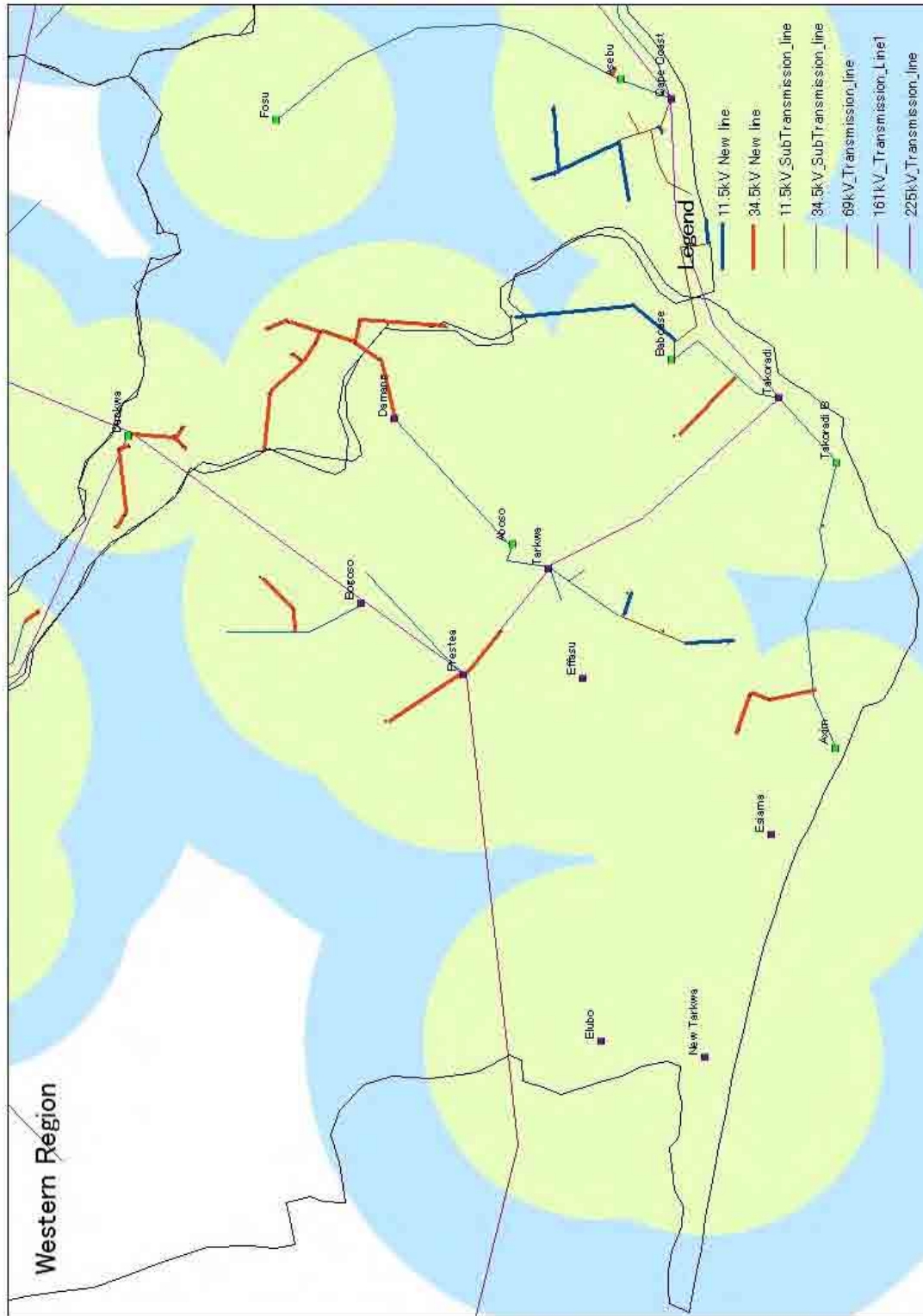
Ashanti Region



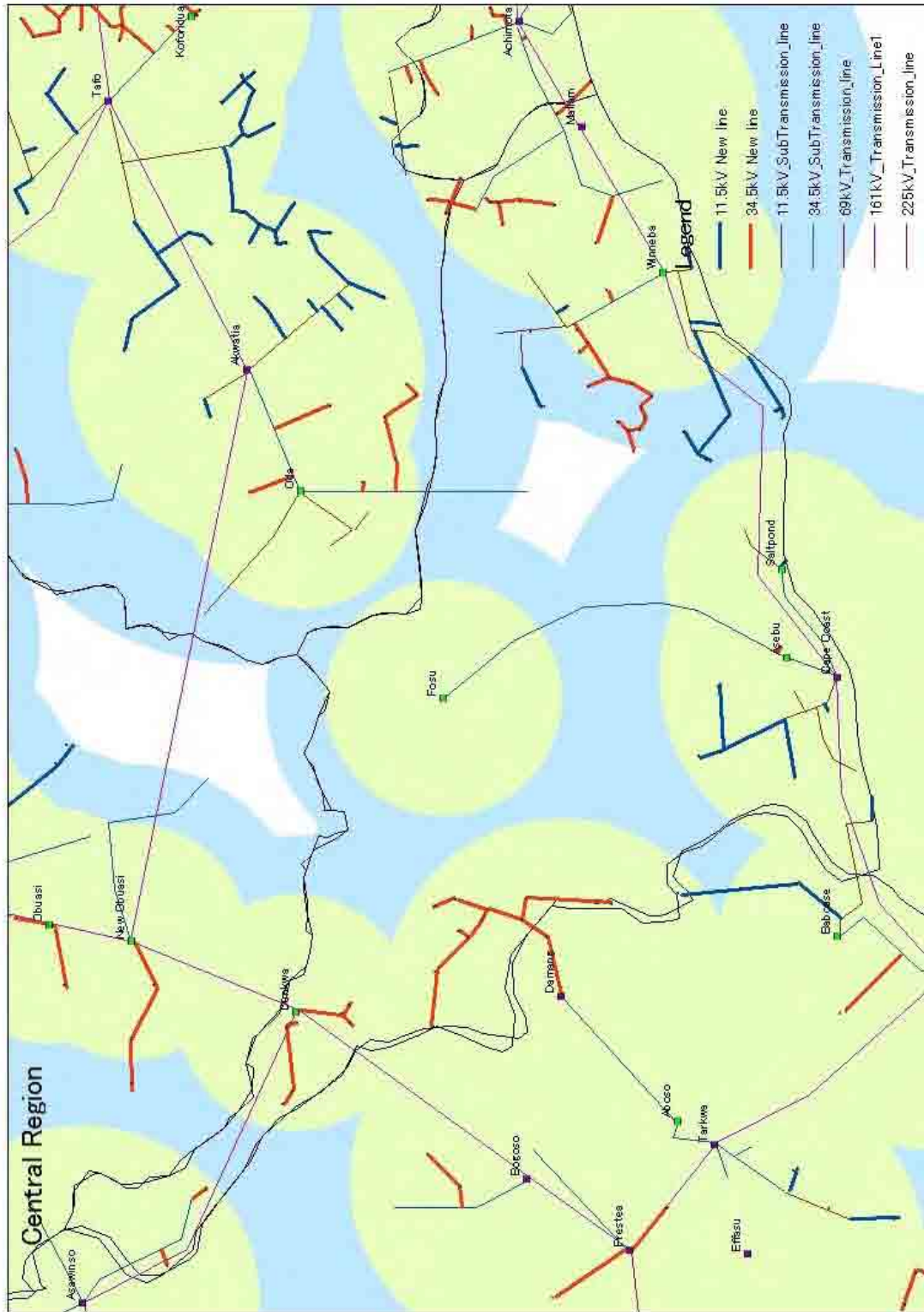
Eastern Region



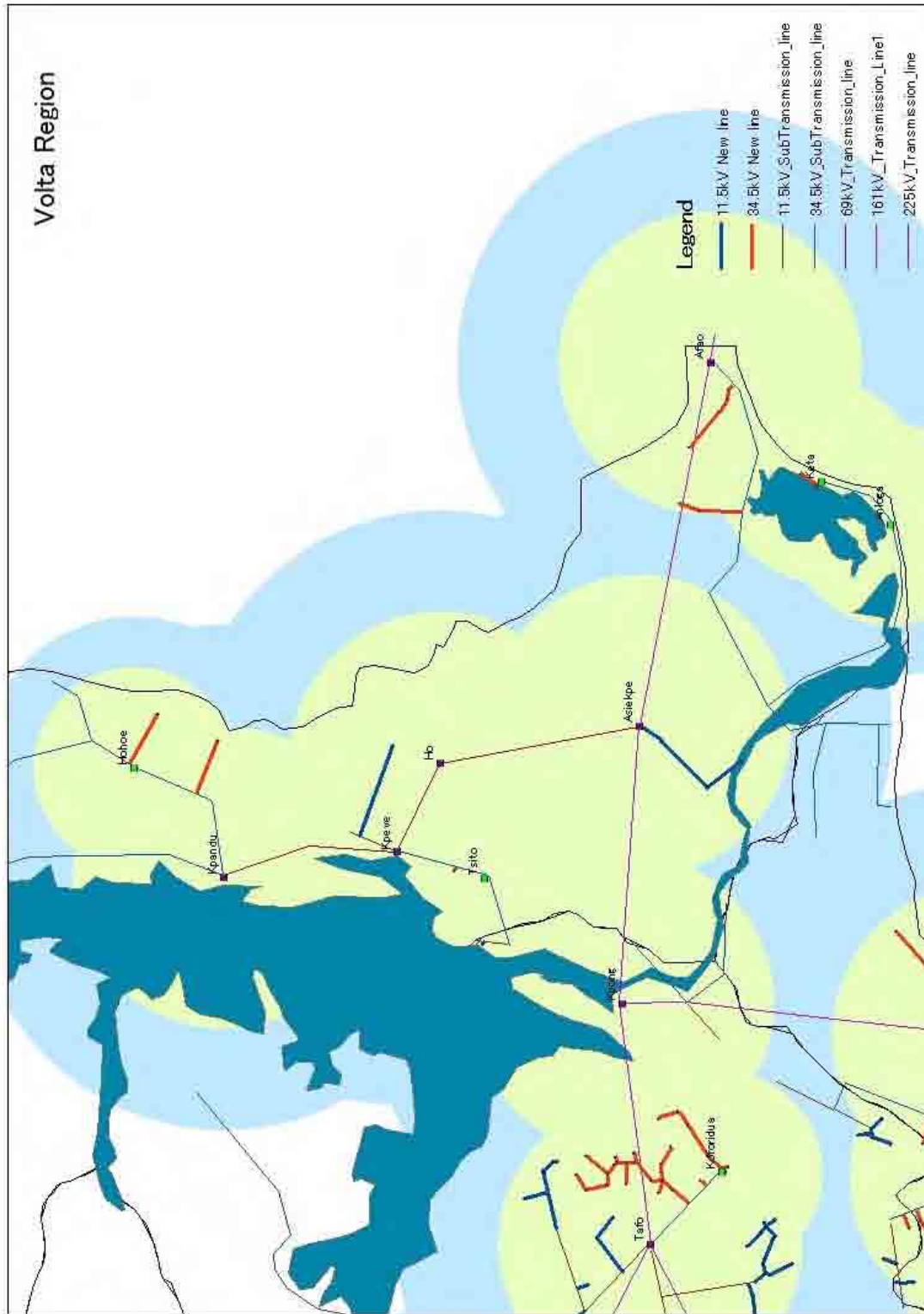
Western Region



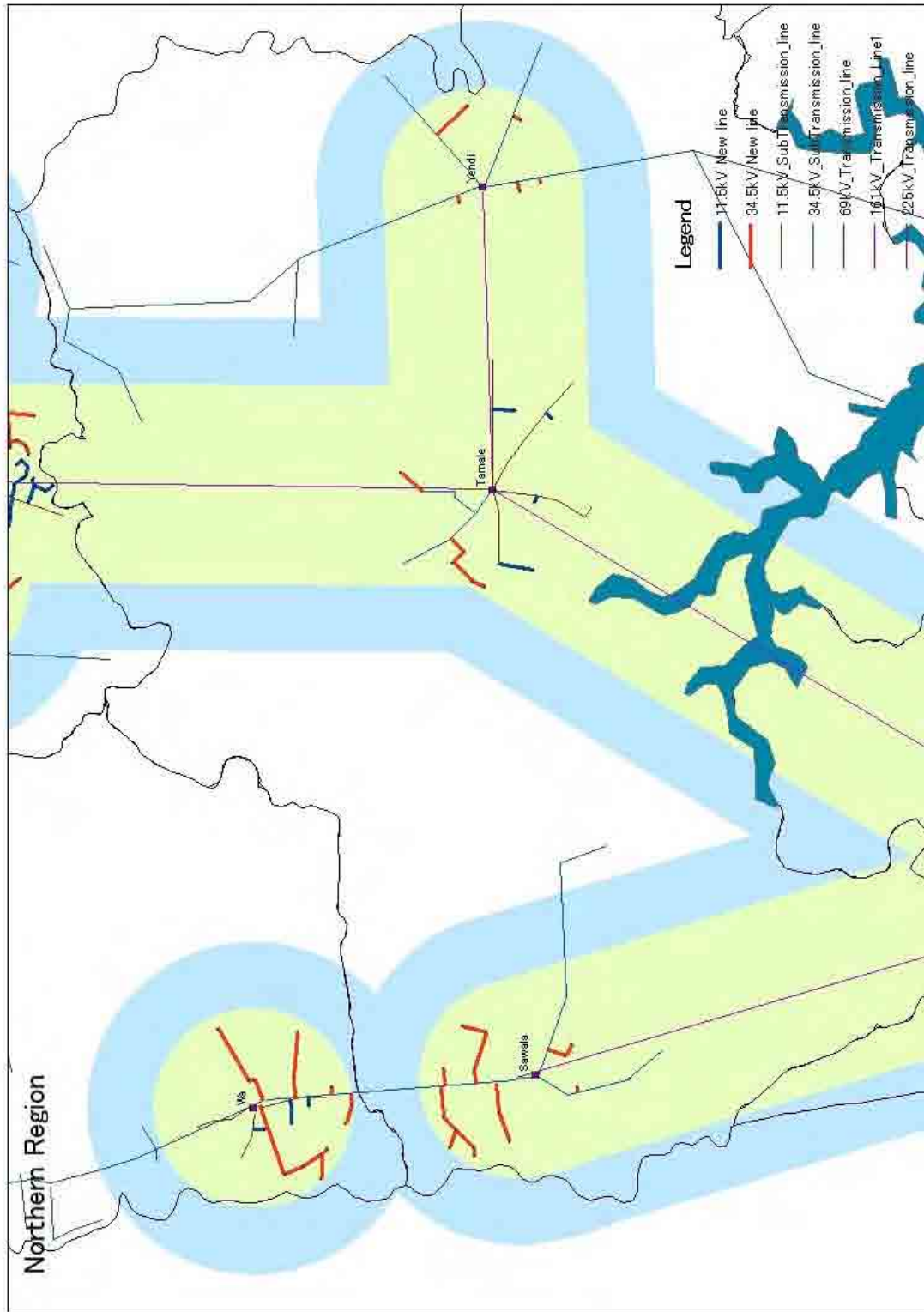
Central Region



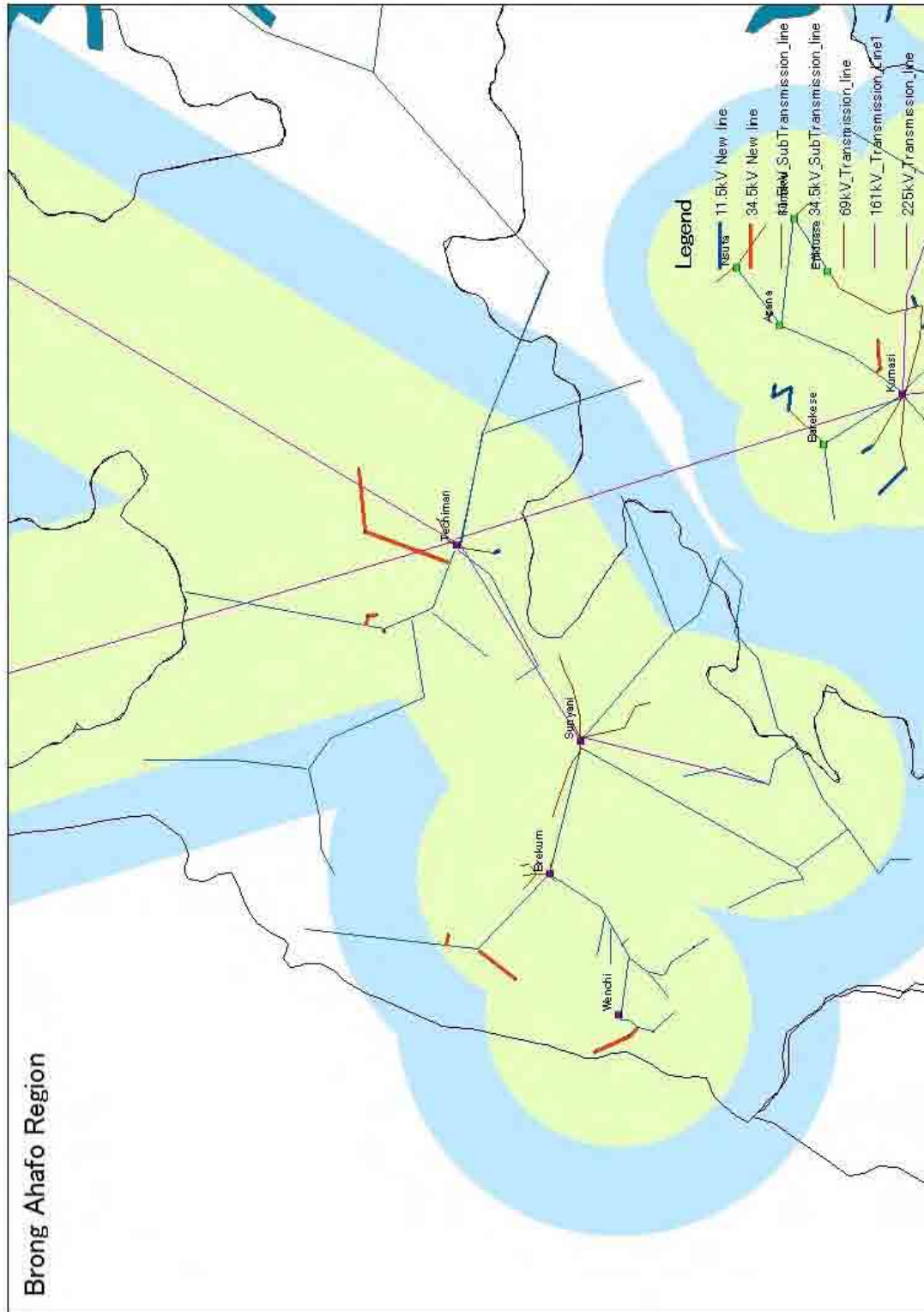
Volta Region



Northern Region

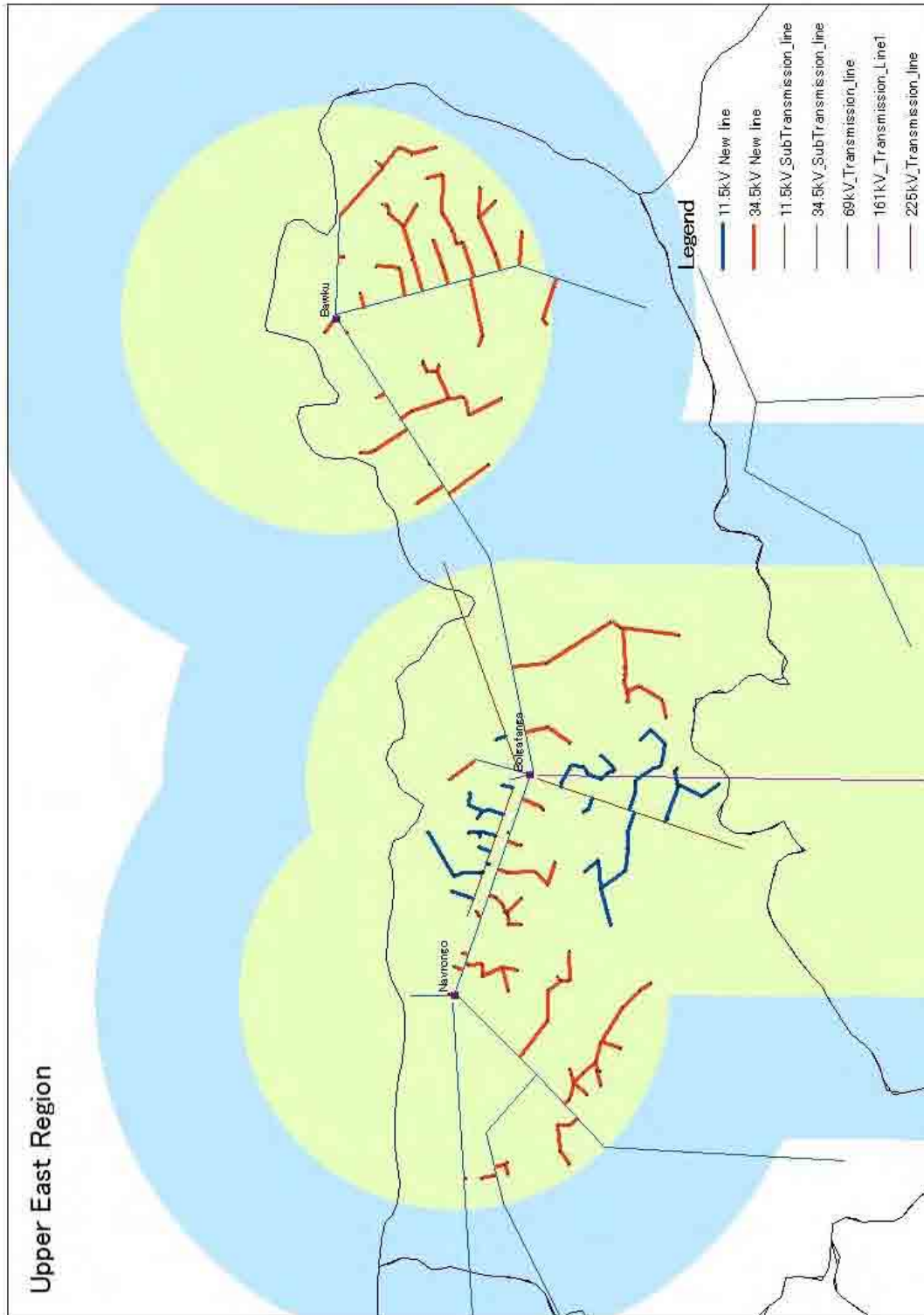


Brong Ahafo Region

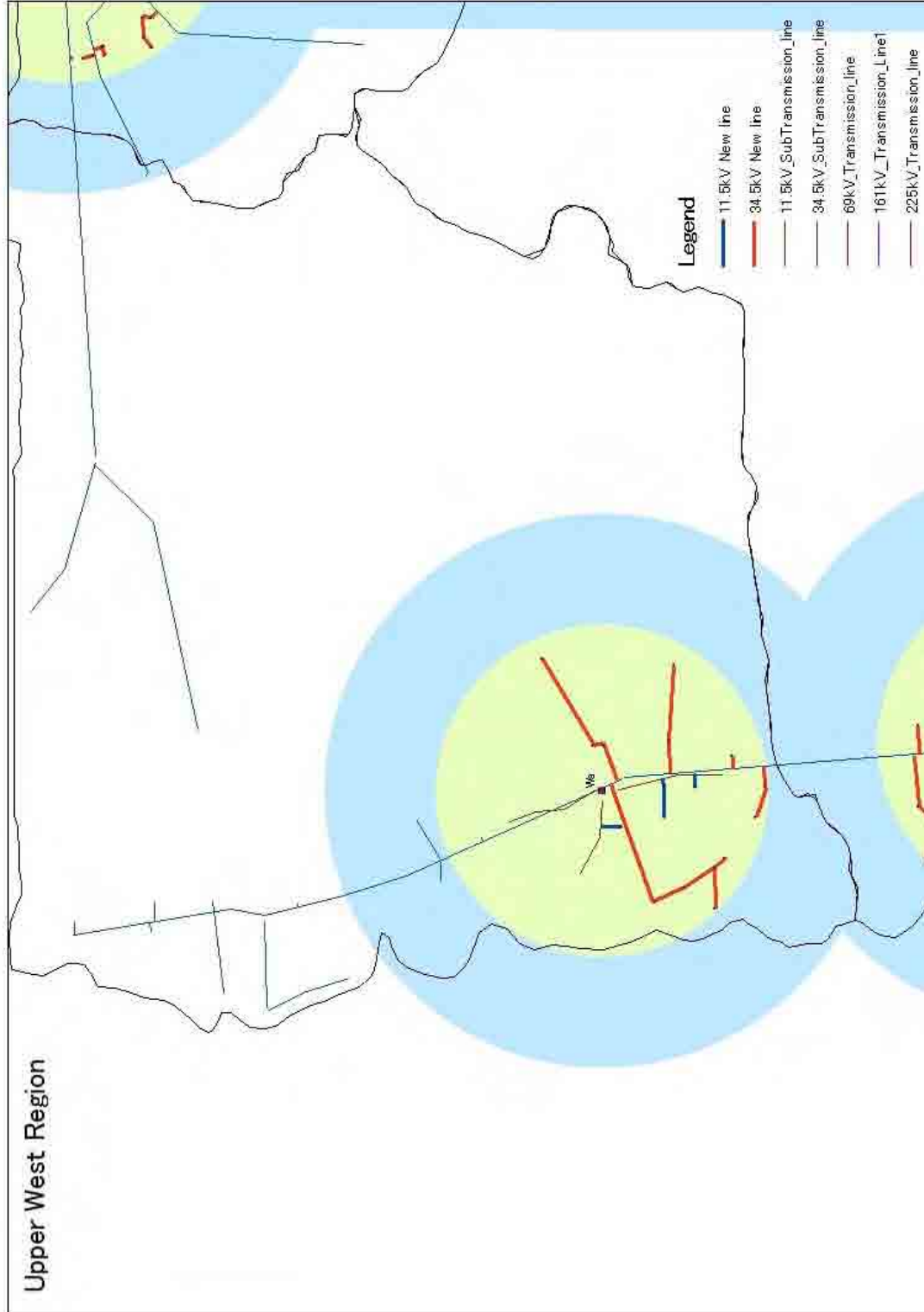


Brong Ahafo Region

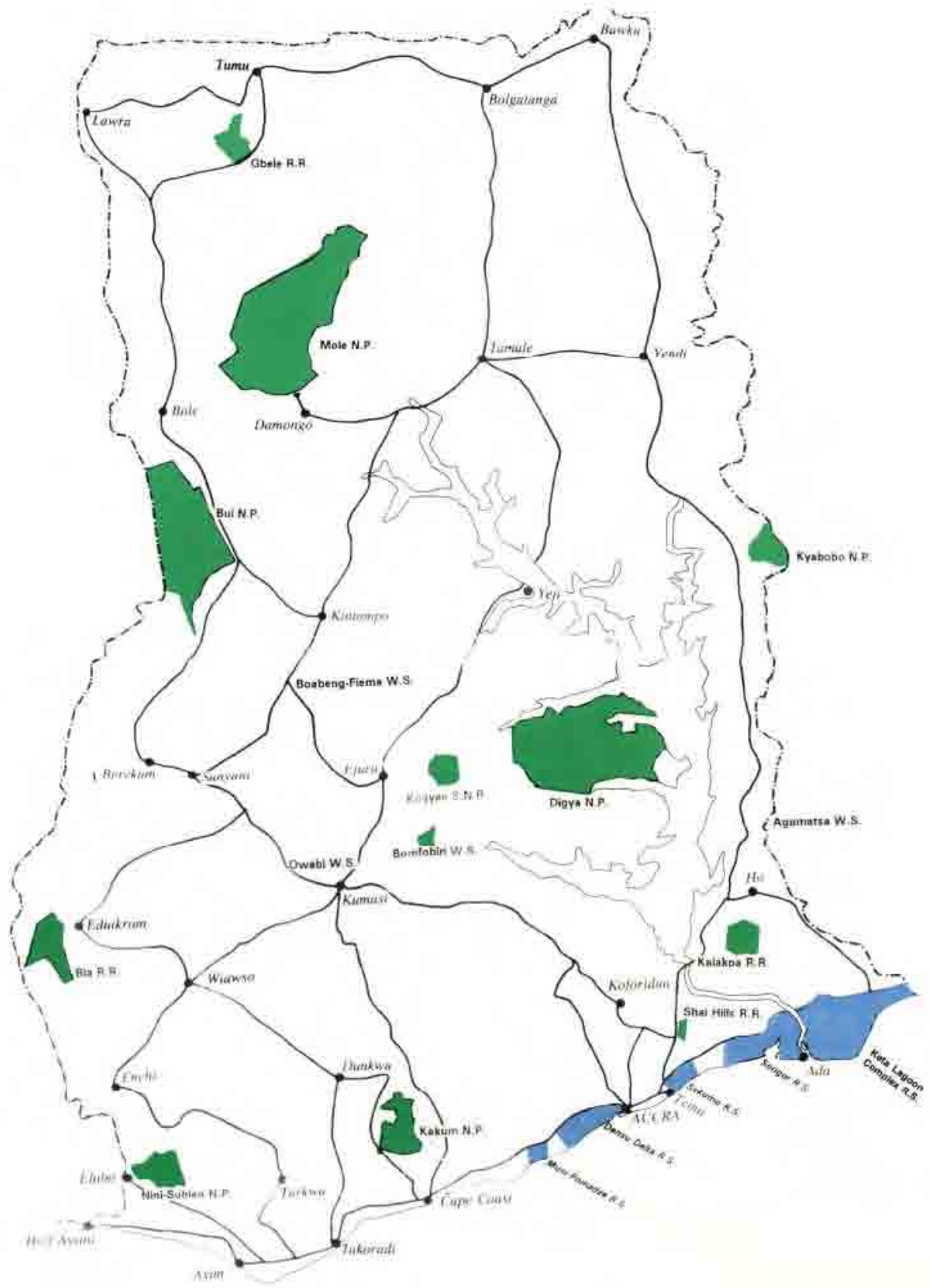
Upper East Region



Upper West Region



Protected Areas in Ghana



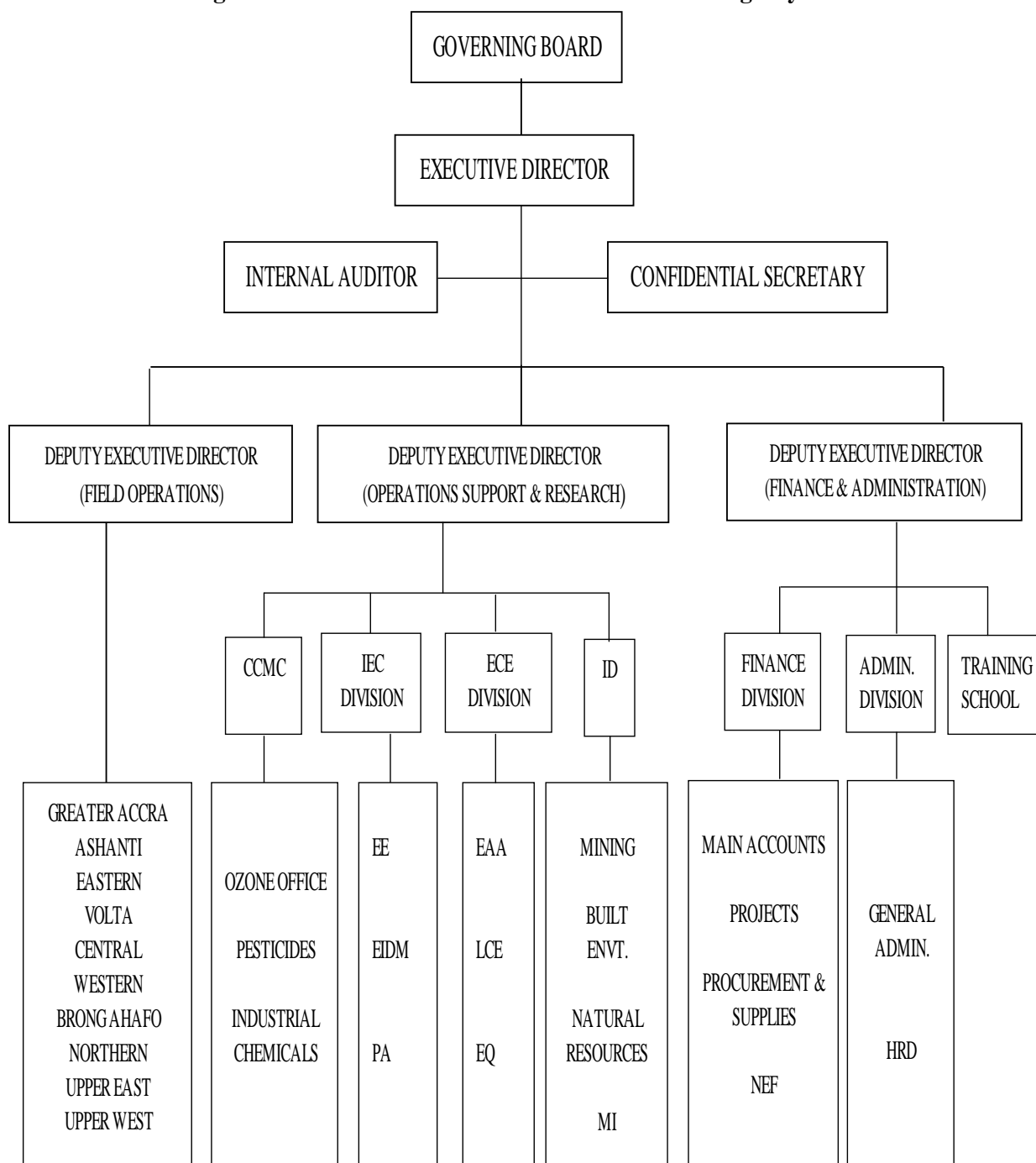
Source: Wildlife Division of Forestry Commission, Ghana

Environmentally Sensitive Areas

- 1 All areas declared by law as national parks, watershed reserves, wildlife reserves and sanctuaries including sacred groves.
- 2 Areas with potential tourist value.
- 3 Areas which constitute the habitat of any endangered or threatened species of indigenous wildlife (flora and fauna).
- 4 Areas of unique historic, archaeological or scientific interests.
- 5 Areas which are traditionally occupied by cultural communities.
- 6 Areas prone to natural disasters (geological hazards, floods, rainstorms, earthquakes, landslides, volcanic activity etc.)
- 7 Areas prone to bushfires.
- 8 Hilly areas with critical slopes.
- 9 Areas classified as prime agricultural lands.
- 10 Recharge areas of aquifers
- 11 Water bodies characterized by one or any combination of the following conditions
 - a. water tapped for domestic purposes;
 - b. water within the controlled and/or protected areas;
 - c. water which support wildlife and fishery activities.
- 12 12. Mangrove areas characterised by one or any combination of the following conditions
 - a. areas with primary pristine and dense growth;
 - b. areas adjoining mouth of major river system;
 - c. areas near or adjacent to traditional fishing grounds;
 - d. areas which act as natural buffers against shore erosion, strong winds or storm floods.

Source: Schedule 5 of Ghana Environmental Assessment Regulations 1999

Organizational Chart of Environmental Protection Agency



CCMC – Chemical Control and Management

IEC – Information Education and Communication

ECE – Environmental Compliance and Enforcement

EE – Environmental Education

EIDM – Environmental Information and Data Management

PA – Public Affairs

EAA – Environmental Audit and Assessment

LCE – Legal Compliance Enforcement

EQ – Environmental Quality

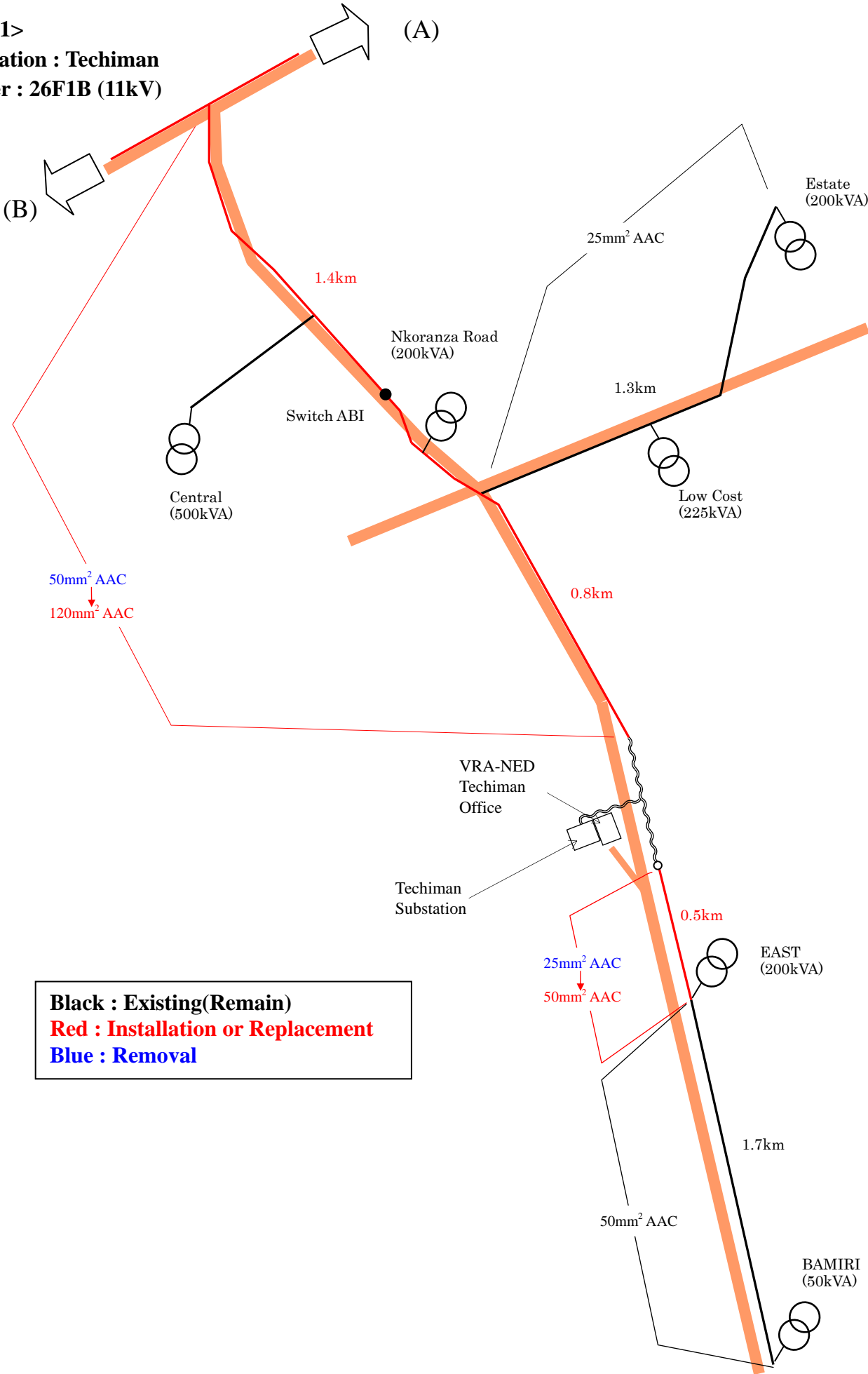
ID – Intersectoral Division

MI – Manufacturing Industries

(Source) EPA

【Example of drawing(Case Study inside Techiman City (VRA Techiman Office))】

<Site 1>
Substation : Techiman
Feeder : 26F1B (11kV)



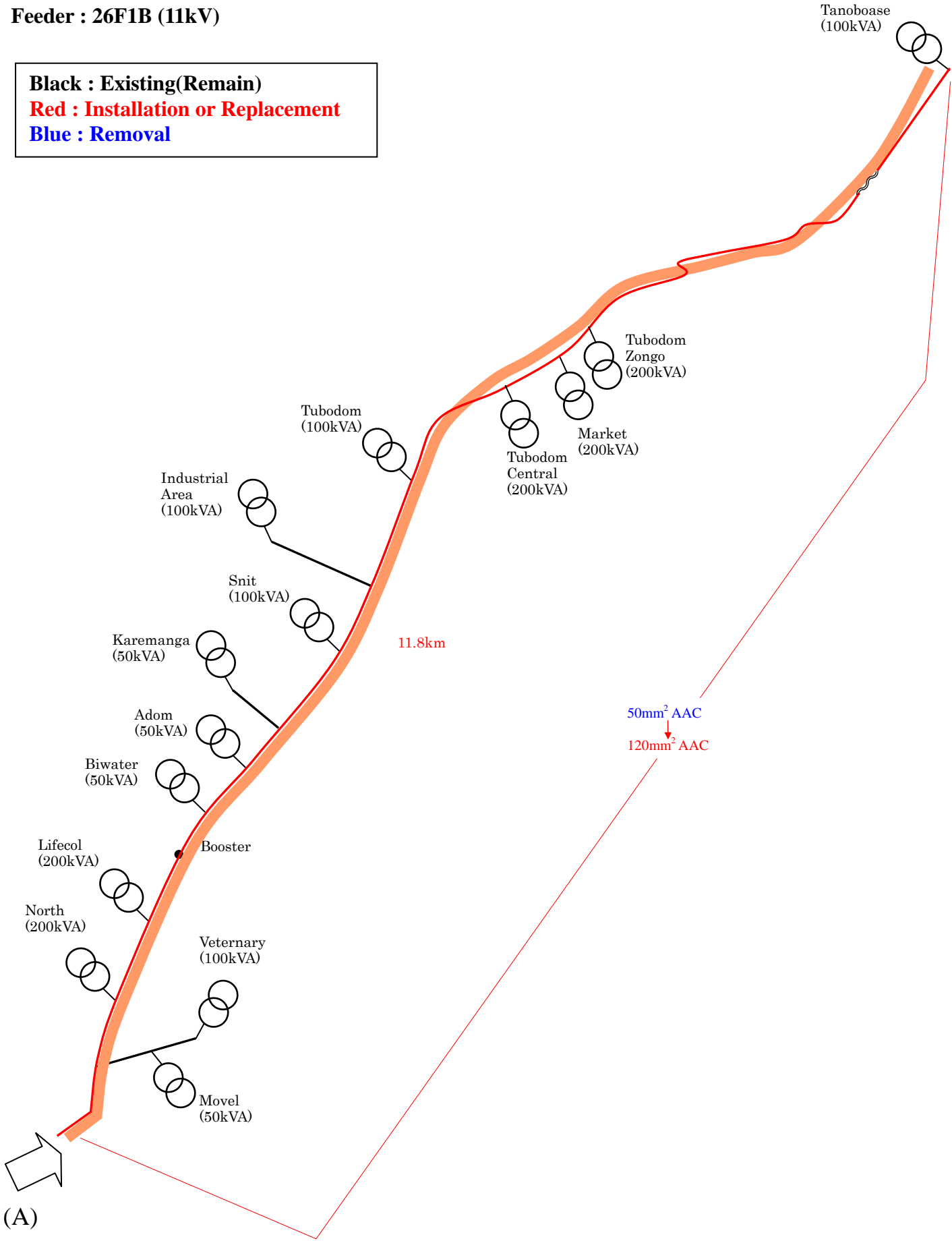
Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

<Site 1>

Substation : Techiman

Feeder : 26F1B (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

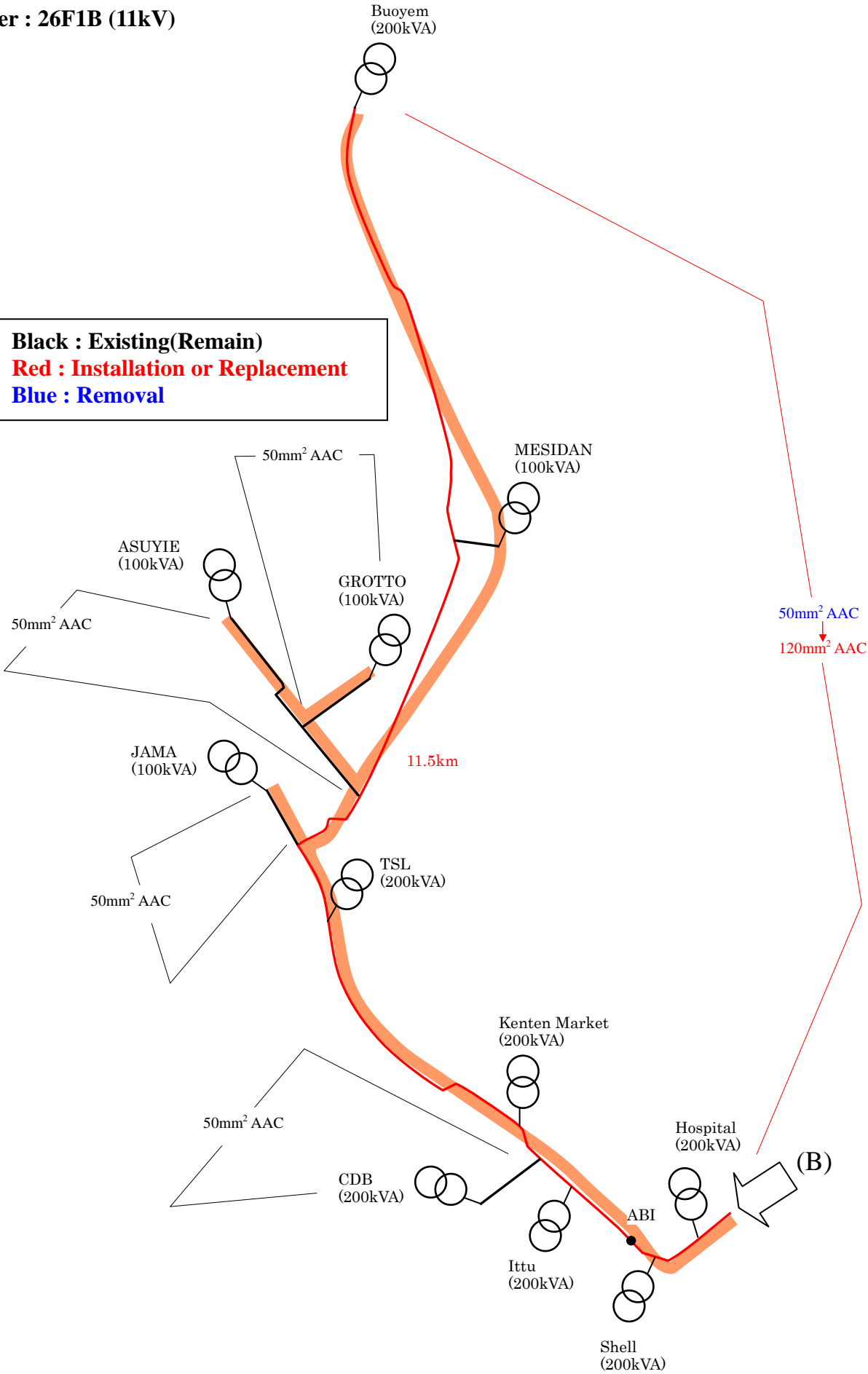


<Site 1>

Substation : Techiman

Feeder : 26F1B (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

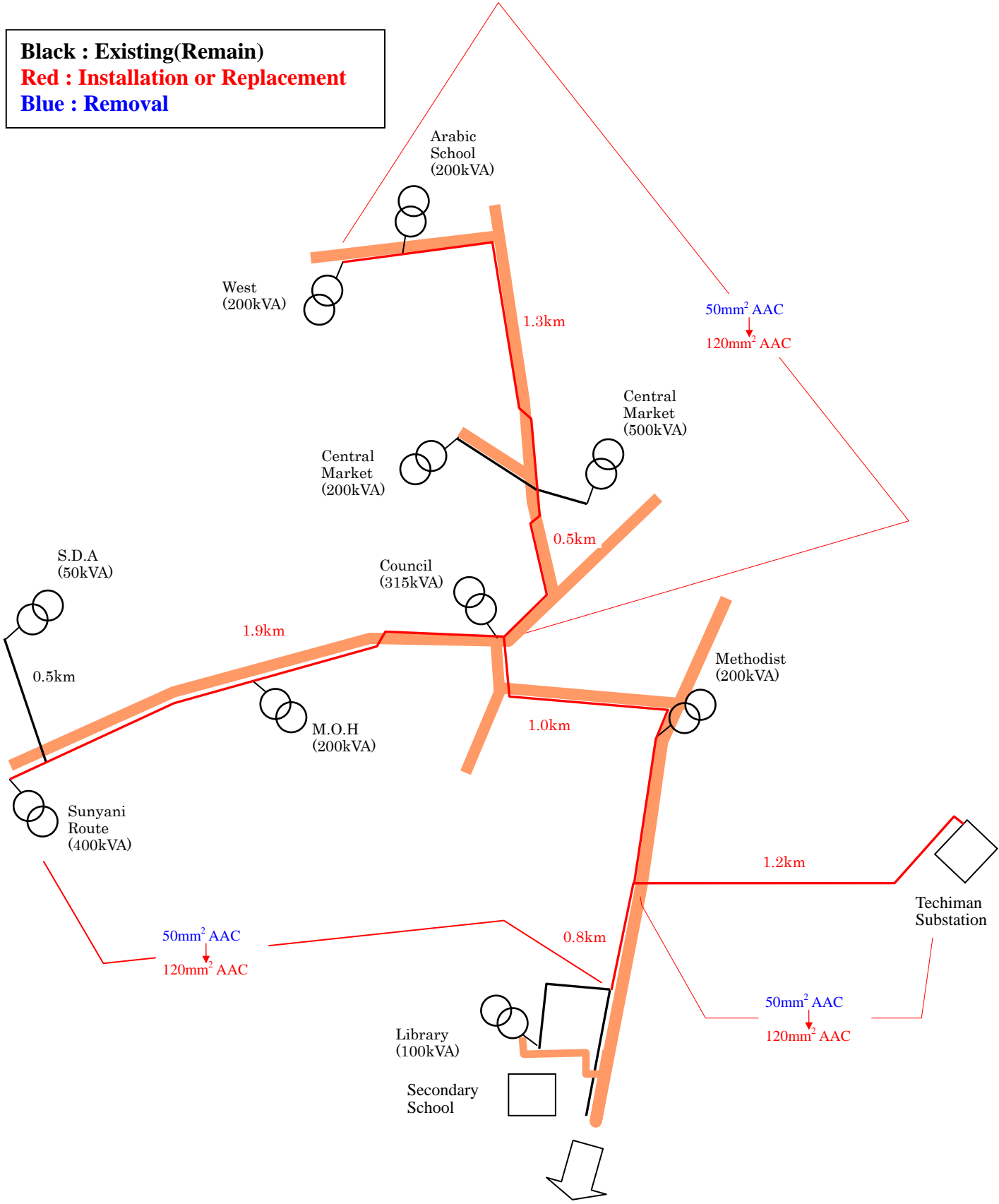


<Site 2>

Substation : Techiman

Feeder : 26F2B (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

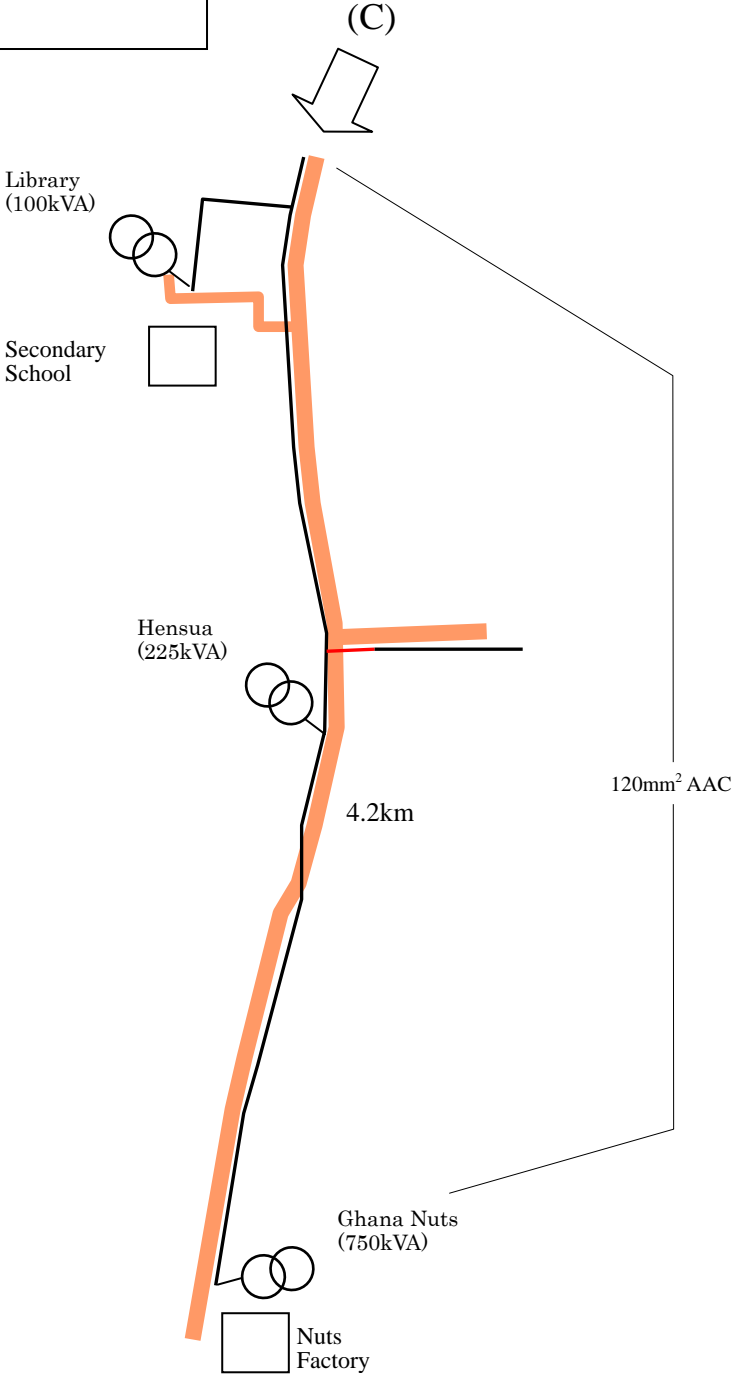


<Site 2>

Substation : Techiman

Feeder : 26F2B (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Techiman Feeder : 26F1B(11kV)	120mm ² AAC (without pole construction) 25.5km 50mm ² AAC (without pole construction) 0.5km $5,106.24(\text{US\$/km}) \times 25.5(\text{km})$ $+3,969.34(\text{US\$/km}) \times 0.5(\text{km})$ $=132,193.8(\text{US\$})$	50mm ² AAC (without pole construction) 25.5km 25mm ² AAC (without pole construction) 0.5km $1,075.11(\text{US\$/km}) \times 25.5(\text{km})$ $1,075.11(\text{US\$/km}) \times 0.5(\text{km})$ $=27,952.86(\text{US\$})$	160,147
<Site 2> Substation: Techiman Feeder: 26F2B(11kV)	120mm ² AAC (without pole construction) 7.2km $5,106.24(\text{US\$/km}) \times 7.2(\text{km})$ $=36,764.93(\text{US\$})$	50mm ² AAC (without pole construction) 7.2km $1,075.11(\text{US\$/km}) \times 7.2(\text{km})$ $=7,740.792(\text{US\$})$	44,506

【Example of drawing (Case Study at Accra East (Greater Accra))】

Substation : Y Baatsona
 Feeder : Y11 Spintex

120 / 240 mm² Al - 3km

120 / 240 mm² Al - 6 km

120 / 240 mm² Al - 3km

Motor Way

App.-100

Y Baatsona Substation

Ghana Cylinder Factory
 Goil

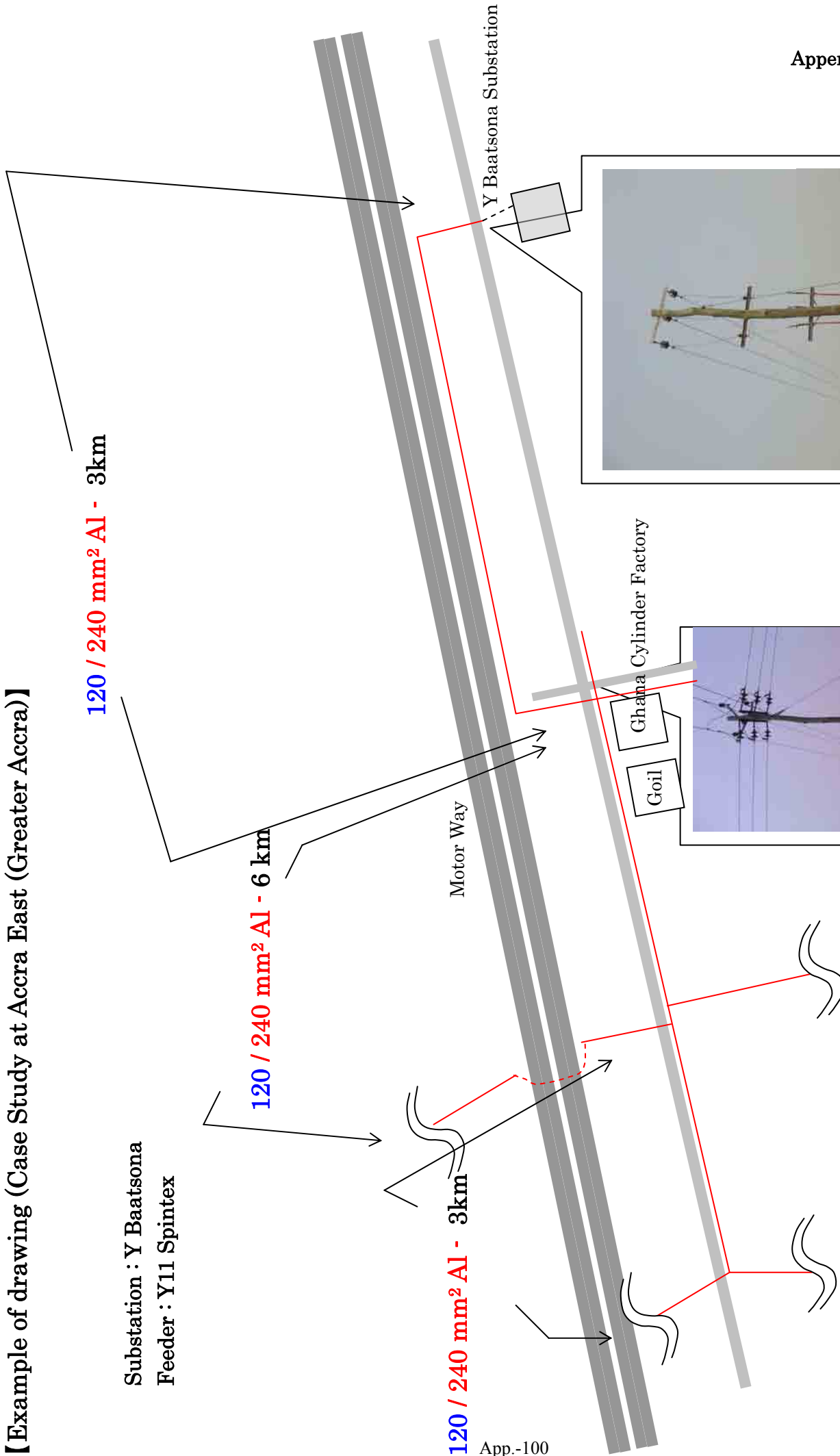


First take-off point



double-T-off point

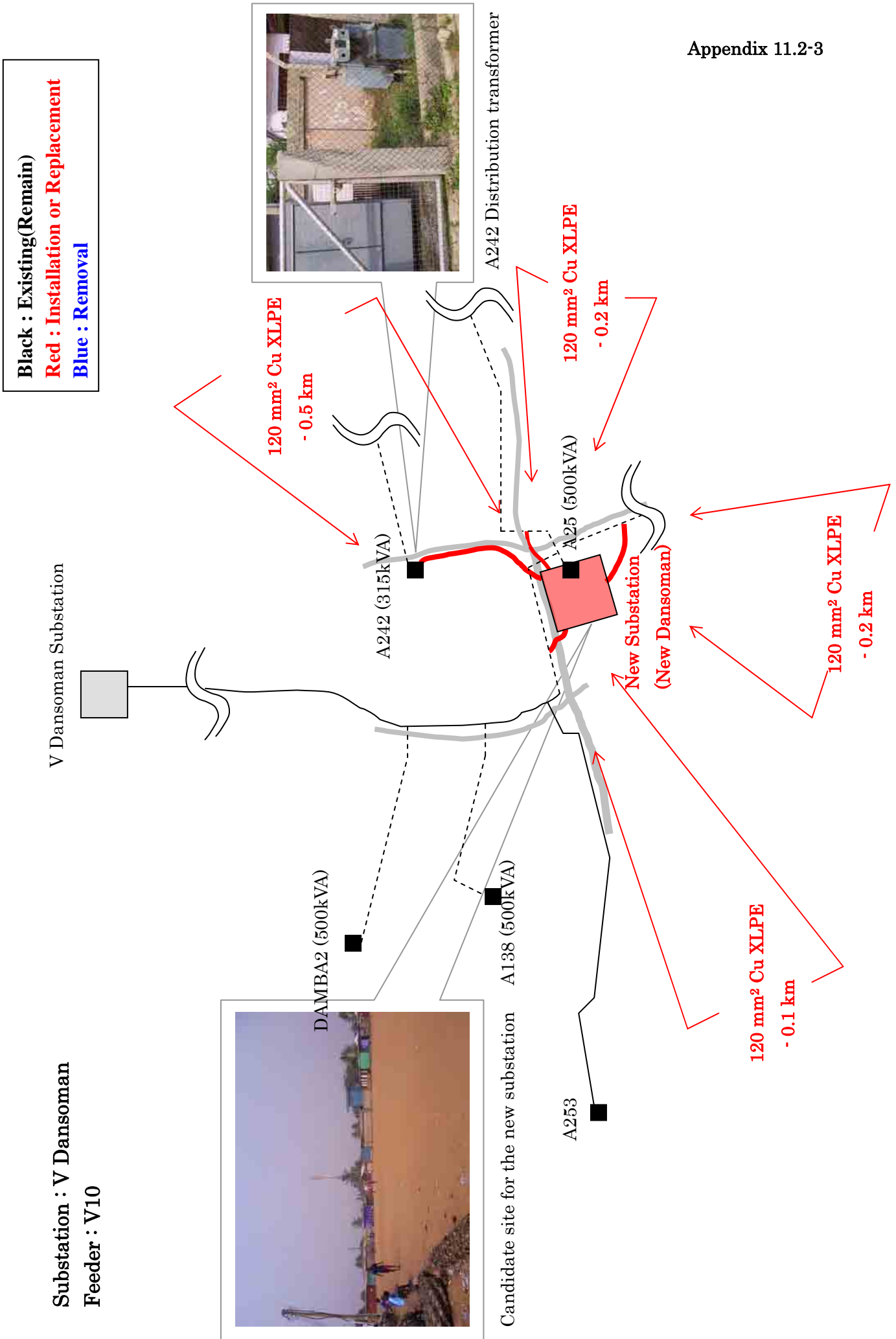
Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Y Baatsona Feeder : Y11 Spintex	240mm ² AAC (without pole construction) 12km 7,111.92(US\$/km) x 12(km) =85343.0(US\$)	120mm ² Cu (without pole construction) 12km 1,117.87(US\$/km) x 12(km) =13,414.4(US\$)	98,757

【Example of drawing (Case Study at Accra East (Greater Accra))】



<Cost Estimation>

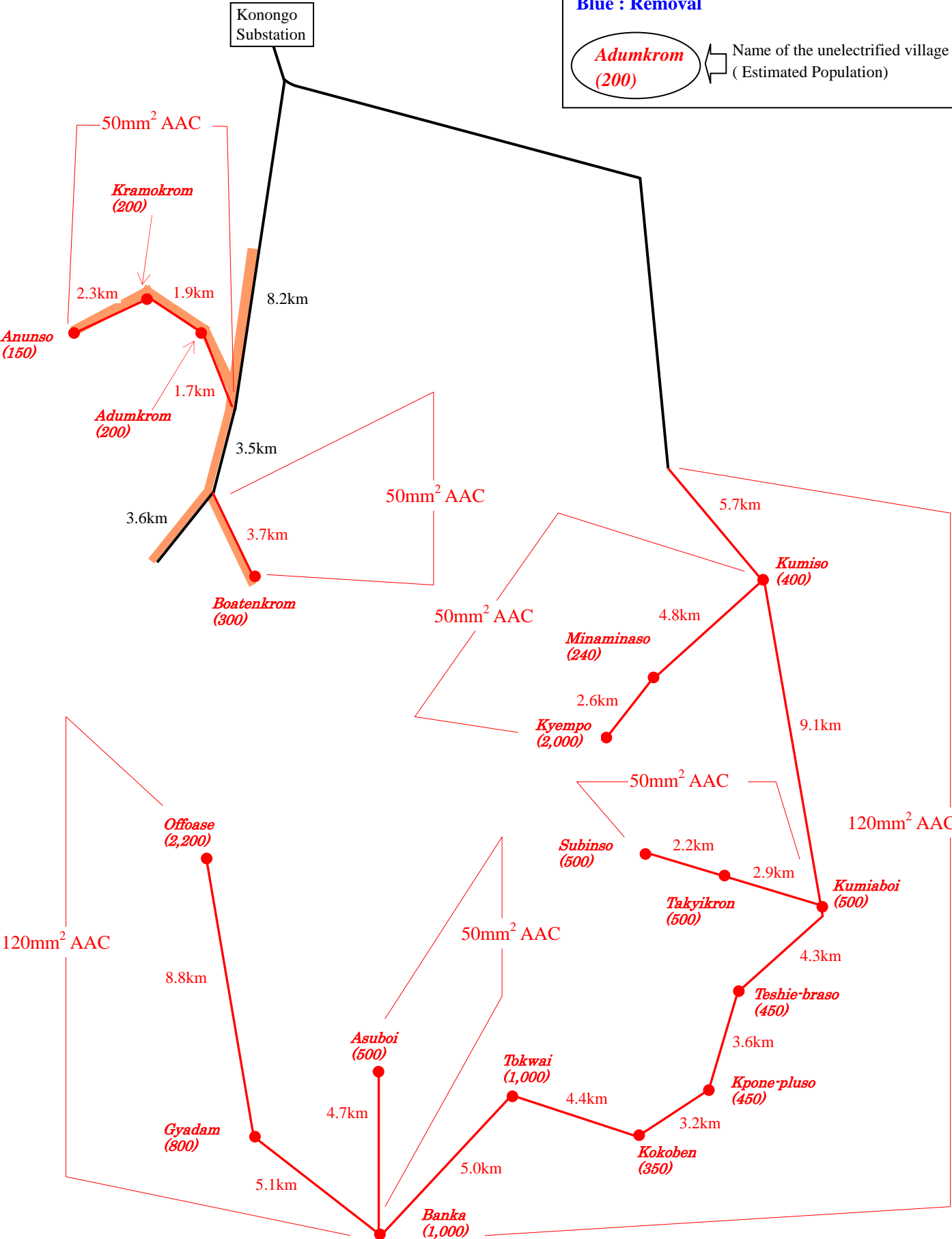
Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<p><Site 1> Substation : V Dansoman Feeder : V10</p>	<p>2 × 20/26MVA Substation 33/11kV (outdoor) 120mm² Cu XLPE 1km 2,500,000(US\$) x 1(place) +32,913.2(US\$/km) x 1(km) =2,532,913(US\$)</p>	<p>nothing</p>	<p>2,532,913</p>

【Example of drawing(Case Study at Konongo Area(Ashanti-East Region)】

Substation : Konongo
Feeder : Konongo(11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

Adumkrom
(200) Name of the unelectrified village
(Estimated Population)



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
Substation : Obuasi Substation Feeder : 12F4 (11kV)	120mm ² AAC (with pole construction) 49.2km 50mm ² AAC (with pole construction) 26.8km $25,168.65(\text{US\$/km}) \times 49.2(\text{km})$ $+ 23,262.31(\text{US\$/km}) \times 26.8(\text{km})$ $=1,861,727(\text{US\$})$	/	1,861,727

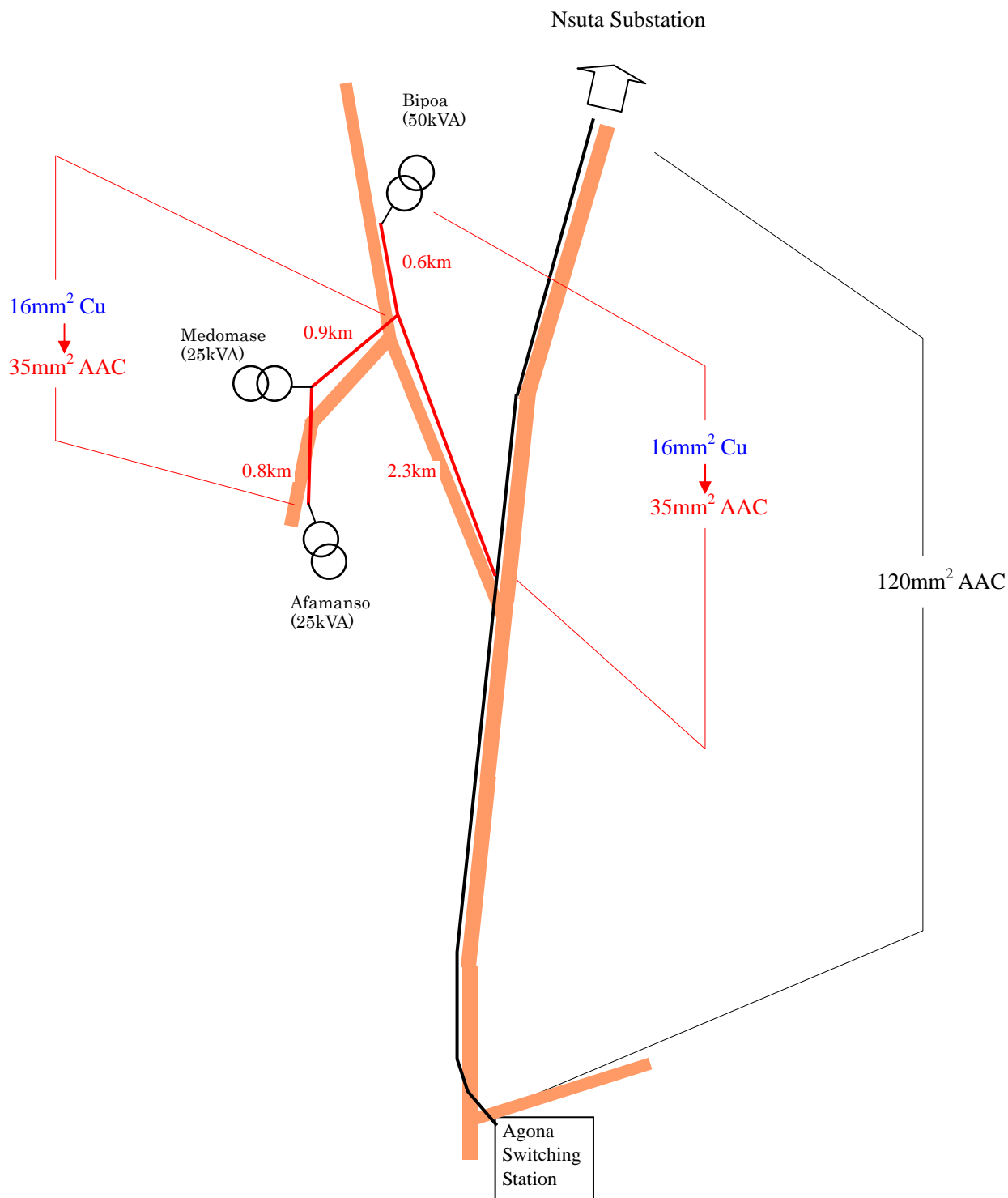
【Example of drawing(Case Study at Nsuta&Manpong Area(Ashanti-East Region)】

<Site 1>

Substation : Agona

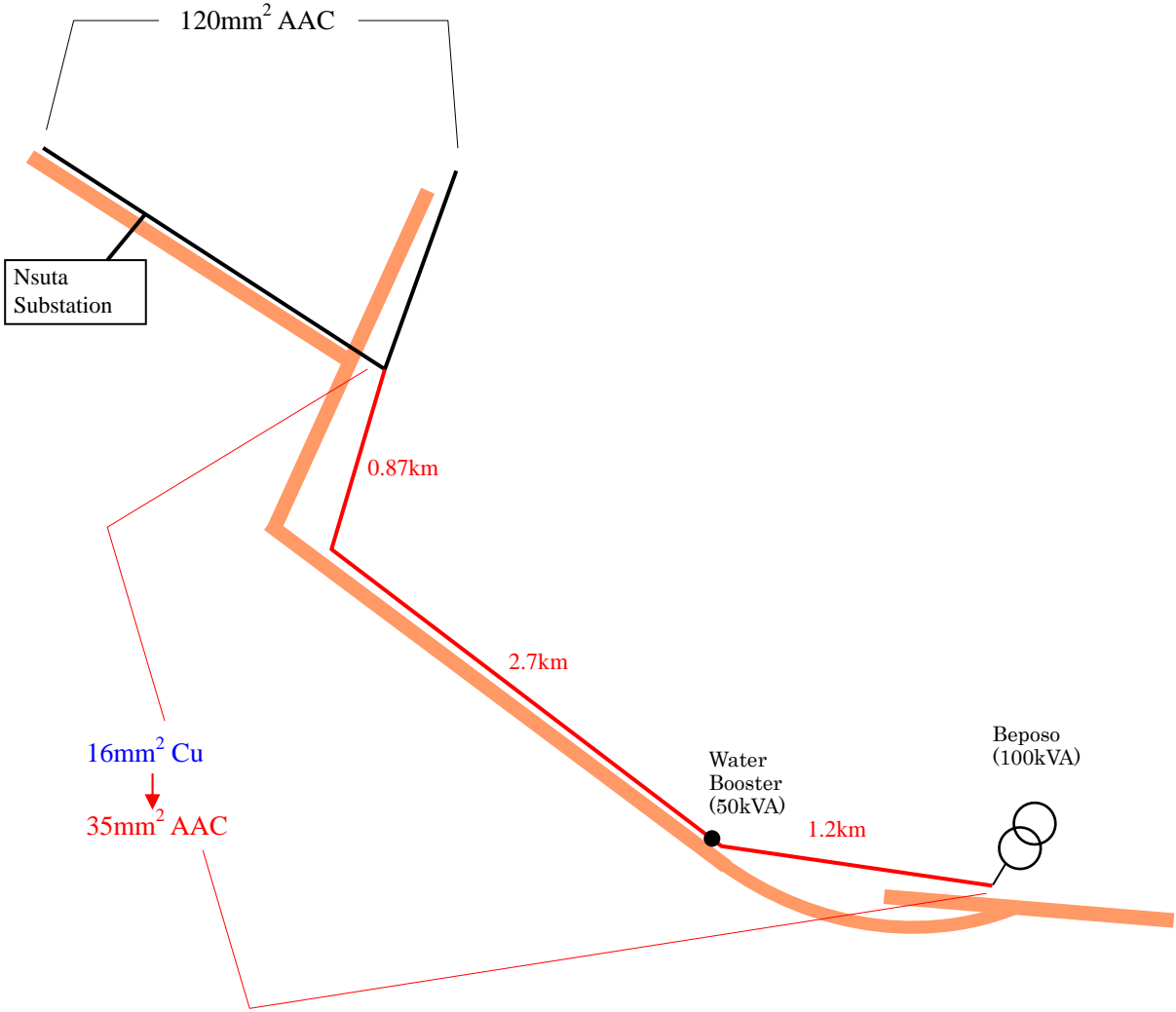
Feeder : Nsuta (33kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

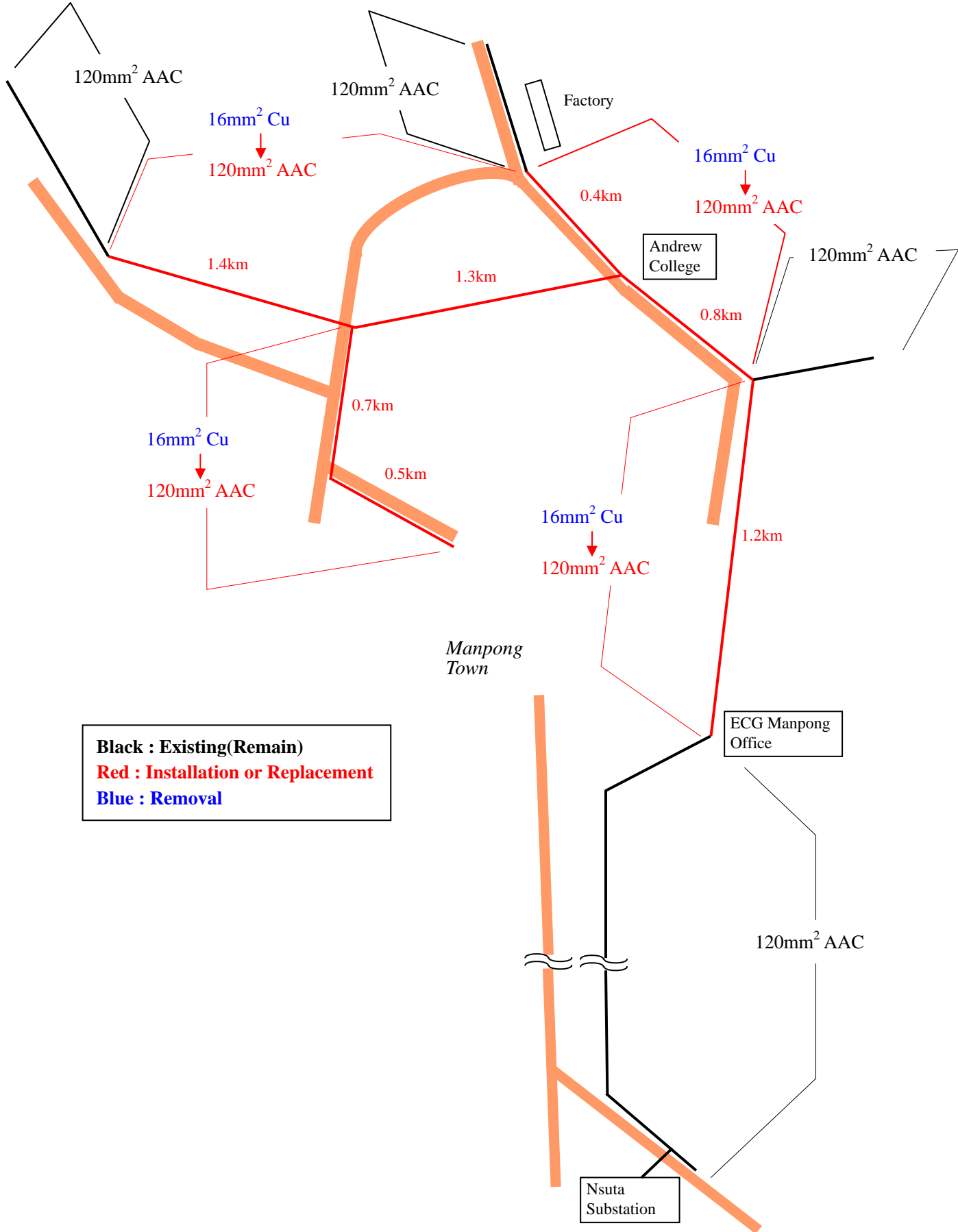


<Site 2>
Substation : Nsuta
Feeder : Nsuta (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Site 3>
Substation : Nsuta
Feeder : Nsuta (11kV)



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Agona Feeder : Nsuta (33kV)	35 mm ² AAC (without pole construction) 4.6km 3,969.34(US\$/km) x 4.6(km) = 18,258.96(US\$)	16 mm ² AAC (without pole construction) 4.6km 1,075.11(US\$/km) x 4.6(km) = 4,945.5(US\$)	23,204
<Site 2> Substation : Nsuta Feeder : Nsuta (11kV)	35 mm ² AAC (without pole construction) 3.6km 3,969.34(US\$/km) x 3.6(km) = 14,289.6(US\$)	16 mm ² AAC (without pole construction) 3.6km 1,075.11(US\$/km) x 3.6(km) = 3,870.4(US\$)	18,160
<Site 3> Substation : Nsuta Feeder : Nsuta (11kV)	120mm ² AAC (without pole construction) 6.3km 5,106.24(US\$/km) x 6.3(km) = 32,169.3(US\$)	16 mm ² AAC (without pole construction) 6.3km 1,075.11(US\$/km) x 6.3(km) = 6,773.2(US\$)	38,943

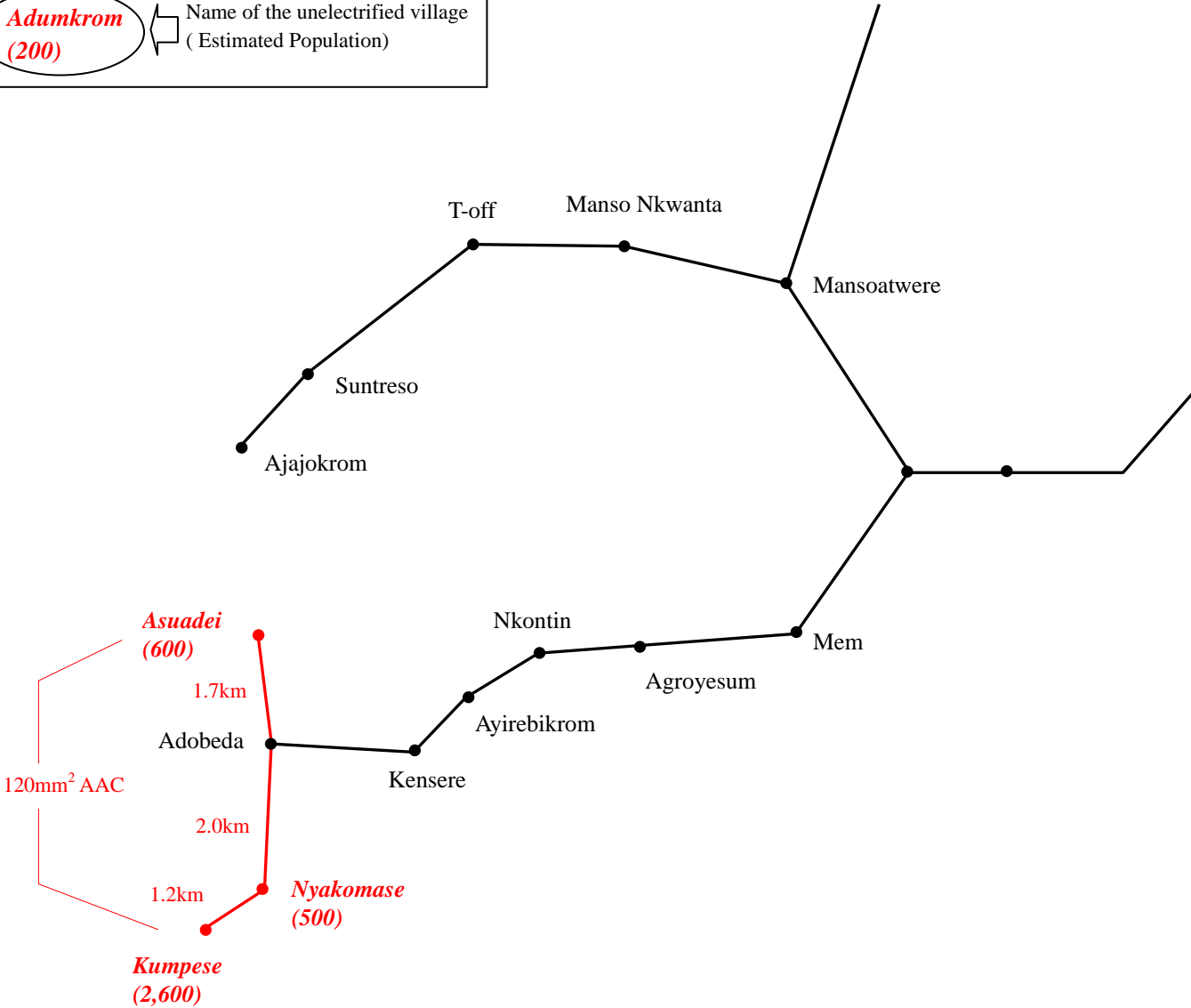
【Example of drawing(Case Study at Manso Nkwanta Area(Ashanti-West Region)】

Substation : MAIN B Substation
Feeder : Manso Nkwanta Feeder(33kV)

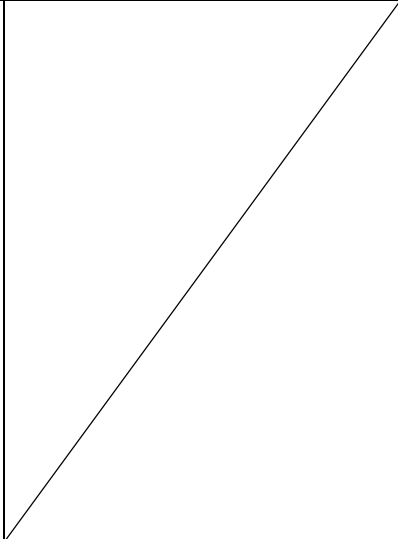
Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

Adumkrom
(200)

↳ Name of the unelectrified village
(Estimated Population)



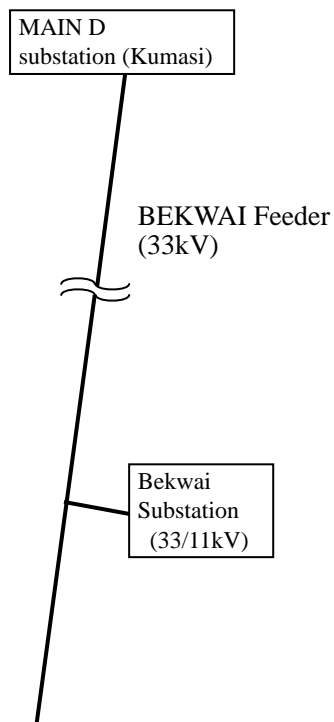
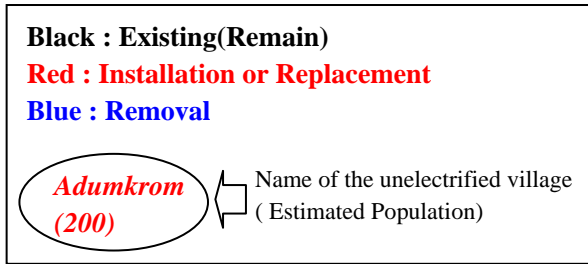
<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
Substation : Obuasi Substation Feeder : 12F4 (11kV)	120mm ² AAC (with pole construction) 4.9km 25,168.65(US\$/km) x 4.9(km) =123,326.4(US\$)		123,326

【Example of drawing(Case Study at Bekwai, Obuasi Area(Ashanti-West Region)】

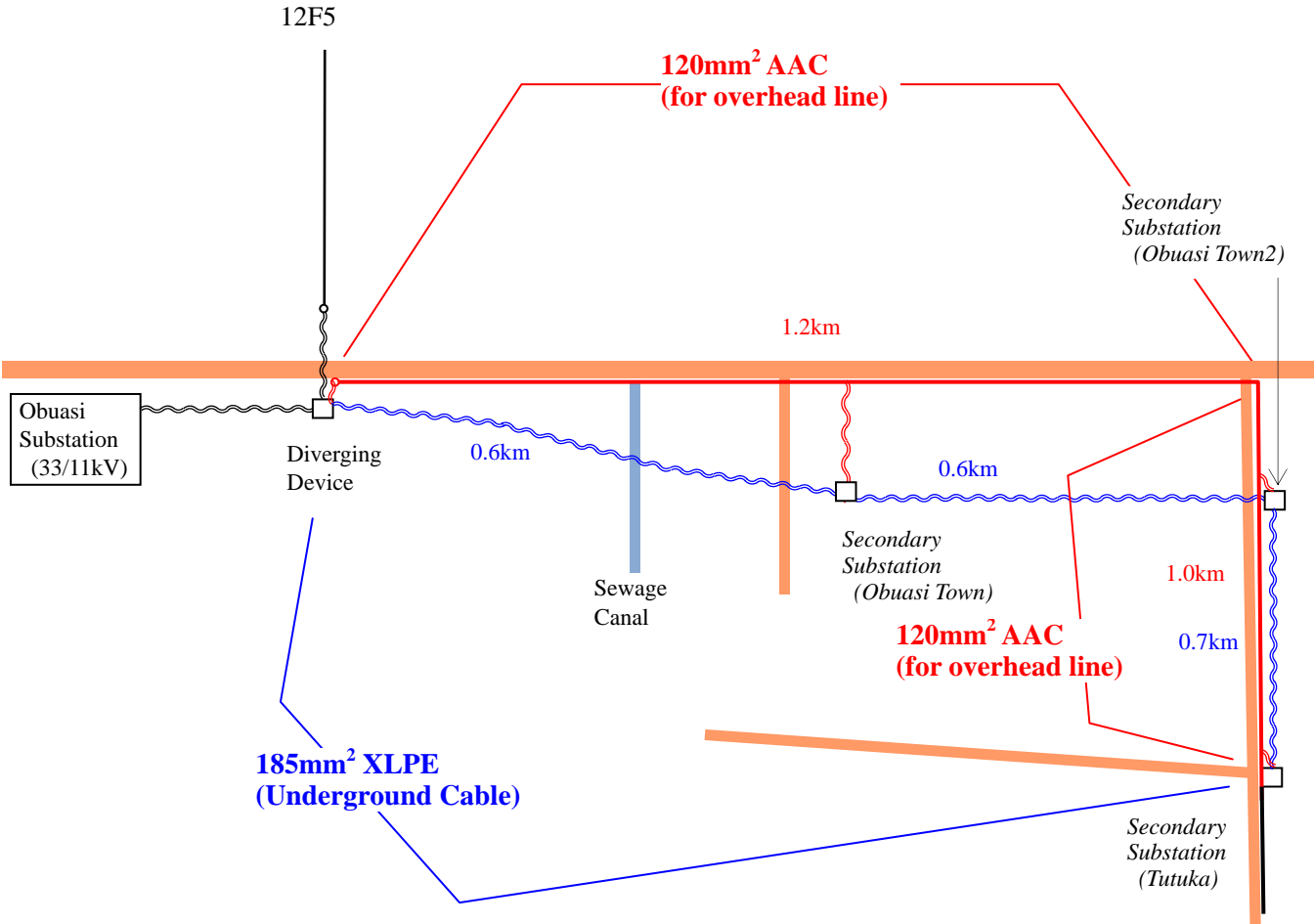
Substation : Bekwai Substation(from MAIN D Substation)

Feeder : KOKOFU Feeder(11kV)



Substation : Obuasi Substation
Feeder : 12F4 (11kV)

Underground cables are along the road in direct buried type, but they will interfere with new road construction. So 11kV over-head lines will be newly constructed and the distribution line will be re-routed.



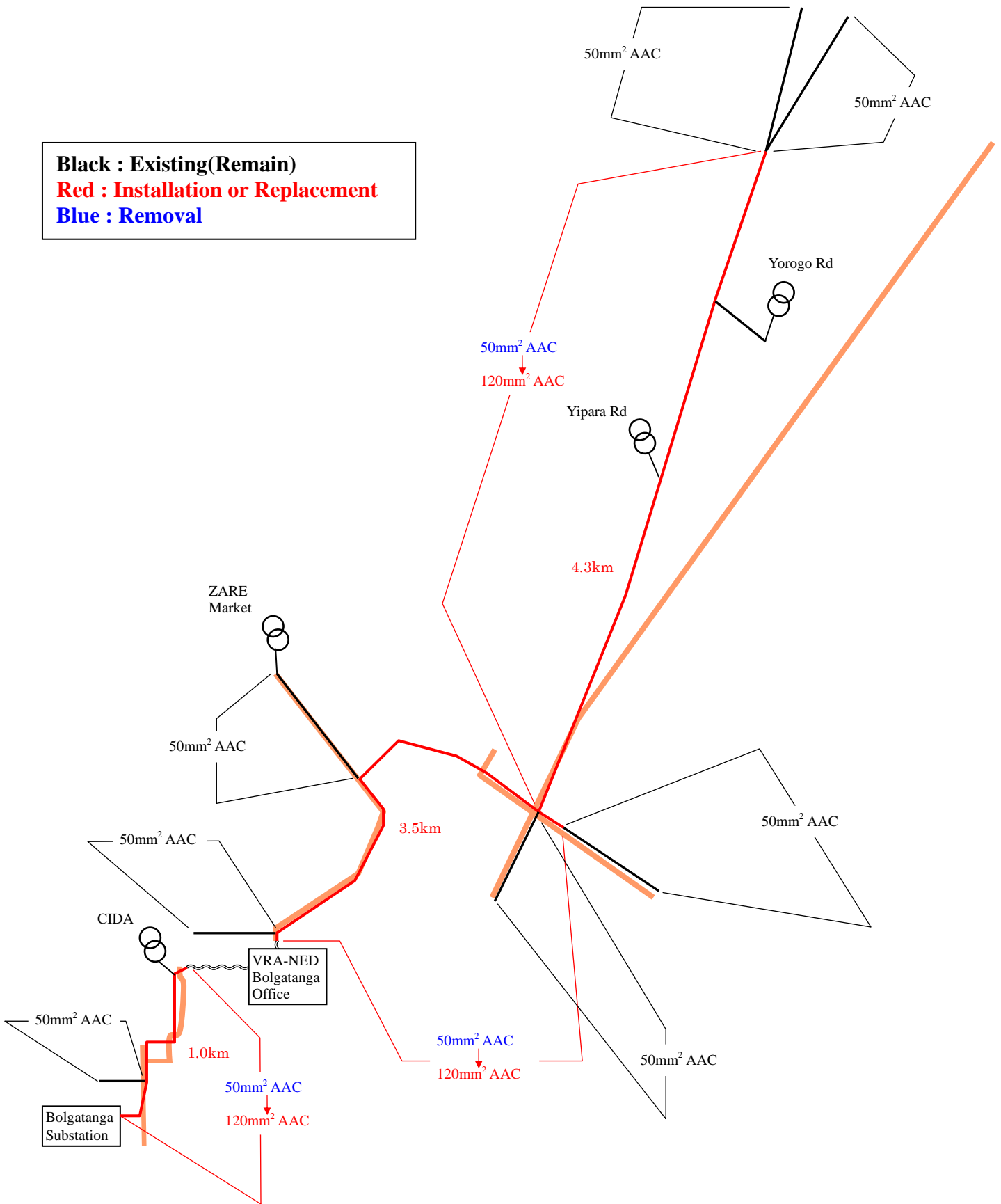
【Example of drawing(Case Study at Bolgatanga Area (VRA Bolgatanga Office))】

<Site 1>

Substation : Bolgatanga

Feeder : 29F6B (11kV)

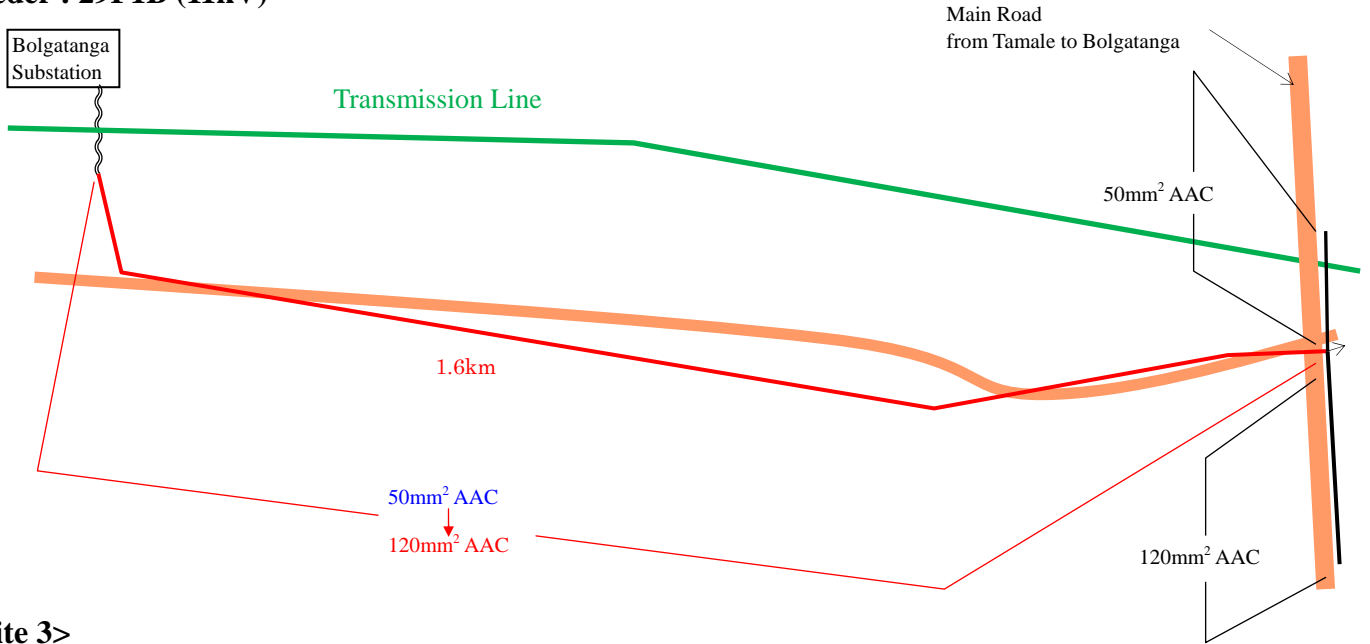
Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Site 2>

Substation : Bolgatanga

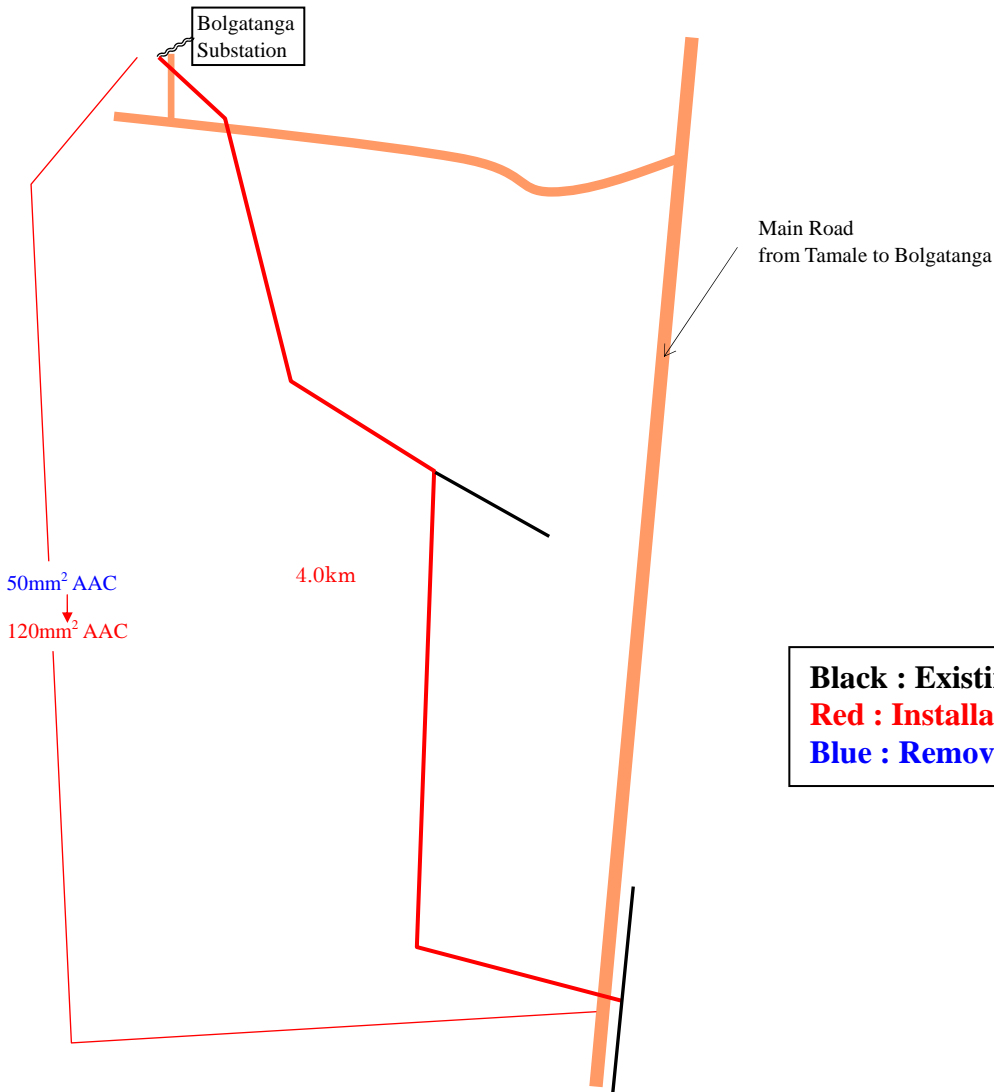
Feeder : 29F1B (11kV)



<Site 3>

Substation : Bolgatanga

Feeder : 29F4B (11kV)



Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

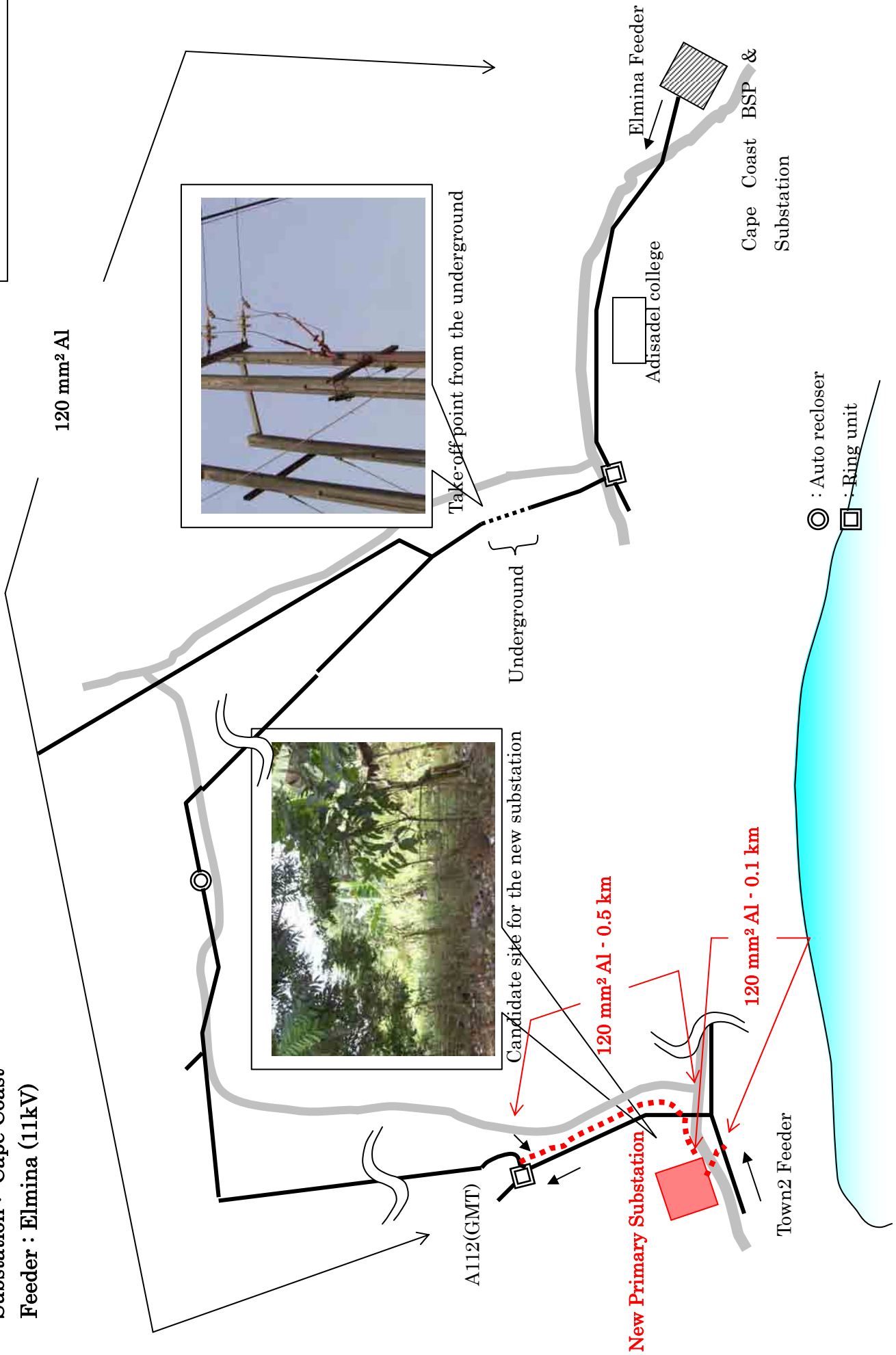
<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Bolgatanga Feeder : 29F6B(11kV)	120mm ² AAC (without pole construction) 8.8km 5,106.24(US\$/km) x 8.8(km) =44,934.91(US\$)	50mm ² AAC (without pole construction) 8.8km 1,075.11(US\$/km) x 8.8(km) =9,460.968(US\$)	54,396
<Site 2> Substation : Bolgatanga Feeder : 29F1B(11kV)	120mm ² AAC (without pole construction) 1.6km 5,106.24(US\$/km) x 1.6(km) =8,169.984(US\$)	50mm ² AAC (without pole construction) 1.6km 1,075.11(US\$/km) x 1.6(km) =1,720.176(US\$)	9,890
<Site 3> Substation : Bolgatanga Feeder : 29F4B(11kV)	120mm ² AAC (without pole construction) 4.0km 5,106.24(US\$/km) x 4.0(km) =20,424.96(US\$)	50mm ² AAC (without pole construction) 4.0km 1,075.11(US\$/km) x 4.0(km) =4,300.44(US\$)	24,725

【Example of drawing (Case Study at Cape Coast (Central))】

Substation : Cape Coast
 Feeder : Elmina (11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Cape Coast Feeder : Elmina (11kV)	2 × 20/26MVA Substation 33/11kV (outdoor) 120mm ² AAC (with pole construction) 0.6km 2,500,000(US\$/km) x 1 (place) +21,323.94(US\$/km) x 0.6(km) =2,512,794 (US\$)	nothing	2,512,794

【Example of drawing(Case Study at Akwatia&Asamankese Area (Eastern Region)】

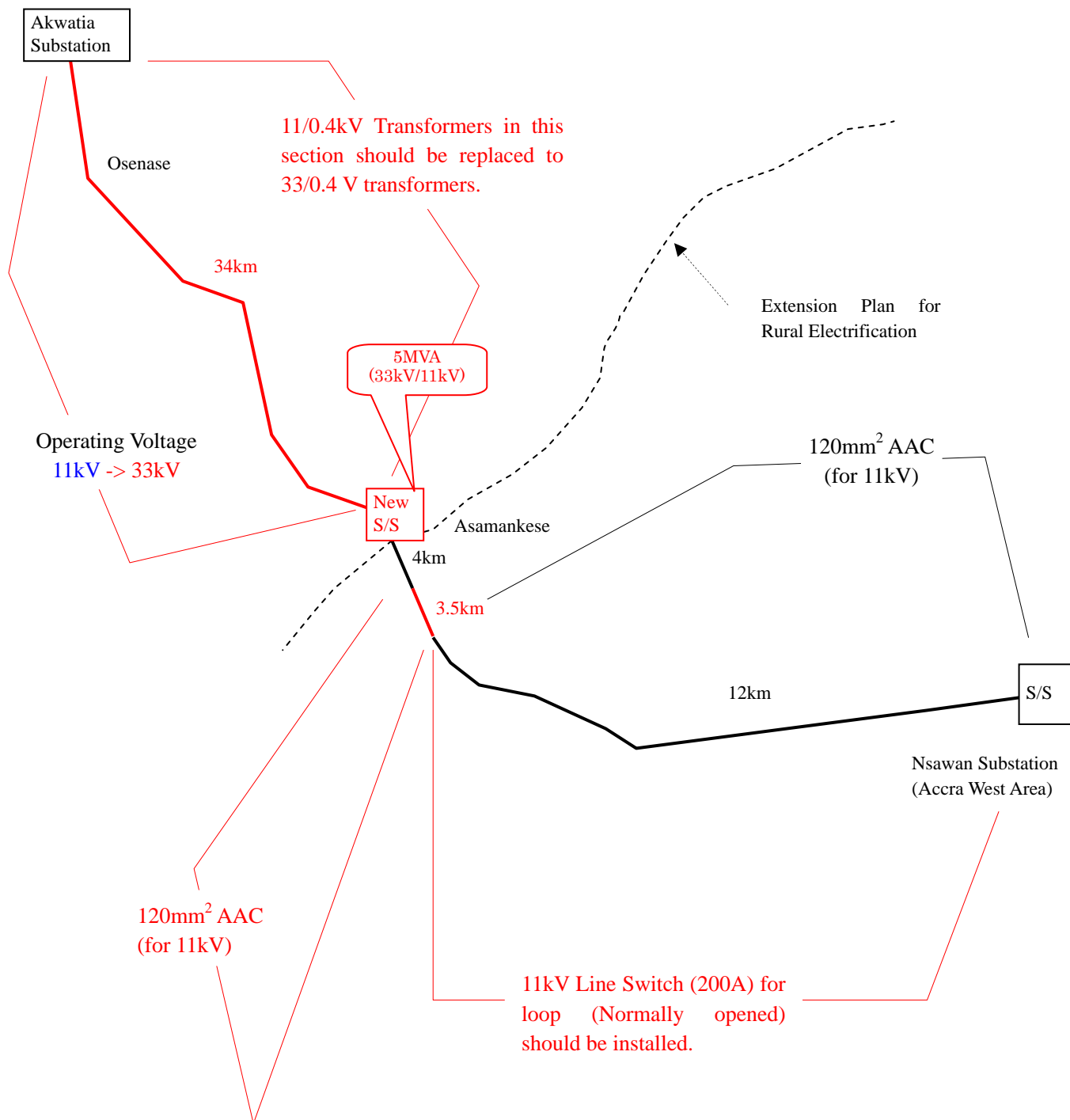
<Site 1>

Substation : Akwatia

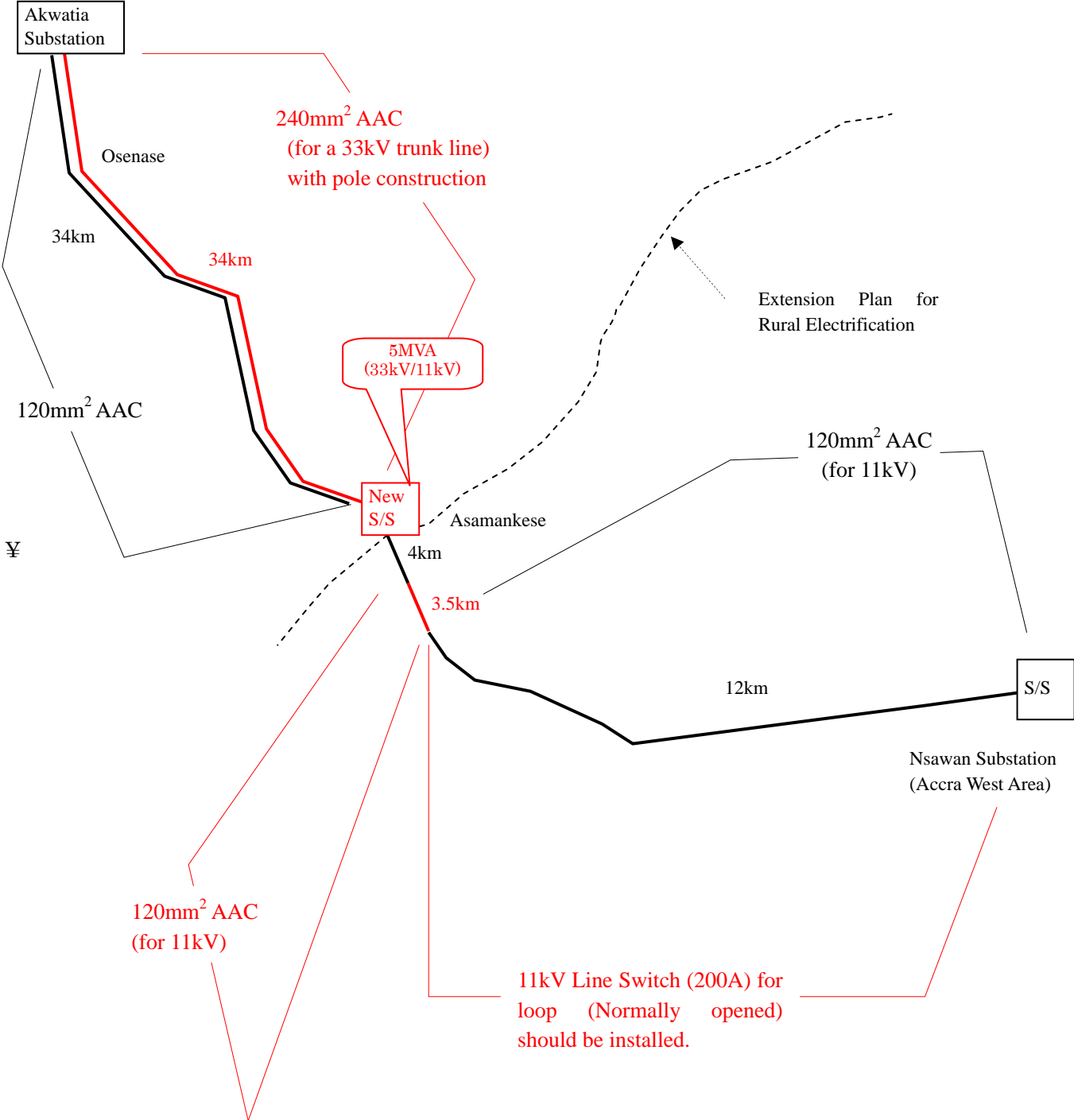
Feeder : Asamankese (11kV)

<p>Black : Existing(Remain) Red : Installation or Replacement Blue : Removal</p>

<Plan 1> Reuse of the existing line as a 33kV trunk line



<Plan 2> Newly Construction of the 33kV trunk line



<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
Substation : Akwatia Feeder : Asamankese (11kV)			
<p><Plan 1> The voltage of the section whose length is 34km is to be upgraded from 11kV to 33kV. And all transformers of this section are to be replaced to “33kV/0.4kV transformers”.</p>	<p>Insulators for 33kV, 34km 137,511(US\$)</p> <p>Transformer <33kV/0.4kV> 500kVA : 2 315kVA : 1 200kVA : 3 100kVA : 5 50kVA : 2 25kVA : 1 265,217(US\$)</p> <p>33kV/11kV Substation (5MVA) 1,000,000(US\$)</p> <p>120mm² AAC (with pole construction), 3.5km 25,168.65(US\$/km)x3.5(km) =88,089</p> <p>MV switchgear for 11kV 891,000</p>	<p>Transformers <11kV/0.4kV> 500kVA : 2 315kVA : 1 200kVA : 3 100kVA : 5 50kVA : 2 25kVA : 1 9,623(US\$)</p>	2,381,817
<p><Plan 2> To improve the voltage drop of existing feeder “Asamankese”, a new 33kV feeder is to be constructed from Akwatia substation to the middle point of existing 11kV Asamankese feeder. The conductor size of it is 240mm².</p> <p>The existing part of Asamankese feeder will be split on this point and be separated to 2 parts.</p> <p>The part from “Akwatia substation” to this point will be left as it is, and the other part will be a new substation that will be constructed in “the Middle part of this existing feeder” and transform 33kV from the new feeder into 11kV.</p>	<p>240 mm² AAC (with pole construction) 34km 80,500(US\$/km) x 34(km) = 2,737,000 (US\$)</p> <p>33kV/11kV Substation (5MVA) 1,000,000(US\$)</p> <p>120mm² AAC (with pole construction), 3.5km 25,168.65(US\$/km)x3.5(km) =88,089</p> <p>MV switchgear for 11kV 891,000</p>		4,716,089

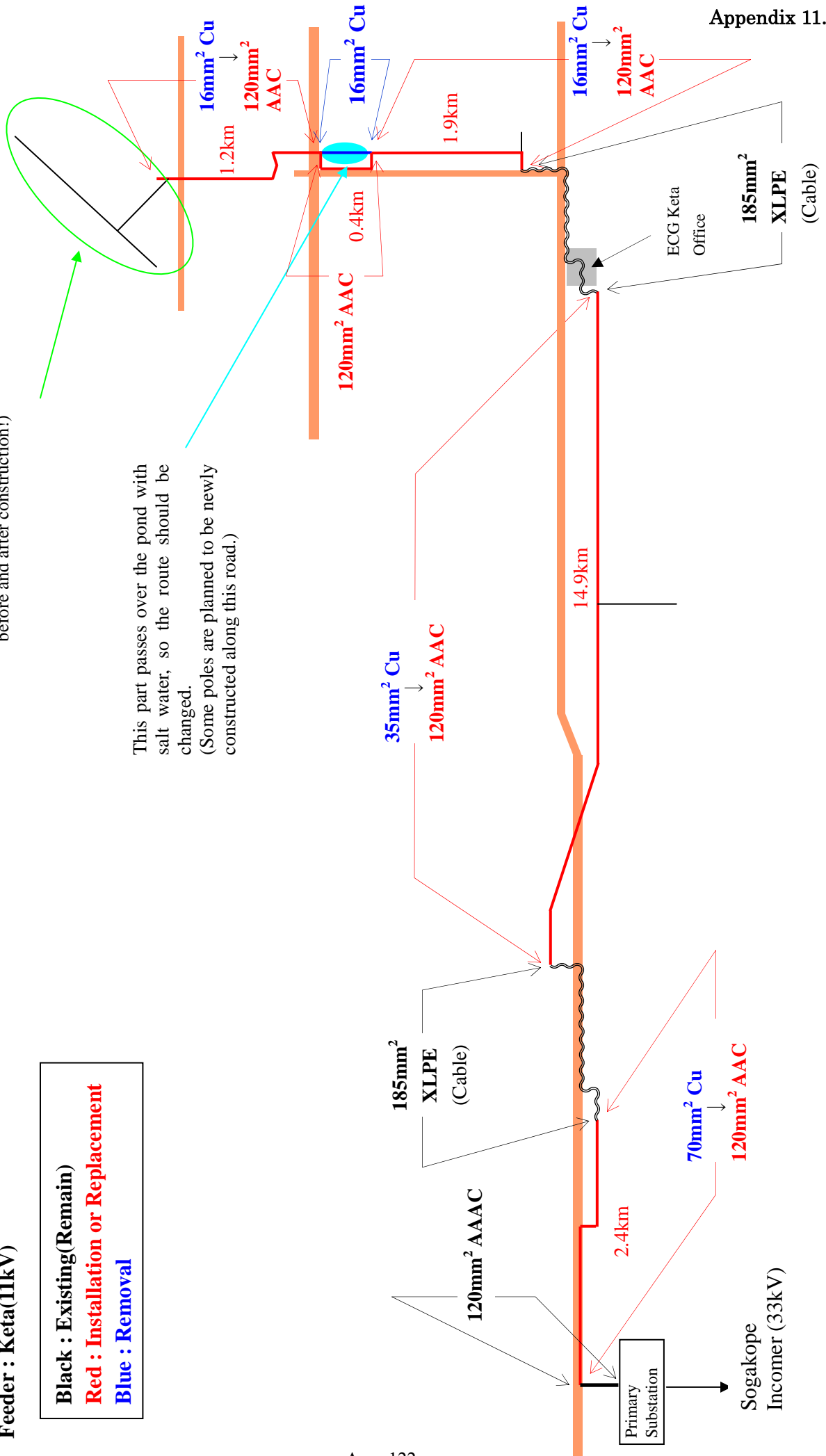
【Example of drawing(Case Study at Keta(Volta Region)】

Substation : Anloga
Feeder : Keta(11kV)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

New line constructed by MOE as rural electrification (Voltage drop was not considered before and after construction!)

This part passes over the pond with salt water, so the route should be changed. (Some poles are planned to be newly constructed along this road.)



<Cost Estimation>

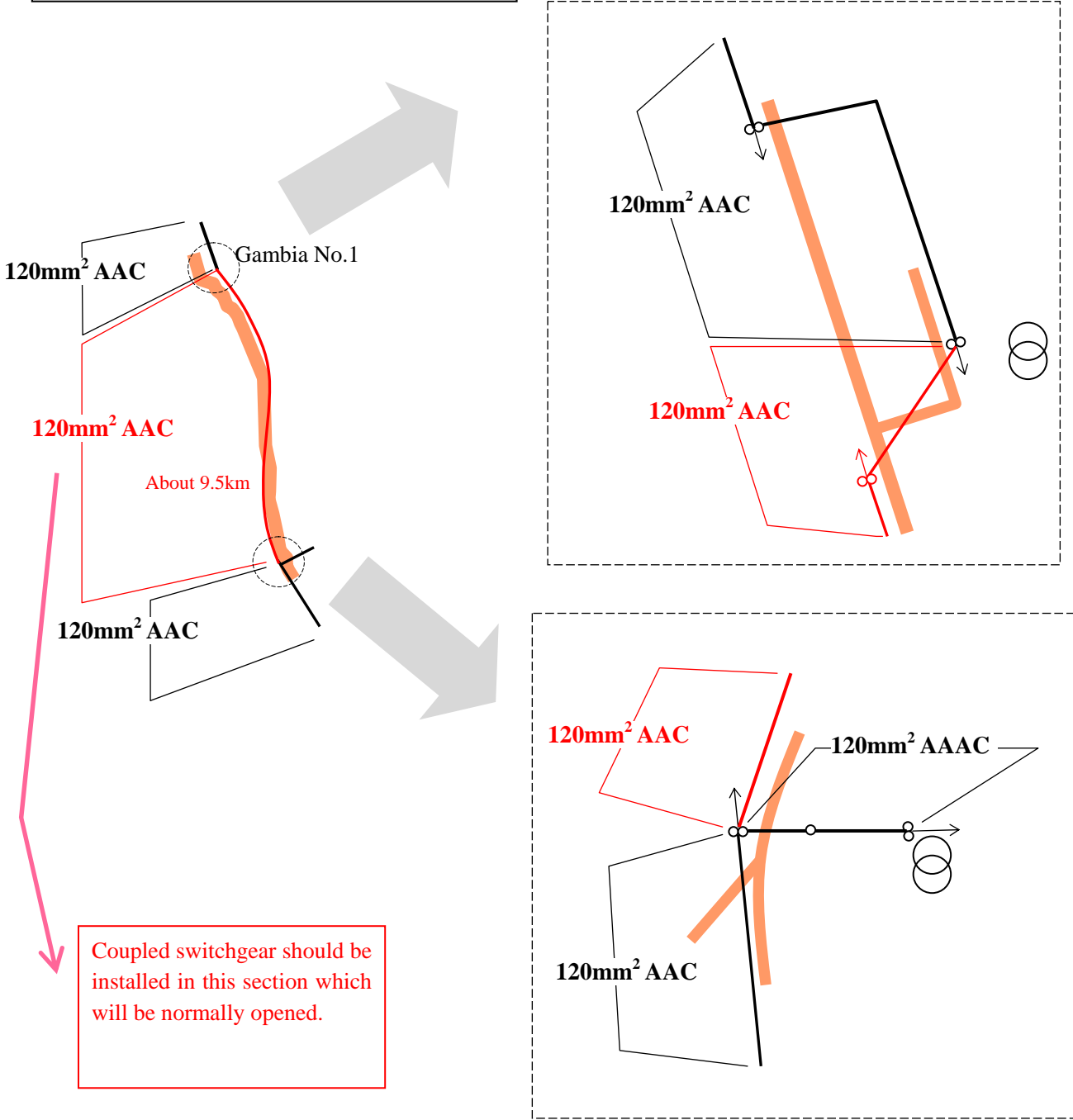
Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Techiman Feeder : 26F1B(11kV)	120mm ² AAC (without pole construction) 20.4km	70mm ² Cu (without pole construction) 2.4km	116,752
	120mm ² AAC (with pole construction) 0.5km	35mm ² Cu (without pole construction) 14.9km	
	5,106.24(US\$/km) x 20.4(km) +25,168.28(US\$/km) x 0.5(km) =104,167.3(US\$)	16mm ² Cu (without pole construction) 3.5km 1,117.87(US\$/km) x 2.4(km) 1,075.11(US\$/km) x 14.9(km) 1,075.11(US\$/km) x 3.5(km) =22,464.3(US\$)	

【Example of drawing(Case Study at Sunyani Office Area (VRA-NED))】

Substation : Sunyani Substation
Feeder : Mim/Goaso/Hwidie (34.5kV)

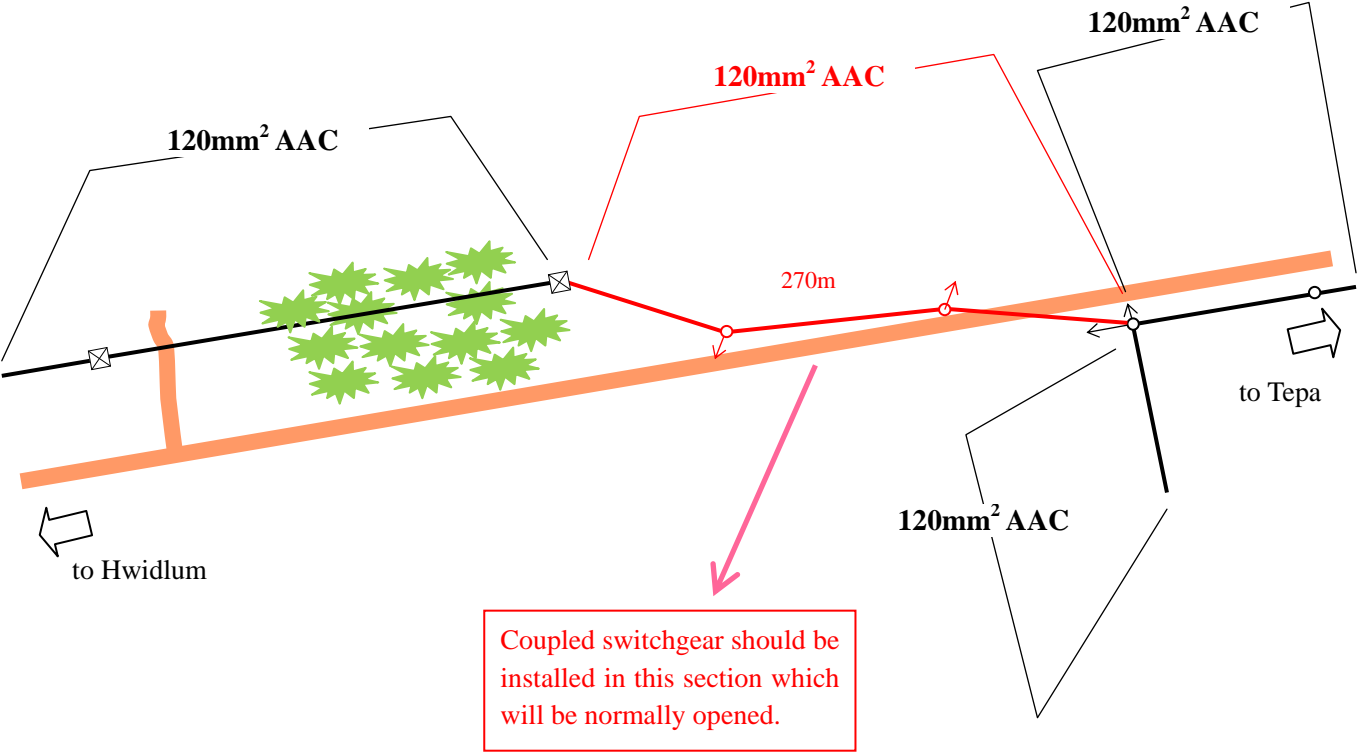
<Unconnected section -1>

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Unconnected section -2>

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



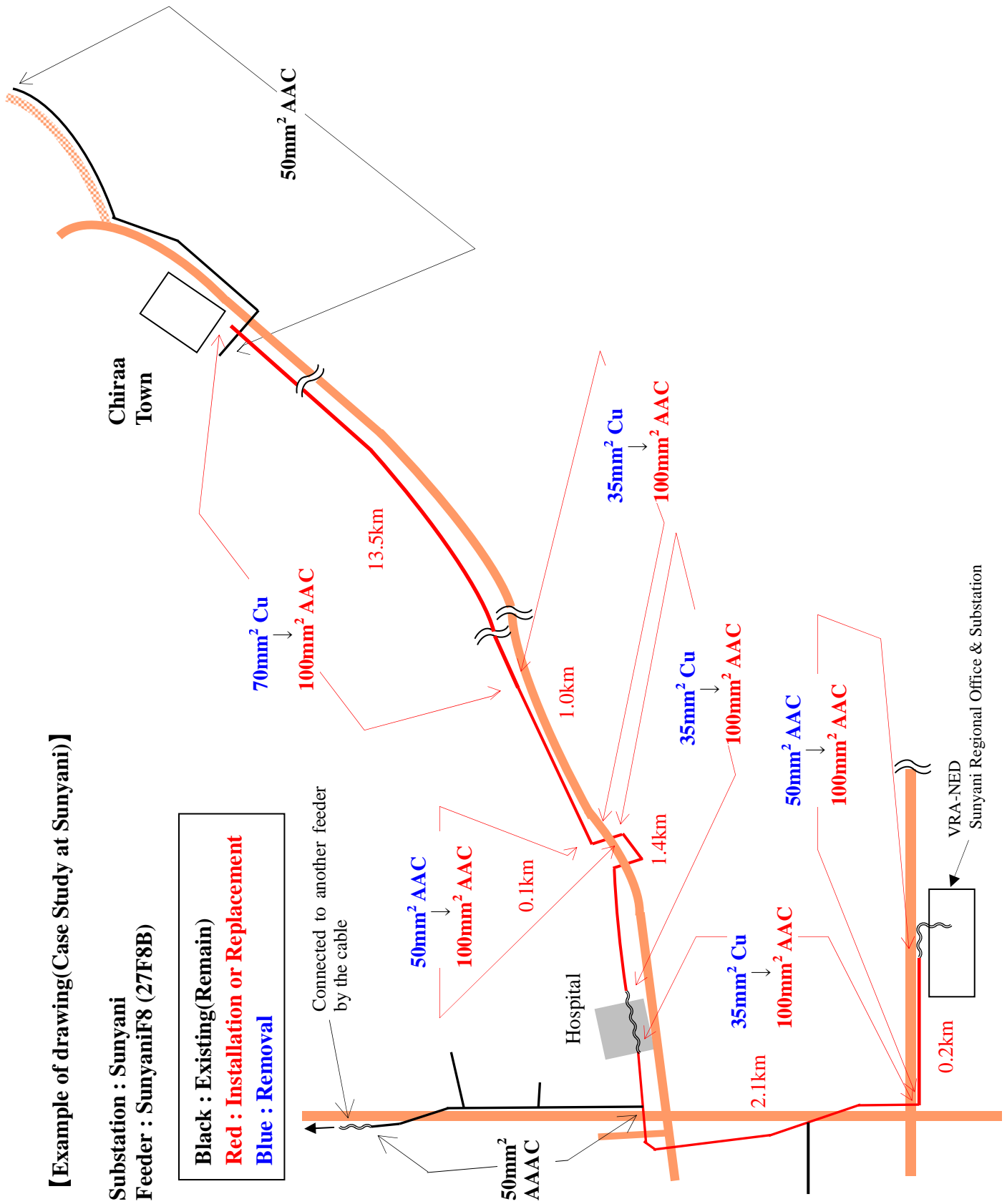
<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
Substation : Sunyani Substation Feeder : Mim/Goaso/Hwidie (34.5kV)	120mm ² AAC (with pole construction) 9.8km 25,168.65(US\$/km) x 9.8(km) =246,652.8(US\$)	/	246,653

【Example of drawing(Case Study at Sunyani)】

Substation : Sunyani
 Feeder : SunyaniF8 (27F8B)

Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal

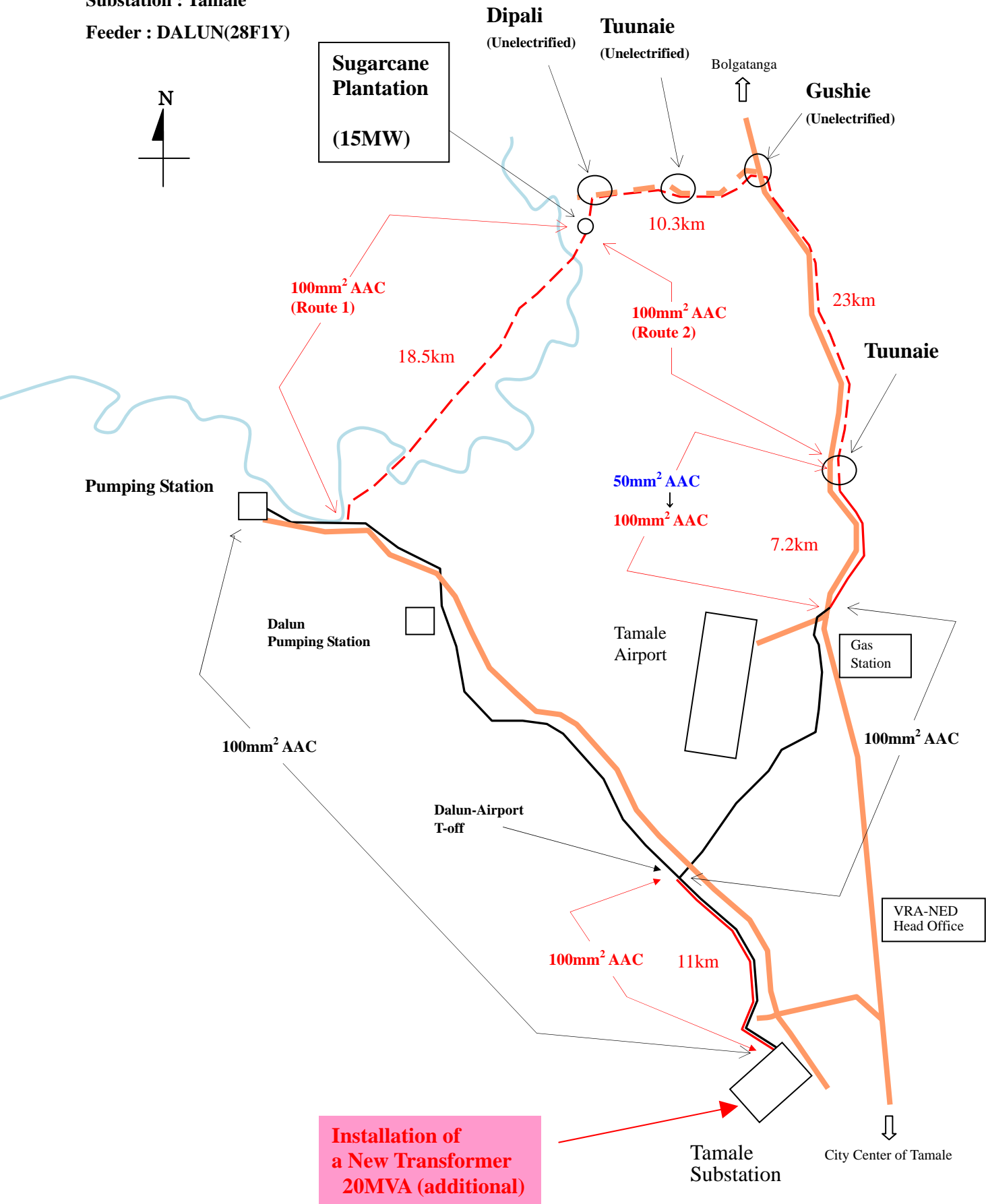


<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Main B Feeder : Circuit 5	<p>100 mm² AAC (without pole construction) 18.3km</p> <p>5,106.24(US\$/km) x 18.3(km) =93,444.2(US\$)</p>	<p>35 mm² AAC (without pole construction) 4.5km</p> <p>50 mm² AAC (without pole construction) 0.3km</p> <p>70 mm² AAC (without pole construction) 13.5km</p> <p>1,075.11(US\$/km) x 4.5(km) 1,075.11(US\$/km) x 0.3(km) 1,075.11(US\$/km) x 13.5(km) =19,674.5(US\$)</p>	113,119

【Example of drawing(Case Study at Tamale (Northern Region))】

Substation : Tamale
Feeder : DALUN(28F1Y)

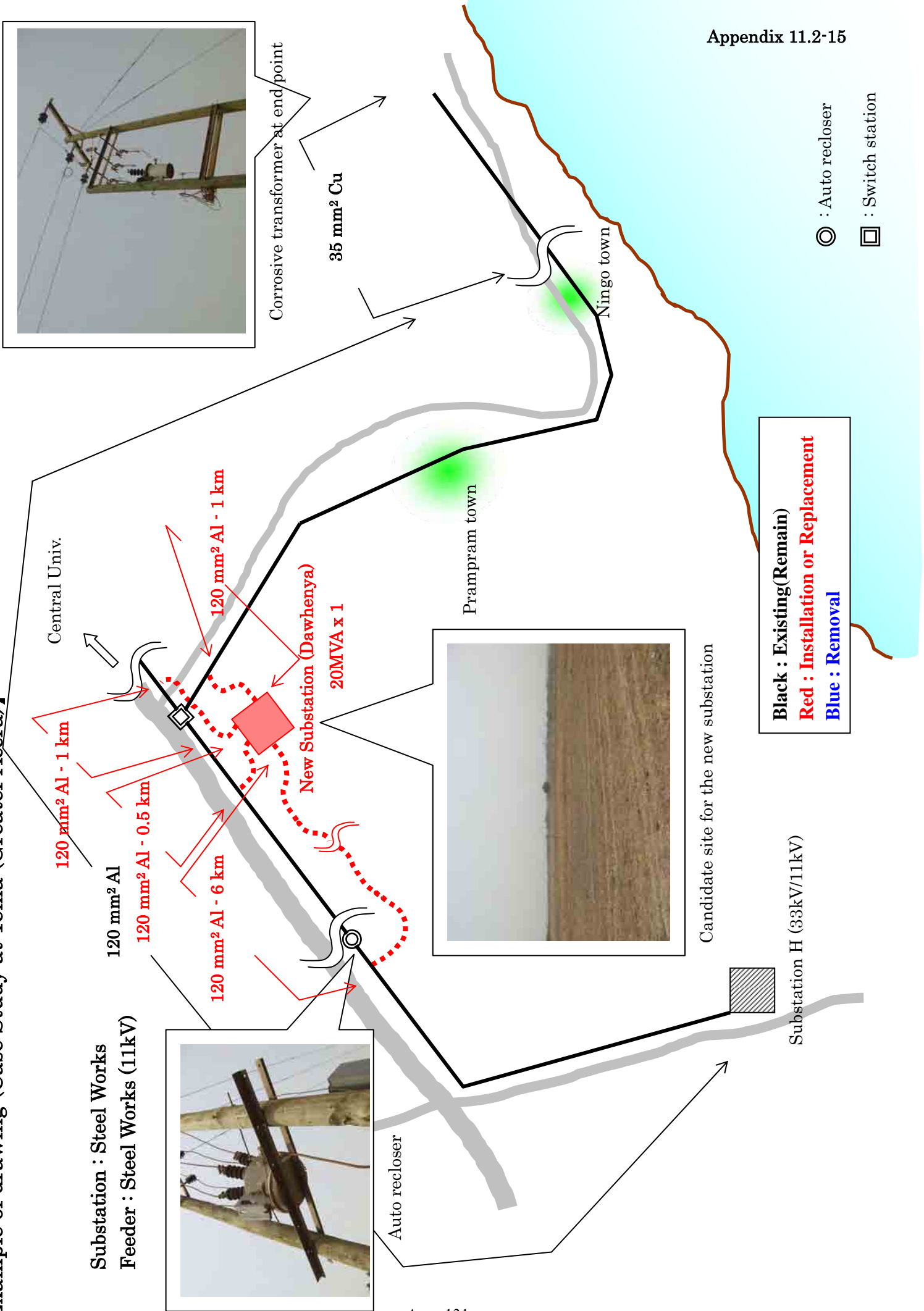


(*) 100mm² AAC line (34.5kV) will be newly constructed from Tamale Substation to “Dalun – Airport T-off” to reinforce the capability of sending power of this feeder. As a result, this section will have 2 circuits on the same supporting structures. (New line can be constructed on existing iron towers.)

<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
Substation : Tamale Feeder : DALUN (28F1Y) [34.5kV]			
<Route 1>	<p>100mm² AAC (with pole construction) 18.5km</p> <p>100mm² AAC (without pole construction) 11km</p> <p>1,000kVA Transformer (34.5kV/0.4kV) : 15 (Estimated total demand is 15MVA, so it is assumed that 15 transformers (34.5kV/0.4kV) with 1,000kVA should be installed.)</p> <p>+ Additionally, they need land leveling cost near the sugarcane.</p> <p>25,168.65(US\$/km) x 18.5(km) = 276,855(US\$) 5,106.24(US\$/km) x 11(km) = 91,912(US\$) 61,261.1(US\$/No.) x 15 = 918,917(US\$)</p>		<p>1,287,684 + Land Leveling Cost</p>
<Route 2>	<p>100mm² AAC (with pole construction) 33.3km</p> <p>100mm² AAC (without pole construction) 7.2km</p> <p>1,000kVA Transformer (34.5kV/0.4kV) : 15 (Estimated total demand is 15MVA, so it is assumed that 15 transformers (34.5kV/0.4kV) with 1,000kVA should be installed.)</p> <p>25,168.65(US\$/km) x 33.3(km) = 838,116(US\$) 5,106.24(US\$/km) x 7.2(km) = 36,765(US\$) 61,261.1(US\$/No.) x 15 = 918,917(US\$)</p>	<p>50mm² AAC (without pole construction) 7.2km</p> <p>1,075.11(US\$/km) x 7.2(km) = 7,741 (US\$)</p>	<p>1,801,538</p>

[Example of drawing (Case Study at Tema (Greater Accra))]



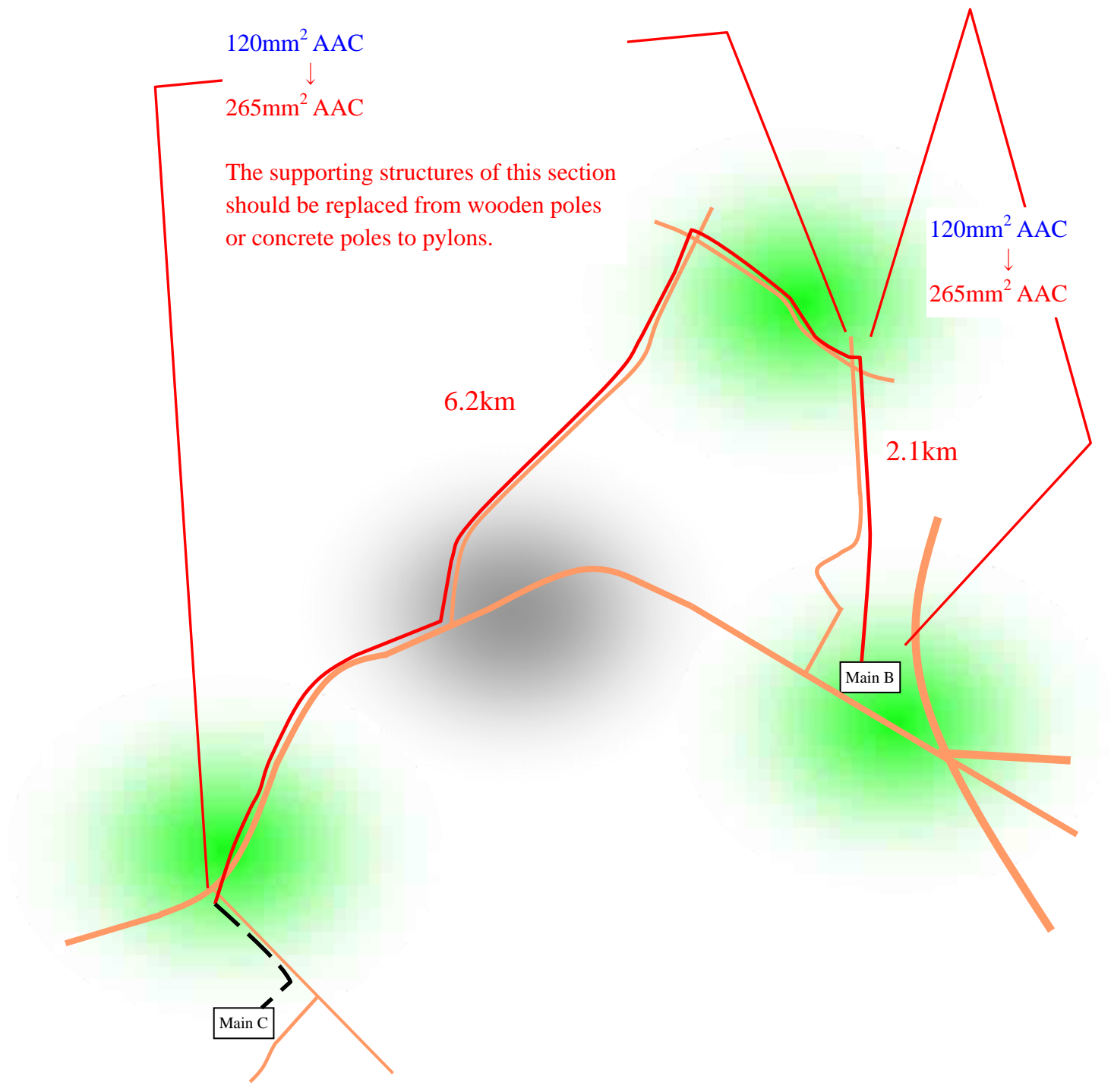
<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<p><Site 1> Substation : Steel Works Feeder : Steel Works (11kV)</p>	<p>1x20MVA Substation (outdoor) 120mm² AAC (with pole construction) 8.5km 2,500.000(US\$/km) x 1 (place) +21,323.94(US\$/km) x 8.5(km) =2,681,253(US\$)</p>	<p>nothing</p>	<p>2,681,253</p>

【Example of drawing(Case Study at Western Area (ECG Western Regional Office))】

<Site 1>
Substation : Main B
Feeder : Circuit 5

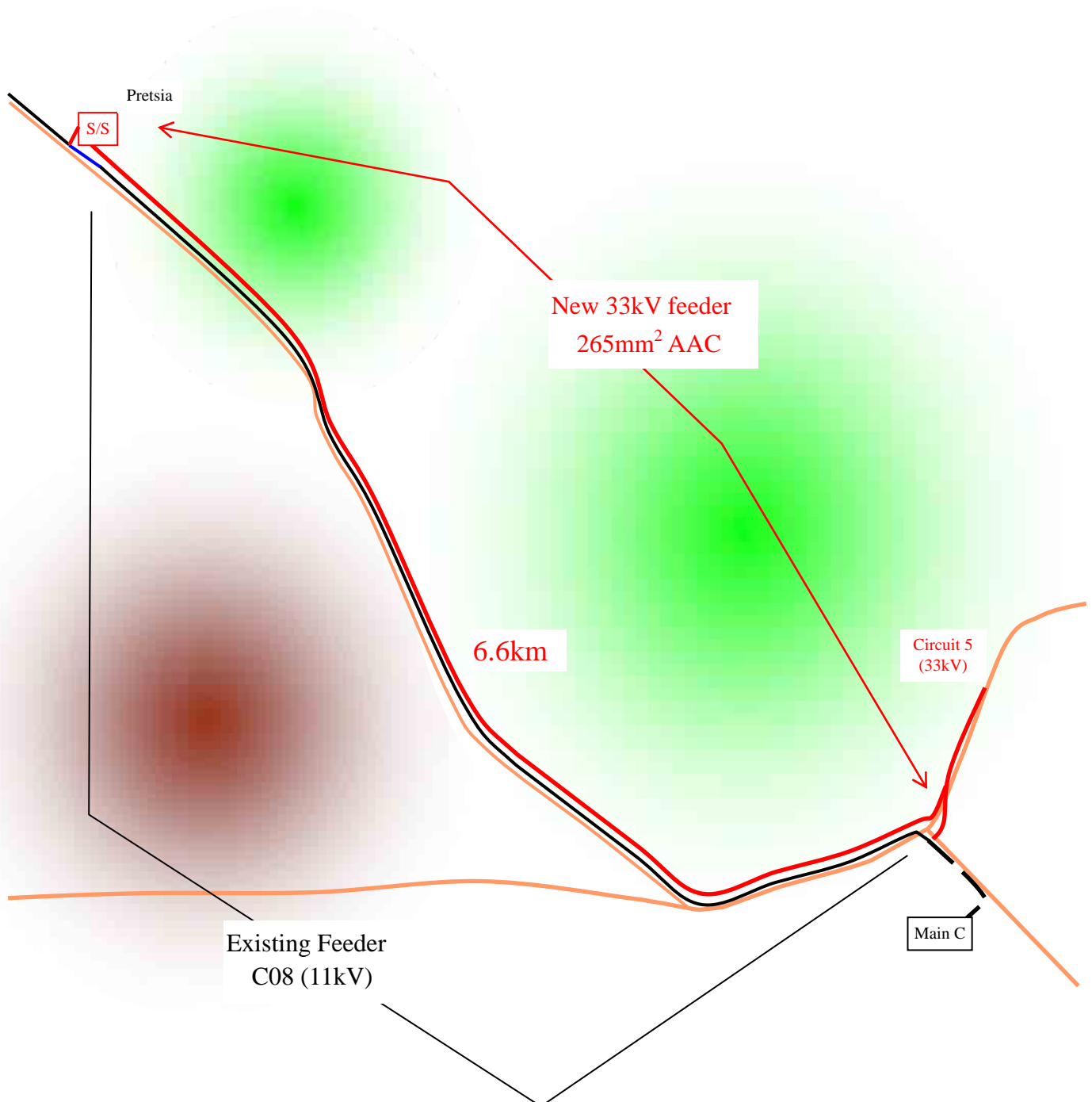
Black : Existing(Remain)
Red : Installation or Replacement
Blue : Removal



<Site 2>

Substation : Main C

Feeder : C08



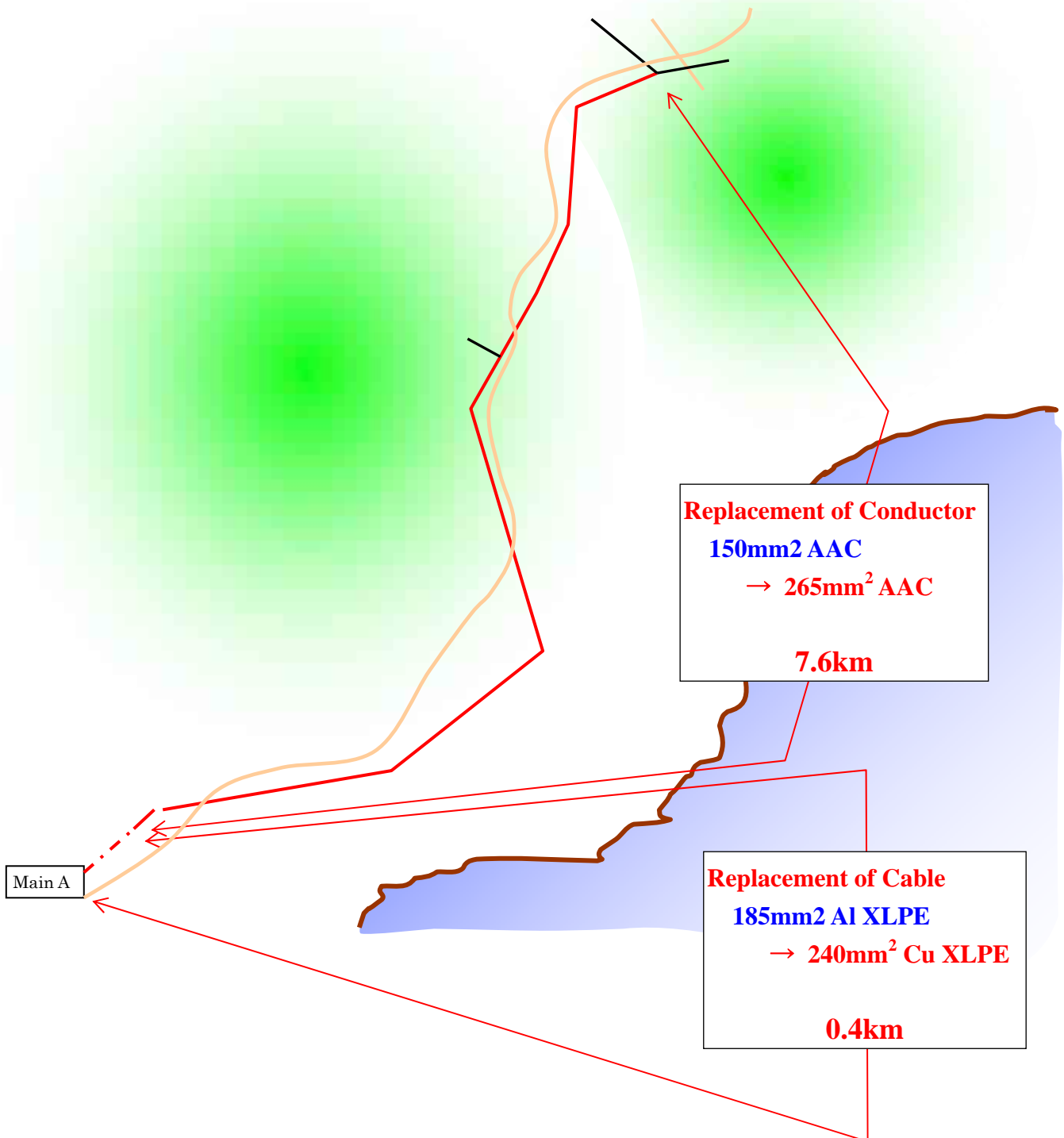
To improve the voltage drop of existing feeder “C08”, a new 33kV feeder is to be constructed from the middle point of 33kV feeder “Circuit 5” to the city “Pretsia”. The conductor size of it is 265mm².

The existing part of “C08” will be split on “Pretsia” and be separated to 2 parts. The part from “Main C” to “Pretsia” will be left as it is, and the other part (from “Pretsia” to the end) will be connected to a new substation that will be constructed in “Pretsia” and transform 33kV from the new feeder into 11kV.

<Site 3>

Substation : Main A

Feeder : A55 (11kV)



To improve the overload current and the voltage drop of existing feeder “A55 (11kV)”, the existing cable (185mm² Al XLPE, 0.4km) should be replaced to 240mm² Cu ALPE, and the existing overhead line (150mm² AAC, 7.6km) should be replaced to 265mm² AAC. The supporting structures of the replaced section are all pylons that can endure the mechanical strengths of 265mm² AAC conductor, so it is not necessary to replace the supporting structure. Only conductors are to be replaced.

<Cost Estimation>

Site	Installation of Facilities	Removal of Facilities	Total Cost (US\$)
<Site 1> Substation : Main B Feeder : Circuit 5	<p>265 mm² AAC (with pole construction) 6.2km</p> <p>265 mm² AAC (without pole construction) 2.1km</p> <p>80,500(US\$/km) x 6.2(km) +17,500(US\$/km) x 2.1(km) = 535,850 (US\$)</p>	<p>120 mm² AAC 8.3km</p> <p>117.87(US\$/km) x 8.3(km) = 978(US\$)</p>	536,828
<Site 2> Substation : Main C Feeder : C08	<p>265 mm² AAC (with pole construction) 6.6km</p> <p>33kV/11kV Substation (5MVA)</p> <p>80,500(US\$/km) x 6.6(km) +1,000,000 = 1,531,300 (US\$)</p>	/	1,531,300
<Site 3> Substation : Main A Feeder : A55	<p>240mm² Cu Cable 0.4km</p> <p>240mm² AAC 7.6km</p> <p>64,181.33(US\$/km) x 0.4(km) +7,111.97(US\$/km) x 7.6(km) =79,724 (US\$)</p>	<p>185mm² Al XLPE Cable 0.4km</p> <p>150mm² AAC 7.6km</p> <p>5,058.02(US\$/km) x 0.4(km) +117.878(US\$/km) x 7.6(km) =2,919(US\$)</p>	82,643

