



REPUBLIC OF ZAMBIA

LUSAKA TRANSMISSION AND DISTRIBUTION REHABILITATION PROJECT (LTDRP) – LOW VOLTAGE DISTRIBUTION NETWORK

Rehabilitation, Extension and Strengthening of the Low Voltage Electrical Distribution Network in Lusaka

- Lot 1:** Townships located North-East of Lusaka Central Business District (CBD)
Lot 2: Townships located North of Lusaka CBD
Lot 3: Townships located South of Lusaka CBD

Tender No: EuropeAid/140514/IH/WKS/ZM

TENDER DOSSIER

Volume 5

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Volume 5:

Section 1	Design Document including Drawings
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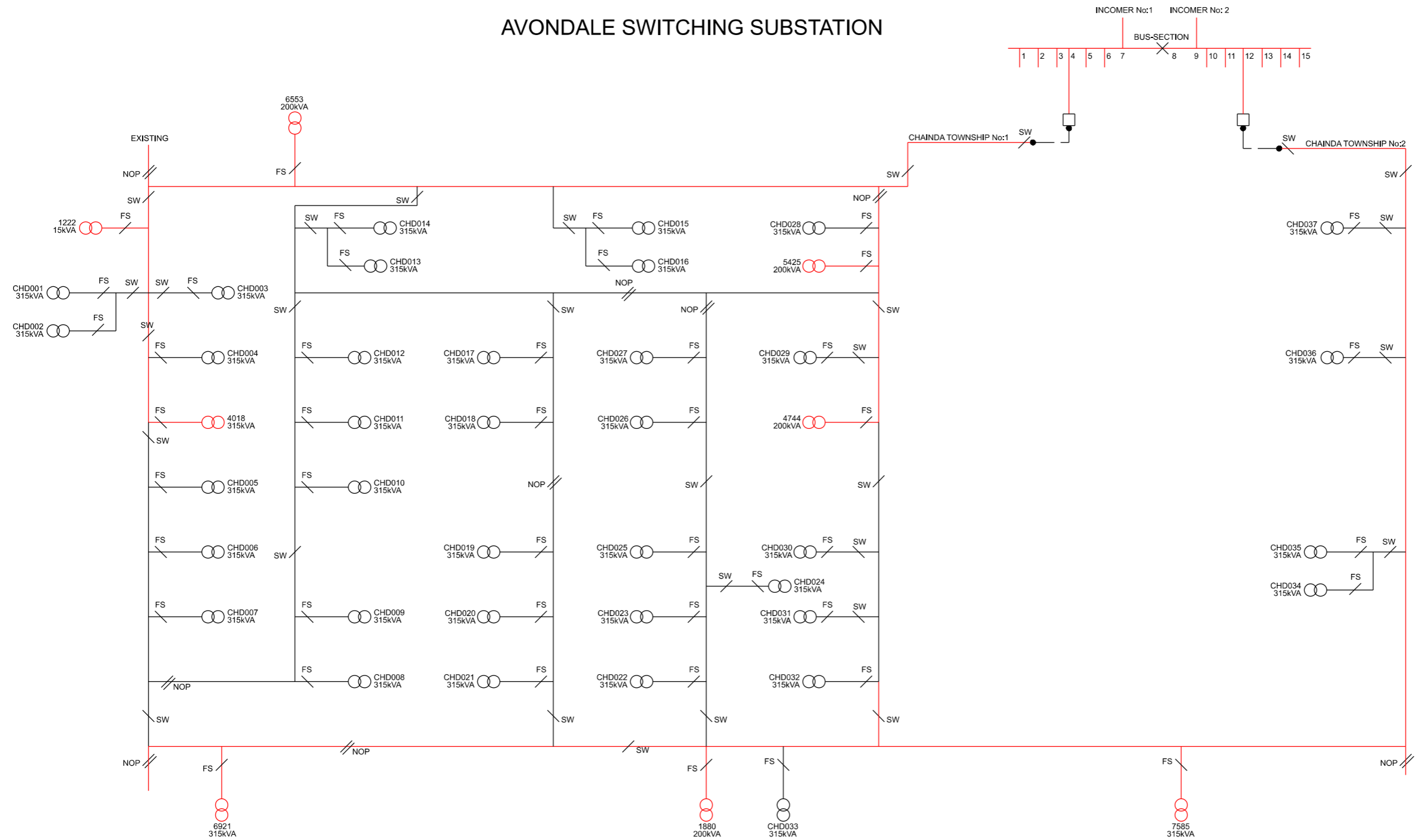
Design Documents and Drawings



Single-Line Diagrams

Drawing No.	Drawing Description
001	Chainda Township MV Network Single Line Diagram, Rev. 1
002	Kamanga Township MV Network Single Line Diagram, Rev. 1
003	Mtendere Townships MV Network Single Line Diagram, Rev. 1
004	Chawama and John Howard Township MV Network Single Line Diagram, Rev. 1
005	Garden Township MV Network Single Line Diagram, Rev. 1
006	Mandevu Township MV Network Single Line Diagram, Rev. 1
007	Ngwerere Township MV Network Single Line Diagram, Rev. 1

AVONDALE SWITCHING SUBSTATION



LEGEND:

Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm ² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm ² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm ² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
○	EXISTING TXS TRANSFORMER
×	BUS-SECTION

Notes:

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

Client:
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).

Consultant:

 GOPA International Energy Consultants

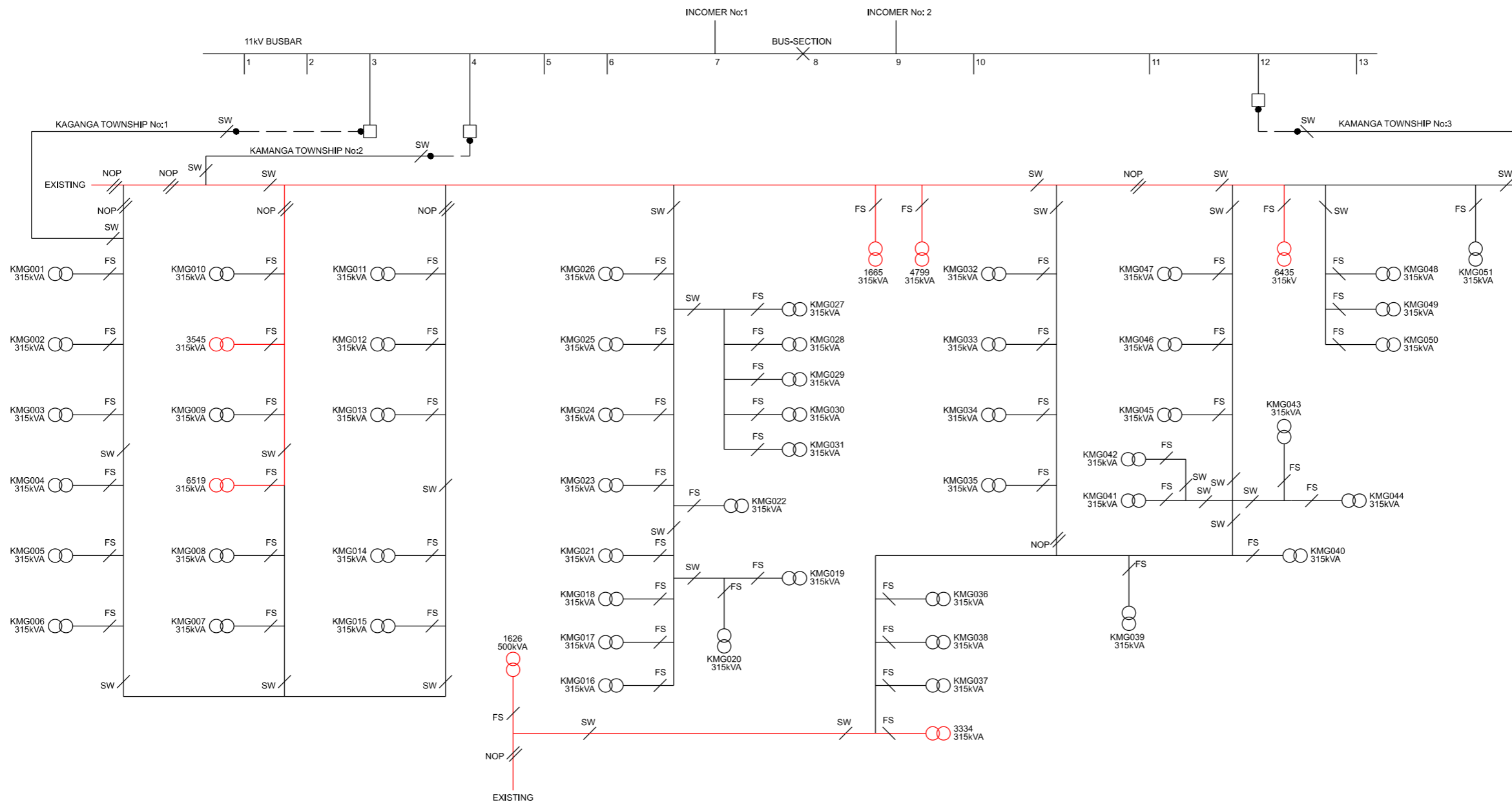
Project:
 Lusaka Transmission and Distribution Rehabilitation Project (LTDRP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
CHAINDA TOWNSHIP SINGLE LINE DIAGRAM

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	SPARE
4	CHAINDA TOWNSHIP No:1
5	SPARE
6	SPARE
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	SPARE
11	SPARE
12	CHAINDA TOWNSHIP No:2
13	SPARE
14	SPARE
15	SPARE

Date:	Drawn:	Checked:	Appr.:	Format:
20/06/2019	M.A	N.B	E.K	A3
Drawing Number:			Rev:	Scale:
001			1	SC.

CHELSTON OBAMA 11kV SWITCHING STATION



LEGEND:	
Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm ² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm ² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm ² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
⊗	EXISTING TXS TRANSFORMER
X	BUS-SECTION

Notes:

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

Client:
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).



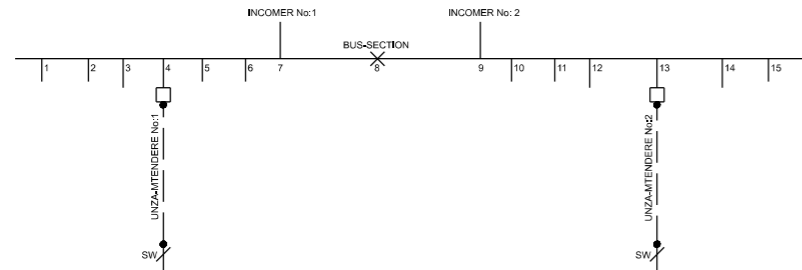
Project:
Lusaka Transmission and Distribution Rehabilitation Project (LTDRP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
KAMANGA TOWNSHIP SINGLE LINE DIAGRAM

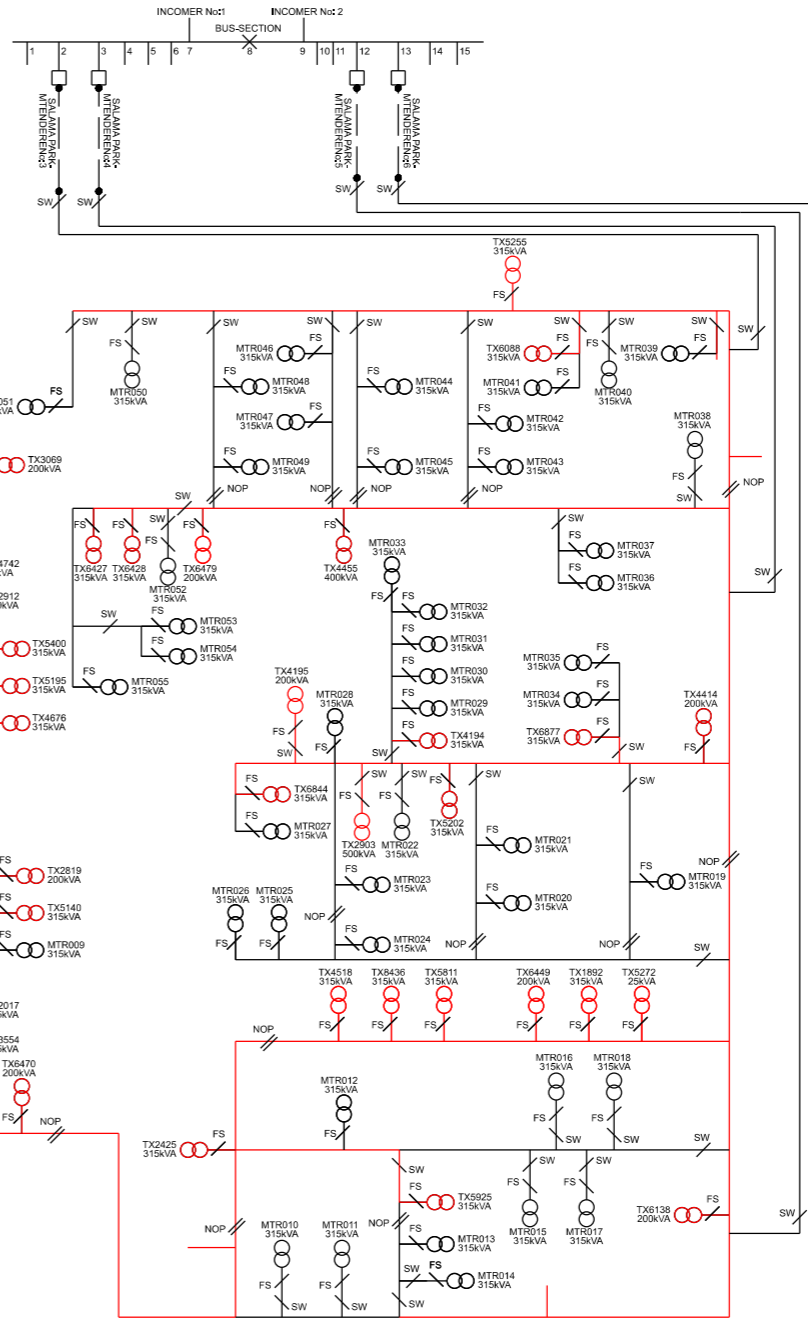
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20/06/2019	M.A	N.B	E.K	A3
Drawing Number:	Rev	Scale:		
002	1	SC.		

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	KAMANGA TOWNSHIP No:1
4	KAMANGA TOWNSHIP No:2
5	LTDRP FEEDER 3 (WESTERN)
6	LTDRP FEEDER 1 (NORTHERN)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LTDRP FEEDER 2 (SOUTHERN)
11	LTDRP FEEDER 2 (EASTERN)
12	KAMANGA TOWNSHIP No:3
13	SPARE
14	SPARE
15	SPARE

UNZA SWITCHING STATION
(CHINESE CENTRE) - UNI_SS 2



IBEX SWITCHING STATION
(SALAMA PARK) IB_SS 1



LEGEND:

Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm ² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm ² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm ² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
⊗	EXISTING TXS TRANSFORMER
×	BUS-SECTION

Notes:

Notes area for project-specific instructions and remarks.

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

Client:
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).



Project:
Lusaka Transmission and Distribution Rehabilitation Project (LTD RP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
MTENDERE TOWNSHIP SINGLE LINE DIAGRAM

Date:	Drawn:	Checked:	Appr.:	Format:
20/06/2019	M.A	N.B	E.K	A3
Drawing Number:	003		Rev:	Scale:
			1	SC.

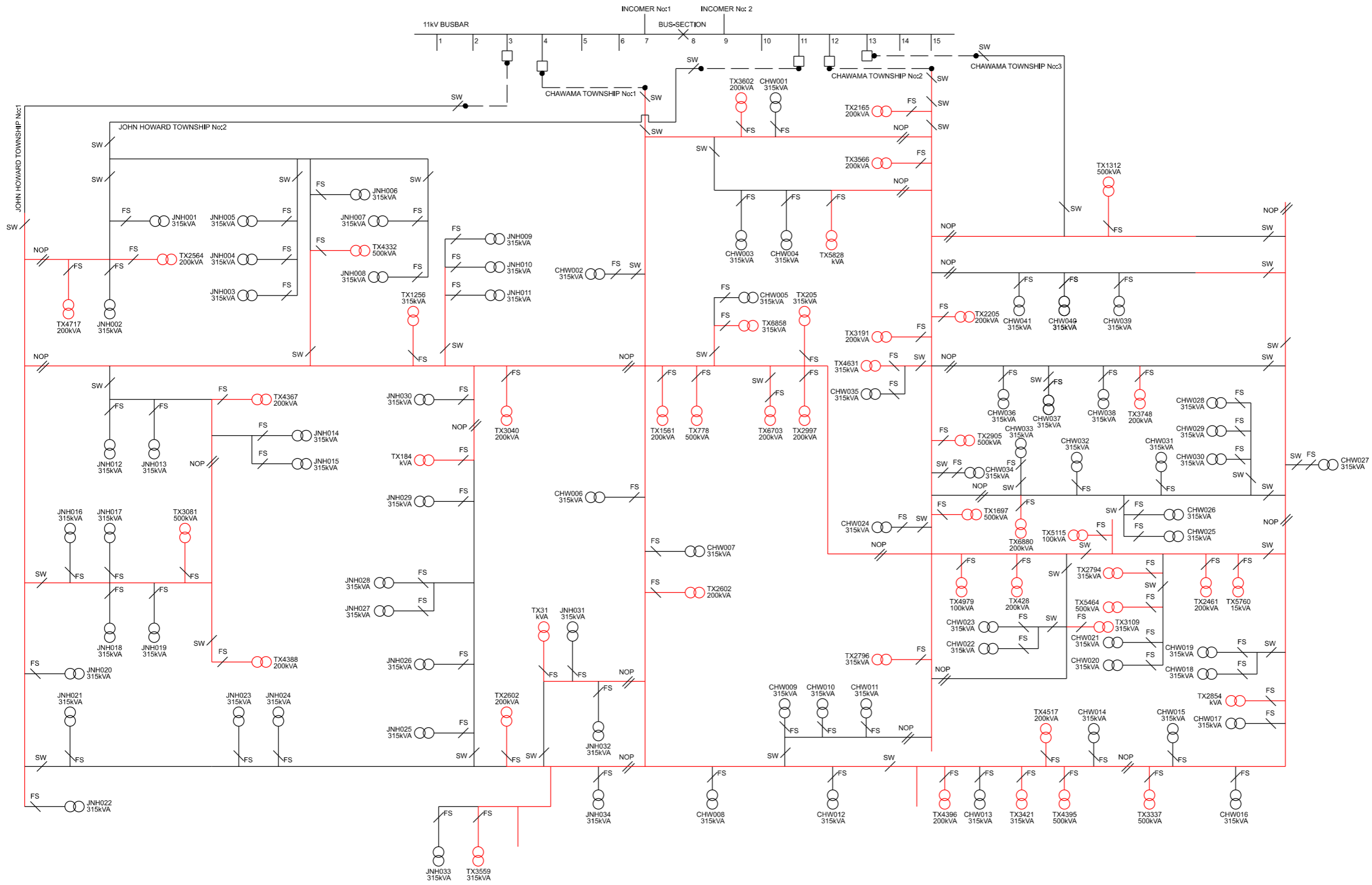
UNZA SWITCHING STATION

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	SPARE
4	MTENDERE TOWNSHIP No:1
5	LAST MILE STUDY FEEDER 2 (ALICK NKHATA Rd/THABO MBEKI JUNCTION)
6	LAST MILE STUDY FEEDER 1 (SOUTHERN DIRECTION ALONG ALICK NKHATA Rd)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY FEEDER 3 (NATIONAL ASSEMBLY MOTELS DIRECTION)
11	LAST MILE STUDY FEEDER 4 (SOUTHEASTERN DIRECTION)
12	SPARE
13	MTENDERE TOWNSHIP No:2
14	SPARE
15	SPARE

SALAMA PARK SWITCHING STATION

PANEL NUMBER	FEEDER NAME
1	SPARE
2	MTENDERE TOWNSHIP No:4
3	MTENDERE TOWNSHIP No:3
4	LAST MILE STUDY FEEDER 3 (NEAR D 1923)
5	LAST MILE STUDY FEEDER 2 (LINK PMT 6418)
6	LAST MILE STUDY FEEDER 1 (LINK PMT 6419)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY FEEDER 4 (LINK PMT 5495)
11	LAST MILE STUDY FEEDER 5 (NEAR SUNLIGHT BAR)
12	MTENDERE TOWNSHIP No:5
13	MTENDERE TOWNSHIP No:6
14	SPARE
15	SPARE

CHAWAMA SWITCHING STATION (MAKENI) - CH_SS 1



LEGEND:

Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm ² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm ² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm ² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
⊗	EXISTING TXS TRANSFORMER
×	BUS-SECTION

Notes:

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).

Consultant:

 Client: **intec**
 GOPA International Energy Consultants

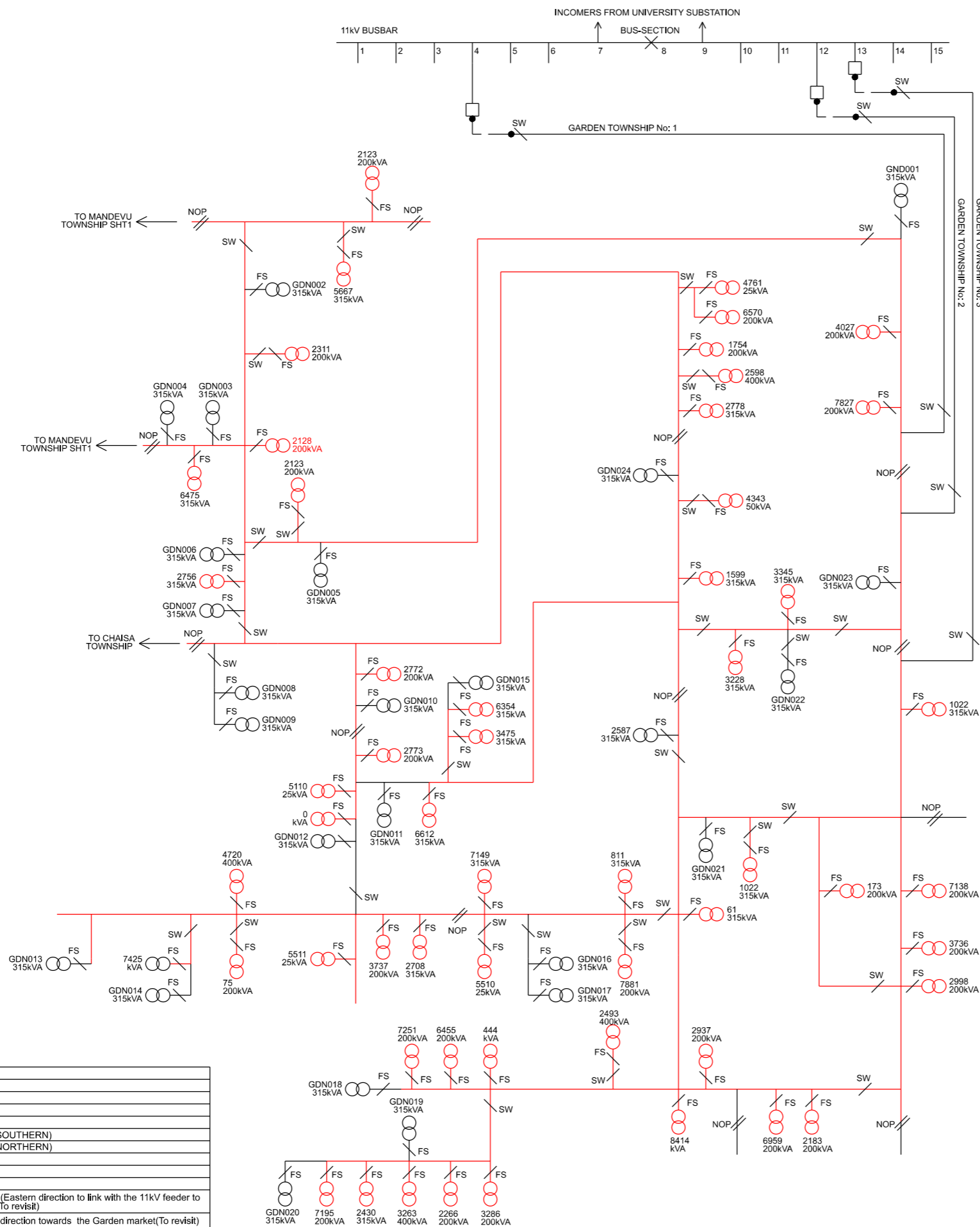
Project:
 Lusaka Transmission and Distribution Rehabilitation Project (LTD RP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
CHAWAMA - JOHN HOWARD TOWNSHIP SINGLE LINE DIAGRAM

Date:	Drawn:	Checked:	Appr.:	Format:
20/06/2019	M.A	N.B	E.K	A3
Drawing Number:	Rev	Scale:		
004	1	SC.		

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	JOHN HOWARD TOWNSHIP No:1
4	CHAWAMA TOWNSHIP No:1
5	LAST MILE STUDY FEEDER 2 (CHIPWENUPWENU EAST FEEDER)
6	LAST MILE STUDY FEEDER 1 (VUMA FEEDER)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY FEEDER 3 (KAFUE NORTH & SOUTH FEEDERS)
11	JOHN HOWARD TOWNSHIP No:2
12	CHAWAMA TOWNSHIP No:2
13	CHAWAMA TOWNSHIP No:3
14	SPARE
15	SPARE

UNIVERSITY 11kV SWITCHING STATION (GARDEN) UNI_SS1



PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	SPARE
4	GARDEN TOWNSHIP No:1
5	LAST MILE STUDY FEEDER (SOUTHERN)
6	LAST MILE STUDY FEEDER (NORTHERN)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY FEEDER 2 (Eastern direction to link with the 11kV feeder to the GMT near Olympia Market (To revisit))
11	LAST MILE STUDY 4 (Western direction towards the Garden market (To revisit))
12	GARDEN TOWNSHIP No: 2
13	GARDEN TOWNSHIP No: 3
14	SPARE
15	SPARE

LEGEND:	
Symbols	Description
	SW (SWITCH)
	FS (FUSED SWITCH)
	NOP (NORMALLY OPEN POINT)
	185mm ² XLPE 11kV 3C CABLE
	New/Planned Construction of 100mm ² ACSR DOG CONDUCTOR OHL
	EXISTING MV LINE (TO BE UPGRADED TO 100mm ² ACSR DOG CONDUCTOR OHL)
	FEEDER CIRCUIT BREAKER
	NEW TXS TRANSFORMER
	EXISTING TXS TRANSFORMER
	BUS-SECTION

Notes:

Client:				
For Engineering Design Report	30/7/19	M.A	E.K	
For Tender Purposes Only	23/8/19	M.A	E.K	
Purpose of Issue	Ref.	Date	Drn.	Appr.

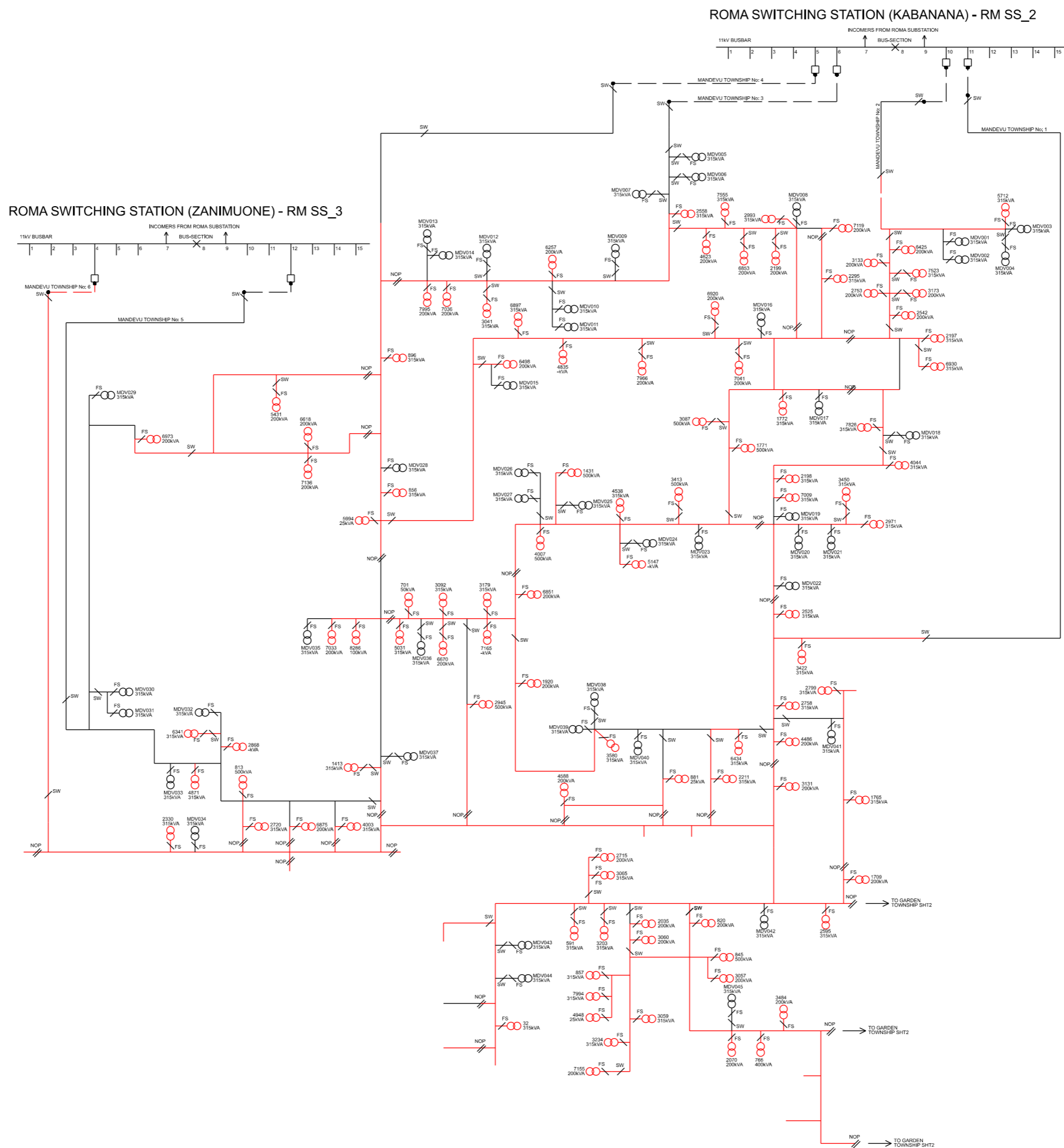
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).



Project:
Lusaka Transmission and Distribution Rehabilitation Project (LTDRP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
GARDEN TOWNSHIP SINGLE LINE DIAGRAM

Date:	Drawn:	Checked:	Appr.:	Format:
20/06/2019	M.A	N.B	E.K	A3
Drawing Number:			Rev	Scale:
005			1	SC.



ROMA SWITCHING STATION (KABANANA) - RM SS_2

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	SPARE
4	SPARE
5	MANDEVU TOWNSHIP No: 4
6	MANDEVU TOWNSHIP No: 3
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LTD RP FEEDER 2 (SOUTHERN)
11	MANDEVU TOWNSHIP No: 2
12	MANDEVU TOWNSHIP No: 1
13	SPARE
14	SPARE
15	SPARE

ROMA SWITCHING STATION (ZANIMUONE) - RM SS_3

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	SPARE
4	MANDEVU TOWNSHIP No:6
5	LAST MILE STUDY (NORTH)
6	LAST MILE STUDY (SOUTH)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY (FEEDER 3)
11	LAST MILE STUDY (OPPOSITE ADNANA BLOCK FACTORY)
12	MANDEVU TOWNSHIP No:5
13	SPARE
14	SPARE
15	SPARE

LEGEND:

Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
⊗	EXISTING TXS TRANSFORMER
×	BUS-SECTION

Notes:

Notes area for project details and instructions.

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

Client:
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).



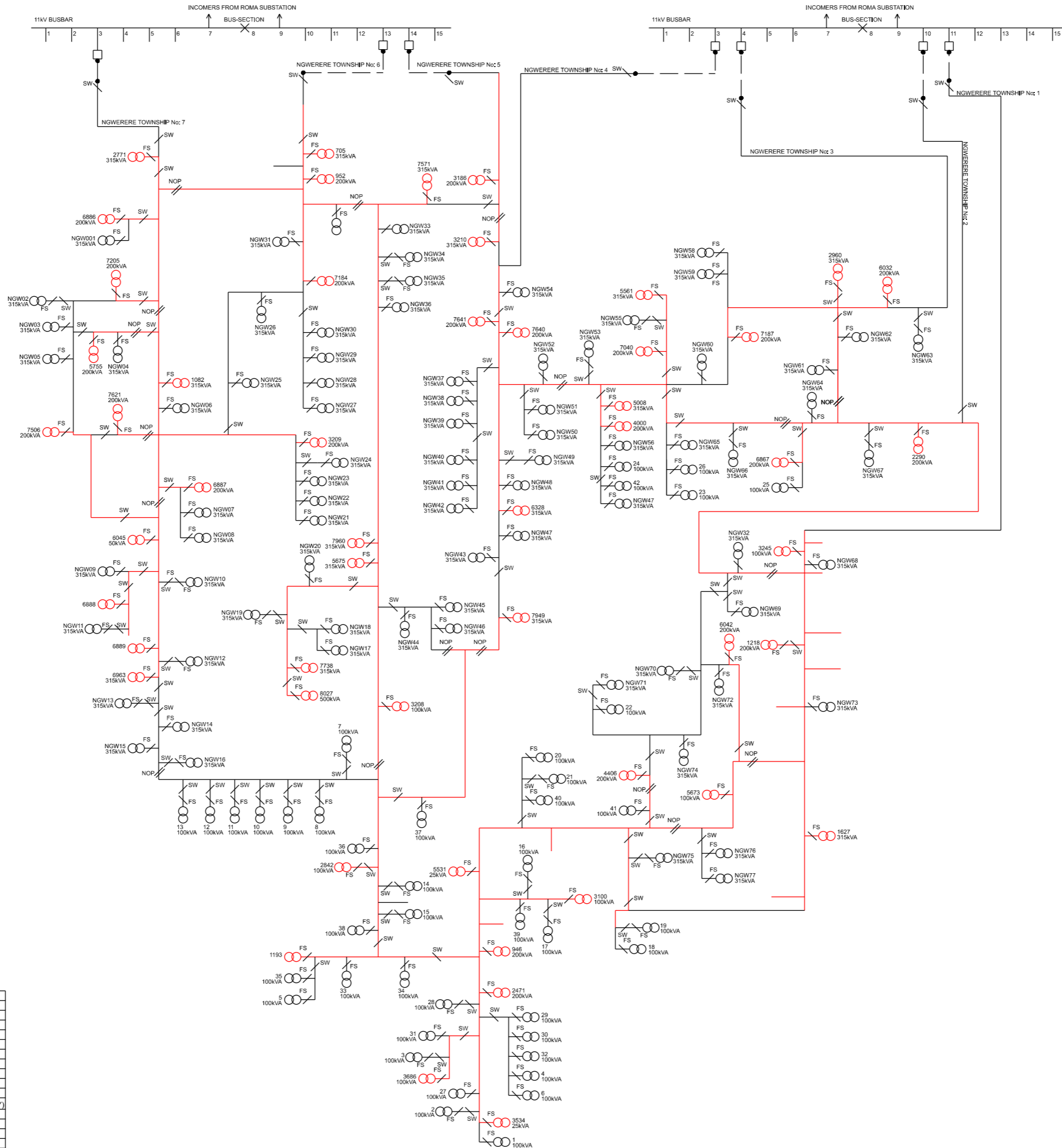
Project:
Lusaka Transmission and Distribution Rehabilitation Project (LTD RP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
MANDEVU TOWNSHIP SINGLE LINE DIAGRAM

Date:	Drawn:	Checked:	Appr.:	Format:
20/06/2019	M.A	N.B	E.K	A3
Drawing Number:	006	Rev:	1	Scale:
				SC.

ROMA SWITCHING STATION (ZANIMUONE) - RM SS_3

ROMA SWITCHING STATION (KABANANA) - RM SS_2



LEGEND:

Symbols	Description
/	SW (SWITCH)
/	FS (FUSED SWITCH)
//	NOP (NORMALLY OPEN POINT)
●—●	185mm² XLPE 11kV 3C CABLE
—	New/Planned Construction of 100mm² ACSR DOG CONDUCTOR OHL
—	EXISTING MV LINE (TO BE UPGRADED TO 100mm² ACSR DOG CONDUCTOR OHL)
□	FEEDER CIRCUIT BREAKER
○	NEW TXS TRANSFORMER
⊗	EXISTING TXS TRANSFORMER
×	BUS-SECTION

Notes:

Notes area for project-specific instructions and clarifications.

ROMA SWITCHING STATION (KABANANA) - RM SS_2

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	NGWERERE TOWNSHIP No:4
4	NGWERERE TOWNSHIP No:3
5	MANDEVU TOWNSHIP No: 2
6	MANDEVU TOWNSHIP No: 1
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	MANDEVU TOWNSHIP No: 3
11	MANDEVU TOWNSHIP No: 4
12	NGWERERE TOWNSHIP No:2
13	NGWERERE TOWNSHIP No:2
14	SPARE
15	SPARE

ROMA SWITCHING STATION (ZANIMUONE) - RM SS_3

PANEL NUMBER	FEEDER NAME
1	SPARE
2	SPARE
3	NGWERERE TOWNSHIP No:7
4	MANDEVU TOWNSHIP No: 5
5	LAST MILE STUDY (NORTH)
6	LAST MILE STUDY (SOUTH)
7	INCOMER No:1
8	BUS-SECTION
9	INCOMER No:2
10	LAST MILE STUDY (FEEDER 3)
11	LAST MILE STUDY (OPPOSITE ADNANA BLOCK FACTORY)
12	MANDEVU TOWNSHIP No: 6
13	NGWERERE TOWNSHIP No:6
14	NGWERERE TOWNSHIP No:5
15	SPARE

For Engineering Design Report	30/7/19	M.A	E.K
For Tender Purposes Only	23/8/19	M.A	E.K
Purpose of Issue	Ref.	Date	Drn. Appr.

Client:
NATIONAL AUTHORISING OFFICE (NAO) of the EUROPEAN DEVELOPMENT FUND (EDF).



Project:
Lusaka Transmission and Distribution Rehabilitation Project (LTRP) - Design and Supervision of the Low Voltage Distribution Network.

Drawing Title:
NGWERERE TOWNSHIP SINGLE LINE DIAGRAM

Date:	Drawn:	Checked:	Appr.:	Format:
24/07/2019	M.A	N.B	E.K	A3
Drawing Number:	007		REV 2	Scale: SC.

Township Medium-Voltage Network Geographical Layout

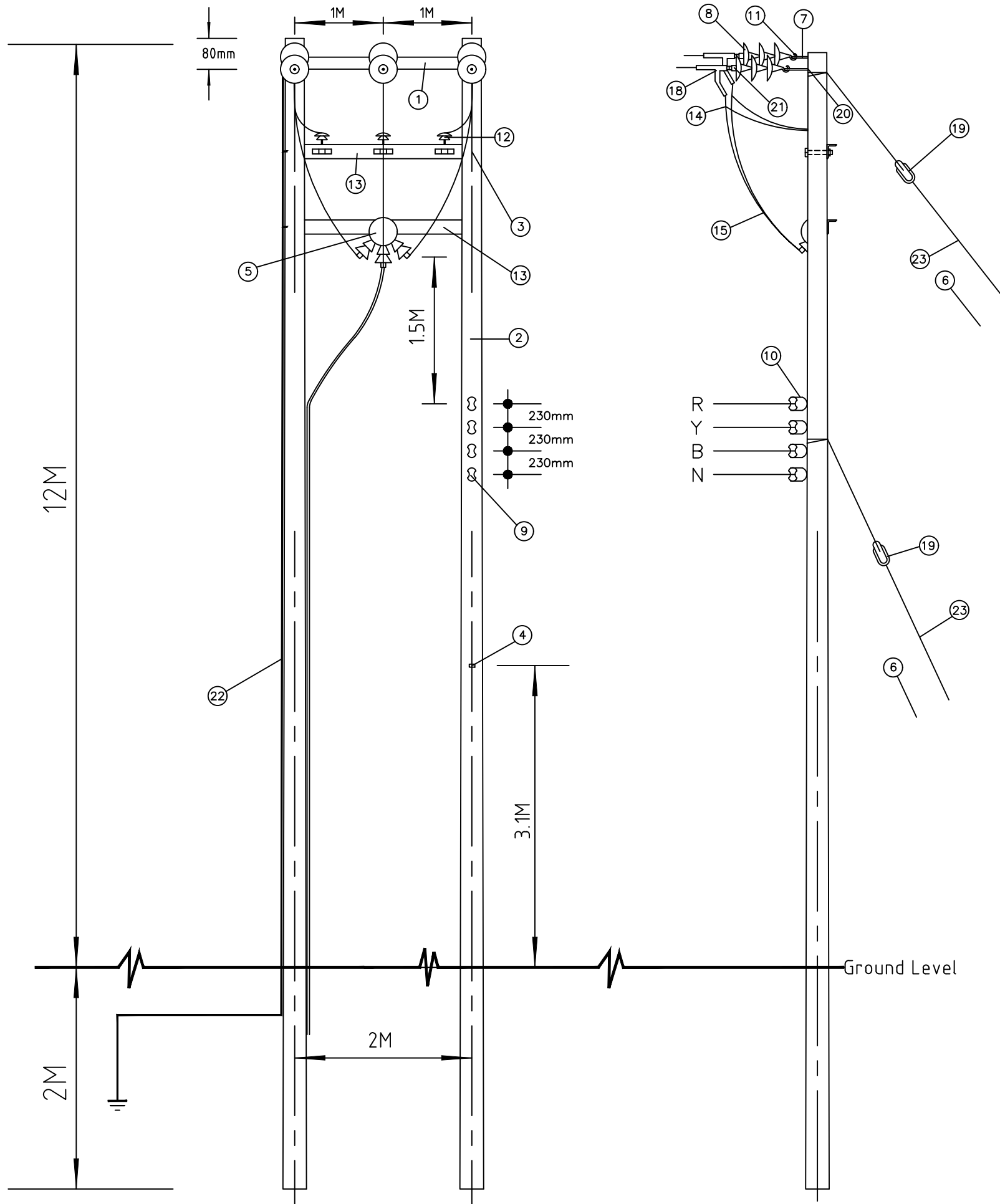
Drawing No.	Drawing Description
009	Chainda Township MV Network Geographical Layout
010	Kamanga Township MV Network Geographical Layout
011	Mtendere Township MV Network Geographical Layout
012	Kalingalinga Township MV Network Geographical Layout
013	Chawama Township MV Network Geographical Layout
014	John Howard Township MV Network Geographical Layout
015	Garden Township MV Network Geographical Layout
016	Mandevu Township MV Network Geographical Layout
017	Ngwerere Township MV Network Geographical Layout

See separate files



Medium Voltage Drawings

Drawing No.	Drawing Description
030	[ZESCO No. GH9709] - Cable Terminal Pole Dual Construction Model
031	[ZESCO No. DS0003] - Transformer Pole Mounted Substation Earthing
032	[ZESCO No. MV0003] - MV OH Line Pole Top Structure Angle 5 to 30 degrees
033	[ZESCO No. G11084] - Standard Earthing Procedure at Pole Mounted Transformer
034	[ZESCO No. ZAM-GEN-DE-41-E-11665] - PMT Substation H-Pole Formation
035	[ZESCO No. ZAM-GEN-DE-41-E-11658] - Transformer Pole Mounted Substation Earthing
036	[ZESCO No. ZAM-GEN-DE-41-E-11661] - PMT Substation H-Pole Formation
037	[ZESCO No. DS 0001] - 11 kV PMT Substation Installation (H-Pole Formation)
038	[ZESCO No. ZAM-GEN-DE-41-E-11662] - PMT Substation H-Pole Formation
039	[ZESCO No. GH10752] - Steel Angle Iron Cross Arm for H-Pole Formation PMT
040	[ZESCO No. ZAM-GEN-DE-41-E-11663] - PMT Substation - Distribution Box
041	[ZESCO No. MV0001] - 11 kV MV OH Line Pole Structure Intermediate
042	[ZESCO No. MV0002] - 11 kV MV Cychline Pole Top Structure Angle 1 to 5 degrees
043	[ZESCO No. MV0003] - 11 kV MV OH Line Pole Top Structure Angle 5 to 30 degrees
044	[ZESCO No. MV0004] - 11 kV Staggered OH Line Pole Top Structures Angle 30-90
045	[ZESCO No. MV0005] - 11 kV MV OH Line Pole Structure - Terminal Model
046	[ZESCO No. MV0006] - 11 kV MV OH Line Pole Top Structure Section Model
047	[ZESCO No. MV 0007] - MV OH Line Pole Top Structure Section with Tee-Off
048	[ZESCO No. MV0008] - 11 kV Staggered OH Line Pole Top Structures Tee Off Model
049	[ZESCO No. ZAM-GEN-DE-GE-12831 A] 11 and 33 kV Stay Assembly - Model
050	[ZESCO No. ZAM-GEN-DC-G-12378] OHL Stay planting details



ITEM	QUANTITY	DESCRIPTION
1	1	Steel Crossarm Angle 2.1m x 130mm x 80mm x 10mm
2	2	Standard Pole 12M
3	6	Galvanised Bolt 200mm x 20mm cw Nut & Washer
4	1	Pole Number
5	1	Terminal Box 70sqmm/120sqmm.
6	3	Stay Assembly Complete 2.5mm
7	1	Terminating Strap
8	6	Disc Insulator 250mm x 140mm B.S.
9	5	M.V. Insulator
10	5	D Bracket
11	3	Pigtail Insulator Hook
12	3	Lightning Arrester
13	2	Steel Crossarm Angle 2.1M x 100mm x 10mm
14	5	P.G. Clamp
15	15M	Copper Conductor 16sqmm
16	1	Service Tube 6sqmm
17	1	P.G. Clamp
18	3	Srain Compression Clamp ACSR 25mm/50mm
19	3	11kV Stay Insulator
20	2	Eye Bolts 200mm x 20mm
21	3	Clevis Ended Adaptor
22	20	PVC Adaptor 16sqmm Copper
23	30M	Stay Wire 7/4mm

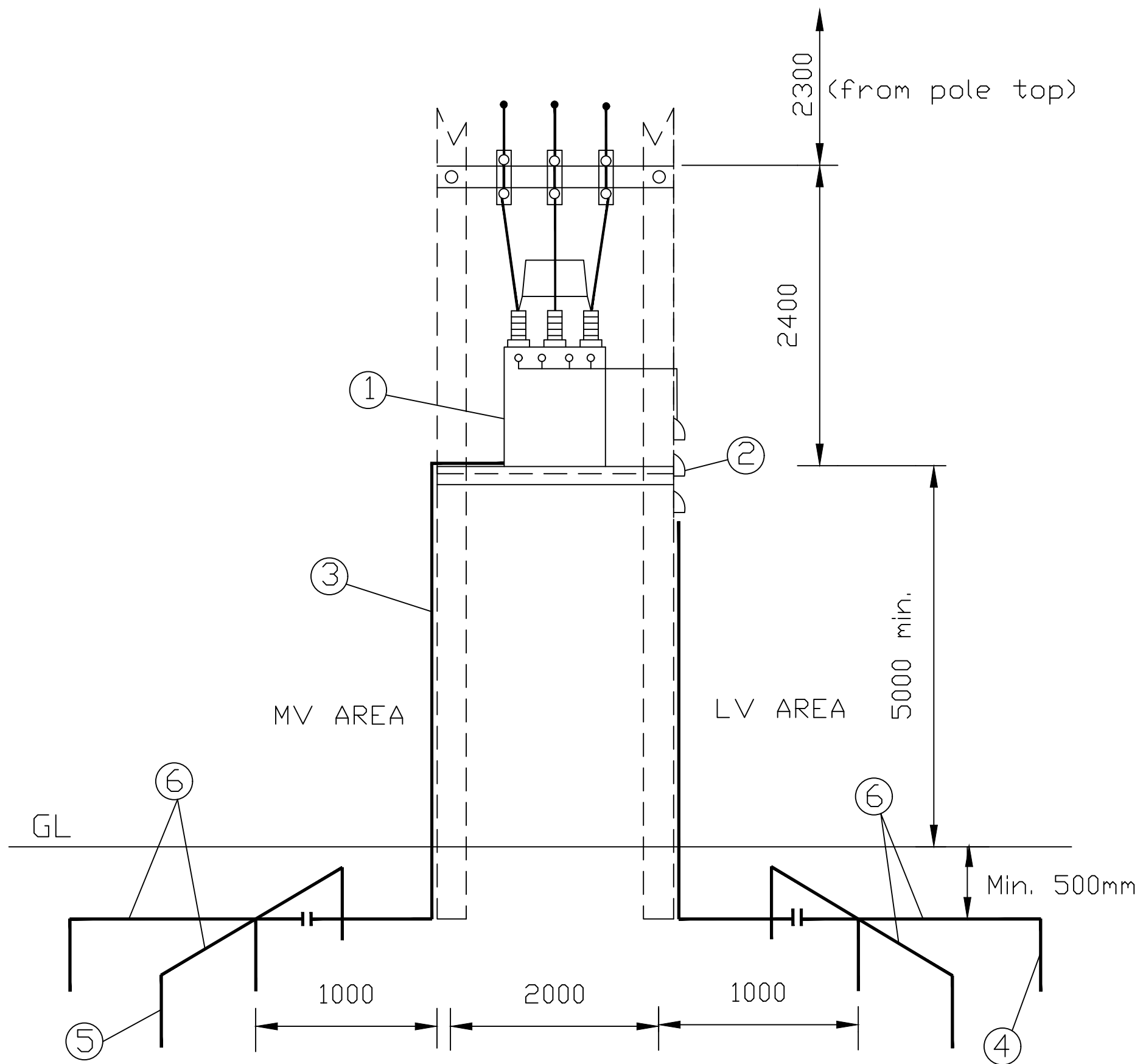
ZESCO LIMITED



GREAT EAST ROAD
P.O. BOX 33304
LUSAKA ZAMBIA
TEL: 228084-9

E			
D			
C			
B			
A			
Rev.	Date	Rev.by	Description

Title of Drawing: CABLE TERMINAL POLE DUAL CONSTRUCTION		
Drawing No. GH9709	Drawn: Nyirenda M.	Date: 22.11.00
	Scale: Not To Scale	Orig.Lyt.A3
Replaces	Checked:	Date:
	Approved:	Date:



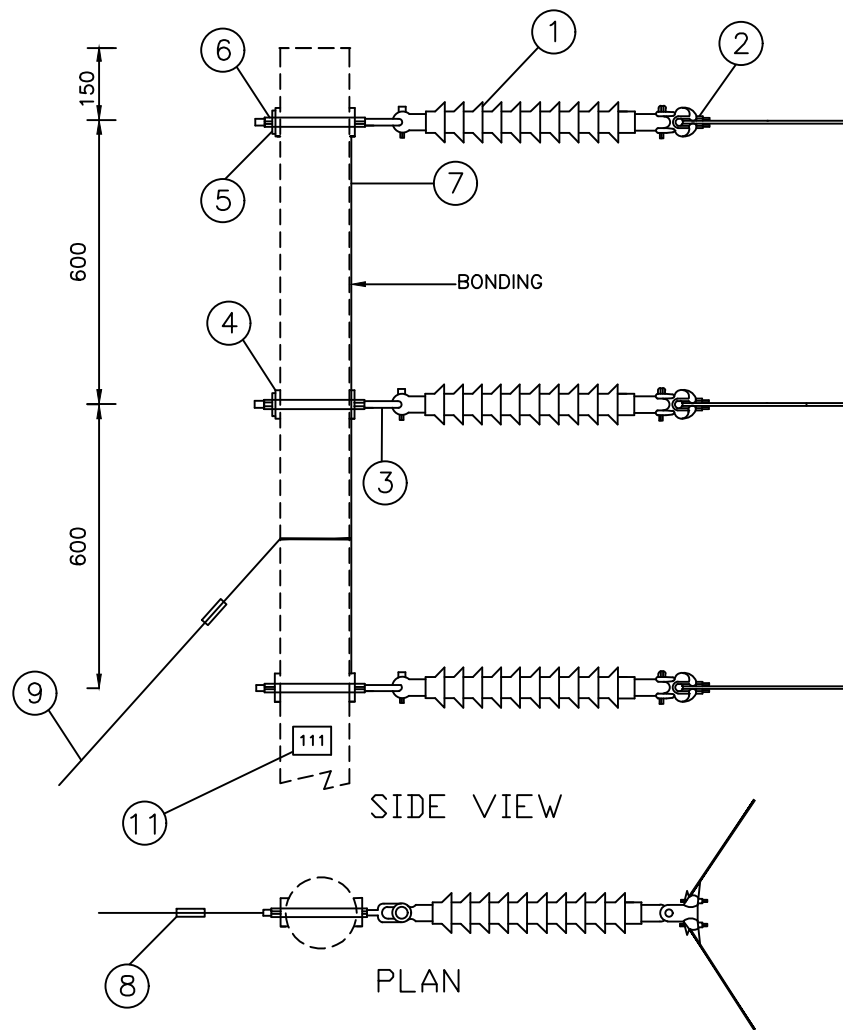
PART No.	QTY	DESCRIPTION	Remarks/Ref.
6		Bare conductor 70mm ²	
5	4	MV electrode	1.20m
4	4	LV electrode	1.00m
3	2	Galv. steel conductors	25mm
2	3	Lucy fuses	
1	1	Transport	
PART No.	QTY	DESCRIPTION	Remarks/Ref.

TITLE TRANSFORMER POLE MOUNTED S/S EARTHING

DRAWING NUMBER	DS0003	DRAWN	S. CHANGWE	DATE	SEPTEMBER,1998
SCALE	N.T.S	CHECKED		DATE	
		APPROVED		DATE	



ZESCO
GREAT EAST ROAD
P.O.BOX 30040
LUSAKA
TEL:228084/9



Part No.	Qty.	Description	Remarks/Ref.
11	1	POLE NUMBER	
10	1	STAY ASSEMBLY 2.50m	REF PT0014
9	8	STAY WIRE 7/4	
8	1	STAY INSULATOR	
7	1	12m POLE	
6	3	NUT M20	
5	3	ROUND WASHER M20	
4	3	WOODEN CURVED WASHER	60 X 60 X 6
3	3	EYEBOLT M20 X 250mm	ST.GALV.
2	3	SUSPENSION CRADLE CLAMP	
1	3	STRAIN INSULATOR 11kV & 33kV	Ref.

Note:

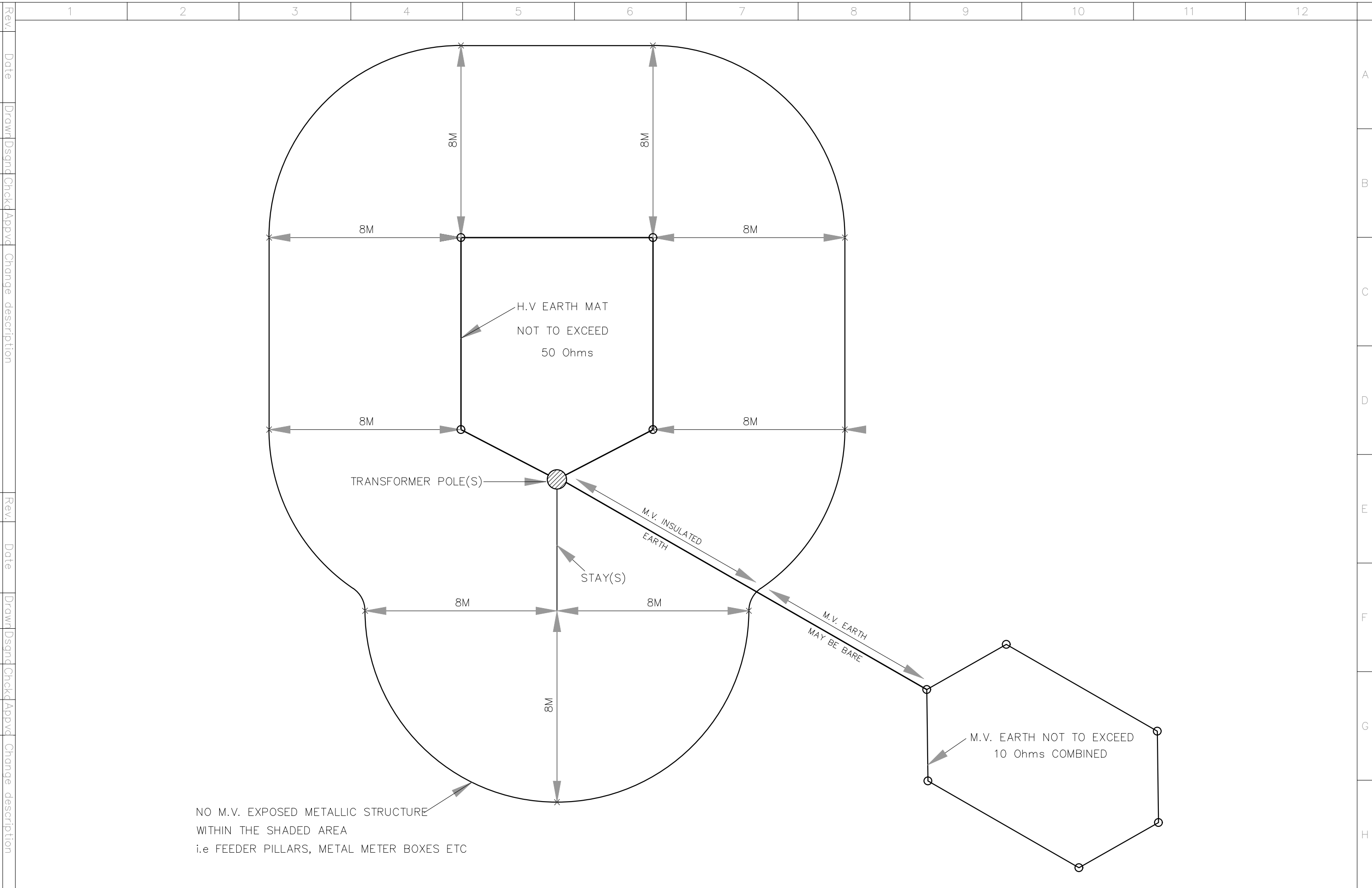
Distance between Insulators for 33kV should be 800mm and 11kV 600mm

ZESCO LIMITED



GREAT EAST ROAD
P.O.BOX 33304
LUSAKA ZAMBIA
TEL: 363636

E				Title of Drawing: MV O/H LINE POLE TOP STRUCTURE ANGLE 5° - 30°		
D				Drawing No. MV0003	Drawn: Changwe S.	Date: October, 1998
C					Checked:	Date:
B				Scale: NTS	Approved:	Date:
A	8.4.99	MN	Outer line removed	Replaces:		Date:
Rev.	Date	Rev. by	Description			Orig.Lay: G-siz.



NO M.V. EXPOSED METALLIC STRUCTURE
WITHIN THE SHADED AREA
i.e FEEDER PILLARS, METAL METER BOXES ETC



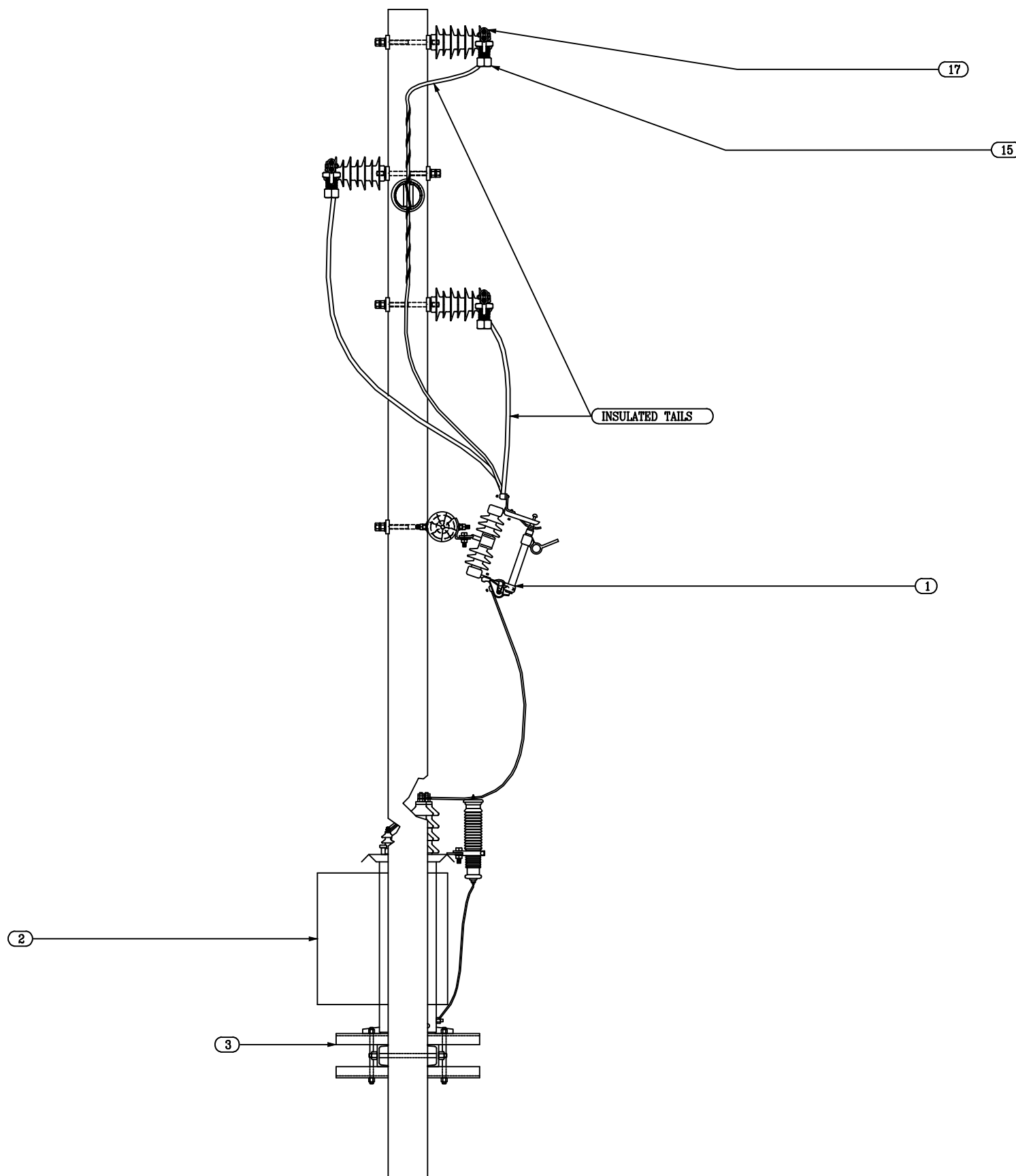
Project Name:

Drawing Title:
STANDARD EARTHING PROCEDURE
AT POLE MOUNTED TRANSFORMER

Drawn: Nyirenda M.	Date: 10.03.06
Designed:	Date:
Checked:	Date:
Approved:	Date:

Scale:	Drawing No. G11084
Rev.	

Sheet/Sheets



Rev.No.	Description	Date

LUSAKA DISTRIBUTION
REHABILITATION PROJECT

ELECTROWATT - EKOND
FINLAND 00 358 9 46911

Title: TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION

ZESCO
GREAT EAST ROAD
P.O.BOX 30040
LUSAKA
TEL:228084/9

Filename:
Same as Drawing No.

Drawing No: ZAM-GEN-DE-41-E-11665

Drawn: Nyirenda M. Date: 23.01.2002

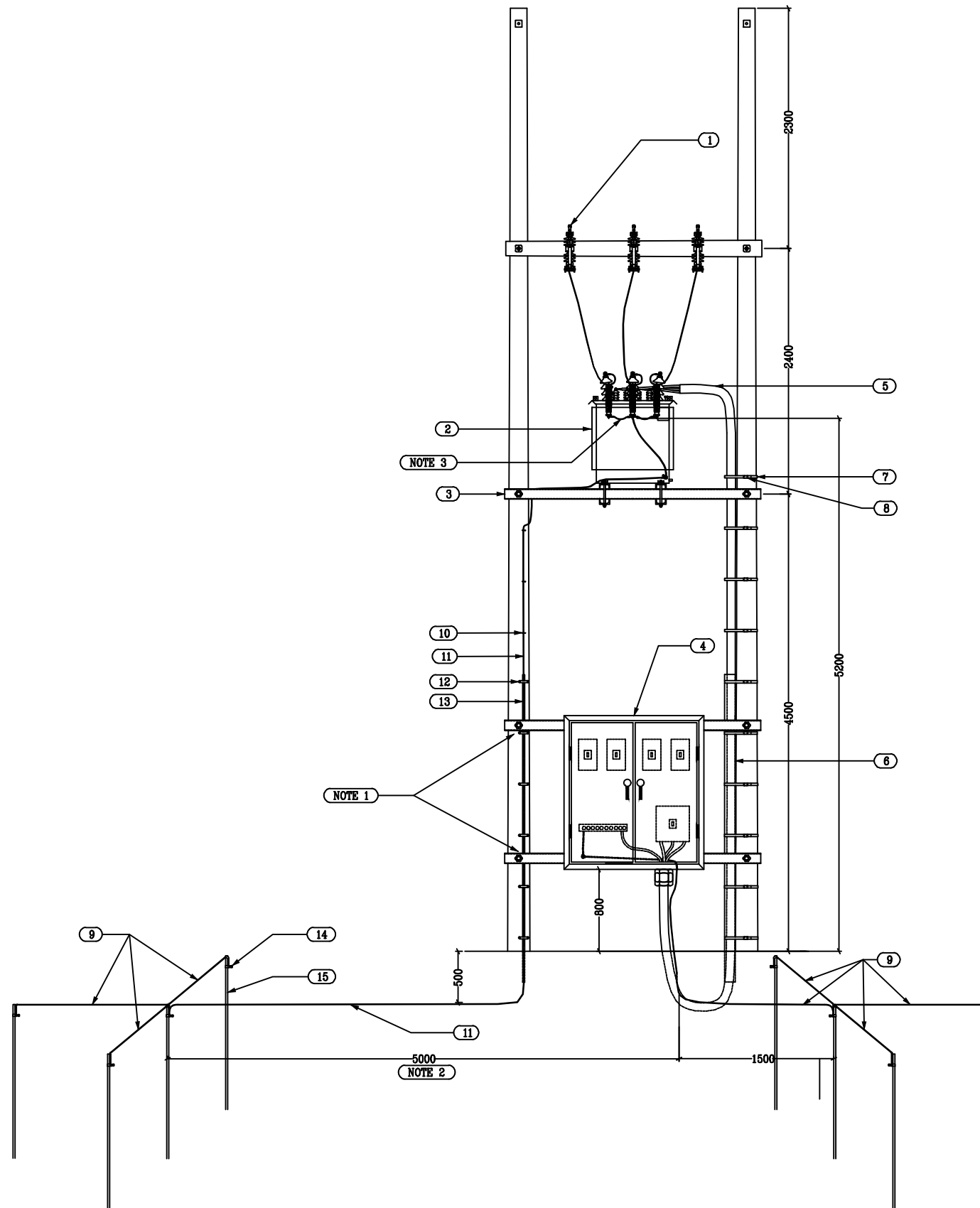
Checked: P.VLAHAKIS Date: xxxx

Scale:

Approved: P.VLAHAKIS Date: xxxx

Replaces: ZAM-GEN-DE-41-232 SHEET 5 of 6

Replaced by:



17			
16			
15	6	1.5m EARTH SPIKE	
14	8	16mmD EARTH SPIKE CLAMP	
13	3m	3m x 20mmD GALV. CONDUIT	
12	6	20mm SADDLES C\W WOOD SCREWS	
11	12m	16mmsq INSULATED EARTH WIRE	
10	4	CLOUT NAILS	
9		16mmsq BARE COPPER EARTH WIRE (BCEW)	
8	10	12mm BUCKLES FOR STRAP	
7	5m	STAINLESS STEEL BANDIT STRAP (12mm)	
6	3m	75mm x 3m GALV. PIPE	
5	15m	LV CABLE	
4	1	LV DISTRIBUTION BOX	
3	1	TRANSFORMER PLATFORM	
2	3	CUTOUT FUSE	
1	1	TRANSFORMER	
PART No.	QTY.	DESCRIPTION	REMARKS/REF.

NOTE 1

MAKE PROVISION FOR TOTAL INSULATION BETWEEN 11kV EARTH AND ANY 0.4kV EQUIPMENT

NOTE 2

SEPARATE AND LV EARTH REQUIRED WHEN THE OVERALL RESISTANCE TO EARTH EXCEEDS 1 OHM

NOTE 3

16mmsq FLEXIBLE EARTH CONDUCTOR

Rev.No.	Description	Date

LUSAKA DISTRIBUTION REHABILITATION PROJECT

ELECTROWATT - EKOND
FINLAND 00 358 9 46911

Title: TRANSFORMER POLE MOUNTED SUBSTATION EARTHING

ZESCO
GREAT EAST ROAD
P.O.BOX 30040
LUSAKA
TEL:228084/9

Filename:

Drawing No: ZAM-GEN-DE-41-E-11658

Drawn: Nyirenda M. Date: 22.01.2002

Scale: NTS

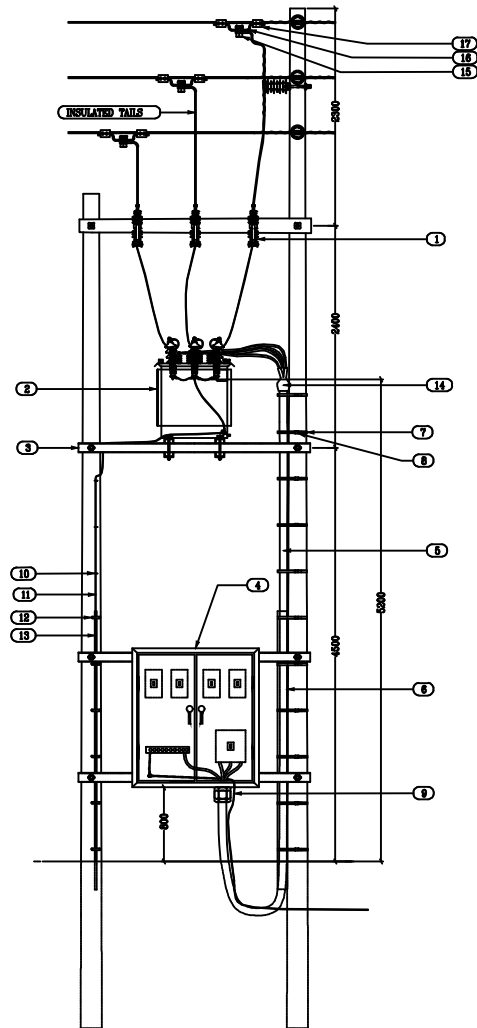
Checked: P.VLAHAKIS Date:

Replaces: ZAM.GEN-DE.41-231 SHEET 1 of 3

Approved: P.VLAHAKIS Date:

Replaced by:

SEE ALSO
ZAM-GEN-DE-41-E-11662



SEE ALSO
ZAM-GEN-DE-41-E-11663

17	3	BAIL CONNECTORS	
16	6	P. G. CLAMP	
15	3	LIVE LINE TAP	
14	1	LV CABLE TERMINATION	
13	3m	3m x 20mmD GALV. CONDUIT	
12	6	20mm SADDLES C/W WOOD SCREWS	
11	12m	16mmsq INSULATED EARTH WIRE	
10	4	CLOUT NAILS	
9		16mmsq BARE COPPER EARTH WIRE (BCEW)	
8	11	12mm BUCKLES FOR STRAP	
7	5.5m	STAINLESS STEEL BANDIT STRAP (12mm)	
6	3m	75mm x 3m GALV. PIPE	
5	15m	LV CABLE	
4	1	LV DISTRIBUTION BOX	
3	1	TRANSFORMER PLATFORM	
2	3	CUTOUT FUSE	
1	1	TRANSFORMER	
PART No.	QTY.	DESCRIPTION	REMARKS/REF.

Rev.No.	Description	Date

LUSAKA DISTRIBUTION
REHABILITATION PROJECT

ELECTROWATT - EKOND
FINLAND 00 358 9 46911

Title: TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION

Drawing No: ZAM-GEN-DE-41-E-11661

Drawn: Nyirenda M. Date: 21.01.2002

Checked: P.VLAHAKIS Date: xxxx

Approved: P.VLAHAKIS Date: xxxx

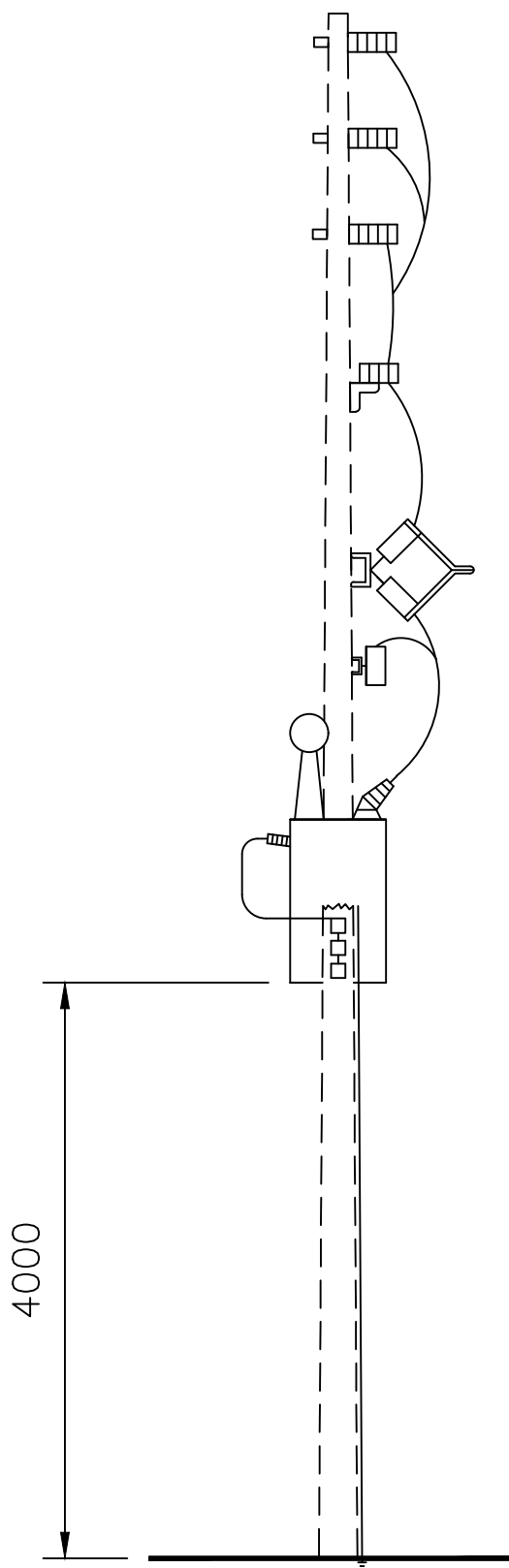
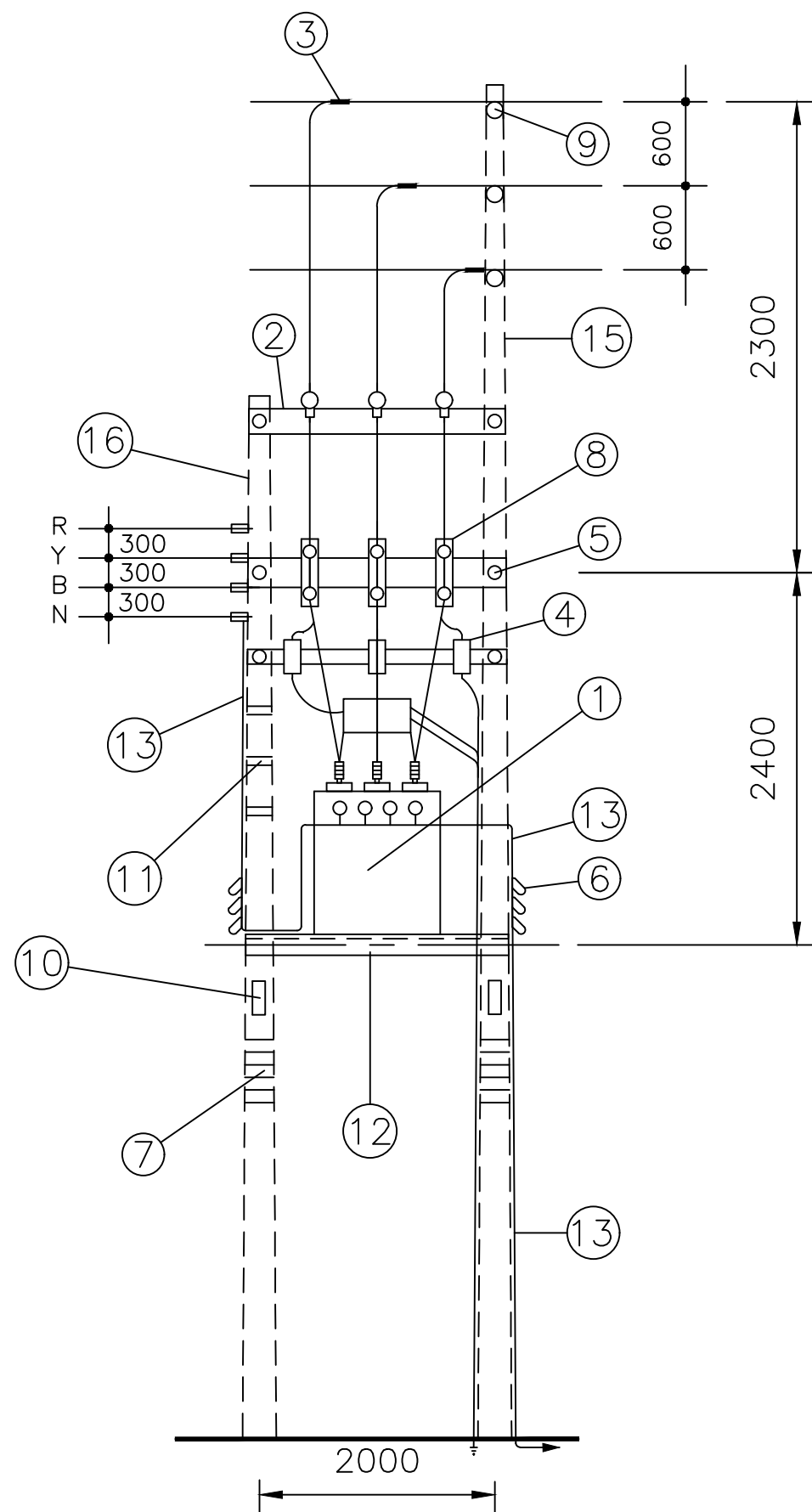
Replaces: ZAM.GEN-DE.41-232 SHEET 1 of 6

Replaced by:



ZESCO
GREAT EAST ROAD
P.O.BOX 30040
LUSAKA
TEL:228084/9

Filename:
Same as Drawing No.



16	1	9M POLE	
15	1	12M POLE	
14	3	Pilot Insulator	
13		4 Core Cable	
12	SET	TRANSFORMER PLATFORM	Ref.
11	3	Steel straps	
10	2	Danger Notices	
9	3	Post Insulator	
8	3	Cut out fuse c/w D-base	
7	2	Anti-climbing device(b-wire)	
6	3	Lucy fuses c/w carries	
5	2	Threaded bolt c/w nut/washer	M20x250
4	3	Lightning Arrestors	
3	3	P.G. Clamp	
2	2	Wood/Steel Cross-arm	Ref.
1	1	Three Phase Transformer	
Part No.	Qty.	Description	Remarks/Ref.

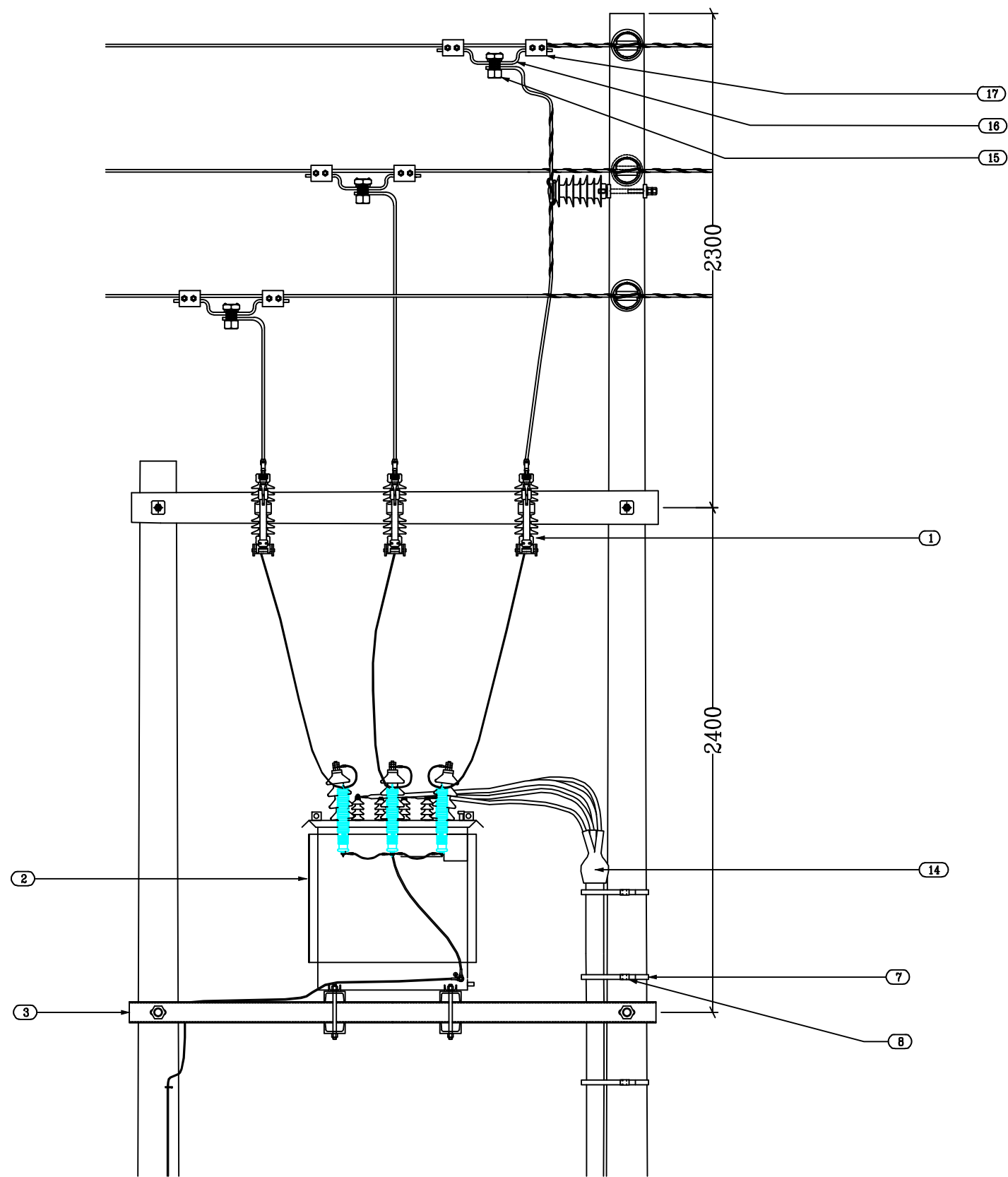
OPTION: USE PILOT INSULATORS

ZESCO LIMITED



GREAT EAST ROAD
P.O.BOX 30040
LUSAKA ZAMBIA
TEL: 228084-9

E				Title of Drawing: 11kV PMT S/S INSTALLATION (H-POLE FORMATION)		
D						
C				Drawing No.	Drawn: Nyirenda M.	Date: 03.09.98
B				DS0001	Checked: A.K.M.	Date:
A	8.4.99	MN	Outer line removed	Scale: NTS	Approved:	Date:
Rev.	Date	Rev. by	Description	Replaces:		Orig.Layt: G-siz.

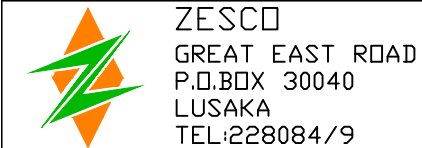


Rev.No.	Description	Date

LUSAKA DISTRIBUTION
REHABILITATION PROJECT

ELECTROWATT - EKOND
FINLAND 00 358 9 46911

Title: TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION



Filename:
Same as Drawing No.

Drawing No: ZAM-GEN-DE-41-E-11662

Drawn: Nyirenda M.

Date: 22.01.2002

Checked: P.VLAHAKIS

Date: xxxx

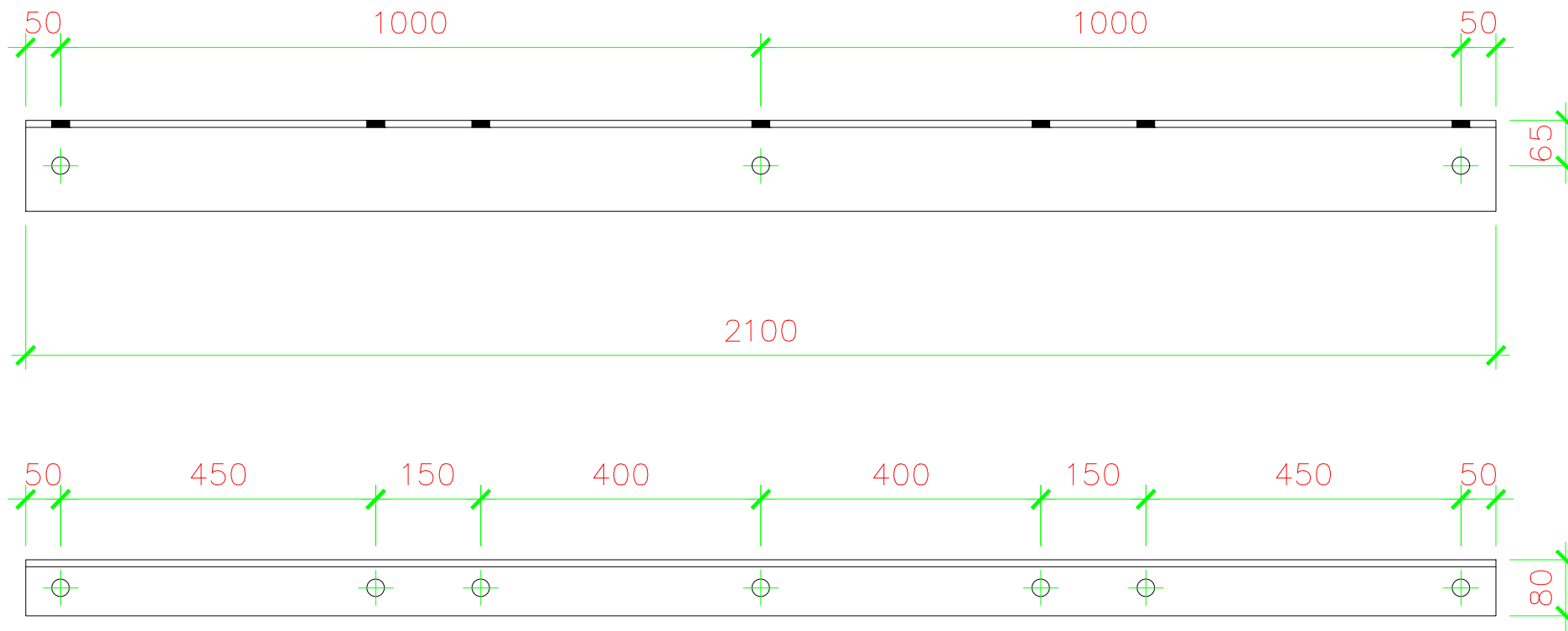
Scale: NTS

Approved: P.VLAHAKIS

Date: xxxx

Replaces: ZAM-GEN-DE-41-232 SHEET 2 of 6

Replaced by:



USED ON DRAWING Nos...					
66	33	11	D	MV	S
		005			
		005			
		005			
		005			
		005			

Material: Mild Steel 30Tonnes quality commodity No. 12405

CONSTRUCTION NOTES

1. For mounting Transformers and Auto Reclosers on 11kv 'H' Poles item to be used with the 130mm face to pole
2. For mounting isolator units on 11kv 'h' or single poles item to be used with the 80mm face to pole
3. For 11kv 25 & 50mm sq. line termination on 'H' Poles item to be used with 80mm face to pole

REF. DRAWING No.
MAT. 0048



ZESCO
GREAT EAST ROAD
P.O.BOX 30040
LUSAKA ZAMBIA
TEL: 228084/9

Project Name:

DRAWING CONVERSION

Drawing Title:

MILD STEEL ANGLE IRON CROSSARM
FOR H-POLE PMT/AutoRECLOSERS

Drawn: Nyirenda Michael

Date: 21.12.05

Designed:

Date:

Checked:

Date:

Approved:

Date:

Scale:

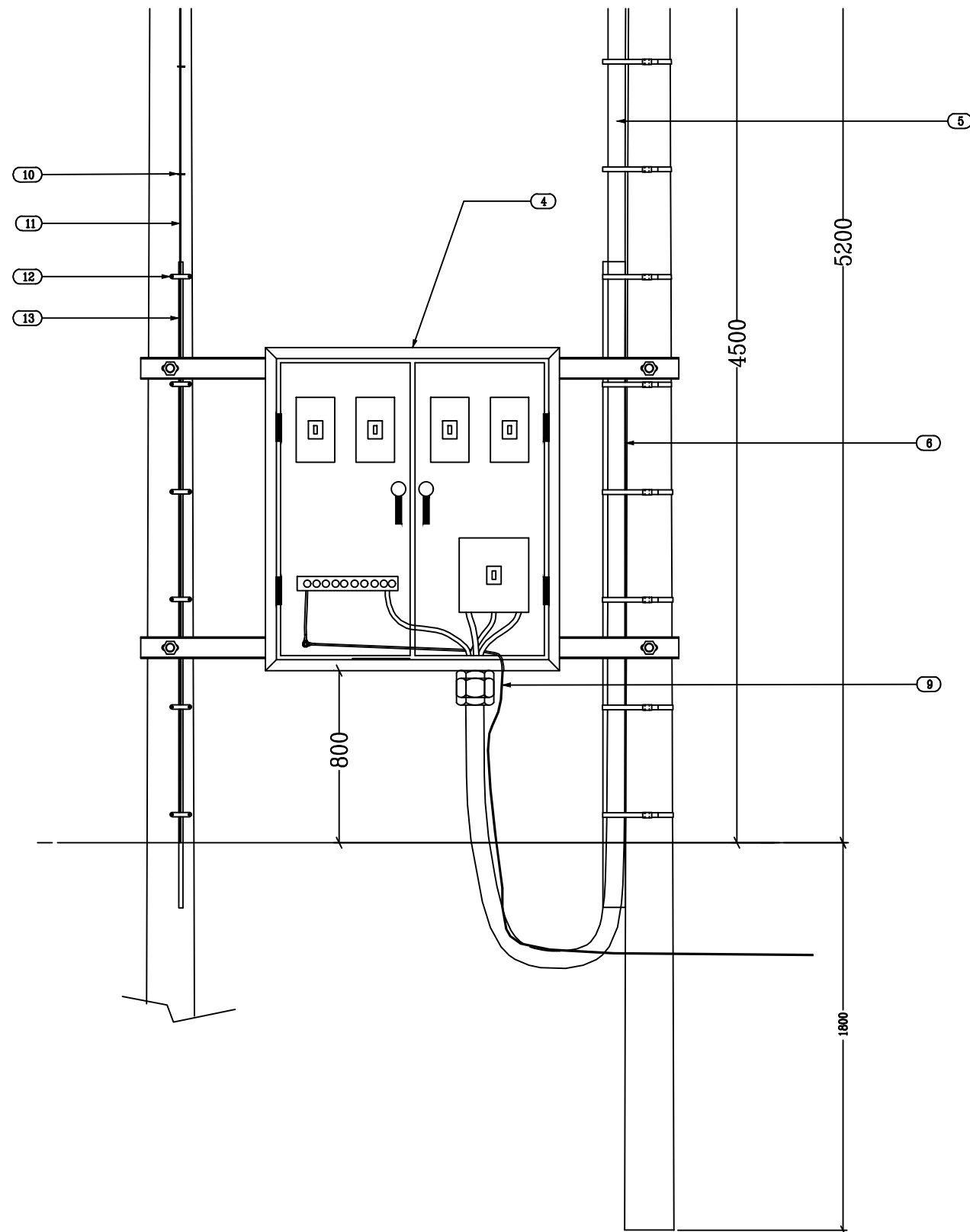
Drawing No.

GH 10752

Sheet/Sheets

Rev.

0



Rev.No.	Description	Date

LUSAKA DISTRIBUTION
REHABILITATION PROJECT

ELECTROWATT - EKOND
FINLAND 00 358 9 46911

Title: TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION

Drawing No: ZAM-GEN-DE-41-E-11663

Drawn: Nyirenda M. Date: 23.01.2002

Scale: Replaces: ZAM.GEN-DE.41-232 SHEET 3 of 6

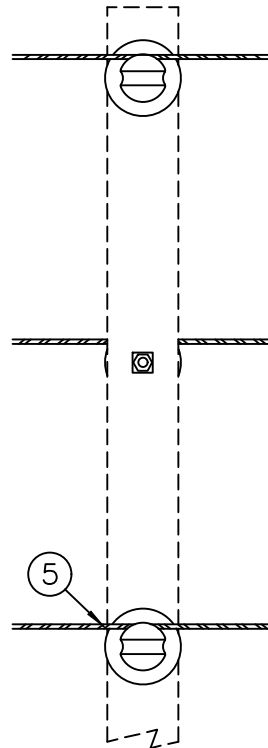
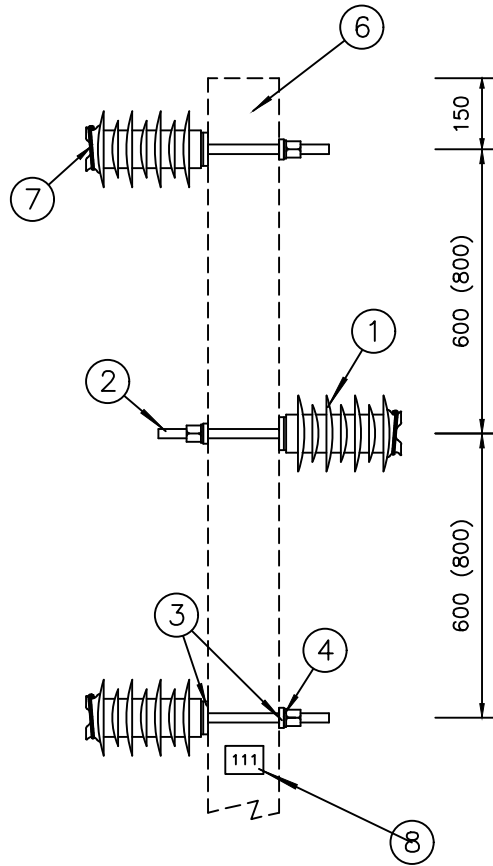
Checked: P.VLAHAKIS Date: xxxx

Approved: P.VLAHAKIS Date: xxxx

Replaced by:

Filename:
Same as Drawing No.





Part No.	QTY	Description	Remarks/Ref.
8	1	POLE NUMBER	Fixed at 1.5M above ground
7	0.2Kg	Binding Wire Alum.3.60mm	
6	1	12M POLE	
5	3	SIDE TIE	
4	3	WASHER	
3	6	CURVED WASHER	
2	3	SPINDLE M20 X 250	
1	3	11/33kv POST INSULATOR	Ref.PT0003

Note:

Distance between Insulators for 33kv should be 800mm and 11kv 600mm

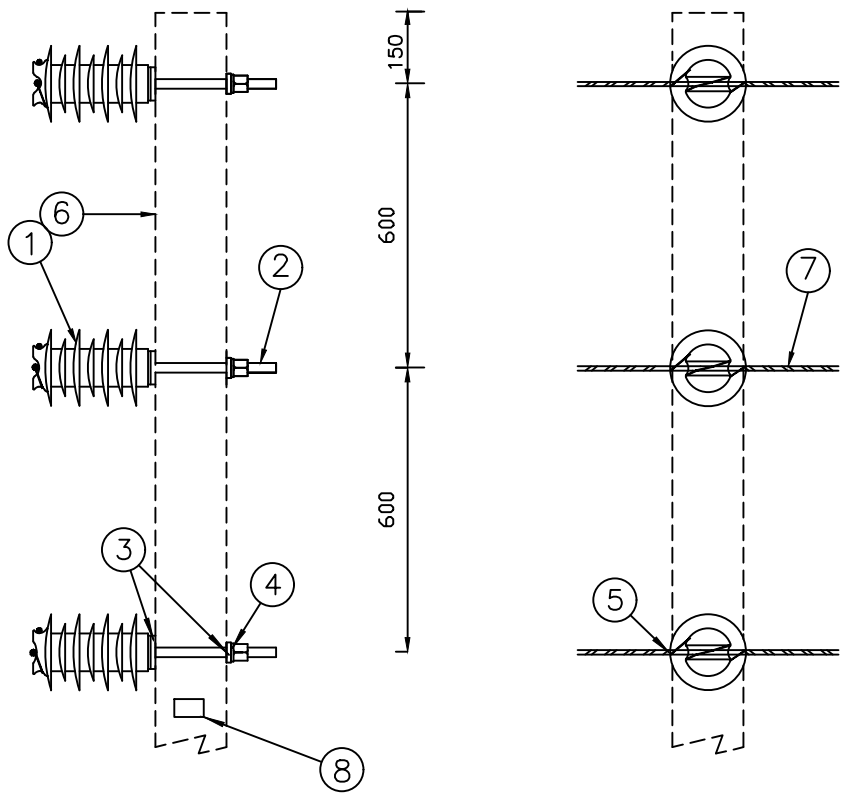
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P.O.BOX 30040
LUSAKA ZAMBIA
TEL: 228084-9

Rev.	Date	Rev. by	Description	Replaces:	Origin:
E					
D					
C					
B					
A	8.4.99	MN	Outer line removed		


Title of Drawing: MV O/H LINE POLE TOP STRUCTURE INTERMEDIATE		Drawn: Nyirenda M.	Date: 07.11.98
Drawing No. MV0001		Checked:	Date:
Scale: NTS		Approved:	Date:
Replaces:		Orig.Lay: G-siz.	

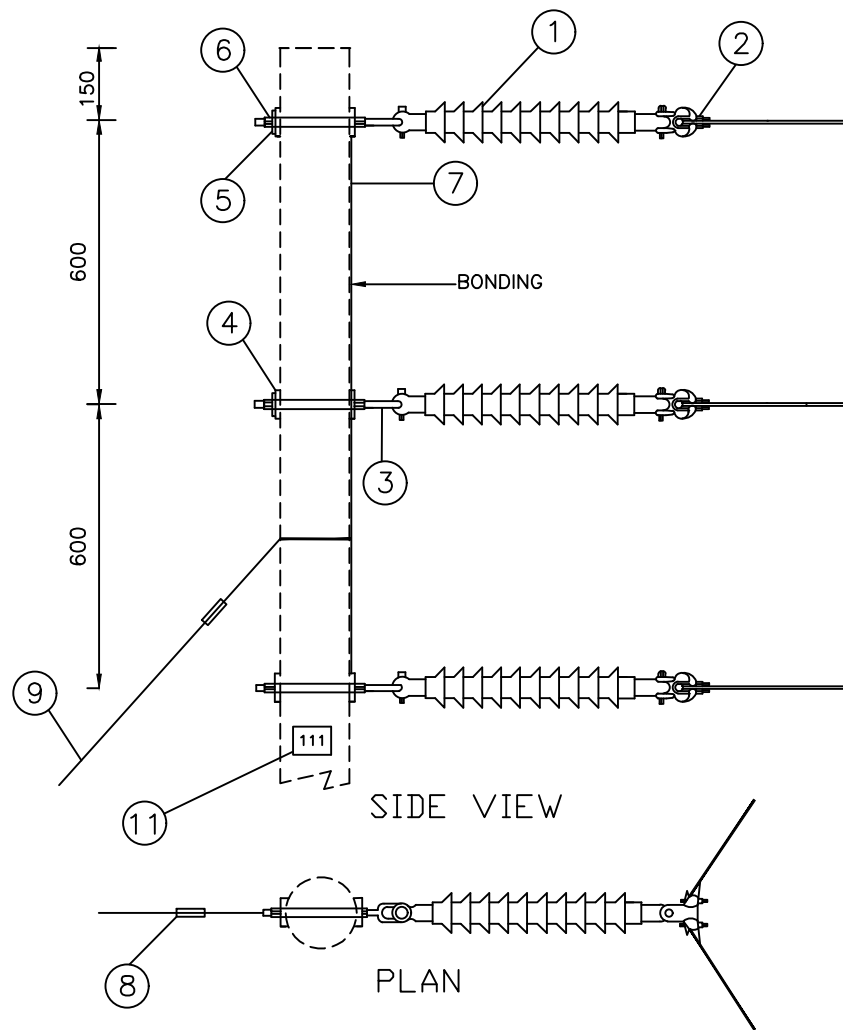


8	1	POLE NUMBER	
7	0.25	AL. BENDING WIRE 3.60mm ²	
6	1	12m POLE	
5	9	SIDE TIE	
4	3	WASHER	
3	6	CURVED WASHER	
2	3	SPINDLE M20 X 250	
1	3	POST INSULATOR 11kv & 33kv	Ref. PT0003
Part No.	Qty.	Ref.PT0003	Remarks/Ref.

Note:

Distance between Insulators for 33kv should be 800mm and 11kv 600mm

ZESCO LIMITED  GREAT EAST ROAD P.O.BOX 33304 LUSAKA ZAMBIA TEL: 363636	E				Title of Drawing: MV CYCHLINE POLE TOP STRUCTURE ANGLE 1° - 5°		
	D				Drawing No. MV0002	Drawn: Changwe S.	Date: October,1998
	C					Checked:	Date:
	B					Approved:	Date:
	A	8.4.99	MN	Outer line removed	Scale: NTS		Date:
	Rev.	Date	Rev. by	Description	Replaces:		Orig.Lay: G-siz.



Part No.	Qty.	Description	Remarks/Ref.
11	1	POLE NUMBER	
10	1	STAY ASSEMBLY 2.50m	REF PT0014
9	8	STAY WIRE 7/4	
8	1	STAY INSULATOR	
7	1	12m POLE	
6	3	NUT M20	
5	3	ROUND WASHER M20	
4	3	WOODEN CURVED WASHER	60 X 60 X 6
3	3	EYEBOLT M20 X 250mm	ST.GALV.
2	3	SUSPENSION CRADLE CLAMP	
1	3	STRAIN INSULATOR 11kV & 33kV	Ref.

Note:

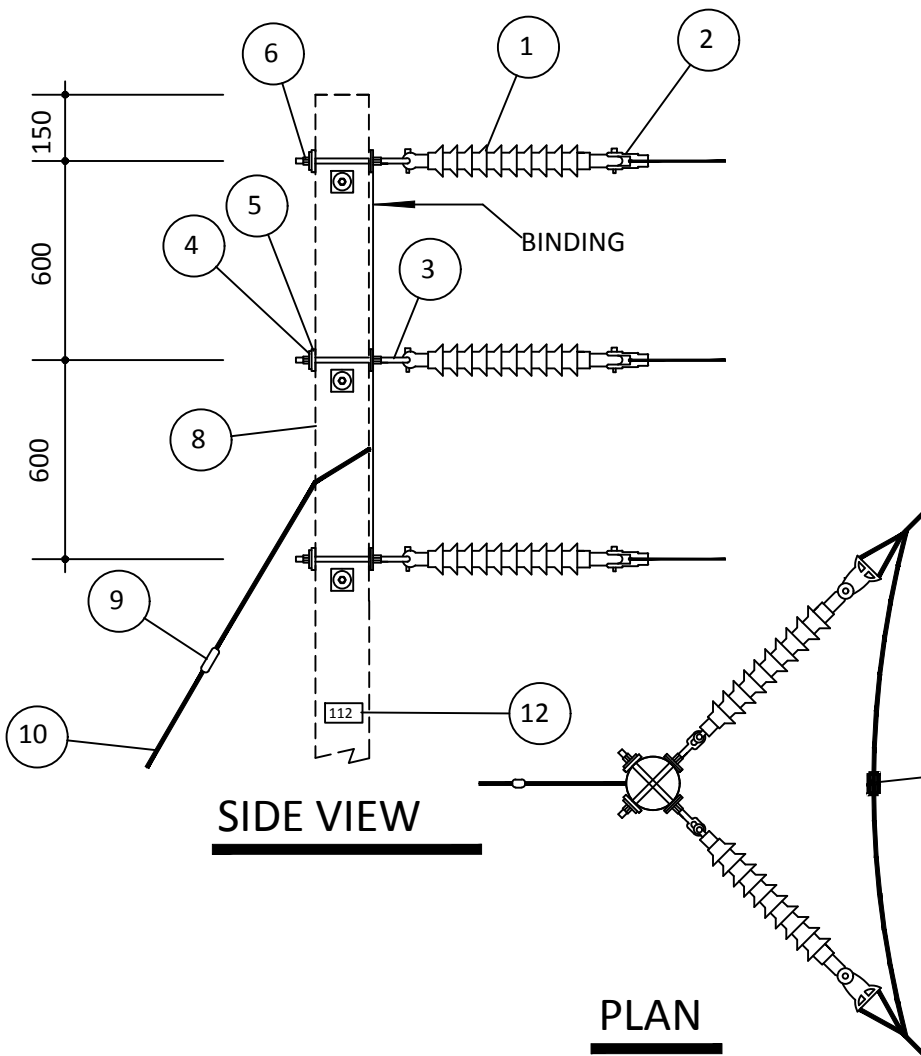
Distance between Insulators for 33kV should be 800mm and 11kV 600mm

ZESCO LIMITED





GREAT EAST ROAD
P.O.BOX 33304
LUSAKA ZAMBIA
TEL: 363636

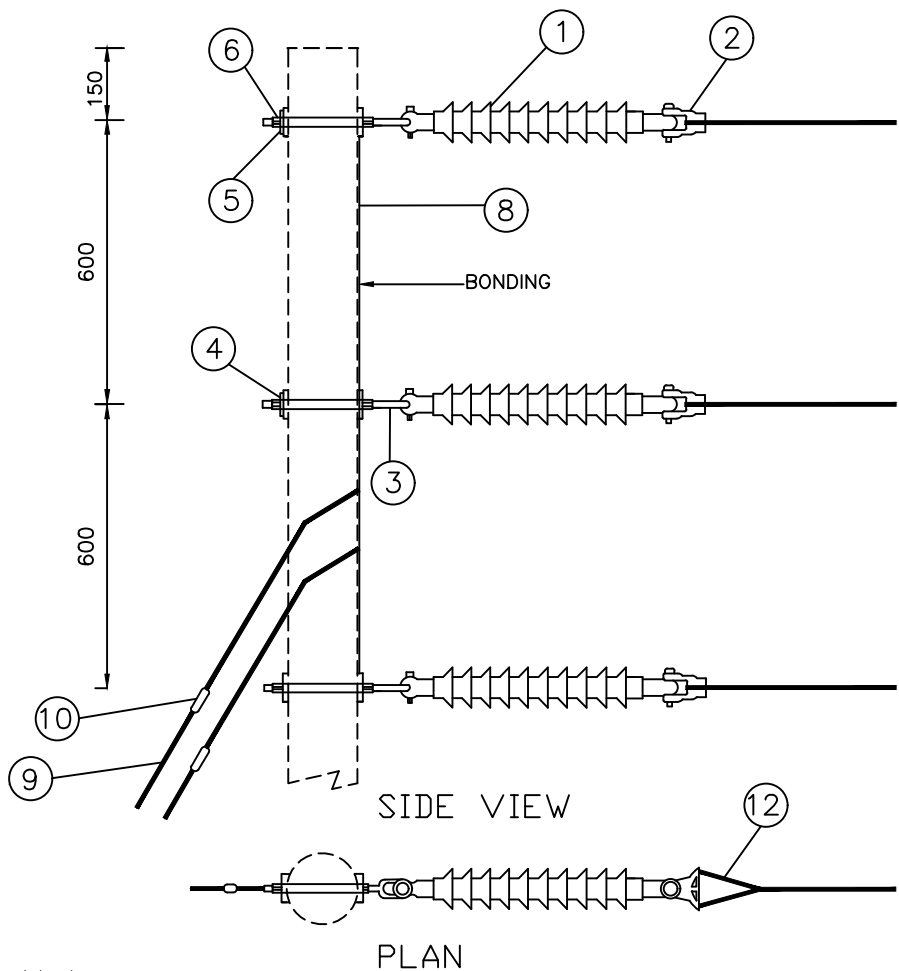
E				Title of Drawing: MV O/H LINE POLE TOP STRUCTURE ANGLE 5° - 30°		
D				Drawing No. MV0003	Drawn: Changwe S.	Date: October, 1998
C					Checked:	Date:
B				Scale: NTS	Approved:	Date:
A	8.4.99	MN	Outer line removed	Replaces:		Date:
Rev.	Date	Rev. by	Description			Orig.Lay: G-siz.



12	1	POLE NUMBER	
11	1	STAY ASSEMBLY 2.50m	PT0014
10	20M	STAY WIRE 7/4	
9	1	STAY INSULATOR	
8	1	12m POLE	
7	3	P.G.CLAMP	
6	3	NUT M20	
5	3	ROUND WASHER M20	
4	3	WOODEN CURVED WASHER	60x60x6 M20
3	3	EYEBOLT M20 X 250mm	ST.GALV.
2	3	CLAMP THIMBLE CLEVIS	
1	6	STRAIN INSULATOR 11kV & 33kV	Ref.
Part No.	Qty.	Description	Remarks/Ref.

Note:
 Distance between Insulators for 33kV should be 800mm and 11kV 600mm

ZESCO LIMITED  GREAT EAST ROAD P.O.BOX 33304 LUSAKA ZAMBIA TEL: 363636		E				Title of Drawing: 11/33kV STAGGERD O/H LINE POLE STRUCTURE ANGLE 30° - 90°		
		D				Drawing No. MV0004		Drawn: Changwe S. Date: October, 1998
 GREAT EAST ROAD P.O.BOX 33304 LUSAKA ZAMBIA TEL: 363636		C				Checked: Date:		
		B				Approved: Date:		
		A	8.4.99	MN	Outer line removed	Scale: NTS	Date:	
Rev.	Date	Rev. by	Description	Replaces:			Orig.Layt: G-siz.	



Note:

Distance between Insulators for 33kV should be 800mm and 11kV 600mm

Part No.	Qty.	Description	Remarks/Ref.
12	3	DEAD END GRIP	
11	2	STAY ASSEMBLY 2.5m	PT 0014
10	2	STAY INSULATOR	
9	40m	STAY WIRE 7/4	
8	1	12m POLE	
6	3	NUT M20	
5	3	ROUND WASHER M20	
4	3	WOODEN CURVED WASHER	60 X 60 X 6
3	3	EYEBOLT M20 X 250mm	ST.GALV.
2	3	CLAMP THIMBLE CLEVIS	
1	3	STRAIN INSULATOR 11kV	Ref.

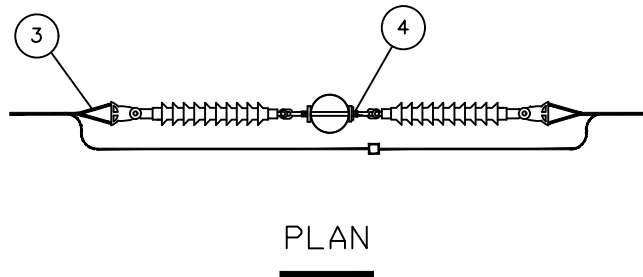
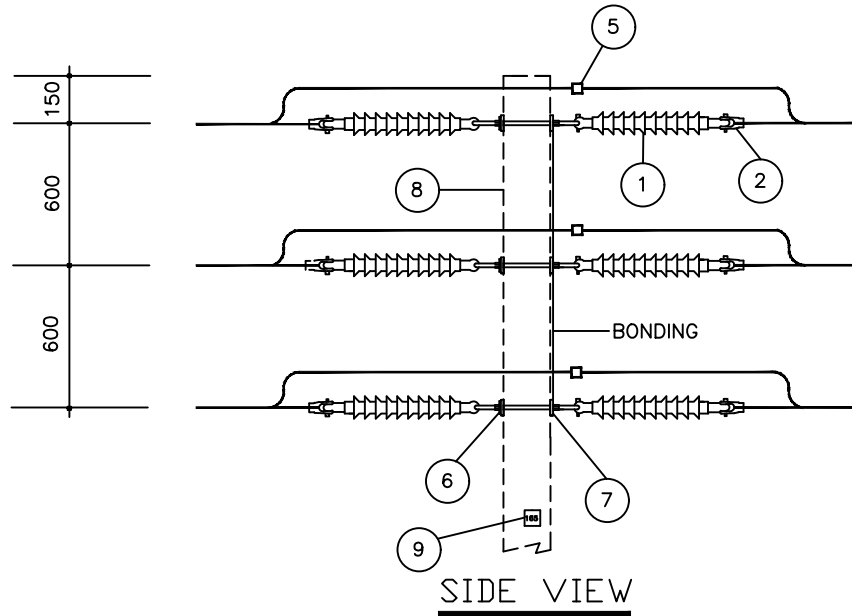
ZESCO LIMITED



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P.O.BOX 30040
LUSAKA ZAMBIA
TEL: 228084-9

Rev.	Date	Rev. by	Description
E			
D			
C			
B			
A	8.4.99	MN	Outer line removed

Title of Drawing: MV O/H LINE POLE TOP STRUCTURE - TERMINAL			
Drawing No. MV0005		Drawn: Changwe S.	Date: October, 1998
Scale: NTS		Checked:	Date:
Replaces:		Approved:	Date:
			Orig.Lay: G-siz.



Note:

Distance between Insulators for 33kV should be 800mm and 11kV 600mm

Part No.	Qty.	Description	Remarks/Ref.
9	1	POLE NUMBER	
8	1	12m POLE	
7	12	CURVED WASHER	60x60x6 M20
6	12	ROUND WASHER	M20
5	6	P.G. CLAMP	
4	1	EYE BOLT & EYE NUT M20	
3	6	DEAD END	ALLUM. ALLOY
2	6	CLAMP THIMBLE CLEVIS	
1	6	STRAIN INSULATOR 11kV & 33kV	Ref.

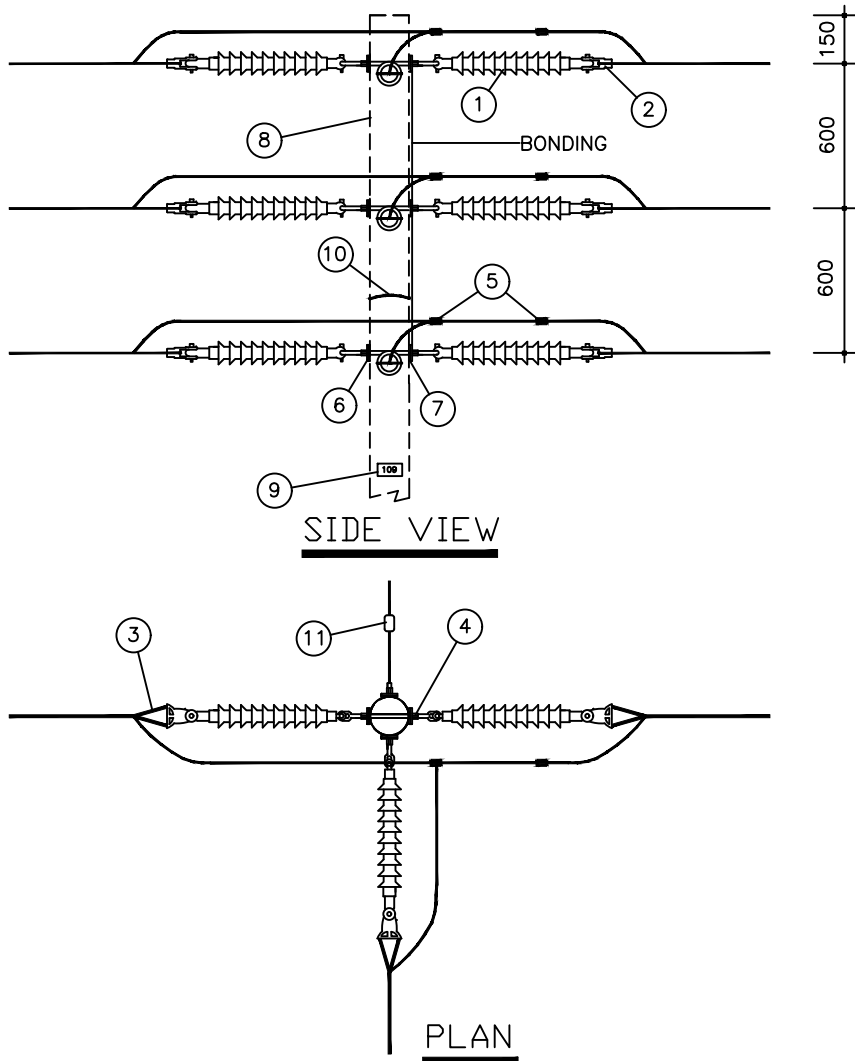
ZESCO LIMITED



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P.O.BOX 33304
LUSAKA ZAMBIA
TEL: 363636

Rev.	Date	Rev. by	Description
E			
D			
C			
B			
A	8.4.99	MN	Outer line removed


Title of Drawing: MV O/H LINE POLE TOP STRUCTURE SECTION			
Drawing No.	Drawn: Changwe S.	Date: November, 1998	
MV0006	Checked:	Date:	
Scale: NTS	Approved:	Date:	
Replaces:			Orig.Lay: G-siz.

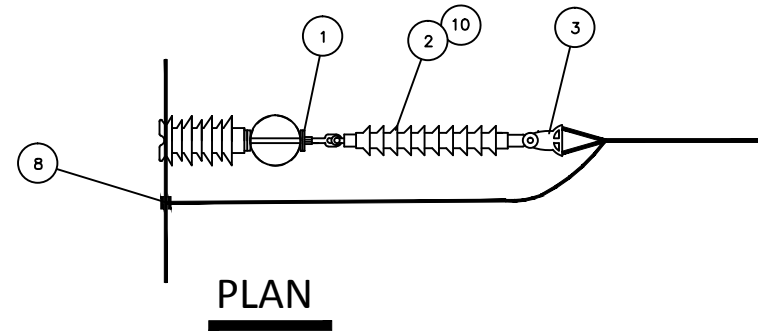
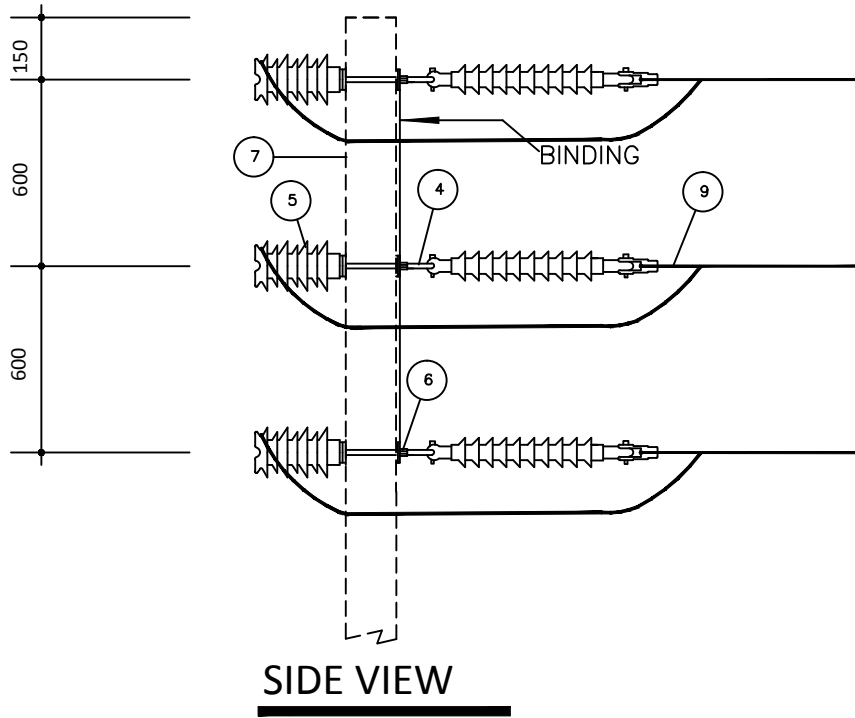


Part No.	Qty.	Description	Remarks/Ref.
11	1	STAY INSULATOR	
10		STAY WIRE 7/4	
9	1	POLE NUMBER	
8	1	12m POLE	
7	12	CURVED WASHER	60x60x6 M20
6	12	ROUND WASHER	M20
5	6	P.G.CLAMP	
4	12	NUT M20	
3	9	DEAD END A/ALLOY	Depending on conductor size
2	9	CLAMP THIMBLE CLEVIS	PT0001
1	9	STRAIN INSULATOR 11kv & 33kv	Ref.

Note:

Distance between Insulators for 33kv should be 800mm and 11kv 600mm

ZESCO LIMITED  GREAT EAST ROAD P.O. BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	E				Title of Drawing: MV O/H LINE POLE TOP STRUCTURE SECTION WITH TEE-OFF			
	D				Drawing No. MV0007		Drawn: Nyirenda M. Checked:	Date: 07.11.98 Date:
	C				Scale: NTS		Approved:	
	B				Replaces:		Date:	
	A	8.4.99	MN	Outer line removed			Date:	
Rev.	Date	Rev. by	Description			Orig.Layt: G-siz.		



Note:

Distance between Insulators for 33kV should be 800mm and 11kV 600mm

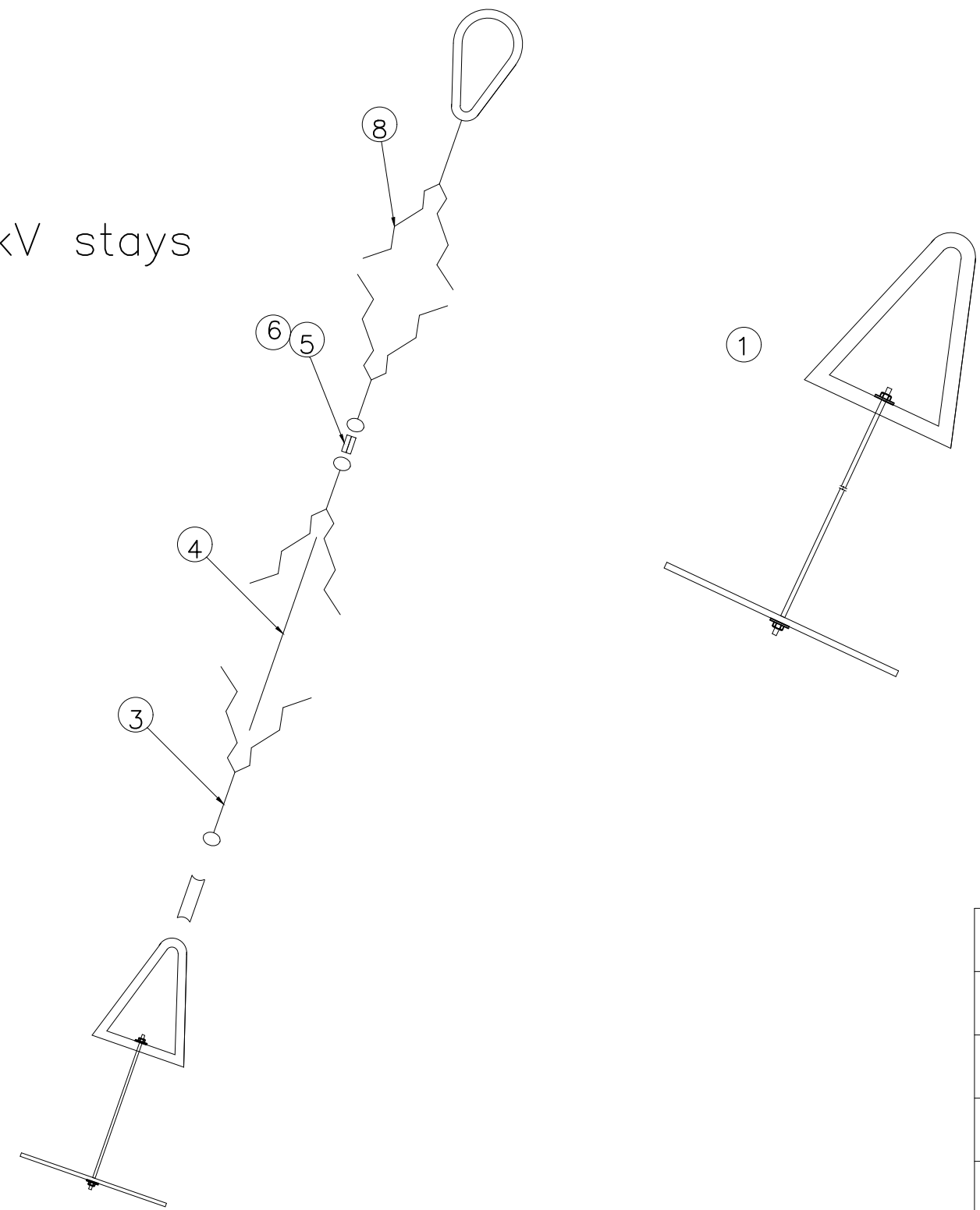
13	1	STAY ASSEMBLY 2.50m	PT0014
12	20M	STAY WIRE 7/4	
11	1	STAY INSULATOR	
10	3	STRAIN INSULATOR 33kV	Ref.
9	3	DEAD END A/ALLOY	Depending on conductor size
8	3	P.G.CLAMP	
7	1	12m POLE	
6	3	NUT M20	
5	3	POST INSULATOR 11kV & 33kV	PT0003
4	3	EYEBOLT M20 X 250mm	
3	3	CLAMP THIMBLE CLEVIS	PT0001
2	3	STRAIN INSULATOR 11kV	Ref.
1	6	ROUND WASHER	
Part No.	Qty.	Description	Remarks/Ref.

Title:		
11/33kV STAGGERED O/H LINE POLE TOP		
STRUCTURE TEE-OFF		
DRG No.	Drawn:	Date:
	Scale:	
	Checked:	Date:
	Approved:	Date:

Rev. Date Drawn Dsgnd Checkd Appvd

Change description

33kV stays



LABEL	QTY	MATERIAL DESCRIPTION
1	1	Stay assembly complete
5	1	Insulator Stay 33kV
4	25	Wire Stay 7/4
3	3	Stay Guy Grip
8	1	Wire Pole Top make off



Project Name:
CHINA GEO ENGINEERING CORPORATION CONTRACTORS

Drawing Title:
33kV STAYS

Drawn: sande s Date: 19.11.10
 Designed: Date:
 Checked: jh bwembelo Date:
 Approved: Date:

Scale: N.T.S.
 Drawing No. **ZAM-GEN-DE-G-12831A**

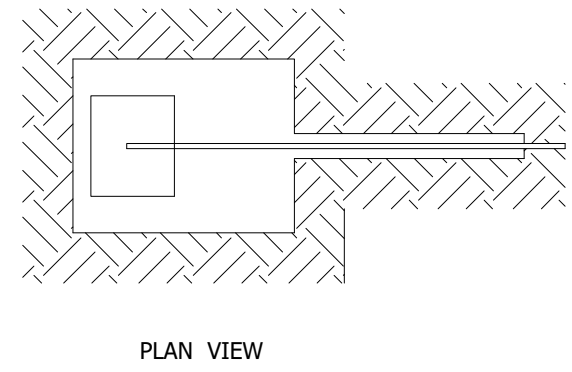
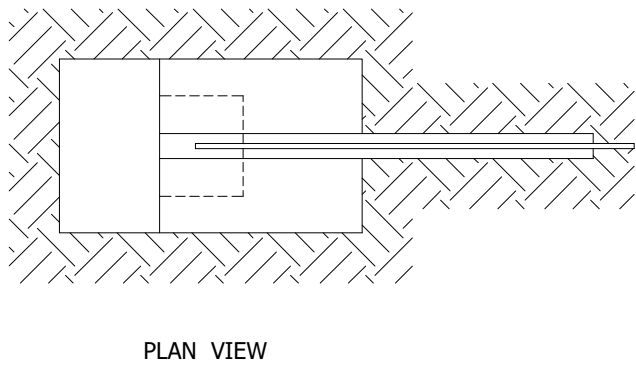
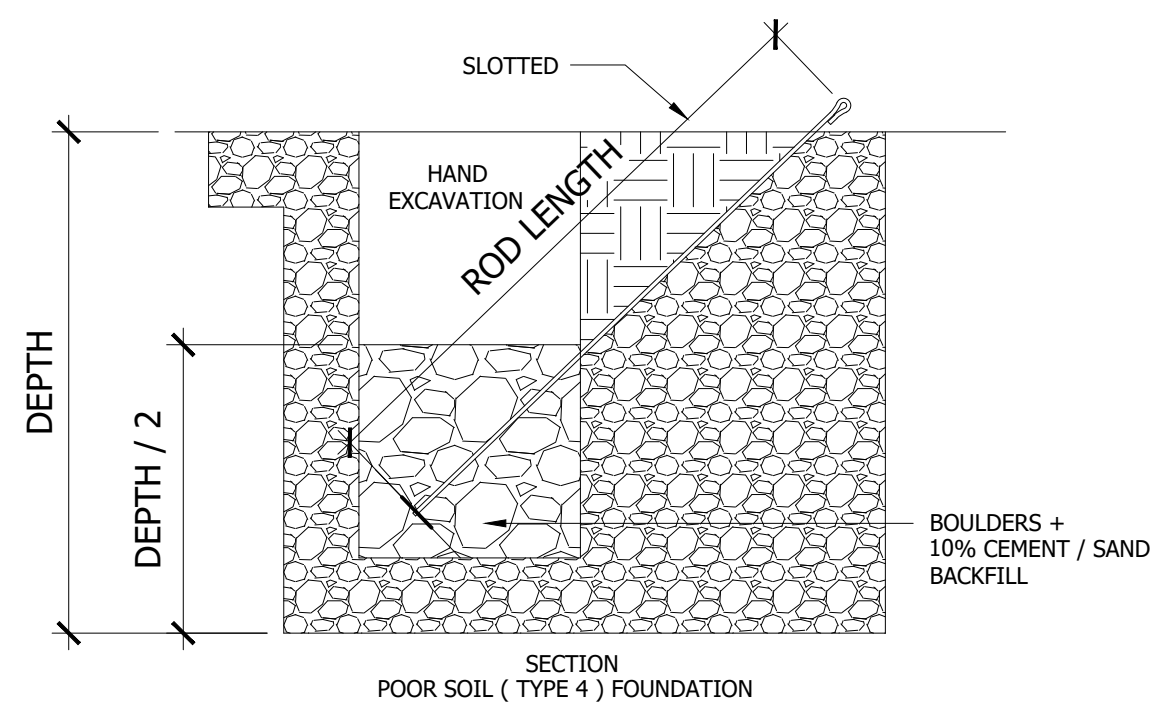
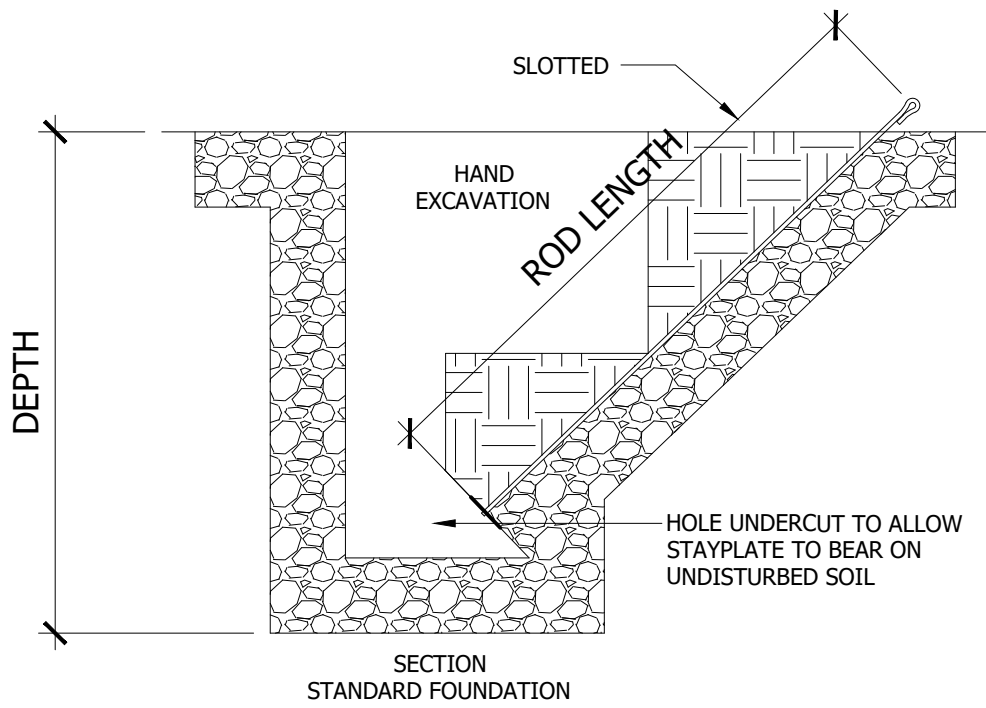
Sheet/Sheets
 Rev.

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B
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H

1 2 3 4 5 6 7 8 9 10 11 12

Rev. Date Drawn Dsgnd Chckd Appvd Change description

A B C D E F G H



STAY DETAILS			
ROD LENGTH	DIAMETER	DEPTH	UTS
2400	20MM	1700	96KN
3000*	20MM	2100	96KN

*MAY BE REQUIRED FOR POOR SOILS



Project Name:

Drawing Title:
STAY PLANTING DETAILS
33KV OVERHEAD LINE
Bison Conductor

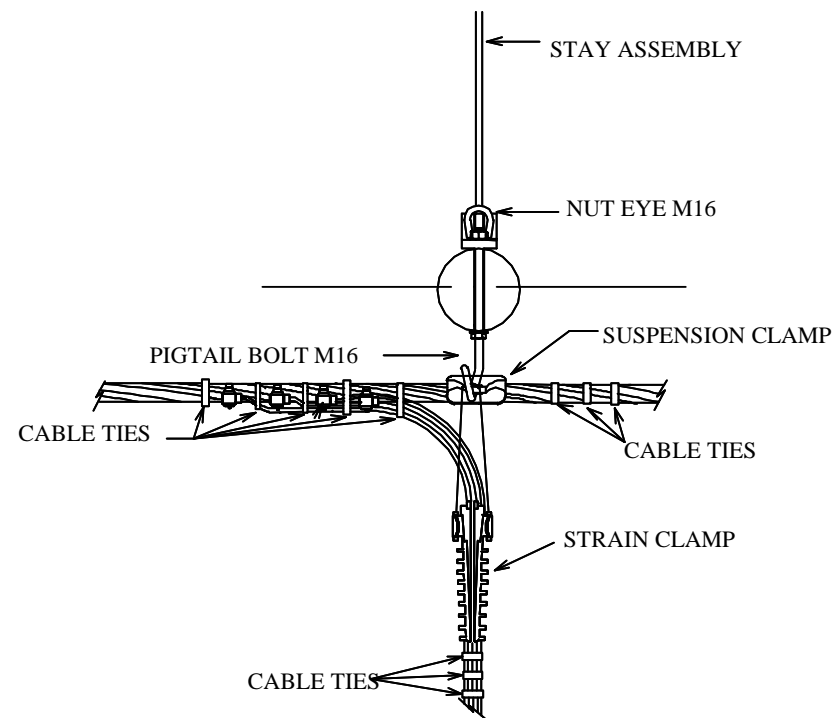
Drawn: Nyirenda M. Date: 09.07.08
Designed: Date:
Checked: Date:
Approved: Date:

Scale:
Drawing No. ZAM-GEN-DC-41-G-12378

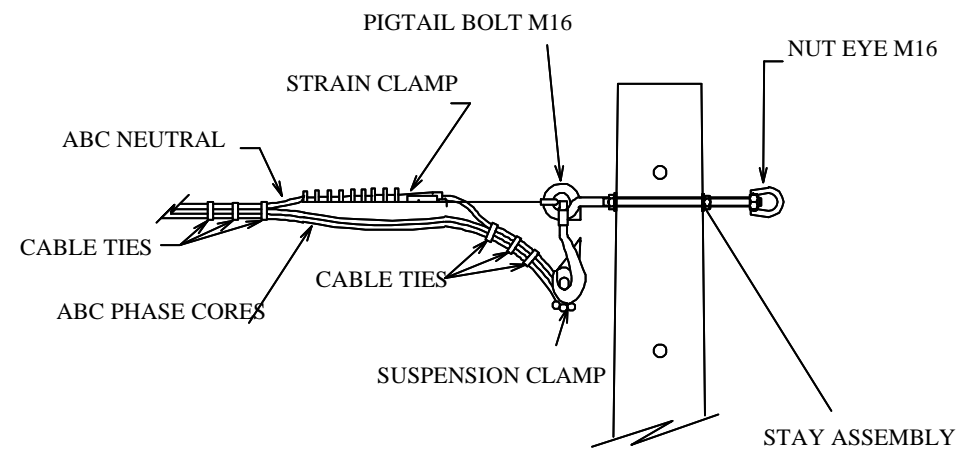
Sheet 22+
Rev.

Low-Voltage Drawings (ABC)

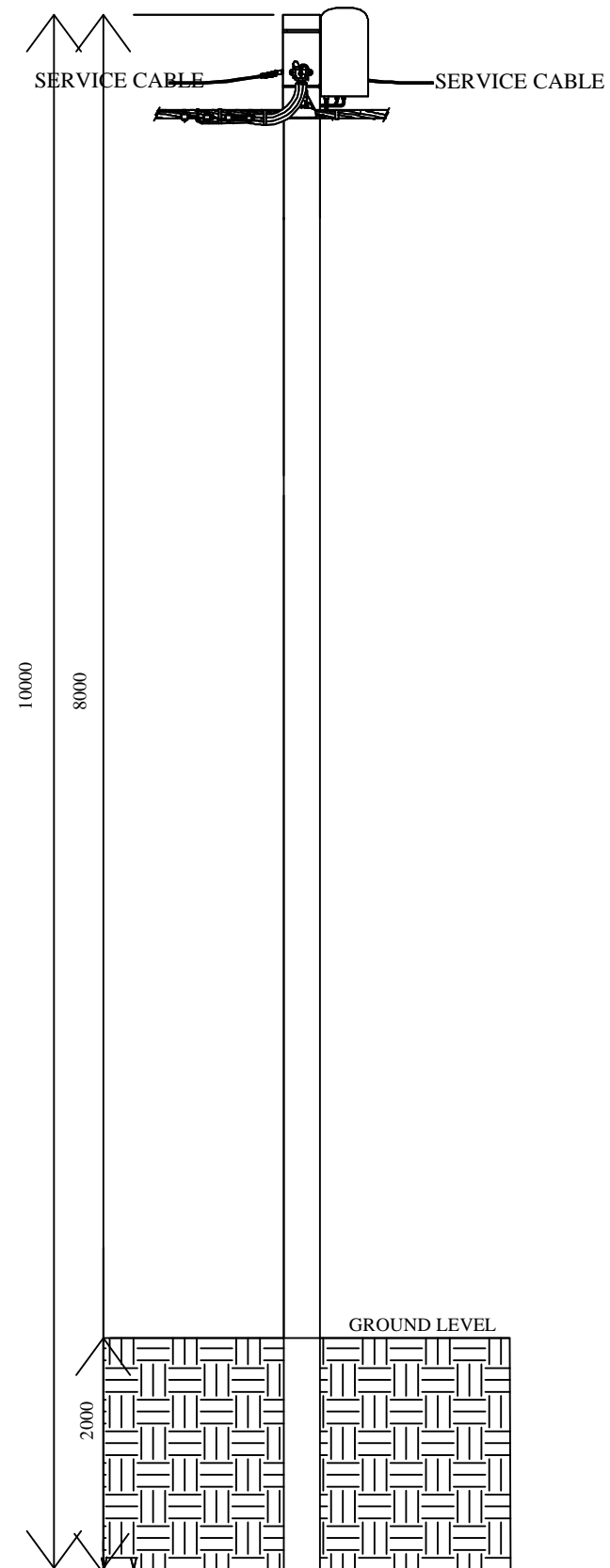
Drawing No.	Drawing Description
070	LV Bare Neutral ABC
071	LV OHL Reticulation - Stay Assembly Wood Pole
072	LV OHL Reticulation - Strut Arrangement for 7m & 9m Wood Poles
073	LV OHL Reticulation - Overhead (Flying) Stay Arrangement for Wood Poles
074	LV OHL Reticulation 3-Phase Bare Neutral ABC - Cross Intermediate - Strain Assembly Wood Pole
075	LV OHL Reticulation 3-Phase Bare Neutral ABC - Strain Assembly (0° to 60°) Wood Pole
076	LV OHL Reticulation 3-Phase Bare Neutral ABC - Strain Assembly (60° to 90°) Wood Pole
077	LV OHL Reticulation 3-Phase Bare Neutral ABC - Suspension Assembly (0° to 30°) Wood Pole
078	LV OHL Reticulation 3-Phase Bare Neutral ABC - Terminal Wood Pole
079	LV Reticulation 3 Bare Neutral ABC Cross Intermediate - Intermediate Assembly Wood Pole
080	LV Reticulation 3-Phase Bare Neutral ABC T-off Assembly from Strain Wood Pole
085	Cable Trench



PLAN VIEW



SIDE VIEW



LEGEND:

Symbols	Description

Notes:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

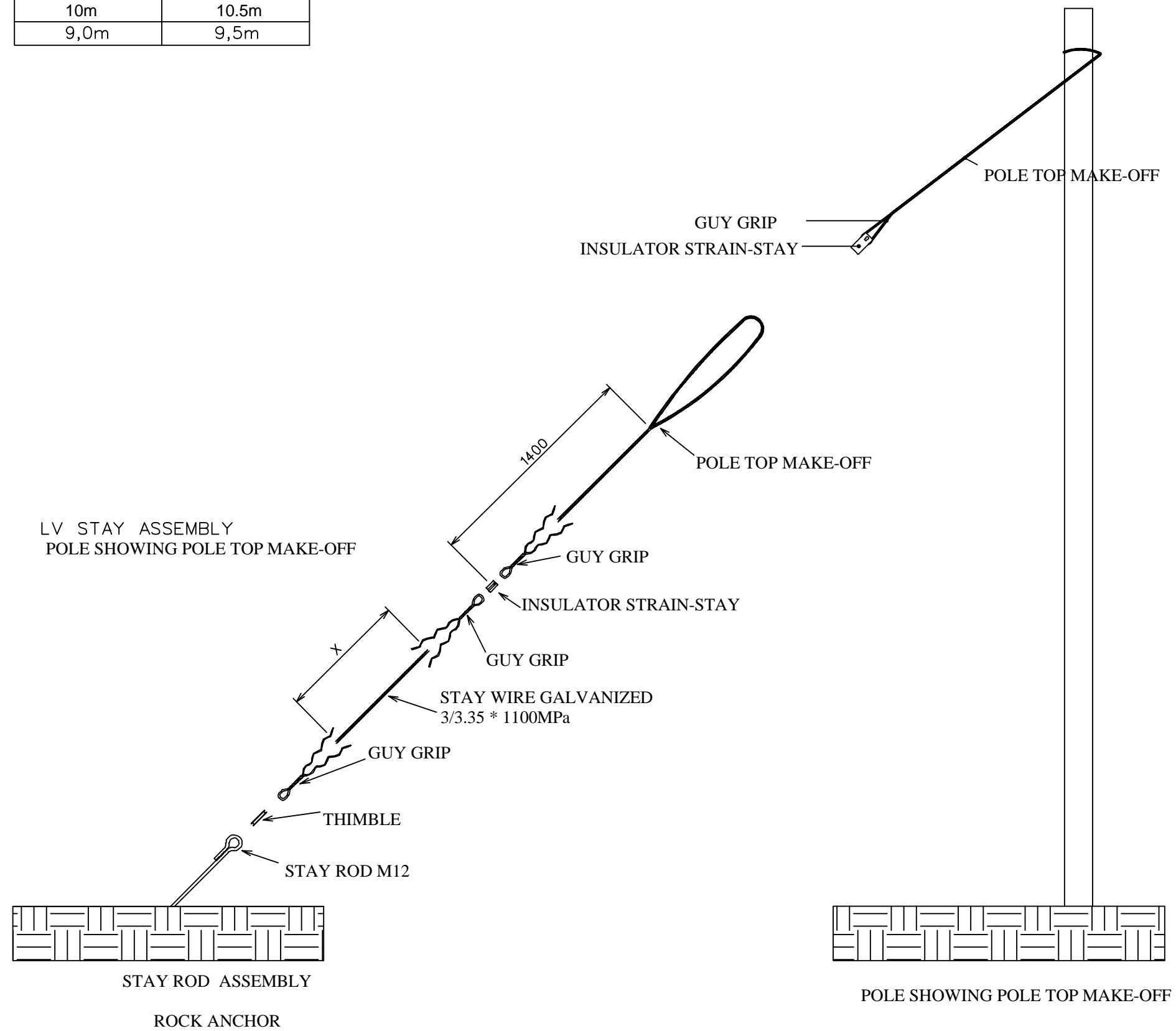
Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
LV Network
Three Phase Bare Neutral ABC
T-Off Assembly from
Intermediate Wood Pole

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:				Scale:
070				NTS

'X' STAY WIRE LENGTH - TABLE

POLE HEIGHT	'X'
10m	10.5m
9,0m	9,5m



LEGEND:

Symbols	Description

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

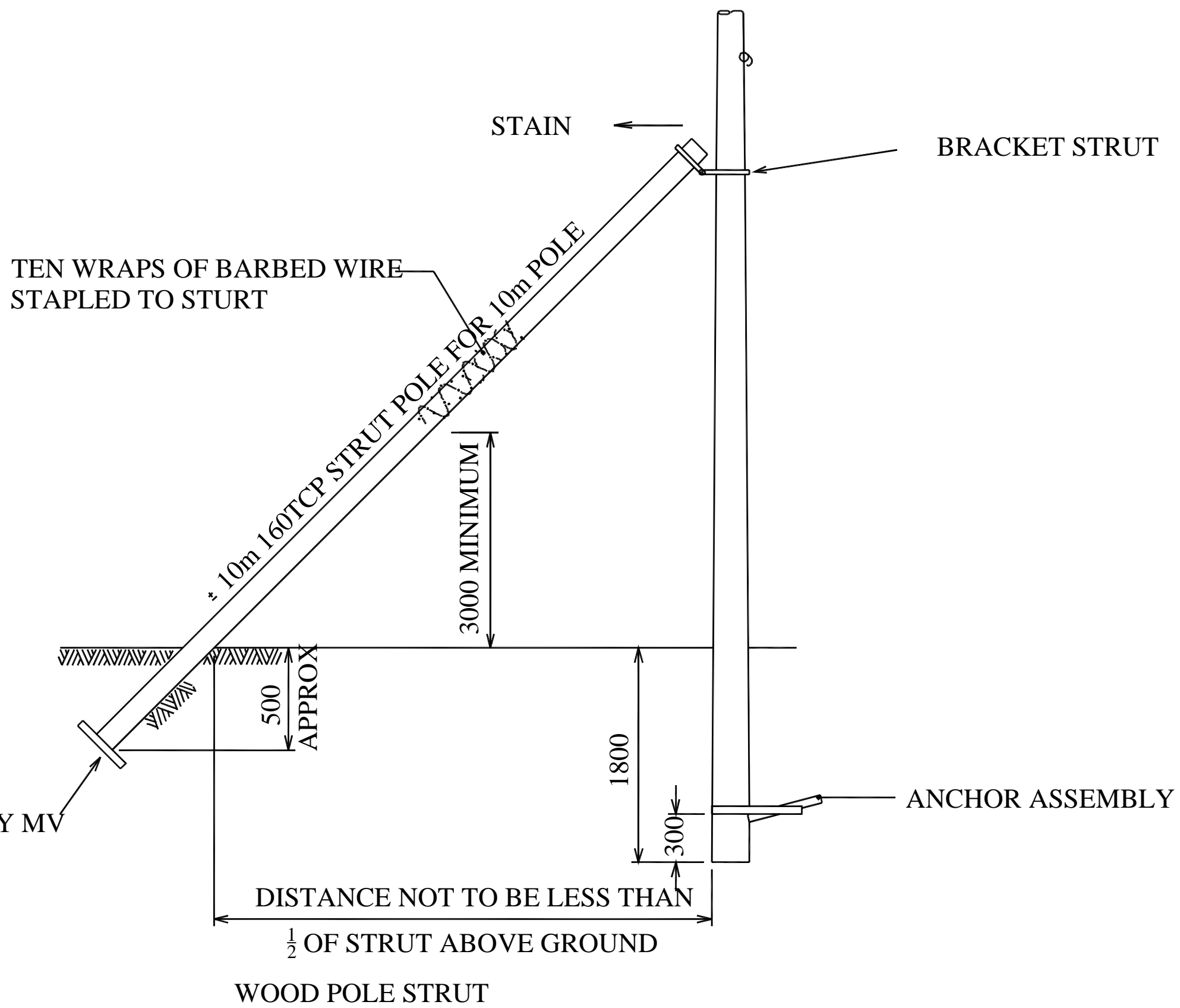
Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Wood Pole Stay Assembly

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:				Scale:
071				NTS



LEGEND:

Symbols	Description

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Strut Arrangement
for 10m Wood Poles

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3

Drawing Number:
072

Scale:
NTS

'X' STAY WIRE LENGTH - TABLE

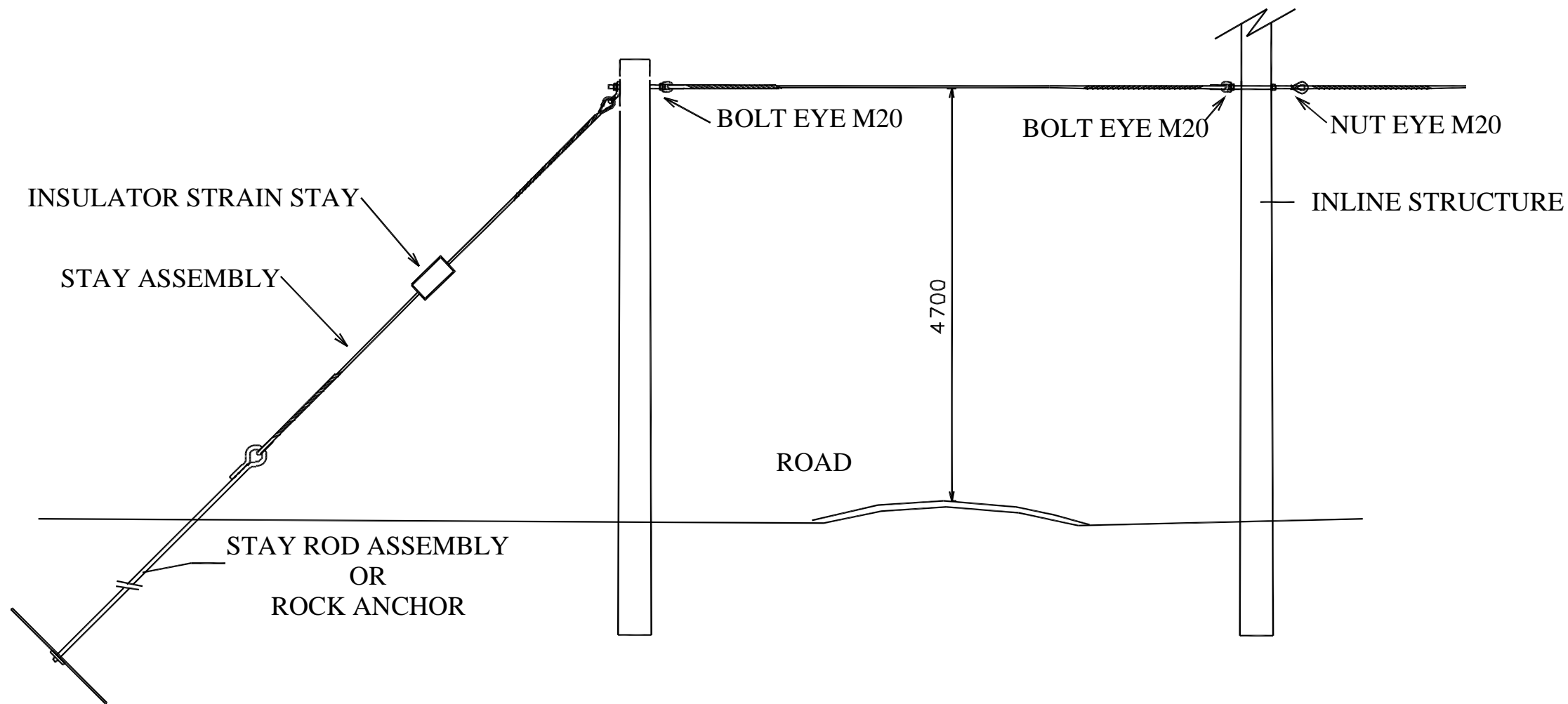
POLE HEIGHT	'X'
10m	10.5m
9,0m	9,5m

LEGEND:

Symbols	Description

Notes:

For Tender Purposes Only



Purpose of Issue	Ref.	Date	Drn.	Appr.
------------------	------	------	------	-------

Client:
 The National Authorising Office (NAO)
 of the
 European Development Fund (EDF)

Consultant:

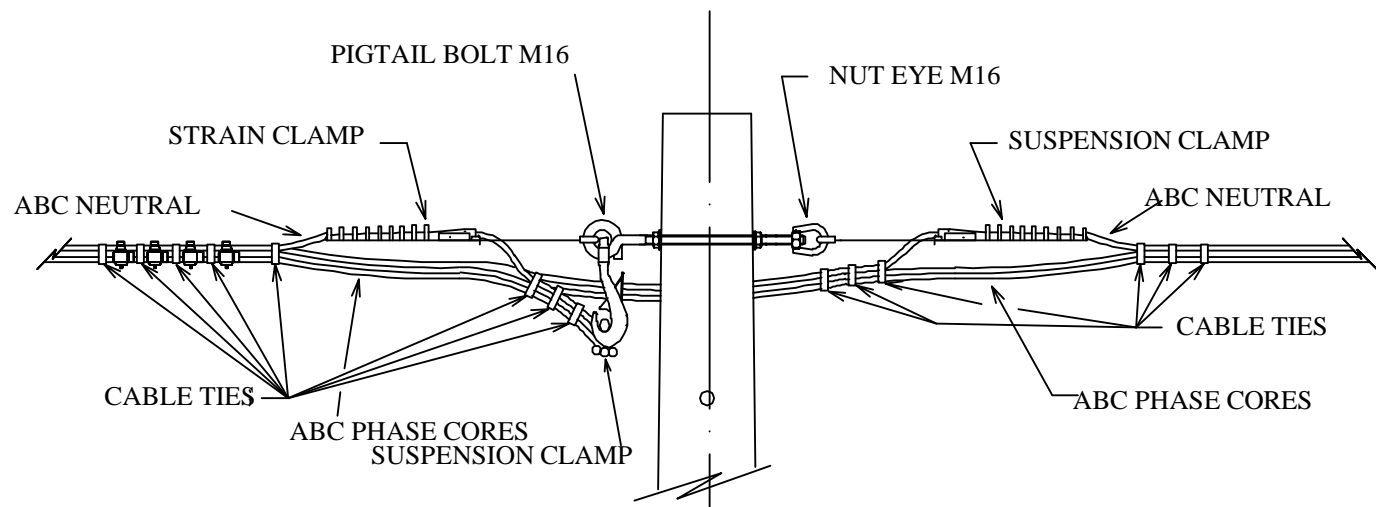
 GOPA International Energy Consultants

Project:
 Rehabilitation, Extension and
 Strengthening of the Low Voltage
 Electrical Distribution Network
 in Lusaka

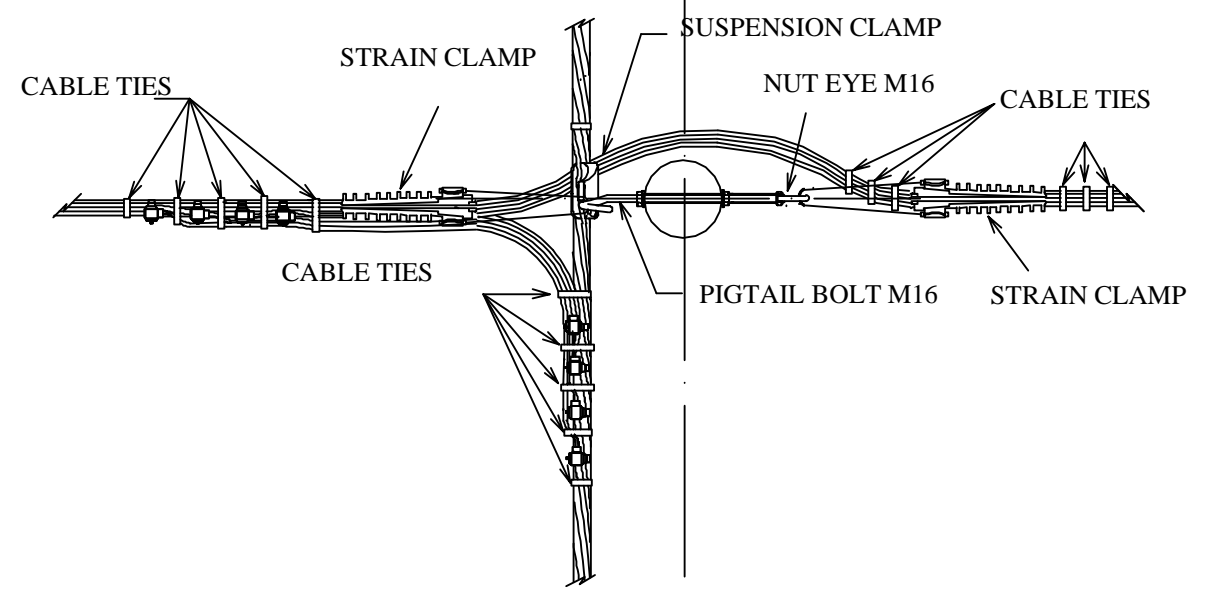
Drawing Title:
 Low Voltage Network
 Overhead (flying) Stay
 Arrangement for Wood Poles

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3

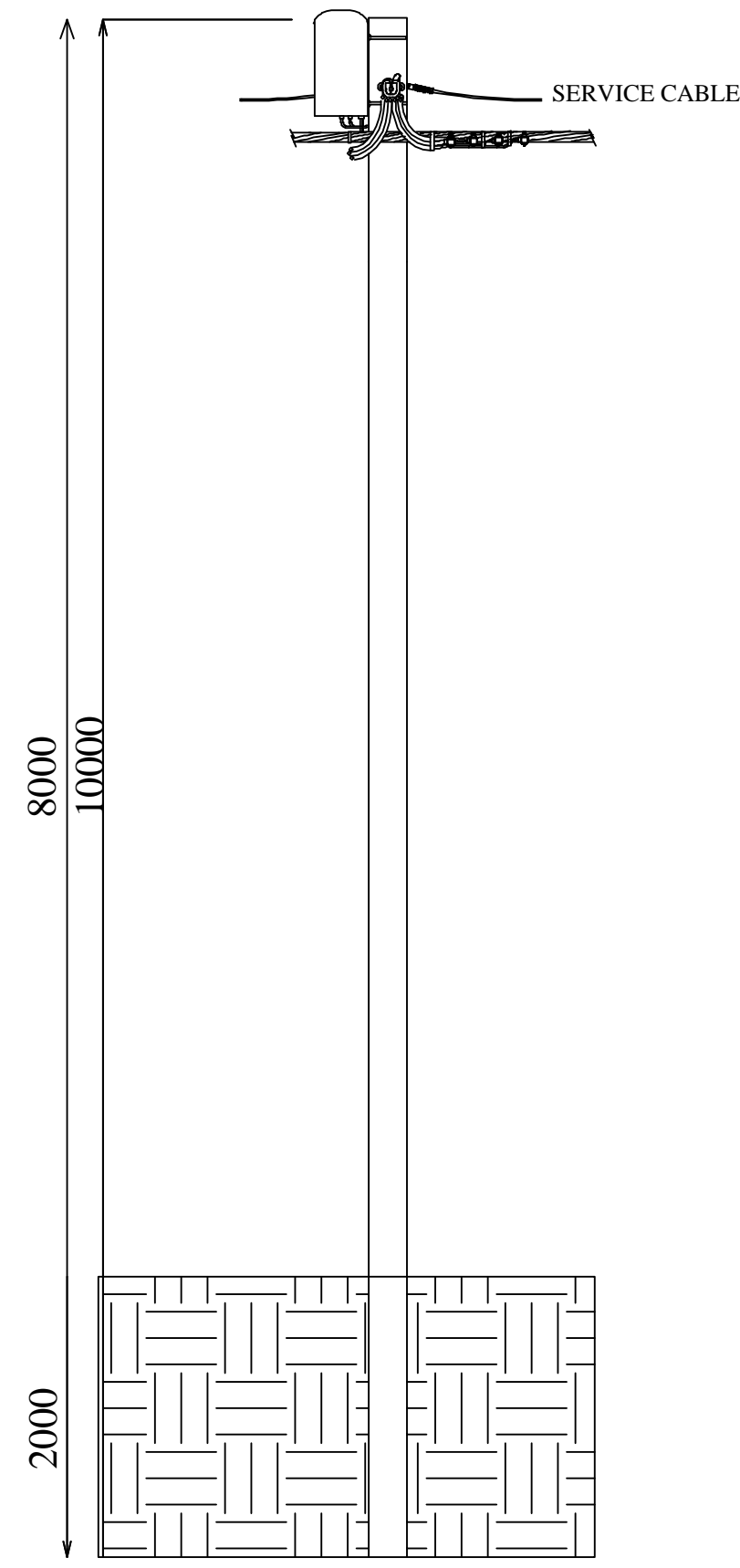
Drawing Number:
 073
 Scale:
 NTS



SIDE VIEW



PLAN VIEW



LEGEND:

Symbols	Description

Notes:
 For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:
 The National Authorising Office (NAO)
 of the
 European Development Fund (EDF)

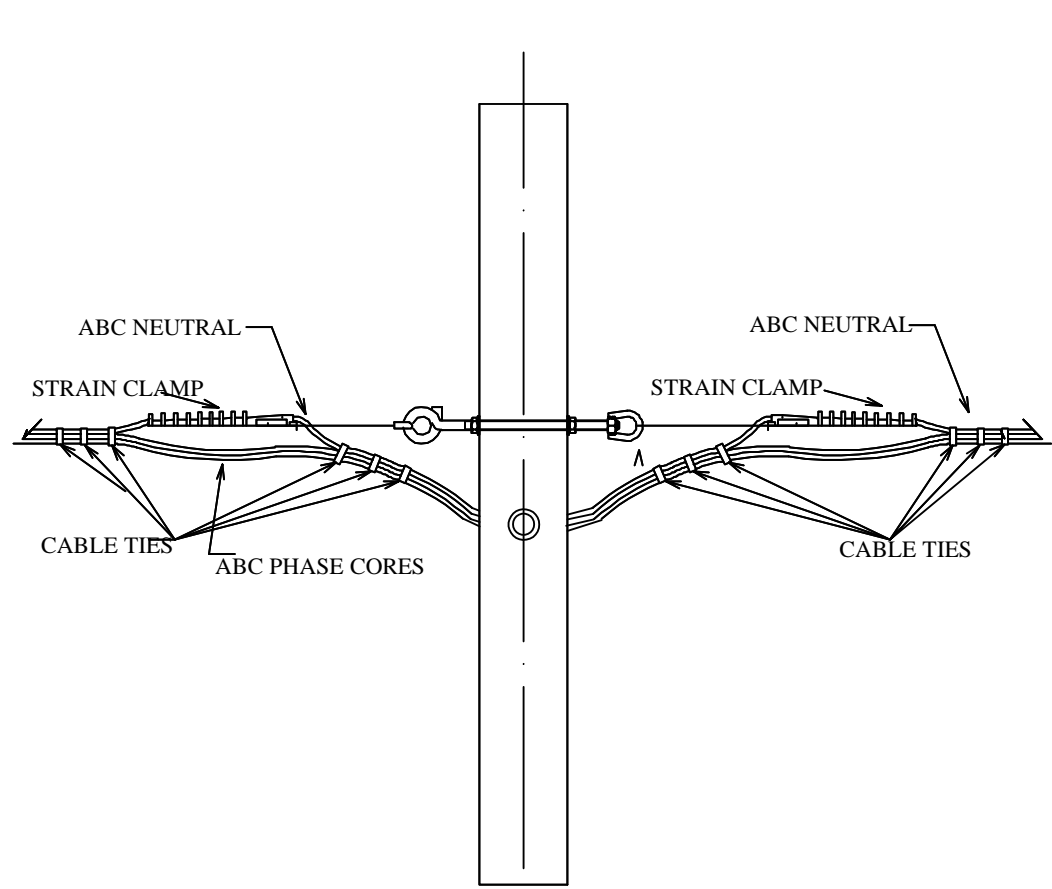
Consultant:

 GOPA International Energy Consultants

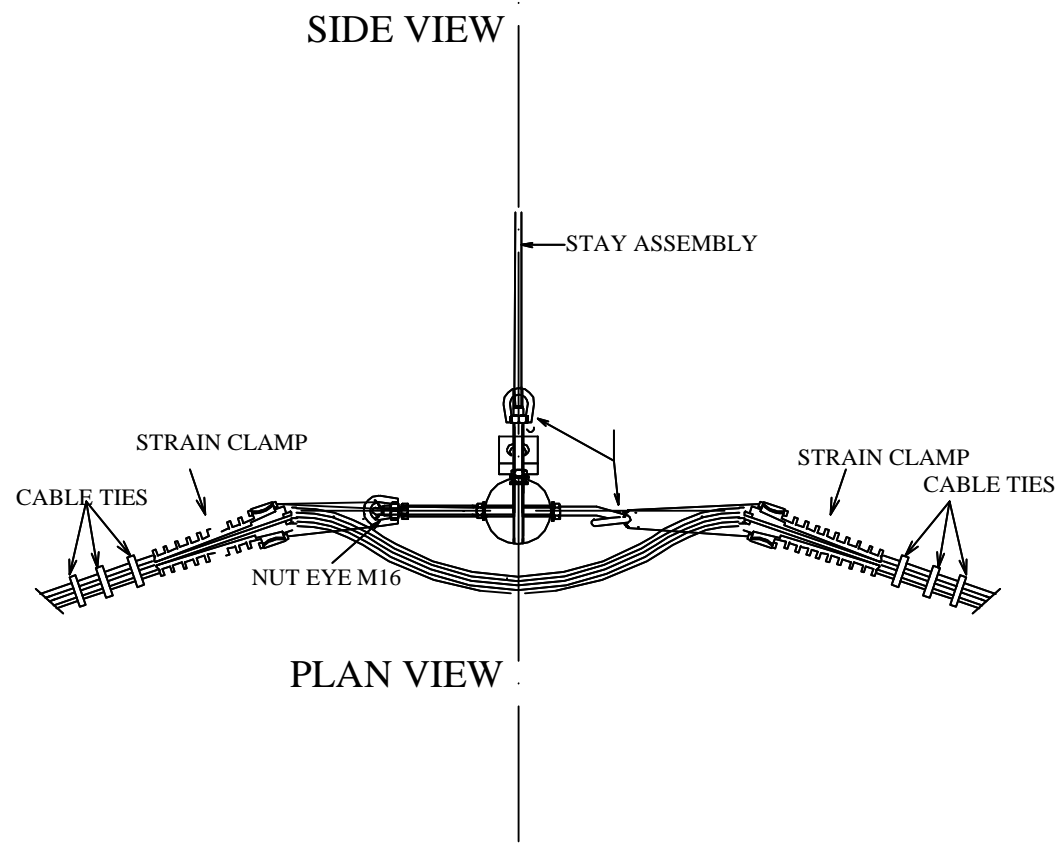
Project:
 Rehabilitation, Extension and
 Strengthening of the Low Voltage
 Electrical Distribution Network
 in Lusaka

Drawing Title:
 Low Voltage Network
 Three Phase Bare Neutral ABC
 T-Off Assembly from
 Intermediate Wood Pole

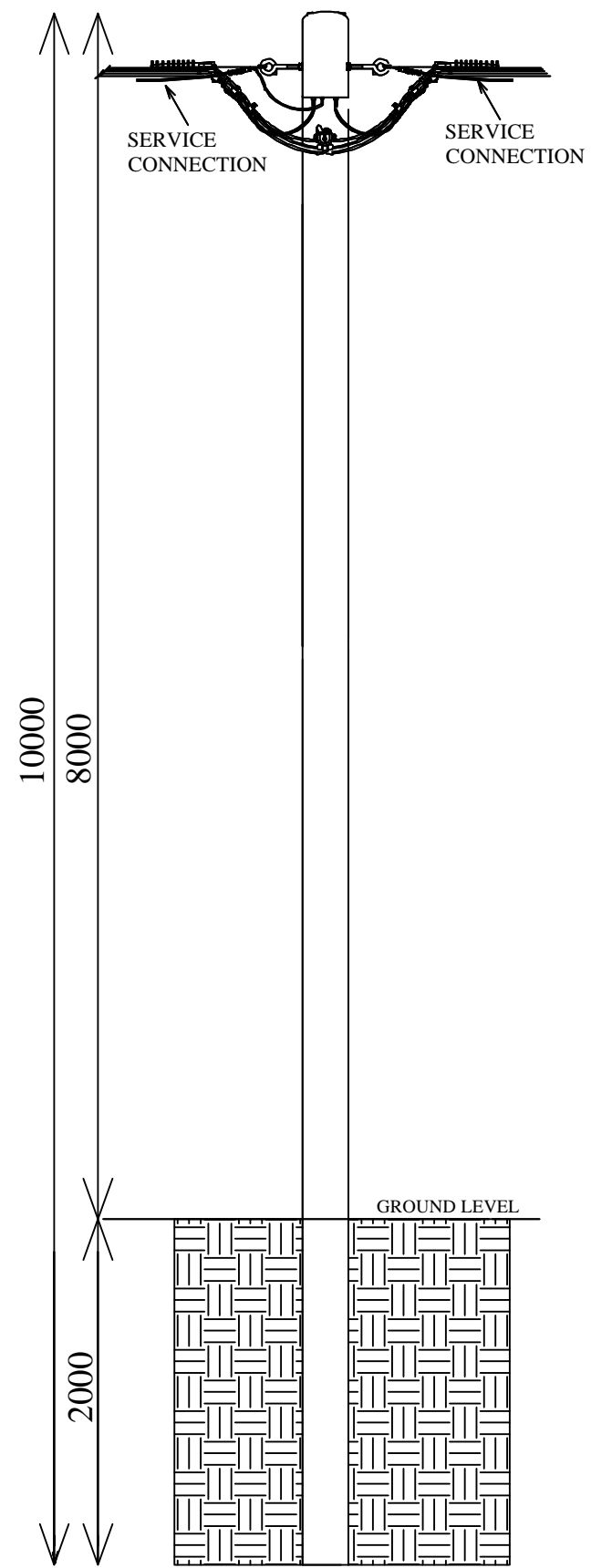
Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
<u>Drawing Number:</u>				<u>Scale:</u>
074				NTS



SIDE VIEW



PLAN VIEW



LEGEND:

Symbols	Description

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

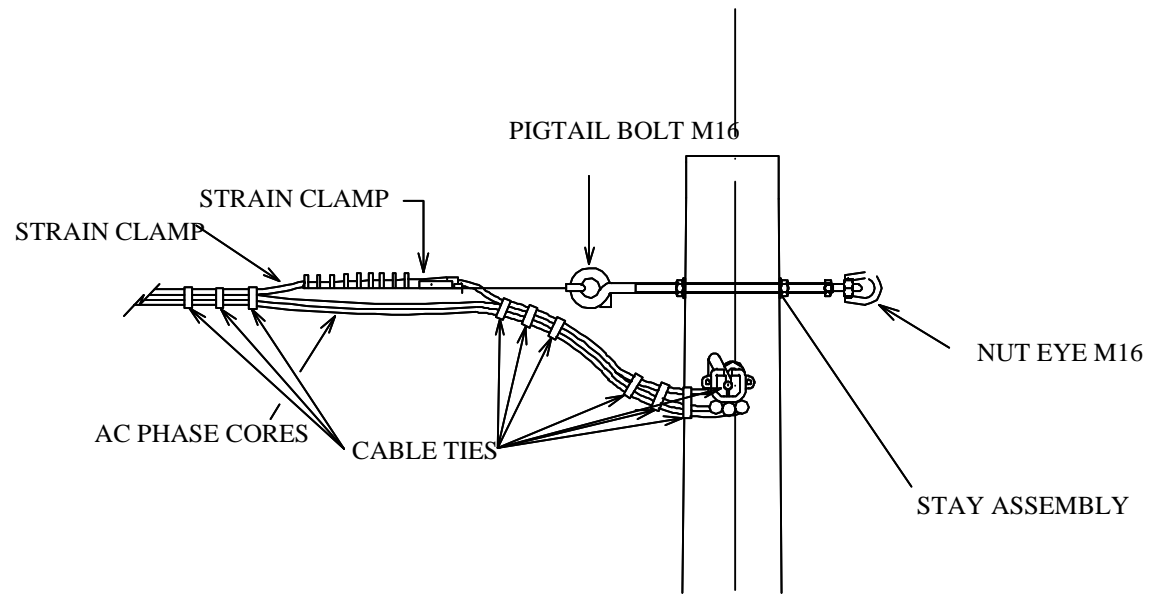
Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

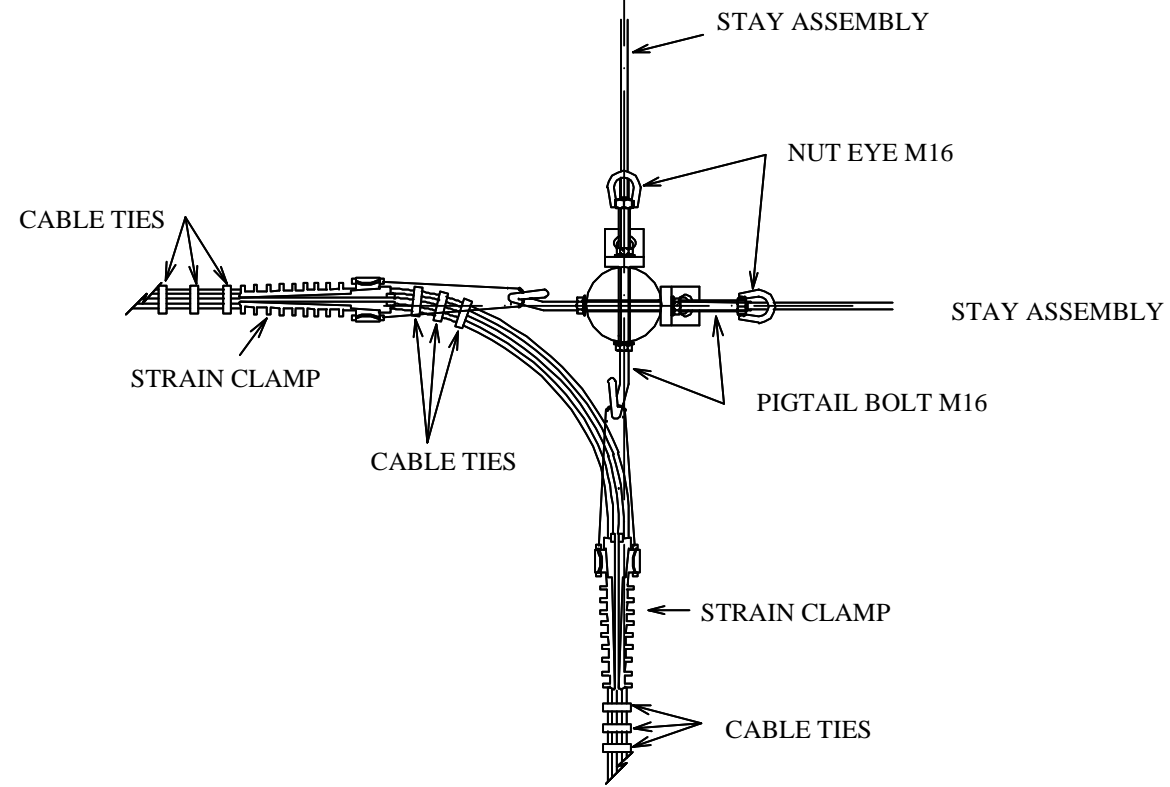
Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Three Phase Bare Neutral ABC
Strain Assembly (0-60 deg)
Wood Pole

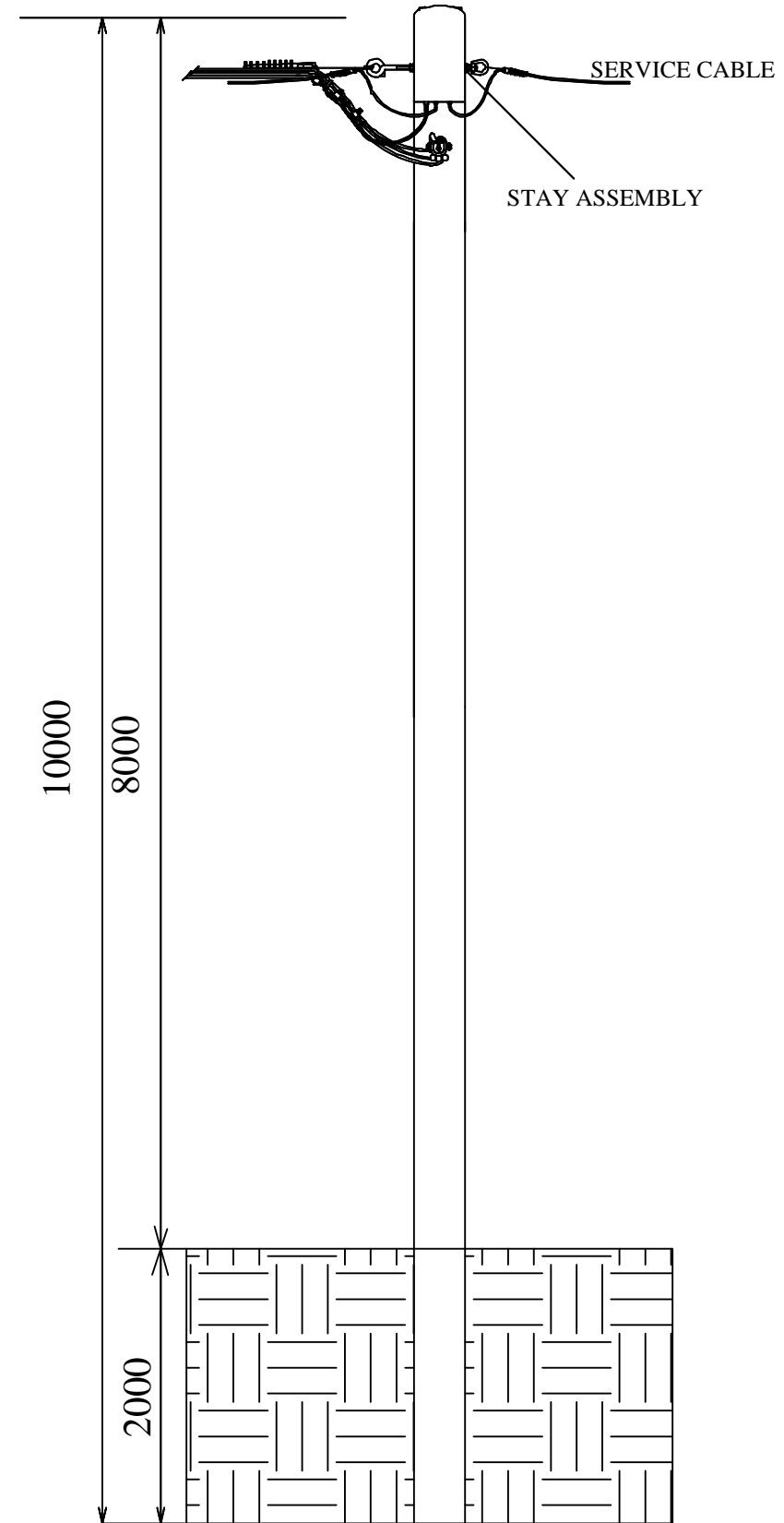
Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:	075			Scale:
				NTS



FRONT VIEW



PLAN VIEW



LEGEND:

Symbols	Description

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

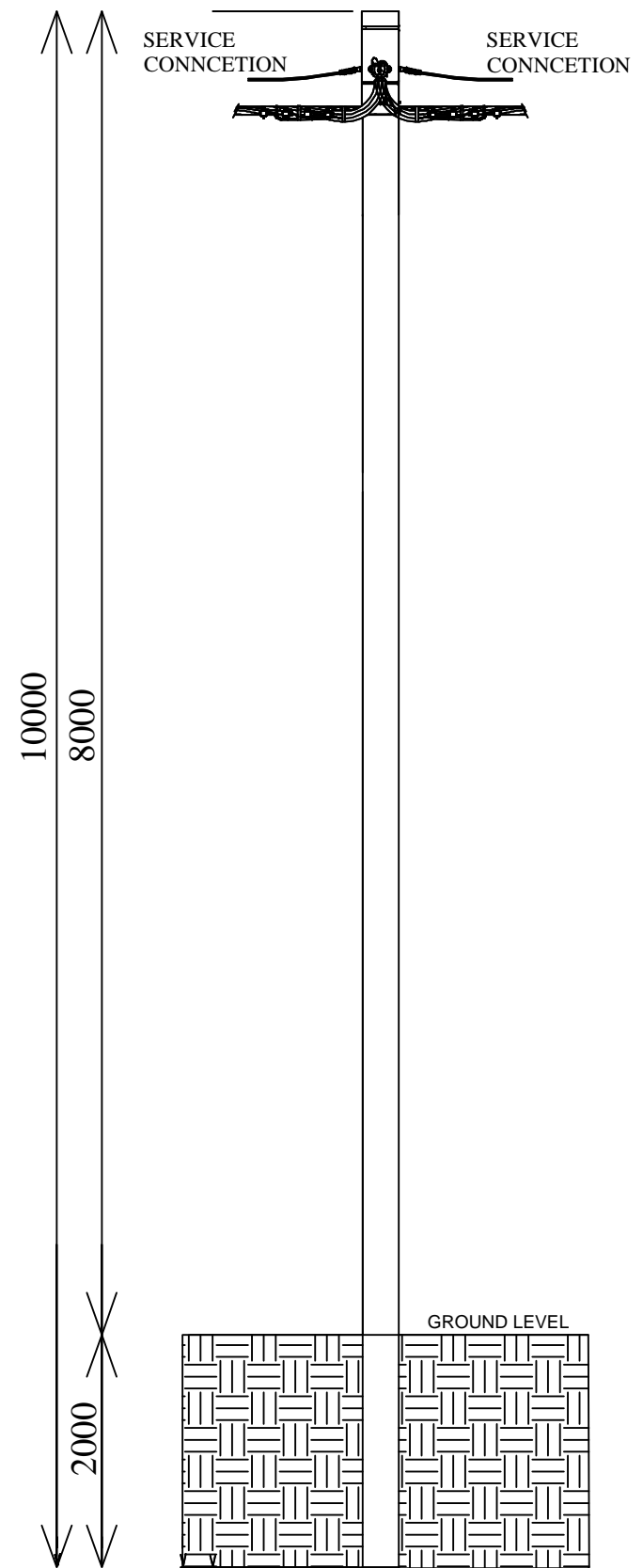
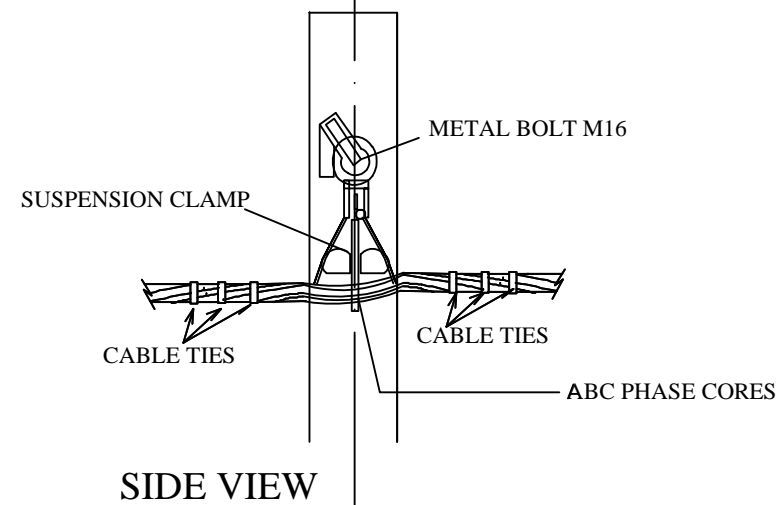
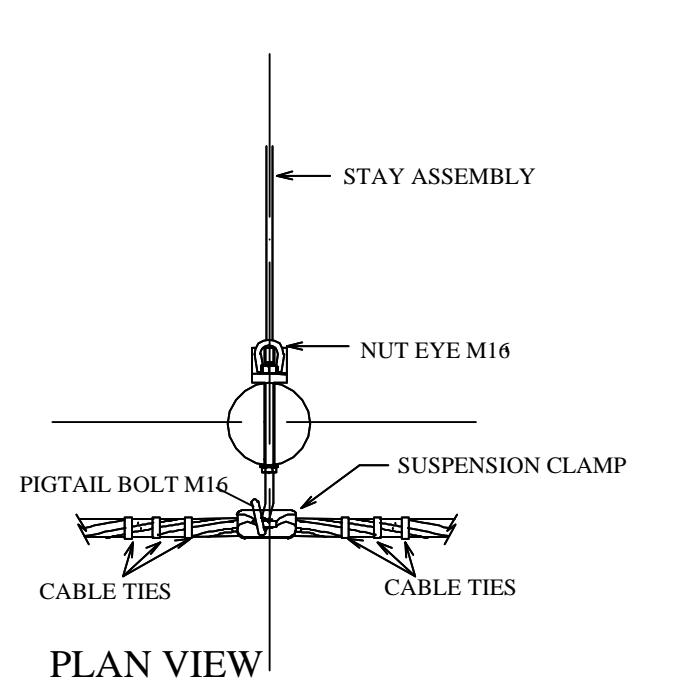
Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:

Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Three Phase Bare Neutral ABC
Strain Assembly (60-90 deg)
Wood Pole

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number: 076				Scale: NTS



LEGEND:

Symbols	Description

Notes:
 For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:
 The National Authorising Office (NAO)
 of the
 European Development Fund (EDF)

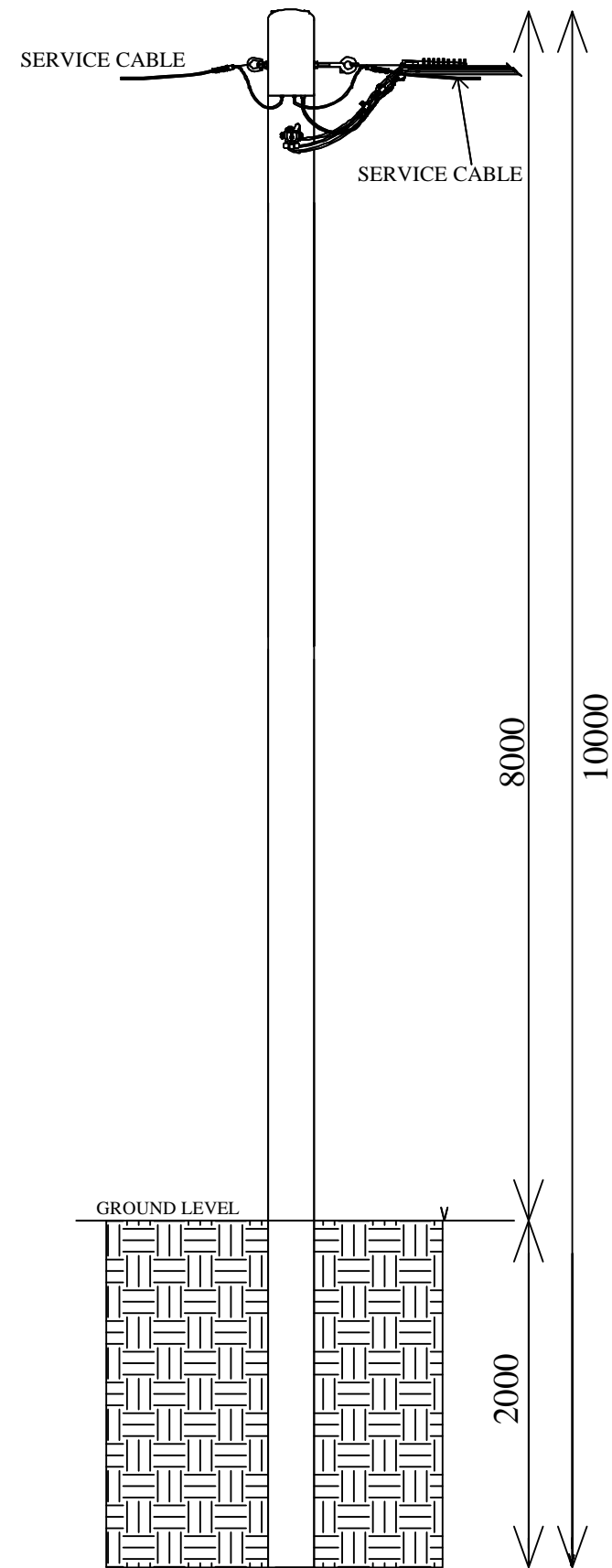
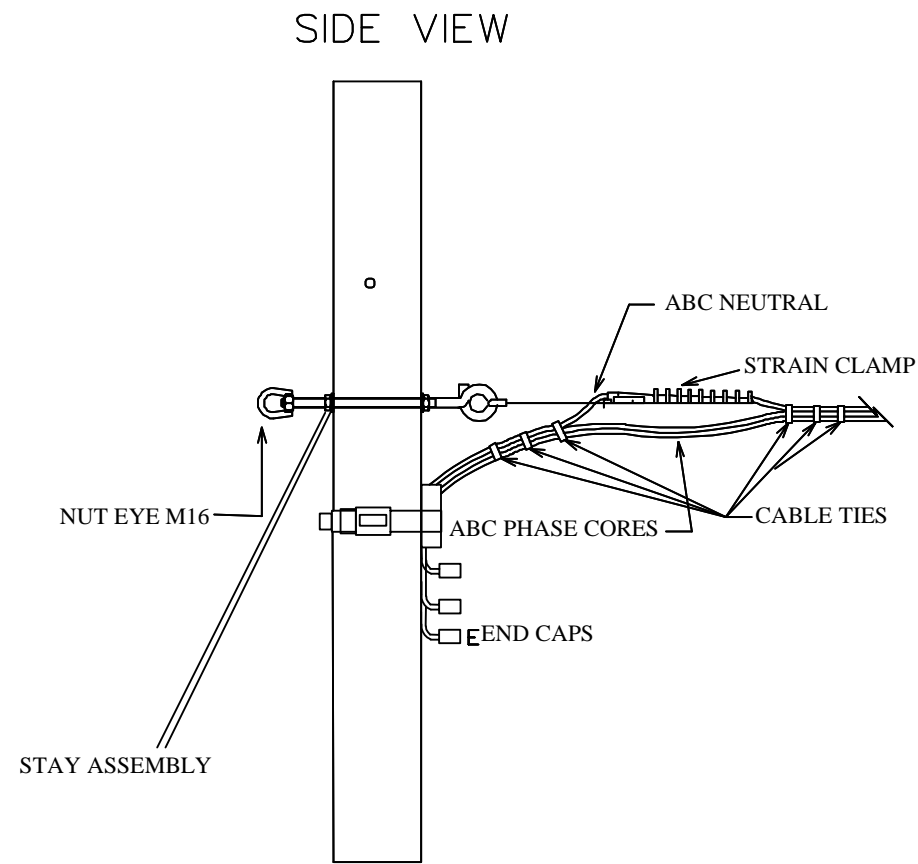
Consultant:

 GOPA International Energy Consultants

Project:
 Rehabilitation, Extension and
 Strengthening of the Low Voltage
 Electrical Distribution Network
 in Lusaka

Drawing Title:
 Low Voltage Network
 Three Phase Bare Neutral ABC
 Suspension Assembly (0-30deg)
 Wood Pole

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number: 077				Scale: NTS



LEGEND:

Symbols	Description

Notes:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

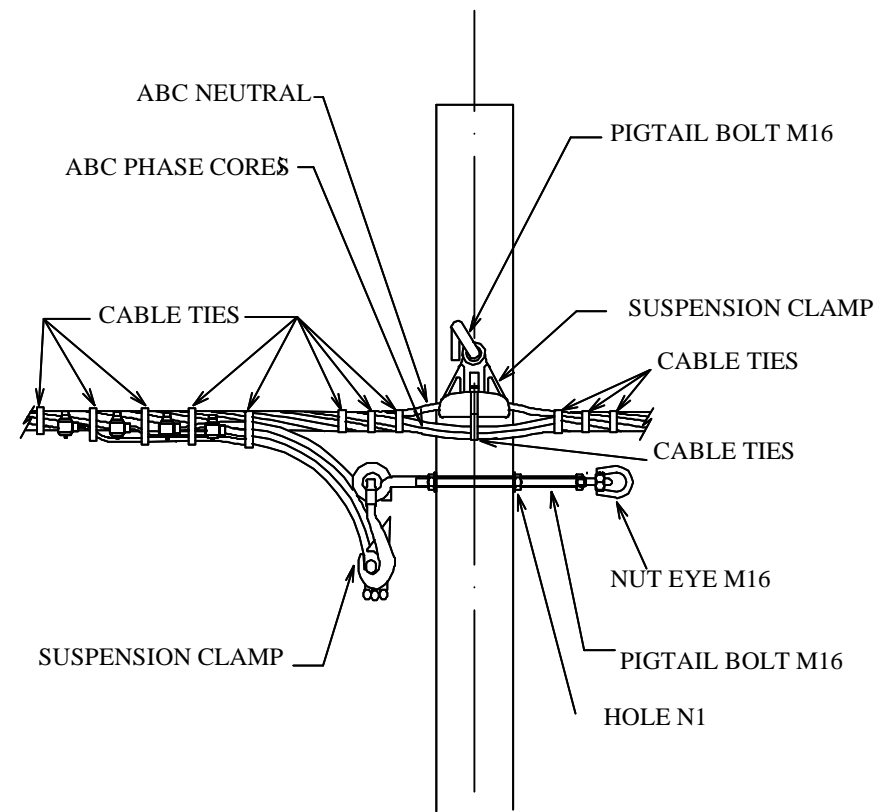
Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

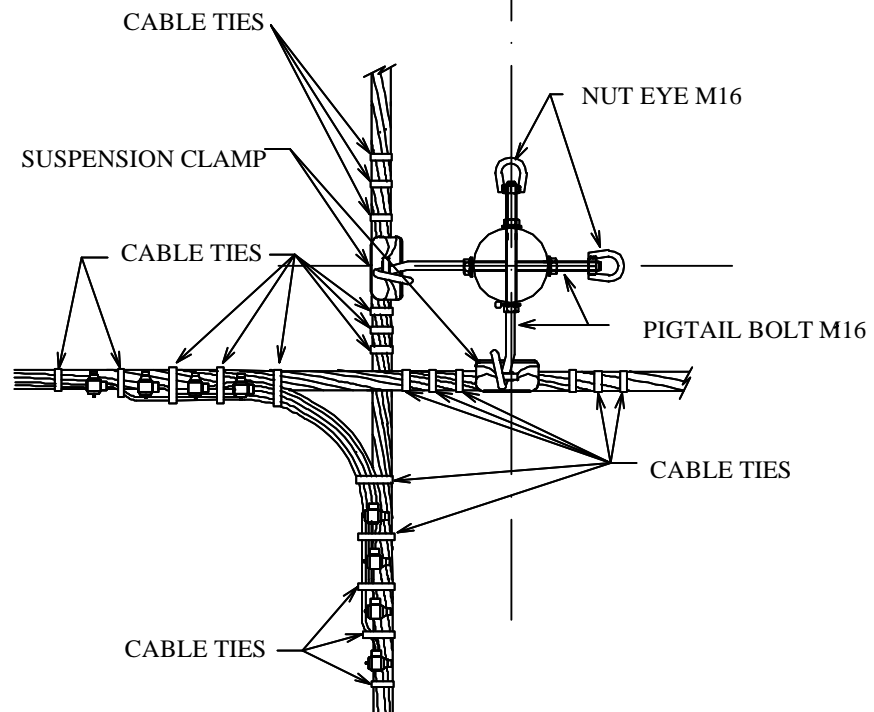
Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Three Phase Bare Neutral ABC
Terminal Wood Pole

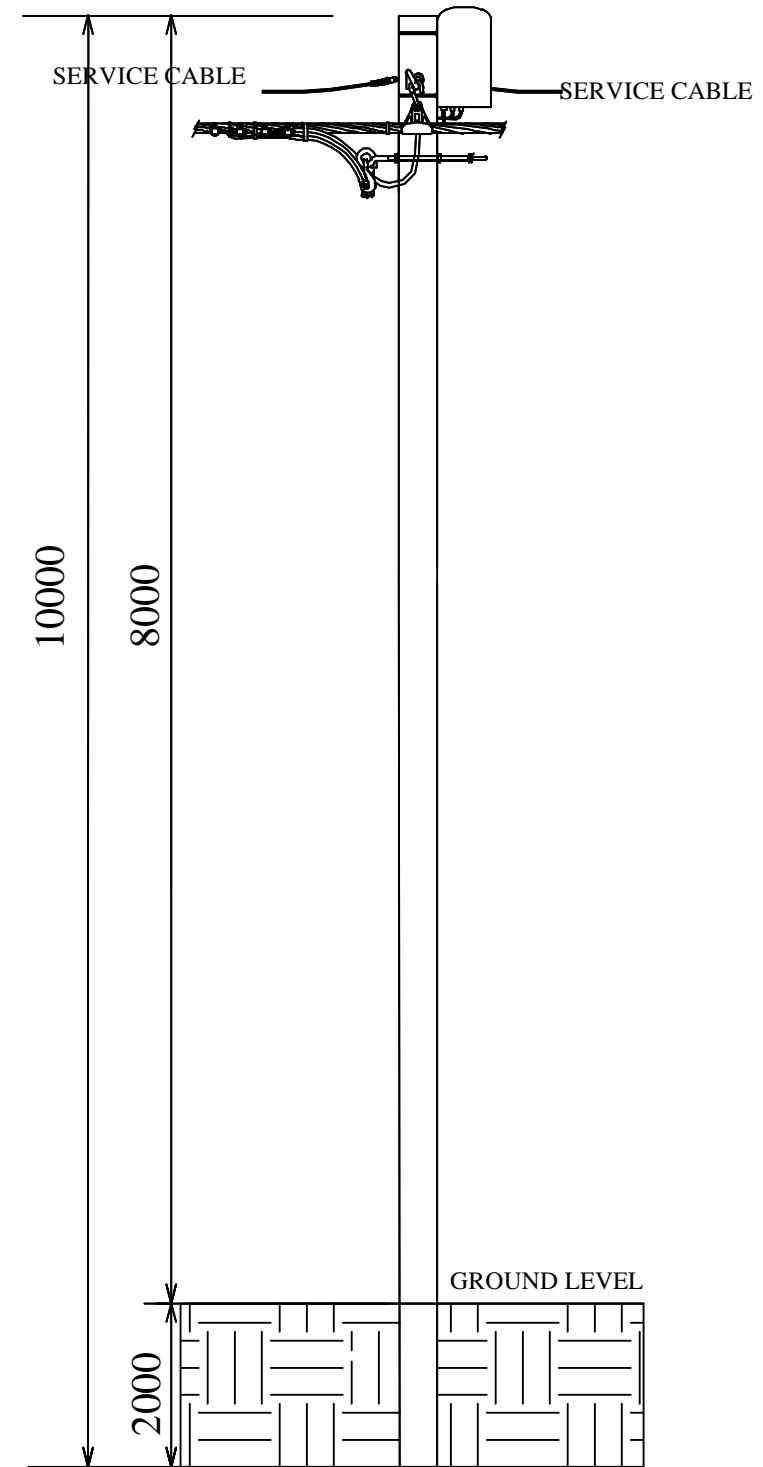
Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number: 078				Scale: NTS



FRONT VIEW



PLAN VIEW



LEGEND:

Symbols	Description

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Apr.

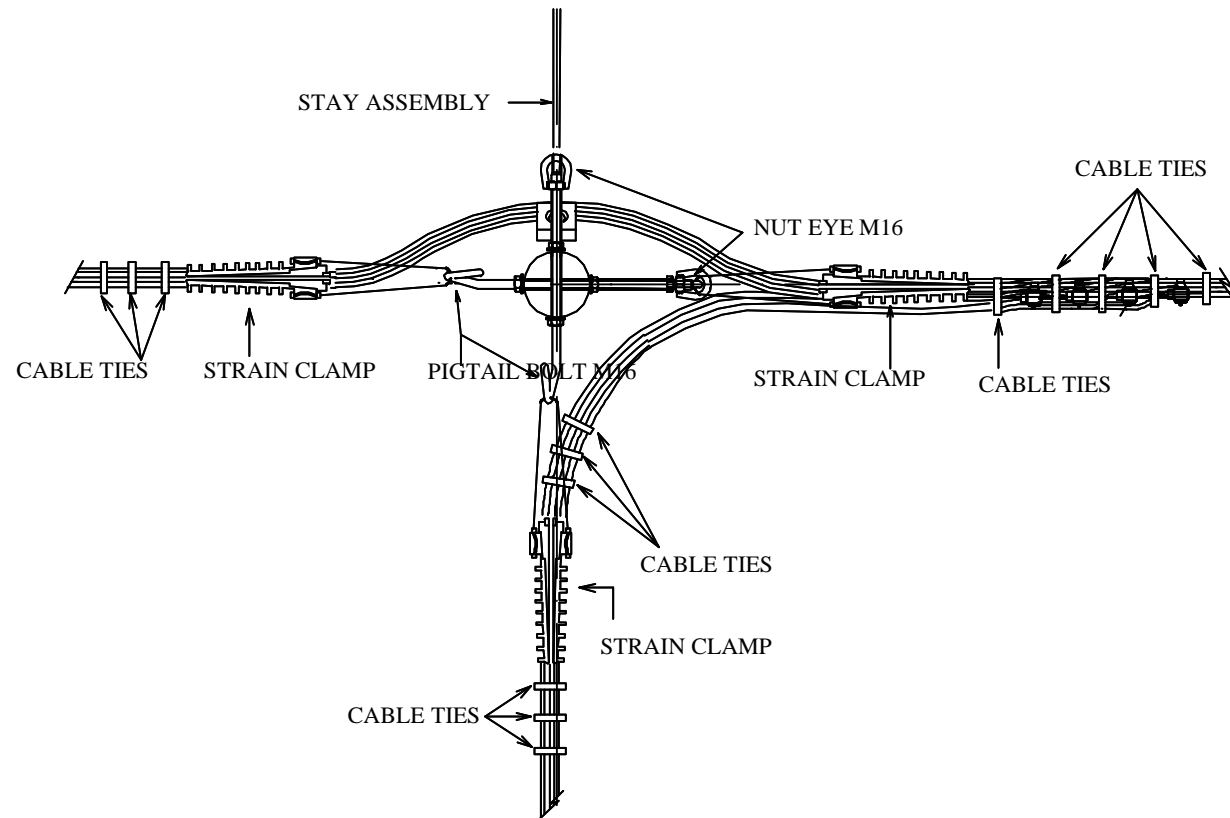
Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:
intec
GOPA International Energy Consultants

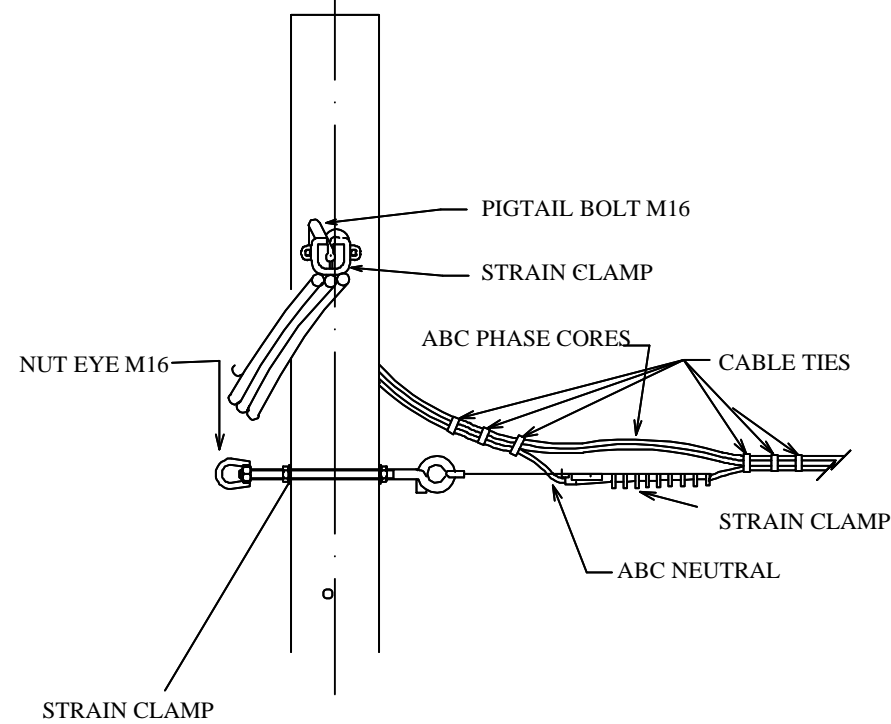
Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Low Voltage Network
Three Phase Bare Neutral ABC
Cross Intermediate Assembly
Wood Pole

Date:	Drawn:	Checked:	Apr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:				Scale:
079				NTS



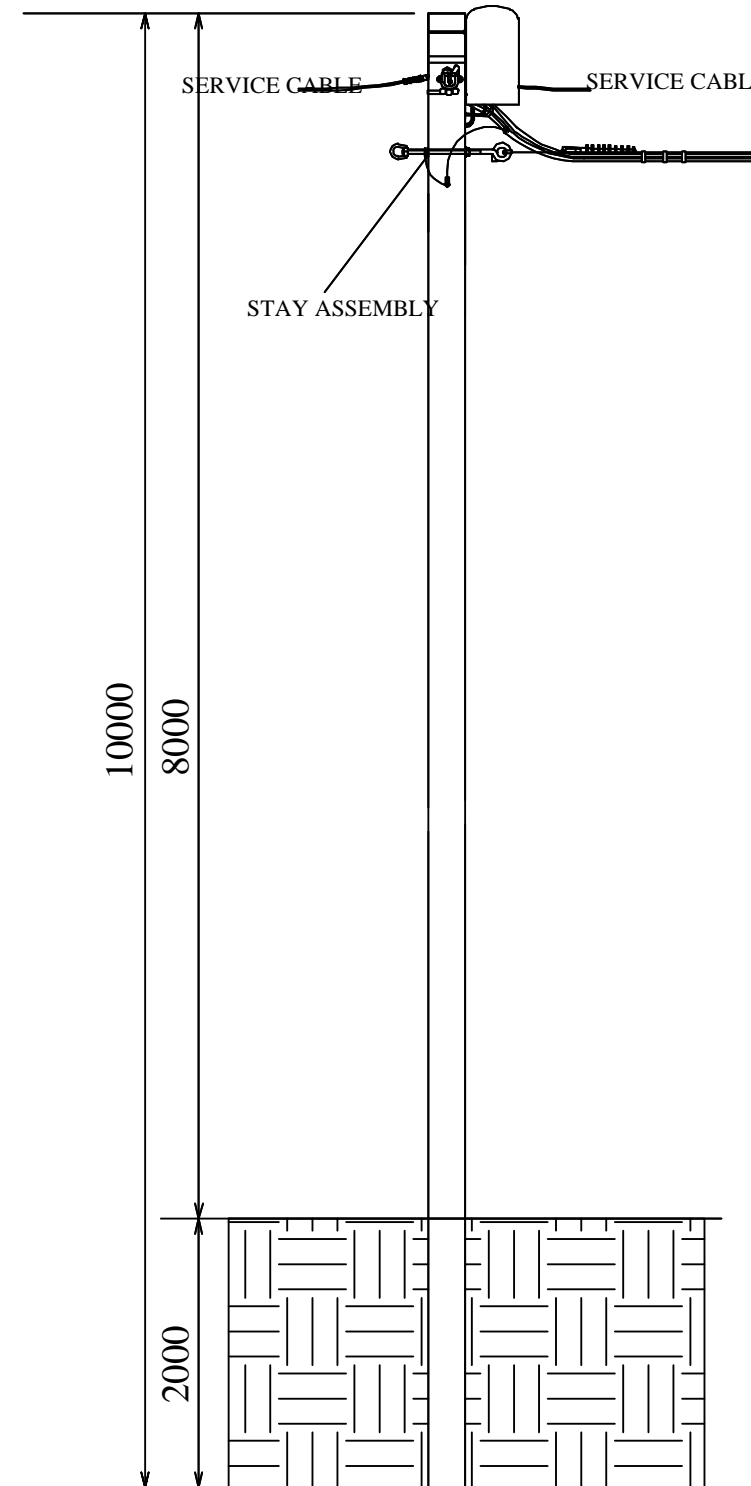
PLAN VIEW



SIDE VIEW

'X' STAY WIRE LENGTH - TABLE

POLE HEIGHT	'X'
10m	10.5m
9,0m	9,5m



LEGEND:

Symbols	Description

Notes:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:

The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:



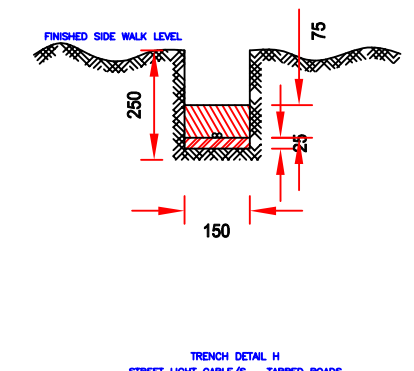
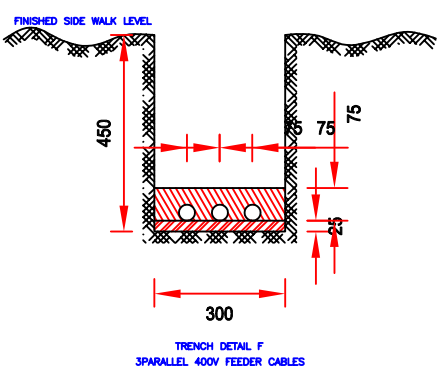
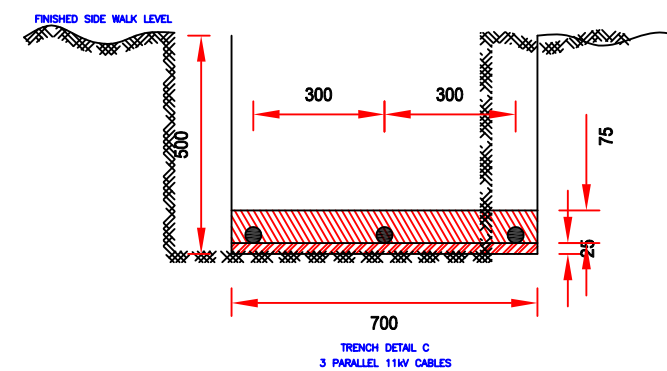
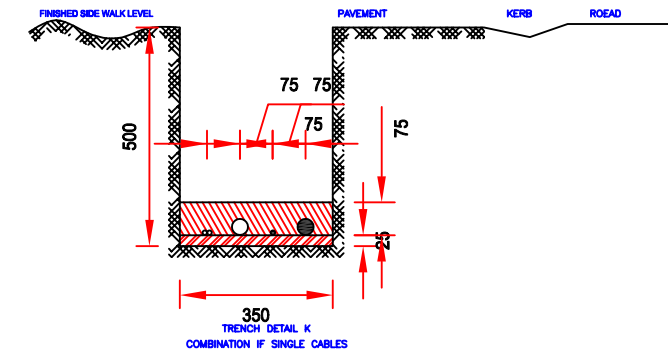
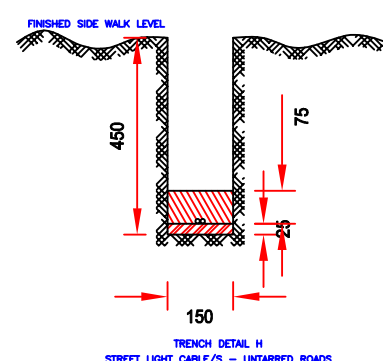
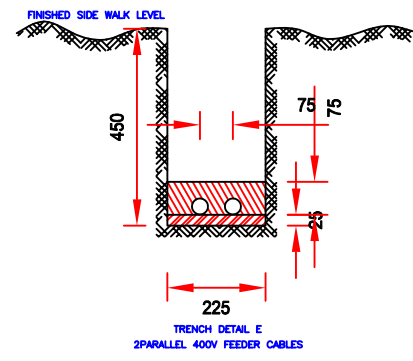
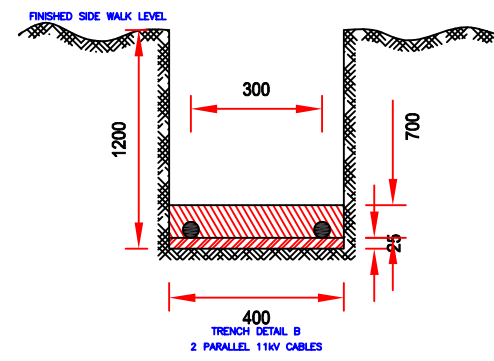
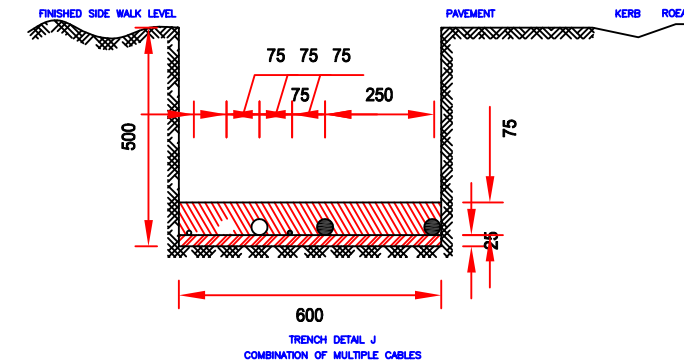
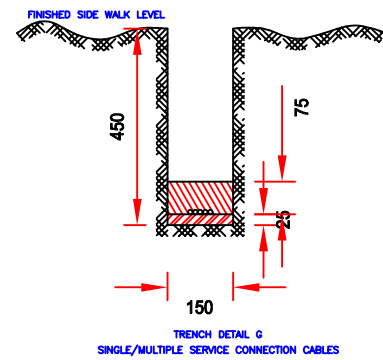
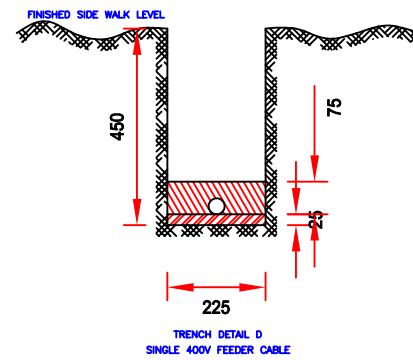
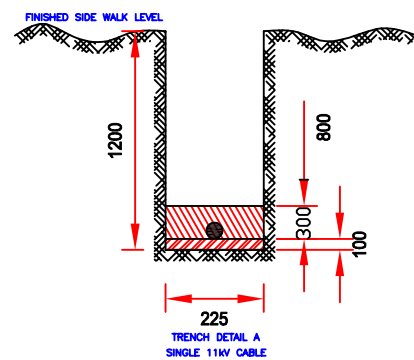
Project:

Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:

Low Voltage Network
Three Phase Bare Neutral ABC
Cross Intermediate Assembly
Wood Pole

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:				Scale:
080				NTS



LEGEND:

Symbols	Description
	Sand Bed Cover
	Cans Bed
	11 kVA Cable
	400 V Feeder Cable
	400 V Street Light Cable
	230 V Service Connection Cable

Notes:
For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

Client:
The National Authorising Office (NAO)
of the
European Development Fund (EDF)

Consultant:

GOPA International Energy Consultants

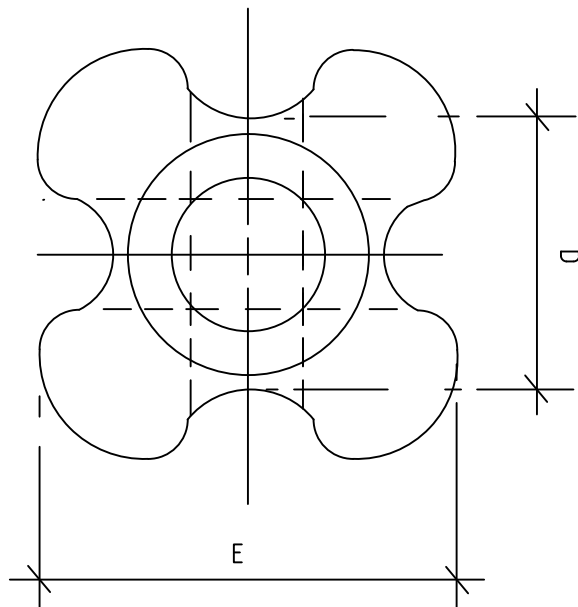
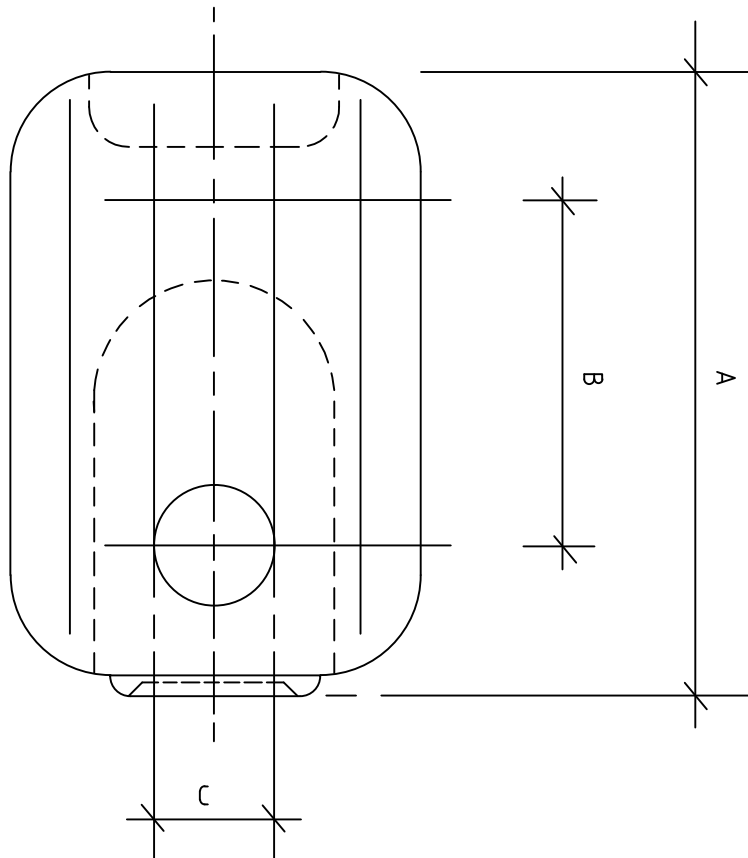
Project:
Rehabilitation, Extension and
Strengthening of the Low Voltage
Electrical Distribution Network
in Lusaka

Drawing Title:
Standard Cable Trench
Details and Dimensions for
Electricity Distribution Networks

Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number: 085				Scale: NTS

Low-Voltage Drawings (ACSR)

Drawing No.	Drawing Description
090	[ZESCO No. E11387] - 0.4 kV and 11 kV stay insulator - Model
091	[ZESCO No. LV0005] - 0.4 kV Line Pole Structure Terminal - Model
092	[ZESCO No. LV0008] - 0.4 kV OH Line Pole Structure Terminal - Model
093	[ZESCO No. LV0002] - 0.4 kV OH Pole Structure Angle 5 to 30 degrees
094	[ZESCO No. LV0003] - 0.4 kV OH Pole Structure Angle 30 to 60 degrees -Model
095	[ZESCO No. LV0001] - 0.4 kV OH Pole Structure Intermediate
096	[ZESCO No. LV0006] - 0.4 kV Line Pole Structure Tee-Off



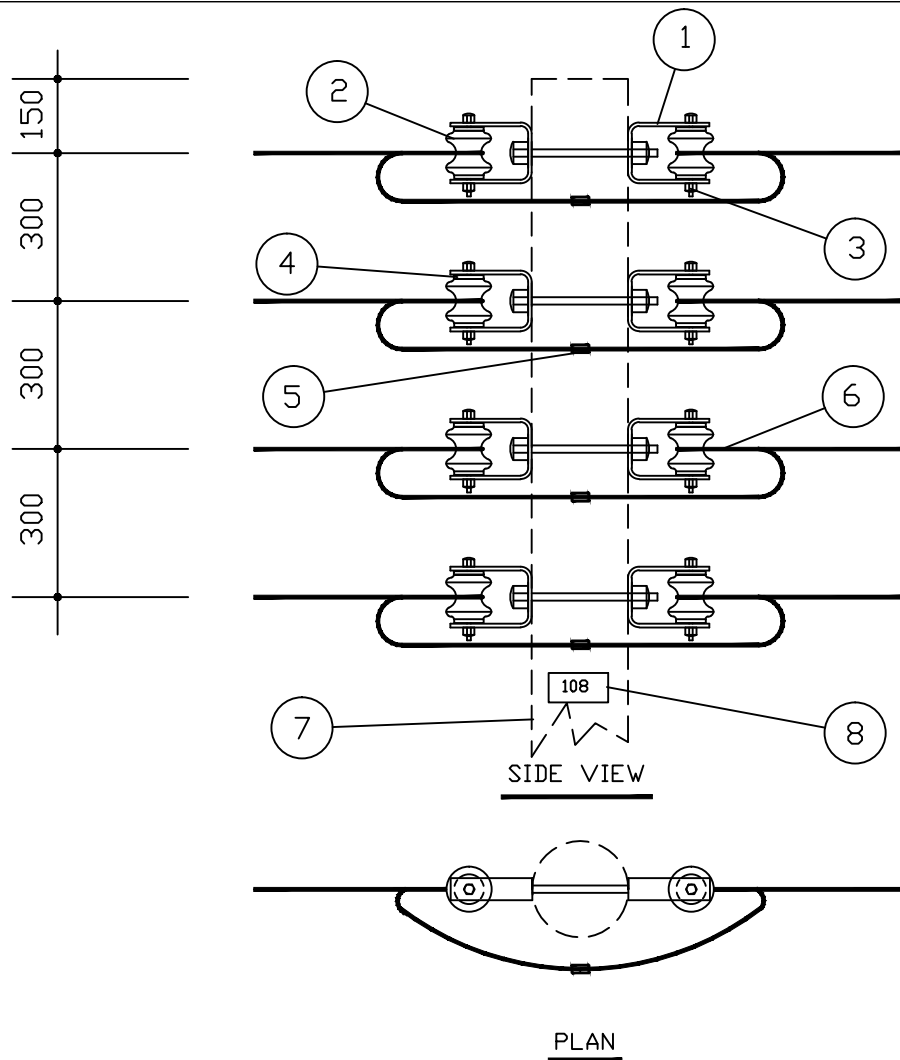
ZESCO LIMITED



GREAT EAST ROAD
P.O. BOX 33304
LUSAKA ZAMBIA
TEL: 228084-9

E			
D			
C			
B			
A			
Rev.	Date	Rev.by	Description

Title of Drawing: 0.4kV & 11kV STAY INSULATOR		
Drawing No. E11387	Drawn: Nyirenda M.	Date: 28.12.00
	Scale: NTS	Orig.Lyt.A4P
Replaces	Checked:	Date:
	Approved:	Date:




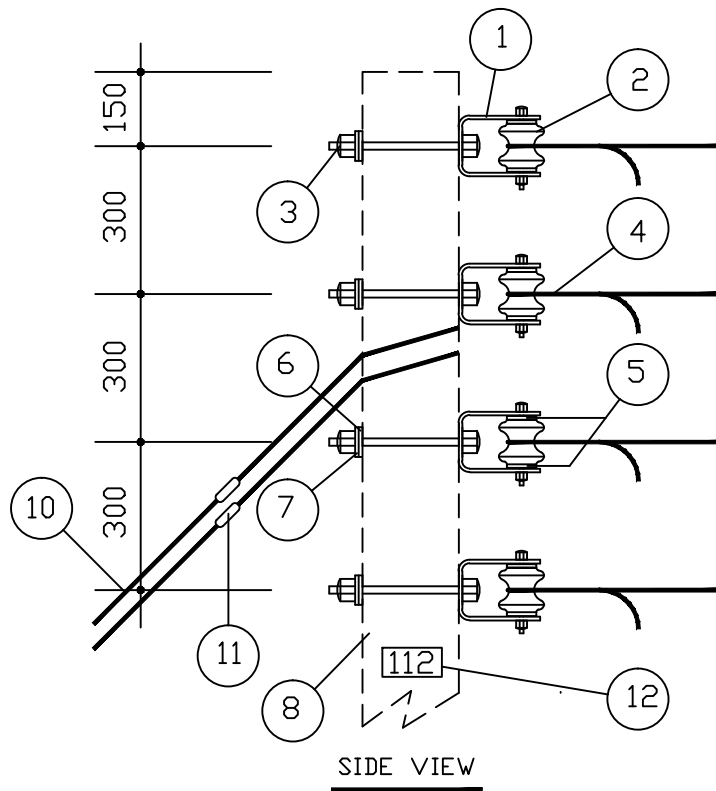
Part No.	Qty.	Description	Remarks/Ref.
8	1	POLE NUMBER	
7	1	9M/10M POLE	
6	8	DEAD END GRIP, A/ALLOY	
5	4	P.G. CLAMP	
4	16	PLASTIC WASHER 50mmx15mm	
3	4	BOLT AND NUT 250x16mm	
2	8	SHACKLE INSULATOR	
1	8	D-BRACKET c/w BOLT AND NUT M16	

NOTE:

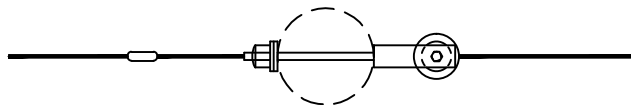
10M Pole is for 3Phase
9M Pole is for Single Phase

Dimensions are in mm except where stated

ZESCO LIMITED				Title: 0.4kV O/H LINE POLE STRUCTURE SECTION			
				Drawing No. LV 0005		Drawn: Nyirenda M.	
 P.O.BOX 34504 LUSAKA ZAMBIA	C	Sichela D.	20.12.99	100mm changed to 150mm	Checked:	Date:	
	A	MN	8.4.99	Outer line removed	Approved:	Date:	
	Rev.	Rev.by	Date	Description	Replaces:	Orig.Lay: E-siz.	



SIDE VIEW



PLAN


STAY SET
STRUCTURE

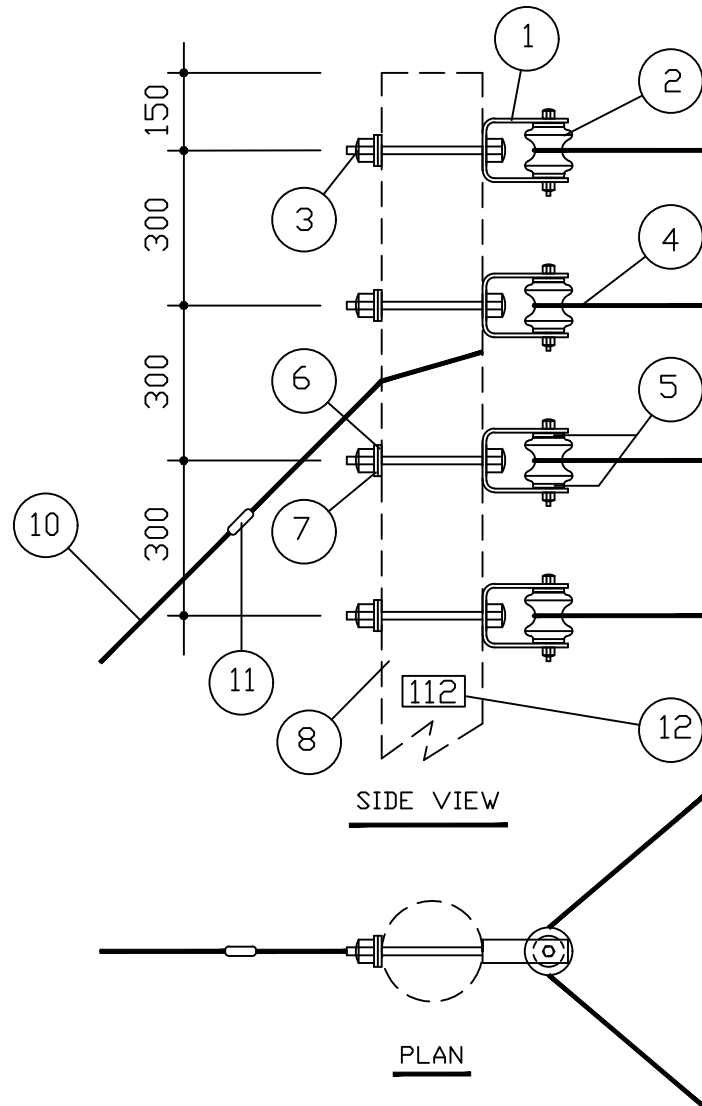
12	1	POLE NUMBER	
11	2	STAY INSULATOR	
10	30M	STAY WIRE 7/4	
9	2	STAY ASSEMBLY	Ref. PT0014
8	1	9M/10M POLE	
7	4	ROUND WASHER M16	
6	4	CURVED WASHER 60x60x6 M16	Ref. PT0002
5	8	PLASTIC WASHER 50mmx16mm	
4	4	DEAD END GRIP, A/ALLOY	Depending on conductor size
3	4	BOLT AND NUT 250x16mm	
2	4	SHACKLE INSULATOR	Ref. PT0009
1	4	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

NOTE:

10M Pole is for 3Phase
9M Pole is for Single Phase

Dimensions are in mm except where stated

ZESCO LIMITED	F				Title: 0.4kV O/H LINE POLE STRUCTURE TERMINAL		
	E				Drawing No. LV0004		
	D				Drawn: Nyirenda M.	Date: 23.10.98	
 GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	C				Checked:	Date:	
	B	Sichela D.	20.12.99	100mm changed to 150 & stays rearranged	Scale: NTS	Approved:	Date:
	A	MN	8.4.99	Outer line removed	Replaces:	Orig.Layt: E-siz.	
	Rev.	Rev.by	Date	Description			




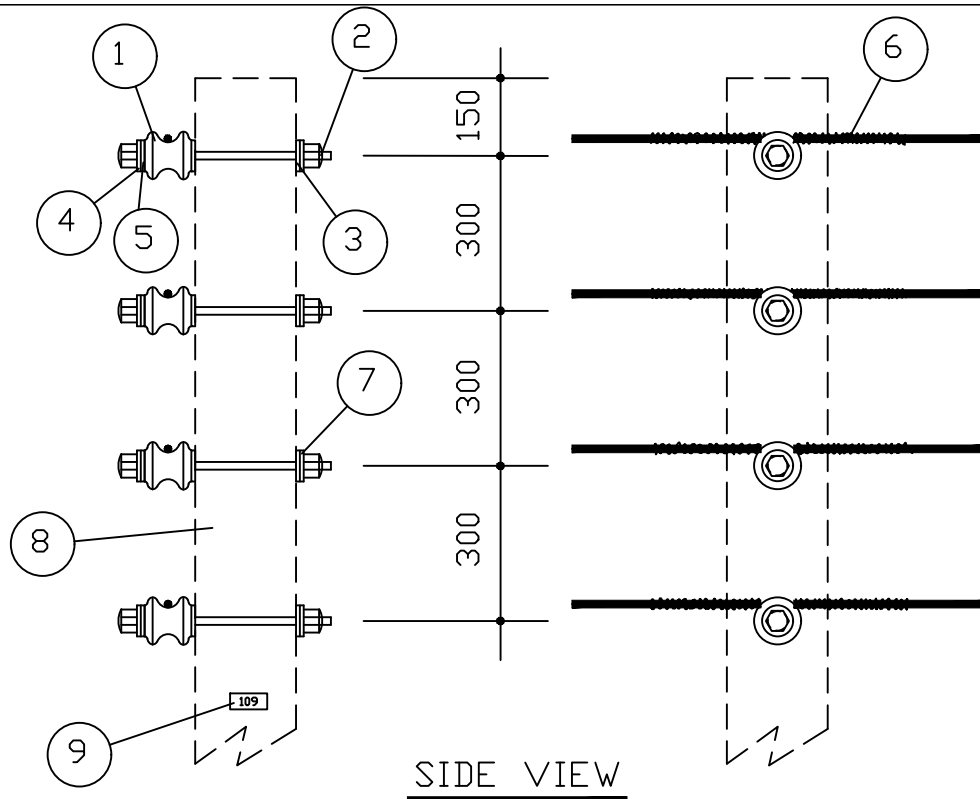
12	1	POLE NUMBER	
11	1	STAY INSULATOR	
10	15M	STAY WIRE 7/4	
9	1	STAY ASSEMBLY	Ref. PT0014
8	1	9M/10M POLE	
7	4	ROUND WASHER M16	
6	4	CURVED WASHER 60x60x6 M16	Ref. PT0002
5	8	PLASTIC WASHER 50mmx16mm	
4	0.4Kg	BINDING WIRE 3.60mm	
3	4	BOLT AND NUT 250x16mm	
2	4	REEL INSULATOR EP194	Ref. PT0008
1	4	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

NOTE:

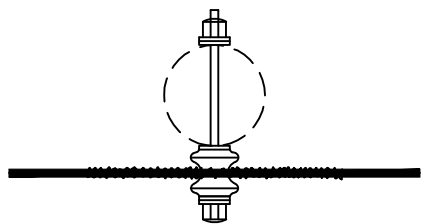
10M Pole is for 3Phase
9M Pole is for Single Phase

Dimensions are in mm except where stated

ZESCO LIMITED	F				Title: 0.4kV O/H POLE STRUCTURE ANGLE 5° - 30°		
	E						
	D						
 GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	C				Drawing No. LV0002	Drawn: Nyirenda M.	Date: 22.10.98
	B	Sichela D.	20.12.99	100mm changed to 150mm & stay wire rearranged		Checked:	Date:
	A	MN	8.4.99	Outer line removed	Scale: NTS	Approved:	Date:
	Rev.	Rev.by	Date	Description	Replaces:	Orig.Layt: E-siz.	



SIDE VIEW



PLAN

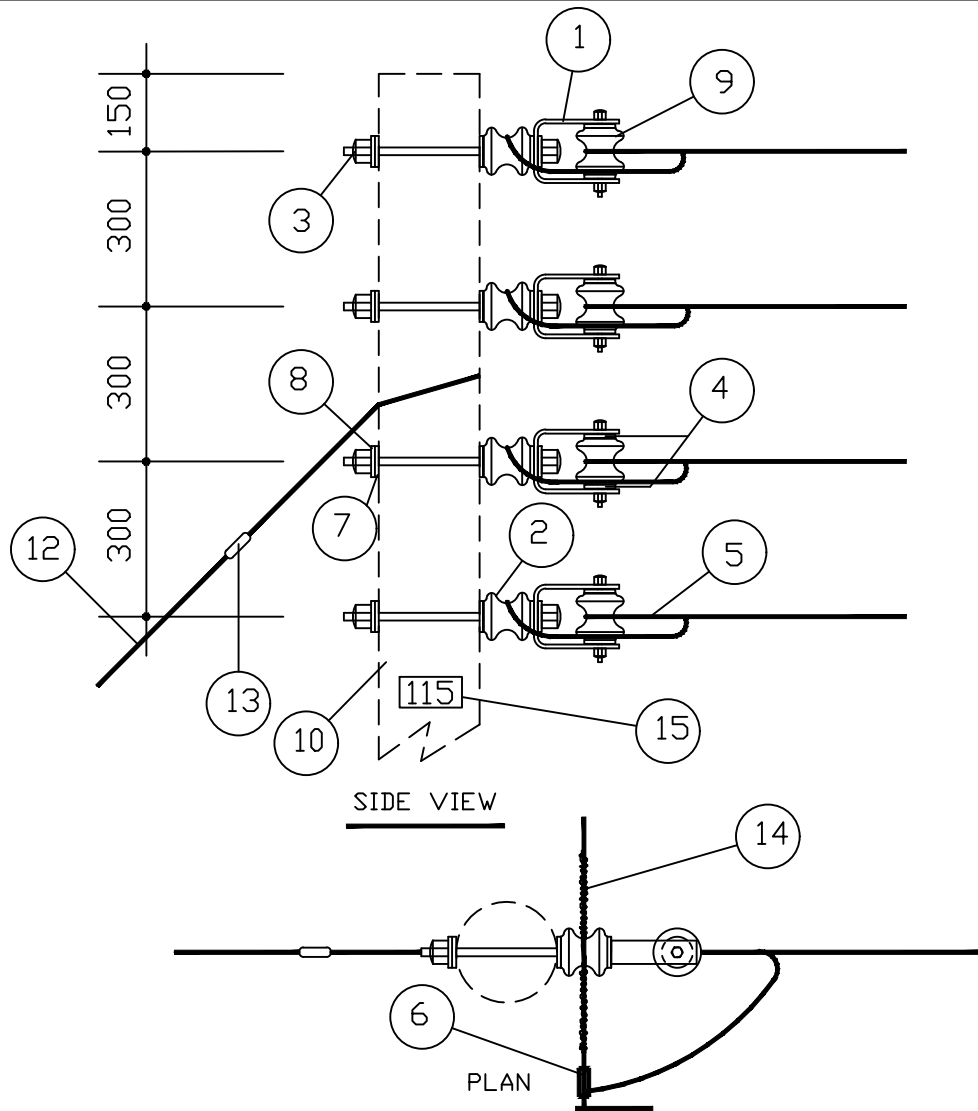
Part No.	Qty.	Description	Remarks/Ref.
9	1	POLE NUMBER	
8	1	9M/10M POLE	
7	4	ROUND WASHER M16	
6	0.4Kg	BINDING WIRE 3.60mm	
5	4	PLASTIC WASHER 50mmx15mm	
4	4	FLAT WASHER 50mmx16mm	
3	4	CURVED WASHER	
2	4	BOLT AND NUT 300x16mm	
1	4	REEL INSULATOR	

NOTE:

10M Pole is for 3Phase
9M Pole is for Single Phase

Dimensions are in mm except where stated

ZESCO LIMITED  GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	F				Title: 0.4kV O/H POLE STRUCTURE -INTERMEDIATE- Drawing No. LV0001 Scale: NTS Replaces:	Drawn: Nyirenda M.	Date: 22.10.98
	E					Checked:	Date:
	D					Approved:	Date:
	C					Origin: E-siz.	
	B	Sichela D.	20.12.99	100mm changed to 150mm			
	A	MN	8.4.99	Outer line removed			
	Rev.	Rev.by	Date	Description			




15	1	POLE NUMBER	
14	0.4Kg	AL. BINDING WIRE 3.60mm	
13	1	STAY INSULATOR	
12	15M	STAY WIRE 7/4	
11	1	STAY ASSEMBLY	Ref. PT0014
10	1	9M/10M POLE	
9	4	SHACKLE INSULATOR	
8	4	ROUND WASHER M16	
7	4	CURVED WASHER 60x60x6 M16	
6	4	P.G. CLAMP 25, 50, 100mm sq.	
5	4	DEAD END GRIP, A/ALLOY	conductor size Ref. PT0002
4	12	PLASTIC WASHER 50mmx15mm	
3	4	BOLT AND NUT 300x16mm	
2	4	REEL INSULATOR EP194	Ref. PT0008
1	4	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

NOTE:

10M Pole is for 3Phase
9M Pole is for Single Phase

Dimensions are in mm except where stated

ZESCO LIMITED  GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	F				Title: 0.4kV O/H LINE POLE STRUCTURE TEE-OFF Drawing No. LV0006 Scale: NTS Replaces:	Drawn: Nyirenda M. Checked: Approved: Date: 26.10.98 Date: Date: Date: Orig.Layt: E-siz.
	E					
	D					
	C					
	B	Sichela D.	20.12.99	100mm changed to 150mm & stay wire rearranged		
	A	MN	8.4.99	Outer line removed		
	Rev.	Rev.by	Date	Description		

Geotechnical Investigation Report
(Part I and II)





Lusaka Transmission Distribution Rehabilitation Project (LTDRP) - Design and Supervision of the Low Voltage Distribution Network

Project Accounting No. FED/2016/038-238

Report on Geotechnical Investigations, September 2019 Part I: Chanda, Kamanga (Nkoloma), Chawama, John Howard, Garden and Kanyama

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Lusaka, Zambia

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Abbreviations

@	at
ASTM	American Society for Testing and Materials (now ASTM International)
CBR	California Bearing Ratio
DCPT	Dynamic Cone Penetration Test
GPR	Ground Potential Rise Studies
LL	Liquid limit
MDD	Maximum Dry Density
PL	Plastic limit
RE	Earth Resistance
RH	Auxiliary Earth Resistance
SPT	Standard Penetration Test
TP	Test Point / Trial Pit
P	Soil Resistivity value
Ω	Ohms

Summary

Geotechnical investigations were carried out at various sites in designated peri-urban townships to provide the Design Engineering Consultant and subsequently the Works Contractor with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters in the various townships, on the basis of which pole hole excavation material types and soil conditions would be determined under the bill of quantities.

Geophysical investigations for soil resistivity were carried out as per ASTM G57 using an MS2308 Advanced Earth Resistance Tester with four probes.

The soil resistivity values of the six sites range from 1572 cm Ω in Garden Township to 4236 cm Ω in Chainda Township.

The bearing capacities of soils in the different sites varied from point to point. The general ground condition of the six sites is underlined by laterite soils and rock. Kanyama Township had rocky surfaces compared to the other five townships with refusal at 1.2 m.

1. Introduction

This geotechnical report has been prepared at the request of GOPA-International Energy Consultants (acronym: **intec**).

It gives details of the investigations carried out in January 2019 on sites in Chainda, Kamanga (Nkoloma), Chawama, John Howard, Garden and Kanyama in Lusaka Province for the Lusaka Transmission and Distribution Rehabilitation Project (LTDRP).

Typical soil tests were done to generally ascertain soil properties and suitability for the intended powerline construction works in the six townships. The tests done were; (i) particle size distribution, (ii) Standard Penetration Test (STP), (iii) Dynamic cone penetration Test (DCPT), (iv) Atterberg limits test, (v) California Bearing Ratio (CBR), (vi) Maximum dry density (MDD) and (vii) Soil resistivity test.

2. Site Locations

The sites are located in Lusaka namely, Chainda, Kamanga (Nkoloma), Chawama, John Howard, Garden and Kanyama.

3. Aim of the Investigation

The aim of the investigation was to determine the estimated bearing pressure capacity of the soil.

4. Investigations Carried Out

4.1 Work at Site

4.1.1 Excavation of Trial Pits

Four trial pits per site were excavated and labelled as TP1, TP2, TP3, and TP4, except in Chawama where they were five and John Howard where they were three. Trial pits were excavated down to 1 m where standard penetration tests (SPTs) were done.

4.1.2 Standard Penetration Test (SPT)

This test is carried out to estimate the safe bearing pressure of a soil according to ASTM D1586 standard. It involves driving a thick-walled sample tube into the ground by blows from a free-falling hammer with a standard weight of 63.5 kg falling at a height of 750 mm. The sample tube is driven 150 mm into the ground, and the number of blows needed to penetrate each 150 mm up to a depth of 450 mm is recorded.

The sum of the number of blows for the second and third 150 mm of penetration is reported as N-value. The N-value is used to estimate the safe bearing capacity of the soil.

The SPTs were carried out in the trial pits at 1 m depth.

4.1.3 Dynamic Cone Penetration Test (DCPT)

This test measures the depth to hard ground (ASTM D6951). It also involves driving rods with a 60-degree permanent cone into the ground by blows from a free-falling 63.5 kg hammer falling at a height of 750 mm. The rods in the DCP test are driven 300 mm in the ground, and the number of blows to penetrate each 300 mm up to hard ground (refusal) is recorded. This test was carried out in each trial pit.

4.2 Laboratory Work

4.2.1 Particle Size Distribution / Sieve Analysis

This test was performed in the laboratory on the samples collected from all site in all trial pits (TMH1 Method A1). The test involves a nested column of sieves with different screens. A weighed sample is poured into the top sieve, which has the biggest screen openings. Each lower sieve in the column has smaller openings than the above. At the base is a round pan.

4.2.2 Atterberg Limits

This lab test is performed to determine the plastic and liquid limits of a fine-grained soil (TMH1 methods A2, A3 and A4).

The liquid limit (LL) is arbitrarily defined as the water content, in percentage, at which a pat of soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second.

The plastic limit (PL) is the water content, in percentage, at which a soil can no longer be deformed by rolling into 3.2 mm diameter threads without crumbling.

4.2.3 Maximum Dry Density (MDD) and Optimum Moisture

Maximum density: The maximum density of a material for a specific compactive effort is the highest density obtainable when the compaction is carried out on the material at varied moisture contents.

Optimum moisture content: The optimum moisture content for a specific compactive effort is the moisture content at which the maximum density is obtained.

The maximum dry density and optimum moisture content, as defined above, is determined by establishing the moisture-density relationship of the material when prepared and compacted with rammer at different moisture contents. This test was done according to TMH1 method A7.

4.2.4 California Bearing Ratio (CBR)

The California Bearing Ratio of a material is the load in Newton, expressed as a percentage of California standard values, required to allow a circular piston of 1,935 mm² to penetrate the surface of a compacted material at a rate of 1.27 mm/min. to depths of 2.54, 5.08, and 7.62 mm. This test was done according to TMH1 method A8.

4.2.5 Soil Resistivity

Soil resistivity testing is the process of measuring a volume of soil to determine the conductivity of the soil. The resulting soil resistivity is expressed in ohm-meter or ohm-centimetre.

Soil resistivity testing is the single most critical factor in electrical grounding design. This is true when discussing simple electrical design, to dedicated low-resistance grounding systems, or to the far more complex issues involved in Ground Potential Rise Studies (GPR). Good soil models are the basis of all grounding designs and they are developed from accurate soil resistivity testing.

5. Equipment Used on Site

Excavation of trial pits

Picks and shovels were used for excavation of testing pits on site.

Standard Penetration Test (SPT)

The following apparatus was used for carrying out SPT and DCP tests:

- tripod stand
- 63.5 kg hammer
- snatch block
- split-barrel sampler tube (for SPT)
- 50 mm diameter by 1.5 m long drilling rods
- sisal rope
- chain block
- cone (DCP)

6. Soil/Core Sampling

Soil samples may be recovered using a variety of methods and equipment depending on the portion of the soil profile required (surface or subsurface), and the type of sample required (disturbed or undisturbed) and the type of soil.

Soil is collected directly using a hand held device such as hand scoop, auger or a post hole digger, indirectly using power activated devices such as power augers, back holes and drill rigs.

In this geotechnical survey, the type of sample required was disturbed sample (bulk sampling not coring). Hence, soils were collected directly using a hand scoop/shovels.

7. Observations

7.1 Chainda

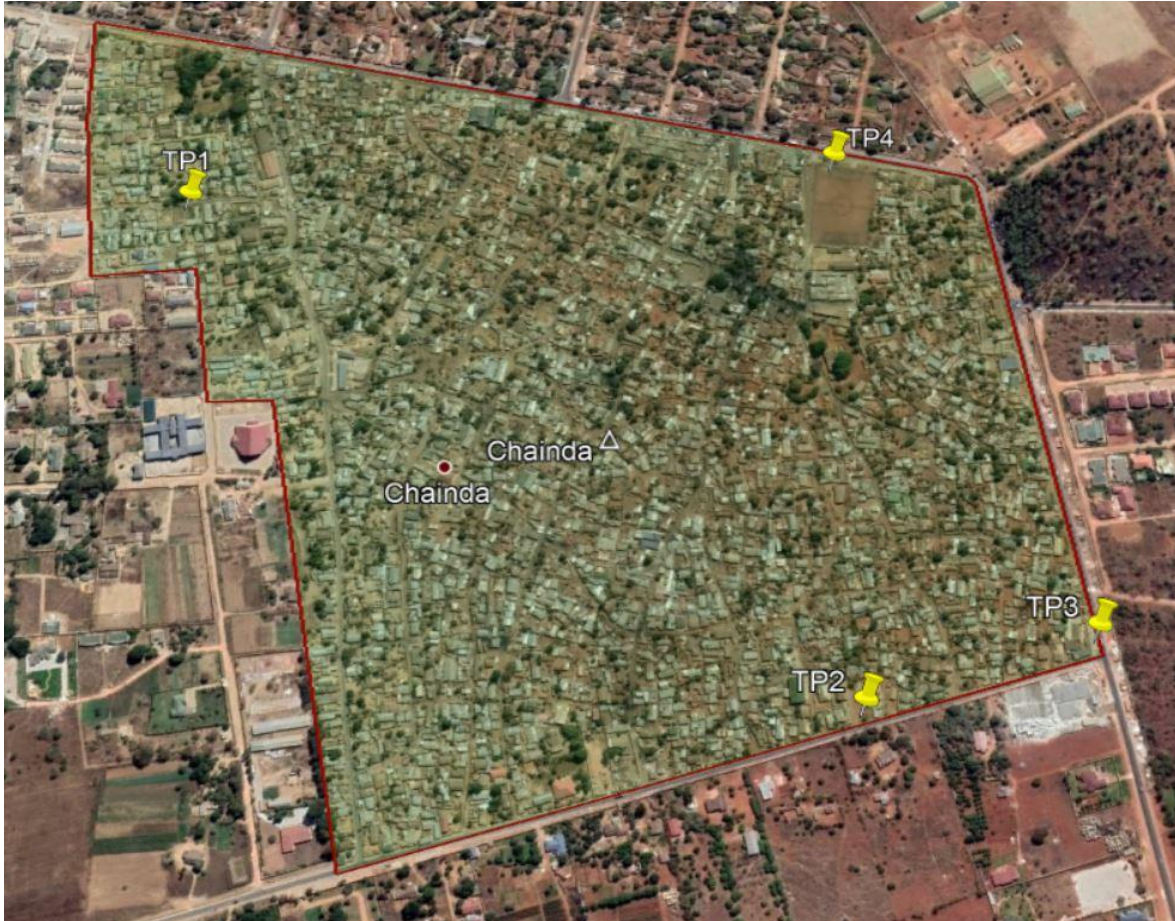


Figure 1: Location of Test Points in Chainda

CHAINDA TEST POINT LOCATIONS COORDINATES		
PT	Eastings	Northings
TP1	650604	8298038
TP2	651333	8297364
TP3	651586	8297425
TP4	651360	8298037

From the SPT results, the following safe bearing capacities were observed:

- Test point 1 (TP1) - 280 kN/m²
- Test point 2 (TP2) - 240 kN/m²
- Test point 3 (TP3) - 260 kN/m²
- Test point 4 (TP4) - 390 kN/m²

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 9.6 m
- Test point 2 (TP2) - 8.1 m
- Test point 3 (TP3) - 9.9 m
- Test point 4 (TP4) - 7.5 m

From the sieve analysis results, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - 59.9% fines, grading modulus 0.5
- Test point 2 at 1.5 m depth (TP2@1.5 m) - 37.9% fines, grading modulus 0.9
- Test point 3 at 1.5 m depth (TP3@1.5 m) - 33.0% fines, grading modulus 0.9
- Test point 4 at 1.5 m depth (TP4@1.5 m) - 65.7% fines, grading modulus 0.4

From the Atterberg limit results, the finest part of the soils was found to have plasticity indices as follows:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - plastic index 18.5%, shrinkage 14mm, soil description: medium plastic
- Test point 2 at 1.5 m depth (TP2@1.5 m) - plastic index N/P, shrinkage N/P, soil description: non-plastic
- Test point 3 at 1.5 m depth (TP3@1.5 m) - plastic index N/P, shrinkage N/P, soil description: non-plastic
- Test point 4 at 1.5 m depth (TP4@1.5 m) - plastic index 20.4%, shrinkage 16mm, soil description: highly plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum moisture content (OMC) were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - MDD 1861 kg/m³, OMC 13.1%
- Test point 2 at 1.5 m depth (TP2@1.5 m) - MDD 1912 kg/m³, OMC 7.1%
- Test point 3 at 1.5 m depth (TP3@1.5 m) - MDD 1925 kg/m³, OMC 8.3%
- Test point 4 at 1.5 m depth (TP4@1.5 m) - MDD 1853 kg/m³, OMC 12%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 10.7, CBR at 95%: 15.9, CBR at 98%: 19.0, general soil type: sand with fines
- Test point 2 at 1.5 m depth (TP2@1.5 m) - CBR at 90%: 14.3, CBR at 95%: 18.6, CBR at 98%: 21.2, general soil type: sand with fines
- Test point 3 at 1.5 m depth (TP3@1.5 m) - CBR at 90%: 16.0, CBR at 95%: 20.3, CBR at 98%: 23.2 general soil type: sand with fines
- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 2.5, CBR at 95%: 5.4, CBR at 98%: 7.2, general soil type: silts and clays

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 3023 ohm-centimetre
- Test point 2 (TP2) - 4236 ohm-centimetre
- Test point 3 (TP3) - 4133 ohm-centimetre
- Test point 4 (TP4) - 3952 ohm-centimetre

Site and laboratory test results for Chainda are attached to this report as Annex 1.

Figure 2: Chainda Trial Pits and Dynamic Cone Penetration (DCP) Test



7.2 Kamanga (Nkoloma)

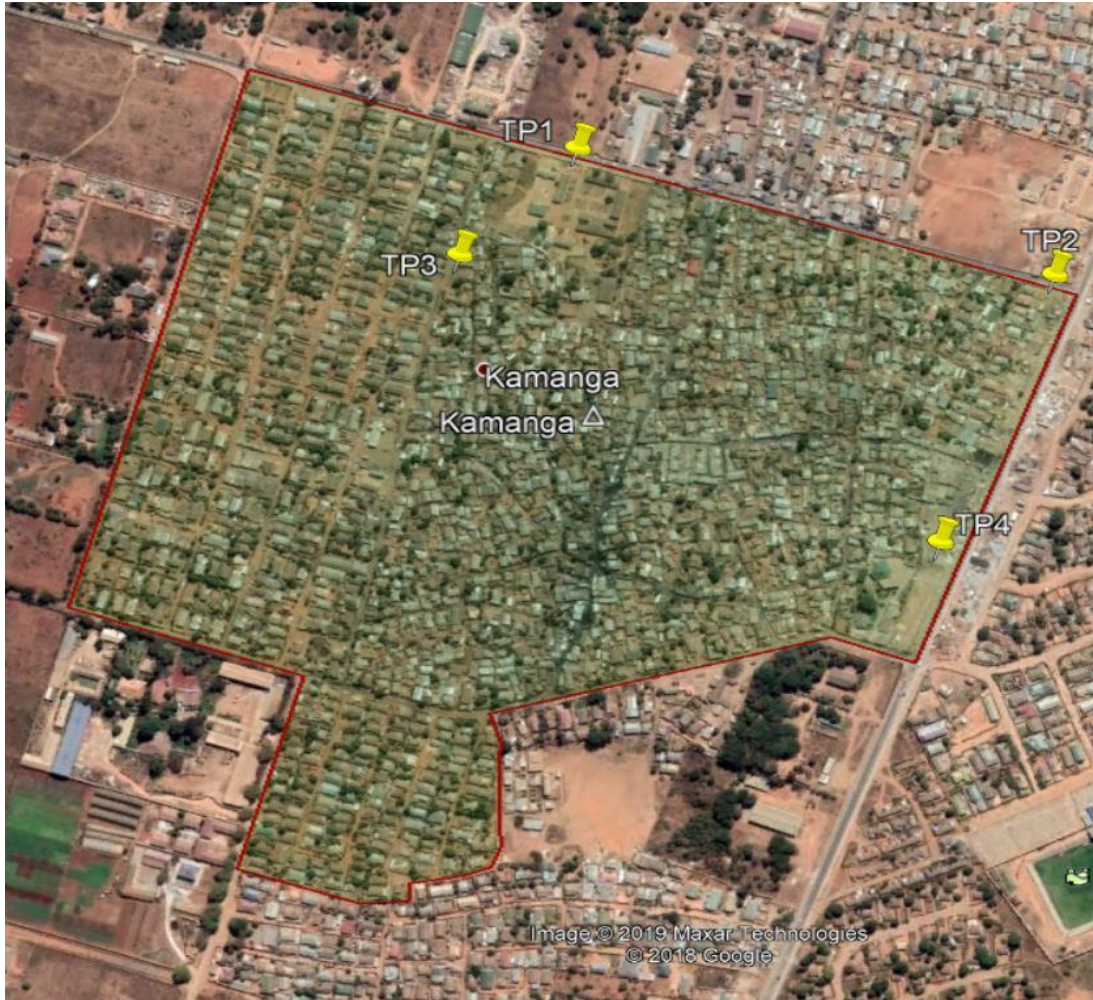


Figure 3: Location of Test Points in Kamanga (Nkoloma)

KAMANGA TEST POINT LOCATION COORDINATES		
PT	Eastings	Northings
TP1	647270	8300907
TP2	647716	8300707
TP3	647138	8300809
TP4	647565	8300428

From the SPT results, the safe bearing capacities were all observed to be greater than 600 kN/m².

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 2.7 m
- Test point 2 (TP2) - 3.3 m
- Test point 3 (TP3) - 3.0 m

- Test point 4 (TP4) - 2.4 m

From the sieve analysis results, the following were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - 22.7% fines, grading modulus 2.1
- Test point 2 at 1.1 m depth (TP2@1.1 m) - 15.5% fines, grading modulus 2.4
- Test point 3 at 1.5 m depth (TP3@1.5 m) - 13.4% fines, grading modulus 2.5

From the Atterberg limit results, the fines part of the soils was found to the following plasticity indices:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - plastic index 13.8%, shrinkage 11 mm, soil description: medium plastic
- Test point 2 at 1.1 m depth (TP2@1.1 m) - plastic index N/P, shrinkage N/P, soil description: non plastic
- Test point 3 at 1.5 m depth (TP3@1.5 m) - plastic index 7.2, shrinkage 6 mm, soil description: low plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum Moisture Content (OMC) were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - MDD 2155 kg/m³, OMC 6.2%
- Test point 2 at 1.1 m depth (TP2@1.1 m) - MDD 2100 kg/m³, OMC 5.0%
- Test point 3 at 1.5 m depth (TP3@1.5 m) - MDD 2104 kg/m³, OMC 6.0%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - CBR at 90%: 33.4, CBR at 95%: 42.2, CBR at 98%: 47.5, general soil type: gravels with fines
- Test point 2 at 1.1 m depth (TP2@1.1m) - CBR at 90%: 27.6, CBR at 95%: 39.0, CBR at 98%: 47.5, general soil type: gravels with fines
- Test point 3 at 1.5 m depth (TP3@1.5 m) - CBR at 90%: 29.0, CBR at 95%: 43.5, CBR at 98%: 52.0 general soil type: gravels with fines

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 3023 ohm-centimetre
- Test point 2 (TP2) - 3192 ohm-centimetre
- Test point 3 (TP3) - 3325 ohm-centimetre
- Test point 4 (TP4) - 5533 ohm-centimetre

Site and laboratory test results for Kamanga (Nkoloma) are attached to this report as **Annex 2**.

Figure 4: Kamanga (Nkoloma) Trial Pits



7.3 Chawama



Figure 5: Location of Test Points in Chawama

CHAWAMA TEST POINT LOCATION COORDINATES		
PT	Eastings	Northings
TP1	637722	8290191
TP2	638108	8291131
TP3	637001	8291171
TP4	637075	8289747

From the SPT results, the following safe bearing capacities were observed:

- Test point 1 (TP1) - 80 kN/m²
- Test point 2 (TP2) - 210 kN/m²
- Test point 3 (TP3) - 210 kN/m²
- Test point 4 (TP4) - 280 kN/m²
- Test point 5 (TP5) - 280 kN/m²

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 6.6 m
- Test point 2 (TP2) - 5.1 m
- Test point 3 (TP3) - 5.1 m
- Test point 4 (TP4) - 4.5 m
- Test point 5 (TP5) - 4.5 m

From the sieve analysis results, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - 29.5% fines, grading modulus 1.4
- Test point 2 at 1.5 m depth (TP2@1.5 m) - 11.9% fines, grading modulus 2.0
- Test point 3 at 1.5 m depth (TP3@1.5 m) - 13.1% fines, grading modulus 1.3
- Test point 4 at 1.5 m depth (TP4@1.5 m) - 15.5% fines, grading modulus 2.2

From the Atterberg limit results, the fines part of the soils was found to have plasticity index as follows:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - plastic index 2.8%, shrinkage 2.5mm, soil description: low plastic
- Test point 2 at 1.5 m depth (TP2@1.5 m) - plastic index N/P, shrinkage N/P, soil description: non plastic
- Test point 3 at 1.5 m depth (TP3@1.5 m) - plastic index N/P, shrinkage N/P, soil description: non plastic
- Test point 4 at 1.5 m depth (TP4@1.5 m) - plastic index 11.5%, shrinkage 9 mm, soil description: medium plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum moisture content (OMC) were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - MDD 1925 kg/m³, OMC 8.1%
- Test point 2 at 1.5 m depth (TP2@1.5 m) - MDD 2035 kg/m³, OMC 6.2%
- Test point 3 at 1.5 m depth (TP3@1.5 m) - MDD 2009 kg/m³, OMC 7.3%
- Test point 4 at 1.5 m depth (TP4@1.5 m) - MDD 2067 kg/m³, OMC 8.0%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 17.5, CBR at 95%: 26.9, CBR at 98%: 33.0, general soil type: sand with fines
- Test point 2 at 1.5 m depth (TP2@1.5 m) - CBR at 90%: 17.5, CBR at 95%: 29.9, CBR at 98%: 39.5, general soil type: gravels with fines
- Test point 3 at 1.5 m depth (TP3@1.5 m) - CBR at 90%: 24.6, CBR at 95%: 37.9, CBR at 98%: 46.0 general soil type: sand with fines
- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 28.4, CBR at 95%: 41.9, CBR at 98%: 50.0, general soil type: gravels with fines

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 3586 ohm-centimetre
- Test point 2 (TP2) - 3320 ohm-centimetre
- Test point 3 (TP3) - 3251 ohm-centimetre
- Test point 4 (TP4) - 3126 ohm-centimetre
- Test point 5 (TP5) - 2950 ohm-centimetre

Site and laboratory test results for Chawama are attached as **Annex 3** to this report.

Figure 6: Chawama Trial Pits



7.4 John Howard



Figure 7: Location of Test Points in John Howard

JOHN HOWARD TEST POINT LOCATION COORDINATES		
PT	Eastings	Northings
TP1	637630	8289411
TP2	638377	8289018
TP3	638118	8289714
TP4	637434	8288892

From the SPT results, the following safe bearing capacities were observed:

- Test point 1 (TP1) - 280 kN/m²
- Test point 2 (TP2) - 280 kN/m²
- Test point 3 (TP3) - 410 kN/m²

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 5.5 m
- Test point 2 (TP2) - 6.0 m
- Test point 3 (TP3) - 3.9 m

From the Sieve Analysis Results, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - 33.7% fines, grading modulus 1.0
- Test point 2 at 1.5 m depth (TP2@1.5 m) - 39.9% fines, grading modulus 0.8
- Test point 3 at 1.5 m depth (TP3@1.5 m) - 18.5% fines, grading modulus 2.0

From the Atterberg limit results, the fines part of the soils was found to have plasticity index as follows:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - plastic index 11.4%, Shrinkage 8 mm, soil description: low plastic
- Test point 2 at 1.5 m depth (TP2@1.5 m) - plastic index 7.0%, Shrinkage 5.0 mm, soil description: low plastic
- Test point 3 at 1.5 m depth (TP3@1.5 m) - plastic index 6.1%, Shrinkage 5.0 mm, soil description: low plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum moisture content (OMC) were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - MDD 1912 kg/m³, OMC 9.1%
- Test point 2 at 1.5 m depth (TP2@1.5 m) - MDD 1878 kg/m³, OMC 7.2%
- Test point 3 at 1.5 m depth (TP3@1.5 m) - MDD 2022 kg/m³, OMC 7.1%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 10.8, CBR at 95%: 15.5, CBR at 98%: 18.7, general soil type: sand with fines
- Test point 2 at 1.5 m depth (TP2@1.5 m) - CBR at 90%: 4.7, CBR at 95%: 11.9, CBR at 98%: 16.2, general soil type: sand with fines
- Test point 3 at 1.5 m depth (TP3@1.5 m) - CBR at 90%: 21.7, CBR at 95%: 27.4, CBR at 98%: 30.8 general soil type: gravel with fines

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 2808 ohm-centimetre
- Test point 2 (TP2) - 2509 ohm-centimetre
- Test point 3 (TP3) - 3001 ohm-centimetre

Site and laboratory test results for John Howard are attached as **Annex 4** to this report.

Figure 8: John Howard Trial Pits



7.5 Garden



Figure 9: Location of Test Points in Garden

GARDEN TEST POINT LOCATION COORDINATES		
PT	Eastings	Northings
TP1	638354	8299500
TP2	639146	8299543
TP3	638644	8297236
TP4	637978	8297860

From the SPT results, the following safe bearing capacities were observed:

- Test point 1 (TP1) - 5000 kN/m²
- Test point 2 (TP2) - 500 kN/m²
- Test point 3 (TP3) - >600 kN/m²
- Test point 3 (TP4) - 500 kN/m²

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 5.7 m
- Test point 2 (TP2) - 6.3 m
- Test point 3 (TP3) - 5.7 m
- Test point 4 (TP4) - 4.8 m

From the sieve analysis results, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - 24.2% fines, grading modulus 1.2
- Test point 2 at 1.5 m depth (TP2@1.5 m) - 18.7% fines, grading modulus 1.2
- Test point 3 at 1.5 m depth (TP3@1.5 m) - 28.7% fines, grading modulus 1.2
- Test point 4 at 1.5 m depth (TP4@1.5 m) - 39.1% fines, grading modulus 0.9

From the Atterberg limit results, the fines part of the soils was found to have plasticity index as follows:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - plastic index S/P, shrinkage 1.5 mm, soil description: slightly plastic
- Test point 2 at 1.5 m depth (TP2@1.5 m) - plastic index N/P, Shrinkage N/P, soil description: non-plastic
- Test point 3 at 1.5 m depth (TP3@1.5 m) - plastic index N/P, shrinkage N/P, soil description: non-plastic
- Test point 4 at 1.5 m depth (TP4@1.5 m) - plastic index 16.3%, shrinkage 12mm, soil description: highly plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum moisture content (OMC) were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - MDD 1815 kg/m³, OMC 5.2%
- Test point 2 at 1.5 m depth (TP2@1.5 m) - MDD 1808 kg/m³, OMC 5.0%
- Test point 3 at 1.5 m depth (TP3@1.5 m) - MDD 1852 kg/m³, OMC 5.9%
- Test point 4 at 1.5 m depth (TP4@1.5 m) - MDD 1822 kg/m³, OMC 11.3%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 9.0, CBR at 95%: 16.5, CBR at 98%: 20.9, general soil type: sand with fines
- Test point 2 at 1.5 m depth (TP2@1.5 m) - CBR at 90%: 10.3, CBR at 95%: 16.2, CBR at 98%: 39.5, general soil type: sand with fines
- Test point 3 at 1.5 m depth (TP3@1.5 m) - CBR at 90%: 13.4, CBR at 95%: 21.7, CBR at 98%: 26.7 general soil type: gravels with fines
- Test point 1 at 1.5 m depth (TP1@1.5 m) - CBR at 90%: 12.4, CBR at 95%: 19.3, CBR at 98%: 24.0, general soil type: sands with fines

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 2002 ohm-centimetre
- Test point 2 (TP2) - 1963 ohm-centimetre
- Test point 3 (TP3) - 1872 ohm-centimetre
- Test point 4 (TP4) - 1572 ohm-centimetre

Site and laboratory test results for Garden are attached as **Annex 5** to this report.

Figure 10: Garden Trial Pit



7.6 Kanyama



Figure 11: Location of Test Points in Kanyama

KANYAMA TEST PIT LOCATION COORDINATES		
PT	Eastings	Northings
TP1	631334	8293908
TP2	630964	8298243
TP3	631908	8298038
TP4	631908	8298038

From the SPT results, the safe bearing capacities were observed to be greater than 600 kN/m² at all points:

From the DCP test results, the following depths were observed as refusal (hard strata) points:

- Test point 1 (TP1) - 1.2 m
- Test point 2 (TP2) - 0.3 m
- Test point 3 (TP3) - 0.3 m
- Test point 4 (TP4) - 0.9 m

From the sieve analysis results, the following were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - 13.5% fines, grading modulus 2.1
- Test point 2 at 0.5 m depth (TP2@0.5 m) - 16.7% fines, grading modulus 2.1
- Test point 3 at 0.3 m depth (TP3@0.3 m) - 21.2% fines, grading modulus 1.9
- Test point 4 at 0.3 m depth (TP4@0.3 m) - 6.3% fines, grading modulus 2.0

From the Atterberg limit results, the fines part of the soils was found to have plasticity index as follows:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - plastic index S/P, shrinkage 2.0mm, soil description: slightly plastic
- Test point 2 at 0.5 m depth (TP2@0.5 m) - plastic index 4%, shrinkage 3.5mm, soil description: slightly plastic
- Test point 3 at 0.3 m depth (TP3@0.3 m) - plastic index 2.1%, shrinkage 2.0mm, soil description: slightly plastic
- Test point 4 at 0.3 m depth (TP4@0.3 m) - plastic index N/P, shrinkage N/P, soil description: non plastic

From the modified proctor compaction test, the following maximum dry density (MDD) and optimum moisture content (OMC) were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - MDD 2079 kg/m³, OMC 6.2%
- Test point 2 at 0.5 m depth (TP2@0.5 m) - MDD 2068 kg/m³, OMC 7.2%
- Test point 3 at 0.3 m depth (TP3@0.3 m) - MDD 2080 kg/m³, OMC 7.5%
- Test point 4 at 0.3 m depth (TP4@0.3 m) - MDD 2063 kg/m³, OMC 6.8%

From the California Bearing Ratio (CBR) test, the following were observed:

- Test point 1 at 1.3 m depth (TP1@1.3 m) - CBR at 90%: 25.3, CBR at 95%: 40.0, CBR at 98%: 49.5, general soil type: gravel with fines
- Test point 2 at 0.5 m depth (TP2@0.5 m) - CBR at 90%: 34.0, CBR at 95%: 61.0, CBR at 98%: 77.0, general soil type: gravel with fines
- Test point 3 at 0.3 m depth (TP3@0.3 m) - CBR at 90%: 33.5, CBR at 95%: 50.0, CBR at 98%: 62.0 general soil type: gravel with fines
- Test point 1 at 0.3 m depth (TP1@0.3 m) - CBR at 90%: 31.5, CBR at 95%: 51.0, CBR at 98%: 64.0, general soil type: gravel with fines

From the soil resistivity results, the following results were observed:

- Test point 1 (TP1) - 3302 ohm-centimetre
- Test point 2 (TP2) - 3023 ohm-centimetre

- Test point 3 (TP3) - 3555 ohm-centimetre
- Test point 4 (TP4) - 3105 ohm-centimetre

Site and laboratory test results for Kanyama are attached as **Annex 7** to this report.

Figure 12: Kanyama Test Points



7.7 Results Summary

Table 1 below provides a summary of the range of values for the soil resistivity and bearing capacities of the six townships for depths between 0 and 10 m.

Table 1: Summary of Soil Resistivity and Bearing Capacity Values in the Six Townships

Township	Soil Resistivity $\rho(\text{cm}\Omega)$	Bearing Capacities kN/m^2
Kanyama	3023 to 3302	>600
Garden	1572 to 2002	>400
Chawama	2950 to 3586	80 to 280
John Howard	2509 to 3001	280 to 410
Kamanga (Nkoloma)	3023 to 5533	>600
Chainda	3023 to 4236	240 to 390

The grounds for all the six township tested appear to be very corrosive hence proper ground-ing/earthing systems must be employed for effective earth conductivity.

8. Sample / Core Preservation, Containers, Handling and Storage

Chemical preservation of soil samples is generally not recommended. Cooling is usually the best approach, supplemented by the appropriate holding time. Air-tight Teflon bags were used as sample containers. The soil samples were transferred from the sample collection to the sample bags using a hand scoop.

9. Sample/Core Measuring and Labelling

The samples were measured on a mass scale on site, and the containers (bags) were labelled and tagged (e.g. Chainda TP1@1 m). Appropriate data on soil samples such as location, test point number, depth, colour, and other observations were recorded on data sheets.

10. Safety Requirement

Safety and health of workers is of vital importance. Safety is a condition of employment with our company and will never be sacrificed for the sake of expediency. It is our belief that all accidents can be prevented, and every effort was made to identify hazards and reduced the risks of those hazards.

11. Quality Assurance/Control

All the data was documented on the field data sheets and in site logbooks. All the instrumentation was operated in accordance with the respective standard specification. Equipment checkout and calibration activities were done prior to sampling/testing and are documented.

12. Conclusion

The estimated bearing pressure capacity of the soils in the six townships Kanyama, Garden, Chawama, John Howard, Kamanga (Nkoloma) and Chainda was determined and is comprehensively outlined in the annexes. The soils in all six townships appear very corrosive; hence, proper grounding / earthing must be applied for effective earth conductivity. Kanyama Township has hard soils/rocks compared to the other townships with refusal at 1.2 m.

Typical tests done in the six townships give general soil properties and suitability for the intended powerline construction works in the six townships. The tests done were; (i) particle size distribution, (ii) Standard Penetration Test (STP), (iii) Dynamic cone penetration Test (DCPT), (iv) Atterberg limits test, (v) California Bearing Ratio (CBR), (vi) Maximum dry density (MDD) and (vii) Soil resistivity test. The results of these tests give a good indication of the soil structure, strength, resistivity and bearing capacities. It must be noted that variations from the results may arise in some places due to the vastness of certain townships like Kanyama and specific interventions must be carried out.

Chainda Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants		Location: Chainda		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation				Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²
1	1	150	15	24	280
		300	14		
		450	10		
2	1	150	8	21	240
		300	11		
		450	10		
3	1	150	9	20	260
		300	11		
		450	9		
4	1	150	13	27	390
		300	12		
		450	15		

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Chainda		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 1	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	6	0.3	4	0.3	8	0.3	6
0.6	7	0.6	7	0.6	7	0.6	9
0.9	8	0.9	11	0.9	8	0.9	21
1.2	8	1.2	13	1.2	9	1.2	26
1.5	7	1.5	13	1.5	8	1.5	20
1.8	7	1.8	14	1.8	7	1.8	16
2.1	8	2.1	9	2.1	7	2.1	17
2.4	4	2.4	10	2.4	6	2.4	12
2.7	9	2.7	15	2.7	5	2.7	12
3.0	5	3.0	15	3.0	5	3.0	10
3.3	5	3.3	14	3.3	6	3.3	8
3.6	8	3.6	21	3.6	10	3.6	10
3.9	7	3.9	20	3.9	5	3.9	21
4.2	3	4.2	20	4.2	5	4.2	24
4.5	4	4.5	16	4.5	6	4.5	24
4.8	3	4.8	16	4.8	9	4.8	44
5.1	4	5.1	17	5.1	6	5.1	38
5.4	8	5.4	18	5.4	5	5.4	39
5.7	7	5.7	24	5.7	4	5.7	43
6.0	4	6.0	31	6.0	4	6.0	41
6.3	3	6.3	38	6.3	3	6.3	47
6.6	3	6.6	34	6.6	2	6.6	49
6.9	2	6.9	41	6.9	2	6.9	51
7.2	9	7.2	47	7.2	4	7.2	50
7.5	7	7.5	53	7.5	5	7.5	>55
7.8	7	7.8	54	7.8	3	7.8	
8.1	4	8.1	>55	8.1	4	8.1	
8.4	3	8.4		8.4	21	8.4	
8.7	38	8.7		8.7	33	8.7	
9.0	39	9.0		9.0	47	9.0	
9.3	48	9.3		9.3	49	9.3	
9.6	>55	9.6		9.6	50	9.6	
9.9		9.9		9.9	>55	9.9	

Act/Go to

PARTICLE SIZE DISTRIBUTION

AASHTO T-27

SIDE:		SAMPLE NO	
REPRESENTATIVE STATION:	CHAINDA TP-1 1.5 m	SAMPLING DATE:	05/01/2019
LOCATION:		TESTING DATE:	12/01/2019

Weight After Washing (g)	994.0	g	loss in fine :	1482.0	g
Weight Before Washing (g)	2476.0	g	loss in fine percentage :	149%	g

Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="checked" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 0.5 GRADING COEFFICIENT (GC) = 2.1
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	0.0	0.0	100.0			
2.00	52.0	2.1	97.9			
1.18	44.0	1.8	96.1			
0.6	53.0	2.1	94.0			
0.425	80.0	3.2	90.8			
0.3	133.0	5.4	85.4			
0.15	543.0	21.9	63.4			
0.075	89.0	3.6	59.9			
Pan	1482.0	59.9	0.0			



Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI Date: 12/01/2019	Approved By: Date
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PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	CHAINDA TP-2 1.5 m		SAMPLING DATE:		05/01/2019	
LOCATION:			TESTING DATE:		12/01/2019	
Weight After Washing (g)	2706.0	g	loss in fine :		1648.0	g
Weight Before Washing (g)	4354.0	g	loss in fine percentage :		61%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/>
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	0.0	0.0	100.0			
2.00	0.0	0.0	100.0			
1.18	142.0	3.3	96.7			
0.6	1106.0	25.4	71.3			
0.425	146.0	3.4	68.0			
0.3	269.0	6.2	61.8			
0.15	396.0	9.1	52.7			
0.075	647.0	14.9	37.9			
Pan	1648.0	37.9	0.0			
					GRADING MODULUS (GM) =	
					0.9	
					GRADING COEFFICIENT (GC) =	
					0.0	

Sieve Size, mm

Remarks:

Tested By: A.KASOKA	Checked By:	Approved By:
	Date: 12/01/2019	Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	CHAINDA TP-3 1.5 m		SAMPLING DATE:	05/01/2019		
LOCATION:			TESTING DATE:	12/01/2019		
Weight After Washing (g)	3353.0	g	loss in fine :	1648.0	g	
Weight Before Washing (g)	5001.0	g	loss in fine percentage :	49%	g	
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 0.9 GRADING COEFFICIENT (GC) = 0.0
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	0.0	0.0	100.0			
2.00	0.0	0.0	100.0			
1.18	196.0	3.9	96.1			
0.6	968.0	19.4	76.7			
0.425	202.0	4.0	72.7			
0.3	406.0	8.1	64.6			
0.15	276.0	5.5	59.0			
0.075	1305.0	26.1	33.0			
Pan	1648.0	33.0	0.0			

Remarks:

Tested By: A.KASOKA	Checked By:	Approved By:
	Date: 12/01/2019	Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	CHAINDA TP-4 1.5 m		SAMPLING DATE:		05/01/2019	
LOCATION:			TESTING DATE:		12/01/2019	
Weight After Washing (g)	716.0	g	loss in fine :		1372.0	g
Weight Before Washing (g)	2088.0	g	loss in fine percentage :		192%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 0.4 GRADING COEFFICIENT (GC) = 1.1
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	4.0	0.2	99.8			
2.00	20.0	1.0	98.9			
1.18	29.0	1.4	97.5			
0.6	62.0	3.0	94.5			
0.425	58.0	2.8	91.7			
0.3	53.0	2.5	89.2			
0.15	319.0	15.3	73.9			
0.075	171.0	8.2	65.7			
Pan	1372.0	65.7	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By:	Approved By:
Date:	Date:	Date:

ATTERBERG LIMIT																
AASHTO T-89 & T- 90																
SIDE			Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>												
LOCATION	CHAINDA TP-1 1.5 m	SAMPLE NO.														
MATERIAL TYPE	FINE YELLOWISH SOIL	DATE SAMPLED		05/01/2019												
MATERIAL SOURCE	CHAINDA TP-1 1.5 m	DATE TESTED		13/01/2019												
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.		U	D-2	E												
Wt of wet soil + container, gm		27.78	25.78	23.41												
Wt of dry soil + container, gm		24.16	22.61	21.05												
Wt of water		3.62	3.17	2.36												
Wt of container		14.68	13.84	13.99												
Wt of dry soil, gm		9.48	8.77	7.06												
Water content, %		38.19	36.15	33.43												
No. of blows		17	24	33												
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at30°C	<input checked="" type="checkbox"/>															
Oven dried at°C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">35.90 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">17.44 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">18.5 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">14.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">9.3 %</td> </tr> </tbody> </table>					Test Result		Liquid Limit	35.90 %	Plastic Limit	17.44 %	Plasticity Index	18.5 %	Shrinkage =	14.0 mm	Shrinkage =	9.3 %
Test Result																
Liquid Limit	35.90 %															
Plastic Limit	17.44 %															
Plasticity Index	18.5 %															
Shrinkage =	14.0 mm															
Shrinkage =	9.3 %															
PLASTIC LIMIT																
Container No.		19	39	Average												
Wt of wet soil + container, gm		21.25	21.34													
Wt of dry soil + container, gm		20.47	20.49													
Wt of water		0.78	0.85													
Wt of container		16.02	15.59													
Wt of dry soil, gm		4.45	4.90													
Water content, %		17.53	17.35	17.44												
Remarks:																
Tested By: A.KASOKA		Checked By: S.T.PHIRI		Approved By:												
		Date: 13/01/2019		Date												

ATTERBERG LIMIT																
AASHTO T-89 & T- 90																
SIDE			Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>												
LOCATION	CHAINDA TP-2 1.5 m		SAMPLE NO.													
MATERIAL TYPE	FINE REDDISH SOIL		DATE SAMPLED	05/01/2019												
MATERIAL SOURCE	CHAINDA TP-2 1.5 m		DATE TESTED	13/01/2019												
MATERIAL DESCRIPTION			SAMPLED BY													
REPRESENTATIVE STATION			TESTED BY													
SAMPLING DEPTH			TEST NO.													
LIQUID LIMIT																
Container No.	10	7	51													
Wt of wet soil + container, gm	27.38	26.54	24.77													
Wt of dry soil + container, gm	24.76	24.26	23.11													
Wt of water	2.62	2.28	1.66													
Wt of container	14.74	13.97	14.06													
Wt of dry soil, gm	10.02	10.29	9.05													
Water content, %	26.15	22.16	18.34													
No. of blows	17	25	33													
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at30°C	<input checked="" type="checkbox"/>															
Oven dried at°C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
PLASTIC LIMIT		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">22.20 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">0.00 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">NP %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">0.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">0.0 %</td> </tr> </tbody> </table>			Test Result		Liquid Limit	22.20 %	Plastic Limit	0.00 %	Plasticity Index	NP %	Shrinkage =	0.0 mm	Shrinkage =	0.0 %
Test Result																
Liquid Limit	22.20 %															
Plastic Limit	0.00 %															
Plasticity Index	NP %															
Shrinkage =	0.0 mm															
Shrinkage =	0.0 %															
PLASTIC LIMIT																
Container No.				Average												
Wt of wet soil + container, gm																
Wt of dry soil + container, gm																
Wt of water																
Wt of container																
Wt of dry soil, gm																
Water content, %				0.00												
Remarks:																
Tested By: A.KASOKA		Checked By:		Approved By:												
		Date: 13/01/2019		Date												

ATTERBERG LIMIT																	
AASHTO T-89 & T- 90																	
SIDE			Random Sample		Yes <input type="checkbox"/> No <input type="checkbox"/>												
LOCATION	CHAINDA TP-3 1.5 m	SAMPLE NO.															
MATERIAL TYPE	FINE REDDISH SOIL	DATE SAMPLED		05/01/2019													
MATERIAL SOURCE	CHAINDA TP-3 1.5 m	DATE TESTED		13/01/2019													
MATERIAL DESCRIPTION			SAMPLED BY														
REPRESENTATIVE STATION			TESTED BY														
SAMPLING DEPTH			TEST NO.														
LIQUID LIMIT																	
Container No.	F-24	J-11	O-3														
Wt of wet soil + container, gm	27.32	26.57	25.71														
Wt of dry soil + container, gm	24.71	24.20	23.52														
Wt of water	2.61	2.37	2.19														
Wt of container	15.02	14.58	13.92														
Wt of dry soil, gm	9.69	9.62	9.60														
Water content, %	26.93	24.64	22.81														
No. of blows	18	25	31														
			<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																	
As received	<input type="checkbox"/>																
Washed on 0.425mm sieve	<input type="checkbox"/>																
Air dried at30°C	<input checked="" type="checkbox"/>																
Oven dried at°C	<input type="checkbox"/>																
Proportion retained on 0.425mm sieve.....																	
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: center;">24.70 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: center;">0.00 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: center;">S/P %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: center;">3.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: center;">2.0 %</td> </tr> </tbody> </table>						Test Result		Liquid Limit	24.70 %	Plastic Limit	0.00 %	Plasticity Index	S/P %	Shrinkage =	3.0 mm	Shrinkage =	2.0 %
Test Result																	
Liquid Limit	24.70 %																
Plastic Limit	0.00 %																
Plasticity Index	S/P %																
Shrinkage =	3.0 mm																
Shrinkage =	2.0 %																
PLASTIC LIMIT																	
Container No.					Average												
Wt of wet soil + container, gm																	
Wt of dry soil + container, gm																	
Wt of water																	
Wt of container																	
Wt of dry soil, gm																	
Water content, %					0.00												
Remarks:																	
Tested By: A.KASOKA		Checked By:		Approved By:													
		Date:13/01/2019		Date													

ATTERBERG LIMIT																
AASHTO T-89 & T- 90																
SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	CHAINDA TP-4 1.5 m	SAMPLE NO.														
MATERIAL TYPE	FINE REDDISH SOIL	DATE SAMPLED	05/01/2019													
MATERIAL SOURCE	CHAINDA TP-4 1.5 m	DATE TESTED	11/01/2019													
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.		M	P	H												
Wt of wet soil + container, gm		30.43	27.76	25.76												
Wt of dry soil + container, gm		26.28	23.74	23.10												
Wt of water		4.15	4.02	2.66												
Wt of container		16.77	13.57	15.57												
Wt of dry soil, gm		9.51	10.17	7.53												
Water content, %		43.64	39.53	35.33												
No. of blows		17	24	32												
		<table border="1"> <thead> <tr> <th colspan="2">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Air dried at 30°C</td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at °C</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Proportion retained on 0.425mm sieve.....</td> <td></td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at 30°C	<input checked="" type="checkbox"/>	Oven dried at °C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
		Sample preparation														
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at 30°C	<input checked="" type="checkbox"/>															
Oven dried at °C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
		<table border="1"> <thead> <tr> <th colspan="2">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td>39.20 %</td> </tr> <tr> <td>Plastic Limit</td> <td>18.82 %</td> </tr> <tr> <td>Plasticity Index</td> <td>20.4 %</td> </tr> <tr> <td>Shrinkage =</td> <td>16.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td>10.7 %</td> </tr> </tbody> </table>			Test Result		Liquid Limit	39.20 %	Plastic Limit	18.82 %	Plasticity Index	20.4 %	Shrinkage =	16.0 mm	Shrinkage =	10.7 %
Test Result																
Liquid Limit	39.20 %															
Plastic Limit	18.82 %															
Plasticity Index	20.4 %															
Shrinkage =	16.0 mm															
Shrinkage =	10.7 %															
PLASTIC LIMIT																
Container No.		5	8	Average												
Wt of wet soil + container, gm		19.57	20.34													
Wt of dry soil + container, gm		18.67	19.36													
Wt of water		0.90	0.98													
Wt of container		13.90	14.14													
Wt of dry soil, gm		4.77	5.22													
Water content, %		18.87	18.77	18.82												
Remarks:																
Tested By: A.KASOKA		Checked By:		Approved By:												
		Date:		Date												

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7.AASHTO 180)

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	05/01/2019	
MATERIAL SOURCE	CHAINDA TP-1 1.5 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	FINE YELLOWISH SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	CHAINDA TP-1 1.5 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

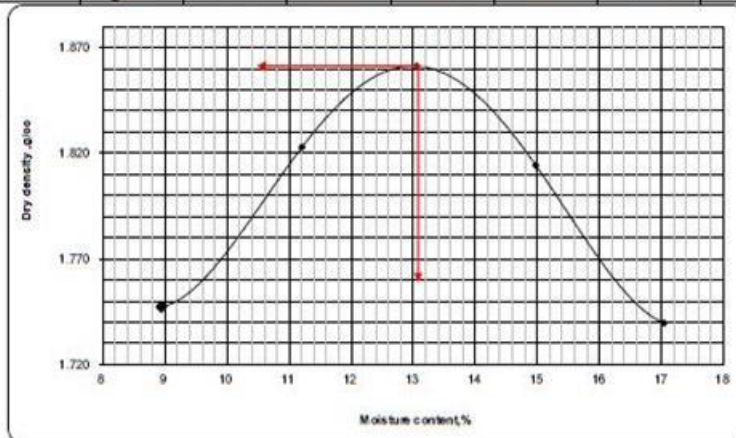
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	9	11	13	15	17
B	Wt. of Mold + Wet Soil	grams	8604	8897	9080	9037	8919
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4519	4812	4995	4952	4834
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.904	2.027	2.104	2.086	2.036
G	Container	No.	N-70	M-300	VM-2	I-18	L-P
H	Wt. Cont + Wet soil	grams	773.0	776.0	759.0	728.0	770.0
I	Wt. Cont + Dry soil	grams	730.0	723.0	700.0	666.0	695.0
J	Weight of Water	grams	43.0	53.0	59.0	62.0	75.0
K	Weight of Container	grams	249.0	250.0	248.0	252.0	255.0
L	Weight of Dry Soil	grams	481.0	473.0	452.0	414.0	440.0
M	Moisture Content	%	8.9	11.2	13.1	15.0	17.0
N	Dry Density	g/cm ³	1.747	1.823	1.861	1.814	1.740

Maximum Dry Density (MDD):

MDD = 1.861 g/cm³

Optimum Moisture Content (OMC):

OMC = 13.1 %



Remarks:

Tested By: AKASOKA

Checked By: S.T PHIRI

Approved By:

Date: 10/01/2019

Date

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7.AASHTO 180)

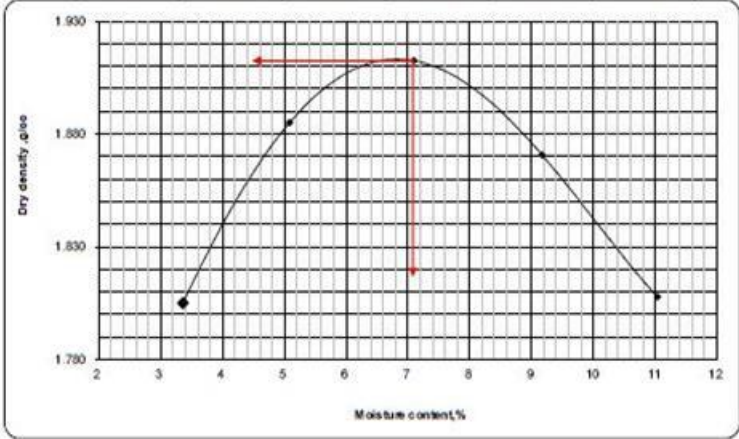
SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	05/01/2019	
MATERIAL SOURCE	CHAINDA TP-2 1.5 m	DATE TESTED	11/01/2019	
MATERIAL DESCRIPTION	FINE REDDISH SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	CHAINDA TP-2 1.5 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8462	8732	8890	8876	8794
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4375	4645	4803	4789	4707
E	Volume of Mold	cm ³	2345	2345	2345	2345	2345
F	Wet Density	g/cm ³	1.866	1.981	2.048	2.042	2.007
G	Container	No.	I-18	L-P	U-45	FR-2	M-61
H	Wt. Cont + Wet soil	grams	775.0	751.0	764.0	733.0	762.0
I	Wt. Cont + Dry soil	grams	758.0	727.0	730.0	692.0	711.0
J	Weight of Water	grams	17.0	24.0	34.0	41.0	51.0
K	Weight of Container	grams	252.0	255.0	251.0	245.0	249.0
L	Weight of Dry Soil	grams	506.0	472.0	479.0	447.0	462.0
M	Moisture Content	%	3.4	5.1	7.1	9.2	11.0
N	Dry Density	g/cm ³	1.805	1.885	1.912	1.871	1.808

Maximum Dry Density (MDD):
MDD = 1.912 g/cm³

Optimum Moisture Content (OMC):
OMC = 7.1 %



Remarks:

Tested By: A. KASOKSA	Checked By:	Approved By:
	Date: 11/01/2019	Date

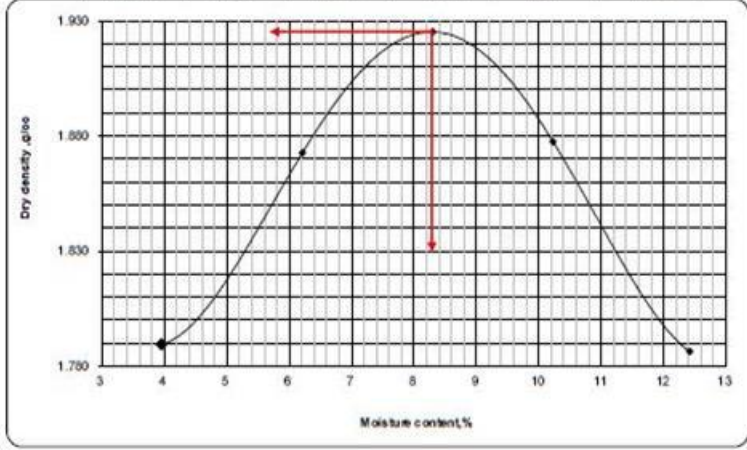
DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)

SIDE	_____	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____			
MATERIAL TYPE	Gravel	DATE SAMPLED	05/01/2019			
MATERIAL SOURCE	CHAINDA TP-3 1.5 m	DATE TESTED	11/01/2019			
MATERIAL DESCRIPTION	FINE REDDISH SOIL	SAMPLED BY	_____			
REPRESENTATIVE STATE	CHAINDA TP-3 1.5 m	TESTED BY	_____			
SAMPLING DEPTH	_____	TEST NO.	_____			

No. of blows : 55+1 Weight of hammer, kg : 4.5
 No. of layers : 5 Volume of mold, cm³ : 2345
 Proportion retained on 19mm sieve size: _____ Single sample / Separate batches : _____
 (pass 50mm sieve and retained on 19mm sieve) Apparent specific gravity : _____

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	4	6	8	10	12
B	Wt. of Mold + Wet Soil	grams	8449	8751	8976	8940	8796
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4362	4664	4889	4853	4709
E	Volume of Mold	cm ³	2345	2345	2345	2345	2345
F	Wet Density	g/cm ³	1.860	1.989	2.085	2.070	2.008
G	Container	No.	D-14	EE-16	N-70	M-41	G-67
H	Wt. Cont + Wet soil	grams	776.0	762.0	764.0	775.0	777.0
I	Wt. Cont + Dry soil	grams	756.0	732.0	725.0	726.0	719.0
J	Weight of Water	grams	20.0	30.0	39.0	49.0	58.0
K	Weight of Container	grams	250.0	249.0	255.0	247.0	252.0
L	Weight of Dry Soil	grams	506.0	483.0	470.0	479.0	467.0
M	Moisture Content	%	4.0	6.2	8.3	10.2	12.4
N	Dry Density	g/cm ³	1.789	1.873	1.925	1.877	1.786

Maximum Dry Density (MDD):
 MDD = 1.925 g/cm³
Optimum Moisture Content (OMC) :
 OMC = 8.3 %



Remarks: _____

Tested By: AKASOKA	Checked By: _____	Approved By: _____
	Date: 11/01/2019	Date: _____

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7,AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	05/01/2019	
MATERIAL SOURCE	CHAINDA TP-4 1.5 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	FINE REDDISH SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATI	CHAINDA TP-4 1.5 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows : 55+1 Weight of hammer,kg : 4.5
 No. of layers : 5 Volume of mold,cm³ : 2374
 Proportion retained on 19mm sieve size: _____ Single sample / Separate batches : _____
 (pass 50mm sieve and retained on 19mm sieve) Apparent specific gravity : _____

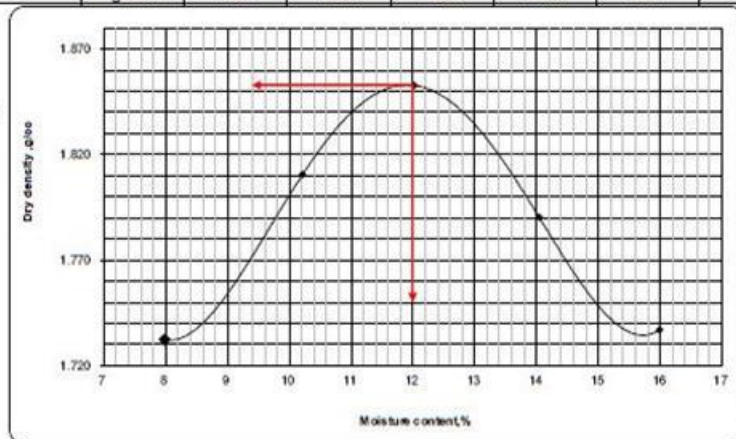
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	8	10	12	14	16
B	Wt. of Mold + Wet Soil	grams	8526	8822	9012	8932	8868
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4441	4737	4927	4847	4783
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.871	1.995	2.075	2.042	2.015
	Container	No.	M-22	N-17	F-21	U-14	J-6
H	Wt. Cont + Wet soil	grams	761.0	770.0	750.0	720.0	769.0
I	Wt. Cont + Dry soil	grams	723.0	722.0	697.0	662.0	698.0
J	Weight of Water	grams	38.0	48.0	53.0	58.0	71.0
K	Weight of Container	grams	247.0	252.0	256.0	249.0	254.0
L	Weight of Dry Soil	grams	476.0	470.0	441.0	413.0	444.0
M	Moisture Content	%	8.0	10.2	12.0	14.0	16.0
N	Dry Density	g/cm ³	1.732	1.810	1.853	1.790	1.737

Maximum Dry Density (MDD):

MDD = 1.853 g/cm³

Optimum Moisture Content (OMC) :

OMC = 12.0 %



Remarks:

Tested By: AKASOKA

Checked By:

Approved By:

Date: 10/01/2019

Date

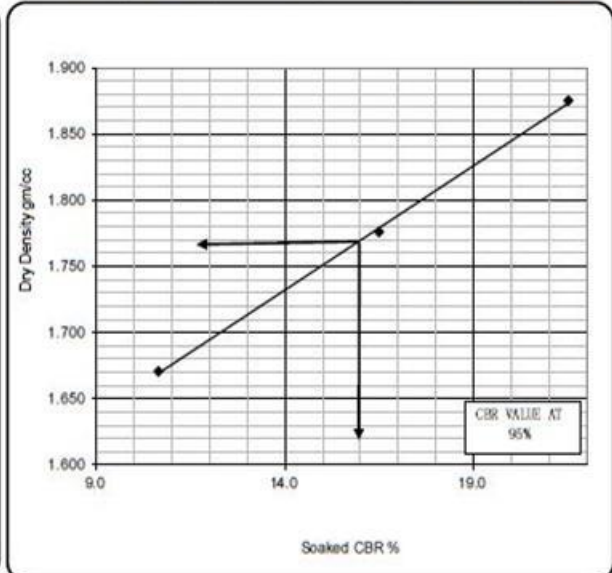
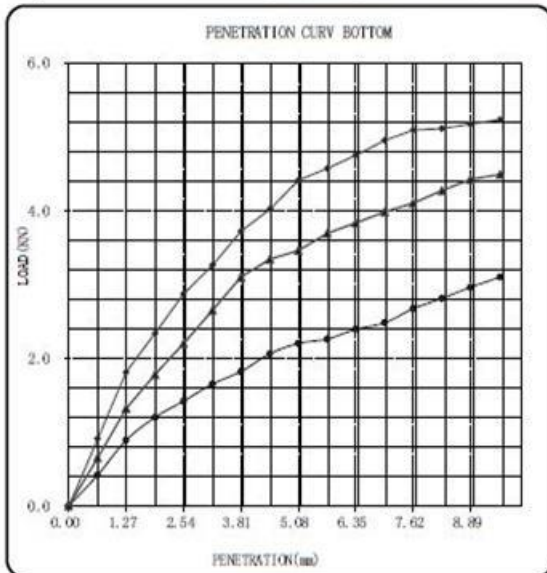
CALIFORNIA BEARING RATIO									
AASHTO T 193									
SAMPLE STATION	CHAINDA TP-1	1.5 m	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.					
MATERIAL TYPE	FINE YELLOWISH SOIL			DATE SAMPLED	05/01/2019				
MATERIAL SOURCE	CHAINDA TP-1 1.5 m			DATE TESTED	11/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY					
REPRESENTATIVE STATION	CHAINDA TP-1 1.5 m			TESTED BY					
SAMPLING DEPTH				TEST NO.					
DENSITY DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
MOLD NUMBER	M-7		M-8		M-22				
WEIGHT OF SOIL + MOLD, g	9056		8841		8518				
WEIGHT OF MOLD, g	4098		4109		4089				
WEIGHT OF SOIL, g	4958		4732		4429				
VOLUME OF MOLD, g	2341		2359		2347				
WET DENSITY OF SOIL, g/cm ³	2.118		2.006		1.887				
DRY DENSITY OF SOIL, g/cm ³	1.875		1.776		1.671				
MOISTURE DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
CONTAINER NUMBER	VM-32		M-39						
WET SOIL + CONTAINER, g	706		795						
DRY SOIL + CONTAINER, g	654		732						
WEIGHT OF CONTAINER, g	249		250						
WEIGHT OF WATER, g	52		63						
WEIGHT OF DRY SOIL, g	405		482						
MOISTURE CONTENT	12.8		13.1						
MOISTURE CONTENT AV=			13.0						
PENETRATION BOTTOM TEST									
PENETRATION DATE			15/01/2019			RING FACTOR		0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)		
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)
0.00		0.00		0.00			0.00		
0.64		0.91		0.65			0.42		
1.27		1.81		1.32			0.89		
1.91		2.34		1.78			1.20		
2.54		2.87	21.5	2.20		16.5	1.42		10.6
3.18		3.26		2.65			1.65		
3.81		3.72		3.10			1.82		
4.45		4.02		3.34			2.06		
5.08		4.41	22.1	3.46		17.3	2.20		11.0
5.72		4.57		3.69			2.26		
6.35		4.75		3.83			2.39		
6.99		4.95		3.98			2.48		
7.62		5.09		4.10			2.67		
8.26		5.11		4.27			2.81		
8.89		5.17		4.42			2.96		
9.55		5.23		4.49			3.10		
			Blows		55		25		55
SWELL			rammar		4,5kg by 5		4,5kg by 5		2,5kg by 3
Soaking Date			Initial reading (mm)						
Time			Final reading (mm)						
			Height of specimen (mm)						
			Percent Swell (%)						
Remarks:									
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:			
			Date:11/01/2019			Date			

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAINDA TP-1 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAINDA TP-1 1.5 m	SAMPLE NO.	
MATERIAL TYPE	FINE YELLOWISH SOIL	DATE SAMPLED	05/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.861	55 by 5	12.8	1.875	21.5	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	13.1	1.776	16.5	0.0	0.00		13.24	20.00
13.1	55 by 3	0.0	1.671	10.6	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.675	CBR Value at 90% from the graph = 10.7
CBR Value at 95% MDD = 1.768	CBR Value at 95% from the graph = 15.9
CBR Value at 98% MDD = 1.824	CBR Value at 98% from the graph = 19.0

Comments:

Checked By: W.MUMBA **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

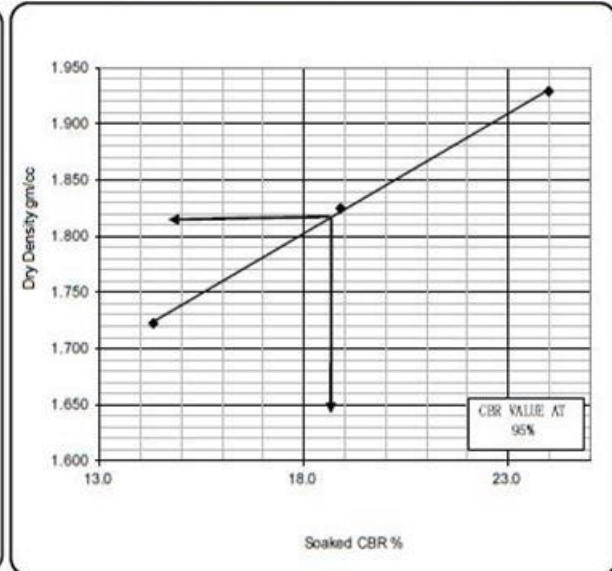
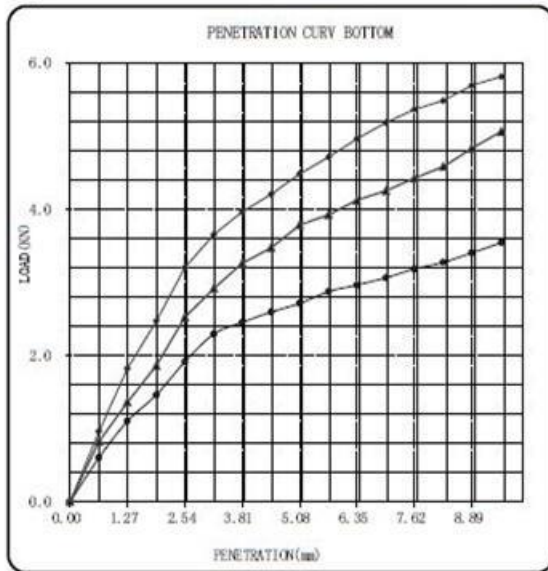
CALIFORNIA BEARING RATIO									
AASHTO T 193									
SAMPLE STATION	CHAINDA TP-2	1.5 m	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.					
MATERIAL TYPE	FINE REDDISH SOIL			DATE SAMPLED	05/01/2019				
MATERIAL SOURCE	CHAINDA TP-2 1.5 m			DATE TESTED	12/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY					
REPRESENTATIVE STATION	CHAINDA TP-2 1.5 m			TESTED BY					
SAMPLING DEPTH				TEST NO.					
DENSITY DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
MOLD NUMBER	B-31		B-33		B-34				
WEIGHT OF SOIL + MOLD, g	8106		7856		7546				
WEIGHT OF MOLD, g	3300		3333		3293				
WEIGHT OF SOIL, g	4806		4523		4253				
VOLUME OF MOLD, g	2326		2314		2305				
WET DENSITY OF SOIL, g/cm ³	2.066		1.955		1.845				
DRY DENSITY OF SOIL, g/cm ³	1.929		1.825		1.722				
MOISTURE DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
CONTAINER NUMBER	F-26		G-70						
WET SOIL + CONTAINER, g	711		738						
DRY SOIL + CONTAINER, g	680		706						
WEIGHT OF CONTAINER, g	247		255						
WEIGHT OF WATER, g	31		32						
WEIGHT OF DRY SOIL, g	433		451						
MOISTURE CONTENT	7.2		7.1						
MOISTURE CONTENT AV=			7.1						
PENETRATION BOTTOM TEST									
PENETRATION DATE			16/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)
0.00	0.00			0.00			0.00		
0.64	0.96			0.82			0.60		
1.27	1.82			1.36			1.10		
1.91	2.47			1.86			1.46		
2.54	3.20	24.0		2.52	18.9		1.91	14.3	
3.18	3.65			2.91			2.29		
3.81	3.96			3.26			2.45		
4.45	4.20			3.47			2.59		
5.08	4.48	22.4		3.78	18.9		2.71	13.6	
5.72	4.71			3.92			2.87		
6.35	4.96			4.12			2.96		
6.99	5.18			4.25			3.06		
7.62	5.36			4.42			3.18		
8.26	5.48			4.58			3.27		
8.89	5.69			4.83			3.40		
9.55	5.81			5.06			3.54		
					Blows	55	25	55	
SWELL					rammar	4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date					Initial reading (mm)				
Time					Final reading (mm)				
					Height of specimen (mm)				
					Percent Swell (%)				
Remarks:									
Tested By: W.MUMBA			Checked By:			Approved By:			
			Date: 12/01/2019			Date			

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAINDA TP-2 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAINDA TP-2 1.5 m	SAMPLE NO.	
MATERIAL TYPE	FINE REDDISH SOIL	DATE SAMPLED	05/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.912	55 by 5	7.2	1.929	24.0	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.1	1.825	18.9	0.0	0.00		13.24	20.00
7.1	55 by 3	0.0	1.722	14.3	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.721	CBR Value at 90% from the graph = 14.3
CBR Value at 95% MDD = 1.816	CBR Value at 95% from the graph = 18.6
CBR Value at 98% MDD = 1.874	CBR Value at 98% from the graph = 21.2

Comments:

Checked By: W.MUMBA **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

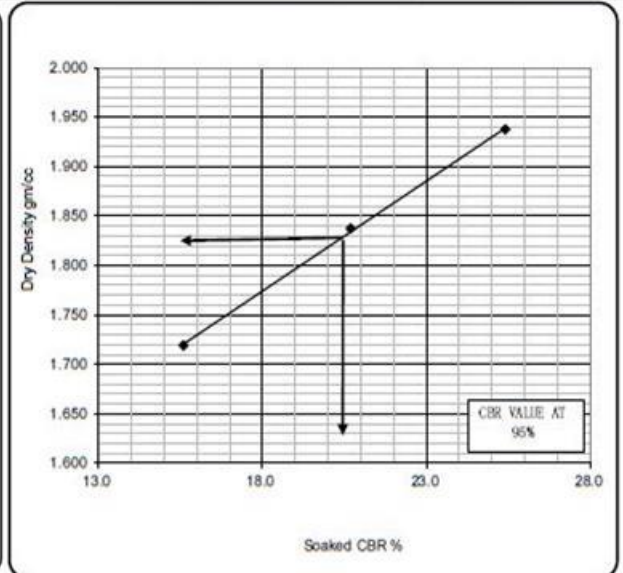
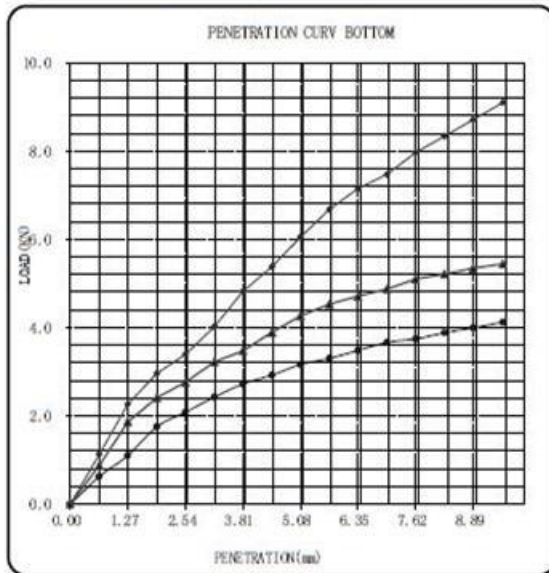
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	CHAINDA TP-3	1.5 m	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>			
LOCATION					SAMPLE NO.					
MATERIAL TYPE	FINE REDDISH SOIL				DATE SAMPLED	05/01/2019				
MATERIAL SOURCE	CHAINDA TP-3	1.5 m	DATE TESTED	12/01/2019						
MATERIAL DESCRIPTION	Gravel				SAMPLED BY					
REPRESENTATIVE STATION	CHAINDA TP-3	1.5 m	TESTED BY							
SAMPLING DEPTH					TEST NO.					
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	B-20		B-23		B-25					
WEIGHT OF SOIL + MOLD, g	8110		7969		7533					
WEIGHT OF MOLD, g	3275		3404		3215					
WEIGHT OF SOIL, g	4835		4565		4318					
VOLUME OF MOLD, g	2310		2300		2325					
WET DENSITY OF SOIL, g/cm ³	2.093		1.985		1.857					
DRY DENSITY OF SOIL, g/cm ³	1.937		1.837		1.719					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	H-70		GT							
WET SOIL + CONTAINER, g	744		764							
DRY SOIL + CONTAINER, g	707		725							
WEIGHT OF CONTAINER, g	240		246							
WEIGHT OF WATER, g	37		39							
WEIGHT OF DRY SOIL, g	467		479							
MOISTURE CONTENT	7.9		8.1							
MOISTURE CONTENT AV=			8.0							
PENETRATION BOTTOM TEST										
PENETRATION DATE			16/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	
0.00		0.00		0.00			0.00			
0.64		1.13		0.87			0.62			
1.27		2.26		1.86			1.10			
1.91		2.96		2.41			1.75			
2.54		3.39	25.4	2.76		20.7	2.08		15.6	
3.18		4.02		3.22			2.42			
3.81		4.82		3.47			2.72			
4.45		5.38		3.89			2.92			
5.08		6.05	30.3	4.26		21.3	3.16		15.8	
5.72		6.68		4.53			3.30			
6.35		7.15		4.71			3.48			
6.99		7.47		4.87			3.66			
7.62		7.97		5.10			3.74			
8.26		8.34		5.21			3.88			
8.89		8.71		5.34			3.99			
9.55		9.10		5.44			4.12			
					Blows		55	25	55	
							4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date			rammar			Initial reading (mm)				
Time						Final reading (mm)				
						Height of specimen (mm)				
						Percent Swell (%)				
Remarks:										
Tested By: W.MUMBA			Checked By:			Approved By:				
			Date: 12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAINDA TP-3 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAINDA TP-3 1.5 m	SAMPLE NO.	
MATERIAL TYPE	FINE REDDISH SOIL	DATE SAMPLED	05/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	%Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.925	55 by 5	7.9	1.937	25.4	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	8.1	1.837	20.7	0.0	0.00		13.24	20.00
8.3	55 by 3	0.0	1.719	15.6	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.733	CBR Value at 90% from the graph = 16.0
CBR Value at 95% MDD = 1.829	CBR Value at 95% from the graph = 20.3
CBR Value at 98% MDD = 1.887	CBR Value at 98% from the graph = 23.2

Comments:

Checked By: W.MUMBA **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

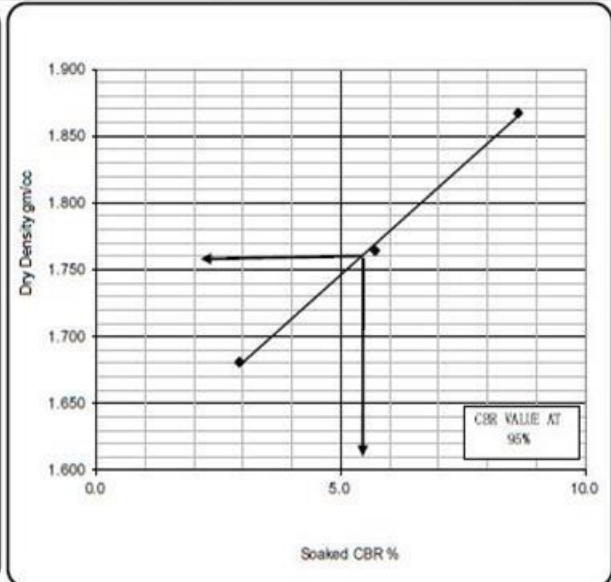
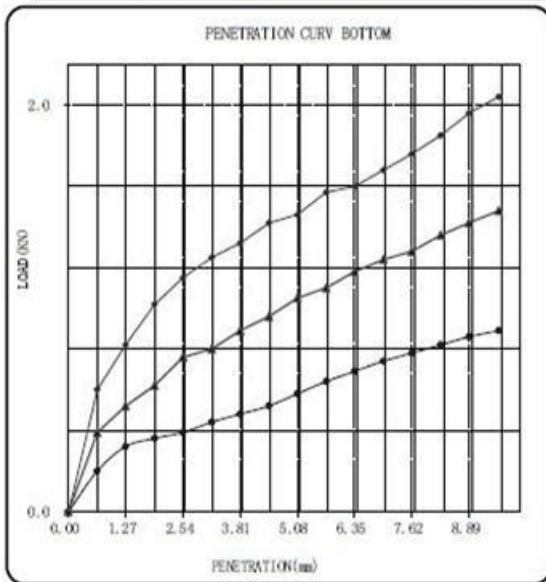
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	CHAINDA TP-4 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	FINE REDDISH SOIL			DATE SAMPLED	05/01/2019					
MATERIAL SOURCE	CHAINDA TP-4 1.5 m			DATE TESTED	11/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	CHAINDA TP-4 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	M-20		M-29		M-11					
WEIGHT OF SOIL + MOLD, g	9003		8732		8502					
WEIGHT OF MOLD, g	4079		4103		4101					
WEIGHT OF SOIL, g	4924		4629		4401					
VOLUME OF MOLD, g	2352		2340		2335					
WET DENSITY OF SOIL, g/cm ³	2.094		1.978		1.885					
DRY DENSITY OF SOIL, g/cm ³	1.867		1.764		1.681					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	MG-71		M-56							
WET SOIL + CONTAINER, g	818		841							
DRY SOIL + CONTAINER, g	757		777							
WEIGHT OF CONTAINER, g	253		250							
WEIGHT OF WATER, g	61		64							
WEIGHT OF DRY SOIL, g	504		527							
MOISTURE CONTENT	12.1		12.1							
MOISTURE CONTENT AV=				12.1						
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
		55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
PENETRATION (mm)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		0.60			0.39			0.20		
1.27		0.82			0.52			0.32		
1.91		1.02			0.62			0.36		
2.54		1.15	8.6		0.76	5.7		0.39	2.9	
3.18		1.25			0.80			0.44		
3.81		1.32			0.89			0.48		
4.45		1.42			0.96			0.52		
5.08		1.46	7.3		1.05	5.3		0.58	2.9	
5.72		1.57			1.10			0.64		
6.35		1.60			1.18			0.69		
6.99		1.68			1.24			0.74		
7.62		1.76			1.28			0.78		
8.26		1.85			1.36			0.82		
8.89		1.96			1.42			0.86		
9.55		2.04			1.48			0.89		
				Blows		55		25		55
				4,5kg by 5		4,5kg by 5		2,5kg by 3		
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By:			Approved By:				
			Date:			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAINDA TP-4 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAINDA TP-4 1.5 m	SAMPLE NO.	
MATERIAL TYPE	FINE REDDISH SOIL	DATE SAMPLED	05/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.853	55 by 5	12.1	1.867	8.6	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	12.1	1.764	5.7	0.0	0.00		13.24	20.00
12.0	55 by 3	0.0	1.681	2.9	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.668	CBR Value at 90% from the graph = 2.5
CBR Value at 95% MDD = 1.760	CBR Value at 95% from the graph = 5.4
CBR Value at 98% MDD = 1.816	CBR Value at 98% from the graph = 7.2

Comments:

Checked By: W.MUMBA **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: Chainda	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.	Resistivity Ohm-Centimetre	
1	3023	
2	4236	
3	4133	
4	3952	

PREPARED BY

BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE: THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY

Kamanga (Nkoloma) Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants			Location: Kamanga		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation					Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²	
1	1	150	38	86	>600	
		300	43			
		450	43			
2	1	150	39	84	>600	
		300	43			
		450	41			
3	1	150	27	68	>600	
		300	32			
		450	36			
4	1	150	44	79	>600	
		300	39			
		450	40			

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Kamanga		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 1	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	18	0.3	8	0.3	13	0.3	9
0.6	13	0.6	12	0.6	15	0.6	15
0.9	24	0.9	27	0.9	20	0.9	29
1.2	24	1.2	35	1.2	24	1.2	49
1.5	41	1.5	45	1.5	38	1.5	39
1.8	51	1.8	49	1.8	49	1.8	48
2.1	50	2.1	51	2.1	43	2.1	53
2.4	52	2.4	48	2.4	47	2.4	>55
2.7	>55	2.7	50	2.7	51	2.7	
3.0		3.0	49	3.0	>55	3.0	
3.3		3.3	>55	3.3		3.3	
3.6		3.6		3.6		3.6	
3.9		3.9		3.9		3.9	
4.2		4.2		4.2		4.2	
4.5		4.5		4.5		4.5	
4.8		4.8		4.8		4.8	
5.1		5.1		5.1		5.1	
5.4		5.4		5.4		5.4	
5.7		5.7		5.7		5.7	
6.0		6.0		6.0		6.0	
6.3		6.3		6.3		6.3	
6.6		6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.0		7.0		7.0		7.0	

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	KAMANGA TP-1 1.3 m		SAMPLING DATE:		03/01/2019	
LOCATION:			TESTING DATE:		11/01/2019	
Weight After Washing (g)	1802.0	g	loss in fine :		528.0	g
Weight Before Washing (g)	2330.0	g	loss in fine percentage :		29%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.1 GRADING COEFFICIENT (GC) = 21.2
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	283.0	12.1	87.9			
26.5	251.0	10.8	77.1			
19	153.0	6.6	70.5			
13.2	180.0	7.7	62.8			
9.5	124.0	5.3	57.5			
6.7	88.0	3.8	53.7			
4.75	98.0	4.2	49.5			
2.00	356.0	15.3	34.2			
1.18	40.0	1.7	32.5			
0.6	14.0	0.6	31.9			
0.425	5.0	0.2	31.7			
0.3	4.0	0.2	31.5			
0.15	50.0	2.1	29.4			
0.075	156.0	6.7	22.7			
Pan	528.0	22.7	0.0			

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 11/01/2019	Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	KAMANGA TP-2 1.1 m			SAMPLING DATE:	03/01/2019	
LOCATION:				TESTING DATE:	11/01/2019	
Weight After Washing (g)	3067.0		g	loss in fine :	561.0	g
Weight Before Washing (g)	3628.0		g	loss in fine percentage :	18%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.4 GRADING COEFFICIENT (GC) = 19.9
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	153.0	4.2	95.8			
26.5	380.0	10.5	85.3			
19	425.0	11.7	73.6			
13.2	434.0	12.0	61.6			
9.5	382.0	10.5	51.1			
6.7	423.0	11.7	39.4			
4.75	273.0	7.5	31.9			
2.00	321.0	8.8	23.1			
1.18	44.0	1.2	21.9			
0.6	30.0	0.8	21.0			
0.425	12.0	0.3	20.7			
0.3	8.0	0.2	20.5			
0.15	72.0	2.0	18.5			
0.075	110.0	3.0	15.5			
Pan	561.0	15.5	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
Date: 11/01/2019		Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	KAMANGA TP-3 1.5 m			SAMPLING DATE:	03/01/2019	
LOCATION:				TESTING DATE:	11/01/2019	
Weight After Washing (g)	3200.0		g	loss in fine :	496.0	g
Weight Before Washing (g)	3696.0		g	loss in fine percentage :	16%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.5 GRADING COEFFICIENT (GC) = 19.6
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	162.0	4.4	95.6			
26.5	362.0	9.8	85.8			
19	502.0	13.6	72.2			
13.2	450.0	12.2	60.1			
9.5	391.0	10.6	49.5			
6.7	433.0	11.7	37.8			
4.75	279.0	7.5	30.2			
2.00	347.0	9.4	20.8			
1.18	36.0	1.0	19.9			
0.6	29.0	0.8	19.1			
0.425	31.0	0.8	18.2			
0.3	12.0	0.3	17.9			
0.15	69.0	1.9	16.0			
0.075	97.0	2.6	13.4			
Pan	496.0	13.4	0.0			

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 11/01/2019	Date

ATTERBERG LIMIT																	
AASHTO T-89 & T- 90																	
SIDE			Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	KAMANGA TP-1 1.3 m		SAMPLE NO.														
MATERIAL TYPE	REDDISH COARSE GRAVEL		DATE SAMPLED	03/01/2019													
MATERIAL SOURCE	KAMANGA TP-1 1.3 m		DATE TESTED	11/01/2019													
MATERIAL DESCRIPTION			SAMPLED BY														
REPRESENTATIVE STATION			TESTED BY														
SAMPLING DEPTH			TEST NO.														
LIQUID LIMIT																	
Container No.	C6		I	F													
Wt of wet soil + container, gm	28.78		26.71	24.87													
Wt of dry soil + container, gm	25.13		23.81	22.87													
Wt of water	3.65		2.90	2.00													
Wt of container	13.34		13.47	15.02													
Wt of dry soil, gm	11.79		10.34	7.85													
Water content, %	30.96		28.05	25.48													
No. of blows	18		25	33													
			<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Proportion retained on 0.425mm sieve.....</td> <td></td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																	
As received	<input type="checkbox"/>																
Washed on 0.425mm sieve	<input type="checkbox"/>																
Air dried at30°C	<input checked="" type="checkbox"/>																
Oven dried at°C	<input type="checkbox"/>																
Proportion retained on 0.425mm sieve.....																	
			<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">28.30 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">14.49 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">13.8 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">11.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">7.3 %</td> </tr> </tbody> </table>			Test Result		Liquid Limit	28.30 %	Plastic Limit	14.49 %	Plasticity Index	13.8 %	Shrinkage =	11.0 mm	Shrinkage =	7.3 %
Test Result																	
Liquid Limit	28.30 %																
Plastic Limit	14.49 %																
Plasticity Index	13.8 %																
Shrinkage =	11.0 mm																
Shrinkage =	7.3 %																
PLASTIC LIMIT																	
Container No.	17		13		Average												
Wt of wet soil + container, gm	20.16		21.52														
Wt of dry soil + container, gm	19.30		20.85														
Wt of water	0.86		0.67														
Wt of container	13.40		16.20														
Wt of dry soil, gm	5.90		4.65														
Water content, %	14.58		14.41		14.49												
Remarks:																	
Tested By:A.KASOKA		Checked By:S.T.PHIRI		Approved By:													
		Date:11/01/2019		Date													

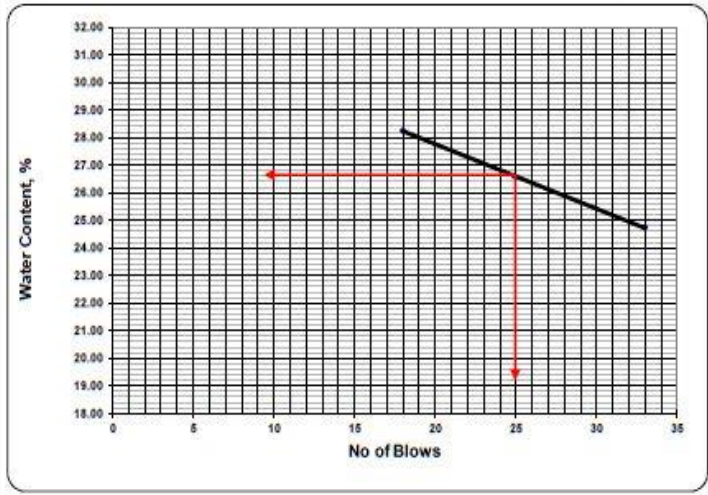
ATTERBERG LIMIT																	
AASHTO T-89 & T- 90																	
SIDE			Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	KAMANGA TP-2 1.1 m		SAMPLE NO.														
MATERIAL TYPE	REDDISH COARSE GRAVEL		DATE SAMPLED	03/01/2019													
MATERIAL SOURCE	KAMANGA TP-2 1.1 m		DATE TESTED	11/01/2019													
MATERIAL DESCRIPTION			SAMPLED BY														
REPRESENTATIVE STATION			TESTED BY														
SAMPLING DEPTH			TEST NO.														
LIQUID LIMIT																	
Container No.		11	35	38													
Wt of wet soil + container, gm		28.64	26.2	24.21													
Wt of dry soil + container, gm		25.57	24.22	22.76													
Wt of water		3.07	1.98	1.45													
Wt of container		14.39	16.34	16.40													
Wt of dry soil, gm		11.18	7.88	6.36													
Water content, %		27.46	25.13	22.80													
No. of blows		18	25	33													
			<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mmsieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mmsieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																	
As received	<input type="checkbox"/>																
Washed on 0.425mmsieve	<input type="checkbox"/>																
Air dried at30°C	<input checked="" type="checkbox"/>																
Oven dried at°C	<input type="checkbox"/>																
Proportion retained on 0.425mm sieve.....																	
TEST RESULT																	
Liquid Limit	25.20 %																
Plastic Limit	0.00 %																
Plasticity Index	NP %																
Shrinkage =	0.0 mm																
Shrinkage =	0.0 %																
PLASTIC LIMIT																	
Container No.					Average												
Wt of wet soil + container, gm																	
Wt of dry soil + container, gm																	
Wt of water																	
Wt of container																	
Wt of dry soil, gm																	
Water content, %																	
Remarks:																	
Tested By: A.KASOKA		Checked By:S.T.PHIRI		Approved By:													
		Date: 11/01/2019		Date													

**ATTERBERG LIMIT
AASHTO T-89 & T- 90**

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	KAMANGA TP-3 1.5 m	SAMPLE NO.				
MATERIAL TYPE	COARSE GRAVEL	DATE SAMPLED		03/01/2019		
MATERIAL SOURCE	KAMANGA TP-3 1.5 m	DATE TESTED		11/01/2019		
MATERIAL DESCRIPTION		SAMPLED BY				
REPRESENTATIVE STATION		TESTED BY				
SAMPLING DEPTH		TEST NO.				

LIQUID LIMIT

Container No.	F-23	RR-5	Y-47	
Wt of wet soil + container, gm	27.84	27.62	28.55	
Wt of dry soil + container, gm	24.90	25.24	26.01	
Wt of water	2.94	2.38	2.54	
Wt of container	14.49	16.28	15.74	
Wt of dry soil, gm	10.41	8.96	10.27	
Water content, %	28.24	26.56	24.73	
No. of blows	18	25	33	



Sample preparation	
As received	<input type="checkbox"/>
Washed on 0.425mm sieve	<input type="checkbox"/>
Air dried at30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result	
Liquid Limit	26.60 %
Plastic Limit	19.35 %
Plasticity Index	7.2 %
Shrinkage =	6.0 mm
Shrinkage =	4.0 %

PLASTIC LIMIT

Container No.	V-66	H-1			Average
Wt of wet soil + container, gm	27.11	25.68			
Wt of dry soil + container, gm	25.20	24.00			
Wt of water	1.91	1.68			
Wt of container	15.42	15.24			
Wt of dry soil, gm	9.78	8.76			
Water content, %	19.53	19.18			19.35

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 11/01/2019	Date

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)

SIDE	_____	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____			
MATERIAL TYPE	Gravel	DATE SAMPLED	03/01/2019			
MATERIAL SOURCE	KAMANGA TP-1 1.3 m	DATE TESTED	10/01/2019			
MATERIAL DESCRIPTION	REDDISH COARSE GRAVEL	SAMPLED BY	_____			
REPRESENTATIVE STATION	KAMANGA TP-1 1.3 m	TESTED BY	_____			
SAMPLING DEPTH	_____	TEST NO.	_____			

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

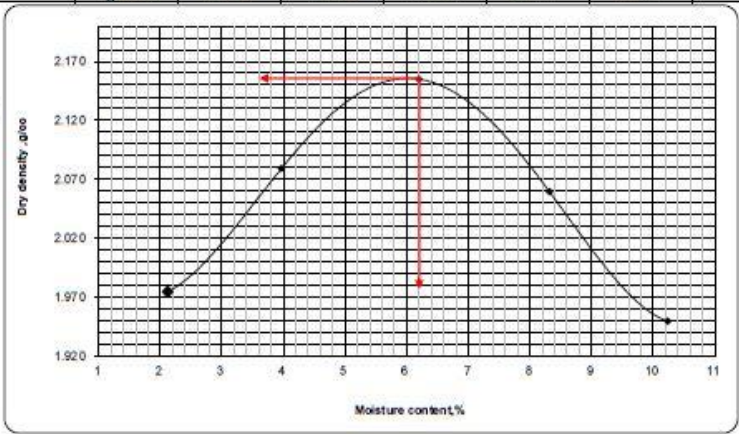
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	2	4	6	8	10
B	Wt. of Mold + Wet Soil	grams	8872	9217	9518	9381	9187
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4787	5132	5433	5296	5102
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	2.016	2.162	2.289	2.231	2.149
G	Container	No.	E-2	B-11	M-7	V-5	Y-8
H	Wt. Cont + Wet soil	grams	729.0	768.0	772.0	789.0	758.0
I	Wt. Cont + Dry soil	grams	719.0	748.0	741.0	748.0	711.0
J	Weight of Water	grams	10.0	20.0	31.0	41.0	47.0
K	Weight of Container	grams	247.0	244.0	241.0	255.0	252.0
L	Weight of Dry Soil	grams	472.0	504.0	500.0	493.0	459.0
M	Moisture Content	%	2.1	4.0	6.2	8.3	10.2
N	Dry Density	g/cm ³	1.975	2.079	2.155	2.060	1.949

Maximum Dry Density (MDD):

MDD = 2.155 g/cm³

Optimum Moisture Content (OMC) :

OMC = 6.2 %



Remarks: _____

Tested By: A.KASOKA	Checked By: W.MUMBA	Approved By: _____
	Date: 10/01/2019	Date _____

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	03/01/2019	
MATERIAL SOURCE	KAMANGA TP-2 1.1 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	REDDISH COARSE GRAVEL	SAMPLED BY	_____	
REPRESENTATIVE STATION	KAMANGA TP-2 1.1 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

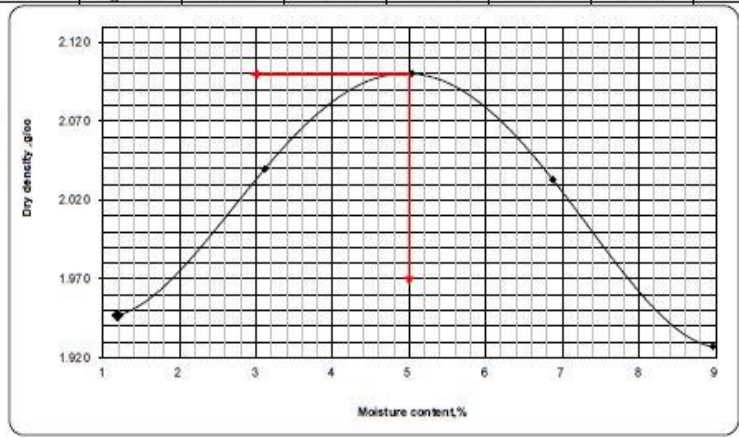
	Mold	No.	M 4	M 4	M 4	M 4	M 4	
A	WATER	%	1	3	5	7	9	
B	Wt. of Mold + Wet Soil	grams	8762	9078	9322	9243	9070	
C	Wt. of Mold	grams	4085	4085	4085	4085	4085	
D	Wt. Wet Soil	grams	4677	4993	5237	5158	4985	
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374	
F	Wet Density	g/cm ³	1.970	2.103	2.206	2.173	2.100	
G	Container	No.	M-2	J-3	M-10	G-7	A-1	
H	Wt. Cont + Wet soil	grams	754.0	778.0	731.0	763.0	794.0	
I	Wt. Cont + Dry soil	grams	748.0	762.0	708.0	730.0	749.0	
J	Weight of Water	grams	6.0	16.0	23.0	33.0	45.0	
K	Weight of Container	grams	244.0	248.0	251.0	250.0	247.0	
L	Weight of Dry Soil	grams	504.0	514.0	457.0	480.0	502.0	
M	Moisture Content	%	1.2	3.1	5.0	6.9	9.0	
N	Dry Density	g/cm ³	1.947	2.040	2.100	2.033	1.927	

Maximum Dry Density (MDD):

MDD = 2.100 g/cm³

Optimum Moisture Content (OMC) :

OMC = 5.0 %



Remarks: _____

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By: _____
	Date: 10/01/2019	Date _____

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)

SIDE	_____	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	_____	SAMPLE NO. _____				
MATERIAL TYPE	Gravel	DATE SAMPLED _____				
MATERIAL SOURCE	KAMANGA TP-3 1.5 m	DATE TESTED _____				
MATERIAL DESCRIPTION	COARSE GRAVEL	SAMPLED BY _____				
REPRESENTATIVE STATION	KAMANGA TP-3 1.5 m	TESTED BY _____				
SAMPLING DEPTH	_____	TEST NO. _____				

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

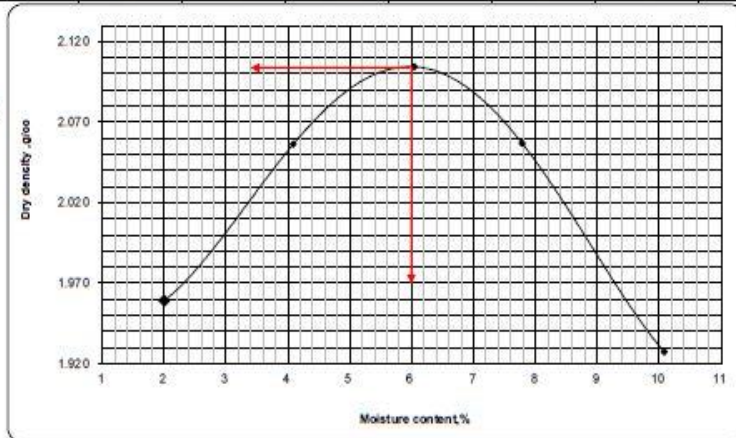
	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	2	4	6	8	10
B	Wt. of Mold + Wet Soil	grams	8773	9106	9320	9286	9062
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4686	5019	5233	5199	4975
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	1.998	2.140	2.232	2.217	2.122
G	Container	No.	M-10	M-2	A-1	J-3	G-7
H	Wt. Cont + Wet soil	grams	761.0	779.0	756.0	788.0	774.0
I	Wt. Cont + Dry soil	grams	751.0	758.0	727.0	749.0	726.0
J	Weight of Water	grams	10.0	21.0	29.0	39.0	48.0
K	Weight of Container	grams	251.0	244.0	247.0	248.0	250.0
L	Weight of Dry Soil	grams	500.0	514.0	480.0	501.0	476.0
M	Moisture Content	%	2.0	4.1	6.0	7.8	10.1
N	Dry Density	g/cm3	1.959	2.056	2.104	2.057	1.927

Maximum Dry Density (MDD):

MDD = 2.104 g/cm3

Optimum Moisture Content (OMC) :

OMC = 6.0 %



Remarks:

Tested By: A.KASOKA

Checked By: S.T.PHIRI

Approved By:

Date: 11/01/2019

Date

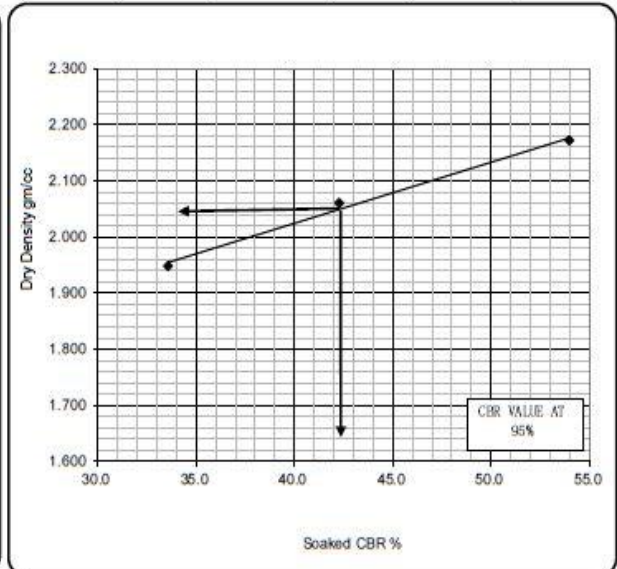
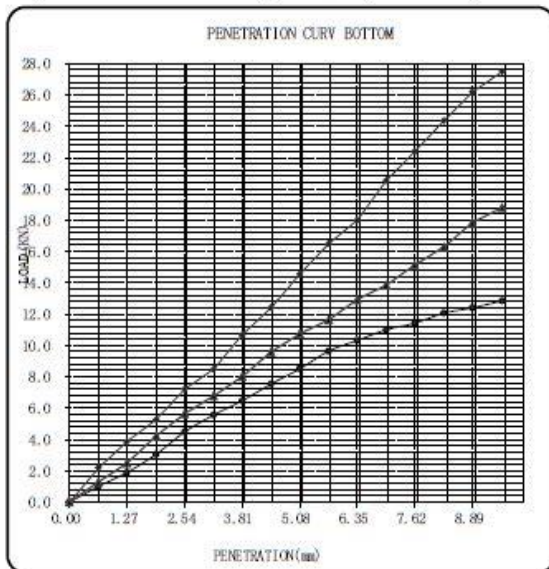
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KAMANGA TP-1 1.3 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	REDDISH COARSE GRAVEL			DATE SAMPLED	03/01/2019					
MATERIAL SOURCE	KAMANGA TP-1 1.3 m			DATE TESTED	11/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KAMANGA TP-1 1.3 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	M-04		M-30		M-43					
WEIGHT OF SOIL + MOLD, g	9548		9209		9016					
WEIGHT OF MOLD, g	4085		4081		4115					
WEIGHT OF SOIL, g	5463		5128		4901					
VOLUME OF MOLD, g	2374		2349		2374					
WET DENSITY OF SOIL, g/cm ³	2.301		2.183		2.064					
DRY DENSITY OF SOIL, g/cm ³	2.172		2.060		1.948					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	M-70		M-3							
WET SOIL + CONTAINER, g	848		812							
DRY SOIL + CONTAINER, g	815		780							
WEIGHT OF CONTAINER, g	253		252							
WEIGHT OF WATER, g	33		32							
WEIGHT OF DRY SOIL, g	562		528							
MOISTURE CONTENT	5.9		6.1							
MOISTURE CONTENT AV=			6.0							
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00	0.00		0.00	0.00		0.00				
0.64	2.18		1.28	1.28		1.00				
1.27	3.86		2.49	2.49		1.89				
1.91	5.26		4.22	4.22		3.05				
2.54	7.20	54.0	5.64	5.64	42.3	4.48		33.6		
3.18	8.48		6.78	6.78		5.56				
3.81	10.67		8.02	8.02		6.47				
4.45	12.42		9.59	9.59		7.54				
5.08	14.55	72.8	10.75	10.75	53.8	8.51		42.6		
5.72	16.50		11.63	11.63		9.64				
6.35	18.01		12.93	12.93		10.32				
6.99	20.53		13.85	13.85		11.00				
7.62	22.39		15.14	15.14		11.42				
8.26	24.35		16.29	16.29		12.06				
8.89	26.19		17.84	17.84		12.40				
9.55	27.50		18.81	18.81		12.85				
					Blows	55	25	55		
SWELL					rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date					Initial reading (mm)					
Time					Final reading (mm)					
					Height of specimen (mm)					
					Percent Swell (%)					
Remarks:										
Tested By: A.KASOKA			Checked By: S.T.PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	KAMANGA TP-1 1.3 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	KAMANGA TP-1 1.3 m	SAMPLE NO.	
MATERIAL TYPE	REDDISH COARSE GRAVEL	DATE SAMPLED	03/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.155	55 by 5	5.9	2.172	54.0	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	6.1	2.060	42.3	0.0	0.00	0.00	13.24	20.00
6.2	55 by 3	0.0	1.948	33.6	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.940

CBR Value at 90% from the graph = 33.4

CBR Value at 95% MDD = 2.047

CBR Value at 95% from the graph = 42.2

CBR Value at 98% MDD = 2.112

CBR Value at 98% from the graph = 47.5

Comments:

Checked By:

APPROVED BY:

Date:

Test Results Within Engineering Limits:

Yes



No



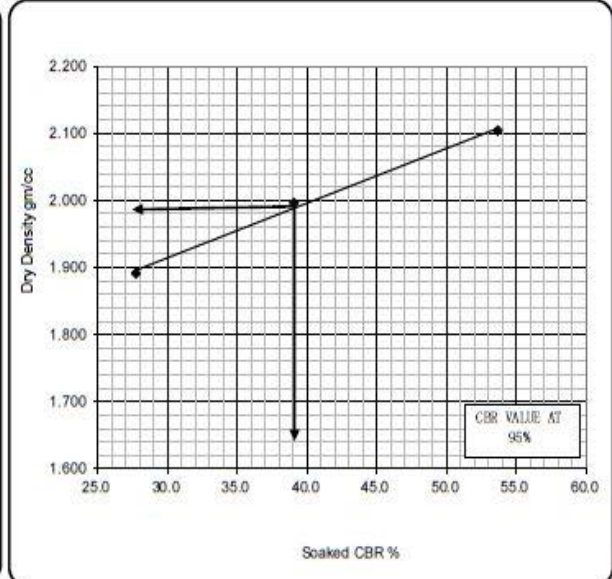
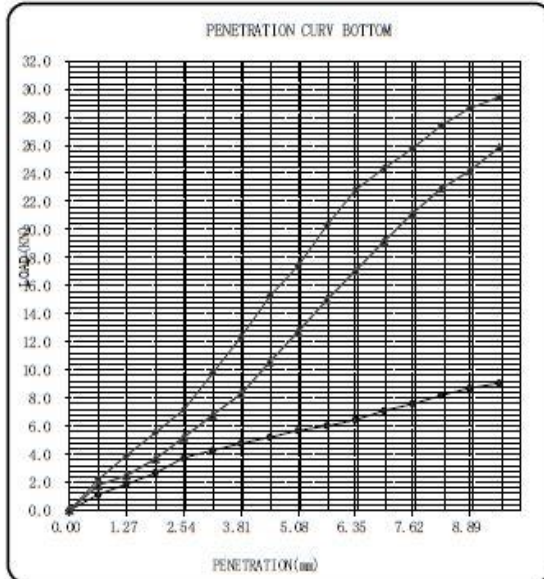
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KAMANGA TP-2 1.1 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	REDDISH COARSE GRAVEL			DATE SAMPLED	03/01/2019					
MATERIAL SOURCE	KAMANGA TP-2 1.1 m			DATE TESTED	11/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KAMANGA TP-2 1.1 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	M-32		M-1		M-37					
WEIGHT OF SOIL + MOLD, g	9287		9039		8744					
WEIGHT OF MOLD, g	4116		4105		4107					
WEIGHT OF SOIL, g	5171		4934		4637					
VOLUME OF MOLD, g	2343		2356		2337					
WET DENSITY OF SOIL, g/cm ³	2.207		2.094		1.984					
DRY DENSITY OF SOIL, g/cm ³	2.104		1.996		1.891					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	M-34		M-68							
WET SOIL + CONTAINER, g	854		857							
DRY SOIL + CONTAINER, g	825		829							
WEIGHT OF CONTAINER, g	242		251							
WEIGHT OF WATER, g	29		28							
WEIGHT OF DRY SOIL, g	583		578							
MOISTURE CONTENT	5.0		4.8							
MOISTURE CONTENT AV=			4.9							
PENETRATION BOTTOM TEST										
PENETRATION DATE				15/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		2.20			1.80			1.10		
1.27		3.92			2.48			1.87		
1.91		5.55			3.67			2.68		
2.54		7.16	53.7		5.21	39.1		3.70	27.7	
3.18		9.78			6.79			4.26		
3.81		12.35			8.30			4.76		
4.45		15.28			10.58			5.20		
5.08		17.42	87.1		12.74	63.7		5.67	28.4	
5.72		20.31			15.01			6.02		
6.35		22.82			17.06			6.45		
6.99		24.37			19.18			7.10		
7.62		25.78			21.15			7.58		
8.26		27.42			22.94			8.18		
8.89		28.64			24.19			8.69		
9.55		29.44			25.86			9.06		
				Blows		55	25	55		
SWELL				rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:				
			Date:11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	KAMANGA TP-2 1.1 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	KAMANGA TP-2 1.1 m	SAMPLE NO.	
MATERIAL TYPE	REDDISH COARSE GRAVEL	DATE SAMPLED	03/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.100	55 by 5	5.0	2.104	53.7	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	4.8	1.996	39.1	0.0	0.00		13.24	20.00
5.0	55 by 3	0.0	1.891	27.7	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.890	CBR Value at 90% from the graph = 27.6
CBR Value at 95% MDD = 1.995	CBR Value at 95% from the graph = 39.0
CBR Value at 98% MDD = 2.058	CBR Value at 98% from the graph = 47.5

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KAMANGA TP-3 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	COARSE GRAVEL			DATE SAMPLED	03/01/2019					
MATERIAL SOURCE	KAMANGA TP-3 1.5 m			DATE TESTED	12/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KAMANGA TP-3 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	CC-5		CC-6		CC-8					
WEIGHT OF SOIL + MOLD, g	10028		9926		9426					
WEIGHT OF MOLD, g	4840		5030		4804					
WEIGHT OF SOIL, g	5188		4896		4622					
VOLUME OF MOLD, g	2314		2303		2307					
WET DENSITY OF SOIL, g/cm ³	2.242		2.126		2.003					
DRY DENSITY OF SOIL, g/cm ³	2.113		2.004		1.889					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	F-74		K-11							
WET SOIL + CONTAINER, g	772		780							
DRY SOIL + CONTAINER, g	742		749							
WEIGHT OF CONTAINER, g	241		247							
WEIGHT OF WATER, g	30		31							
WEIGHT OF DRY SOIL, g	501		502							
MOISTURE CONTENT	6.0		6.2							
MOISTURE CONTENT AV=			6.1							
PENETRATION BOTTOM TEST										
PENETRATION DATE				16/01/2019		RING FACTOR		0.00		
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00	0.00		0.00	0.00		0.00				
0.64	2.37		1.97			0.96				
1.27	4.06		2.92			1.78				
1.91	6.27		4.16			2.87				
2.54	8.02	60.1	5.76	43.2		3.86	28.9			
3.18	10.28		7.47			4.47				
3.81	13.18		8.96			4.87				
4.45	15.47		10.87			5.32				
5.08	18.32	91.6	12.64	63.2		5.84	29.2			
5.72	21.34		14.20			6.14				
6.35	23.87		16.08			6.47				
6.99	25.69		18.12			7.18				
7.62	27.48		20.16			7.69				
8.26	29.72		21.86			8.28				
8.89	31.14		22.89			8.47				
9.55	32.62		23.67			8.88				
					Blows	55	25	55		
SWELL					rammar	4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date					Initial reading (mm)					
Time					Final reading (mm)					
					Height of specimen (mm)					
					Percent Swell (%)					
Remarks:										
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:				
			Date: 12/01/2019			Date				

CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KAMANGA TP-3 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	COARSE GRAVEL			DATE SAMPLED	03/01/2019					
MATERIAL SOURCE	KAMANGA TP-3 1.5 m			DATE TESTED	12/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KAMANGA TP-3 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	CC-5		CC-6		CC-8					
WEIGHT OF SOIL + MOLD, g	10028		9926		9426					
WEIGHT OF MOLD, g	4840		5030		4804					
WEIGHT OF SOIL, g	5188		4896		4622					
VOLUME OF MOLD, g	2314		2303		2307					
WET DENSITY OF SOIL, g/cm ³	2.242		2.126		2.003					
DRY DENSITY OF SOIL, g/cm ³	2.113		2.004		1.889					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	F-74		K-11							
WET SOIL + CONTAINER, g	772		780							
DRY SOIL + CONTAINER, g	742		749							
WEIGHT OF CONTAINER, g	241		247							
WEIGHT OF WATER, g	30		31							
WEIGHT OF DRY SOIL, g	501		502							
MOISTURE CONTENT	6.0		6.2							
MOISTURE CONTENT AV=			6.1							
PENETRATION BOTTOM TEST										
PENETRATION DATE			16/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	
0.00		0.00		0.00			0.00			
0.64		2.37		1.97			0.96			
1.27		4.06		2.92			1.78			
1.91		6.27		4.16			2.87			
2.54		8.02	60.1	5.76	43.2		3.86	28.9		
3.18		10.28		7.47			4.47			
3.81		13.18		8.96			4.87			
4.45		15.47		10.87			5.32			
5.08		18.32	91.6	12.64	63.2		5.84	29.2		
5.72		21.34		14.20			6.14			
6.35		23.87		16.08			6.47			
6.99		25.69		18.12			7.18			
7.62		27.48		20.16			7.69			
8.26		29.72		21.86			8.28			
8.89		31.14		22.89			8.47			
9.55		32.62		23.67			8.88			
				Blows		55	25	55		
SWELL				rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:				
			Date: 12/01/2019			Date				

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: Kamanga (Nkoloma)	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.	Resistivity Ohm-Centimetre	
1	3023	
2	3192	
3	3325	
4	5533	

PREPARED BY

BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE:

THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY

Chawama Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants			Location: Chawama		Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation				Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²
1	1	150	5	8	80
		300	4		
		450	4		
2	1	150	6	15	210
		300	8		
		450	7		
3	1	150	9	16	210
		300	8		
		450	8		
4	1	150	13	23	280
		300	11		
		450	12		
5	1	150	9	24	280
		300	13		
		450	11		

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Chawama		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 1	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	7	0.3	6	0.3	7	0.3	9
0.6	8	0.6	6	0.6	10	0.6	13
0.9	7	0.9	7	0.9	11	0.9	11
1.2	6	1.2	5	1.2	11	1.2	13
1.5	4	1.5	4	1.5	10	1.5	18
1.8	3	1.8	9	1.8	9	1.8	27
2.1	6	2.1	8	2.1	17	2.1	19
2.4	6	2.4	8	2.4	13	2.4	5
2.7	5	2.7	8	2.7	15	2.7	3
3.0	4	3.0	24	3.0	27	3.0	3
3.3	7	3.3	35	3.3	35	3.3	5
3.6	8	3.6	35	3.6	18	3.6	9
3.9	8	3.9	36	3.9	43	3.9	40
4.2	9	4.2	40	4.2	40	4.2	51
4.5	13	4.5	43	4.5	49	4.5	>55
4.8	10	4.8	50	4.8	48	4.8	
5.1	38	5.1	>55	5.1	>55	5.1	
5.4	49	5.4		5.4		5.4	
5.7	37	5.7		5.7		5.7	
6.0	41	6.0		6.0		6.0	
6.3	21	6.3		6.3		6.3	
6.6	>55	6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.2		7.2		7.2		7.2	
7.5		7.5		7.5		7.5	
7.8		7.8		7.8		7.8	
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	
8.7		8.7		8.7		8.7	
9.0		9.0		9.0		9.0	
9.3		9.3		9.3		9.3	
9.6		9.6		9.6		9.6	
9.9		9.9		9.9		9.9	

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Kanyama		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 5		Test Pit No. 6		Test Pit No. 7		Test Pit No. 8	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	15	0.3		0.3		0.3	
0.6	8	0.6		0.6		0.6	
0.9	7	0.9		0.9		0.9	
1.2	12	1.2		1.2		1.2	
1.5	10	1.5		1.5		1.5	
1.8	8	1.8		1.8		1.8	
2.1	8	2.1		2.1		2.1	
2.4	13	2.4		2.4		2.4	
2.7	28	2.7		2.7		2.7	
3.0	31	3.0		3.0		3.0	
3.3	30	3.3		3.3		3.3	
3.6	43	3.6		3.6		3.6	
3.9	51	3.9		3.9		3.9	
4.2	51	4.2		4.2		4.2	
4.5	>55	4.5		4.5		4.5	
4.8		4.8		4.8		4.8	
5.1		5.1		5.1		5.1	
5.4		5.4		5.4		5.4	
5.7		5.7		5.7		5.7	
6.0		6.0		6.0		6.0	
6.3		6.3		6.3		6.3	
6.6		6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.2		7.2		7.2		7.2	
7.5		7.5		7.5		7.5	
7.8		7.8		7.8		7.8	
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	
8.7		8.7		8.7		8.7	
9.0		9.0		9.0		9.0	
9.3		9.3		9.3		9.3	
9.6		9.6		9.6		9.6	
9.9		9.9		9.9		9.9	

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	CHAWAMA TP-1 1.5 m (387)			SAMPLING DATE:	06/01/2019	
LOCATION:				TESTING DATE:	13/01/2019	
Weight After Washing (g)	1875.0	g	loss in fine :		784.0	g
Weight Before Washing (g)	2659.0	g	loss in fine percentage :		42%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.4 GRADING COEFFICIENT (GC) = 27.9
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	10.0	0.4	99.6			
13.2	0.0	0.0	99.6			
9.5	0.0	0.0	99.6			
6.7	0.0	0.0	99.6			
4.75	86.0	3.2	96.4			
2.00	674.0	25.3	71.0			
1.18	126.0	4.7	66.3			
0.6	152.0	5.7	60.6			
0.425	47.0	1.8	58.8			
0.3	98.0	3.7	55.1			
0.15	485.0	18.2	36.9			
0.075	197.0	7.4	29.5			
Pan	784.0	29.5	0.0			

Sieve Size, mm

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
Date: 13/01/2019		Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	CHAWAMA TP-2 1.5 m			SAMPLING DATE:	06/01/2019	
LOCATION:				TESTING DATE:	12/01/2019	
Weight After Washing (g)	2468.0		g	loss in fine :	334.0	g
Weight Before Washing (g)	2802.0		g	loss in fine percentage :	14%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.0 GRADING COEFFICIENT (GC) = 32.7
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	263.0	9.4	90.6			
13.2	183.0	6.5	84.1			
9.5	190.0	6.8	77.3			
6.7	232.0	8.3	69.0			
4.75	217.0	7.7	61.3			
2.00	409.0	14.6	46.7			
1.18	66.0	2.4	44.3			
0.6	45.0	1.6	42.7			
0.425	86.0	3.1	39.7			
0.3	128.0	4.6	35.1			
0.15	521.0	18.6	16.5			
0.075	128.0	4.6	11.9			
Pan	334.0	11.9	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date: 12/01/2019	Date

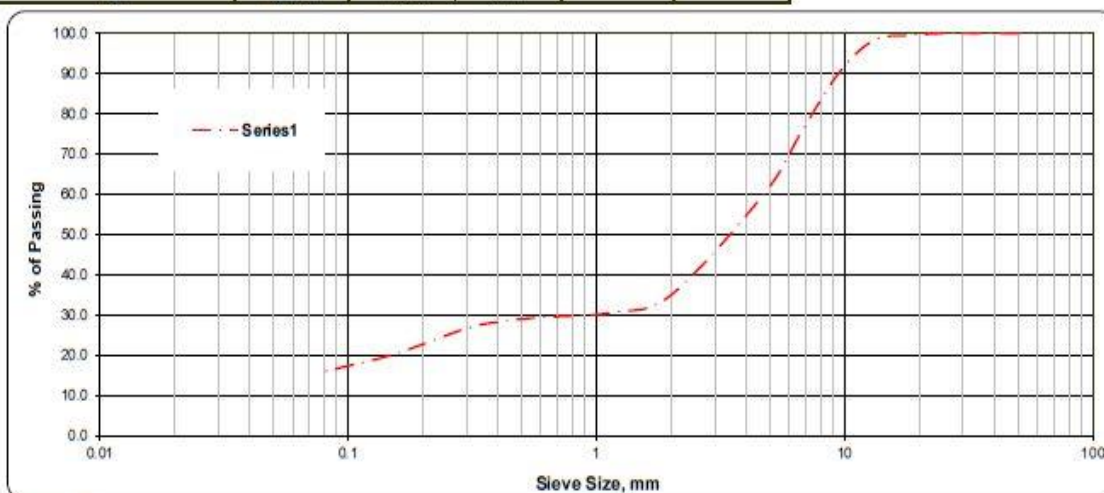
PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	CHAWAMA TP-3 1.5 m			SAMPLING DATE:	06/01/2019	
LOCATION:				TESTING DATE:	12/01/2019	
Weight After Washing (g)	1791.0	g	loss in fine :		271.0	g
Weight Before Washing (g)	2062.0	g	loss in fine percentage :		15%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.3 GRADING COEFFICIENT (GC) = 11.6
50	0.0	0.0	100.0	Lower Limit	Upper Limit	
37.5	0.0	0.0	100.0			
26.5	21.0	1.0	99.0			
19	19.0	0.9	98.1			
13.2	34.0	1.6	96.4			
9.5	24.0	1.2	95.2			
6.7	23.0	1.1	94.1			
4.75	34.0	1.6	92.5			
2.00	125.0	6.1	86.4			
1.18	75.0	3.6	82.8			
0.6	69.0	3.3	79.4			
0.425	89.0	4.3	75.1			
0.3	197.0	9.6	65.6			
0.15	906.0	43.9	21.6			
0.075	175.0	8.5	13.1			
Pan	271.0	13.1	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
Date: 12/01/2019		Date

PARTICLE SIZE DISTRIBUTION

AASHTO T-27

SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	CHAWAMA TP-4 1.5 m			SAMPLING DATE:	06/01/2019	
LOCATION:				TESTING DATE:	11/01/2019	
Weight After Washing (g)	1880.0	g	loss in fine :		344.0	g
Weight Before Washing (g)	2224.0	g	loss in fine percentage :		18%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.2 GRADING COEFFICIENT (GC) = 39.1
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	10.0	0.4	99.6			
13.2	28.0	1.3	98.3			
9.5	181.0	8.1	90.2			
6.7	328.0	14.7	75.4			
4.75	340.0	15.3	60.1			
2.00	561.0	25.2	34.9			
1.18	96.0	4.3	30.6			
0.6	27.0	1.2	29.4			
0.425	22.0	1.0	28.4			
0.3	40.0	1.8	26.6			
0.15	146.0	6.6	20.0			
0.075	101.0	4.5	15.5			
Pan	344.0	15.5	0.0			



Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 11/01/2019

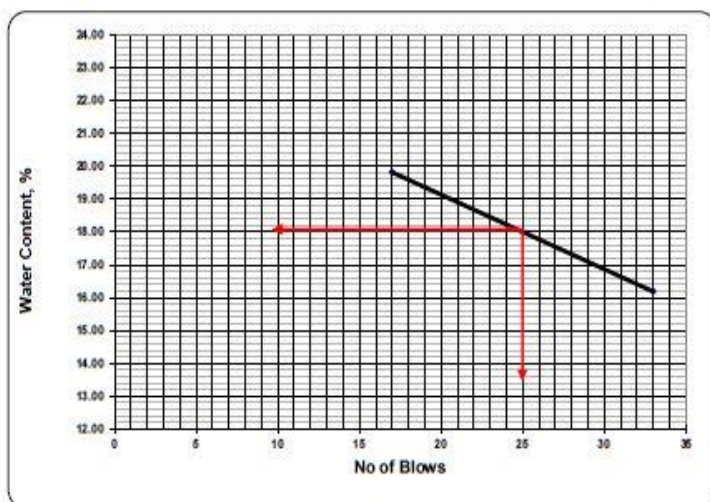
Date

ATTERBERG LIMIT AASHTO T-89 & T- 90																
SIDE			Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>												
LOCATION	CHAWAMA TP-1 1.5 m (387)	SAMPLE NO.														
MATERIAL TYPE	YELLOWISH FINE SOIL	DATE SAMPLED		06/01/2019												
MATERIAL SOURCE	CHAWAMA TP-1 1.5 m (387)	DATE TESTED		13/01/2019												
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.	L-3	H-82	R-17													
Wt of wet soil + container, gm	27.48	29.47	26.26													
Wt of dry soil + container, gm	24.98	26.34	24.20													
Wt of water	2.50	3.13	2.06													
Wt of container	15.81	13.58	14.77													
Wt of dry soil, gm	9.17	12.76	9.43													
Water content, %	27.26	24.53	21.85													
No. of blows	18	24	30													
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at30°C	<input checked="" type="checkbox"/>															
Oven dried at°C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">24.10 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">21.30 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">2.8 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">2.5 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">1.7 %</td> </tr> </tbody> </table>		Test Result		Liquid Limit	24.10 %	Plastic Limit	21.30 %	Plasticity Index	2.8 %	Shrinkage =	2.5 mm	Shrinkage =	1.7 %			
Test Result																
Liquid Limit	24.10 %															
Plastic Limit	21.30 %															
Plasticity Index	2.8 %															
Shrinkage =	2.5 mm															
Shrinkage =	1.7 %															
PLASTIC LIMIT																
Container No.	50	M-26		Average												
Wt of wet soil + container, gm	21.06	22.75														
Wt of dry soil + container, gm	20.20	21.34														
Wt of water	0.86	1.41														
Wt of container	16.15	14.74														
Wt of dry soil, gm	4.05	6.60														
Water content, %	21.23	21.36		21.30												
Remarks:																
Tested By: A.KASOKA		Checked By: T.S PHIRI		Approved By:												
		Date: 13/01/2019		Date												

ATTERBERG LIMIT			
AASHTO T-89 & T- 90			
SIDE		Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>
LOCATION	CHAWAMA TP-2 1.5 m	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH COARSE GRAVEL	DATE SAMPLED	06/01/2019
MATERIAL SOURCE	CHAWAMA TP-2 1.5 m	DATE TESTED	12/01/2019
MATERIAL DESCRIPTION		SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

LIQUID LIMIT

Container No.	12	19	3	
Wt of wet soil + container, gm	31.10	28.3	26.65	
Wt of dry soil + container, gm	28.24	26.34	25.08	
Wt of water	2.86	1.96	1.57	
Wt of container	13.80	15.46	15.38	
Wt of dry soil, gm	14.44	10.88	9.70	
Water content, %	19.81	18.01	16.19	
No. of blows	17	25	33	



Sample preparation	
As received	<input type="checkbox"/>
Washed on 0.425mm sieve	<input type="checkbox"/>
Air dried at30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result	
Liquid Limit	18.10 %
Plastic Limit	0.00 %
Plasticity Index	N/P %
Shrinkage =	0.0 mm
Shrinkage =	0.0 %

PLASTIC LIMIT

Container No.					Average
Wt of wet soil + container, gm					
Wt of dry soil + container, gm					
Wt of water					
Wt of container					
Wt of dry soil, gm					
Water content, %					

Remarks:

Tested By: A.KASOKA

Checked By: T.S PHIRI

Approved By:

Date: 12/01/2019

Date

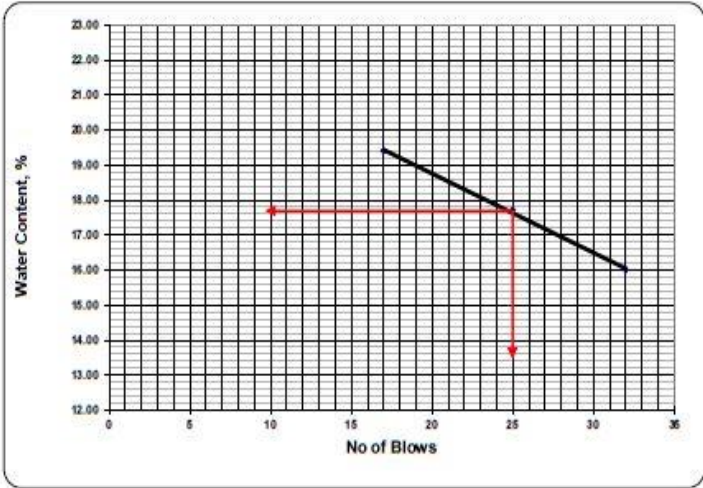
ATTERBERG LIMIT

AASHTO T-89 & T- 90

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	CHAWAMA TP-3 1.5 m	SAMPLE NO.				
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED		06/01/2019		
MATERIAL SOURCE	CHAWAMA TP-3 1.5 m	DATE TESTED		11/01/2019		
MATERIAL DESCRIPTION		SAMPLED BY				
REPRESENTATIVE STATION		TESTED BY				
SAMPLING DEPTH		TEST NO.				

LIQUID LIMIT

Container No.	I	13	27	
Wt of wet soil + container, gm	30.64	28.48	26.54	
Wt of dry soil + container, gm	27.94	26.51	24.81	
Wt of water	2.70	1.97	1.73	
Wt of container	14.02	15.39	14.00	
Wt of dry soil, gm	13.92	11.12	10.81	
Water content, %	19.40	17.72	16.00	
No. of blows	17	25	32	



Sample preparation	
As received	<input type="checkbox"/>
Washed on 0.425mmsieve	<input type="checkbox"/>
Air dried at30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result	
Liquid Limit	17.70 %
Plastic Limit	0.00 %
Plasticity Index	N/P %
Shrinkage =	0.0 mm
Shrinkage =	0.0 %

PLASTIC LIMIT

Container No.					Average
Wt of wet soil + container, gm					
Wt of dry soil + container, gm					
Wt of water					
Wt of container					
Wt of dry soil, gm					
Water content, %					

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date:12/01/2019	Date:

ATTERBERG LIMIT				
AASHTO T-89 & T- 90				
SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	CHAWAMA TP-4 1.5 m	SAMPLE NO.		
MATERIAL TYPE	GREYISH COARSE GRAVEL	DATE SAMPLED		06/01/2019
MATERIAL SOURCE	CHAWAMA TP-4 1.5 m	DATE TESTED		12/01/2019
MATERIAL DESCRIPTION		SAMPLED BY		
REPRESENTATIVE STATION		TESTED BY		
SAMPLING DEPTH		TEST NO.		
LIQUID LIMIT				
Container No.	38	18	35	
Wt of wet soil + container, gm	29.20	27.72	25.60	
Wt of dry soil + container, gm	26.53	25.02	23.88	
Wt of water	2.67	2.70	1.72	
Wt of container	16.90	14.19	16.35	
Wt of dry soil, gm	9.63	10.83	7.53	
Water content, %	27.73	24.93	22.84	
No. of blows	19	25	30	
		Sample preparation		
		As received <input type="checkbox"/> Washed on 0.425mm sieve <input type="checkbox"/> Air dried at 30°C <input checked="" type="checkbox"/> Oven dried at °C <input type="checkbox"/> Proportion retained on 0.425mm sieve.....		
		Test Result		
		Liquid Limit 25.00 % Plastic Limit 13.46 % Plasticity Index 11.5 % Shrinkage = 9.0 mm Shrinkage = 6.0 %		
PLASTIC LIMIT				
Container No.	23	50		Average
Wt of wet soil + container, gm	20.74	21.78		
Wt of dry soil + container, gm	19.99	21.11		
Wt of water	0.75	0.67		
Wt of container	14.40	16.15		
Wt of dry soil, gm	5.59	4.96		
Water content, %	13.42	13.51		13.46
Remarks:				
Tested By: A.KASOKA		Checked By: T.S PHIRI		Approved By:
		Date: 12/01/2019		Date

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)**

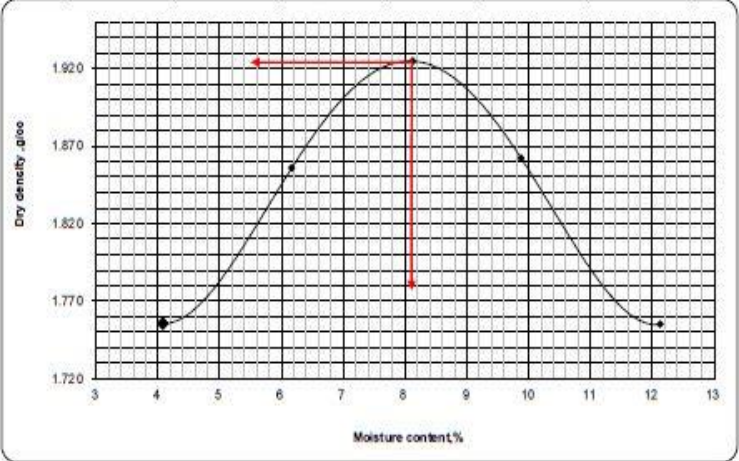
SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	06/01/2019	
MATERIAL SOURCE	CHAWAMA TP-1 1.5 m (387)	DATE TESTED	11/01/2019	
MATERIAL DESCRIPTION	YELLOWISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	CHAWAMA TP-1 1.5 m (387)	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	4	6	8	10	12
B	Wt. of Mold + Wet Soil	grams	8372	8707	8967	8885	8702
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4285	4620	4880	4798	4615
E	Volume of Mold	cm ³	2345	2345	2345	2345	2345
F	Wet Density	g/cm ³	1.827	1.970	2.081	2.046	1.968
G	Container	No.	X-69	G-56	K-11	G-101	F-41
H	Wt. Cont + Wet soil	grams	772.0	715.0	767.0	784.0	775.0
I	Wt. Cont + Dry soil	grams	751.0	688.0	728.0	736.0	718.0
J	Weight of Water	grams	21.0	27.0	39.0	48.0	57.0
K	Weight of Container	grams	236.0	250.0	248.0	250.0	248.0
L	Weight of Dry Soil	grams	515.0	438.0	480.0	486.0	470.0
M	Moisture Content	%	4.1	6.2	8.1	9.9	12.1
N	Dry Density	g/cm ³	1.756	1.856	1.925	1.862	1.755

Maximum Dry Density (MDD):
MDD = 1.925 g/cm³

Optimum Moisture Content (OMC) :
OMC = 8.1 %



Remarks: _____

Tested By: A.KASOKA	Checked By: T.S PHIRI	Approved By:
	Date: 11/01/2019	Date

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)**

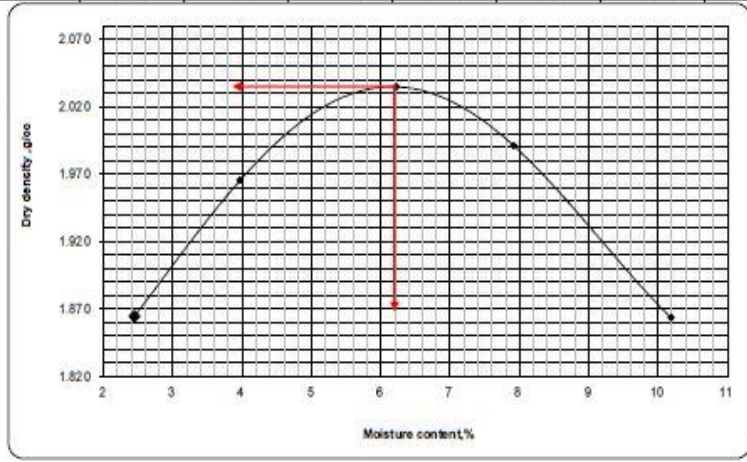
SIDE	_____	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____			
MATERIAL TYPE	Gravel	DATE SAMPLED	06/01/2019			
MATERIAL SOURCE	CHAWAMA TP-2 1.5 m	DATE TESTED	10/01/2019			
MATERIAL DESCRIPTION	YELLOWISH COARSE GRAVEL	SAMPLED BY	_____			
REPRESENTATIVE STATION	CHAWAMA TP-2 1.5 m	TESTED BY	_____			
SAMPLING DEPTH	_____	TEST NO.	_____			

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	2	4	6	8	10
B	Wt. of Mold + Wet Soil	grams	8620	8936	9216	9186	8960
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4535	4851	5131	5101	4875
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.910	2.043	2.161	2.149	2.053
G	Container	No.	Q-96	V-12	U-70	D-46	B-16
H	Wt. Cont + Wet soil	grams	754.0	768.0	743.0	770.0	775.0
I	Wt. Cont + Dry soil	grams	742.0	748.0	714.0	732.0	726.0
J	Weight of Water	grams	12.0	20.0	29.0	38.0	49.0
K	Weight of Container	grams	251.0	244.0	248.0	252.0	245.0
L	Weight of Dry Soil	grams	491.0	504.0	466.0	480.0	481.0
M	Moisture Content	%	2.4	4.0	6.2	7.9	10.2
N	Dry Density	g/cm ³	1.865	1.965	2.035	1.991	1.864

Maximum Dry Density (MDD):
MDD = 2.035 g/cm³

Optimum Moisture Content (OMC) :
OMC = 6.2 %



Remarks: _____

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date: 10/01/2019	Date

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	06/01/2019	
MATERIAL SOURCE	CHAWAMA TP-3 1.5 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	BROWNISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	CHAWAMA TP-3 1.5 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

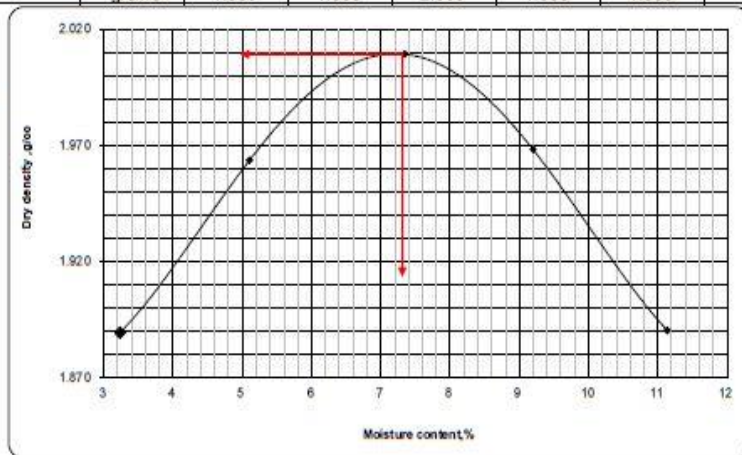
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8715	8984	9205	9187	9072
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4630	4899	5120	5102	4987
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.950	2.064	2.157	2.149	2.101
G	Container	No.	T-1M	N-J	M-62	D-777	KO
H	Wt. Cont + Wet soil	grams	759.0	770.0	746.0	728.0	791.0
I	Wt. Cont + Dry soil	grams	743.0	745.0	712.0	689.0	737.0
J	Weight of Water	grams	16.0	25.0	34.0	39.0	54.0
K	Weight of Container	grams	248.0	255.0	249.0	265.0	252.0
L	Weight of Dry Soil	grams	495.0	490.0	463.0	424.0	485.0
M	Moisture Content	%	3.2	5.1	7.3	9.2	11.1
N	Dry Density	g/cm ³	1.889	1.963	2.009	1.968	1.890

Maximum Dry Density (MDD):

MDD = 2.009 g/cm³

Optimum Moisture Content (OMC) :

OMC = 7.3 %



Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 10/01/2019

Date

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

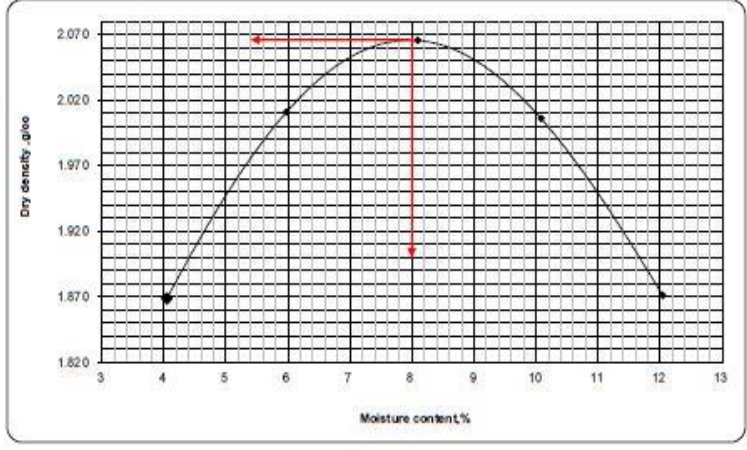
SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	06/01/2019	
MATERIAL SOURCE	CHAWAMA TP-4 1.5 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	GREYISH COARSE GRAVEL	SAMPLED BY	_____	
REPRESENTATIVE STATION	CHAWAMA TP-4 1.5 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)		Single sample / Separate batches : _____	
		Apparent specific gravity : _____	

	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	4	6	8	10	12
B	Wt. of Mold + Wet Soil	grams	8701	9144	9385	9327	9062
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4616	5059	5300	5242	4977
E	Volume of Mold	cm3	2374	2374	2374	2374	2374
F	Wet Density	g/cm3	1.944	2.131	2.233	2.208	2.096
G	Container	No.	G-56	F-41	X-69	G-101	K-11
H	Wt. Cont + Wet soil	grams	764.0	780.0	757.0	796.0	769.0
I	Wt. Cont + Dry soil	grams	744.0	750.0	718.0	746.0	713.0
J	Weight of Water	grams	20.0	30.0	39.0	50.0	56.0
K	Weight of Container	grams	250.0	248.0	236.0	250.0	248.0
L	Weight of Dry Soil	grams	494.0	502.0	482.0	496.0	465.0
M	Moisture Content	%	4.0	6.0	8.1	10.1	12.0
N	Dry Density	g/cm3	1.869	2.011	2.065	2.006	1.871

Maximum Dry Density (MDD):
MDD = 2.067 g/cm3

Optimum Moisture Content (OMC) :
OMC = 8.0 %



Remarks: _____

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By: _____
	Date: 10/01/2019	Date _____

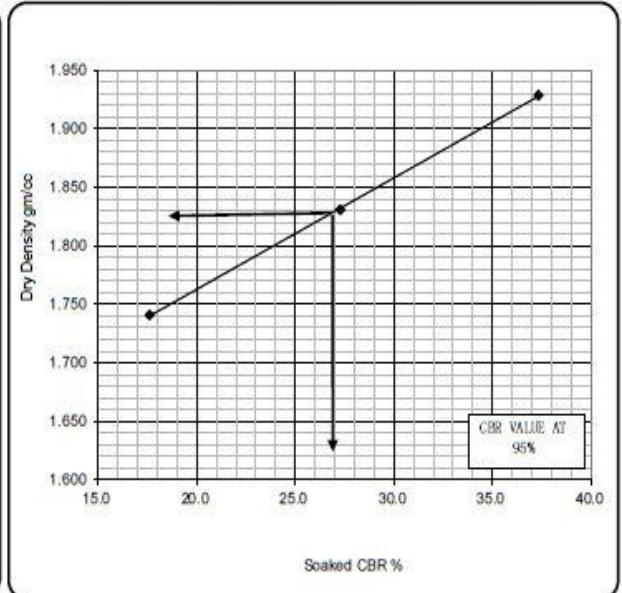
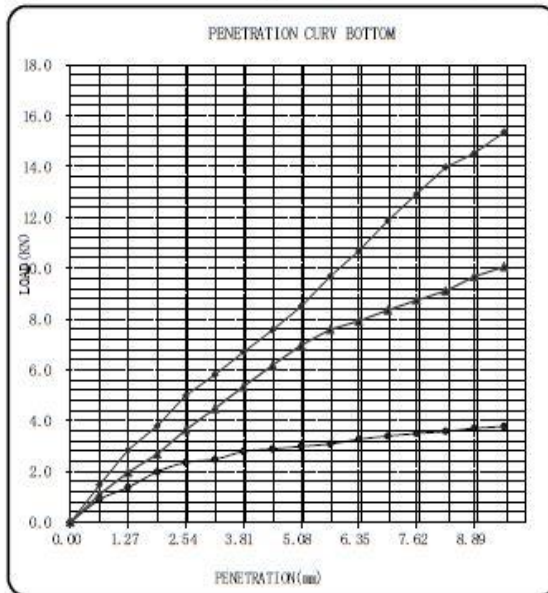
CALIFORNIA BEARING RATIO											
AASHTO T 193											
SAMPLE STATION	CHAWAMA TP-1 1.5 m (387)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>			
LOCATION				SAMPLE NO.							
MATERIAL TYPE	YELLOWISH FINE SOIL			DATE SAMPLED	06/01/2019						
MATERIAL SOURCE	CHAWAMA TP-1 1.5 m (387)			DATE TESTED	12/01/2019						
MATERIAL DESCRIPTION	Gravel			SAMPLED BY							
REPRESENTATIVE STATION	CHAWAMA TP-1 1.5 m (387)			TESTED BY							
SAMPLING DEPTH				TEST NO.							
DENSITY DETERMINATION											
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)						
	Before		Before		Before						
MOLD NUMBER	CC-12		CC-4		CC-34						
WEIGHT OF SOIL + MOLD, g	9804		9418		9196						
WEIGHT OF MOLD, g	4963		4826		4833						
WEIGHT OF SOIL, g	4841		4592		4363						
VOLUME OF MOLD, g	2322		2320		2318						
WET DENSITY OF SOIL, g/cm ³	2.085		1.979		1.882						
DRY DENSITY OF SOIL, g/cm ³	1.928		1.831		1.741						
MOISTURE DETERMINATION											
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)						
	Before		Before		Before						
CONTAINER NUMBER	W-62		J-6								
WET SOIL + CONTAINER, g	770		764								
DRY SOIL + CONTAINER, g	731		725								
WEIGHT OF CONTAINER, g	247		248								
WEIGHT OF WATER, g	39		39								
WEIGHT OF DRY SOIL, g	484		477								
MOISTURE CONTENT	8.1		8.2								
MOISTURE CONTENT AV=			8.1								
PENETRATION BOTTOM TEST											
PENETRATION DATE			16/01/2019			RING FACTOR			0.00		
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)					
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)		
0.00		0.00		0.00				0.00			
0.64		1.46		1.08				0.89			
1.27		2.84		1.96				1.37			
1.91		3.79		2.67				1.98			
2.54		4.98	37.3	3.64		27.3		2.35	17.6		
3.18		5.81		4.47				2.47			
3.81		6.69		5.34				2.78			
4.45		7.57		6.18				2.88			
5.08		8.49	42.5	6.97		34.9		2.98	14.9		
5.72		9.67		7.59				3.08			
6.35		10.68		7.92				3.26			
6.99		11.87		8.35				3.39			
7.62		12.92		8.74				3.49			
8.26		13.97		9.10				3.57			
8.89		14.52		9.67				3.69			
9.55		15.36		10.06				3.77			
					Blows		55	25	55		
					rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date				Initial reading (mm)							
Time				Final reading (mm)							
				Height of specimen (mm)							
				Percent Swell (%)							
Remarks:											
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:					
			Date: 12/01/2019			Date					

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAWAMA TP-1 1.5 m (387)	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAWAMA TP-1 1.5 m (387)	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH FINE SOIL	DATE SAMPLED	06/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.925	55 by 5	8.1	1.928	37.3	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	8.2	1.831	27.3	0.0	0.00	0.00	13.24	20.00
8.1	55 by 3	0.0	1.741	17.6	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.733	CBR Value at 90% from the graph = 17.5
CBR Value at 95% MDD = 1.829	CBR Value at 95% from the graph = 26.9
CBR Value at 98% MDD = 1.887	CBR Value at 98% from the graph = 33.0

Comments:

Checked By: W.MUMBA **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAWAMA TP-2 1.5 m	Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION		SAMPLE NO.				
MATERIAL TYPE	YELLOWISH COARSE GRAVEL	DATE SAMPLED	06/01/2019			
MATERIAL SOURCE	CHAWAMA TP-2 1.5 m	DATE TESTED	11/01/2019			
MATERIAL DESCRIPTION	Gravel	SAMPLED BY				
REPRESENTATIVE STATION	CHAWAMA TP-2 1.5 m	TESTED BY				
SAMPLING DEPTH		TEST NO.				

DENSITY DETERMINATION

SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)	25 by 5 layers Blows (4,5kg)	55 by 3 layers Blows (2,5kg)
	Before	Before	Before
MOLD NUMBER	M-10	M-21	M-14
WEIGHT OF SOIL + MOLD, g	9247	8954	8743
WEIGHT OF MOLD, g	4084	4081	4176
WEIGHT OF SOIL, g	5163	4873	4567
VOLUME OF MOLD, g	2375	2370	2342
WET DENSITY OF SOIL, g/cm ³	2.174	2.056	1.950
DRY DENSITY OF SOIL, g/cm ³	2.047	1.937	1.837

MOISTURE DETERMINATION

SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)	25 by 5 layers Blows (4,5kg)	55 by 3 layers Blows (2,5kg)
	Before	Before	Before
CONTAINER NUMBER	M-611	M-300	
WET SOIL + CONTAINER, g	882	939	
DRY SOIL + CONTAINER, g	845	899	
WEIGHT OF CONTAINER, g	252	244	
WEIGHT OF WATER, g	37	40	
WEIGHT OF DRY SOIL, g	593	655	
MOISTURE CONTENT	6.2	6.1	
MOISTURE CONTENT AV=	6.2		

PENETRATION BOTTOM TEST

PENETRATION DATE		15/01/2019			RING FACTOR			0.00		
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.56			1.31			0.90		
1.27		2.93			2.06			1.38		
1.91		4.49			3.19			2.01		
2.54		6.35	47.6		4.02	30.1		2.36	17.7	
3.18		8.26			4.47			2.85		
3.81		9.60			4.92			3.14		
4.45		11.43			5.49			3.39		
5.08		13.16	65.8		6.10	30.5		3.65	18.3	
5.72		14.24			6.62			3.89		
6.35		15.18			7.12			4.12		
6.99		16.37			7.56			4.26		
7.62		16.97			8.31			4.47		
8.26		17.47			8.94			4.78		
8.89		18.02			9.65			4.95		
9.55		18.59			10.02			5.20		
							Blows	55	25	55
SWELL				rammar			4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						

Remarks:

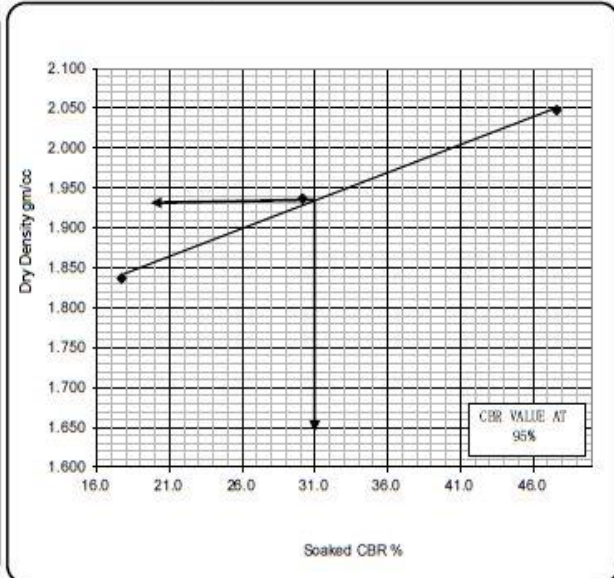
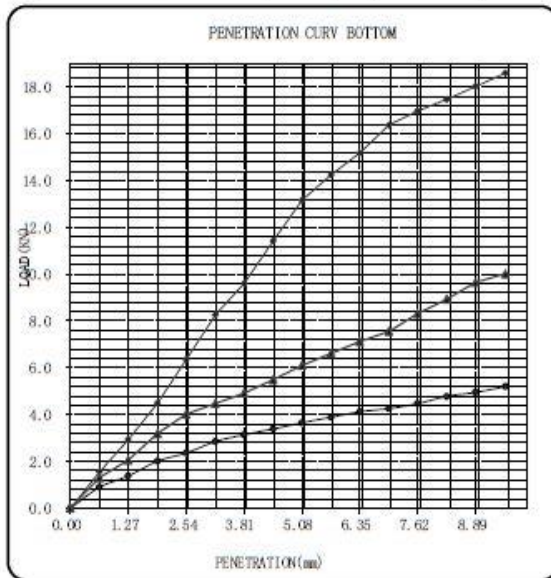
Tested By: W.MUMBA	Checked By: T.S.PHIRI	Approved By:
	Date: 11/01/2019	Date

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAWAMA TP-2 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAWAMA TP-2 1.5 m	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH COARSE GRAVEL	DATE SAMPLED	06/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.035	55 by 5	6.2	2.047	47.6	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	6.1	1.937	30.1	0.0	0.00		13.24	20.00
6.2	55 by 3	0.0	1.837	17.7	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.832	CBR Value at 90% from the graph = 17.5
CBR Value at 95% MDD = 1.933	CBR Value at 95% from the graph = 29.9
CBR Value at 98% MDD = 1.994	CBR Value at 98% from the graph = 39.5

Comments:

Checked By: W.MUMBA **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

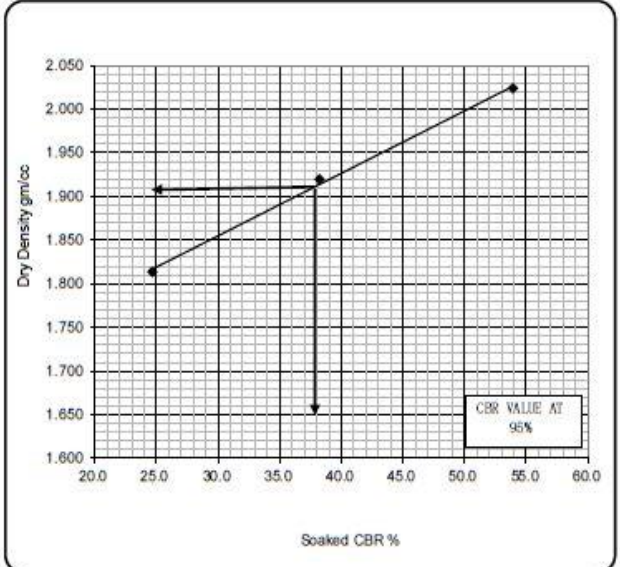
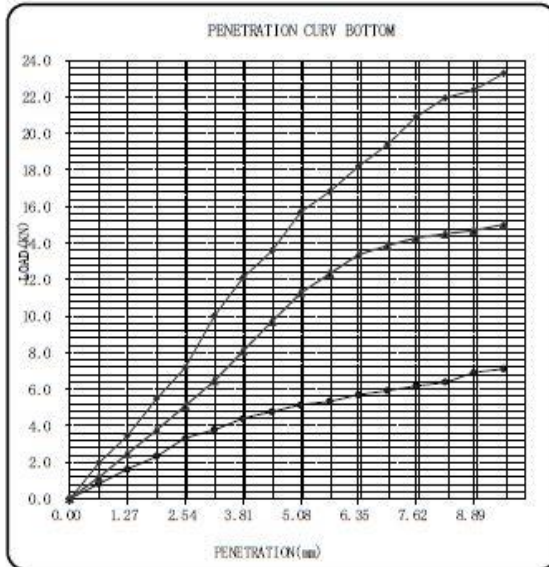
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	CHAWAMA TP-3 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	BROWNISH FINE SOIL			DATE SAMPLED		06/01/2019				
MATERIAL SOURCE	CHAWAMA TP-3 1.5 m			DATE TESTED		11/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	CHAWAMA TP-3 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	M-36			M-38			M-41			
WEIGHT OF SOIL + MOLD, g	9166			8904			8650			
WEIGHT OF MOLD, g	4098			4097			4106			
WEIGHT OF SOIL, g	5068			4807			4544			
VOLUME OF MOLD, g	2339			2339			2340			
WET DENSITY OF SOIL, g/cm ³	2.167			2.055			1.942			
DRY DENSITY OF SOIL, g/cm ³	2.024			1.919			1.814			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	M-34			T-10						
WET SOIL + CONTAINER, g	745			779						
DRY SOIL + CONTAINER, g	712			744						
WEIGHT OF CONTAINER, g	244			251						
WEIGHT OF WATER, g	33			35						
WEIGHT OF DRY SOIL, g	468			493						
MOISTURE CONTENT	7.1			7.1						
MOISTURE CONTENT AV=				7.1						
PENETRATION BOTTOM TEST										
PENETRATION DATE				15/01/2019			RING FACTOR			
				0.00						
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.97			1.17			0.82		
1.27		3.46			2.48			1.62		
1.91		5.49			3.76			2.34		
2.54		7.19	53.9		5.10	38.2		3.29	24.7	
3.18		10.02			6.46			3.78		
3.81		12.10			8.09			4.39		
4.45		13.60			9.71			4.77		
5.08		15.70	78.5		11.27	56.4		5.14	25.7	
5.72		16.82			12.34			5.34		
6.35		18.20			13.37			5.69		
6.99		19.40			13.86			5.92		
7.62		20.93			14.30			6.18		
8.26		21.96			14.51			6.39		
8.89		22.39			14.69			6.89		
9.55		23.30			15.02			7.11		
						Blows	55	25	55	
							4,5kg by 5	4,5kg by 5	2,5kg by 3	
SWELL				rammar						
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date:11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAWAMA TP-3 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAWAMA TP-3 1.5 m	SAMPLE NO.	
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED	06/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.009	55 by 5	7.1	2.024	53.9	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.1	1.919	38.2	0.0	0.00	0.00	13.24	20.00
7.3	55 by 3	0.0	1.814	24.7	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.808	CBR Value at 90% from the graph = 24.6
CBR Value at 95% MDD = 1.909	CBR Value at 95% from the graph = 37.9
CBR Value at 98% MDD = 1.969	CBR Value at 98% from the graph = 46.0

Comments:

Checked By: W.MUMBA **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

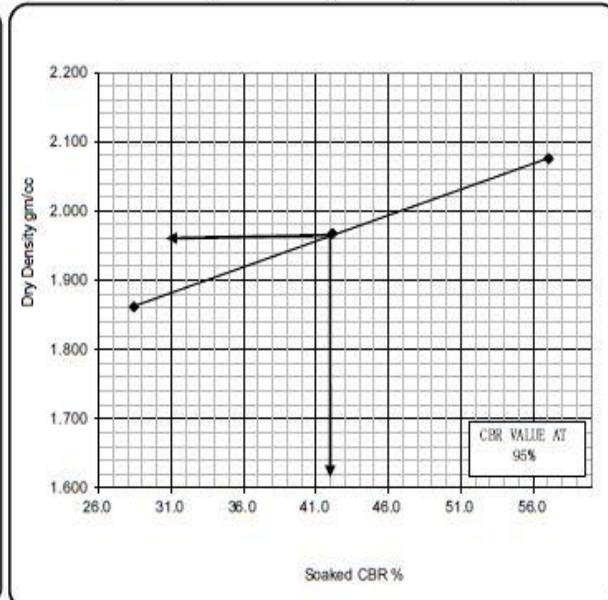
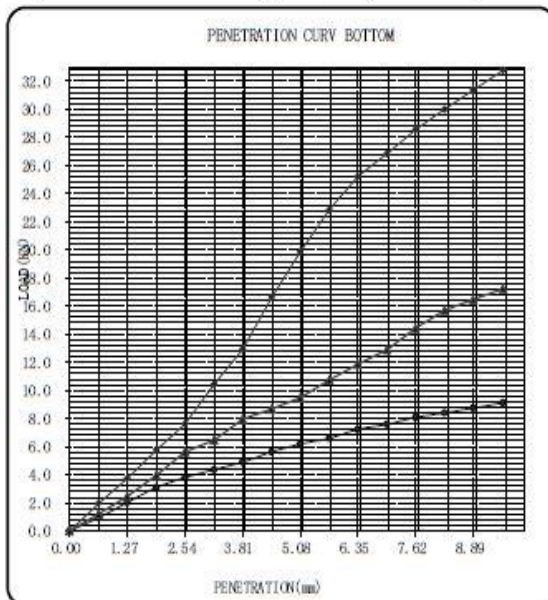
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	CHAWAMA TP-4 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	GREYISH COARSE GRAVEL			DATE SAMPLED						
MATERIAL SOURCE	CHAWAMA TP-4 1.5 m			DATE TESTED						
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	CHAWAMA TP-4 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	M-16			M-17			M-19			
WEIGHT OF SOIL + MOLD, g	9320			9091			8813			
WEIGHT OF MOLD, g	4092			4097			4092			
WEIGHT OF SOIL, g	5228			4994			4721			
VOLUME OF MOLD, g	2331			2349			2347			
WET DENSITY OF SOIL, g/cm ³	2.243			2.126			2.012			
DRY DENSITY OF SOIL, g/cm ³	2.075			1.967			1.861			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	C-12			M-200						
WET SOIL + CONTAINER, g	789			818						
DRY SOIL + CONTAINER, g	748			775						
WEIGHT OF CONTAINER, g	239			244						
WEIGHT OF WATER, g	41			43						
WEIGHT OF DRY SOIL, g	509			531						
MOISTURE CONTENT	8.1			8.1						
MOISTURE CONTENT AV= 8.1										
PENETRATION BOTTOM TEST										
PENETRATION DATE				15/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00		0.00			0.00			
0.64		1.96		1.20			0.94			
1.27		3.72		2.46			2.02			
1.91		5.76		3.96			3.08			
2.54		7.61	57.0	5.62		42.1	3.79		28.4	
3.18		10.43		6.45			4.36			
3.81		12.91		7.94			4.89			
4.45		16.63		8.67			5.62			
5.08		19.86	99.3	9.48		47.4	6.18		30.9	
5.72		22.85		10.74			6.59			
6.35		25.23		11.86			7.22			
6.99		26.84		12.89			7.58			
7.62		28.55		14.42			8.07			
8.26		30.01		15.69			8.39			
8.89		31.37		16.47			8.74			
9.55		32.79		17.24			9.10			
				Blows						
							55 25 55			
SWELL				rammar						
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			T.S.PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	CHAWAMA TP-4 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	CHAWAMA TP-4 1.5 m	SAMPLE NO.	
MATERIAL TYPE	GREYISH COARSE GRAVEL	DATE SAMPLED	06/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.067	55 by 5	8.1	2.075	57.0	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	8.1	1.967	42.1	0.0	0.00	0.00	13.24	20.00
8.0	55 by 3	0.0	1.861	28.4	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.860	CBR Value at 90% from the graph = 28.4
CBR Value at 95% MDD = 1.964	CBR Value at 95% from the graph = 41.9
CBR Value at 98% MDD = 2.026	CBR Value at 98% from the graph = 50.0

Comments:

Checked By: W.MUMBA **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: Chawama	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.	Resistivity Ohm-Centimetre	
1	3586	
2	3320	
3	3251	
4	3126	
5	2950	

PREPARED BY

BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE:

THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY

John Howard Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants			Location: John Howard		Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation				Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²
1	1	150	10	24	280
		300	13		
		450	11		
2	1	150	13	23	280
		300	14		
		450	9		
3	1	150	17	30	410
		300	15		
		450	15		
4	1	150			
		300			
		450			

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: John Howard		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 1	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	10	0.3	6	0.3	10	0.3	
0.6	13	0.6	7	0.6	17	0.6	
0.9	9	0.9	4	0.9	13	0.9	
1.2	10	1.2	10	1.2	18	1.2	
1.5	11	1.5	7	1.5	15	1.5	
1.8	18	1.8	13	1.8	23	1.8	
2.1	8	2.1	14	2.1	27	2.1	
2.4	7	2.4	13	2.4	26	2.4	
2.7	10	2.7	14	2.7	26	2.7	
3.0	9	3.0	8	3.0	35	3.0	
3.3	18	3.3	8	3.3	45	3.3	
3.6	23	3.6	6	3.6	51	3.6	
3.9	38	3.9	13	3.9	>55	3.9	
4.2	41	4.2	21	4.2		4.2	
4.5	50	4.5	28	4.5		4.5	
4.8	49	4.8	19	4.8		4.8	
5.1	>55	5.1	29	5.1		5.1	
5.4		5.4	43	5.4		5.4	
5.7		5.7	51	5.7		5.7	
6.0		6.0	>55	6.0		6.0	
6.3		6.3		6.3		6.3	
6.6		6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.2		7.2		7.2		7.2	
7.5		7.5		7.5		7.5	
7.8		7.8		7.8		7.8	
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	
8.7		8.7		8.7		8.7	
9.0		9.0		9.0		9.0	
9.3		9.3		9.3		9.3	
9.6		9.6		9.6		9.6	
9.9		9.9		9.9		9.9	

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	JOHN HOWARD TP-1 1.5 m (399)			SAMPLING DATE:	07/01/2019	
LOCATION:				TESTING DATE:	11/01/2019	
Weight After Washing (g)	1432.0		g	loss in fine :	728.0	g
Weight Before Washing (g)	2160.0		g	loss in fine percentage :	51%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.0 GRADING COEFFICIENT (GC) = 12.9
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	92.0	4.3	95.7			
6.7	87.0	4.0	91.7			
4.75	46.0	2.1	89.6			
2.00	86.0	4.0	85.6			
1.18	46.0	2.1	83.5			
0.6	57.0	2.6	80.8			
0.425	89.0	4.1	76.7			
0.3	143.0	6.6	70.1			
0.15	607.0	28.1	42.0			
0.075	179.0	8.3	33.7			
Pan	728.0	33.7	0.0			

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 11/01/2019	Date

PARTICLE SIZE DISTRIBUTION

AASHTO T-27

SIDE:		SAMPLE NO	
REPRESENTATIVE STATION:	JOHN HOWARD TP-2 1.5 m (400)	SAMPLING DATE:	07/01/2019
LOCATION:		TESTING DATE:	11/01/2019
Weight After Washing (g)	1050.0	g	loss in fine : 697.0 g
Weight Before Washing (g)	1747.0	g	loss in fine percentage : 66% g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing
			Specification
			Lower Limit Upper Limit
50	0.0	0.0	100.0
37.5	0.0	0.0	100.0
26.5	0.0	0.0	100.0
19	0.0	0.0	100.0
13.2	0.0	0.0	100.0
9.5	0.0	0.0	100.0
6.7	0.0	0.0	100.0
4.75	11.0	0.6	99.4
2.00	42.0	2.4	97.0
1.18	45.0	2.6	94.4
0.6	43.0	2.5	91.9
0.425	70.0	4.0	87.9
0.3	129.0	7.4	80.5
0.15	553.0	31.7	48.9
0.075	157.0	9.0	39.9
Pan	697.0	39.9	0.0

Sample preparation : Oven-dried sample

Method of sieving:
 Wet sieving
 Dry sieving

GRADING MODULUS (GM) = 0.8

GRADING COEFFICIENT (GC) = 3.0

The graph plots the percentage of material passing through various sieve sizes. The x-axis represents sieve size in millimeters on a logarithmic scale from 0.01 to 100. The y-axis represents the percentage of material passing, ranging from 0.0 to 100.0. A single data series, labeled 'Series1', is shown as a red dashed line. Key data points from the table are plotted: (0.075, 39.9), (0.15, 48.9), (0.3, 80.5), (0.425, 87.9), (0.6, 91.9), (1.18, 94.4), (2.0, 97.0), (4.75, 99.4), and (75, 100.0).

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
Date: 11/01/2019		Date

PARTICLE SIZE DISTRIBUTION							
AASHTO T-27							
SIDE:				SAMPLE NO			
REPRESENTATIVE STATION:	JOHN HOWARD TP-3 1.5 m			SAMPLING DATE:	07/01/2019		
LOCATION:				TESTING DATE:	13/01/2019		
Weight After Washing (g)	2312.0	g	loss in fine :		526.0	g	
Weight Before Washing (g)	2838.0	g	loss in fine percentage :		23%	g	
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/>	
				Lower Limit	Upper Limit		
50	0.0	0.0	100.0				GRADING MODULUS (GM) =
37.5	224.0	7.9	92.1				2.0
26.5	186.0	6.6	85.6				GRADING COEFFICIENT (GC) =
19	149.0	5.3	80.3				20.3
13.2	142.0	5.0	75.3				
9.5	180.0	6.3	69.0				
6.7	196.0	6.9	62.1				
4.75	259.0	9.1	52.9				
2.00	162.0	5.7	47.2				
1.18	57.0	2.0	45.2				
0.6	164.0	5.8	39.4				
0.425	94.0	3.3	36.1				
0.3	133.0	4.7	31.4				
0.15	268.0	9.4	22.0				
0.075	98.0	3.5	18.5				
Pan	526.0	18.5	0.0				

Remarks:

Tested By: AKASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 13/01/2019	Date

ATTERBERG LIMIT																	
AASHTO T-89 & T- 90																	
SIDE			Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	JOHN HOWARD TP-1 1.5 m (399)		SAMPLE NO.														
MATERIAL TYPE	GREYISH FINE SOIL		DATE SAMPLED	07/01/2019													
MATERIAL SOURCE	JOHN HOWARD TP-1 1.5 m (399)		DATE TESTED	13/01/2019													
MATERIAL DESCRIPTION			SAMPLED BY														
REPRESENTATIVE STATION			TESTED BY														
SAMPLING DEPTH			TEST NO.														
LIQUID LIMIT																	
Container No.			X	Q	S-6												
Wt of wet soil + container, gm	29.46		27.11	29.68													
Wt of dry soil + container, gm	26.28		24.65	26.70													
Wt of water	3.18		2.46	2.98													
Wt of container	15.27		15.26	14.23													
Wt of dry soil, gm	11.01		9.39	12.47													
Water content, %	28.88		26.20	23.90													
No. of blows	18		25	31													
			<p style="text-align: center; margin: 0;">Sample preparation</p> <p>As received <input type="checkbox"/></p> <p>Washed on 0.425mm sieve <input type="checkbox"/></p> <p>Air dried at30°C <input checked="" type="checkbox"/></p> <p>Oven dried at°C <input type="checkbox"/></p> <p>Proportion retained on 0.425mm sieve.....</p>														
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">26.20 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">14.79 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">11.4 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">8.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">5.3 %</td> </tr> </tbody> </table>						Test Result		Liquid Limit	26.20 %	Plastic Limit	14.79 %	Plasticity Index	11.4 %	Shrinkage =	8.0 mm	Shrinkage =	5.3 %
Test Result																	
Liquid Limit	26.20 %																
Plastic Limit	14.79 %																
Plasticity Index	11.4 %																
Shrinkage =	8.0 mm																
Shrinkage =	5.3 %																
PLASTIC LIMIT																	
Container No.	XZ-2		L-6	Average													
Wt of wet soil + container, gm	21.99		20.98														
Wt of dry soil + container, gm	21.18		20.21														
Wt of water	0.81		0.77														
Wt of container	15.74		14.97														
Wt of dry soil, gm	5.44		5.24														
Water content, %	14.89		14.69	14.79													
Remarks:																	
Tested By: A.KASOKA		Checked By:T.S.PHIRI		Approved By:													
		Date: 13/01/2019		Date													

ATTERBERG LIMIT AASHTO T-89 & T- 90																
SIDE			Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>												
LOCATION	JOHN HOWARD TP-2 1.5 m (400)	SAMPLE NO.														
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED		07/01/2019												
MATERIAL SOURCE	JOHN HOWARD TP-2 1.5 m (400)	DATE TESTED		12/01/2019												
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.	A	27	30													
Wt of wet soil + container, gm	30.48	28.51	26.22													
Wt of dry soil + container, gm	27.85	26.04	24.25													
Wt of water	2.63	2.47	1.97													
Wt of container	16.53	14.03	13.64													
Wt of dry soil, gm	11.32	12.01	10.61													
Water content, %	23.23	20.57	18.57													
No. of blows	17	25	31													
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at30°C	<input checked="" type="checkbox"/>															
Oven dried at°C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
PLASTIC LIMIT		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: right;">22.60 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: right;">15.58 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: right;">7.0 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">5.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: right;">3.3 %</td> </tr> </tbody> </table>			Test Result		Liquid Limit	22.60 %	Plastic Limit	15.58 %	Plasticity Index	7.0 %	Shrinkage =	5.0 mm	Shrinkage =	3.3 %
Test Result																
Liquid Limit	22.60 %															
Plastic Limit	15.58 %															
Plasticity Index	7.0 %															
Shrinkage =	5.0 mm															
Shrinkage =	3.3 %															
PLASTIC LIMIT																
Container No.	19	2		Average												
Wt of wet soil + container, gm	21.90	21.44														
Wt of dry soil + container, gm	21.12	20.66														
Wt of water	0.78	0.78														
Wt of container	16.11	15.66														
Wt of dry soil, gm	5.01	5.00														
Water content, %	15.57	15.60		15.58												
Remarks:																
Tested By: A.KASOKA		Checked By: S.T.PHIRI	Approved By:													
		Date: 12/01/2019	Date													

ATTERBERG LIMIT AASHTO T-89 & T- 90																
SIDE	Random Sample		Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	JOHN HOWARD TP-3 1.5 m	SAMPLE NO.														
MATERIAL TYPE	YELLOWISH COARSE SOIL	DATE SAMPLED	07/01/2019													
MATERIAL SOURCE	JOHN HOWARD TP-3 1.5 m	DATE TESTED	13/01/2019													
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.	D-17	J-69	23													
Wt of wet soil + container, gm	29.78	26.75	27.96													
Wt of dry soil + container, gm	26.63	24.06	25.50													
Wt of water	3.15	2.69	2.46													
Wt of container	15.12	13.46	14.78													
Wt of dry soil, gm	11.51	10.60	10.72													
Water content, %	27.37	25.38	22.95													
No. of blows	19	24	31													
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
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Proportion retained on 0.425mm sieve.....																
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Result</th> </tr> </thead> <tbody> <tr> <td>Liquid Limit</td> <td style="text-align: center;">25.20 %</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: center;">19.12 %</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: center;">6.1 %</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: center;">5.0 mm</td> </tr> <tr> <td>Shrinkage =</td> <td style="text-align: center;">3.3 %</td> </tr> </tbody> </table>		Test Result		Liquid Limit	25.20 %	Plastic Limit	19.12 %	Plasticity Index	6.1 %	Shrinkage =	5.0 mm	Shrinkage =	3.3 %			
Test Result																
Liquid Limit	25.20 %															
Plastic Limit	19.12 %															
Plasticity Index	6.1 %															
Shrinkage =	5.0 mm															
Shrinkage =	3.3 %															
PLASTIC LIMIT																
Container No.	C-7	D-41		Average												
Wt of wet soil + container, gm	22.71	21.96														
Wt of dry soil + container, gm	21.60	21.04														
Wt of water	1.11	0.92														
Wt of container	15.78	16.24														
Wt of dry soil, gm	5.82	4.80														
Water content, %	19.07	19.17		19.12												
Remarks:																
Tested By: A.KASOKA		Checked By: S.T.MUMBA		Approved By:												
		Date:13/01/2019		Date												

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	07/01/2019	
MATERIAL SOURCE	JOHN HOWARD TP-1 1.5 m (399)	DATE TESTED	11/01/2019	
MATERIAL DESCRIPTION	GREYISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	JOHN HOWARD TP-1 1.5 m (399)	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

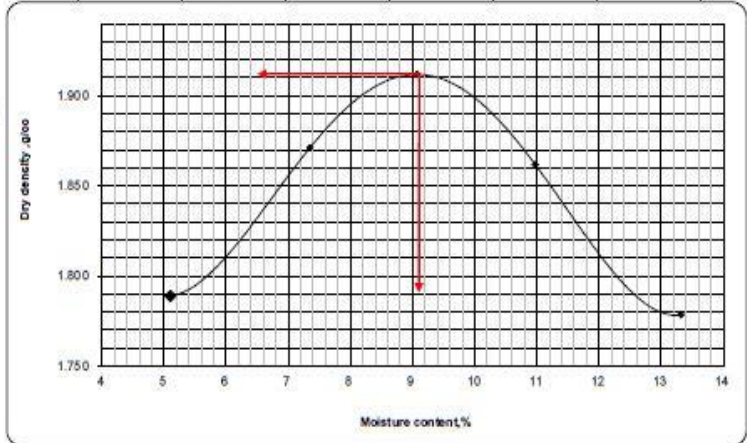
	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	5	7	9	11	13
B	Wt. of Mold + Wet Soil	grams	8496	8797	8977	8932	8813
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4409	4710	4890	4845	4726
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	1.880	2.009	2.085	2.066	2.015
G	Container	No.	CC-26	K-106	NM-2	O-57	MV-1
H	Wt. Cont + Wet soil	grams	767.0	773.0	784.0	780.0	764.0
I	Wt. Cont + Dry soil	grams	742.0	737.0	740.0	727.0	705.0
J	Weight of Water	grams	25.0	36.0	44.0	53.0	59.0
K	Weight of Container	grams	252.0	247.0	255.0	244.0	262.0
L	Weight of Dry Soil	grams	490.0	490.0	485.0	483.0	443.0
M	Moisture Content	%	5.1	7.3	9.1	11.0	13.3
N	Dry Density	g/cm3	1.789	1.871	1.912	1.862	1.778

Maximum Dry Density (MDD):

MDD = 1.912 g/cm3

Optimum Moisture Content (OMC) :

OMC = 9.1 %



Remarks: _____

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By: _____
	Date: 11/01/2019	Date _____

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	07/01/2019	
MATERIAL SOURCE	JOHN HOWARD TP-2 1.5 m (400)	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	BROWNISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	JOHN HOWARD TP-2 1.5 m (400)	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

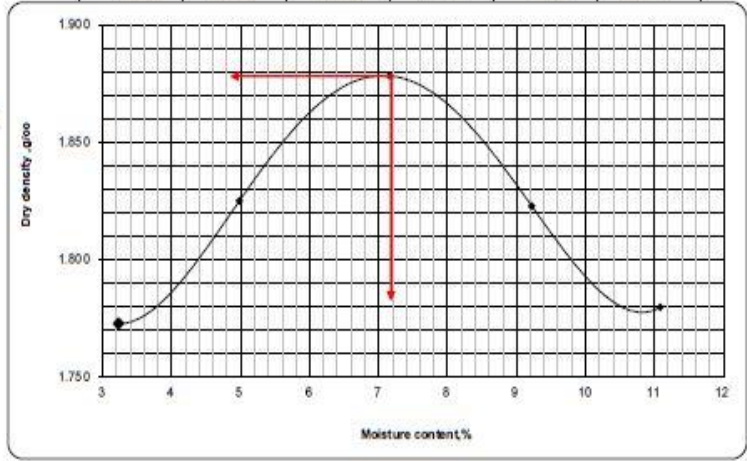
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8429	8633	8863	8811	8778
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4344	4548	4778	4726	4693
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.830	1.916	2.013	1.991	1.977
G	Container	No.	V-32	T-39	H-27	C-15	T-30
H	Wt. Cont + Wet soil	grams	760.0	778.0	747.0	780.0	725.0
I	Wt. Cont + Dry soil	grams	744.0	753.0	714.0	735.0	677.0
J	Weight of Water	grams	16.0	25.0	33.0	45.0	48.0
K	Weight of Container	grams	248.0	251.0	253.0	247.0	244.0
L	Weight of Dry Soil	grams	496.0	502.0	461.0	488.0	433.0
M	Moisture Content	%	3.2	5.0	7.2	9.2	11.1
N	Dry Density	g/cm ³	1.773	1.825	1.878	1.823	1.780

Maximum Dry Density (MDD):

MDD = 1.878 g/cm³

Optimum Moisture Content (OMC) :

OMC = 7.2 %



Remarks: _____

Tested By: _____	Checked By: _____	Approved By: _____
	Date: _____	Date: _____

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION		SAMPLE NO.				
MATERIAL TYPE	Gravel	DATE SAMPLED				
MATERIAL SOURCE	JOHN HOWARD TP-3 1.5 m	DATE TESTED				
MATERIAL DESCRIPTION	YELLOWISH COARSE SOIL	SAMPLED BY				
REPRESENTATIVE STATION	JOHN HOWARD TP-3 1.5 m	TESTED BY				
SAMPLING DEPTH		TEST NO.				

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)		Single sample / Separate batches :	
		Apparent specific gravity :	

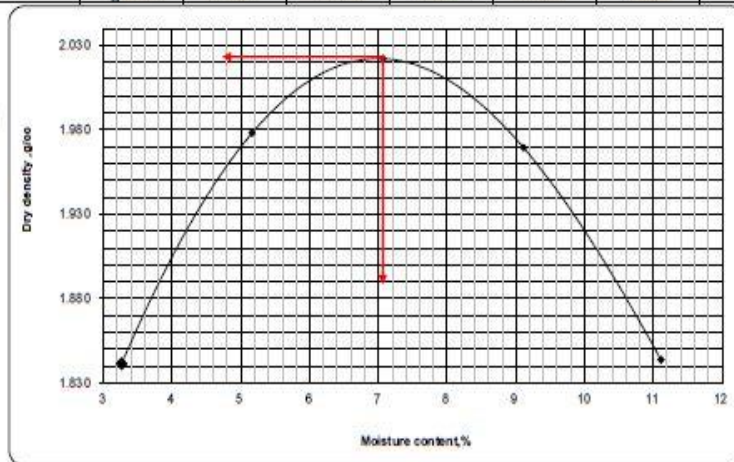
	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8546	8965	9164	9126	8891
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4459	4878	5077	5039	4804
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	1.901	2.080	2.165	2.149	2.049
G	Container	No.	T-30	R-95	T-39	V-32	N-115
H	Wt. Cont + Wet soil	grams	782.0	735.0	766.0	727.0	764.0
I	Wt. Cont + Dry soil	grams	765.0	711.0	732.0	687.0	714.0
J	Weight of Water	grams	17.0	24.0	34.0	40.0	50.0
K	Weight of Container	grams	244.0	246.0	251.0	248.0	264.0
L	Weight of Dry Soil	grams	521.0	465.0	481.0	439.0	450.0
M	Moisture Content	%	3.3	5.2	7.1	9.1	11.1
N	Dry Density	g/cm3	1.841	1.978	2.022	1.969	1.844

Maximum Dry Density (MDD):

MDD = 2.022 g/cm3

Optimum Moisture Content (OMC) :

OMC = 7.1 %



Remarks:

Tested By: A.KASOKA

Checked By: S.T.PHIRI

Approved By:

Date: 11/01/2019

Date

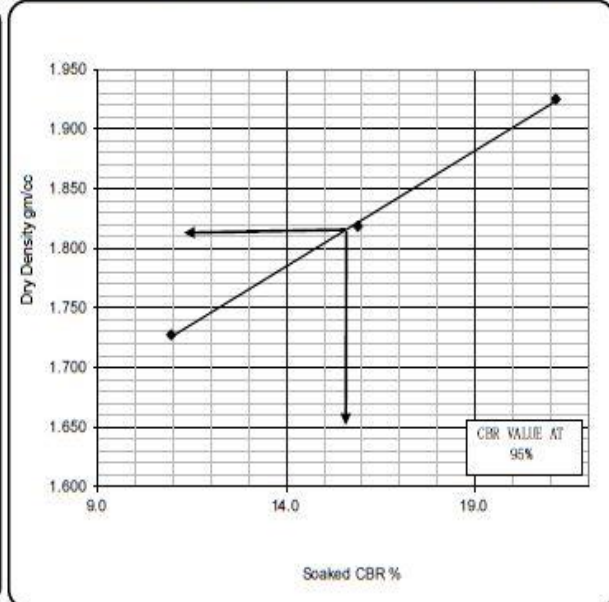
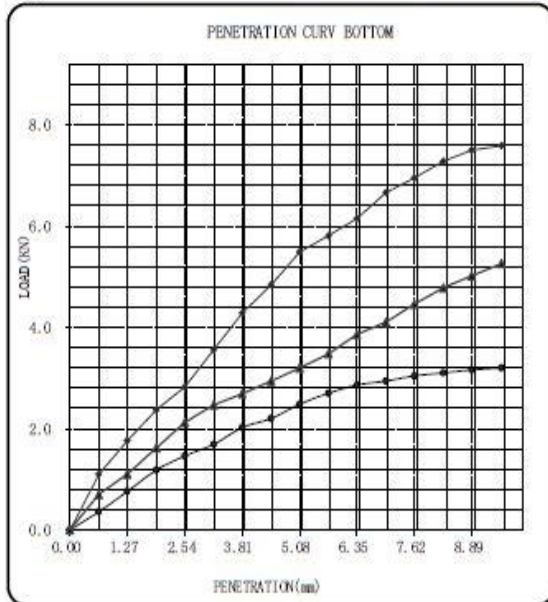
CALIFORNIA BEARING RATIO									
AASHTO T 193									
SAMPLE STATION	JOHN HOWARD TP-1 1.5 m (399)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	
LOCATION				SAMPLE NO.					
MATERIAL TYPE	GREYISH FINE SOIL			DATE SAMPLED		07/01/2019			
MATERIAL SOURCE	JOHN HOWARD TP-1 1.5 m (399)			DATE TESTED		12/01/2019			
MATERIAL DESCRIPTION	Gravel			SAMPLED BY					
REPRESENTATIVE STATION	JOHN HOWARD TP-1 1.5 m (399)			TESTED BY					
SAMPLING DEPTH				TEST NO.					
DENSITY DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
MOLD NUMBER	CC-9		CC-1		CC-10				
WEIGHT OF SOIL + MOLD, g	9678		9426		9258				
WEIGHT OF MOLD, g	4823		4830		4884				
WEIGHT OF SOIL, g	4855		4596		4374				
VOLUME OF MOLD, g	2315		2320		2324				
WET DENSITY OF SOIL, g/cm ³	2.097		1.981		1.882				
DRY DENSITY OF SOIL, g/cm ³	1.925		1.818		1.727				
MOISTURE DETERMINATION									
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before		Before		Before				
CONTAINER NUMBER	VB-19		JI-2						
WET SOIL + CONTAINER, g	778		724						
DRY SOIL + CONTAINER, g	734		685						
WEIGHT OF CONTAINER, g	245		247						
WEIGHT OF WATER, g	44		39						
WEIGHT OF DRY SOIL, g	489		438						
MOISTURE CONTENT	9.0		8.9						
MOISTURE CONTENT AV=			9.0						
PENETRATION BOTTOM TEST									
PENETRATION DATE			16/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)
0.00		0.00		0.00			0.00		
0.64		1.10		0.70			0.36		
1.27		1.76		1.10			0.76		
1.91		2.37		1.62			1.18		
2.54		2.82	21.1	2.12		15.9	1.46		10.9
3.18		3.56		2.47			1.69		
3.81		4.28		2.69			2.02		
4.45		4.84		2.94			2.20		
5.08		5.49	27.5	3.20		16.0	2.48		12.4
5.72		5.81		3.48			2.70		
6.35		6.15		3.86			2.86		
6.99		6.66		4.10			2.94		
7.62		6.95		4.46			3.04		
8.26		7.28		4.78			3.10		
8.89		7.50		5.02			3.16		
9.55		7.59		5.26			3.20		
					Blows	55	25	55	
					rammar	4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date				Initial reading (mm)					
Time				Final reading (mm)					
				Height of specimen (mm)					
				Percent Swell (%)					
Remarks:									
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:			
			Date: 12/01/2019			Date			

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	JOHN HOWARD TP-1 1.5 m (399)	Random Sample	YES <input type="checkbox"/> NO <input type="checkbox"/>
LOCATION	JOHN HOWARD TP-1 1.5 m (399)	SAMPLE NO.	
MATERIAL TYPE	GREYISH FINE SOIL	DATE SAMPLED	07/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.912	55 by 5	9.0	1.925	21.1	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	8.9	1.818	15.9	0.0	0.00	0.00	13.24	20.00
9.1	55 by 3	0.0	1.727	10.9	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.721	CBR Value at 90% from the graph = 10.8
CBR Value at 95% MDD = 1.816	CBR Value at 95% from the graph = 15.5
CBR Value at 98% MDD = 1.874	CBR Value at 98% from the graph = 18.7

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

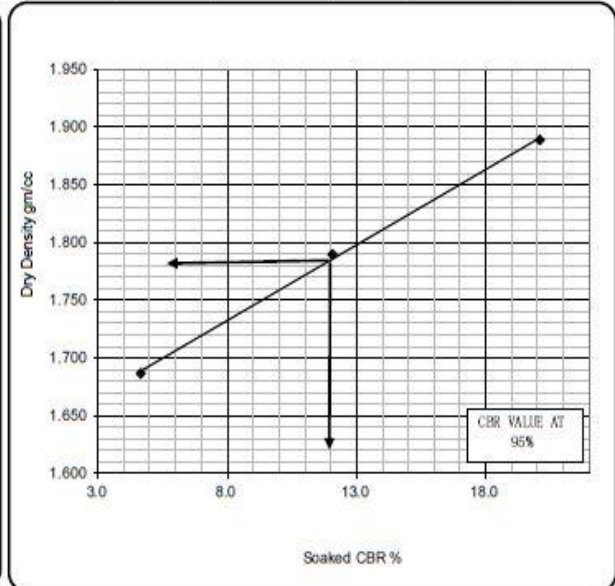
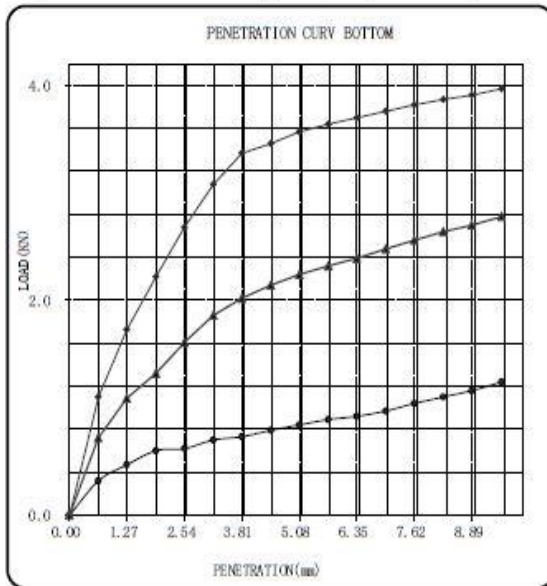
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	JOHN HOWARD TP-2 1.5 m (400)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	BROWNISH FINE SOIL			DATE SAMPLED		07/01/2019				
MATERIAL SOURCE	JOHN HOWARD TP-2 1.5 m (400)			DATE TESTED		11/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	JOHN HOWARD TP-2 1.5 m (400)			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	M-31		M-95		8-B					
WEIGHT OF SOIL + MOLD, g	8872		8625		8329					
WEIGHT OF MOLD, g	4102		4136		4360					
WEIGHT OF SOIL, g	4770		4489		3969					
VOLUME OF MOLD, g	2356		2340		2195					
WET DENSITY OF SOIL, g/cm ³	2.025		1.918		1.808					
DRY DENSITY OF SOIL, g/cm ³	1.889		1.789		1.687					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	M-83		SAM-2							
WET SOIL + CONTAINER, g	773		713							
DRY SOIL + CONTAINER, g	737		682							
WEIGHT OF CONTAINER, g	244		246							
WEIGHT OF WATER, g	36		31							
WEIGHT OF DRY SOIL, g	493		436							
MOISTURE CONTENT	7.3		7.1							
MOISTURE CONTENT AV=			7.2							
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00		0.00			0.00			
0.64		1.10		0.72			0.32			
1.27		1.73		1.09			0.47			
1.91		2.22		1.32			0.60			
2.54		2.68	20.1	1.61	12.1		0.62	4.6		
3.18		3.08		1.86			0.70			
3.81		3.37		2.02			0.73			
4.45		3.46		2.14			0.79			
5.08		3.57	17.9	2.24	11.2		0.84	4.2		
5.72		3.64		2.32			0.89			
6.35		3.70		2.39			0.92			
6.99		3.76		2.48			0.97			
7.62		3.82		2.56			1.04			
8.26		3.87		2.64			1.10			
8.89		3.91		2.70			1.16			
9.55		3.97		2.78			1.24			
					Blows	55	25	55		
SWELL					rammar	4.5kg by 5	4.5kg by 5	2.5kg by 3		
Soaking Date					Initial reading (mm)					
Time					Final reading (mm)					
					Height of specimen (mm)					
					Percent Swell (%)					
Remarks:										
Tested By: W.MUMBA			Checked By: S.T,PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	JOHN HOWARD TP-2 1.5 m (400)	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	JOHN HOWARD TP-2 1.5 m (400)	SAMPLE NO.	
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED	07/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.878	55 by 5	7.3	1.889	20.1	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.1	1.789	12.1	0.0	0.00	0.00	13.24	20.00
7.2	55 by 3	0.0	1.687	4.6	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.690	CBR Value at 90% from the graph = 4.7
CBR Value at 95% MDD = 1.784	CBR Value at 95% from the graph = 11.9
CBR Value at 98% MDD = 1.840	CBR Value at 98% from the graph = 16.2

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits:

Yes



No



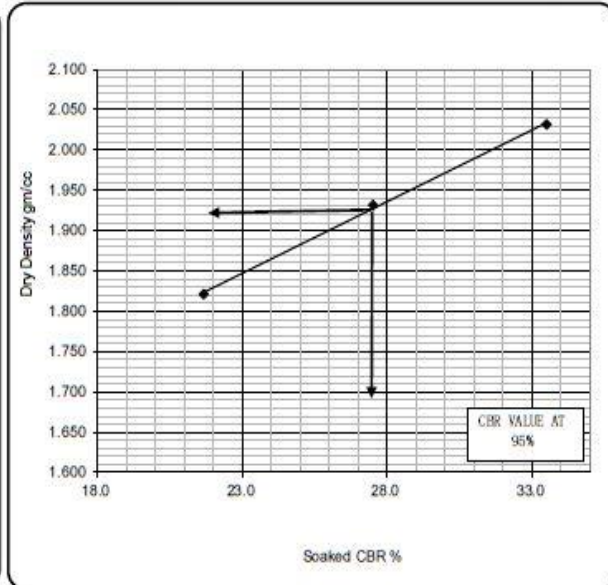
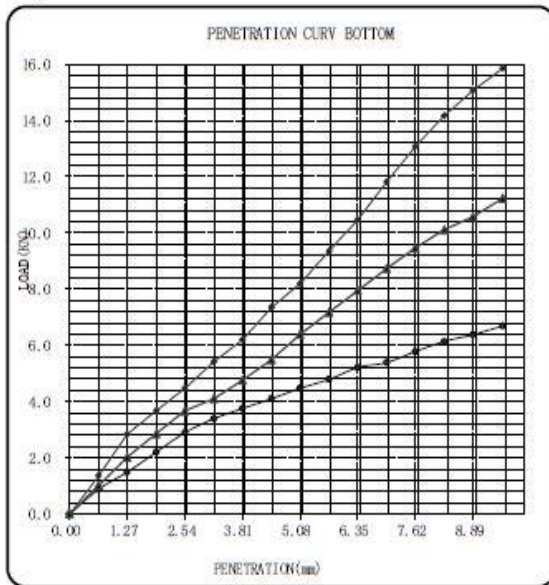
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	JOHN HOWARD TP-3 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	YELLOWISH COARSE SOIL			DATE SAMPLED		07/01/2019				
MATERIAL SOURCE	JOHN HOWARD TP-3 1.5 m			DATE TESTED		12/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	JOHN HOWARD TP-3 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	B-32			B-02			B-03			
WEIGHT OF SOIL + MOLD, g	8346			8119			7739			
WEIGHT OF MOLD, g	3318			3330			3249			
WEIGHT OF SOIL, g	5028			4789			4490			
VOLUME OF MOLD, g	2311			2315			2302			
WET DENSITY OF SOIL, g/cm ³	2.176			2.069			1.950			
DRY DENSITY OF SOIL, g/cm ³	2.031			1.932			1.821			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	D-56			KL-1						
WET SOIL + CONTAINER, g	774			747						
DRY SOIL + CONTAINER, g	739			714						
WEIGHT OF CONTAINER, g	248			247						
WEIGHT OF WATER, g	35			33						
WEIGHT OF DRY SOIL, g	491			467						
MOISTURE CONTENT	7.1			7.1						
MOISTURE CONTENT AV=				7.1						
PENETRATION BOTTOM TEST										
PENETRATION DATE				16/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.36			1.01			0.88		
1.27		2.84			2.02			1.49		
1.91		3.68			2.86			2.20		
2.54		4.47	33.5		3.67	27.5		2.89	21.7	
3.18		5.42			4.10			3.39		
3.81		6.20			4.76			3.75		
4.45		7.36			5.49			4.10		
5.08		8.20	41.0		6.39	32.0		4.47	22.4	
5.72		9.36			7.18			4.79		
6.35		10.47			7.95			5.21		
6.99		11.82			8.74			5.39		
7.62		13.08			9.47			5.78		
8.26		14.18			10.12			6.14		
8.89		15.08			10.58			6.38		
9.55		15.87			11.24			6.69		
						Blows	55	25	55	
SWELL				rammar		4,5kg by 5		4,5kg by 5		2,5kg by 3
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: S.T.MUMBA			Approved By:				
			Date:12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	JOHN HOWARD TP-3 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	JOHN HOWARD TP-3 1.5 m	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH COARSE SOIL	DATE SAMPLED	07/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.022	55 by 5	7.1	2.031	33.5	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.1	1.932	27.5	0.0	0.00	0.00	13.24	20.00
7.1	55 by 3	0.0	1.821	21.7	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.820	CBR Value at 90% from the graph = 21.7
CBR Value at 95% MDD = 1.921	CBR Value at 95% from the graph = 27.4
CBR Value at 98% MDD = 1.982	CBR Value at 98% from the graph = 30.8

Comments:

Checked By: _____ **APPROVED BY:** _____
Date: _____

Test Results Within Engineering Limits: Yes No

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: John Howard	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.		
1	Resistivity Ohm-Centimetre	
2	2908	
3	2509	
	3001	

PREPARED BY

BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE:

THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY

Garden Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants			Location: Garden		Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation				Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²
1	1	150	12	32	400
		300	17		
		450	15		
2	1	150	20	42	500
		300	19		
		450	23		
3	1	150	20	56	>600
		300	26		
		450	30		
4	1	150	18	41	500
		300	21		
		450	20		

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Garden		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 4	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	6	0.3	6	0.3	6	0.3	4
0.6	10	0.6	11	0.6	11	0.6	4
0.9	12	0.9	31	0.9	18	0.9	15
1.2	13	1.2	21	1.2	23	1.2	6
1.5	11	1.5	28	1.5	19	1.5	21
1.8	10	1.8	19	1.8	28	1.8	23
2.1	18	2.1	18	2.1	31	2.1	20
2.4	23	2.4	31	2.4	25	2.4	19
2.7	18	2.7	28	2.7	29	2.7	22
3.0	13	3.0	19	3.0	34	3.0	18
3.3	17	3.3	19	3.3	27	3.3	19
3.6	14	3.6	18	3.6	47	3.6	18
3.9	29	3.9	20	3.9	43	3.9	16
4.2	47	4.2	25	4.2	50	4.2	14
4.5	43	4.5	24	4.5	48	4.5	48
4.8	50	4.8	38	4.8	49	4.8	>50
5.1	48	5.1	49	5.1	43	5.1	
5.4	49	5.4	51	5.4	51	5.4	
5.7	>55	5.7	50	5.7	>55	5.7	
6.0		6.0	51	6.0		6.0	
6.3		6.3	>55	6.3		6.3	
6.6		6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.0		7.0		7.0		7.0	

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	GARDEN TP-1 1.5 m (1860)		SAMPLING DATE:		04/01/2019	
LOCATION:			TESTING DATE:		12/01/2019	
Weight After Washing (g)	2674.0 g		loss in fine :		856.0	g
Weight Before Washing (g)	3530.0 g		loss in fine percentage :		32%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.2 GRADING COEFFICIENT (GC) = 2.7
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	0.0	0.0	100.0			
2.00	96.0	2.7	97.3			
1.18	186.0	5.3	92.0			
0.6	1102.0	31.2	60.8			
0.425	136.0	3.9	56.9			
0.3	236.0	6.7	50.3			
0.15	406.0	11.5	38.8			
0.075	512.0	14.5	24.2			
Pan	856.0	24.2	0.0			

Remarks:		
Tested By: BA.KASOKA	Checked By: T.S.PHIRI	Approved By:
Date: 12/01/2019		Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	GARDEN TP-2 1.5 m			SAMPLING DATE:	04/01/2019	
LOCATION:				TESTING DATE:	12/01/2019	
Weight After Washing (g)	2068.0		g	loss in fine :	476.0	g
Weight Before Washing (g)	2544.0		g	loss in fine percentage :	23%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.2 GRADING COEFFICIENT (GC) = 9.6
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	172.0	6.8	93.2			
26.5	0.0	0.0	93.2			
19	67.0	2.6	90.6			
13.2	61.0	2.4	88.2			
9.5	44.0	1.7	86.5			
6.7	46.0	1.8	84.7			
4.75	27.0	1.1	83.6			
2.00	47.0	1.8	81.8			
1.18	17.0	0.7	81.1			
0.6	19.0	0.7	80.3			
0.425	32.0	1.3	79.1			
0.3	82.0	3.2	75.9			
0.15	1014.0	39.9	36.0			
0.075	440.0	17.3	18.7			
Pan	476.0	18.7	0.0			

Remarks:

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date: 12/01/2019	Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	GARDEN TP-3 1.8 m			SAMPLING DATE:	04/01/2019	
LOCATION:				TESTING DATE:	12/01/2019	
Weight After Washing (g)	2400.0	g	loss in fine :		968.0	g
Weight Before Washing (g)	3368.0	g	loss in fine percentage :		40%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.2 GRADING COEFFICIENT (GC) = 2.9
50	0.0	0.0	100.0	Lower Limit	Upper Limit	
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	29.0	0.9	99.1			
2.00	69.0	2.0	97.1			
1.18	172.0	5.1	92.0			
0.6	1129.0	33.5	58.5			
0.425	89.0	2.6	55.8			
0.3	269.0	8.0	47.8			
0.15	218.0	6.5	41.4			
0.075	425.0	12.6	28.7			
Pan	968.0	28.7	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
Date: 12/01/2019		Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	GARDEN TP-4 1.5 m		SAMPLING DATE:	04/01/2019		
LOCATION:			TESTING DATE:	12/01/2019		
Weight After Washing (g)	1776.0	g	loss in fine :	1139.0	g	
Weight Before Washing (g)	2915.0	g	loss in fine percentage :	64%	g	
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = <div style="text-align: right;">0.9</div> GRADING COEFFICIENT (GC) = <div style="text-align: right;">4.7</div>
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	0.0	0.0	100.0			
9.5	0.0	0.0	100.0			
6.7	0.0	0.0	100.0			
4.75	65.0	2.2	97.8			
2.00	74.0	2.5	95.2			
1.18	186.0	6.4	88.9			
0.6	269.0	9.2	79.6			
0.425	71.0	2.4	77.2			
0.3	569.0	19.5	57.7			
0.15	306.0	10.5	47.2			
0.075	236.0	8.1	39.1			
Pan	1139.0	39.1	0.0			

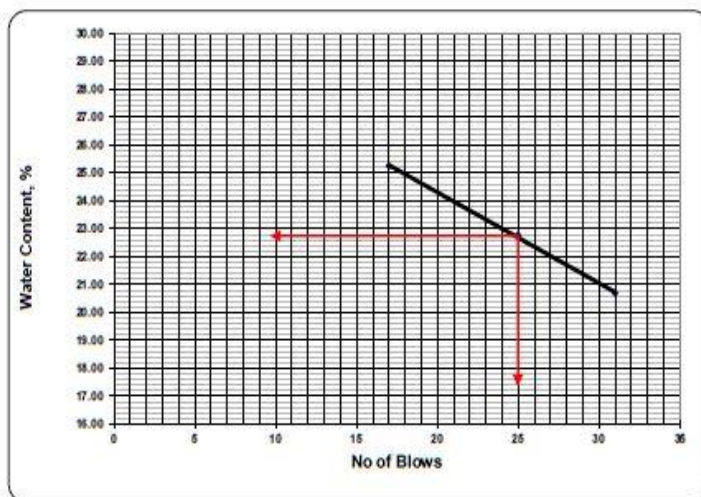
Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI Date: 12/01/2019	Approved By: Date

ATTERBERG LIMIT																
AASHTO T-89 & T- 90																
SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>												
LOCATION	GARDEN TP-1 1.5 m (1860)	SAMPLE NO.														
MATERIAL TYPE	GREYISH FINE SOIL	DATE SAMPLED		04/01/2019												
MATERIAL SOURCE	GARDEN TP-1 1.5 m (1860)	DATE TESTED		13/01/2019												
MATERIAL DESCRIPTION		SAMPLED BY														
REPRESENTATIVE STATION		TESTED BY														
SAMPLING DEPTH		TEST NO.														
LIQUID LIMIT																
Container No.	G-2	33	69													
Wt of wet soil + container, gm	27.69	26.85	24.67													
Wt of dry soil + container, gm	24.86	24.60	23.20													
Wt of water	2.83	2.25	1.47													
Wt of container	14.22	15.05	16.28													
Wt of dry soil, gm	10.64	9.55	6.92													
Water content, %	26.60	23.56	21.24													
No. of blows	18	25	30													
		<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Sample preparation</th> </tr> </thead> <tbody> <tr> <td>As received</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Washed on 0.425mm sieve</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td>Air dried at30°C</td> <td style="text-align: right;"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Oven dried at°C</td> <td style="text-align: right;"><input type="checkbox"/></td> </tr> <tr> <td colspan="2">Proportion retained on 0.425mm sieve.....</td> </tr> </tbody> </table>			Sample preparation		As received	<input type="checkbox"/>	Washed on 0.425mm sieve	<input type="checkbox"/>	Air dried at30°C	<input checked="" type="checkbox"/>	Oven dried at°C	<input type="checkbox"/>	Proportion retained on 0.425mm sieve.....	
Sample preparation																
As received	<input type="checkbox"/>															
Washed on 0.425mm sieve	<input type="checkbox"/>															
Air dried at30°C	<input checked="" type="checkbox"/>															
Oven dried at°C	<input type="checkbox"/>															
Proportion retained on 0.425mm sieve.....																
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Test Result																
Liquid Limit	23.60 %															
Plastic Limit	0.00 %															
Plasticity Index	S/P %															
Shrinkage =	1.5 mm															
Shrinkage =	1.0 %															
PLASTIC LIMIT																
Container No.				Average												
Wt of wet soil + container, gm																
Wt of dry soil + container, gm																
Wt of water																
Wt of container																
Wt of dry soil, gm																
Water content, %																
Remarks:																
Tested By: A.KASOKA		Checked By: T.S.PHIRI		Approved By:												
		Date: 13/01/2019		Date												

ATTERBERG LIMIT AASHTO T-89 & T- 90			
SIDE		Random Sample	Yes <input type="checkbox"/> No <input type="checkbox"/>
LOCATION	GARDEN TP-2 1.5 m	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH FINE SOIL	DATE SAMPLED	04/01/2019
MATERIAL SOURCE	GARDEN TP-2 1.5 m	DATE TESTED	12/01/2019
MATERIAL DESCRIPTION		SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

LIQUID LIMIT

	I	F	A	
Container No.				
Wt of wet soil + container, gm	27.70	25.52	23.28	
Wt of dry soil + container, gm	24.83	23.58	22.12	
Wt of water	2.87	1.94	1.16	
Wt of container	13.46	15.06	16.51	
Wt of dry soil, gm	11.37	8.52	5.61	
Water content, %	25.24	22.77	20.68	
No. of blows	17	25	31	



Sample preparation

As received	<input type="checkbox"/>
Washed on 0.425mm sieve	<input type="checkbox"/>
Air dried at30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result

Liquid Limit	22.70 %
Plastic Limit	0.00 %
Plasticity Index	N/P %
Shrinkage =	0.0 mm
Shrinkage =	0.0 %

PLASTIC LIMIT

					Average
Container No.					
Wt of wet soil + container, gm					
Wt of dry soil + container, gm					
Wt of water					
Wt of container					
Wt of dry soil, gm					
Water content, %					

Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 12/01/2019

Date

**ATTERBERG LIMIT
AASHTO T-89 & T- 90**

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	GARDEN TP-3 1.8 m	SAMPLE NO.				
MATERIAL TYPE	REDDISH FINE SOIL	DATE SAMPLED		04/01/2019		
MATERIAL SOURCE	GARDEN TP-3 1.8 m	DATE TESTED		11/01/2019		
MATERIAL DESCRIPTION		SAMPLED BY				
REPRESENTATIVE STATION		TESTED BY				
SAMPLING DEPTH		TEST NO.				

LIQUID LIMIT

Container No.	R-23	D-5	A-47	
Wt of wet soil + container, gm	28.62	26.78	26.45	
Wt of dry soil + container, gm	25.80	24.90	24.67	
Wt of water	2.82	1.88	1.78	
Wt of container	14.26	16.42	15.71	
Wt of dry soil, gm	11.54	8.48	8.96	
Water content, %	24.44	22.17	19.87	
No. of blows	19	25	32	



Sample preparation

As received	<input type="checkbox"/>
Washed on 0.425mm sieve	<input type="checkbox"/>
Air dried at 30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result

Liquid Limit	22.30 %
Plastic Limit	0.00 %
Plasticity Index	NP %
Shrinkage =	0.0 mm
Shrinkage =	0.0 %

PLASTIC LIMIT

Container No.					Average
Wt of wet soil + container, gm					
Wt of dry soil + container, gm					
Wt of water					
Wt of container					
Wt of dry soil, gm					
Water content, %					

Remarks:

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date: 11/01/2019	Date

ATTERBERG LIMIT AASHTO T-89 & T- 90																	
SIDE			Random Sample Yes <input type="checkbox"/> No <input type="checkbox"/>														
LOCATION	GARDEN TP-4 1.5 m		SAMPLE NO.														
MATERIAL TYPE	FINE SOIL		DATE SAMPLED 04/01/2019														
MATERIAL SOURCE	GARDEN TP-4 1.5 m		DATE TESTED 12/01/2019														
MATERIAL DESCRIPTION			SAMPLED BY														
REPRESENTATIVE STATION			TESTED BY														
SAMPLING DEPTH			TEST NO.														
LIQUID LIMIT																	
Container No.		H-71	G-23	D-42													
Wt of wet soil + container, gm		27.67	26.51	27.48													
Wt of dry soil + container, gm		23.68	23.45	24.20													
Wt of water		3.99	3.06	3.28													
Wt of container		13.78	15.26	14.75													
Wt of dry soil, gm		9.90	8.19	9.45													
Water content, %		40.30	37.36	34.71													
No. of blows		18	26	33													
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Sample preparation																	
As received	<input type="checkbox"/>																
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Test Result																	
Liquid Limit	37.70 %																
Plastic Limit	21.40 %																
Plasticity Index	16.3 %																
Shrinkage =	12.0 mm																
Shrinkage =	8.0 %																
PLASTIC LIMIT																	
Container No.		41	56		Average												
Wt of wet soil + container, gm		24.75	25.45														
Wt of dry soil + container, gm		22.72	23.48														
Wt of water		2.03	1.97														
Wt of container		13.25	14.26														
Wt of dry soil, gm		9.47	9.22														
Water content, %		21.44	21.37		21.40												
Remarks:																	
Tested By: A.KASOKA		Checked By: T.S.PHIRI		Approved By:													
		Date: 12/01/2019		Date													

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

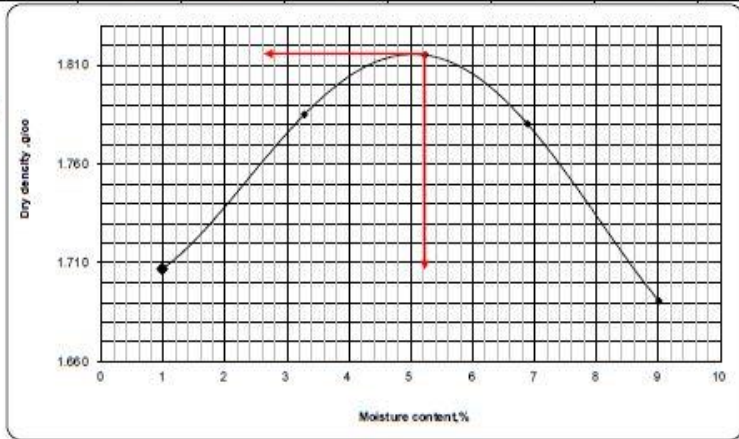
SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	GARDEN NEXT TO APOSTOLIC FAITH		SAMPLE NO.			
MATERIAL TYPE	SAND SOIL		DATE SAMPLED	04/01/2019		
MATERIAL SOURCE	GARDEN TP-1 1.5 m (1860)		DATE TESTED	11/01/2019		
MATERIAL DESCRIPTION	GREYISH FINE SOIL		SAMPLED BY			
REPRESENTATIVE STATION	GARDEN TP-1 1.5 m (1860)		TESTED BY			
SAMPLING DEPTH			TEST NO.			

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)		Single sample / Separate batches :	
		Apparent specific gravity :	

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	1	3	5	7	9
B	Wt. of Mold + Wet Soil	grams	8129	8410	8566	8549	8409
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4042	4323	4479	4462	4322
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	1.724	1.843	1.910	1.903	1.843
G	Container	No.	N-41	L-23	L-98	F-70	M196
H	Wt. Cont + Wet soil	grams	770.0	762.0	758.0	776.0	721.0
I	Wt. Cont + Dry soil	grams	765.0	746.0	733.0	742.0	682.0
J	Weight of Water	grams	5.0	16.0	25.0	34.0	39.0
K	Weight of Container	grams	255.0	258.0	255.0	248.0	249.0
L	Weight of Dry Soil	grams	510.0	488.0	478.0	494.0	433.0
M	Moisture Content	%	1.0	3.3	5.2	6.9	9.0
N	Dry Density	g/cm3	1.707	1.785	1.815	1.780	1.691

Maximum Dry Density (MDD):
MDD = 1.815 g/cm3

Optimum Moisture Content (OMC) :
OMC = 5.2 %



Remarks:

Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
	Date: 11/01/2019	Date

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	GARDEN NEAR RAILWAY LINE	SAMPLE NO.				
MATERIAL TYPE	SAND SOIL	DATE SAMPLED	04/01/2019			
MATERIAL SOURCE	GARDEN TP-2 1.5 m	DATE TESTED	10/01/2019			
MATERIAL DESCRIPTION	YELLOWISH FINE SOIL	SAMPLED BY				
REPRESENTATIVE STATION	GARDEN TP-2 1.5 m	TESTED BY				
SAMPLING DEPTH		TEST NO.				

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)		Single sample / Separate batches :	
		Apparent specific gravity :	

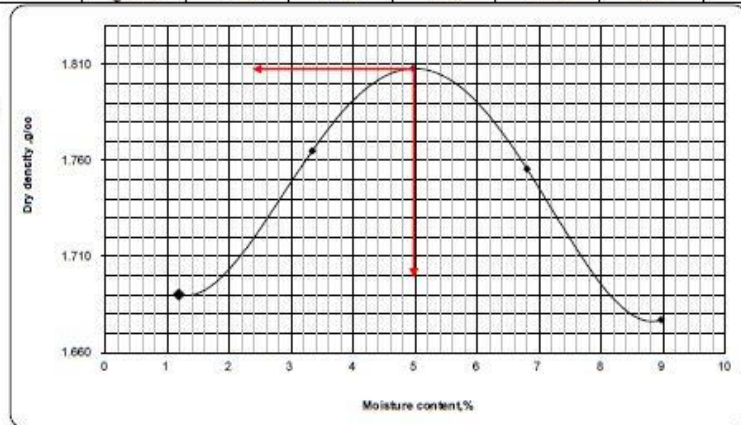
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	1	3	5	7	9
B	Wt. of Mold + Wet Soil	grams	8145	8415	8590	8536	8423
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4060	4330	4505	4451	4338
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.710	1.824	1.898	1.875	1.827
G	Container	No.	K-B	Y-50	R-16	L-12	M-42
H	Wt. Cont + Wet soil	grams	767.0	773.0	780.0	768.0	806.0
I	Wt. Cont + Dry soil	grams	761.0	756.0	755.0	735.0	760.0
J	Weight of Water	grams	6.0	17.0	25.0	33.0	46.0
K	Weight of Container	grams	256.0	247.0	252.0	250.0	247.0
L	Weight of Dry Soil	grams	505.0	509.0	503.0	485.0	513.0
M	Moisture Content	%	1.2	3.3	5.0	6.8	9.0
N	Dry Density	g/cm ³	1.690	1.765	1.808	1.755	1.677

Maximum Dry Density (MDD):

MDD = 1.808 g/cm³

Optimum Moisture Content (OMC):

OMC = 5.0 %



Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 10/01/2019

Date

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

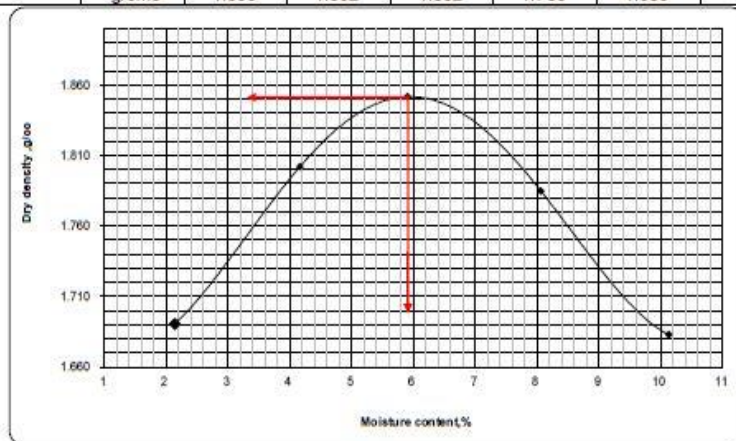
SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	GARDEN NEXT TO HEALTH CENTER	SAMPLE NO.				
MATERIAL TYPE	SAND SOIL	DATE SAMPLED	04/01/2019			
MATERIAL SOURCE	GARDEN TP-3 1.8 m	DATE TESTED	11/01/2019			
MATERIAL DESCRIPTION	REDDISH FINE SOIL	SAMPLED BY				
REPRESENTATIVE STATION	GARDEN TP-3 1.8 m	TESTED BY				
SAMPLING DEPTH		TEST NO.				

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)		Single sample / Separate batches :	
		Apparent specific gravity :	

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	2	4	6	8	10
B	Wt. of Mold + Wet Soil	grams	8136	8489	8686	8610	8433
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4049	4402	4599	4523	4346
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	1.727	1.877	1.961	1.929	1.853
G	Container	No.	F-90	S-55	U-19	M-23	C-22
H	Wt. Cont + Wet soil	grams	776.0	727.0	779.0	717.0	762.0
I	Wt. Cont + Dry soil	grams	765.0	708.0	750.0	682.0	715.0
J	Weight of Water	grams	11.0	19.0	29.0	35.0	47.0
K	Weight of Container	grams	252.0	252.0	259.0	248.0	251.0
L	Weight of Dry Soil	grams	513.0	456.0	491.0	434.0	464.0
M	Moisture Content	%	2.1	4.2	5.9	8.1	10.1
N	Dry Density	g/cm3	1.690	1.802	1.852	1.785	1.683

Maximum Dry Density (MDD):
MDD = 1.852 g/cm3

Optimum Moisture Content (OMC) :
OMC = 5.9 %



Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 11/01/2019

Date

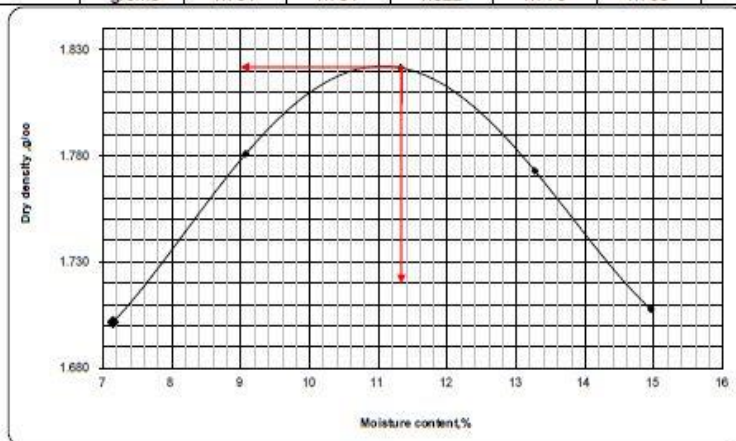
**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

SIDE		Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
LOCATION	GARDEN NEAR ZESCO POLE (OPPOSITE PRESSBYTARRIAN)		SAMPLE NO.			
MATERIAL TYPE	SAND SOIL		DATE SAMPLED	04/01/2019		
MATERIAL SOURCE	GARDEN TP-4 1.5 m		DATE TESTED	11/01/2019		
MATERIAL DESCRIPTION	FINE SOIL		SAMPLED BY			
REPRESENTATIVE STATION	GARDEN TP-4 1.5 m		TESTED BY			
SAMPLING DEPTH			TEST NO.			

No. of blows : 55+1 Weight of hammer,kg : 4.5
 No. of layers : 5 Volume of mold,cm³ : 2345
 Proportion retained on 19mm sieve size: _____ Single sample / Separate batches : _____
 (pass 50mm sieve and retained on 19mm sieve) Apparent specific gravity :

	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	7	9	11	13	15
B	Wt. of Mold + Wet Soil	grams	8362	8642	8842	8796	8690
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4275	4555	4755	4709	4603
E	Volume of Mold	cm ³	2345	2345	2345	2345	2345
F	Wet Density	g/cm ³	1.823	1.942	2.028	2.008	1.963
G	Container	No.	V-71	L-69	M-23	C-52	NK
H	Wt. Cont + Wet soil	grams	773.0	731.0	786.0	726.0	748.0
I	Wt. Cont + Dry soil	grams	738.0	691.0	732.0	670.0	684.0
J	Weight of Water	grams	35.0	40.0	54.0	56.0	64.0
K	Weight of Container	grams	248.0	250.0	255.0	248.0	256.0
L	Weight of Dry Soil	grams	490.0	441.0	477.0	422.0	428.0
M	Moisture Content	%	7.1	9.1	11.3	13.3	15.0
N	Dry Density	g/cm ³	1.701	1.781	1.822	1.773	1.708

Maximum Dry Density (MDD):
 MDD = 1.822 g/cm³
Optimum Moisture Content (OMC):
 OMC = 11.3 %



Remarks:

Tested By: A.KASOKA

Checked By: T.S.PHIRI

Approved By:

Date: 11/01/2019

Date

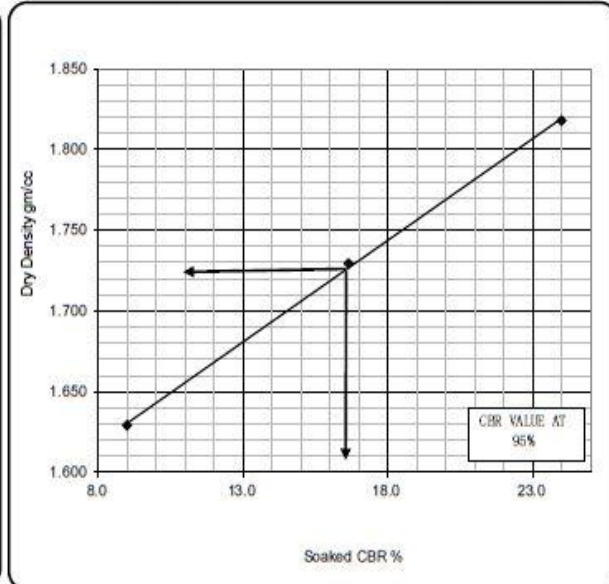
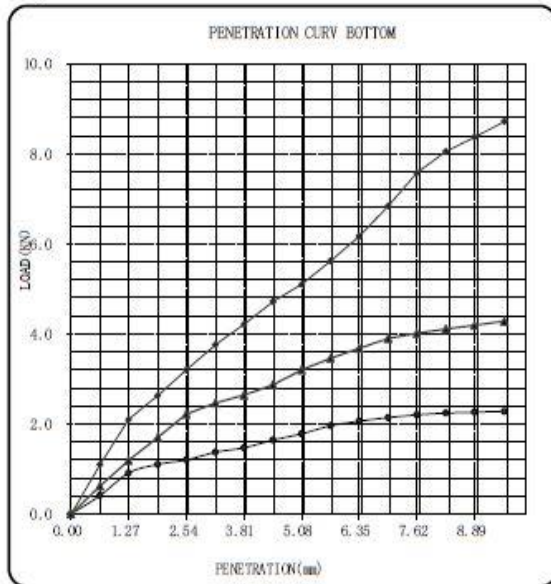
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	GARDEN TP-1 1.5 m (1860)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	GREYISH FINE SOIL			DATE SAMPLED	04/01/2019					
MATERIAL SOURCE	GARDEN TP-1 1.5 m (1860)			DATE TESTED	12/01/2019					
MATERIAL DESCRIPTION	SAND SOIL			SAMPLED BY						
REPRESENTATIVE STATION	GARDEN TP-1 1.5 m (1860)			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	B-11		B-13		B-14					
WEIGHT OF SOIL + MOLD, g	7812		7546		7269					
WEIGHT OF MOLD, g	3406		3327		3310					
WEIGHT OF SOIL, g	4406		4219		3959					
VOLUME OF MOLD, g	2303		2318		2309					
WET DENSITY OF SOIL, g/cm ³	1.913		1.820		1.715					
DRY DENSITY OF SOIL, g/cm ³	1.818		1.729		1.629					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	C-56		L-45							
WET SOIL + CONTAINER, g	739		745							
DRY SOIL + CONTAINER, g	715		720							
WEIGHT OF CONTAINER, g	255		246							
WEIGHT OF WATER, g	24		25							
WEIGHT OF DRY SOIL, g	460		474							
MOISTURE CONTENT	5.2		5.3							
MOISTURE CONTENT AV=			5.2							
PENETRATION BOTTOM TEST										
PENETRATION DATE			16/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.10			0.62			0.41		
1.27		2.10			1.19			0.91		
1.91		2.63			1.70			1.10		
2.54		3.20	24.0		2.22	16.6		1.20	9.0	
3.18		3.76			2.46			1.37		
3.81		4.21			2.64			1.47		
4.45		4.72			2.87			1.64		
5.08		5.10	25.5		3.20	16.0		1.78	8.9	
5.72		5.62			3.46			1.96		
6.35		6.17			3.68			2.06		
6.99		6.84			3.90			2.14		
7.62		7.58			4.01			2.20		
8.26		8.05			4.11			2.24		
8.89		8.37			4.19			2.26		
9.55		8.72			4.28			2.28		
					Blows		55	25	55	
SWELL					rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date					Initial reading (mm)					
Time					Final reading (mm)					
					Height of specimen (mm)					
					Percent Swell (%)					
Remarks:										
Tested By: W.MUMBA			Checked By:T.SPHIRI			Approved By:				
			Date:12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	GARDEN TP-1 1.5 m (1860)	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	GARDEN TP-1 1.5 m (1860)	SAMPLE NO.	
MATERIAL TYPE	GREYISH FINE SOIL	DATE SAMPLED	04/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	SAND SOIL	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.815	55 by 5	5.2	1.818	24.0	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	5.3	1.729	16.6	0.0	0.00	0.00	13.24	20.00
5.2	55 by 3	0.0	1.629	9.0	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.634	CBR Value at 90% from the graph = 9.0
CBR Value at 95% MDD = 1.724	CBR Value at 95% from the graph = 16.5
CBR Value at 98% MDD = 1.779	CBR Value at 98% from the graph = 20.9

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

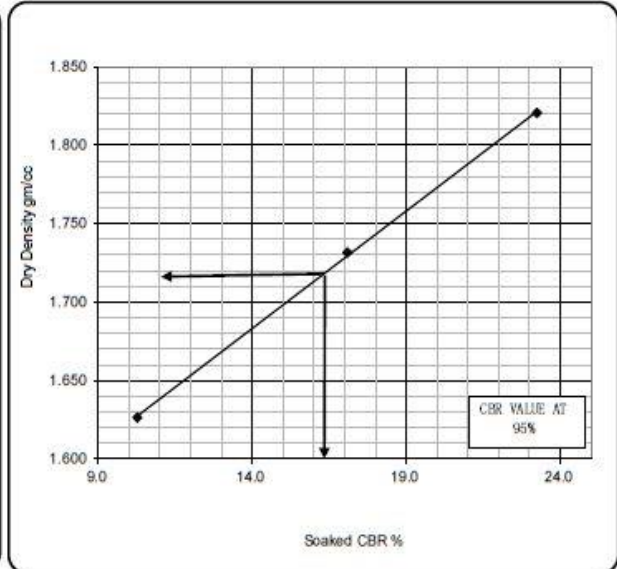
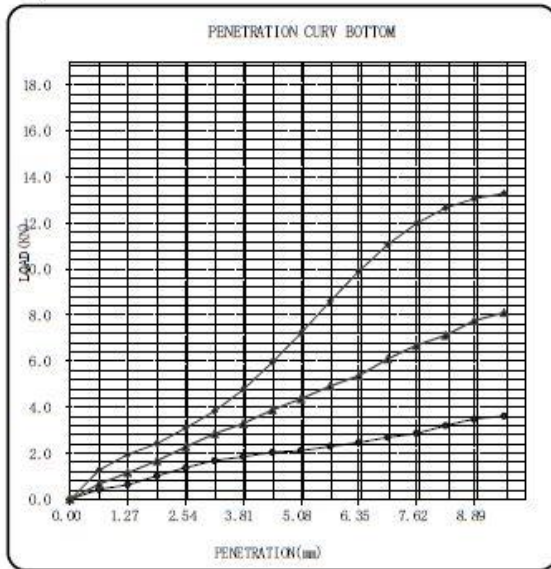
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	GARDEN TP-2 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	YELLOWISH FINE SOIL			DATE SAMPLED						
MATERIAL SOURCE	GARDEN TP-2 1.5 m			DATE TESTED						
MATERIAL DESCRIPTION	SAND SOIL			SAMPLED BY						
REPRESENTATIVE STATION	GARDEN TP-2 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	M-12			M-13			M-33			
WEIGHT OF SOIL + MOLD, g	8592			8336			8125			
WEIGHT OF MOLD, g	4108			4091			4112			
WEIGHT OF SOIL, g	4484			4245			4013			
VOLUME OF MOLD, g	2348			2337			2352			
WET DENSITY OF SOIL, g/cm ³	1.910			1.816			1.706			
DRY DENSITY OF SOIL, g/cm ³	1.820			1.732			1.626			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	M-1000			M-31						
WET SOIL + CONTAINER, g	728			727						
DRY SOIL + CONTAINER, g	706			704						
WEIGHT OF CONTAINER, g	250			242						
WEIGHT OF WATER, g	22			23						
WEIGHT OF DRY SOIL, g	456			462						
MOISTURE CONTENT	4.8			5.0						
MOISTURE CONTENT AV=				4.9						
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.28			0.67			0.42		
1.27		1.95			1.16			0.64		
1.91		2.42			1.68			1.02		
2.54		3.10	23.2		2.28	17.1		1.37	10.3	
3.18		3.83			2.86			1.68		
3.81		4.78			3.30			1.85		
4.45		5.96			3.89			2.04		
5.08		7.22	36.1		4.37	21.9		2.12	10.6	
5.72		8.60			4.92			2.30		
6.35		9.90			5.37			2.47		
6.99		11.07			6.10			2.69		
7.62		11.98			6.69			2.87		
8.26		12.66			7.12			3.20		
8.89		13.05			7.76			3.48		
9.55		13.29			8.11			3.62		
					Blows	55	25	55		
SWELL					rammar	4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date					Initial reading (mm)					
Time					Final reading (mm)					
					Height of specimen (mm)					
					Percent Swell (%)					
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	GARDEN TP-2 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	GARDEN TP-2 1.5 m	SAMPLE NO.	
MATERIAL TYPE	YELLOWISH FINE SOIL	DATE SAMPLED	04/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	SAND SOIL	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.808	55 by 5	4.8	1.820	23.2	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	5.0	1.732	17.1	0.0	0.00	0.00	13.24	20.00
5.0	55 by 3	0.0	1.626	10.3	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.627	CBR Value at 90% from the graph = 10.3
CBR Value at 95% MDD = 1.718	CBR Value at 95% from the graph = 16.2
CBR Value at 98% MDD = 1.772	CBR Value at 98% from the graph = 39.5

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

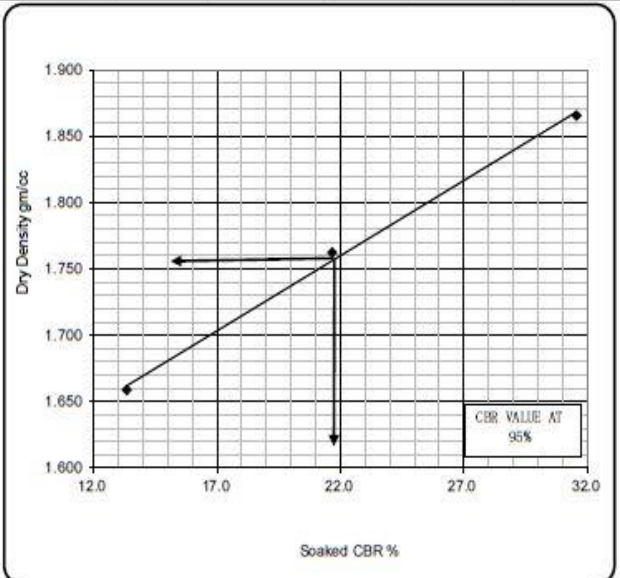
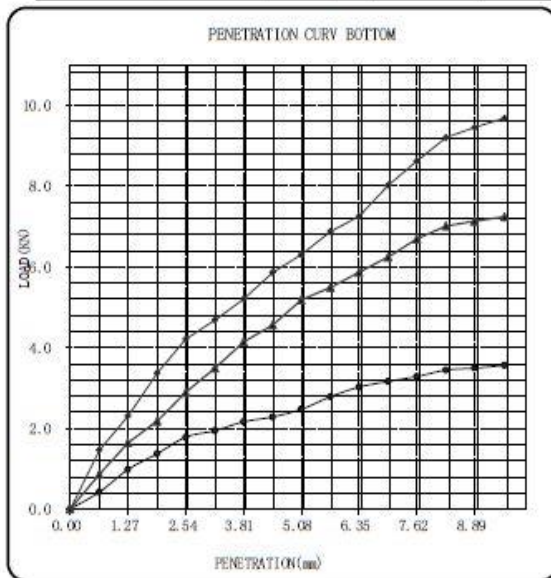
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	GARDEN TP-3 1.8 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	REDDISH FINE SOIL			DATE SAMPLED		04/01/2019				
MATERIAL SOURCE	GARDEN TP-3 1.8 m			DATE TESTED		12/01/2019				
MATERIAL DESCRIPTION	SAND SOIL			SAMPLED BY						
REPRESENTATIVE STATION	GARDEN TP-3 1.8 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	B-20			B-23			B-25			
WEIGHT OF SOIL + MOLD, g	7838			7696			7299			
WEIGHT OF MOLD, g	3275			3404			3215			
WEIGHT OF SOIL, g	4563			4292			4084			
VOLUME OF MOLD, g	2310			2300			2325			
WET DENSITY OF SOIL, g/cm ³	1.975			1.866			1.757			
DRY DENSITY OF SOIL, g/cm ³	1.865			1.762			1.659			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	G-97			K-17						
WET SOIL + CONTAINER, g	738			771						
DRY SOIL + CONTAINER, g	711			742						
WEIGHT OF CONTAINER, g	255			247						
WEIGHT OF WATER, g	27			29						
WEIGHT OF DRY SOIL, g	456			495						
MOISTURE CONTENT	5.9			5.9						
MOISTURE CONTENT AV=				5.9						
PENETRATION BOTTOM TEST										
PENETRATION DATE				16/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.46			0.86			0.42		
1.27		2.30			1.64			0.98		
1.91		3.37			2.18			1.37		
2.54		4.21	31.6		2.89	21.7		1.78	13.3	
3.18		4.68			3.49			1.94		
3.81		5.20			4.14			2.16		
4.45		5.86			4.56			2.28		
5.08		6.30	31.5		5.18	25.9		2.47	12.4	
5.72		6.87			5.49			2.78		
6.35		7.25			5.86			3.02		
6.99		8.02			6.24			3.16		
7.62		8.62			6.69			3.28		
8.26		9.20			7.01			3.44		
8.89		9.45			7.13			3.49		
9.55		9.68			7.24			3.56		
						Blows	55	25	55	
							4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date				rammar		Initial reading (mm)				
Time						Final reading (mm)				
						Height of specimen (mm)				
						Percent Swell (%)				
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date: 12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	GARDEN TP-3 1.8 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	GARDEN TP-3 1.8 m	SAMPLE NO.	
MATERIAL TYPE	REDDISH FINE SOIL	DATE SAMPLED	04/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	SAND SOIL	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.852	55 by 5	5.9	1.865	31.6	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	5.9	1.762	21.7	0.0	0.00		13.24	20.00
5.9	55 by 3	0.0	1.659	13.3	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.667	CBR Value at 90% from the graph = 13.4
CBR Value at 95% MDD = 1.759	CBR Value at 95% from the graph = 21.7
CBR Value at 98% MDD = 1.815	CBR Value at 98% from the graph = 26.7

Comments:

Checked By: _____ **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

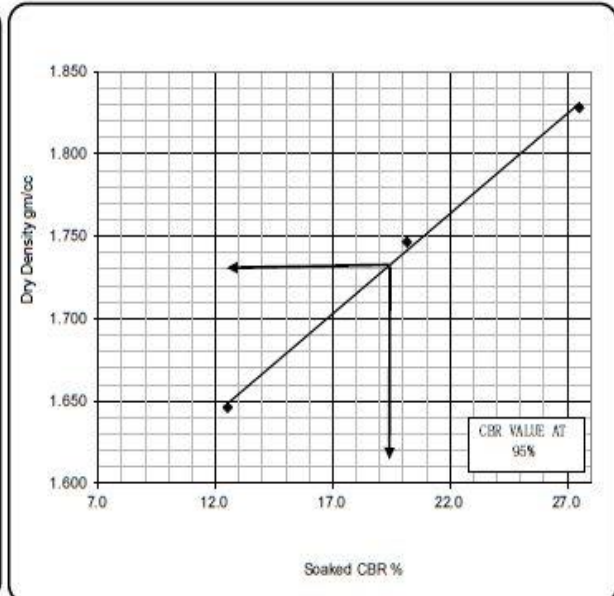
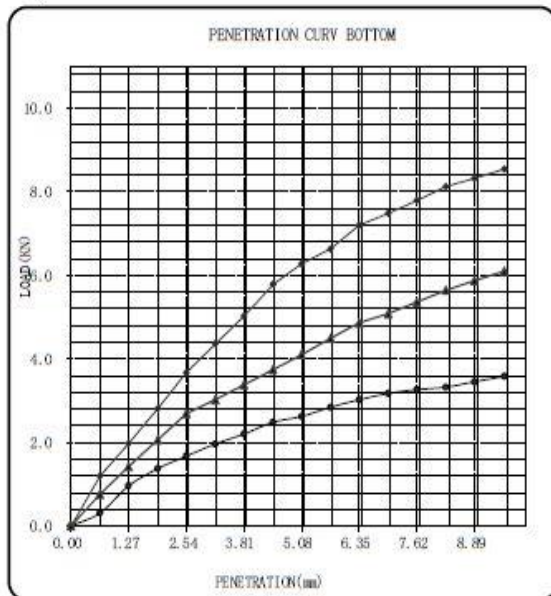
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	GARDEN TP-4 1.5 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	FINE SOIL			DATE SAMPLED	04/01/2019					
MATERIAL SOURCE	GARDEN TP-4 1.5 m			DATE TESTED	12/01/2019					
MATERIAL DESCRIPTION	SAND SOIL			SAMPLED BY						
REPRESENTATIVE STATION	GARDEN TP-4 1.5 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	B-35			B-36			B-39			
WEIGHT OF SOIL + MOLD, g	7960			7869			7486			
WEIGHT OF MOLD, g	3257			3335			3280			
WEIGHT OF SOIL, g	4703			4534			4206			
VOLUME OF MOLD, g	2311			2332			2295			
WET DENSITY OF SOIL, g/cm ³	2.035			1.944			1.833			
DRY DENSITY OF SOIL, g/cm ³	1.828			1.746			1.646			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	D-78			O-11						
WET SOIL + CONTAINER, g	745			760						
DRY SOIL + CONTAINER, g	695			708						
WEIGHT OF CONTAINER, g	248			255						
WEIGHT OF WATER, g	50			52						
WEIGHT OF DRY SOIL, g	447			453						
MOISTURE CONTENT	11.2			11.5						
MOISTURE CONTENT AV=				11.3						
PENETRATION BOTTOM TEST										
PENETRATION DATE				16/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		1.20			0.76			0.31		
1.27		1.97			1.42			0.96		
1.91		2.81			2.06			1.37		
2.54		3.67	27.5		2.69	20.2		1.67	12.5	
3.18		4.36			3.02			1.96		
3.81		5.02			3.38			2.20		
4.45		5.78			3.74			2.48		
5.08		6.27	31.4		4.10	20.5		2.62	13.1	
5.72		6.63			4.49			2.84		
6.35		7.20			4.86			3.02		
6.99		7.48			5.08			3.17		
7.62		7.79			5.36			3.26		
8.26		8.12			5.64			3.32		
8.89		8.32			5.87			3.45		
9.55		8.54			6.10			3.58		
							Blows	55	25	55
SWELL				rammar			4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date: 12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	GARDEN TP-4 1.5 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	GARDEN TP-4 1.5 m	SAMPLE NO.	
MATERIAL TYPE	FINE SOIL	DATE SAMPLED	04/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	SAND SOIL	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
1.822	55 by 5	11.2	1.828	27.5	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	11.5	1.746	20.2	0.0	0.00		13.24	20.00
11.3	55 by 3	0.0	1.646	12.5	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.640	CBR Value at 90% from the graph = 12.4
CBR Value at 95% MDD = 1.731	CBR Value at 95% from the graph = 19.3
CBR Value at 98% MDD = 1.786	CBR Value at 98% from the graph = 24.0

Comments:

Checked By: _____ **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: Garden	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.	Resistivity Ohm-Centimetre	
1	2002	
2	1963	
3	1872	
4	1572	

PREPARED BY
BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE:
THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY

Kanyama Site and Lab Results

STANDARD PENETRATION TEST (SPT) RESULTS

Client: GOPA-ITEC International Energy Consultants			Location: Kanyama		Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation				Tested by: W. Mumba	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m ²
1	1	150	>55	>60	>600
		300			
		450			
2	1	150	>55	>60	>600
		300			
		450			
3	1	150	>55	>60	>600
		300			
		450			
4	1	150	>55	>60	>600
		300			
		450			

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA-ITEC International Energy Consultants				Location: Kanyama		Date Tested: 04/01/19	
Project: Lusaka Transmission and Distribution Rehabilitation						Tested by: W. Mumba	
Test Pit No. 1		Test Pit No. 2		Test Pit No. 3		Test Pit No. 4	
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)
0.3	13	0.3	>55	0.3	>55	0.3	14
0.6	41	0.6		0.6		0.6	38
0.9	50	0.9		0.9		0.9	>55
1.2	>55	1.2		1.2		1.2	
1.5		1.5		1.5		1.5	
1.8		1.8		1.8		1.8	
2.1		2.1		2.1		2.1	
2.4		2.4		2.4		2.4	
2.7		2.7		2.7		2.7	
3.0		3.0		3.0		3.0	
3.3		3.3		3.3		3.3	
3.6		3.6		3.6		3.6	
3.9		3.9		3.9		3.9	
4.2		4.2		4.2		4.2	
4.5		4.5		4.5		4.5	
4.8		4.8		4.8		4.8	
5.1		5.1		5.1		5.1	
5.4		5.4		5.4		5.4	
5.7		5.7		5.7		5.7	
6.0		6.0		6.0		6.0	
6.3		6.3		6.3		6.3	
6.6		6.6		6.6		6.6	
6.9		6.9		6.9		6.9	
7.2		7.2		7.2		7.2	
7.5		7.5		7.5		7.5	
7.8		7.8		7.8		7.8	
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	
8.7		8.7		8.7		8.7	
9.0		9.0		9.0		9.0	
9.3		9.3		9.3		9.3	
9.6		9.6		9.6		9.6	
9.9		9.9		9.9		9.9	

PARTICLE SIZE DISTRIBUTION					
AASHTO T-27					
SIDE:				SAMPLE NO	
REPRESENTATIVE STATION:	KANYAMA TP-1 1.3 m (409) (900m)			SAMPLING DATE:	08/01/2019
LOCATION:				TESTING DATE:	13/01/2019
Weight After Washing (g)	1893.0	g	loss in fine :	296.0	g
Weight Before Washing (g)	2189.0	g	loss in fine percentage :	16%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification	
				Lower Limit	Upper Limit
50	0.0	0.0	100.0		
37.5	0.0	0.0	100.0		
26.5	0.0	0.0	100.0		
19	11.0	0.5	99.5		
13.2	23.0	1.1	98.4		
9.5	29.0	1.3	97.1		
6.7	86.0	3.9	93.2		
4.75	187.0	8.5	84.7		
2.00	850.0	38.8	45.8		
1.18	245.0	11.2	34.6		
0.6	63.0	2.9	31.7		
0.425	37.0	1.7	30.1		
0.3	57.0	2.6	27.5		
0.15	184.0	8.4	19.0		
0.075	121.0	5.5	13.5		
Pan	296.0	13.5	0.0		
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p style="font-size: small;">Sample preparation : Oven-dried sample</p> <p style="font-size: small;">Method of sieving:</p> <p style="font-size: small;">Wet sieving <input checked="" type="checkbox"/></p> <p style="font-size: small;">Dry sieving <input type="checkbox"/></p> </div> <div style="width: 35%;"> <p style="font-size: small;">GRADING MODULUS (GM) =</p> <p style="text-align: center;">2.1</p> <p style="font-size: small;">GRADING COEFFICIENT (GC) =</p> <p style="text-align: center;">45.9</p> </div> </div>					
<div style="border: 1px solid black; padding: 10px;"> </div>					
Remarks:					
Tested By: A.KASOKA		Checked By: S.T.PHIRI		Approved By:	
		Date: 13/01/2019		Date	

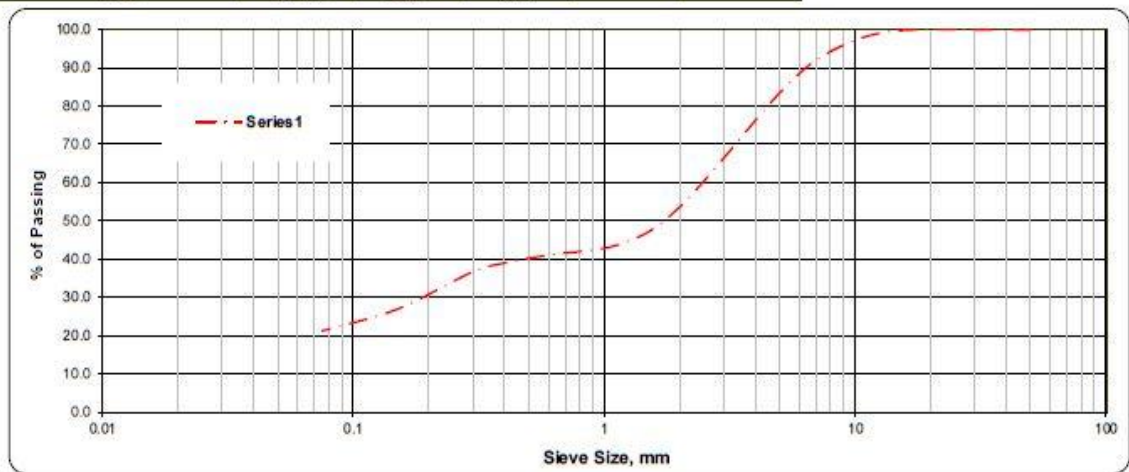
PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:			SAMPLE NO			
REPRESENTATIVE STATION:	KANYAMA TP-2 0.5 m (410)		SAMPLING DATE:		08/01/2019	
LOCATION:			TESTING DATE:		12/01/2019	
Weight After Washing (g)	2559.0 g		loss in fine :		512.0 g	
Weight Before Washing (g)	3071.0 g		loss in fine percentage :		20% g	
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.1 GRADING COEFFICIENT (GC) = 45.2
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	16.0	0.5	99.5			
9.5	56.0	1.8	97.7			
6.7	160.0	5.2	92.4			
4.75	300.0	9.8	82.7			
2.00	1146.0	37.3	45.4			
1.18	282.0	9.2	36.2			
0.6	89.0	2.9	33.3			
0.425	51.0	1.7	31.6			
0.3	73.0	2.4	29.2			
0.15	257.0	8.4	20.9			
0.075	129.0	4.2	16.7			
Pan	512.0	16.7	0.0			

Remarks:		
Tested By: A.KASOKA	Checked By: T.S.PHIRI	Approved By:
Date: 12/01/2019		Date

PARTICLE SIZE DISTRIBUTION

AASHTO T-27

SIDE:		SAMPLE NO				
REPRESENTATIVE STATION:	KANYAMA TP-3 0.3 m	SAMPLING DATE:	08/01/2019			
LOCATION:		TESTING DATE:	13/01/2019			
Weight After Washing (g)	2504.0	g	loss in fine : 674.0 g			
Weight Before Washing (g)	3178.0	g	loss in fine percentage : 27% g			
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 1.9 GRADING COEFFICIENT (GC) = 37.9
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	22.0	0.7	99.3			
9.5	86.0	2.7	96.6			
6.7	174.0	5.5	91.1			
4.75	296.0	9.3	81.8			
2.00	896.0	28.2	53.6			
1.18	303.0	9.5	44.1			
0.6	97.0	3.1	41.0			
0.425	56.0	1.8	39.3			
0.3	82.0	2.6	36.7			
0.15	310.0	9.8	26.9			
0.075	182.0	5.7	21.2			
Pan	674.0	21.2	0.0			



Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
Date: 13/01/2019		Date

PARTICLE SIZE DISTRIBUTION						
AASHTO T-27						
SIDE:				SAMPLE NO		
REPRESENTATIVE STATION:	KANYAMA TP-4 0.3 m			SAMPLING DATE:	08/01/2019	
LOCATION:				TESTING DATE:	12/01/2019	
Weight After Washing (g)	2105.0		g	loss in fine :	141.0	g
Weight Before Washing (g)	2246.0		g	loss in fine percentage :	7%	g
Sieve size (mm)	Weight Retained (gm)	% Retained	% Passing	Specification		Sample preparation : Oven-dried sample Method of sieving: Wet sieving <input checked="" type="checkbox"/> Dry sieving <input type="checkbox"/> GRADING MODULUS (GM) = 2.0 GRADING COEFFICIENT (GC) = 30.3
				Lower Limit	Upper Limit	
50	0.0	0.0	100.0			
37.5	0.0	0.0	100.0			
26.5	0.0	0.0	100.0			
19	0.0	0.0	100.0			
13.2	20.0	0.9	99.1			
9.5	53.0	2.4	96.7			
6.7	98.0	4.4	92.4			
4.75	140.0	6.2	86.2			
2.00	479.0	21.3	64.8			
1.18	343.0	15.3	49.6			
0.6	273.0	12.2	37.4			
0.425	136.0	6.1	31.3			
0.3	111.0	4.9	26.4			
0.15	271.0	12.1	14.3			
0.075	181.0	8.1	6.3			
Pan	141.0	6.3	0.0			

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 12/01/2019	Date

ATTERBERG LIMIT AASHTO T-89 & T- 90				
SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	KANYAMA TP-1 1.3 m (409) (900m)	SAMPLE NO.		
MATERIAL TYPE	GREYISH COARSE SOIL	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-1 1.3 m (409) (900m)	DATE TESTED	12/01/2019	
MATERIAL DESCRIPTION		SAMPLED BY		
REPRESENTATIVE STATION		TESTED BY		
SAMPLING DEPTH		TEST NO.		
LIQUID LIMIT				
Container No.		19	26	5
Wt of wet soil + container, gm		28.82	26.69	24.59
Wt of dry soil + container, gm		26.52	24.93	23.10
Wt of water		2.30	1.76	1.49
Wt of container		15.46	15.48	13.89
Wt of dry soil, gm		11.06	9.45	9.21
Water content, %		20.80	18.62	16.18
No. of blows		18	25	31
		Sample preparation		
		As received <input type="checkbox"/> Washed on 0.425mm sieve <input type="checkbox"/> Air dried at 30°C <input checked="" type="checkbox"/> Oven dried at °C <input type="checkbox"/> Proportion retained on 0.425mm sieve.....		
		Test Result		
		Liquid Limit 18.50 % Plastic Limit 0.00 % Plasticity Index S/P % Shrinkage = 2.0 mm Shrinkage = 1.3 %		
PLASTIC LIMIT				
Container No.				Average
Wt of wet soil + container, gm				
Wt of dry soil + container, gm				
Wt of water				
Wt of container				
Wt of dry soil, gm				
Water content, %				
Remarks:				
Tested By: A.KASOKA	Checked By: S.T.KASOKA	Approved By:		
	Date: 12/01/2019	Date		

ATTERBERG LIMIT AASHTO T-89 & T- 90				
SIDE		Random Sample Yes <input type="checkbox"/> No <input type="checkbox"/>		
LOCATION	KANYAMA TP-2 0.5 m (410)	SAMPLE NO.		
MATERIAL TYPE	GREYISH FINE SOIL	DATE SAMPLED		08/01/2019
MATERIAL SOURCE	KANYAMA TP-2 0.5 m (410)	DATE TESTED		13/01/2019
MATERIAL DESCRIPTION		SAMPLED BY		
REPRESENTATIVE STATION		TESTED BY		
SAMPLING DEPTH		TEST NO.		
LIQUID LIMIT				
Container No.		14	23	R
Wt of wet soil + container, gm		29.95	27.66	25.61
Wt of dry soil + container, gm		27.35	25.47	23.77
Wt of water		2.60	2.19	1.84
Wt of container		15.03	14.34	13.82
Wt of dry soil, gm		12.32	11.13	9.95
Water content, %		21.10	19.68	18.49
No. of blows		18	25	32
		Sample preparation As received <input type="checkbox"/> Washed on 0.425mm sieve <input type="checkbox"/> Air dried at30°C <input checked="" type="checkbox"/> Oven dried at°C <input type="checkbox"/> Proportion retained on 0.425mm sieve.....		
		Test Result Liquid Limit 19.80 % Plastic Limit 15.76 % Plasticity Index 4.0 % Shrinkage = 3.5 mm Shrinkage = 2.3 %		
PLASTIC LIMIT				
Container No.		X	L-5	Average
Wt of wet soil + container, gm		17.65	16.42	
Wt of dry soil + container, gm		17.27	16.05	
Wt of water		0.38	0.37	
Wt of container		14.87	13.69	
Wt of dry soil, gm		2.40	2.36	
Water content, %		15.83	15.68	15.76
Remarks:				
Tested By: A.KASOKA		Checked By: S.T.PHIRI		Approved By:
		Date: 13/01/2019		Date

**ATTERBERG LIMIT
AASHTO T-89 & T- 90**

SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	KANYAMA TP-3 0.3 m	SAMPLE NO.		
MATERIAL TYPE	FINE SOIL	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-3 0.3 m	DATE TESTED	13/01/2019	
MATERIAL DESCRIPTION		SAMPLED BY		
REPRESENTATIVE STATION		TESTED BY		
SAMPLING DEPTH		TEST NO.		

LIQUID LIMIT

Container No.	T-9	J-16	D-12	
Wt of wet soil + container, gm	29.96	27.56	26.70	
Wt of dry soil + container, gm	27.35	25.51	24.90	
Wt of water	2.61	2.05	1.80	
Wt of container	14.96	14.36	13.96	
Wt of dry soil, gm	12.39	11.15	10.94	
Water content, %	21.07	18.39	16.45	
No. of blows	18	25	31	



Sample preparation	
As received	<input type="checkbox"/>
Washed on 0.425mm sieve	<input type="checkbox"/>
Air dried at30°C	<input checked="" type="checkbox"/>
Oven dried at°C	<input type="checkbox"/>
Proportion retained on 0.425mm sieve.....	

Test Result	
Liquid Limit	18.60 %
Plastic Limit	16.51 %
Plasticity Index	2.1 %
Shrinkage =	2.0 mm
Shrinkage =	1.3 %

PLASTIC LIMIT

Container No.	U-19	H			Average
Wt of wet soil + container, gm	17.72	16.48			
Wt of dry soil + container, gm	17.30	16.08			
Wt of water	0.42	0.40			
Wt of container	14.71	13.7			
Wt of dry soil, gm	2.59	2.38			
Water content, %	16.22	16.81			16.51

Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 13/01/2019	Date

ATTERBERG LIMIT				
AASHTO T-89 & T- 90				
SIDE		Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	KANYAMA TP-4 0.3 m	SAMPLE NO.		
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED		
MATERIAL SOURCE	KANYAMA TP-4 0.3 m	DATE TESTED		
MATERIAL DESCRIPTION		SAMPLED BY		
REPRESENTATIVE STATION		TESTED BY		
SAMPLING DEPTH		TEST NO.		
LIQUID LIMIT				
Container No.		H	C	K
Wt of wet soil + container, gm		29.70	27.59	25.42
Wt of dry soil + container, gm		27.50	25.72	23.98
Wt of water		2.20	1.87	1.44
Wt of container		15.53	14.34	14.30
Wt of dry soil, gm		11.97	11.38	9.68
Water content, %		18.38	16.43	14.88
No. of blows		17	24	30
		<p style="text-align: center;">Sample preparation</p> <p>As received <input type="checkbox"/></p> <p>Washed on 0.425mm sieve <input type="checkbox"/></p> <p>Air dried at30°C <input checked="" type="checkbox"/></p> <p>Oven dried at°C <input type="checkbox"/></p> <p>Proportion retained on 0.425mm sieve.....</p>		
		<p style="text-align: center;">Test Result</p> <p>Liquid Limit 16.20 %</p> <p>Plastic Limit 0.00 %</p> <p>Plasticity Index NP %</p> <p>Shrinkage = 0.0 mm</p> <p>Shrinkage = 0.0 %</p>		
PLASTIC LIMIT				
Container No.				Average
Wt of wet soil + container, gm				
Wt of dry soil + container, gm				
Wt of water				
Wt of container				
Wt of dry soil, gm				
Water content, %				
Remarks:				
Tested By: A.KASOKA		Checked By: S.T.PHIRI		Approved By:
		Date: 11/01/2019		Date:

DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)

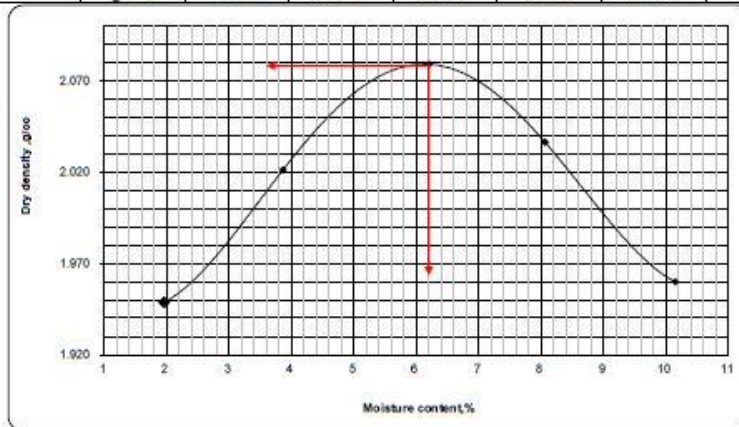
SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-1 1.3 m (409) (900m)	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	GREYISH COARSE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	KANYAMA TP-1 1.3 m (409) (900m)	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	2	4	6	8	10
B	Wt. of Mold + Wet Soil	grams	8802	9069	9327	9309	9210
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4717	4984	5242	5224	5125
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.987	2.099	2.208	2.201	2.159
G	Container	No.	V-61	QA-4	B-47	NU-6	X-96
H	Wt. Cont + Wet soil	grams	767.0	759.0	748.0	781.0	764.0
I	Wt. Cont + Dry soil	grams	757.0	740.0	719.0	741.0	717.0
J	Weight of Water	grams	10.0	19.0	29.0	40.0	47.0
K	Weight of Container	grams	248.0	249.0	252.0	245.0	254.0
L	Weight of Dry Soil	grams	509.0	491.0	467.0	496.0	463.0
M	Moisture Content	%	2.0	3.9	6.2	8.1	10.2
N	Dry Density	g/cm ³	1.949	2.021	2.079	2.036	1.960

Maximum Dry Density (MDD):
MDD = 2.079 g/cm³

Optimum Moisture Content (OMC):
OMC = 6.2 %



Remarks:

Tested By: A.KASOKA	Checked By: S.T.PHIRI Date: 10/01/2019	Approved By: Date
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**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 METHOD A7, AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-2 0.5 m (410)	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	GREYISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	KANYAMA TP-2 0.5 m (410)	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer, kg :	4.5
No. of layers :	5	Volume of mold, cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8846	9132	9348	9312	9220
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4761	5047	5263	5227	5135
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	2.005	2.126	2.217	2.202	2.163

	Container	No.	E-18	R-15	H-14	G-19	H-12
H	Wt. Cont + Wet soil	grams	752.0	761.0	738.0	770.0	779.0
I	Wt. Cont + Dry soil	grams	736.0	737.0	705.0	725.0	726.0
J	Weight of Water	grams	16.0	24.0	33.0	45.0	53.0
K	Weight of Container	grams	242.0	258.0	247.0	238.0	249.0
L	Weight of Dry Soil	grams	494.0	479.0	458.0	487.0	477.0

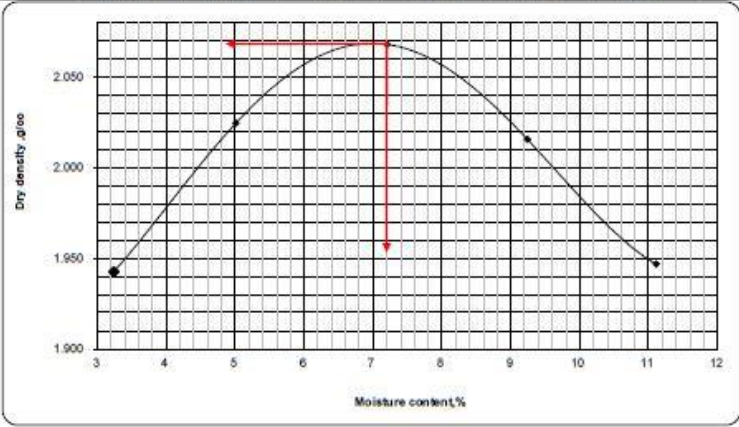
M	Moisture Content	%	3.2	5.0	7.2	9.2	11.1
N	Dry Density	g/cm ³	1.943	2.025	2.068	2.016	1.947

Maximum Dry Density (MDD):

MDD = 2.068 g/cm³

Optimum Moisture Content (OMC) :

OMC = 7.2 %



Remarks: _____

Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By: _____
	Date: 10/01/2019	Date: _____

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7,AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-3 0.3 m	DATE TESTED	11/01/2019	
MATERIAL DESCRIPTION	FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	KANYAMA TP-3 0.3 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2345
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

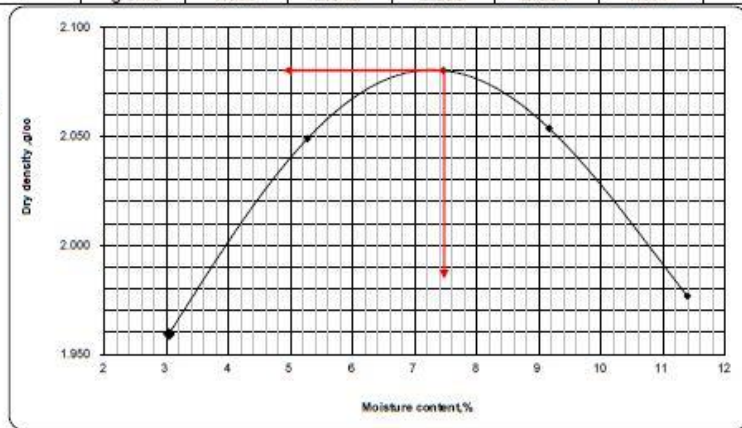
	Mold	No.	M 44	M 44	M 44	M 44	M 44
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8821	9145	9329	9344	9250
C	Wt. of Mold	grams	4087	4087	4087	4087	4087
D	Wt. Wet Soil	grams	4734	5058	5242	5257	5163
E	Volume of Mold	cm3	2345	2345	2345	2345	2345
F	Wet Density	g/cm3	2.019	2.157	2.235	2.242	2.202
G	Container	No.	H-14	H-12	E-18	G-19	R-15
H	Wt. Cont + Wet soil	grams	755.0	768.0	746.0	762.0	786.0
I	Wt. Cont + Dry soil	grams	740.0	742.0	711.0	718.0	732.0
J	Weight of Water	grams	15.0	26.0	35.0	44.0	54.0
K	Weight of Container	grams	247.0	249.0	242.0	238.0	258.0
L	Weight of Dry Soil	grams	493.0	493.0	469.0	480.0	474.0
M	Moisture Content	%	3.0	5.3	7.5	9.2	11.4
N	Dry Density	g/cm3	1.959	2.049	2.080	2.054	1.977

Maximum Dry Density (MDD):

MDD = 2.080 g/cm³

Optimum Moisture Content (OMC):

OMC = 7.5 %



Remarks:		
Tested By: A.KASOKA	Checked By: S.T.PHIRI	Approved By:
	Date: 11/01/2019	Date:

**DETERMINATION OF MODIFIED PROCTOR COMPACTION
(TMH 1 MATHOD A7.AASHTO 180)**

SIDE	_____	Random Sample	Yes <input type="checkbox"/>	No <input type="checkbox"/>
LOCATION	_____	SAMPLE NO.	_____	
MATERIAL TYPE	Gravel	DATE SAMPLED	08/01/2019	
MATERIAL SOURCE	KANYAMA TP-4 0.3 m	DATE TESTED	10/01/2019	
MATERIAL DESCRIPTION	BROWNISH FINE SOIL	SAMPLED BY	_____	
REPRESENTATIVE STATION	KANYAMA TP-4 0.3 m	TESTED BY	_____	
SAMPLING DEPTH	_____	TEST NO.	_____	

No. of blows :	55+1	Weight of hammer,kg :	4.5
No. of layers :	5	Volume of mold,cm ³ :	2374
Proportion retained on 19mm sieve size: (pass 50mm sieve and retained on 19mm sieve)	_____	Single sample / Separate batches :	_____
		Apparent specific gravity :	_____

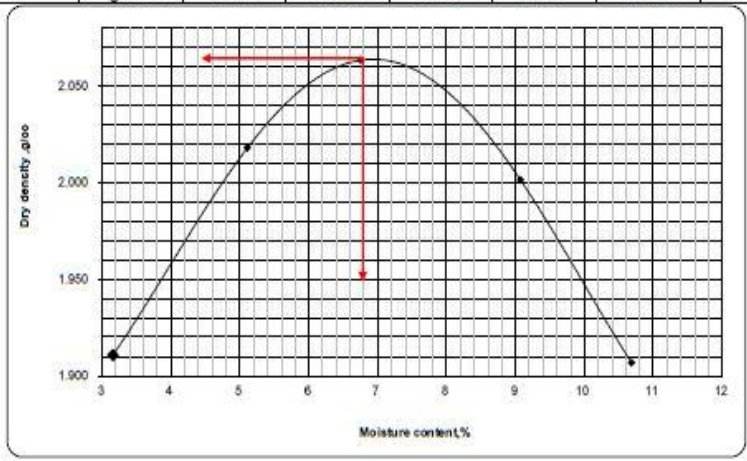
	Mold	No.	M 4	M 4	M 4	M 4	M 4
A	WATER	%	3	5	7	9	11
B	Wt. of Mold + Wet Soil	grams	8764	9120	9314	9267	9095
C	Wt. of Mold	grams	4085	4085	4085	4085	4085
D	Wt. Wet Soil	grams	4679	5035	5229	5182	5010
E	Volume of Mold	cm ³	2374	2374	2374	2374	2374
F	Wet Density	g/cm ³	1.971	2.121	2.203	2.183	2.110
G	Container	No.	S-11	Y-74	B-56	NF-56	HJ-2
H	Wt. Cont + Wet soil	grams	770.0	782.0	738.0	758.0	742.0
I	Wt. Cont + Dry soil	grams	754.0	756.0	707.0	715.0	695.0
J	Weight of Water	grams	16.0	26.0	31.0	43.0	47.0
K	Weight of Container	grams	247.0	247.0	248.0	241.0	255.0
L	Weight of Dry Soil	grams	507.0	509.0	459.0	474.0	440.0
M	Moisture Content	%	3.2	5.1	6.8	9.1	10.7
N	Dry Density	g/cm ³	1.911	2.018	2.063	2.001	1.907

Maximum Dry Density (MDD):

MDD = 2.063 g/cm³

Optimum Moisture Content (OMC):

OMC = 6.8 %



Remarks: _____

Tested By:	Checked By:	Approved By:
Date:	Date:	Date:

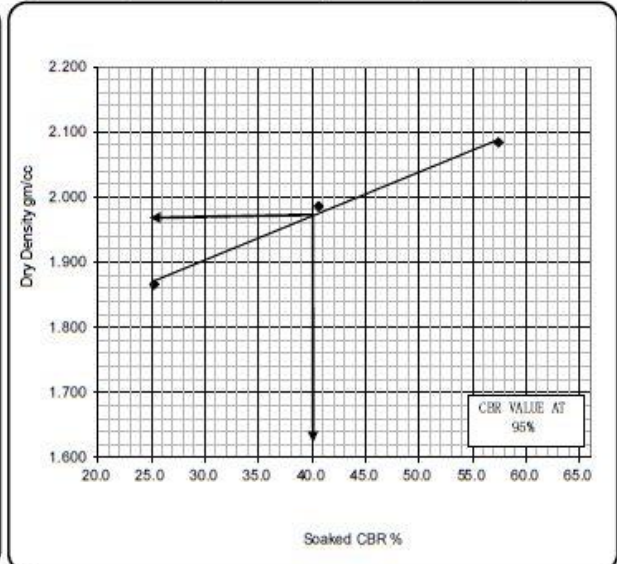
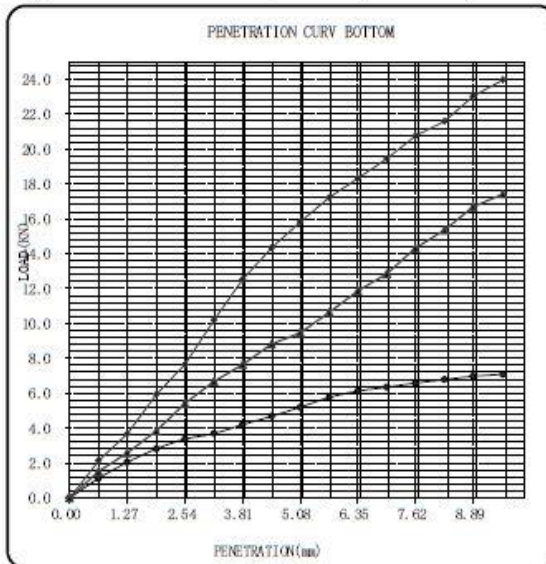
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KANYAMA TP-1 1.3 m (409) (900m)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	GREYISH COARSE SOIL			DATE SAMPLED	08/01/2019					
MATERIAL SOURCE	KANYAMA TP-1 1.3 m (409) (900m)			DATE TESTED	11/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KANYAMA TP-1 1.3 m (409) (900m)			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	M-23			M-24			M-27			
WEIGHT OF SOIL + MOLD, g	9264			9106			8724			
WEIGHT OF MOLD, g	4086			4117			4101			
WEIGHT OF SOIL, g	5178			4989			4623			
VOLUME OF MOLD, g	2344			2370			2337			
WET DENSITY OF SOIL, g/cm ³	2.209			2.105			1.978			
DRY DENSITY OF SOIL, g/cm ³	2.083			1.985			1.866			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	M-C6			A-12						
WET SOIL + CONTAINER, g	884			810						
DRY SOIL + CONTAINER, g	847			779						
WEIGHT OF CONTAINER, g	253			247						
WEIGHT OF WATER, g	37			31						
WEIGHT OF DRY SOIL, g	594			532						
MOISTURE CONTENT	6.2			5.8						
MOISTURE CONTENT AV=				6.0						
PENETRATION BOTTOM TEST										
PENETRATION DATE				15/01/2019			RING FACTOR			0.00
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		2.14			1.52			1.12		
1.27		3.67			2.58			2.04		
1.91		5.94			3.84			2.81		
2.54		7.66	57.4		5.42	40.6		3.37	25.3	
3.18		10.20			6.68			3.69		
3.81		12.53			7.64			4.20		
4.45		14.34			8.82			4.68		
5.08		15.82	79.1		9.47	47.4		5.20	26.0	
5.72		17.22			10.64			5.76		
6.35		18.33			11.87			6.12		
6.99		19.45			12.86			6.35		
7.62		20.75			14.32			6.58		
8.26		21.60			15.36			6.78		
8.89		23.04			16.69			6.97		
9.55		23.97			17.42			7.09		
							Blows	55	25	55
SWELL				rammar			Blows	4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By:W.MUMBA			Checked By:S.T.MUMBA			Approved By:				
			Date:11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	<ANYAMA TP-1 1.3 m (409) (900m)	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	<ANYAMA TP-1 1.3 m (409) (900m)	SAMPLE NO.	
MATERIAL TYPE	GREYISH COARSE SOIL	DATE SAMPLED	08/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.079	55 by 5	6.2	2.083	57.4	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	5.8	1.985	40.6	0.0	0.00		13.24	20.00
6.2	55 by 3	0.0	1.866	25.3	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.871	CBR Value at 90% from the graph = 25.3
CBR Value at 95% MDD = 1.975	CBR Value at 95% from the graph = 40.0
CBR Value at 98% MDD = 2.037	CBR Value at 98% from the graph = 49.5

Comments:

Checked By: _____ **APROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

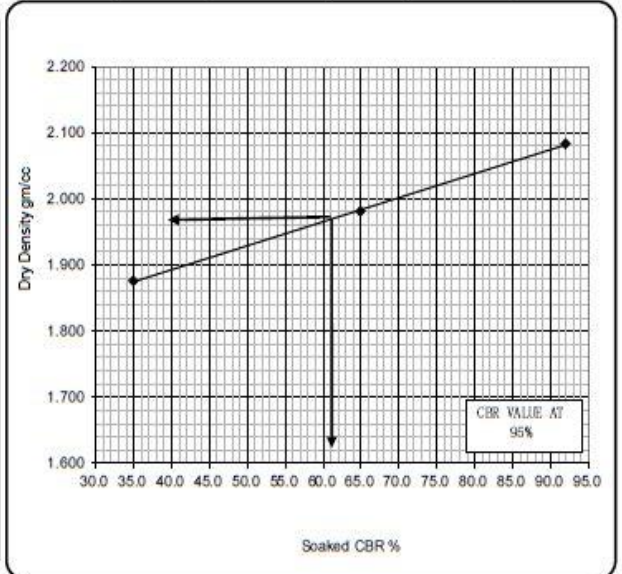
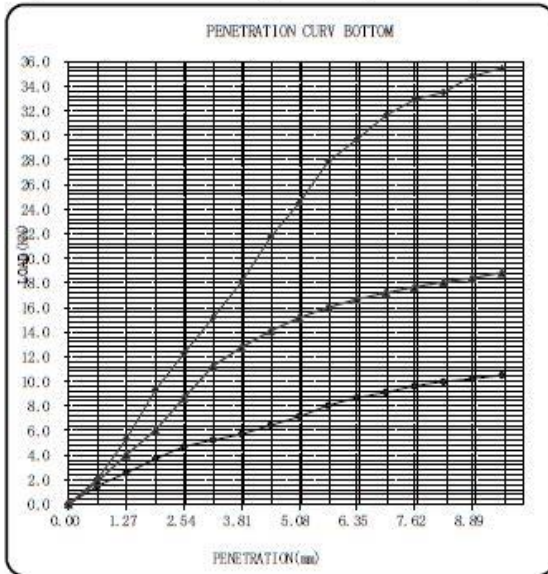
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KANYAMA TP-2 0.5 m (410)			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	GREYISH FINE SOIL			DATE SAMPLED	08/01/2019					
MATERIAL SOURCE	KANYAMA TP-2 0.5 m (410)			DATE TESTED	11/01/2019					
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KANYAMA TP-2 0.5 m (410)			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
MOLD NUMBER	M-26		M-03		M-25					
WEIGHT OF SOIL + MOLD, g	9298		9106		8791					
WEIGHT OF MOLD, g	4078		4075		4098					
WEIGHT OF SOIL, g	5220		5031		4693					
VOLUME OF MOLD, g	2339		2370		2335					
WET DENSITY OF SOIL, g/cm ³	2.232		2.123		2.010					
DRY DENSITY OF SOIL, g/cm ³	2.083		1.981		1.876					
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)		25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)					
	Before		Before		Before					
CONTAINER NUMBER	V-3		V-10							
WET SOIL + CONTAINER, g	849		890							
DRY SOIL + CONTAINER, g	809		847							
WEIGHT OF CONTAINER, g	249		246							
WEIGHT OF WATER, g	40		43							
WEIGHT OF DRY SOIL, g	560		601							
MOISTURE CONTENT	7.1		7.2							
MOISTURE CONTENT AV=			7.1							
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00	0.00			0.00			0.00			
0.64	2.09			1.87			1.47			
1.27	5.30			4.02			2.55			
1.91	9.31			6.03			3.67			
2.54	12.27	92.0		8.66	64.9		4.66	34.9		
3.18	15.19			11.24			5.21			
3.81	18.08			12.76			5.71			
4.45	21.76			14.11			6.42			
5.08	24.52	122.6		15.18	75.9		7.14	35.7		
5.72	27.87			16.01			8.02			
6.35	29.68			16.67			8.64			
6.99	31.63			17.20			9.10			
7.62	32.91			17.67			9.61			
8.26	33.50			18.08			9.96			
8.89	34.82			18.39			10.20			
9.55	35.45			18.84			10.48			
				Blows		55	25	55		
SWELL				rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3		
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	KANYAMA TP-2 0.5 m (410)	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	KANYAMA TP-2 0.5 m (410)	SAMPLE NO.	
MATERIAL TYPE	GREYISH FINE SOIL	DATE SAMPLED	08/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.068	55 by 5	7.1	2.083	92.0	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.2	1.981	64.9	0.0	0.00	0.00	13.24	20.00
7.2	55 by 3	0.0	1.876	34.9	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.861	CBR Value at 90% from the graph = 34.0
CBR Value at 95% MDD = 1.965	CBR Value at 95% from the graph = 61.0
CBR Value at 98% MDD = 2.027	CBR Value at 98% from the graph = 77.0

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

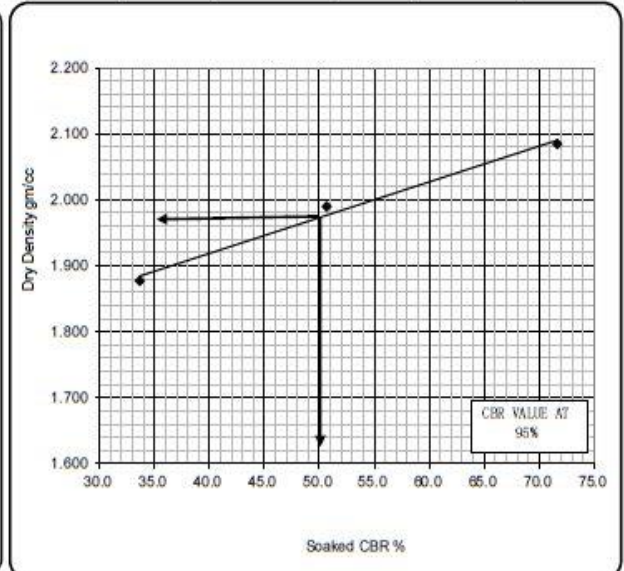
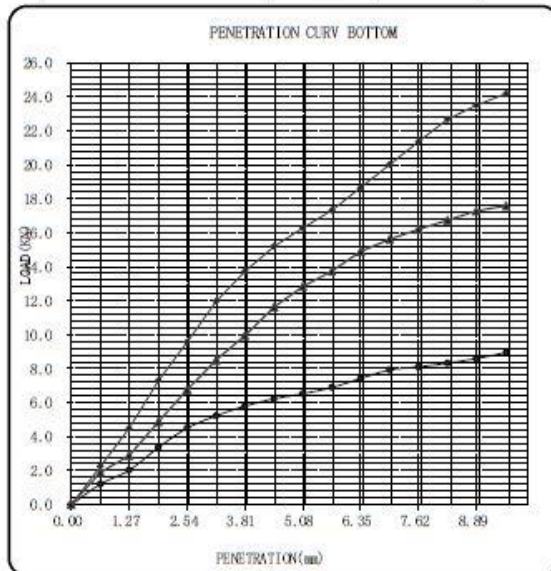
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KANYAMA TP-3 0.3 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	FINE SOIL			DATE SAMPLED						
MATERIAL SOURCE	KANYAMA TP-3 0.3 m			DATE TESTED						
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KANYAMA TP-3 0.3 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
MOLD NUMBER	B-4			B-9			B-10			
WEIGHT OF SOIL + MOLD, g	8458			8145			7956			
WEIGHT OF MOLD, g	3301			3203			3296			
WEIGHT OF SOIL, g	5157			4942			4660			
VOLUME OF MOLD, g	2304			2313			2312			
WET DENSITY OF SOIL, g/cm ³	2.238			2.137			2.016			
DRY DENSITY OF SOIL, g/cm ³	2.084			1.990			1.877			
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Before			Before			Before			
CONTAINER NUMBER	S-51			X-17						
WET SOIL + CONTAINER, g	771			732						
DRY SOIL + CONTAINER, g	735			699						
WEIGHT OF CONTAINER, g	256			244						
WEIGHT OF WATER, g	36			33						
WEIGHT OF DRY SOIL, g	479			455						
MOISTURE CONTENT	7.5			7.3						
MOISTURE CONTENT AV=				7.4						
PENETRATION BOTTOM TEST										
PENETRATION DATE				16/01/2019			RING FACTOR		0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	Dial reading	Load (KN)	C.B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		2.26			1.89			1.20		
1.27		4.48			2.89			2.02		
1.91		7.30			4.87			3.36		
2.54		9.56	71.7		6.76	50.7		4.49	33.7	
3.18		11.98			8.51			5.22		
3.81		13.72			9.95			5.79		
4.45		15.20			11.62			6.22		
5.08		16.28	81.4		12.84	64.2		6.52	32.6	
5.72		17.32			13.75			6.89		
6.35		18.65			14.89			7.42		
6.99		20.02			15.62			7.92		
7.62		21.36			16.20			8.10		
8.26		22.68			16.74			8.32		
8.89		23.51			17.28			8.59		
9.55		24.20			17.59			8.95		
							Blows	55	25	55
SWELL				rammar		4,5kg by 5		4,5kg by 5		2,5kg by 3
Soaking Date				Initial reading (mm)						
Time				Final reading (mm)						
				Height of specimen (mm)						
				Percent Swell (%)						
Remarks:										
Tested By: W.MUMBA			Checked By: T.S.PHIRI			Approved By:				
			Date: 12/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	KANYAMA TP-3 0.3 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	KANYAMA TP-3 0.3 m	SAMPLE NO.	
MATERIAL TYPE	FINE SOIL	DATE SAMPLED	08/01/2019
MATERIAL SOURCE		DATE TESTED	16/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.080	55 by 5	7.5	2.084	71.7	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.3	1.990	50.7	0.0	0.00	0.00	13.24	20.00
7.5	55 by 3	0.0	1.877	33.7	0.0	0.00	0.00	13.24	20.00



CBR Value at 90% MDD = 1.872	CBR Value at 90% from the graph = 33.5
CBR Value at 95% MDD = 1.976	CBR Value at 95% from the graph = 50.0
CBR Value at 98% MDD = 2.038	CBR Value at 98% from the graph = 62.0

Comments: _____

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

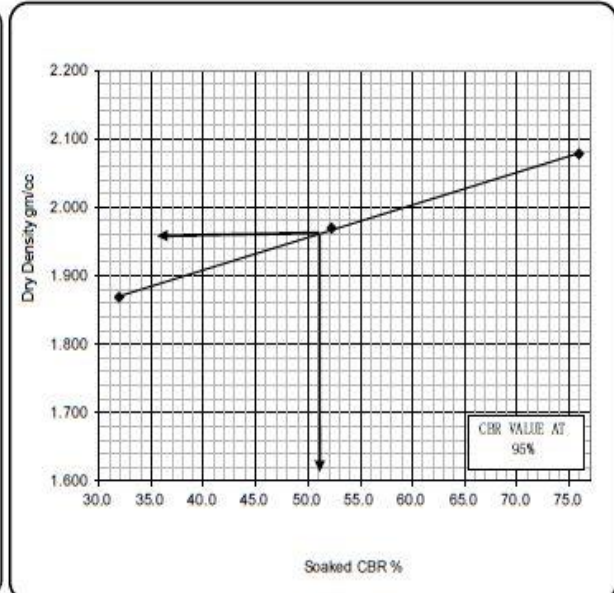
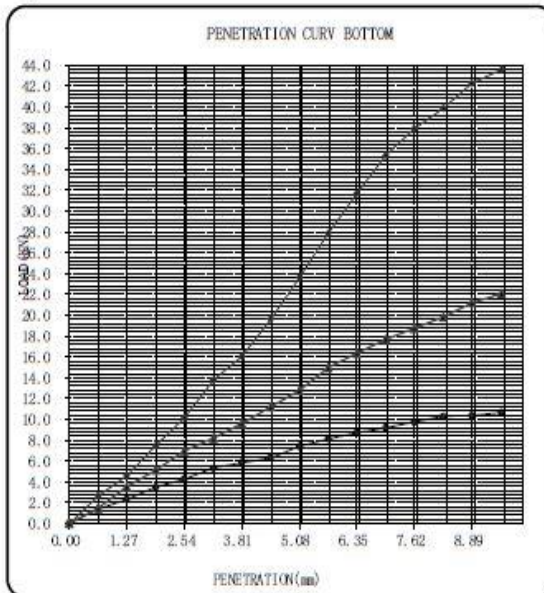
CALIFORNIA BEARING RATIO										
AASHTO T 193										
SAMPLE STATION	KANYAMA TP-4 0.3 m			Random Sample	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>		
LOCATION				SAMPLE NO.						
MATERIAL TYPE	BROWNISH FINE SOIL			DATE SAMPLED		08/01/2019				
MATERIAL SOURCE	KANYAMA TP-4 0.3 m			DATE TESTED		11/01/2019				
MATERIAL DESCRIPTION	Gravel			SAMPLED BY						
REPRESENTATIVE STATION	KANYAMA TP-4 0.3 m			TESTED BY						
SAMPLING DEPTH				TEST NO.						
DENSITY DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before			Before		Before				
MOLD NUMBER	M-2			M-5		M-6				
WEIGHT OF SOIL + MOLD, g	9360			8990		8856				
WEIGHT OF MOLD, g	4073			4073		4129				
WEIGHT OF SOIL, g	5287			4917		4727				
VOLUME OF MOLD, g	2379			2334		2365				
WET DENSITY OF SOIL, g/cm ³	2.222			2.107		1.999				
DRY DENSITY OF SOIL, g/cm ³	2.078			1.970		1.869				
MOISTURE DETERMINATION										
SOAKING CONDITION	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)		55 by 3 layers Blows (2,5kg)				
	Before			Before		Before				
CONTAINER NUMBER	MG-3			M-50						
WET SOIL + CONTAINER, g	772			764						
DRY SOIL + CONTAINER, g	739			730						
WEIGHT OF CONTAINER, g	257			250						
WEIGHT OF WATER, g	33			34						
WEIGHT OF DRY SOIL, g	482			480						
MOISTURE CONTENT	6.8			7.1						
MOISTURE CONTENT AV=				7.0						
PENETRATION BOTTOM TEST										
PENETRATION DATE			15/01/2019			RING FACTOR			0.00	
PENETRATION (mm)	55+1 by 5 Layer Blows (4,5kg)			25 by 5 layers Blows (4,5kg)			55 by 3 layers Blows (2,5kg)			
	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	Dial reading	Load (KN)	C. B.R.(%)	
0.00		0.00			0.00			0.00		
0.64		2.67			1.48			1.36		
1.27		4.58			3.53			2.32		
1.91		7.49			5.12			3.48		
2.54		10.13	75.9		6.97	52.2		4.26	31.9	
3.18		13.76			8.18			5.29		
3.81		16.03			9.60			5.82		
4.45		19.64			11.19			6.33		
5.08		23.60	118.0		12.78	63.9		7.38	36.9	
5.72		27.87			14.97			8.10		
6.35		31.67			16.33			8.69		
6.99		35.34			17.69			9.18		
7.62		37.91			18.73			9.74		
8.26		39.87			19.82			10.26		
8.89		42.26			21.18			10.37		
9.55		43.59			22.08			10.65		
						Blows				
						55		55		
						4,5kg by 5		2, 5kg by 3		
Soaking Date			rammar			Initial reading (mm)				
Time						Final reading (mm)				
						Height of specimen (mm)				
						Percent Swell (%)				
Remarks:										
Tested By: W.MUMBA			Checked By: S.T.PHIRI			Approved By:				
			Date: 11/01/2019			Date				

CALIFORNIA BEARING RATIO

AASHTO T 193

SAMPLE STATION	KANYAMA TP-4 0.3 m	Random Sample	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
LOCATION	KANYAMA TP-4 0.3 m	SAMPLE NO.	
MATERIAL TYPE	BROWNISH FINE SOIL	DATE SAMPLED	08/01/2019
MATERIAL SOURCE		DATE TESTED	15/01/2019
MATERIAL DESCRIPTION	Gravel	SAMPLED BY	
REPRESENTATIVE STATION		TESTED BY	
SAMPLING DEPTH		TEST NO.	

M.D.D (gm/cm ³)	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Load (KN)	
								2.54 mm	5.08 mm
2.063	55 by 5	6.8	2.078	75.9	0.0	0.00	0.00	13.24	20.00
O.M.C. %	30 by 5	7.1	1.970	52.2	0.0	0.00		13.24	20.00
6.8	55 by 3	0.0	1.869	31.9	0.0	0.00		13.24	20.00



CBR Value at 90% MDD = 1.857	CBR Value at 90% from the graph = 31.5
CBR Value at 95% MDD = 1.960	CBR Value at 95% from the graph = 51.0
CBR Value at 98% MDD = 2.022	CBR Value at 98% from the graph = 64.0

Comments:

Checked By: _____ **APPROVED BY:** _____

Date: _____

Test Results Within Engineering Limits: Yes No

SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Location: Kanyama	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehabilitation		Tested by: W. Mumba
Trial Pit No.	Resistivity Ohm-Centimetre	
1	3302	
2	3023	
3	3555	
4	3105	

PREPARED BY

BONIFACE M PHIRI (RENG, MEIZ) 0955-884126 OR 0965-884126

NOTE:

THE GROUNDS APPEAR TO BE VERY CORROSIVE, PROPER GROUNDING/EARTHING SYSTEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY



Lusaka Transmission Distribution Rehabilitation Project (LTDRP) - Design and Supervision of the Low Voltage Distribution Network

Project Accounting No. FED/2016/038-238

Report on Geotechnical Investigations, September 2019 Part II: Kalingalinga, Mtendere, Mandevu, and Ngwerere

Financier:



European Union under the 11th European Development Fund
Plot No. 4889, Los Angeles Boulevard, P.O. Box 34871
Lusaka, Zambia

Contracting Authority:



National Authorising Office (NAO) of the European Development
Fund (EDF), on behalf of the Ministry of Finance
Lusaka, Zambia

Supervisor:



ZESCO Limited
Stand No. 6949, Great East Road
P.O. Box 33304, Lusaka, Zambia

Contractor:



GOPA-International Energy Consultants GmbH
Justus-von-Liebig-Str. 1, 61352 Bad Homburg, Germany
Phone: +49-6172-1791-800; Fax: +49-6172-944 95 20
eMail: info@gopa-intec.de; www.gopa-intec.de

This project is funded by the European Union



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Abbreviations

DCPT	Dynamic Cone Penetration Test
SPT	Standard Penetration Test
RH	Auxiliary Earth Resistance
RE	Earth Resistance
Ω	Ohms
P	Soil Resistivity value

Summary

The Geotechnical investigation was carried out at various sites in designated peri-urban townships to provide the design engineering consultant and subsequently the works contractor with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters in the various townships on the basis of which pole hole excavation material types and soil conditions would be determined under the bill of quantities.

Geophysical investigation for soil resistivity was carried out as per ASTM G57 using an MS2308 Advanced Earth Resistance Tester with four probes. The Wenner's four-electrode method was used to determine the earth resistivity.

The results obtained from the¹ pole Wenner test method from the four sites reveal that the soil resistance ranges from 0.8 to 298 Ω .

Kalingalinga had the lowest recorded values whilst Ngwerere site had the highest recorded values. The soil resistivity values of the four sites range from 42.08 m Ω in Kabanana area under Mandevu township to 2244.4 m Ω in Mtendere area.

The bearing capacities of soils in different sites varied from point to point. The general ground condition of the four sites is underlined by laterite soils and rock. Mtendere and Ngwerere townships had rocky surfaces compared to Kalingalinga and Mandevu.

Groundwater within a depth of 10 meter was only located in Kalingalinga and in Mandevu townships at depths of 3.3 m and 1.3 m, respectively.

¹ Volker Hennings, Jan Willer, Sesele Sokotela, Angela Bwalya & Tewodros Tena: (Technical Note No. 9) Development of a Groundwater Information & Management Program for the Lusaka Groundwater Systems

1. Introduction

Civil Elements Consulting Engineers (CECE) was commissioned by AMP Consult Limited on behalf of GOPA-International Energy Consultants GmbH (acronym: **intec**) in March 2019 to provide geotechnical services in support of the design and construction of low voltage networks under the Lusaka Transmission and Distribution Rehabilitation Project.

Sites in four townships, namely Kalingalinga, Mtendere, Mandevu and Ngwerere, were investigated with a total number of 16 test points. Standard penetration tests (SPT), dynamic cone penetration tests (DCPT) and earth resistance and soil resistivity tests were performed.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of the proposed project. The findings and resulting geotechnical recommendations are presented in this report.

This report describes the general soil conditions for the area covered by each township based on the tests that were specified. The results are agreeable with the subsurface conditions for Lusaka region which has the soil type Pd5 consisting of a parent material of Limestone/Dolomite of the Cheta Formation and Schists of the Chunga Formations.

2. Site Locations

The sites are located within Lusaka (cf. Figure 1 to Figure 3)

Figure 1: Site Location for Kalingalinga and Mtendere Test Points



Test point where both SPT and soil resistivity tests were conducted



Test point where only SPTs were conducted

Figure 2: Site Location for Mandevu Test Points

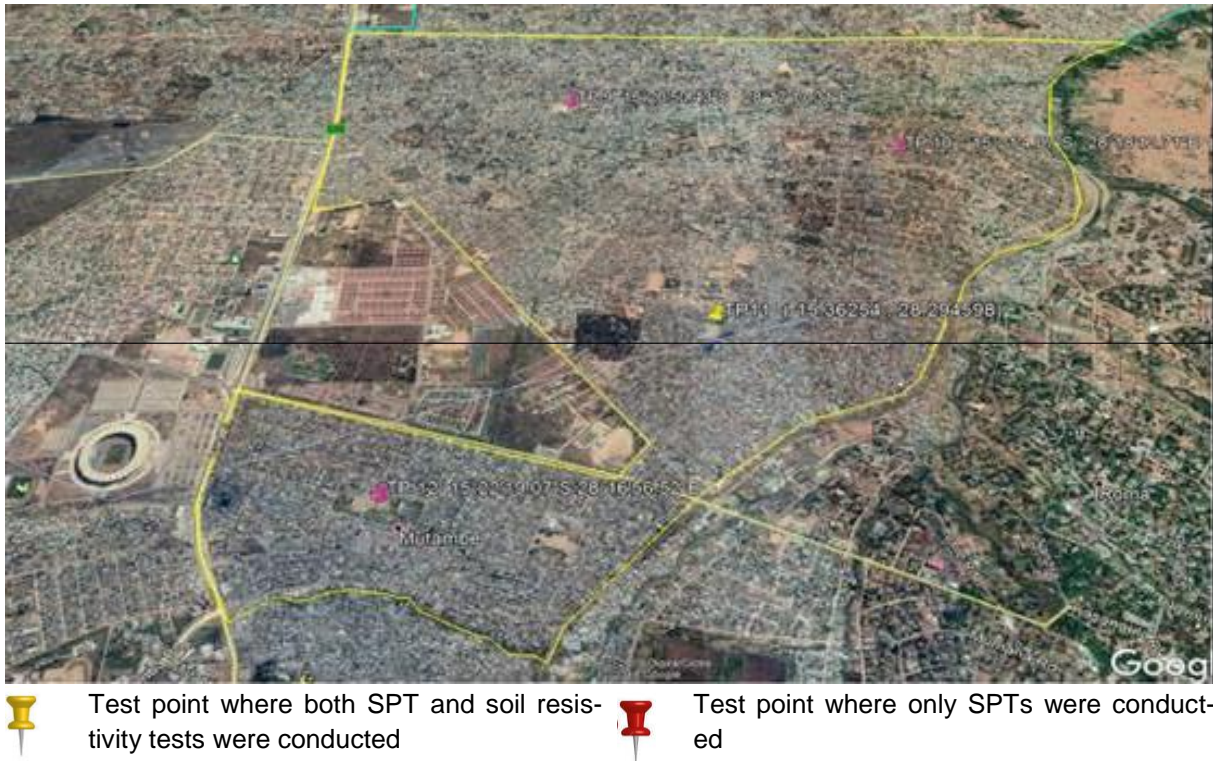
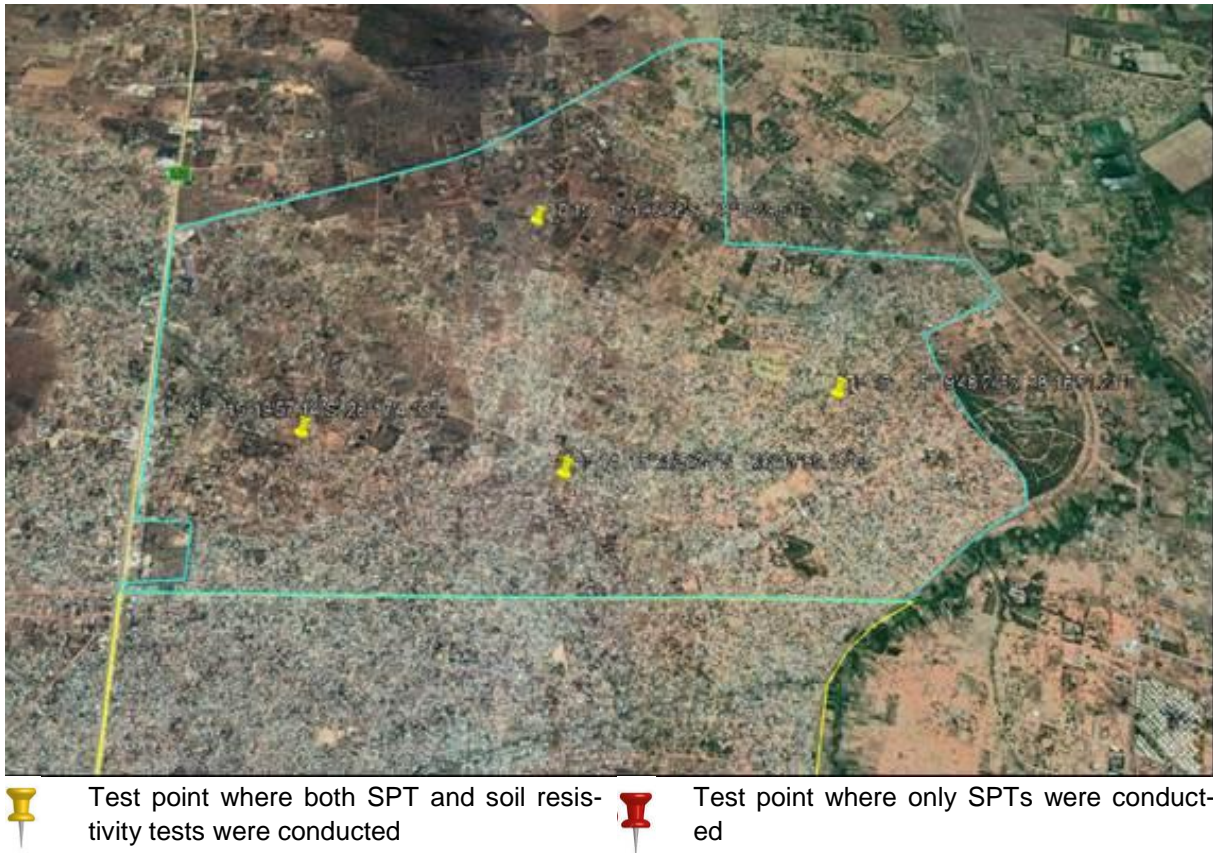


Figure 3: Site Location for Ngwerere Test Points



The location coordinates of the test points are as shown in Table 1 below.

Table 1: Coordinates of the Test Points

Site	Test Point	Coordinates	
Kalingalinga	TP1	15°24'18.44"S	28°19'52.13"E
Mtendere	TP2	15°24'19.28"S	28°21'30.58"E
Kalingalinga	TP3	15°24'15.06"S	28°20'53.55"E
Mtendere	TP4	15°23'56.76"S	28°21'34.71"E
Mtendere	TP5	15°24'25.68"S	28°22'4.01"E
Mtendere	TP6	15°24'1.24"S	28°22'19.30"E
Mtendere	TP7	15°24'9.69"S	28°22'47.47"E
Mtendere	TP8	15°23'50.97"S	28°22'41.98"E
Mandevu	TP9	15°20'50.43"S	28°17'17.31"E
Mandevu	TP10	15°21'4.07"S	28°18'12.71"E
Mandevu	TP11	15°21'45.69"S	28°17'40.26"E
Mandevu	TP12	15°22'19.07"S	28°16'56.52"E
Ngwerere	TP13	15°19'57.14"S	28°17'4.13"E
Ngwerere	TP14	15°20'5.34"S	28°17'56.10"E
Ngwerere	TP15	15°19'8.68"S	28°17'49.51"E
Ngwerere	TP16	15°19'48.24"S	28°18'51.21"E

3. Surface Conditions / Climate

Lusaka city experiences a subtropical climate that is strongly seasonal. It has three distinct seasons namely:

- Cool, dry season from mid-April to mid-August, with mean day temperature varying between 15°C and 23°C. Minimum temperatures may sometimes fall below 10°C in June and July.
- A hot dry season lasting from mid-August to mid-November. During this period, day temperatures may vary between 27°C and 38°C.
- A warm, wet season from mid-November to mid-April, during which 95% of the annual rainfall takes place. The annual rainfall averages about 8mm/a

The average wind speed is 7 mph (3.3 m/s)

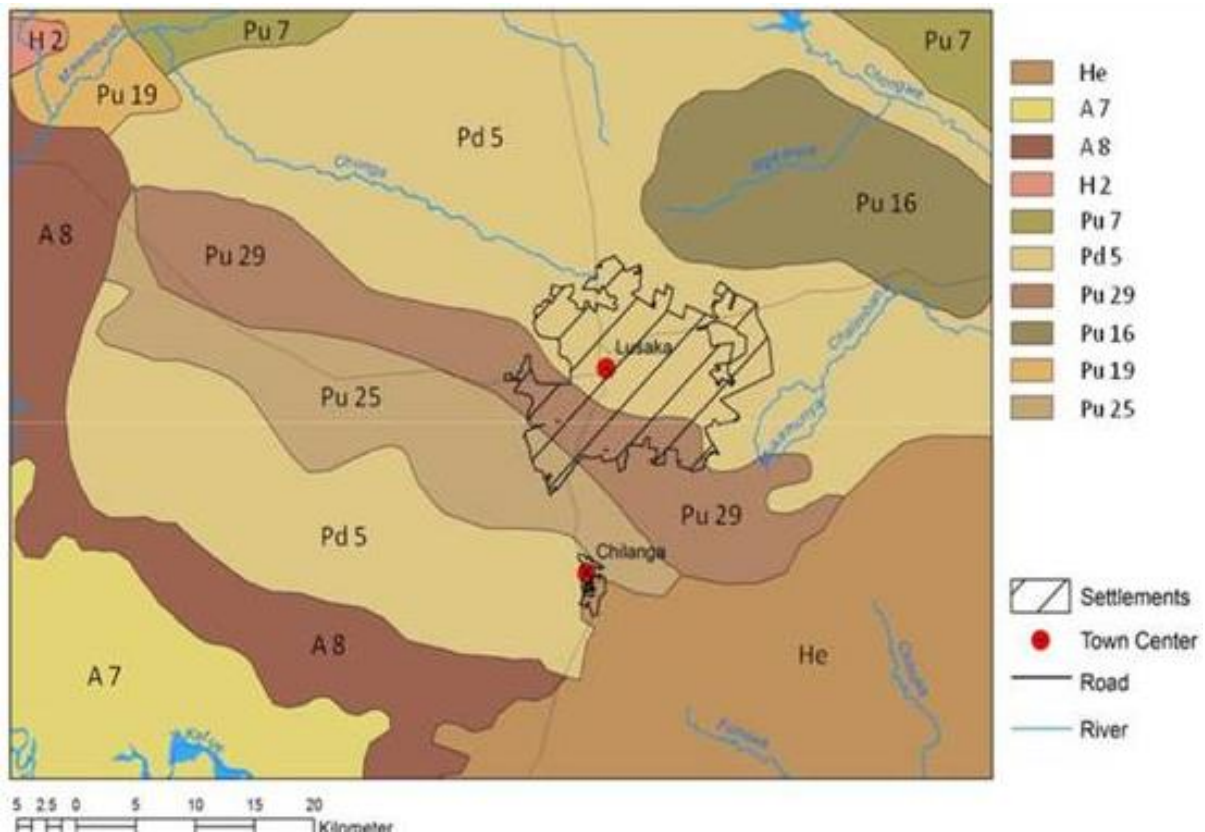
4. Subsurface Conditions

4.1 Geological Conditions

Lusaka is the capital city of Zambia, a country in the Central African Plateau with an average altitude of 1,000 to 1,400 m above sea level.

As can be seen from the detailed exploratory soil map of Zambia below, Lusaka lies in soils classified as Pu 25, Pu 29 and Pd5.

Figure 4: Soil Map of Zambia



Pu29 are Leptosols, loamy soils that are shallow, well to poorly drained soils. Their parent material is Lusaka dolomite.

Pu25 are Phaeozems, clayey soils, which are very deep, well drained, and humous. Their parent material is schist and quartzite of the Cheta formation.

Pd5 are Leptosols + Lixisols found in plateaus; they are shallow, loamy to clayey soils with a humous top soil deep, loamy to clay soils with clay reaching. Their parent material Limestone/Dolomite of the Cheta formation and Schists of the Chunga formation².

The geological formation of Lusaka area is underlain by Precambrian metasediments (metamorphosed sediments), which have been intruded by the Katanga system (sequence of rocks older than 700 million years) and the basement complex (rocks older than 1700 million years). The area east of Lusaka is underlain by the lower part of the Katanga system and is composed of rocks belonging to the Chunga and Cheta formations. (Shitumbanuma)¹

According to Victor Chitumbanuma³ 1989 "The Cheta formation which is assumed to be of the upper Katanga formation is made up of two calcareous and two schists members. The lower of the two limestones is thicker. Both of the limestone range in composition from pure dolomite to pure limestone. Banded argillaceous limestone occurs in the east of Lusaka.

The Schist of the Cheta formation include a number of thin quartzite horizons and are of a lower metamorphic grade than those of the Chunga. In these schists, biotite is subordinate to muscovite, and garnet is rare. The commonest type of rock is fine grained quartzite-muscovite schist. In the east of Lusaka the Schist is predominantly aging in a succession of grey quartzite schists and weakly foliated semi pelitic rocks. These Schist are thought to be originally the same as the schists of Chunga.

The deposits of the quaternary to recent period are thought to have formed during the last the last 20000 years. These superficial deposits are mainly products of decomposition of underlying rocks that have had various forms of transportation and redistribution. Schists and quartzite have been covered by thick deposits of superficial clay and quartz gravel in most parts east of Lusaka.

The site is are in Kalingalinga, Mtendere, Mandevu and Ngwerere, which is located in the region with the soil type Pd5 as indicated above. This region has a parent material of Limestone/Dolomite of the Cheta formation and Schists of the Chunga formation.

4.2 Seismic Hazards

The Seismic Hazard Map⁴ (United Nations Global Seismic Hazard Assessment Program (cf. Figure 5) and the United Nations Office for the Coordination of Humanitarian Affairs resource centre indicates that:

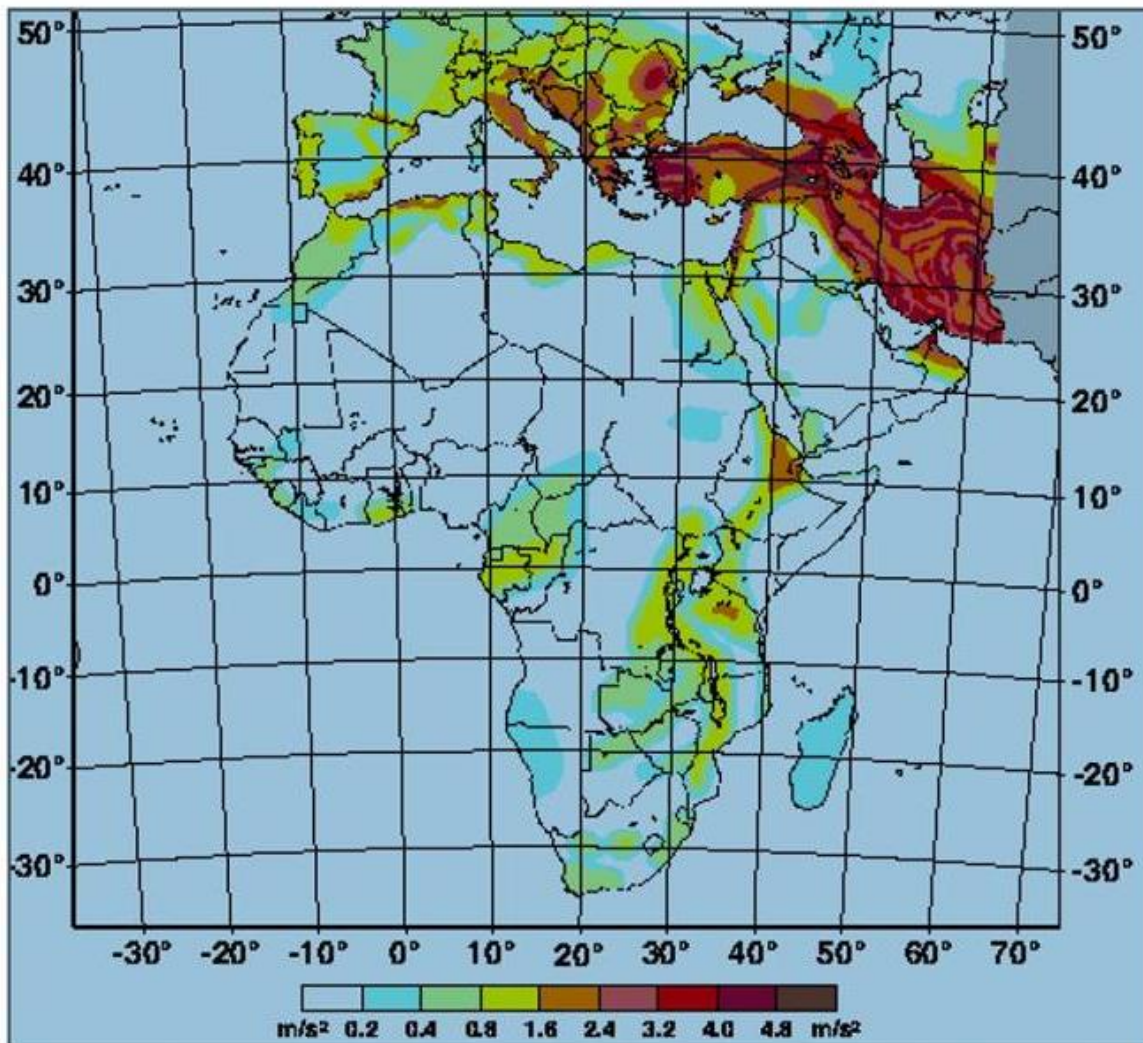
- the project is located in a zone of Moderate Intensity Seismicity with Peak Ground Accelerations up to 0.8 m²/s
- this value is the equivalent of an Operating Basis Earthquake (OBE); and the OBE is considered to occur not more than once in a period of 100 years.

² Volker Hennings, Jan Willer, Sesele Sokotela, Angela Bwalya & Tewodros Tena: Technical Note No. 9

³ Victor Shatumbanuma. Thesis: Mineralogical and Micromorphological Characteristics of Two Soil Sequences of the UNZA Farm in Zambia, Pg. 9

⁴ <http://gmo.gfz-potsdam.de/pub/poster/poster.html>

Figure 5: Seismic Hazard Map



4.3 Groundwater

The Upper Roan Dolomite and Kundelungu Limestone of the Katanga Super group form highly productive aquifers in which fractures provide the dominant permeability and storage. The aquifers are mostly between 15 and 50 m thick. The water table is generally from 20 to 35 m below ground surface. The aquifers are usually unconfined. The maximum borehole depth is 50 to 70 m, with water occasionally struck at depths as great as 120 to 150 m. Transmissivity values of up to 800 to 1000 m²/day are reported (United Nations 1989). Yields are typically high: one study of 190 boreholes found an average yield of 6 l/s, with some boreholes known to yield 10-20 l/s and even more than 50 l/s. The highest yielding boreholes are in the areas of Lusaka, Ndola, Kabwe and Mpongwe. (Nkhuwa et al)⁵

⁵ Nkhuwa, D.C.W., Kang'omba, S., Chomba, K.C., Crane, E., Upton, K. & Ó Dochartaigh, B.É. 2016. Africa Groundwater Atlas: Hydrogeology of Zambia. British Geological Survey (http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Zambia)

5. Scope of Works

5.1 Earth Resistance and Soil Resistivity

Geophysical investigation for soil resistivity was carried out as per ASTM G57 using an MS2308 Advanced Earth Resistance Tester with four probes. The Wenner four-electrode method was used to determine the earth resistivity.

The four metal electrodes were placed with equal separation in a straight line in the surface of the soil to a depth not exceeding 5 % of the minimum separation of the electrodes. The spacing between the electrodes was at 1m, 2m, 3m, 6m and 10m.

The electrode separation was selected with consideration of the soil strata of interest. The resulting resistivity measurement represented the average resistivity of a hemisphere of soil of a radius equal to the electrode separation.

2 points at Kalingalinga site, 4 points at Mtendere site, 2 points at Mandevu site and 4 points at Ngwerere site were tested (refer to Figure 1 to Figure 3 above).

Figure 6: MS2308 Advanced Earth Resistance Tester



Figure 7: Soil Resistivity Testing at Kalingalinga Grounds



Figure 8: Soil Resistivity Testing at Kalikiliki Grounds



Figure 9: Soil Resistivity Testing at Chitukuko Basic School in Mtendere



Figure 10: Soil Resistivity Testing at Kalikiliki Grounds at Kabangwe, Mtendere East



Figure 11: Soil Resistivity Testing at Kabangwe (Ngwerere Site)



Figure 12: Soil Resistivity Testing at Vera Chiluba Basic School in Kalingalinga



Figure 13: Soil Resistivity Testing in Mandevu



Figure 14: Soil Resistivity Testing at Mandevu



Figure 15: Soil Resistivity Testing at Ibex Extension (Mtendere)



Figure 16: Rocky Ground at Kabangwe Area in Ngwerere



Figure 17: Rocky Ground at Kabangwe Area in Ngwerere



Figure 18: Rocky Ground at Ibex Extension in Mtendere



Figure 19: Laterite Soils at Ibex Extension in Mtendere



5.2 Dynamic Cone Penetration Test

This test was done in accordance with BS 1377: 1990, Part 9.

In this test, a standard cone 50 mm in diameter, having an apex angle of 60°, attached to a string of drill rods is driven directly in the ground under the bows of a 65 kg hammer falling from a height of 750 mm. The number of blows for 30 cm penetration is termed the penetration resistance and is designated as N_{cd} . The N_{cd} value is correlated with SPT value, N as under:

$$N_{cd} = 1.5N$$

Refusal is deemed to have met if under 50 blows penetration achieved is less than 10 cm. The definition of Refusal in geotechnical terms means that the condition reached when a pile or a soil sampler being driven by a hammer has negligible penetration from each blow of the hammer occurring when very hard soil or rock is encountered.

The above correlation is meant for sandy soils. In bouldery deposits and friable rocky strata, evaluation of strength and compressibility characteristics by using elaborate tests is prohibitively uneconomical. As a conservative approach, the above correlation can be used in such a strata to arrive at a safe value of 'N' that takes care of highly erratic variations of properties of such strata. Once the "N" value based on N_{cd} value is known, the bearing capacity analysis can be performed as in case of sandy deposits.

Figure 20: DCPT at Vera Chiluba Basic School in Helen Kaunda



Figure 21: DCPT in Progress at Chitukuko Basic School Mtendere



Figure 22: DCPT in Progress at Chipata Ground in Mandevu



Figure 23: Pole Tilted Due to Weak Founding Soils near Mutamba Grounds



Figure 24: SPT in Progress in Mtendere



Figure 25: SPT in Progress at Kalikiliki Ground in Mtendere



Figure 26: Rocky Ground at Ibex Extension in Mtendere



Figure 27: Preparatory works at a work site



Figure 28: DCPT in Progress at Ibex Extension in Mtendere



Figure 29: DCPT in Progress



6. Discussion

6.1 Soil Resistance and Resistivity

Table 2 below indicates the limits of mean values of resistivity for different soil types. The results obtained from the field tests were compared with these values so as to describe the type of soil.

Table 2: Mean Value of Resistivity for Different Soil Types

Type of Soil	Mean Value of Resistivity in Ωm
Swampy soil, bogs	1 - 30
Silt alluvium	20 - 100
Humus, leaf mould	10 - 150
Peat, turf	5 - 100
Soft clay	50
Marl and compacted clay	100 - 200
Jurassic marl	30 - 40
Clayey sand	50 - 500
Siliceous sand	200 - 300
Stoney ground	1,500 - 3,000
Grass-covered-stoney sub-soil	300 - 500
Chalky soil	100 - 300
Limestone	1,000 - 5,000
Fissured limestone	500 - 1,000
Schist, shale	50 - 300
Mica schist	800
Granite and sandstone	1,500 - 10,000
Modified granite and sandstone	100 - 600
Fertile soil, compacted damp fill	50
Arid soil, gravel, uncompacted non-uniform fill	500
Stoney soil, bare, dry sand, fissured rocks	3,000

Source: <https://www.electricalengineeringtoolbox.com/2015/12/soil-resistivity-values-for-different.html>



A summary of the earth resistance and soil resistivity results obtained during the tests for the four sites are as shown in Table 3. The results obtained from the 4-pole Wenner test method from the four sites reveal that the soil resistance ranges from 0.8 to 298 Ω . Kalingaliga had the lowest recorded values whilst Ngwerere site had the highest recorded values.



The soil resistivity values of the four sites range from 42.08 m Ω in Kabanana area under Mandevu township to 2244.4 m Ω in Mtendere township.



Ngwerere township sites consistently had higher values of soil resistivity than all the sites due to the laterite rocks in the area. The values were ranging between 334.25 to 1973 m Ω.

Low soil resistivity values were observed at Kalingalinga ground, ranging from 42.12 to 287.95 m Ω. The soil type in this area ranged from gravelly sandy clay to sandy clay.

Table 3: Summary of Soil Resistivity Results

SOIL RESISTIVITY TEST					
					
		LOCATION	DEPTH (m)	EARTH RESISTANCE RE (Ω)	SOIL RESISTIVITY ρ (mΩ)
Kalingalinga Ground TP1 15°24'19.2"S 28°19'51.7"E	10	3	110	gravelly sandy clay	
	6	3.54	88.3	gravelly sandy clay	
	3	4.79	60.2	sandy clay	
	2	6.75	42.12	sandy clay	
	1	0.83	53	sandy clay	
Kalingalinga (Vera Chiluba basic school) TP3 15°24'14.4"S 28°20'53.3"E	10	1.69	104.345	gravelly sandy	
	6	4.305	160.25	gravelly sandy	
	3	15.485	267.6	sandy clay	
	2	21.06	287.95	firm sandy clay	
	1	26.235	164.1	firm sandy clay	
Mutendere (Chitukuko Basic School) TP4 15°23'56.76"S 28°21'34.71"E	10	2.835	177.95	gravelly sandy clay	
	6	4.66	173.45	gravelly sandy clay	
	3	11.255	211.2	gravelly sandy clay	
	2	15.135	190.45	sandy clay	
	1	29.085	182.85	sandy clay	
Mutendere East TP5 15°24'21.3"S 28°22'07.8"E	10	28.45	2244.4	Laterite rock	
	6	15.835	594.05	laterite	
	3	36.05	669.65	laterite	
	2	54.35	680.4	laterite	
	1	77.45	484.6	laterite	
Mutendere East TP6 15°24'01.9"S 28°22'19.3"E	10	2.525	156.55	sandy clay	
	6	6.95	266.6	laterite	
	3	19.24	363.05	sandy laterite	
	2	33.2	416.35	sandy laterite	
	1	52.7	330.8	sandy clay	
Mutendere (IBEX EXTENSION) TP7 15°24'11.0"S 28°22'47.1"E	10	14.9	829.1	laterite	
	6	26	958.5	laterite	
	3	4.4	120.1	shale	
	2	11.03	136.8	shale	
	1	84	402.3	shale	

SOIL RESISTIVITY TEST		Civil Elements consulting Engineers			
					
		(m)	RE (Ω)	ρ ($m\Omega$)	
Mandevu Kabanana TP10 15°21'04.1"S 28°18'14.6"E	10	1.69	114.8	gravelly sandy	
	6	2.68	100.2	gravelly sandy	
	3	3.62	67.83	sandy clay	
	2	4.79	59.9	sandy clay	
	1	6.71	42.08	sandy clay	
Mandevu (Chipata Compound) TP11 15°21'45.2"S 28°17'40.6"E	10	1.425	87.16	laterite soils	
	6	3.2	118.85	laterite soils	
	3	6.305	117.7	gravelly sandy clay	
	2	9.43	118.45	gravelly sandy clay	
	1	18.355	115.15	compacted sandy clay	

SOIL RESISTIVITY TEST		Civil Elements consulting Engineers			
					
		LOCATION	DEPTH	EARTH RESISTANCE	SOIL RESISTIVITY
		(m)	RE (Ω)	ρ (mΩ)	
Ngwerere (Kabangwe) TP13 15°19'58.1"S 28°17'04.2"E	10	12.1	760.85	Laterite rock	
	6	40.3	1468	Laterite rock	
	3	90.8	1973.5	Laterite rock	
	2	148.15	2190	Laterite rock	
	1	195.8	1632	laterite	
Ngwerere (Maichola) Tp14 15°20'05.3"S 28°17'56.3"E	10	5.325	334.25	laterite	
	6	10.8	389.9	laterite	
	3	41.8	787.7	laterite soils	
	2	63.75	623.5	laterite soils	
	1	78.25	491.7	gravelly sandy clay	
Ngwerere TP15 15°19'05.6"S 28°17'47.7"E	10	14.3	895.4	Laterite soils	
	6	29.36	1107	Laterite soils	
	3	75.7	1426	Laterite rock and soil	
	2	81.9	1029	Laterite soils	
	1	163	1024	Laterite soils	
Ngwerere TP16 15°19'34.6"S 28°18'43.4"E	10	8.35	659.2	Laterite	
	6	26.65	1000.6	Laterite rock	
	3	92.65	1746	Laterite rock	
	2	130.8	1660	Laterite rock	
	1	292.45	1836.5	Laterite rock	

6.2 Bearing Capacity

A summary of bearing capacity for the four sites is as shown in Table 4 below. Generally, the four sites are underlain by laterite soils and rock.

Table 4: Summary of Soil Bearing Capacities

Material Testing Report (Bearing Capacities kN/m ²)						
Depth	Varying					
Test Pit No. Sample No.	TP1	TP2	TP3	TP4	TP5	TP6
Depth						
0	0	0	0	0	0	0
0.3	365	275	162	325	365	195
0.6	464	365	217	380	464	280
0.9	404	180	310	217	404	105
1.2	440	217	275	152	440	20
1.5	325	217	245	131	325	60
1.8	365	275	195	105	365	75
2.1	464	245	131	152	464	105
2.4	392	392	75	152	392	152
2.7	488	310	75	152	488	245
3	440	365	45	152	440	162
3.3	464	325	30	131	464	245
3.6	476	206	45	295	476	275
3.9	392	275	105	428	392	217
4.2	428	217	131	464	428	245
4.5	365	340	260	488	365	275
4.8	416	275	380		416	217
5.1	476	464	365		476	245
5.4	440	280	392		440	275
5.7	488	245	392		488	280
6	380	275	452			295
6.3	325	325	404			275
6.6	392	275	428			260
6.9	428	340	464			280
7.2	404		488			340
7.5	464					>600
7.8						
8.1						
8.4						
8.7						
9						
9.3						

Material Testing Report (Bearing Capacities kN/m ²)						
Depth	Varying					
Test Pit No. Sample No.	TP7	TP8	TP9	TP10	TP11	TP12
Depth						
0	0	0	0	0	0	0
0.3	365	275	162	325	365	195
0.6	464	365	217	380	464	280
0.9	195	195	245	184	162	75
1.2	195	245	195	295	120	120
1.5	184	184	217	452	75	152
1.8	206	295	180	365	45	20
2.1	245	365	245	260	60	nil
2.4	217	325	365	275	184	nil
2.7	275	295	245	310	365	nil
3	295	365	275	416	392	nil
3.3	365	392	295	260	340	45
3.6	245	275	275	275	380	75
3.9	217	260	217	275	440	75
4.2	325	325	295	365	404	105
4.5	404	365	340	295	440	142
4.8	464	404	404	245	476	120
5.1	392	275	452	280	512	245
5.4	488	195	428	325	535	245
5.7	488	245	392	380	550	142
6	440	245	440	392		340
6.3	488	295	476	416		392
6.6		365	340	440		440
6.9		365	380	464		464
7.2		392	404	440		488
7.5		440	452	404		440
7.8		404	428	380		416
8.1		512	416	440		440
8.4			452	>600		464
8.7						488
9						512
9.3						525
9.6						488
9.9						525
10.2						

Material Testing Report (Bearing Capacities kN/m ²)						
Depth	Varying					
Test Pit No. Sample No.	TP13	TP14	TP15	TP16		
Depth						
0	0	0	0	0		
0.3	195	75	60	75		
0.6	275	105	45	120		
0.9	295	75	45	260		
1.2	365	131	45	280		
1.5	340	162	75	380		
1.8	404	142	60	325		
2.1	404	120	75	405		
2.4	380	195	105	310		
2.7	440	217	105	380		
3	464	75	75	450		
3.3	488	131	131	405		
3.6	428	90	120	365		
3.9	416	142	131	180		
4.2	464	162	152	440		
4.5	464	195	180	392		
4.8	500	180	152	500		
5.1	452	206	180	550		
5.4	50	275	152	512		
5.7	535	275	131	610		
6	560	295	142	535		
6.3		365	184	600		
6.6		404	195	535		
6.9		464	217	585		
7.2			275	572		
7.5			310	625		
7.8			365	>600		
8.1				>600		
8.4				572		
8.7				>600		
9						
9.3						
9.6						
9.9						
10.2						

All test points except for TP3 in Kalingalinga and TP12 in Mandevu townships, had consistent stable bearing grounds with increasing bearing capacities with depth. However, TP3 had decreased bearing values at depths below 2.4 m.

TP1 in Kalingalinga had the weakest bearing values up to a depth of 1.2 m. The results of test point 1 (TP1) located at Kalingalinga grounds reveal that the location is underlain by sandy clay soils up to a depth of 2.1m with a bearing values 105 kN/m² at this depth. There after the soils are underlain by

dense coarse gravelly soils and laterite rocks with bearing values greater than 365 kN/m² at depths greater than 2.1 m.

Similarly, TP15 in Ngwerere had low and un stable bearing values up to a depth of 2.1 m (see summary of the bearing capacity values in Table 4).

Table 5 below shows a summary of the range of values for the earth resistance, soil resistivity and bearing capacities of the four townships at a depth ranging from 0 m to 10 m.

Table 5: Summary - Range of Values for Earth Resistance, Soil Resistivity and Bearing Capacities of the Four Townships at Depths between 0 and 10 m

Township	Earth Resistance RE (Ω)	Soil Resistivity ρ (mΩ)	Bearing Capacity kN/m ²	Soil Type
Kalingalinga	0.83 - 26.235	53 - 287.95	75 - 488	gravelly sandy clay
Mtendere	2.525 - 84	120.1 - 2244.4	20 - >600	laterite soil, rock, shale
Mandevu	1.425 - 18.355	42.08 - 118.35	20 - > 600	sandy clay, gravelly sand and laterite
Ngwerere	5.325 - 292.45	334.25 - 2190	45 - >600	laterite soil and rock

6.3 Ground Water

Ground water was present at TP1 in Kalingalinga and at TP 12 in Mandevu only.

At TP3 in Kalingalinga, the ground water was located at a depth of 3.3 m whilst at TP12 it was located at 1.3 m.

For the rest of the test points no signs of ground water were visible during the cone penetration test.

7. Conclusion

The four townships Kalingalinga, Mtendere, Mandevu and Ngwerere were investigated with a total number of 16 test points. Standard penetration tests (SPT), dynamic cone penetration tests (DCPT) and earth resistance and soil resistivity tests were performed.

It was found that in general, all four sites are underlain with laterite with a consistent stable bearing ground that increase bearing capacities with depth.

Earth Resistance and Resistivity Results

SOIL RESISTIVITY TEST**Civil Elements consulting Engineers**

LOCATION: LUSAKA

SITE : KALINGALINGA (KALINGALINGA GROUND)

TP1

DATE: 06/03/2019

COORDINATES :

-15.405342

28.331032

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 288° w

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	3	6.6	3.4	110
6	3.54	1.12	1.1	68.3
3	4.79	0.6	0.5	60.2
2	6.75	1.54	1.1	42.12
1	0.83	4.4	9.7	53

sign

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : KALINGALINGA (VERA CHILUBA)

TP3

DATE: 06/03/2019

COORDINATES : -15.403987 28.348145

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 164° S

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
1	27.47	2.1	4.3	172.5
2	26.12	2.2	2.5	328.1
3	11.17	2.2	5.8	208.6
6	3.37	2.2	4.4	126
10	1.32	2.2	3.7	80.69

TRAVERSE 254° S

1	25	76.2	4	155.7
2	16	1	3	247.8
3	19.8	3.7	1	326.6
6	5.24	0.6	0.5	194.5
10	2.06	1.5	0.6	128

Sign

SOIL RESISTIVITY TEST



Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : MUTENDERE (CHITUKUKO BASIC SCHOOL) TP4

DATE: 07/03/2019

COORDINATES : 15°23'56.76" 28°21'34.71"

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 78° E

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH ($K\Omega$)	PROBE RESISTANCE RS ($K\Omega$)	SOIL RESISTIVITY ρ ($m\Omega$)
10	1.81	3.8	2.3	113.4
6	3.1	6.7	6.9	113.5
3	8.5	9.1	5.7	159
2	11.23	3.5	2.7	140.9
1	18.57	2.9	2.4	116.6

TRAVERSE 348° N

10	3.86	1.4	1.5	242.5
6	6.22	4	2.2	233.4
3	14.01	5.8	4.4	263.4
2	19.04	3.9	23.7	240
1	39.6	6.9	13.2	249.1

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : Mutendere east

TP5

DATE: 08/03/2019

COORDINATES : -15.405923 28.368838

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 264°W

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	4.9	18.4	10.7	335.8
6	14.6	7.1	3	546
3	35.2	12.4	4.7	662.6
2	51.7	7.9	3.8	651
1	71.7	4.2	3.2	449

TRAVERSE 20° N

10	52	125	73.4	4153
6	17.07	3.3	3.5	642.1
3	36.9	4.8	5.1	676.7
2	57	5.5	3.4	709.8
1	83.2	5.8	3.3	520.2

SIGN

SOIL RESISTIVITY TEST



Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : Mutendere east

TP6

DATE: 07/03/2019

COORDINATES :

-15.400532

28.372033

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 15° N

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	3.1	10.6	3.9	189.3
6	8.1	8.3	6.1	300.7
3	15.07	4.5	9.8	284
2	30.7	6.4	8.6	385.2
1	44.5	6.8	2.4	279.5

TRAVERSE 110° E

10	1.95	2	12.8	123.8
6	5.8	13.1	13.1	232.5
3	23.41	4.4	7	442.1
2	35.7	9.2	7.3	447.5
1	60.9	3.4	4.4	382.1

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : MUTENDERE (IBEX EXTENSION)

TP7

DATE: 08/03/2019

COORDINATES : -15.403041 28.379753

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 270°W

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	14.9	18.7	11.9	829.1
6	26	103	3.6	958.5
3	4.4	43.2	3.4	120.1
2	11.03	4.4	111	136.8
1	84	270	116	402.3

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : MANDEVU KABANANA

TP10

DATE: 06/03/2019

COORDINATES : -15.351125 28.304049

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 288° w

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	1.69	0.9	0.7	114.8
6	2.68	5.6	1.6	100.2
3	3.62	1.1	0.4	67.83
2	4.79	0.4	0.4	59.9
1	6.71	1.5	1	42.08

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : MANDEVU (CHIPATA COMPUND)

TP11

DATE: 09/03/2019

COORDINATES : -15.362542 28.294598

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 97° E

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	0.83	4.4	9.7	51.22
6	2.9	6.8	3.1	108.5
3	6.05	1.1	2.7	112.3
2	9.37	2.3	13.2	117.6
1	16.21	2.6	6.9	101.6

TRAVERSE 211° SW

10	2.02	5.7	3.4	123.1
6	3.5	3.3	3	129.2
3	6.56	1.4	3.9	123.1
2	9.49	4	22.7	119.3
1	20.5	10.1	2.8	128.7

SIGN

SOIL RESISTIVITY TEST



Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : NGWERERE (KABANGWE)

TP13

DATE: 10/03/2019

COORDINATES : -15.33281 28.284491

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 216° SW

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	13.1	7	4.1	828.2
6	46.6	5.9	4.1	1757
4	80.9	5.5	6.4	2033
3	100.6	18.4	12	1894
2	130	19.5	14.8	1621
1	184.4	22.5	18.2	1180

TRAVERSE 112° E

10	11.1	12.8	15.3	693.5
6	34	67.9	49.5	1179
3	100.7	57.9	27.4	1914
2	195.7	38	51.7	2486
1	261.6	11.4	11.6	1643

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : NGWERERE (KABANGWE)

TP14

DATE: 10/03/2019

COORDINATES : -15.334801 28.298978

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 201° S

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	5.8	6.4	13.4	365.7
6	10.6	9.9	4.2	398.6
3	49.3	12.8	14.3	926
2	71.1	9.5	3	892.9
1	92.3	2.5	1.3	579.8

TRAVERSE 131° SE

10	4.85	2.9	2.5	302.8
6	11	10.8	6.9	381.2
3	34.3	6.8	4.5	649.4
2	56.4	4.9	2.8	354.1
1	64.2	3.3	1.2	403.6

SIGN

SOIL RESISTIVITY TEST



Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : NGWERERE (KABANGWE)

TP15

DATE: 10/03/2019

COORDINATES :	-15.318211	28.296593		
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ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 87° E

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH (KΩ)	PROBE RESISTANCE RS (KΩ)	SOIL RESISTIVITY ρ (mΩ)
10	14.3	6.8	2	895.4
6	29.36	3.5	6.9	1107
3	75.7	3.1	2.4	1426
2	81.9	2.4	5	1029
1	163	5	7	1024

SIGN

SOIL RESISTIVITY TEST

Civil Elements consulting Engineers



LOCATION: LUSAKA

SITE : NGWERERE (KABANGWE)

TP16

DATE: 10/03/2019

COORDINATES : -15.326289 28.312062

ELEVATION

FIELD CONDITION Dry

EQUIPMENT MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR DAN LUPANDILA

ELECTRODE ARRANGEMENT 4 POLE TEST (WENNER METHOD)

TRAVERSE 160° SE

DEPTH (m)	EARTH RESISTANCE RE (Ω)	AUXILLARY EARTHING RESISTANCE RH ($K\Omega$)	PROBE RESISTANCE RS ($K\Omega$)	SOIL RESISTIVITY ρ ($m\Omega$)
10	6.4	6	13	723
6	32.6	24.4	40.4	1226
3	67.9	14.2	15.2	1281
2	106.8	14.7	31.1	1340
1	205.9	15.8	9.3	1294

TRAVERSE 70° E

10	10.3	10.1	14.5	595.4
6	20.7	15.7	14.4	775.2
3	117.4	14.2	49.3	2211
2	154.8	59.4	9	1980
1	379	41.3	118	2379

SIGN

Dynamic Cone Penetration Test Results

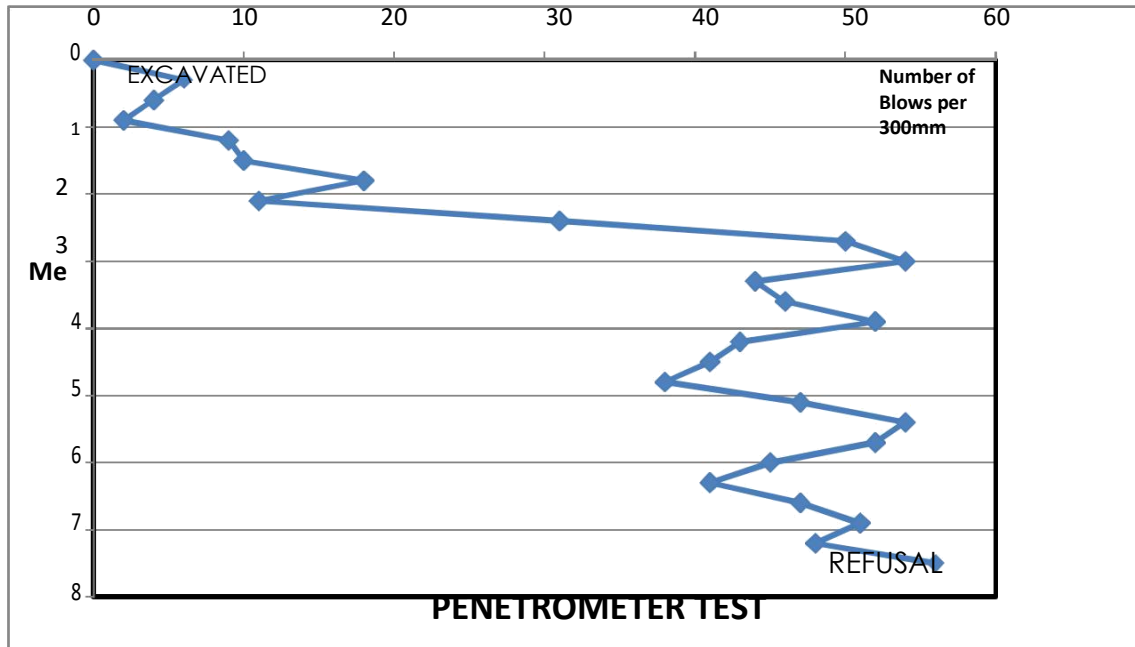
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
6	0.3
4	0.6
2	0.9
9	1.2
10	1.5
18	1.8
11	2.1
31	2.4
50	2.7
54	3
44	3.3
46	3.6
52	3.9
43	4.2
41	4.5
38	4.8
47	5.1
54	5.4
52	5.7
45	6
41	6.3
47	6.6
51	6.9
48	7.2
56	7.5

CLIENT:
Project:
Site: KALINGALINGA
Location: KALINGALINGA
Test position: 1 -15.405342 28.331032
Date:13/03/19
logging @0 - 7.5m



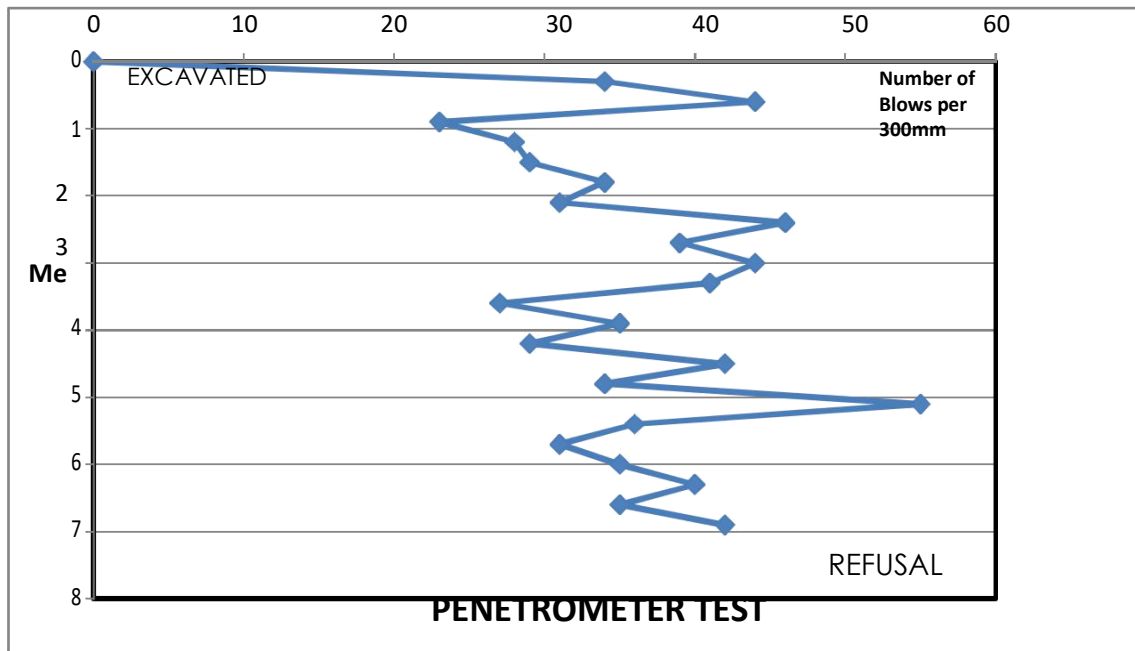
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
34	0.3
44	0.6
23	0.9
28	1.2
29	1.5
34	1.8
31	2.1
46	2.4
39	2.7
44	3
41	3.3
27	3.6
35	3.9
29	4.2
42	4.5
34	4.8
55	5.1
36	5.4
31	5.7
35	6
40	6.3
35	6.6
42	6.9
	7.2
	7.5

CLIENT:
Project:
Site: Mtendere East
Location: Helen Kaunda
Test position: 2 -15.405299 28.358514
Date: 06/03/19
logging @ 0 - 7.5m



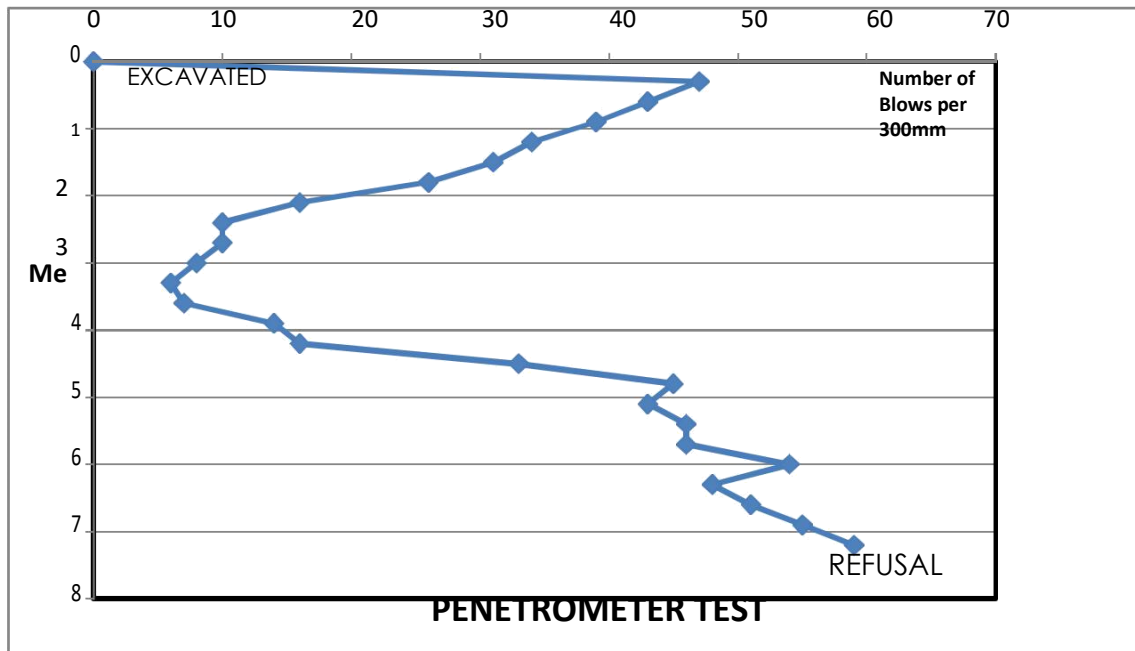
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
47	0.3
43	0.6
39	0.9
34	1.2
31	1.5
26	1.8
16	2.1
10	2.4
10	2.7
8	3
6	3.3
7	3.6
14	3.9
16	4.2
33	4.5
45	4.8
43	5.1
46	5.4
46	5.7
54	6
48	6.3
51	6.6
55	6.9
59	7.2
	7.5

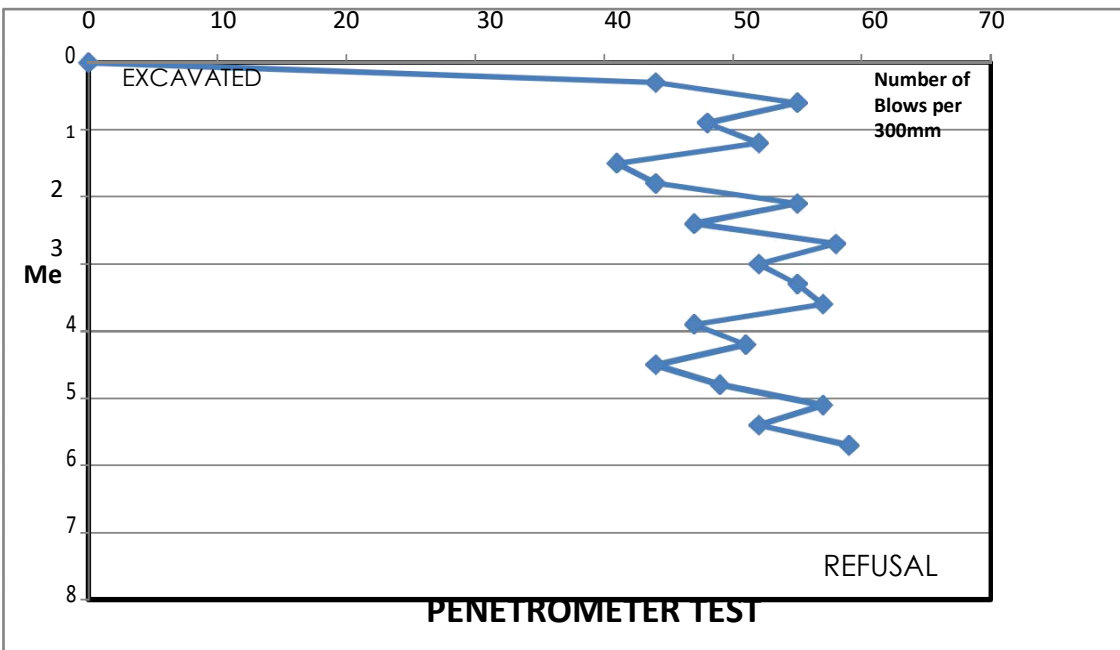
CLIENT:
Project:
Site: Vera Chiluba Primary School
Location: Helen Kaunda
Test position: 3 -15.403987 28.348145
Date: 13/03/19
logging @ 0 - 7.5m



PENETROMETER TEST

No of Blows	Penetration(m)
0	0
44	0.3
55	0.6
48	0.9
52	1.2
41	1.5
44	1.8
55	2.1
47	2.4
58	2.7
52	3
55	3.3
57	3.6
47	3.9
51	4.2
44	4.5
49	4.8
57	5.1
52	5.4
59	5.7
	6
	6.3
	6.6
	6.9
	7.2
	7.5

CLIENT:
Project:
Site: Mtendere east
Location: Mtendere
Test position: 5 -15.405923 28.368838
Date: 08/03/19
logging @ 0 - 7.5m



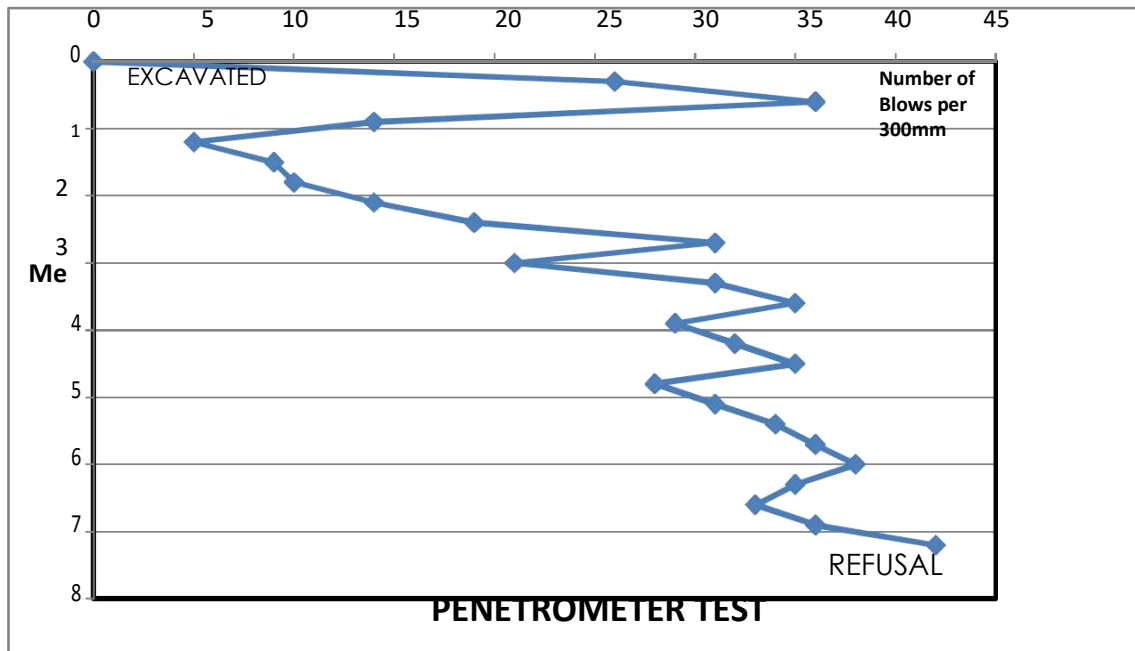
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
26	0.3
36	0.6
14	0.9
5	1.2
9	1.5
10	1.8
14	2.1
19	2.4
31	2.7
21	3
31	3.3
35	3.6
29	3.9
32	4.2
35	4.5
28	4.8
31	5.1
34	5.4
36	5.7
38	6
35	6.3
33	6.6
36	6.9
42	7.2
	7.5

CLIENT:
Project:
Site: Mtendere East
Location: Mtendere
Test position: 6 -15.400532 28.372033
Date: 07/03/19
logging @ 0 - 7.5m



PENETROMETER TEST

No of Blows	Penetration(m)
0	0
26	0.3
25	0.6
24	0.9
27	1.2
32	1.5
28	1.8
34	2.1
38	2.4
44	2.7
32	3
28	3.3
41	3.6
48	3.9
55	4.2
47	4.5
58	4.8
59	5.1
53	5.4
59	5.7
	6
	6.3
	6.6
	6.9
	7.2
	7.5

CLIENT:

Project:

Site: Ibex

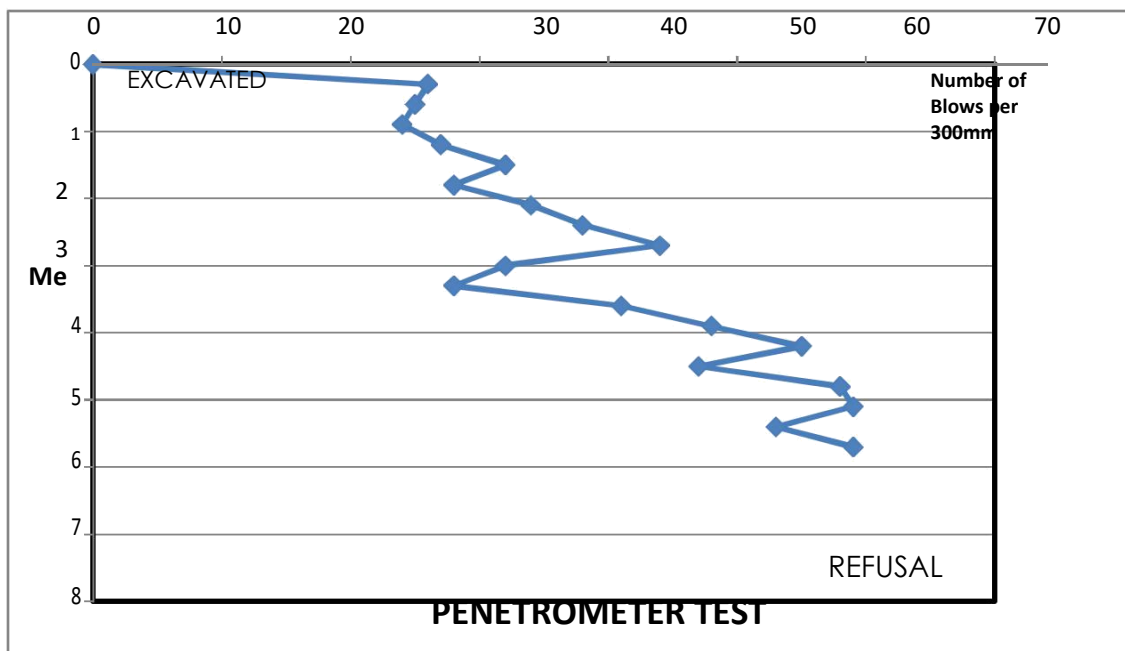
Location: Mtendere

Test position: 7

-15.403041 28.379753

Date: 08/03/19

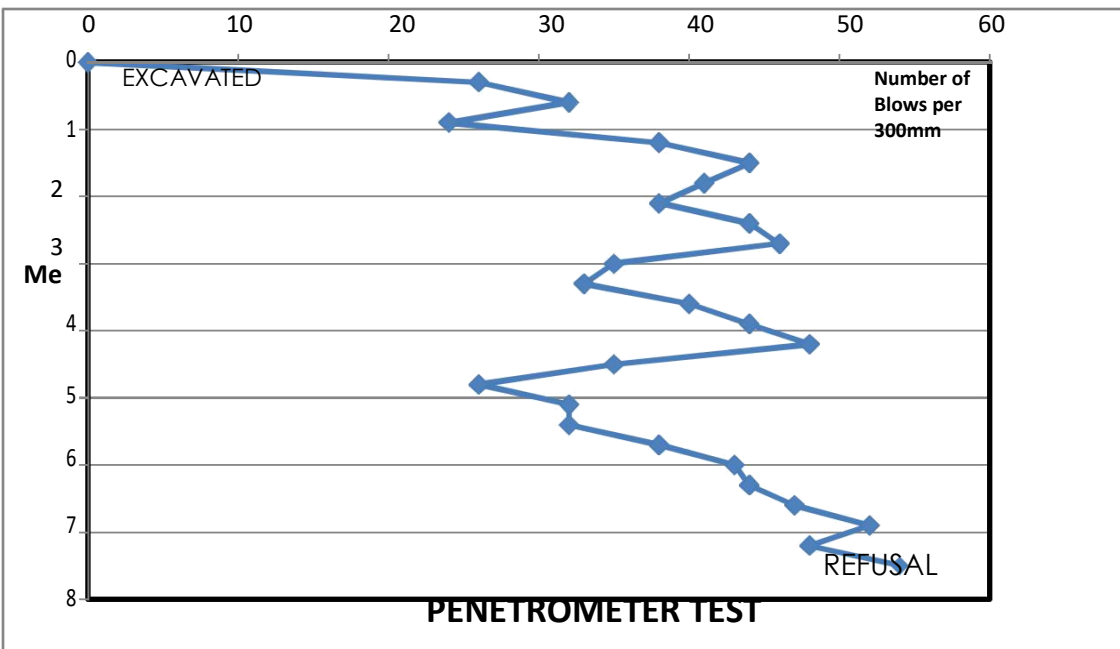
logging @ 0 - 7.5m



PENETROMETER TEST

No of Blows	Penetration(m)
0	0
26	0.3
32	0.6
24	0.9
38	1.2
44	1.5
41	1.8
38	2.1
44	2.4
46	2.7
35	3
33	3.3
40	3.6
44	3.9
48	4.2
35	4.5
26	4.8
32	5.1
32	5.4
38	5.7
43	6
44	6.3
47	6.6
52	6.9
48	7.2
54	7.5

CLIENT:
Project:
Site: Mtendere
Location: Valley View
Test position: 8 **-15.397451 28.378446**
Date:08/03/19
logging @0 - 7.5m



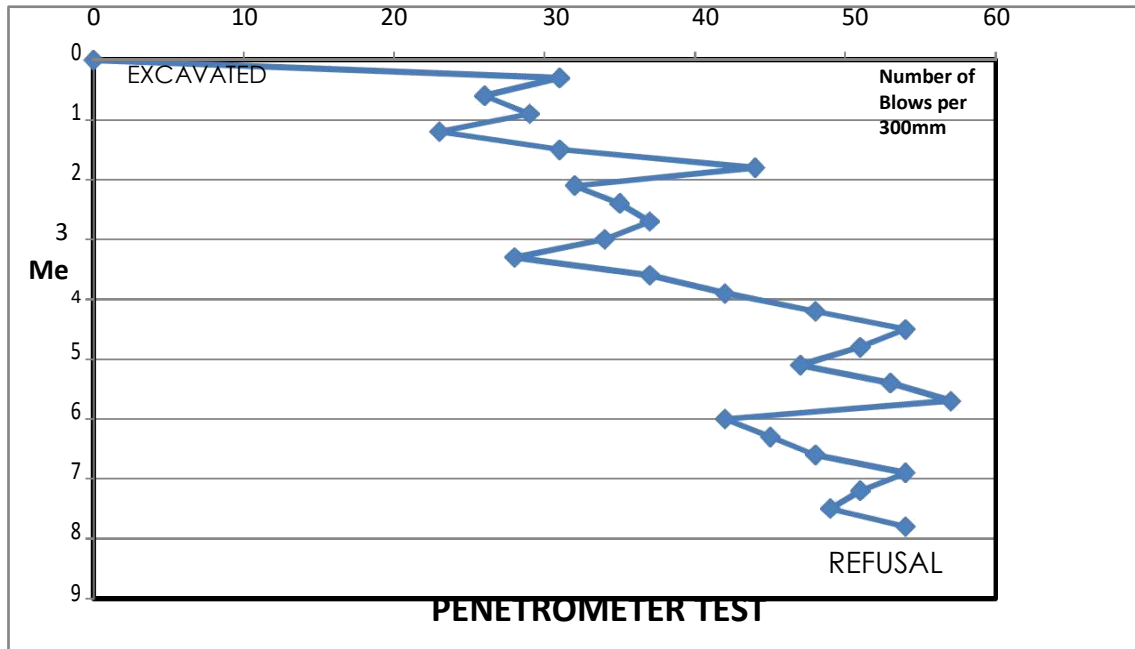
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
31	0.3
26	0.6
29	0.9
23	1.2
31	1.5
44	1.8
32	2.1
35	2.4
37	2.7
34	3
28	3.3
37	3.6
42	3.9
48	4.2
54	4.5
51	4.8
47	5.1
53	5.4
57	5.7
42	6
45	6.3
48	6.6
54	6.9
51	7.2
49	7.5
54	7.8

CLIENT:
Project:
Site: CHAZANGA
Location: MANDEVU
Test position: 9 -15.347278 28.287419
Date: 09/03/19
logging @ 0 - 7.5m



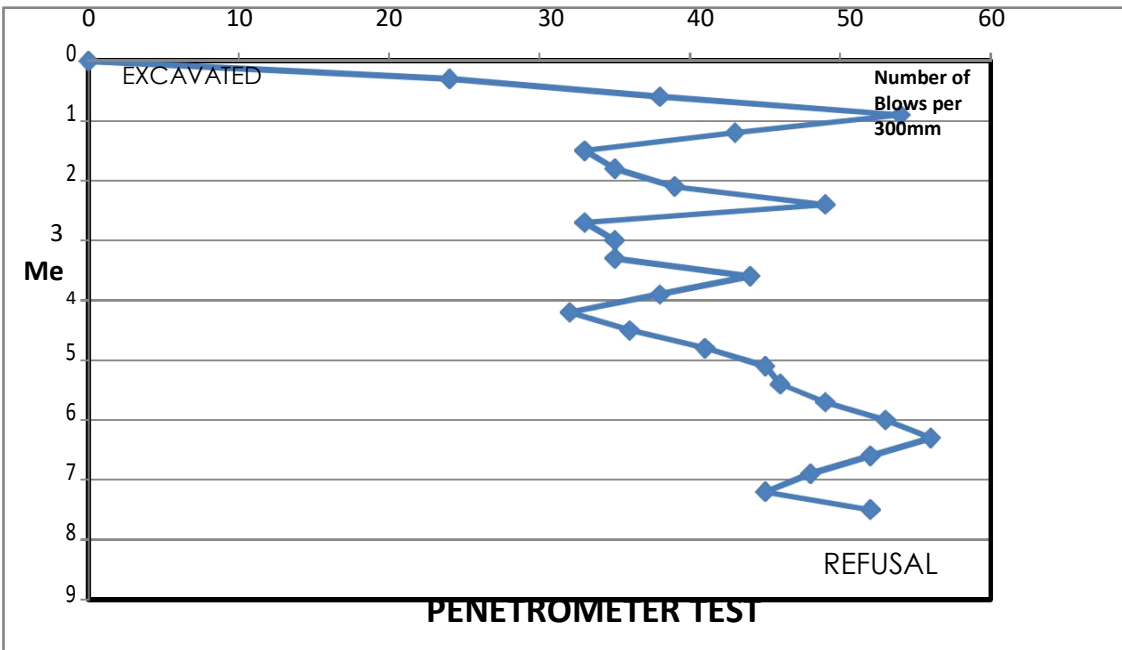
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
24	0.3
38	0.6
54	0.9
43	1.2
33	1.5
35	1.8
39	2.1
49	2.4
33	2.7
35	3
35	3.3
44	3.6
38	3.9
32	4.2
36	4.5
41	4.8
45	5.1
46	5.4
49	5.7
53	6
56	6.3
52	6.6
48	6.9
45	7.2
52	7.5
	7.8

CLIENT:
Project:
Site: KABANANA
Location: MANDEVU
Test position: 10 -15.351125 28.304049
Date: 09/03/19
logging @ 0 - 7.5m



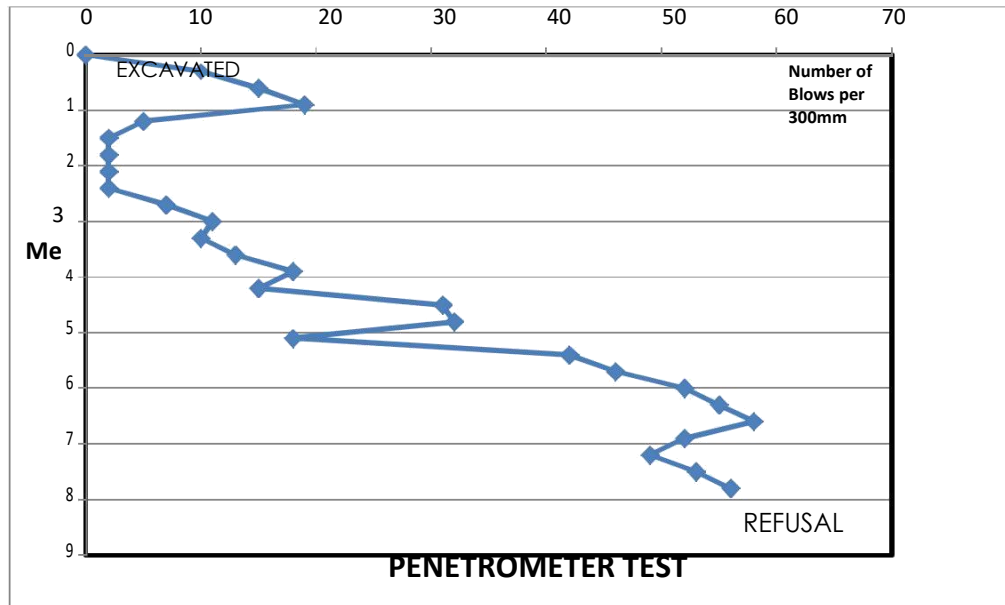
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
10	0.3
15	0.6
19	0.9
5	1.2
2	1.5
2	1.8
2	2.1
2	2.4
7	2.7
11	3
10	3.3
13	3.6
18	3.9
15	4.2
31	4.5
32	4.8
18	5.1
42	5.4
46	5.7
52	6
55	6.3
58	6.6
52	6.9
49	7.2
53	7.5
56	7.8
59	
61	
63	
59	
63	

CLIENT:
Project:
Site: Mutamba ground
Location: MANDEVU
Test position: 12 -15.371704 28.282819
Date: 09/03/19
logging @ 0 - 7.5m



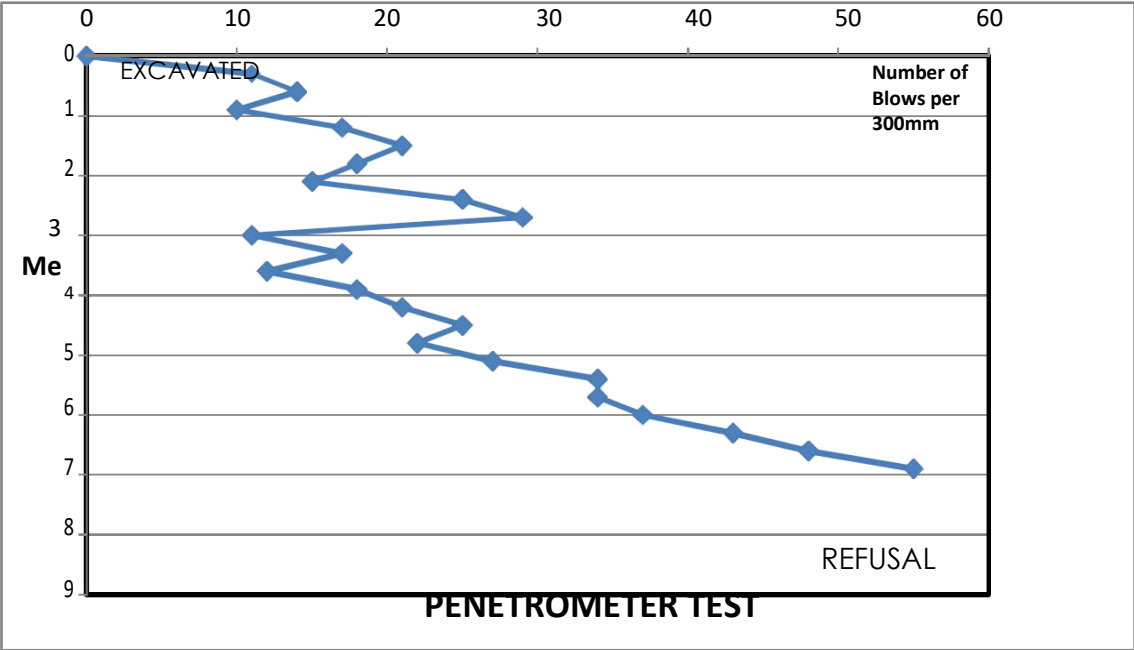
PENETROMETER TEST

Civil Elements consulting Engineers



No of Blows	Penetration(m)
0	0
11	0.3
14	0.6
10	0.9
17	1.2
21	1.5
18	1.8
15	2.1
25	2.4
29	2.7
11	3
17	3.3
12	3.6
18	3.9
21	4.2
25	4.5
22	4.8
27	5.1
34	5.4
34	5.7
37	6
43	6.3
48	6.6
55	6.9
	7.2
	7.5
	7.8

CLIENT:
Project:
Site: Kabangwe (MAICHOLA)
Location: NGWERERE
Test position: 14 -15.334801 28.298978
Date: 10/03/19
logging @ 0 - 7.5m





LOG OF BOREHOLE TP3

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: KALINGALINGA

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP3
LINING:	N/A		
COORDINATES	-15.403987	28.3481	

DATE STARTED: 06/03/2019

DATE COMPLETED: 06/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
Firm compacted sandy clay soils		0		0	0
		0.3	↓	14	162
		0.6	↓	19	217
		0.9	↓	26	310
		1.2	↓	23	275
		1.5	↓	21	245
		1.8	↓	17	195
		2.1	↓	11	131
Coarse gravelly soils		2.4	↓	7	75
		2.7	↓	7	75
		3	↓	5	45
		3.3	↓	4	30
		3.6	↓	5	45
		3.9	↓	9	105
		4.2	↓	11	131
Coarse gravelly soils		4.5	↓	22	260
		4.8	↓	30	380
		5.1	↓	29	365
		5.4	↓	31	392
		5.7	↓	31	392
		6	↓	36	452
		6.3	↓	32	404
		6.6	↓	34	428
		6.9	↓	37	464
		7.2	↓	39	488
Limestone/Dolomite rock		7.5	↓	WW	

GROUND LEVEL		BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE		DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING		UNDISTURBED SAMPLE ■	gravelly sandy clay	<input type="checkbox"/>
S.P.T		WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>
Sign:				



LOG OF BOREHOLE TP4

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE:MTENDERE (CHITUKUKO BASIC SCHOOL)

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP4
LINING:	N/A		
COORDINATES	15°23'56.76" 28°21'34.71"		

DATE STARTED: 07/03/2019

DATE COMPLETED: 07/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
compacted sandy clay soils		0		0	0
		0.3	↓	27	325
		0.6	↓	30	380
		0.9	↓	19	217
gravelly sandy clay soils		1.2	↓	13	152
		1.5	↓	11	131
		1.8	↓	9	105
		2.1	↓	13	152
		2.4	↓	13	152
		2.7	↓	13	152
		3	↓	13	152
		3.3	↓	11	131
slates laterite rocks and soils		3.6	↓	25	295
		3.9	↓	34	428
		4.2	↓	37	464
		4.5	↓	39	488

Limestone/Dolomite rock

W/W V

GROUND LEVEL	—	BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE	=====	DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING	W/W	UNDISTURBED SAMPLE ■	gravelly sandy clay	<input type="checkbox"/>
S.P.T	—	WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>
Sign:				



LOG OF BOREHOLE TP5

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: MTENDERE (KALIKILIKI GROUND)

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP5
LINING:	N/A		
COORDINATES	-15.405923	28.3688	

DATE STARTED: 06/03/2019

DATE COMPLETED: 06/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
dense Coarse gravelly soils		0		0	0
		0.3	↓	29	365
		0.6	↓	37	464
		0.9	↓	32	404
		1.2	↓	35	440
		1.5	↓	27	325
		1.8	↓	29	365
		2.1	↓	37	464
		2.4	↓	31	392
		2.7	↓	39	488
		3	↓	35	440
		3.3	↓	37	464
		3.6	↓	38	476
		3.9	↓	31	392
		4.2	↓	34	428
		4.5	↓	29	365
	4.8	↓	33	416	
	5.1	↓	38	476	
	5.4	↓	35	440	
	5.7	↓	39	488	

Limestone/Dolomite rock

M/W ∇

GROUND LEVEL	—	BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE	≡≡≡	DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING	<i>M/W</i>	UNDISTURBED SAMPLE ■	gravelly sandy clay	<input type="checkbox"/>
S.P.T	—	WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>

Sign:



LOG OF BOREHOLE TP6

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE:Mtendere east

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP6
LINING:	N/A		
COORDINATES	-15.400532	28.372033	

DATE STARTED: 06/03/2019

DATE COMPLETED: 06/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
Compacted sandy clay soils		0		0	0
		0.3	↓	17	195
		0.6	↓	24	280
sandy clay soils		0.9	↓	9	105
		1.2	↓	3	20
		1.5	↓	6	60
		1.8	↓	7	75
		2.1	↓	9	105
		2.4	↓	13	152
dense Coarse gravelly soils		2.7	↓	21	245
		3	↓	14	162
		3.3	↓	21	245
		3.6	↓	23	275
		3.9	↓	19	217
		4.2	↓	21	245
		4.5	↓	23	275
		4.8	↓	19	217
		5.1	↓	21	245
		5.4	↓	23	275
		5.7	↓	24	280
		6	↓	25	295
		6.3	↓	23	275
	6.6	↓	22	260	
	6.9	↓	24	280	
	7.2	↓	28	340	
Slates of laterite rock		7.5	↓ <i>W/W</i>	54	>600

GROUND LEVEL	BULK SAMPLE ● B	sandy clay loamy <input type="checkbox"/>
WATER TABLE	DISTURBED S ● D	gravelly clay <input type="checkbox"/>
END OF DRILLING	UNDISTURBED SAMPLE ■	gravelly sandy clay <input type="checkbox"/>
S.P.T	WATER SAMP ● W	Coarse gravelly sand <input type="checkbox"/>
		Rock <input type="checkbox"/>
Sign:		



LOG OF BOREHOLE TP11

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE:MTENDERE (VALLEY VIEW)

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP11
LINING:	N/A		
COORDINATES	-15.362542	28.294598	

DATE STARTED: 08/03/2019

DATE COMPLETED: 08/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m ²
sandy clay loamy		0		0	0
		0.3	↓	14	162
		0.6	↓	10	120
		0.9	↓	7	75
		1.2	↓	5	45
		1.5	↓	6	60
dense Coarse gravelly soils		1.8	↓	16	184
		2.1	↓	29	365
		2.4	↓	31	392
		2.7	↓	28	340
		3	↓	30	380
Slates of laterite rock		3.3	↓	35	440
		3.6	↓	32	404
		3.9	↓	35	440
		4.2	↓	38	476
		4.5	↓	41	512
		4.8	↓	43	535
	5.1	W		44	550

GROUND LEVEL		BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE		DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING		UNDISTURBED SAMPLE ■	gravelly sandy clay	<input type="checkbox"/>
S.P.T		WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>
		Sign:		



LOG OF BOREHOLE TP8

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE:MANDEVU (MUTAMBA GROUND)

TYPE OF BORING:

DATE STARTED: 09/03/2019

DATE COMPLETED: 09/03/2019

DIAMETER:	N/A	B/H No:	TP12
LINING:	N/A		
COORDINATES	-15.371704 28.282819		

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m ²
sandy clay loamy		0	↓	0	0
		0.3	↓	7	75
		0.6	↓	10	120
		0.9	↓	13	152
		1.2	↓	3	20
		1.5	↓	1	nil
		1.8	↓	1	nil
		2.1	↓	1	nil
		2.4	↓	1	nil
		2.7	↓	5	45
		3	↓	7	75
		3.3	↓	7	75
		3.6	↓	9	105
Dense Coarse gravelly soils		4.5	↓	21	245
		4.8	↓	21	245
		5.1	↓	12	142
Slates of laterite rock		5.4	↓	28	340
		5.7	↓	31	392
		6	↓	35	440
		6.3	↓	37	464
		6.6	↓	39	488
		6.9	↓	35	440
		7.2	↓	33	416
		7.5	↓	35	440
		8	↓	37	464
			↓	39	488
			↓	41	512
		↓	42	525	
		↓	39	488	
		↓	42	525	

GROUND LEVEL	BULK SAMPLE ● B	<input type="checkbox"/>
WATER TABLE	DISTURBED S ● D	<input type="checkbox"/>
END OF DRILLING	UNDISTURBED SAMPLE ■	gravelly sandy clay <input type="checkbox"/>
S.P.T	WATER SAMP ● W	Coarse gravelly sand <input type="checkbox"/>
		Rock <input type="checkbox"/>
Sign: _____		



LOG OF BOREHOLE TP13

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: NGWERERE

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP13
LINING:	N/A		
COORDINATES	-15.33281 28.284491		

DATE STARTED: 10/03/2019

DATE COMPLETED: 10/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPLE RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m ²
		0		0	0
		0.3	↓	17	195
laterite soils		0.6	↓	23	275
		0.9	↓	25	295
		1.2	↓	29	365
		1.5	↓	28	340
		1.8	↓	32	404
		2.1	↓	32	404
		2.4	↓	30	380
		2.7	↓	35	440
		3	↓	37	464
		3.3	↓	39	488
laterite rock		3.6	↓	34	428
		3.9	↓	33	416
		4.2	↓	37	464
		4.5	↓	37	464
		4.8	↓	40	500
		5.1	↓	36	452
		5.4	↓	44	50
		5.7	↓	43	535
		6	↓	45	560

GROUND LEVEL	—	BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE	≡≡≡	DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING	Ww	UNDISTURBED SAMPLE ■	gravelly sandy clay	<input type="checkbox"/>
S.P.T	—	WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>
		Sign:		



LOG OF BOREHOLE TP14

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: NGWERERE

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP14
LINING:	N/A		
COORDINATES	-15.334801 28.298978		

DATE STARTED: 10/03/2019

DATE COMPLETED: 10/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPL E RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
sandy clay soils		0		0	0
		0.3	↓	7	75
		0.6	↓	9	105
		0.9	↓	7	75
dense Coarse gravelly soils		1.2	↓	11	131
		1.5	↓	14	162
		1.8	↓	12	142
		2.1	↓	10	120
		2.4	↓	17	195
		2.7	↓	19	217
		3	↓	7	75
		3.3	↓	11	131
		3.6	↓	8	90
		3.9	↓	12	142
		4.2	↓	14	162
		4.5	↓	17	195
laterite rock		4.8	↓	15	180
		5.1	↓	18	206
		5.4	↓	23	275
		5.7	↓	23	275
		6	↓	25	295
		6.3	↓	29	365
	6.6	↓	32	404	
	6.9	↓	37	464	

GROUND LEVEL	—	BULK SAMPLE ● B	sandy clay loamy	<input type="checkbox"/>
WATER TABLE	====	DISTURBED S ● D	gravelly clay	<input type="checkbox"/>
END OF DRILLING	Ww	UNDISTURBED SAMPLE □	gravelly sandy clay	<input type="checkbox"/>
S.P.T	—	WATER SAMP ● W	Coarse gravelly sand	<input type="checkbox"/>
			Rock	<input type="checkbox"/>
Sign:				



LOG OF BOREHOLE TP15

CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: NGWERERE

TYPE OF BORING:

DIAMETER:	N/A	B/H No:	TP15
LINING:	N/A		
COORDINATES	-15.318211 28.296593		

DATE STARTED: 10/03/2019

DATE COMPLETED: 10/03/2019

SOIL DESCRIPTION	PROFILE	DEPTH M	SAMPL E RECORDS	S.P.T RESULTS	REMARKS
					Allowable bearing capacity kN/m2
sandy clay soils		0		0	0
		0.3	↓	6	60
		0.6	↓	5	45
		0.9	↓	5	45
dense Coarse gravelly soils		1.2	↓	5	45
		1.5	↓	7	75
		1.8	↓	6	60
		2.1	↓	7	75
		2.4	↓	9	105
		2.7	↓	9	105
		3	↓	7	75
		3.3	↓	11	131
		3.6	↓	10	120
		3.9	↓	11	131
		4.2	↓	13	152
		4.5	↓	15	180
		4.8	↓	13	152
		5.1	↓	15	180
		5.4	↓	13	152
		5.7	↓	11	131
	6	↓	12	142	
	6.3	↓	16	184	
	6.6	↓	17	195	
	6.9	↓	19	217	
Slates of laterite rock		7.2	↓	23	275
		7.5	↓	26	310
		7.8	↓ <i>W/W</i>	29	365
GROUND LEVEL	—		BULK SAMPLE ● B sandy clay loamy <input type="checkbox"/>		
WATER TABLE	=		DISTURBED S ● D gravelly clay <input type="checkbox"/>		
END OF DRILLING	<i>W/W</i>		UNDISTURBED SAMPLE □ gravelly sandy clay <input type="checkbox"/>		
S.P.T	—		WATER SAMP ● W Coarse gravelly sand <input type="checkbox"/>		
			Rock <input type="checkbox"/>		
Sign: _____					

HV Cable Installation, Testing and Commissioning



Technical Instruction



Document No:
DS.13510.TCHI.00081

Title:
HV Cable Installation,
Testing and Commissioning

Date of Approval:
04/01/2017

Version:
1

Division:
Distribution and Customer
Services



HV Cable Installation, Testing and Commissioning

Document No:

DS.13510.TCHI.00081

Version No: 1

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Version	Changes from Previous Editions (Section: Documentation Revised or Discarded)	Date Changed MM/Year
1	Document Developed	12/2016

Distribution

Controlled Copy No.

Assigned To: The Technical Instructions shall be available to employees within the IBMS (Register of manual distribution to be kept by the relevant supervisors).



HV Cable Installation, Testing and Commissioning




Document No:

DS.13510.TCHI.00081

Version No: 1

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Development, Review and Approval

Prepared By	Date	Reviewed By	Date	Approved By	Date
 Thomas Sinkamba Technical Services Manager	14/12/16	 Gyavira M. Bwalya Divisional Manager	23-12-16	 Dennis Banda Director Distribution	4/01/17



HV Cable Installation, Testing and Commissioning

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1. PURPOSE

The purpose of this Technical Instruction is to outline works that shall be done in connection HV (power) cables.

2. SCOPE

This Technical Instruction applies to works that shall be carried out when installing, testing, fault-finding HV Cables.

3. REFERENCES

ISO 9001 Standard: Quality Management System.

ISO 14001 Standard: Environmental Management System.

OHSAS 18001 Specification: Occupational Health and Safety Assessment Series.

4. RESPONSIBILITIES

In executing this technical instruction the following responsibilities shall be recognised:

4.1 Preparation

The Technical Services Manager shall be responsible for the preparation of this Technical Instruction.

4.2 Review

The Divisional Manager shall be responsible for the review of this technical instruction.

4.3 Approval

The Director Distribution and Customer Services shall be responsible for the approval of this technical instruction.



HV Cable Installation, Testing and Commissioning

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4.4 Distribution

The Director Distribution and Customer Services shall be responsible for the distribution of this technical instruction.

5. DEFINITIONS AND GENERAL CONTENTS

This technical instruction does not have any definitions.

6. DEVELOPMENT

6.1. High Voltage Cable Management

1	Works Preceding HV Cable Installation	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Check the received items against your order using the shipment /packaging manifest.	
6	Check that the cable selected is proper for your application	
7	Review the installation manuals and drawings carefully	
8	Check for any in-transit /storage damage on the cable before accepting consignment. Record any damage found	
9	Confirm that the cable specified was received	
10	Verify that the cable end seals are intact	
11	Protect cable from mechanical damage and from liquid spills	
12	Advise all jointers, installers and handlers of all special instructions	
13	Clean up work area	
14	Clear safety document	
Tools and Equipment:		

2	HV Cable Trench Excavation	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate excavation permit from the local authority	
5	Obtain the appropriate safety document from the local utility, including site maps	
6	Ensure you have all the cable trench drawings , including the arrangement of the cable in the trench	
7	Carry out excavation for the cable trench paying attention to the site map (Excavation should be done with maximum caution even where the site map does not show presence of existing cables	
8	Excavation must be done up to the specified laying depth (a minimum of 75cm for cables up to 11kV) of the cable	
9	Prepare the cable trench up to the required purpose for direct buried installation on sand bed , concrete bed installation or trays in concrete trench installation	
10	Cancel any safety documents previously obtained	
11	On completion of all works, ensure as-built drawings are be provided both to the local utility and local authority for update and future reference	
<p>Tools and Equipment: Excavators, picks & shovels, depth gauges, excavation tapes or warning notices</p>		

3	Laying an HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	

5	Place rollers along the cable trench at 4-metre intervals
6	Place a leading roller at the trench side at the pulling end, with slide rollers on bends and hoop rollers along straight sections
7	Ensure all rollers used are in serviceable condition, moving easily on their spindle and with rolling surfaces free from damage
8	Unroll the cable into the trench using cable rollers, with maximum care to avoid mechanical damage to the cable
9	Ensure a sand cable bed is laid along the cable trench
10	Ensure the cable is slightly snaked as it is laid in the trench so as to accommodate longitudinal expansion and contraction
11	Where the cable trench makes a bend, ensure the cable bending radius is taken into consideration, as per manufacturer's instructions
12	Inspect the cable for damage immediately following its installation and prepare the cable ends for section testing
13	Pressure Test the cable sections laid as per procedure
14	Secure the cable against the ingress of moisture by fitting appropriate heat-shrink caps
15	Backfill the cable trench with sand, and compact appropriately up to about 40cm and then lay cable marker tape or slabs to warn about approach to the HV cable
16	Mark the cable point positions appropriately and leave space for jointing where necessary. The cable ends must be prepared and secured for section testing
17	Install the cable route identification markers at appropriate lengths (preferably every 80-100m)
18	Where cable markers are removed from existing cables during the course of works or have not been previously installed, they should be replaced or installed as appropriate
19	Backfill the rest of the cable trench with sand, and compact appropriately
20	Clean up work area
21	Cancel any safety documents previously obtained
<p>Tools and Equipment:</p> <p>Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Joints Tool Box</p>	

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4	HV cable jointing	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Cancel any previous safety document and obtain the appropriate safety document	
5	Ensure cable jointing is done only by qualified jointers	
6	Before jointing, test each section of the cable and also retest after jointing, as per Procedure	
7	Joint the cables in accordance with the instructions issued by the joint kit manufacturer. Bear in mind phase sequence and possible parallel operation of cables	
8	Backfill joints holes only after the resin/joint filler is fully hardened. Joints must be kept dry until resin / joint filler is fully hardened	
9	Mark the cable point positions appropriately and leave space for jointing where necessary	
10	Backfill the rest of the cable trench with sand, and compact appropriately	
11	Clean up the work area	
12	Cancel any safety documents previously obtained	
Tools and Equipment:		
Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Joints Tool Box		

5	HV cable termination	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	

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5	Before terminating, test the whole cable length	
6	Ensure cable termination is done only by qualified jointers	
7	Ensure all terminations are made in accordance with the instructions issued by the termination kit manufacturer	
8	After terminating, test the whole cable with terminations in place as per procedure	
9	Firmly connect the termination to the switchgear /equipment at a torque recommended by the cable manufacturer. The connection must be done bearing in mind the phase sequence and possible parallel operation with other cables	
10	Clean up the work area	
11	Cancel any safety documents previously obtained	
12	Cancel any safety documents previously obtained	
Tools and Equipment:		
Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Joints Tool Box		

6	HV cable Pre-commissioning	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Carry out pre-commissioning checks as per pre-commissioning checklist	
6	Clean up the work area	
7	Cancel any safety documents previously obtained	
Tools and Equipment:		
Picks and shovels, Pressure Testing equipment, Cable Joints Tool Box		

7	HV cable Commissioning	Tool Time
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HV Cable Installation, Testing and Commissioning

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1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Carry out commissioning of the cable as per commissioning checklist	
6	Clean up the work area	
7	Cancel any safety documents previously obtained	

Tools and Equipment:

Cable Jointer's Tool Box, Phasing out set and Phase Rotation Testers

8	HV Cable Pressure Testing	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Ensure cable pressure testing is done only by qualified personnel	
6	Connect the test equipment and test each core against earth, in turn. A pressure test voltage (DC) up to about 1.5 is normally accepted, otherwise refer to the cable manufacturer's guide	
7	Record the pressure test results in an appropriate manner for future reference	
8	Clean up work area	
9	Cancel any safety documents previously obtained	

Tools and Equipment:

Cable Jointer's Tool Box, Pressure Testing equipment

9	HV cable Phase Sequence and phasing out	Tool Time
1	Conduct risk assessment	

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2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Ensure phase sequence test and phasing out is done only by qualified personnel	
6	Energise the cable from one end and check phase sequence from the other end, using approved means	
7	Energise the cable from one end and phase out against the other source, using approved means	
8	Record the results in an appropriate manner for future reference	
9	Clean up work area	
10	Clear any safety documents previously obtained	
Tools and Equipment:		
Cable Jointer's Tool Box, Phase Rotation Tester, Phasing out Set		

10	Tasks Preceding Work on a Faulty HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Carry out switching to isolate the faulty cable from all sources of supply	
5	Carry out switching to earth the faulty cable at all points of supply, where applicable	
6	Review the site maps for presence of other existing cables in the vicinity	

11	Tracing the Route of an HV Cable and Pre-locating the Faulty point	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	

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3	Wear correct PPE	
4	Ensure the faulty HV cable has been isolated from all sources of supply and earthed at all points of supply, where applicable	
5	Obtain a Sanction For Test (SFT) for Pre-location of the fault, including tracing of the cable route, where the route is not known	
6	Connect the Test Equipment and carry out the Pre-location of the fault, including tracing of the cable route, where the route is not known	
7	After pinpointing the fault, disconnect the test equipment and cancel the SFT	

Tools and Equipment:

Fault Location Equipment, Danger Notices and Caution notices

12	Excavating for a Faulty HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate excavation permit from the local authority, where necessary	
5	Ensure no safety document is in force on the HV cable	
6	Obtain a Limitation-Of-Access (LOA) for the excavation of the pin pointed area on the HV cable route	
7	Ensure the excavation is done with maximum care and caution, beginning with cross-cuts, to avoid damaging the existing cables in the vicinity. Refer to site maps, if available	
8	After exposing the cable/s, ensure enough room is created around the cable for spiking purposes	
9	Cancel the Limitation-Of-Access	

Tools and Equipment:

Excavators, picks & shovels, depth gauges, excavation tapes or warning notices

13	Identifying an HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Ensure no safety document is in force on the HV cable	
5	Ensure the cable to be identified has been switched off, earthed and exposed using the relevant procedures	
6	Obtain a Sanction For Test for identifying the cable in question	
7	Connect the Test Equipment and carry out the cable identification	
8	After cable identification, disconnect the test equipment and cancel the SFT	
Tools and Equipment:		
Cable Identification Equipment, Danger Notices and Caution notices		

14	HV Cable Spiking, Cutting and Cleaning the Cable Ends	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Ensure no safety document is in force on the HV cable to be spiked	
5	Ensure the cable to be identified has been switched off, earthed, exposed and identified using the relevant procedures	
6	Obtain a Permit To Work (PTW) for spiking the cable, cutting and cleaning the cable in question	
7	Connect the Test Equipment and carry out the cable spiking. N/B: Cable spiking must only be done using the correct size of spiking tools as using smaller spiking blades or bullets may miss the target cores and give wrong results.	
8	If spiking has been effectively and successfully done, there will be explosion, meaning the correct cable has been identified and spiked. Should there be an explosion, with a consequence of system outage, then a wrong cable was identified and spiked.	
9	After spiking, carefully remove the spiking tool. N:B It may still have been possible that the cores were missed during spiking, hence the need to be	

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	cautious when removing the spiking tool	
10	Cut the cable at the point of spiking, cut out the faulty portion of the cable and clean the cable ends in readiness for testing	
11	After spiking, cutting and cleaning the cable, disconnect the test equipment and cancel the PTW	

Tools and Equipment:

Cable spiking Tool, Cable Jointer’s Toolbox

15	Pressure Testing the cable ends of an HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Ensure no safety document is in force on the HV cable to be pressure tested	
5	Ensure the cable to be identified has been switched off, earthed, exposed, identified, spiked and cut using the relevant procedures	
6	Obtain a SFT for pressure testing the cable ends of the cable in question	
7	Connect the Test Equipment and carry out pressure testing. N:B if the pressure testing is being done from remote substations, then the portion with exposed cable ends must be secured off and appropriate safety notices must be posted	
8	The pressure testing results must be compared to acceptable results for the type and length of the cable being tested.	
9	If the pressure testing is successful disconnect the test equipment and cancel the SFT	
10	If the pressure testing is NOT successful disconnect the test equipment and cancel the SFT. REPEAT the fault location process until the cable is free of any other fault	

Tools and Equipment:

Pressure Testing Equipment

16	Joining an HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Cancel any previous safety document and obtain a PTW for jointing	
5	Ensure cable jointing is done only by qualified jointers	
6	Joint the cables in accordance with the instructions issued by the joint kit manufacturer. Bear in mind phase sequence and possible parallel operation of cables	
7	Clean up the work area	
8	Cancel the PTW	
9	N:B Ensure the whole cable length is tested as per procedure before restoring into service	
Tools and Equipment:		
Crimping Tool, Cable Jointer's Toolbox		

17	Burying/backfilling an HV Cable after Jointing	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Cancel any previous safety document and obtain an LOA for burying of the cable	
5	Bury the cable or backfill joints holes only after the resin/joint filler is fully hardened. Joints must be kept dry until resin / joint filler is fully hardened	
6	Mark the cable joint positions appropriately using joint markers for future reference	
7	Bury /backfill the rest of the cable trench with sand, and compact appropriately	
8	Clean up the work area	



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9	Cancel the LOA	
Tools and Equipment:		
Shovels		

18	Re-terminating an HV Cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Before re-terminating, ensure the cable has been cleaned and tested as per procedure	
5	Cancel any previous safety document and obtain a PTW for re-terminating	
6	Ensure cable re-terminating is done only by qualified jointers	
7	Ensure all terminations are made in accordance with the instructions issued by the termination kit manufacturer	
8	After re-terminating, test the whole cable with terminations in place as per procedure	
9	Firmly connect the termination to the switchgear /equipment at a torque recommended by the cable manufacturer. The connection must be done bearing in mind the phase sequence and possible parallel operation with other cables	
10	Clean up the work area	
11	Cancel the PTW	
12	N:B Ensure the whole cable length is tested as per procedure before restoring into service	
Tools and Equipment:		
Crimping Tool, Cable Jointer's Toolbox		

19	Pressure Testing an HV Cable (General)	Tool Time
1	Conduct risk assessment	



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2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain a Sanction For Test (SFT), if the cable is connected to the system	
5	Ensure cable pressure testing is done only by qualified personnel	
6	Connect the test equipment and test each core against earth, in turn. A pressure test voltage (DC) up to about 1.5 is normally accepted, otherwise refer to the cable manufacturer's guide	
7	Record the pressure test results in an appropriate manner for future reference	
8	Disconnect the test equipment	
9	Cancel the SFT, if the cable is connected to the system	

Tools and Equipment:

Pressure Testing Equipment, Cable Jointer's Toolbox

20	HV Cable Phase Sequence and phasing out (General)	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain appropriate safety document	
5	Ensure phase sequence test and phasing out is done only by qualified personnel	
6	For Phase sequence checks, energise the cable from one end and check phase sequence from the other end, using approved means	
7	For phasing out check, energise the cable from one end and phase out against the other source, using approved means	
8	Record the results in an appropriate manner for future reference	
9	Cancel any safety documents previously obtained	

Tools and Equipment:

Phase Sequence or Phasing out Equipment, Cable Jointer's Toolbox



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21	Managing Forced Outage on HV cable	Tool Time
1	Conduct risk assessment	
2	Carry appropriate tools, equipment and materials	
3	Wear correct PPE	
4	Obtain the appropriate safety document	
5	Carry out forced outage management of the HV cable as per HV Cable Fault Procedures 10 to 20 above	
6	Clean up work area	
7	Clear any safety documents previously obtained	
Tools and Equipment: Cable Joints Tool Box, Phase Rotation Tester, Phasing out Set		

22	Failure Investigation Procedure	Tool Time
	Conduct risk assessment	
	Carry appropriate tools, equipment and materials	
	Wear correct PPE	
	Obtain the appropriate safety document	
	Carry out failure investigation on the HV cable as per HV Cable Fault Procedures 10 to 20 above	
	Clean up work area	
	Clear any safety documents previously obtained	
Tools and Equipment: Cable Joints Tool Box, Phase Rotation Tester, Phasing out Set		

23	HV Cable Sizing	Tool Time
	Determine the Load that the cable will be carrying based on customer	

	requirements	
	Determine the Voltage level at which the cable will be connected based on customer requirements	
	Determine the Short-circuit current of cable based on customer requirements	
	Determine the laying condition of the cable based on customer requirements	
	Determine the cable type and design based on type of insulation	
	Determine the conductor material (Cu, Al) based on economic aspects (Price, Losses)	
	Determine the earthing method of the sheath based on the route length and layout	
	Determine the conductor cross section based on Economic aspects and Safety margin including Short-circuit and thermal rating of the cable	
	Select cable accessories and Leakage path based on whether the cable will be used Indoor or Outdoor	
	Determine the laying conditions based on Losses, Economic aspects, Local boundaries and Safety regulation	
	In all this cable selection and sizing process, refer to specific cable manufacturer's manuals, specifications and type test results	
<p>Tools and Equipment:</p> <p>Cable sizing software, Cable datasheets and various manufacturers' manuals, Customer Technical Specifications/Requirements</p>		



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7. RECORDS

In the execution of this technical instruction no records shall be generated.

8. APPENDICES

This Technical Instruction does not have appendices.

Environmental and Social Management Plan



General Procedure



Document No:
BD.15100.SPPR.00020

Title:
Environmental and Social
Management Plan

Date of Approval:
23/05/2016

Version:
1

Division:
Environmental and Social
Analysis Unit






Environmental and Social Management Plan

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Development, Review and Approval					
Prepared By	Date	Reviewed By	Date	Approved By	Date
 Brenda L. M. Chizinga Chief Environmental and Social Analyst	12-05-16	 Chitembo Simwanza Senior Manager- Business Development	20/05/16	 Besty Phiri Director-Strategy & Corporate Services	23/5/2016



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1. PURPOSE

The purpose of this Procedure is to provide guidance on how to develop and implement comprehensive Environmental and Social Management Plans (ESMPs) for all ZESCO projects and operations. It also outlines the duties and responsibilities of the Developer and the Contractor with respect to environmental management and protection during construction and operation phases of Projects.

The procedure ensures compliance with local and international environmental and social laws, regulations and guidelines. Further, the Procedure provides a framework for the planning, preparation, implementation, monitoring and review of the ESMP.

2. SCOPE

This procedure applies to all ZESCO projects and operations with potential environmental and social impacts.

3. REFERENCES


ISO 14001 Standard: Environmental Management System.
 ISO 26000 Standard: Social Responsibility
 Environmental Management Act No. 12 of 2011 of the laws of Zambia.
 ZESCO Waste Management Procedure CO.14900.GNPR 00004.
 ZESCO Hydrocarbons Management Procedure
 ZESCO Management of PCBs containing Materials Procedure
 ZESCO Management of Chemicals Procedure
 IUCN Environmental and Social Management System Manual of 2015

4. RESPONSIBILITIES

In executing this Procedure the following responsibilities shall be recognised:

4.1 Preparation

The Chief Environmental and Social Analyst shall be responsible for the preparation of this Procedure.

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4.2 Review

The Senior Manager Business Development shall be responsible for the review of this Corporate Procedure.

4.3 Approval

The Director Strategy and Corporate Services shall be responsible for approval of this Procedure.

4.4 Distribution

The Director Strategy and Corporate Services shall be responsible for the distribution of this Procedure.

5. DEFINITIONS AND GENERAL CONTENTS

5.1 Assessment

A structured investigation and evaluation of information for the basis of making inferences.

5.2 Audit

A systematic, documented verification process of objectively obtaining and evaluating audit evidence to determine whether specified environmental activities, events, conditions, management systems or information about these matters conform to audit criteria, and communicating the results of this process to the client.

5.3 Baseline

Prevailing conditions of an area prior to project implementation that may potentially be affected by the proposed project.

5.4 Biodiversity

The variability among living organisms in an area and the ecological complexes of which they are part, including diversity within species, between species, and of ecosystems.

5.5 Biophysical

The part of the environment that does not originate with human activities (e.g. biological, physical and chemical processes); pertaining to the natural environment.

5.5 Compliance

Operating or carrying out works in accordance with legal requirements and/or procedures.

5.6 Contaminant

A substance or physical agent, or a combination of both, that may contribute to the contamination of the environment.

5.7 Contamination

Pollution of the natural environment.

5.8 Conservation

Refers to the preservation or safeguarding of resources.

5.9 Disposal Site


Land or water area where waste disposal facilities are located.

5.10 Ecological Processes

Processes which play an essential part in maintaining the integrity of the ecosystem, which include the water, nutrients, energy cycles and biological diversity.

5.11 Ecosystem

A community of interdependent plants, animals and other living organisms (including humans) together with the environment which supports them and with which they interact.

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5.12 Effects/Impacts

The resulting change (positive or negative) in the environment due to a project action. Effects can be ecological (such as the effects on components of natural resources, the structure and/or functioning of affected ecosystems), aesthetic, historic, cultural, economic and social, whether direct, indirect or cumulative.

5.13 Environment

The natural or man-made surroundings at any place, comprising air, water, land, natural resources, animals buildings and other constructions.

5.14 Environmental Impact Statement

This is an Environmental and Social Impact Assessment (ESIA) report prepared in respect of projects likely to have significant negative impacts on the environment.

5.15 Environmental and Social Impact Assessment


This process is the identification and evaluation of environmental and social impacts that projects are likely to have, analysing alternative plans, and preparing adequate mitigation measures and monitoring plans in accordance with applicable laws and guidelines.

5.16 Environmental and Social Management Plan

A Plan that seeks to achieve a required end state of the environment and describes how activities, that could have a negative impact, will be managed and monitored and how impacted areas will be rehabilitated. An ESMP specifies how, when and by whom these measures shall be implemented.

5.17 Habitat

The natural home or environment of an animal or plant, or any other organism.

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5.18 Hazardous Waste

Any kind of waste that is poisonous, corrosive, irritant, explosive, inflammable, toxic or harmful to man, animal, plant and/or the environment.

5.19 Issue

A concern regarding an environmental impact, consequence or effect after an activity.

5.20 Material Safety Data Sheet (MSDS)

A document that provides information on the appropriate procedures for handling or working with hazardous substances in a safe manner, and includes information such as physical data (melting point, boiling point, etc.), toxicity, health effects, first aid, storage, disposal, protective equipment, and spill-handling procedures.

5.21 Mitigation


An activity aimed at reducing severity, avoiding or controlling environmental and social impacts of a project, through design alternatives, scheduling or other means.

5.22 Monitoring

An activity involving repeated observation, according to a predetermined schedule, of one or more elements of the environment to detect their characteristics (status and trends) and to assess the environmental and social performance of a project and its compliance with the ESIA and ESMP, and/or other approval and regulatory conditions.

5.23 Project Implementation Unit

This is a team comprising multi-disciplinary personnel in charge of project implementation.

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5.24 Project Developer (Proponent)

The organization, company or institution planning to initiate a project with environmental and social implications.

5.25 Personal Protective Equipment

Personal Protective Equipment used for the purpose of protecting the user from injury or infection by minimizing exposure to various hazards.

5.26 Polluter

A person who contributes to or creates a condition of pollution.

5.27 Pollution

The introduction into the natural environment of one or more contaminants in such quantities and under such conditions as may cause discomfort to or endanger the health, safety and welfare of human beings, or which may cause injury or damage to plant or animal life or property. This is also referred to as Contamination.

5.28 Risk


The likelihood of occurrence of an adverse project effect.

5.29 Stakeholder

These are people/communities/organisations who may - directly or indirectly, positively or negatively – affect or be affected by the outcomes of projects or programs.

5.30 Water Quality

A measurement of the purity of water, or drinking water.

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5.31 ESMP

The ESMP will operationalize the ESIA by taking cognizance of the mitigation measures recommended for the identified impacts. It shall determine the roles and responsibilities of the Developer and Contractor regarding the effective and timely management of environmental and social aspects. Additionally, the ESMP shall describe the mechanisms by which mitigation measures will be implemented.

The ESMP shall be developed by the contractor as per the template below.

5.31.1 Introduction

The ESMP shall describe measures that the contractor will take to mitigate potential negative impacts and enhance the positive outcomes of the project on the environment and the local communities. The measures in the ESMP shall be based on the assessment of potential impacts in the Environmental Impact Statement (EIS) for the project, which shall form companion volumes to the ESMP.

5.31.2 ESMP Objectives

The main objective of the ESMP shall be to give a comprehensive plan on how proposed mitigation measures shall be implemented during construction and operation. Hence, the ESMP shall not be read in isolation, but together with the EIS.

Specific objectives shall include:

- Outlining duties and responsibilities of the developer and the Contractor with respect to environmental and social management and protection during construction and operational phases of Projects;
- Stipulating how the Contractor shall comply with all the requirements and specific actions required, time tables for implementation, and associated costs; as well as capacity building and training requirements for the implementation;
- Carrying out the specified environmental protection requirements to the approval of the Project Environmental Coordinator (ECO) or the Site

Manager on behalf of the Developer. If so instructed by the ECO or the Site Manager, the Contractor shall implement additional mitigation measures payable under the applicable rates in the Work Schedule.

5.32 Project Description

The contractor shall give a detailed description and location of the project.

5.33 Scope

This section shall give a detailed scope of the project works outlining the extent and technical specifications.

5.34 Roles and Responsibilities

This section shall describe the organizational structure and responsibilities for the implementation of the ESMP. The organisational structure shall comprise but shall not be limited to the following:

(a) ZESCO Limited - The Developer


The developer shall be responsible for the overall supervision of the implementation of the ESMP through the Project Implementation Unit (PIU). The role of the PIU shall be to supervise the implementation and ensure contractor's compliance to the ESMP.

(b) The Contractor

The Contractor shall be responsible for constituting a team to prepare, implement and adhere to the ESMP in order to comply with the Developer's requirements and all applicable local and international laws.

(c) The Consultant

The Developer may engage a Consultant, an Engineer or Representative to supervise and/or monitor the implementation and compliance by the Contractor of the ESMP. The detailed ToRs

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for the Consultant shall be outlined in the Contract between the Developer and the Consultant.

5.35 Institutional and Legal Framework

The developer shall carry the ultimate responsibility for ensuring that the Project and all supporting infrastructure are designed, constructed and operated in conformance with local and international legislative requirements and industry best practice.

Therefore, the Contractor shall comply with all laws, policies and regulations applicable to the project to ensure successful implementation of the ESMP. This requirement shall extend to all established local customs and traditions in the project area.


5.36 Impact Management and Mitigation Measures

The ESMP shall list the proposed measures to mitigate significant adverse social and environmental impacts to acceptable levels. It shall include evidence of technical and economic feasibility, cultural adequacy of proposed measures, cost estimates of mitigation measures and indicate compensatory measures to be employed if mitigation measure are not feasible, cost-efficient or sufficient. Therefore, the contractor(s) shall formulate specific, detailed and action oriented impact mitigation plans.

5.36.1 Ecological Management Plan

The objective of this management plan is to enhance conservation and prevent, minimize, or mitigate adverse impacts to natural resources and ecosystems, (including flora and fauna) that are related to the project. This Plan shall apply to all works that may cause risks or impacts to the ecological system, or natural resources in the project area such as:

- a) Vegetation clearance;
- b) Pollution of water, air and soil;
- c) Hunting or fishing;
- d) Earth movements and excavations; and
- e) Noise.

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5.36.2 Erosion and Sedimentation Management Plan

The objective of this Plan is to manage erosion and sedimentation that could be induced by the project. Therefore, the contractor shall demonstrate how the following will be achieved:

- a) Overall soil conservation in the project area;
- b) sustain quality erosion and sediment management in the project area;
- c) Minimise the negative impacts of erosion on rivers' ecological systems;
- d) Promotion of reduction of sedimentation in order to maintain good water flows downstream; and
- e) Prevent and reduce run off of environmentally unfriendly substances as per national and international requirements.

5.36.3 Waste Management Plan

This Plan shall specify the procedure for the management, control and disposal of items designated as waste material resulting from project activities. The following is a list of the different categories of materials that will be generated during the project:


- a) Reusable Materials;
- b) Recyclable Materials;
- c) Waste/Refuse Materials; and
- d) Hazardous waste.

5.36.4 Environmental Rehabilitation and Restoration Plan

The contractor shall outline all activities to be undertaken as remedial, rehabilitation and restoration works upon completion of project works.

5.36.5 Stakeholder Engagement Plan

The contractor shall engage project affected communities and relevant stakeholders in accordance with the

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stakeholder engagement plan as per Environmental and Social Impact Assessment (ESIA) Procedure.

5.36.6 Health and Safety Management Plan

The Health and Safety Management Plan is an important project component providing a link between Environmental Impact Statement (EIS) recommendations, legislative commitments and practical environmental and social outcomes. It also identifies the principles, approaches, procedures and methods that shall be used to control and minimize the environmental and social impacts of all construction and operational activities associated with the Project.

The HSMP will highlight the EIS commitments listed in the Environmental impacts and mitigation measures, of any conditions of approval issued by the Zambia Environmental Management Agency (ZEMA), and any requirements of lending institutions associated with the Project. The ESMP should address the community and site health and safety impacts. Where applicable, a separate HSMP shall be developed in accordance with the HSMP Procedure.

5.36.7 Corporate Social Responsibility

This refers to activities that the Developer and contractor shall undertake to contribute to a better society by way of promoting business accountability towards the environment and community in which they operate. The type of contribution could be major, minor, one off and sustainable or continuous as stipulated in the Corporate Social Responsibility Procedure No.CO.14900.GNPR 00038.

5.36.8 Traffic Management Plan

The scope of this Plan shall include provision for the safe movement of vehicular and pedestrian traffic, the protection of workers from passing traffic, the provision for access to properties located within the limits of the construction site, the design, construction, maintenance

and removal of any necessary temporary roadways and detours, the provision of traffic controllers, the installation of temporary signs, road markings, lighting and safety barriers.

It shall also cover maintenance of the existing road corridor, including the existing road and road shoulder that may be used for the temporary diversion of traffic, over the duration of the construction works.

5.36.9 Cultural Heritage Management Plan

The main objective of this Plan is to outline how best to document, conserve, preserve and manage Cultural Heritage resources should they be found during the development of the project.

The National Heritage Conservation Commission (NHCC) is responsible for the identification, recovery and/preservation of both movable and immovable heritage sites and objects in accordance with the local and International conventions that Zambia is party to on Cultural Heritage resources protection. Any artefacts that may be discovered during excavation works shall be brought to the attention of NHCC. Hence, appropriate chance-find management plans shall be put in place.

5.36.10 Induction and Training Plan

The contractor shall conduct appropriate site induction and training to contracted personnel and/or visitors prior to commencement of works. The level of training shall be commensurate with the type of duties of the personnel. The training programmes shall cover plans and procedures specific to the project.

5.37 Reporting and Recording Procedures

The contractor shall clearly outline procedures and tools for reporting and recording incidences and establish a database for the same.

5.38 Monitoring and Evaluation Framework

The developer shall monitor, audit and evaluate the performance of the ESMP.

Monitoring and evaluation of the ESMP shall be carried out in under two categories; operational and performance monitoring.

5.38.1 Performance Monitoring


Performance monitoring deals with how well the ESMP is achieving results. After the indicators for the ESMP are identified and means of verification specified, a monitoring plan for each result indicator shall be prepared following steps outlined below:

- a) Establish the use and scope of the plan;
- b) Re-verify the intervention logic;
- c) Refine indicators, identify targets and milestones;
- d) Development a monitoring action Plan (What, where, who, when);
- e) Design an information analysis and management system;
- f) Clarify the monitoring budget;
- g) Design a learning and feedback process; and
- h) Create monitoring report and test use.

5.38.2 Operation Monitoring

This part of monitoring concerns tracking on implementation of activities and the production of outputs and is based on the project operational plans. This process is on-going and is complimented by set periods of reflection. Operational monitoring shall be carried out by establishing the following:

- a) Whether all project tasks where carried out;
- b) What worked well and why;
- c) What did not work well and why not;
- d) If activities lead to outputs;
- e) If the budget expenditure was on time;

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- f) If stakeholder participation was on track; and
- g) What needed to be adjusted to ensure that tasks and activities were implemented and that outputs were achieved?

5.39 ESMP Review and Update

The Developer shall periodically review, monitor and recommend for the update of the ESMP by the contractor, including all sub-plans to ensure they are effective and relevant at all times. This shall be carried out:

- a) Annually;
- b) Following a reportable incident, or a significant non-compliance; and
- c) Following an addition, up-date or change order to the ESMP, or a sub-plan.

The review shall include analysis of the data collected, monitoring reports, incident reports, complaints/grievances and feedback from stakeholders, consultation and awareness meeting minutes, and training records to evaluate the effectiveness of ESMP procedures. Site visits, interviews and other auditing methods may also be used.


5.40 Control of the ESMP

The ESMP document shall be issued as a controlled document to all relevant staff and institutions. The procedure to be followed to control the issuance of the document shall be as follows:

- a) Issued copies by the contractor shall be numbered;
- b) The Developer shall initiate a review of any relevant sections following modification to the ESMP; and
- c) Receipt of written request by ZEMA, or a change to internal procedures based on corrective actions or improvements in methodologies or analytical procedures.

5.41 Additional Studies

In order to ensure adequate information during the implementation of the ESMP, studies will be added as necessary to ensure effective completion and implementation of the ESMP by the contractor.

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5.42 Implementation Schedule and Mitigation Budget

In addition to the indicative environmental and social mitigation budget in the ESIA, the Contractor shall make his own cost estimates for the implementation of the ESMP. All these costs shall form part of the total project budget to be included in the contract.

The budget shall exclusively be for Environmental and Social risk management, and shall be managed with the environmental coordinator's guidance.

5.43 Approval Of ESMP by ZESCO

ZESCO Limited shall review the contractor's draft ESMP document. If satisfied, the ESMP shall be approved for implementation. Where necessary, the contractor shall be requested to make amendments to the document and resubmit to ZESCO Limited for approval.

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The following process flowchart from the IBMS shall be adhered to in the execution of this procedure:

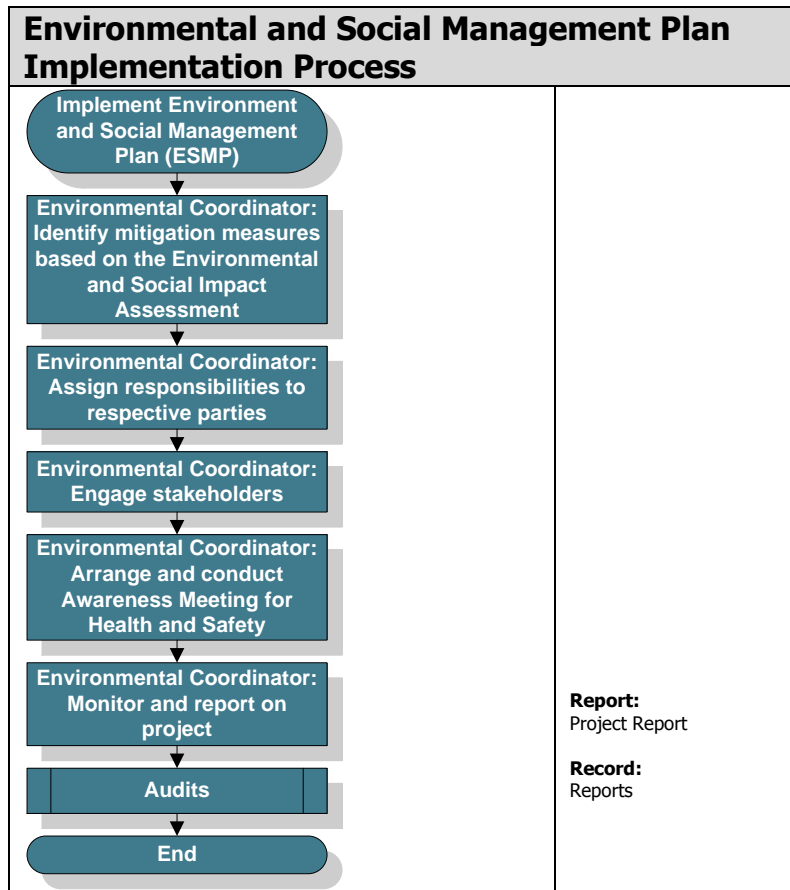


Figure 2: Environmental and Social Management Plan Implementation Process

7. RECORDS

In the execution of this procedure, the records generated shall be managed as indicated in the table below:

Record Name	Retention Period	Archive Period	Location Stored	Responsible Person	Disposal Method
Audit Check List	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Incident Record Sheet	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Waste Management Plan	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Ecological Management Plan	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Soil erosion and Sedimentation Control Plan	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Traffic Management Plan	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Air Quality Management Plan	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record




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Archaeological and Cultural Management Plan (Chance-Find)	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Hydrocarbon Transport Check List	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Hydrocarbon Storage Checklist	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Hydrocarbon Use Checklist	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Hydrocarbon Spill Assessment and Corrective Action	8 Years	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record
Material Safety Data Sheet (MSDS)	Duration of Storage and Use of Hydrocarbon	2 Years	HQMS Database	Chief Environmental and Social Analyst	SHEQ shall Remove Record

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APPENDIX 2: ESMP OUTLINE

LIST OF ABBREVIATIONS AND ACRONYMS

DEFINITION OF TERMS

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

1.2 THE ESMP OBJECTIVES

1.3 LAYOUT OF THE MANAGEMENT PLAN

2.0 PROJECT DESCRIPTION

2.1 PROJECT SCOPE

2.2 PROJECT COST

3.0 MANAGEMENT ARRANGEMENTS

3.1 ROLES AND RESPONSIBILITIES

3.1.1 ZESCO LIMITED - THE EMPLOYER

3.1.2 ENVIRONMENT AND SOCIAL AFFAIRS DEPARTMENT (ESD)

3.1.3 THE CONTRACTOR

3.1.4 SUPERVISING CONSULTANT

3.1.5 ENVIRONMENTAL COORDINATOR (ECO)

3.1.6 SAFETY AND HEALTH OFFICER

3.1.8 ESMP IMPLEMENTATION ORGANIZATION STRUCTURE

4.0 INSTITUTIONAL AND LEGAL FRAMEWORK

5.0 IMPACT MANAGEMENT GUIDELINES

5.1 ECOLOGICAL MANAGEMENT PLAN

5.2 EROSION AND SEDIMENT MANAGEMENT PLAN

5.4 HEALTH AND SAFETY MANAGEMENT PLAN

5.4.1 MANAGEMENT STRUCTURE

5.4.2 HEALTH & SAFETY MEETINGS

5.4.3 LICENSES

5.4.4 HEALTH AND SAFETY GUIDELINES

5.4.5 PROCEDURES FOR CONTROLLING HEALTH & SAFETY RISKS

5.4.6 REDUCING NOISE AND VIBRATIONS

5.4.7 DRINKING WATER AND SANITARY FACILITIES

5.4.8 THE HEALTH AND SAFETY FILING SYSTEM

5.4.9 RISK ASSESSMENT IDENTIFICATION AND CONTROL

5.4.10 SITE INDUCTION TRAINING, SITE RULES AND FIRE PLAN

5.4.11 FIRE PLAN

5.5 WASTE MANAGEMENT PLAN

5.5.1 GENERAL CONSTRUCTION WASTE

5.5.2 DECOMMISSIONED EQUIPMENT UTILISATION PLAN

THE PROJECT WILL INVOLVE THE REMOVAL AND REPLACEMENT OF THE FOLLOWING EQUIPMENT

5.5.3 OPERATION

5.6 TRAFFIC MANAGEMENT PLAN

5.7 CULTURAL AND ARCHAEOLOGICAL MANAGEMENT PLAN

5.7.1 OBJECTIVES OF THE CULTURAL HERITAGE MANAGEMENT PLAN

5.7.2 POTENTIAL IMPACTS OF THE PROJECT ON CULTURAL HERITAGE RESOURCES

6.0 MONITORING AND AUDIT FRAMEWORK

6.1 MONITORING PROGRAMME

6.2 FEEDBACK AND AUDIT



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- 6.3 CORRECTIVE ACTIONS AND DISCIPLINARY PROCEDURES
- 6.4 DESIGN AND BUILD CONTRACTOR/OPERATOR: DIRECT IMPACTS
- 6.5 ADHERENCE TO ESMP MEASURES
- 7.0 RECOMMENDED ADDITIONAL STUDIES
- 7.1 SCHEDULE OF THE ACTIVITIES OF THE ESMP
- 8.0 ESMP REVIEW AND UPDATE
- 8.1 REVIEW OF THE ESMP
- 8.2 CONTROL AND UPDATE OF THE ESMP
- 9.0 ENVIRONMENTAL MITIGATION BUDGET
- 9.1 ESMP BUDGET
- 10.0 REFERENCES