





# 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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	Annex 2	Network Geographical Layout			
	Annex 3	Medium Voltage Drawings			
	Annex 4	Low Voltage Drawings (ABC)			
	Annex 5	Low Voltage Drawings (ACSR)			
	Annex 6	Geo-technical Investigations Report			
	Annex 7	HV Cable Installation, Testing and Commissioning			
	Annex 8	Environmental and Social Management Plan (ESMP)			

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Section 5 Administrative Compliance Grid and Evaluation Grid

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Section 2 General Conditions for Works Contracts

Section 3 Special Conditions of Contract (with Annex 12)

Section 4 Pre-financing Guarantee Section 5 Performance Guarantee Section 6 Retention Guarantee

Section 7 Tax and Customs Arrangements

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Section 4 Standard Technical Requirements

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Section 2 Bill of Quantities
Section 3 Unit Price Schedules
Section 4 Day works Schedule
Section 5 Breakdown of Unit Prices

#### Volume 5:

Section 1 Design Document including Drawings



Volume 5

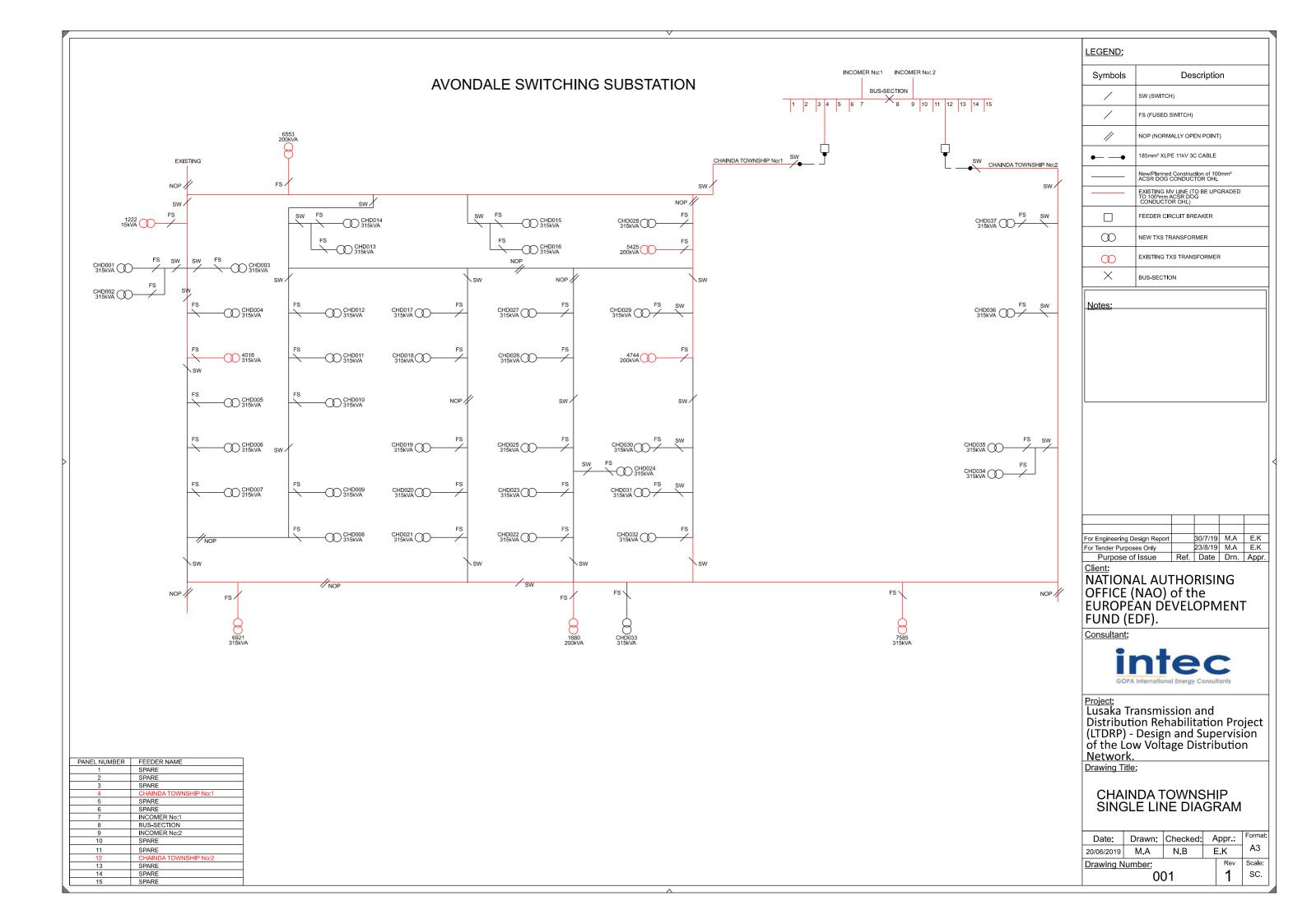
**Design Documents and Drawings** 



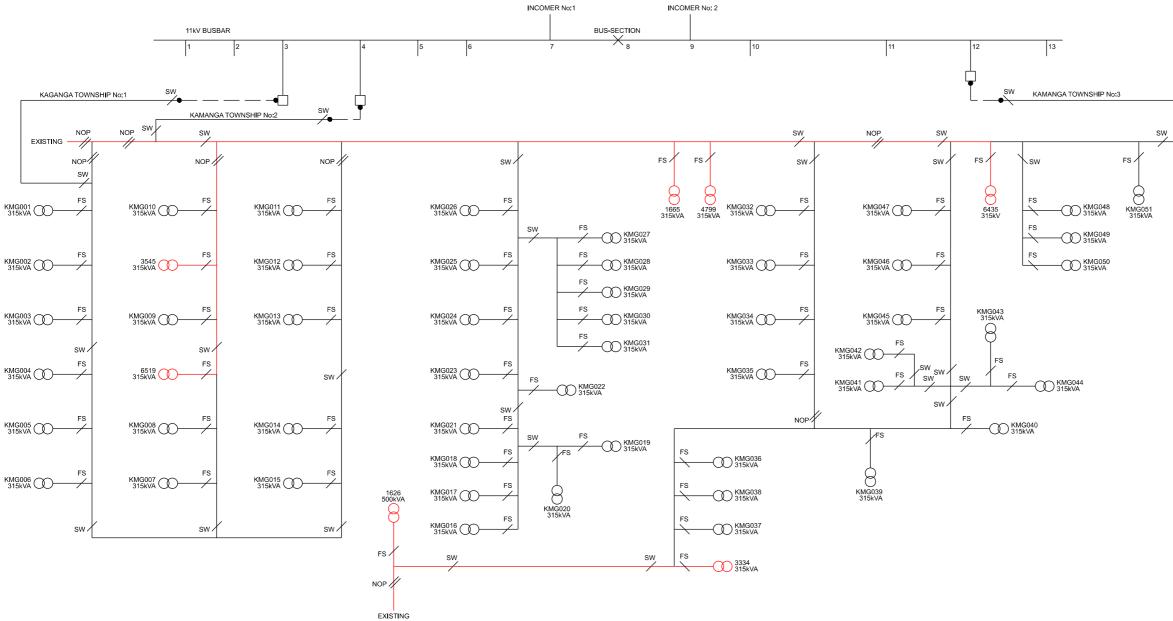
Annex 1

### **Single-Line Diagrams**

<b>Drawing No.</b>	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



# CHELSTON OBAMA 11kV SWITCHING STATION



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

	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 100°mm ACSR DOG CONDUCTOR OHL)
		FEEDER CIRCUIT BREAKER
	8	NEW TXS TRANSFORMER
	$\infty$	EXISTING TXS TRANSFORMER
	×	BUS-SECTION

For Engineering Design Report 30/7/19 M.A E.K For Tender Purposes Only 23/8/19 M.A E.K				
To any and any and any and any				
To any and any and any and any				
To any and any and any and any	For Engineering Design Report	30/7/19	МА	FK
				E.K

Notes:

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

Consultant:

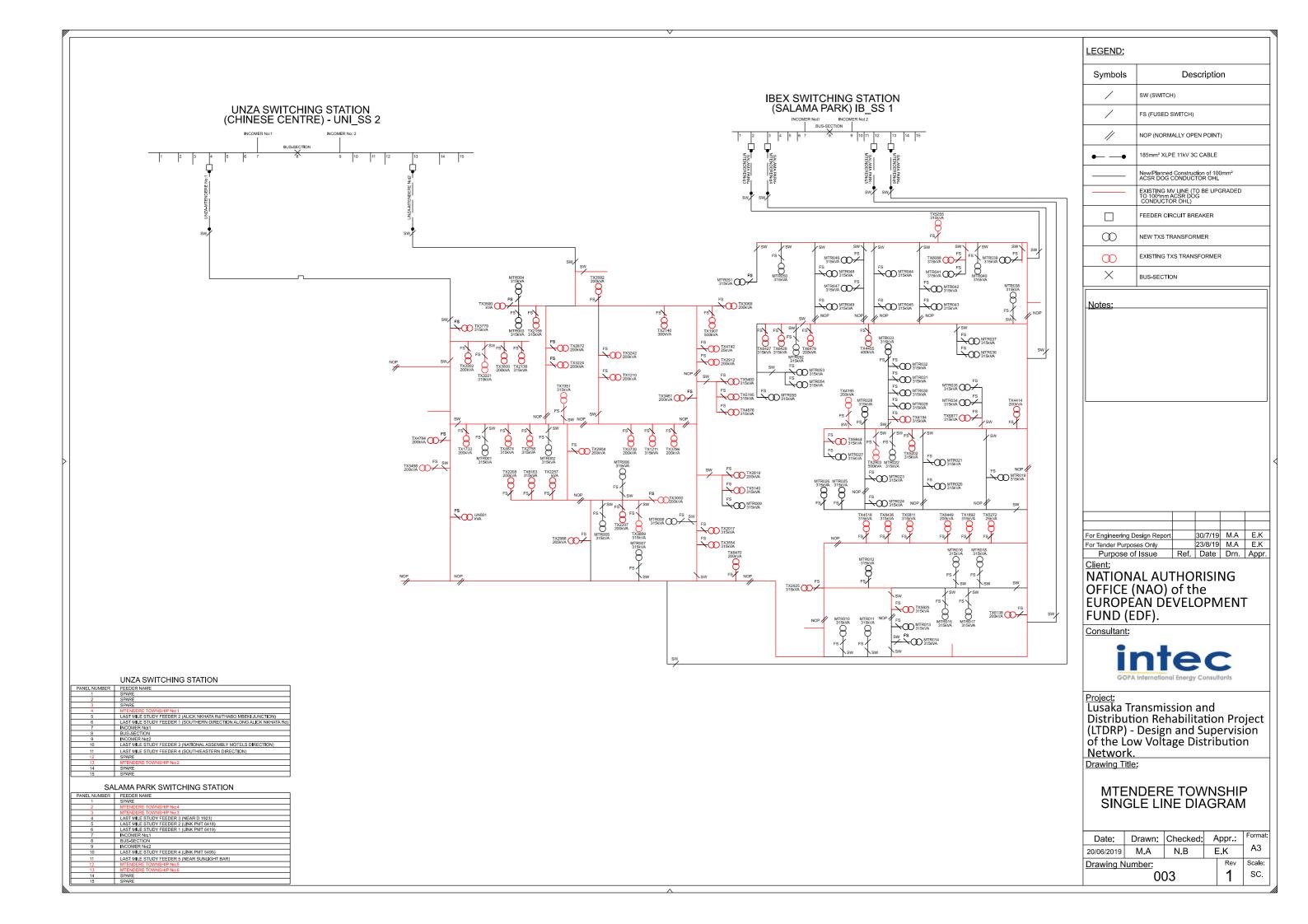


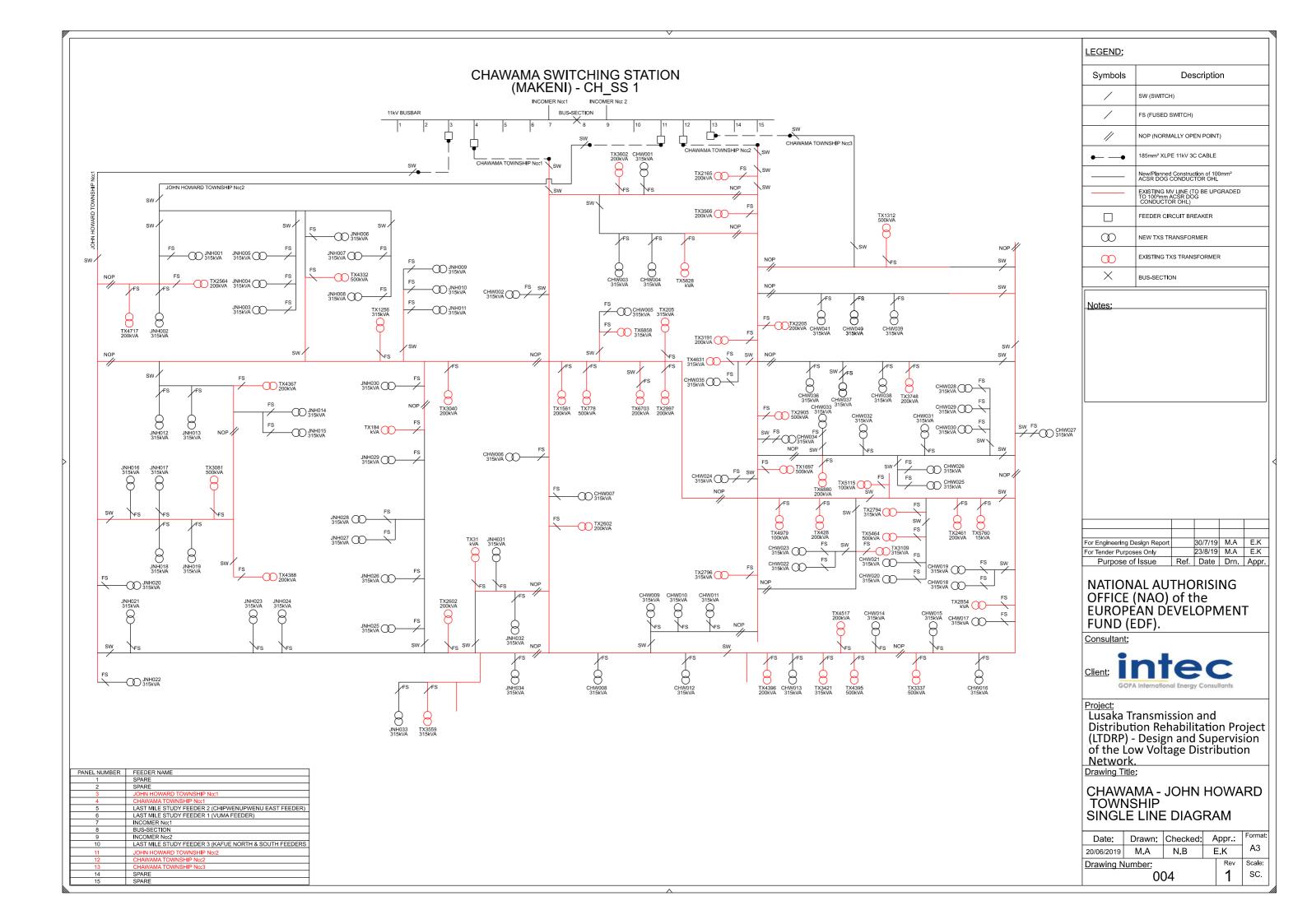
Project:
Lusaka Transmission and
Distribution Rehabilitation Project
(LTDRP) - Design and Supervision
of the Low Voltage Distribution

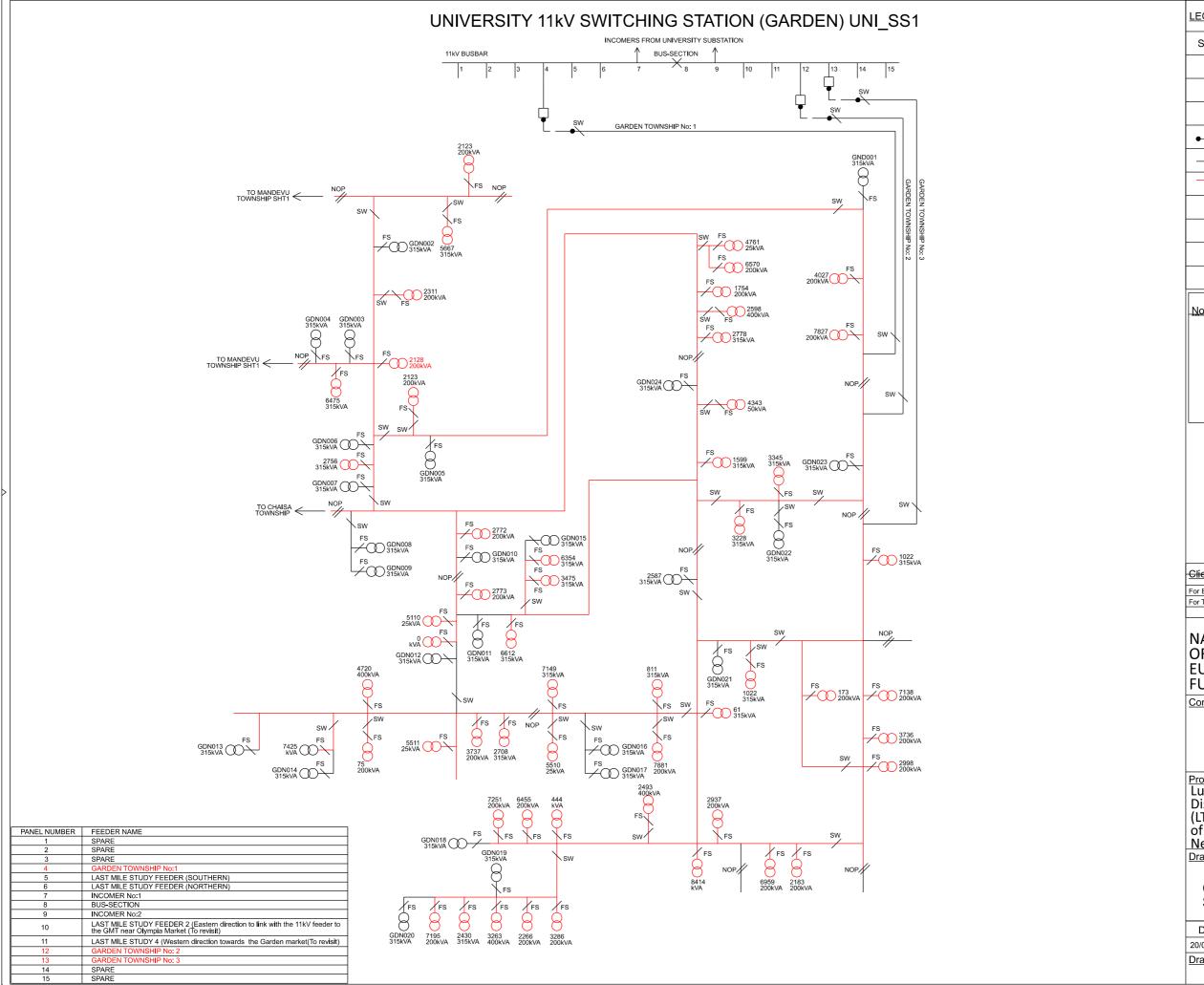
Drawing Title:

#### KAMANGA TOWNSHIP SINGLE LINE DIAGRAM

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







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 1002mm ACSR DOG CONDUCTOR OHL)
	FEEDER CIRCUIT BREAKER
$\infty$	NEW TXS TRANSFORMER
$\infty$	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).

Consultant:

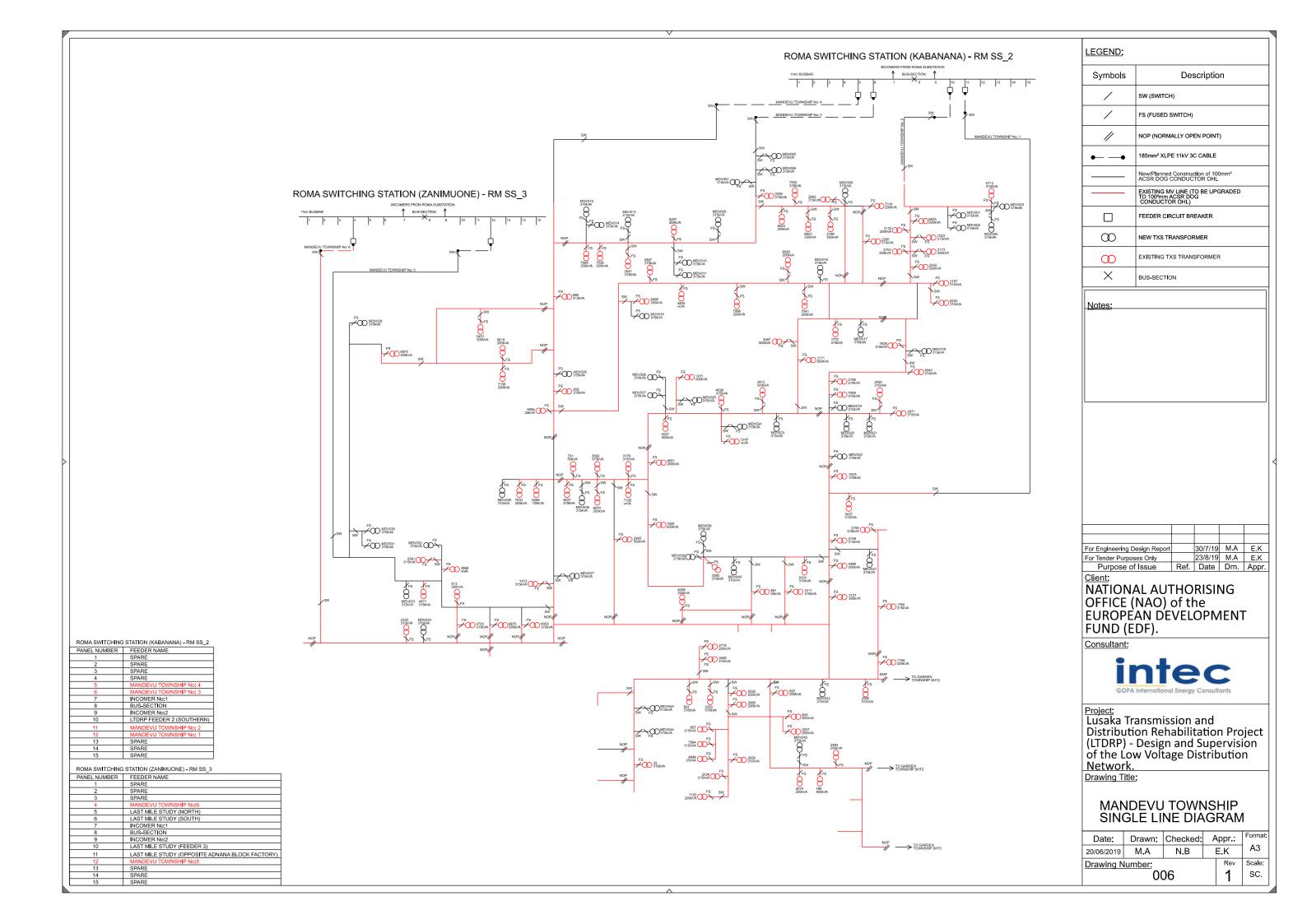


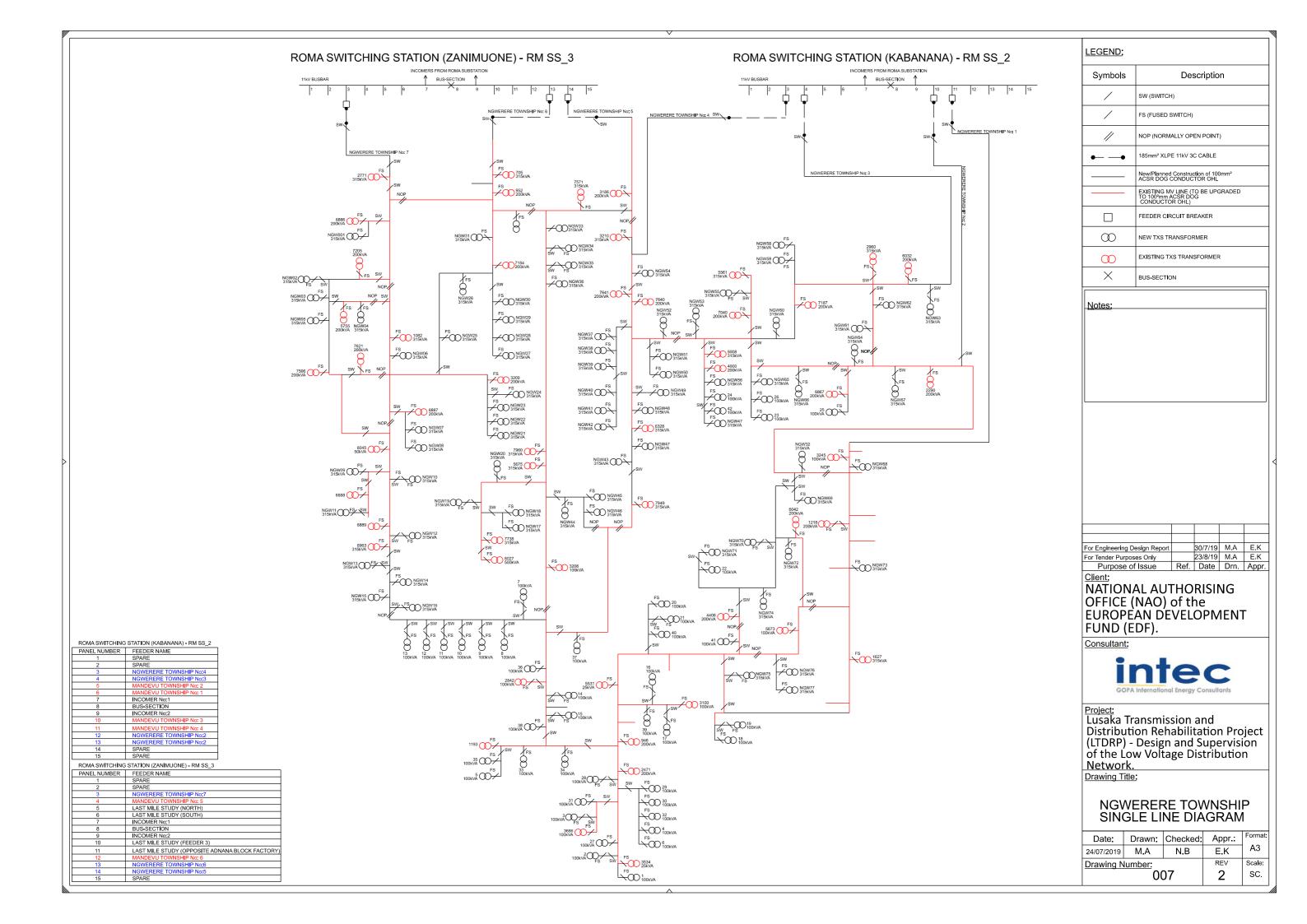
Project:
Lusaka Transmission and
Distribution Rehabilitation Project
(LTDRP) - Design and Supervision
of the Low Voltage Distribution
Network.

Drawing Title:

#### GARDEN TOWNSHIP SINGLE LINE DIAGRAM

Date: Drawn: Checked:			A	Appr.:	Format:
20/06/2019 M.A N.B E				Ξ.K	<b>A</b> 3
Drawing Number: Rev					
005 1					SC.





Annex 2

### Township Medium-Voltage Network Geographical Layout

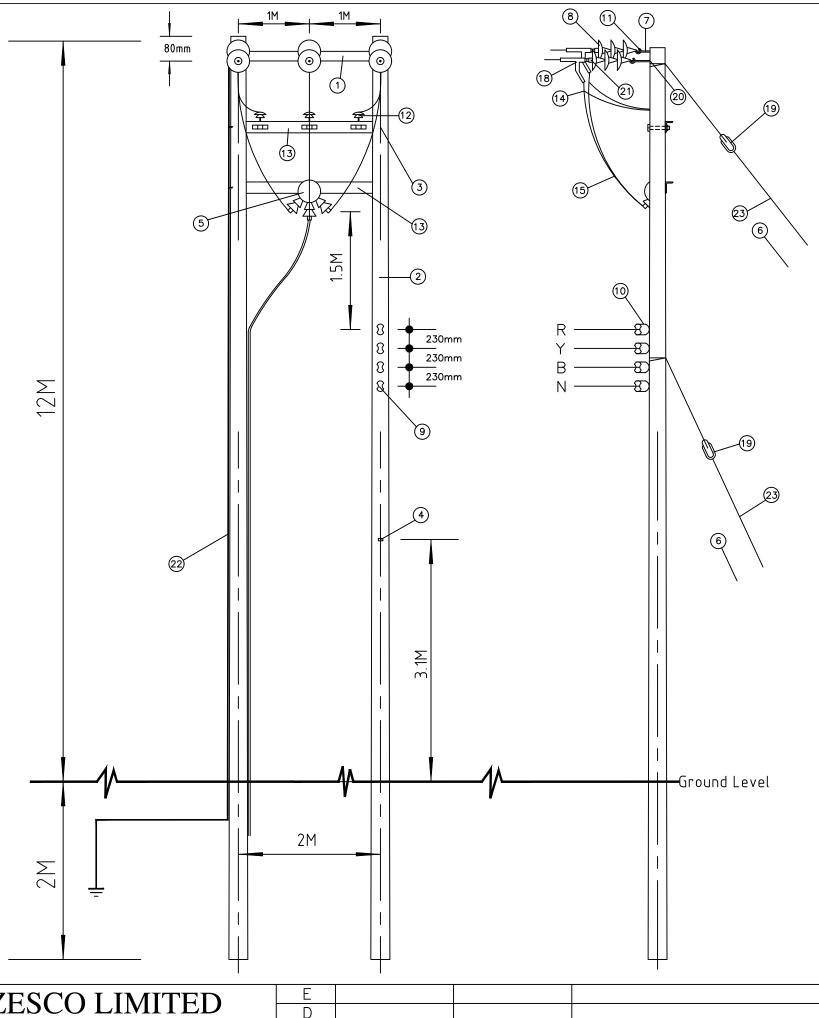
Drawing No.	Drawing Description		
009	Chainda Township MV Network Geographical Layout		
010	amanga Township MV Network Geographical Layout		
011	Mtendere Township MV Network Geographical Layout		
012	Kalingalinga Township MV Network Geographical Layout		
013	Chawama Township MV Network Geographical Layout		
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

Annex 3

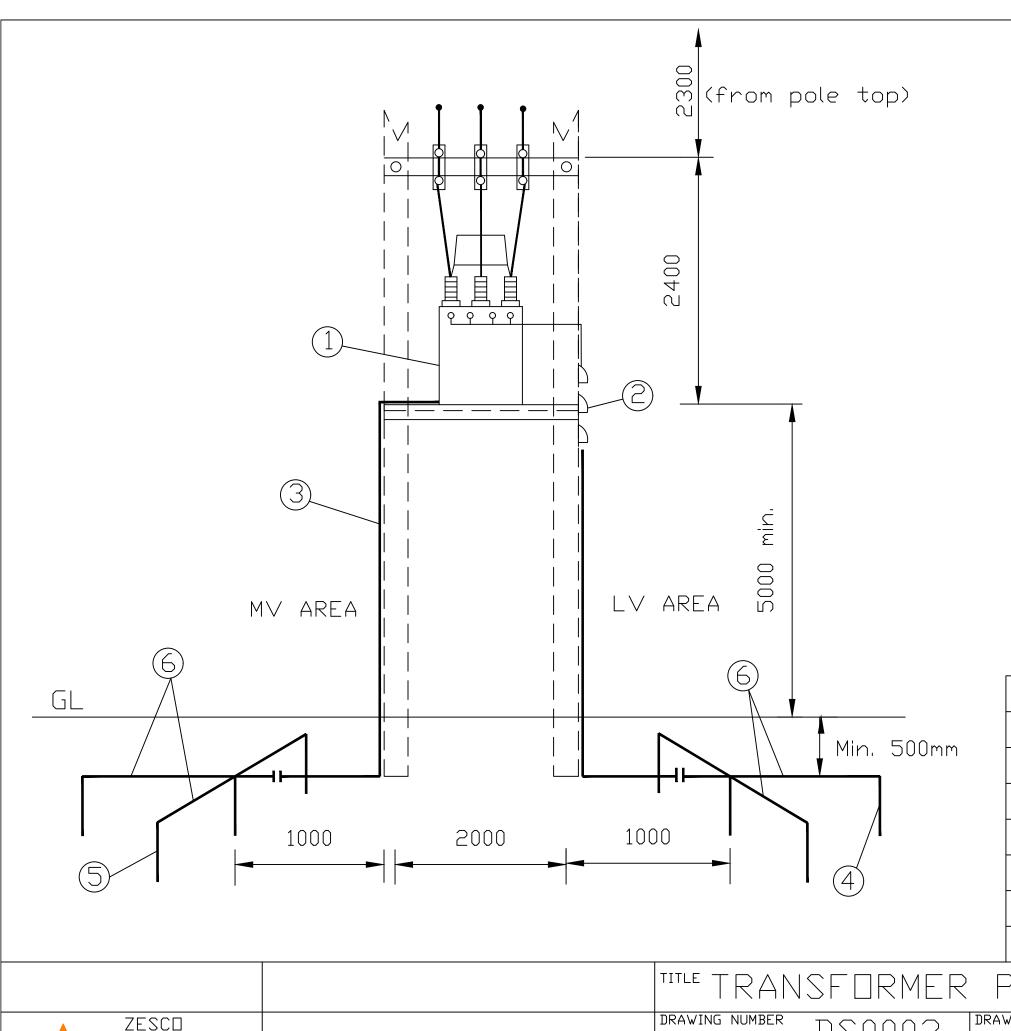
### **Medium Voltage Drawings**

Drawing	
No.	<b>Drawing Description</b>
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-41-11658] - 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 2.1mx130mmx80mmx10mm
2	2	Standard Pole 12M
3	6	Galvanised Bolt 200mmx20mm 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 250mmx140mm 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 2.1Mx100mmx10mm
14	5	P.G. Clamp
15	15M	Copper Conductor 16sqmm
16	1	Service Tube 6sqmm
17	1	P.G. Clamp
18	3	Srain CompressionClamp ACSR 25mm/50mm
19	3	11kV Stay Insulator
20	2	Eye Bolts 200mmx20mm
21	3	Clevis Ended Adaptor
22	20	PVC Adaptor 16sqmm Copper
23	30M	Stay Wire 7/4mm

<b>ZESCO LIMITED</b>		Е				Title of Drawing:	CABLE TERMINAL POLE DUA	N CONSTRUCTION
		D				GABLE TERMINAL POLE DUAL CONSTRUC		
	GREAT EAST ROAD	С				Drawing No.	Drawn: Nyirenda M.	Date: 22.11.00
	P.O.BOX 33304	В				_	Scale: Not To Scale	Orig.Lyt.A3
	LUSAKA ZAMBIA	Α				GH9709	Checked:	Date:
	TEL: 228084-9	Rev.	Date	Rev.by	Description	Replaces	Approved:	Date:



6		Bare conductor 70mm2	
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

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

DRAWING NUMBER

DATE SEPTEMBER,1998

CHECKED

DATE

SCALE

N.T.S

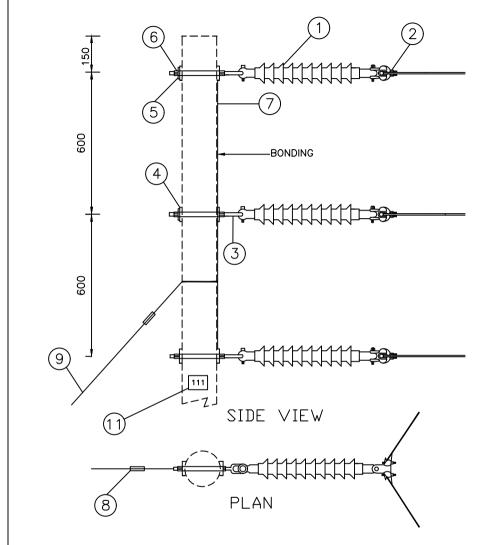
DRAWN S. CHANGWE

DATE

DATE

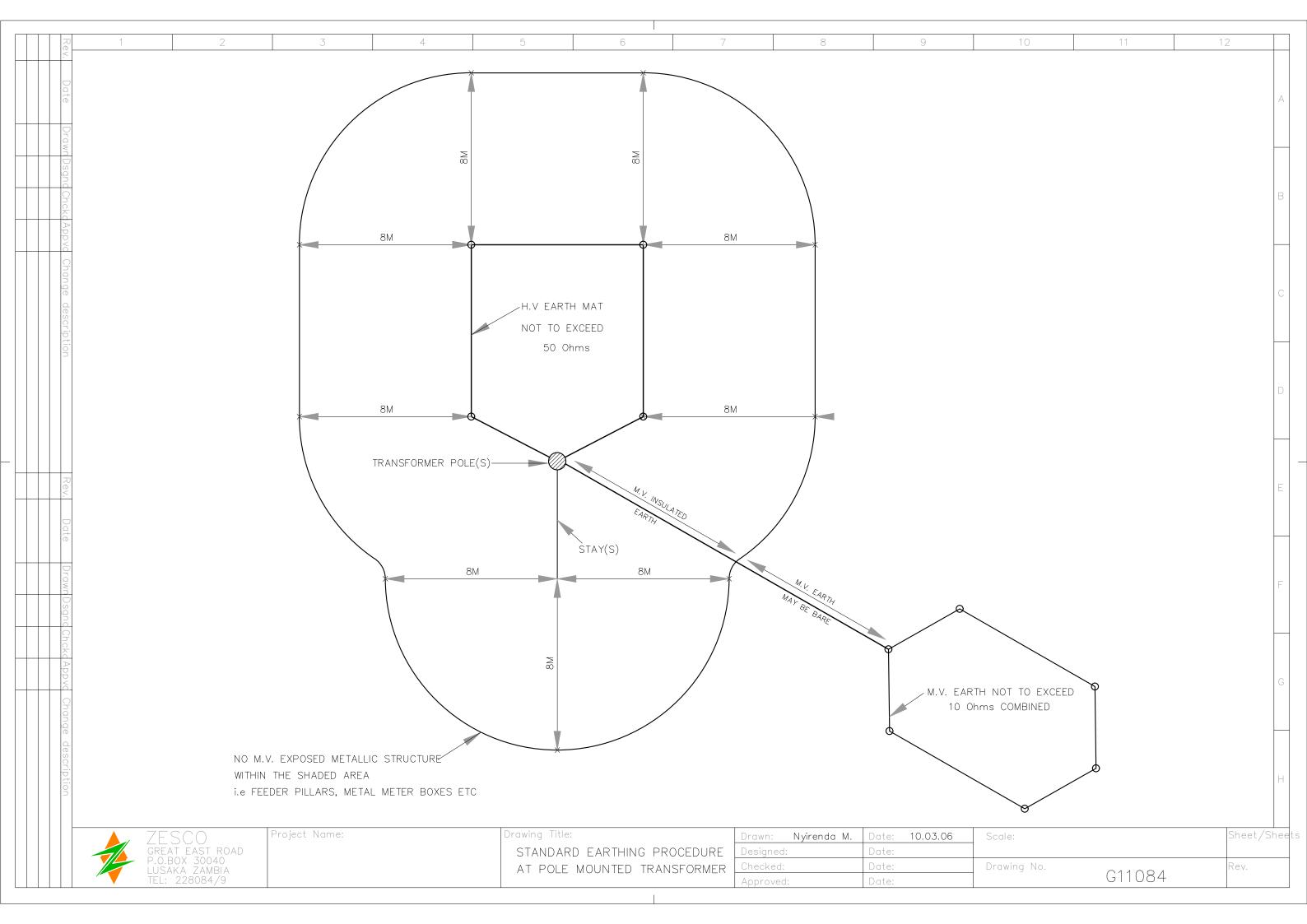
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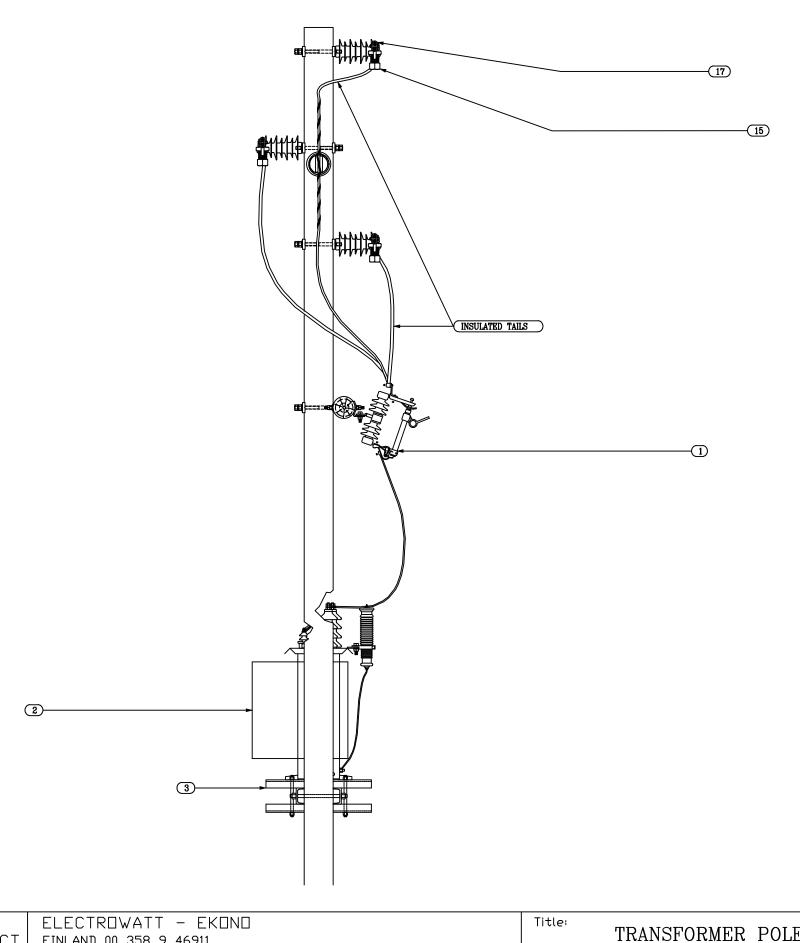
DATE



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.
Part No.	Qty.	Description	Remarks/Ref.

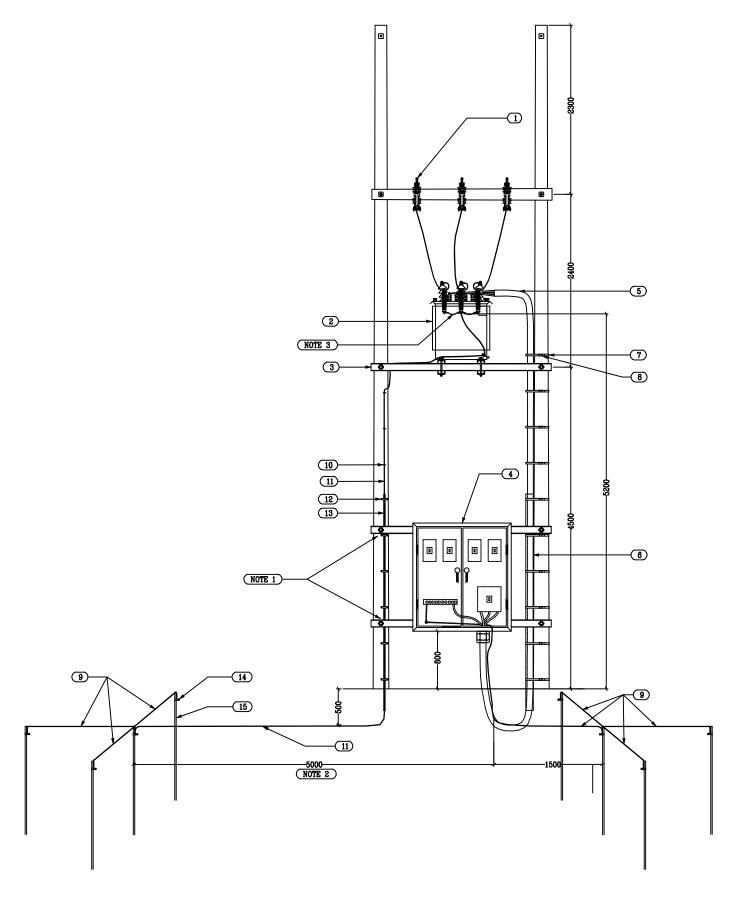
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	GREAT EAST ROAD	С				Drawing No.	Drawn: Changwe S.	Date: October,1998
	P.O.BOX 33304 LUSAKA ZAMBIA	B A	8.4.99	MN	Outer line removed	MV0003 Scale: NTS	Checked: Approved:	Date:
	TEL: 363636	Rev.	Date	Rev. by	Description	Replaces:		Orig.Layt: G—siz.





Rev.No.	Description	Date

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DISTRIBUTION LITATION PROJECT	ELECTROWATT — EKONO Finland 00 358 9 46911	Title:	TRANSFORMER POLE MC	UNTED SUB	STATION	H-POLE FORM	ATION
ZESCO		Drawing No:	5114 GEN DE 44 E 44005	Drawn:	Nyirenda M.	Date:	23.01.2002
GREAT EAST ROAD	Filename:		ZAM-GEN-DE-41-E-11665	Checked:	P.VLAHAKIS	Date:	xxxx
P.□.B□X 30040 LUSAKA	Same as Drawing No.	Scale:		Approved:	P.VLAHAKIS	Date:	xxxx
TEL:228084/9	<b>O</b>	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 EXEEDS I OHM

#### NOTE 3

16mmsq <u>FLEXIBLE</u> <u>E</u>ARTH CONDUCTOR

Rev.No.	Description	Date

#### LUSAKA DISTRIBUTION REHABILITATION PROJECT

ZESCD

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

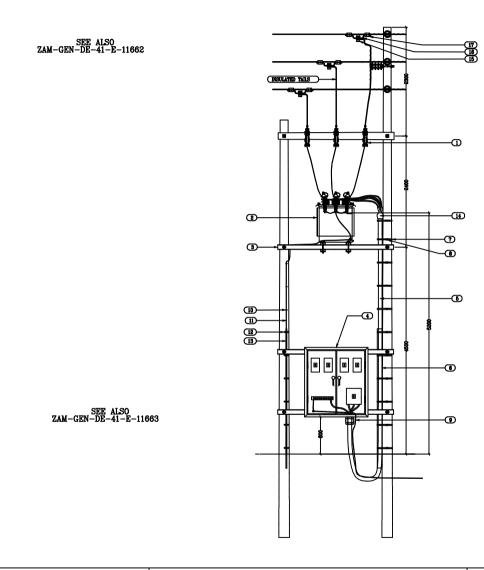
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FINLAND	00	358	9	46911

Filename:

## TRANSFORMER POLE MOUNTED SUBSTATION EARTHING

Title

INANSFORMER FOLE MOUNTED SUBSTATION EARTHING								
Drawing No:	Drawn:	Nyirenda M.	Date:	22.01.2002				
ZAM-GEN-DE-41-E-11658	Checked:	P.VLAHAKIS	Date:					
Scale: NTS	Approved:	P.VLAHAKIS	Date:					
Replaces: ZAM.GEN-DE.41-231 SHEET 1 of 3			Replaced by:					
THE PROCESS MAINTAIN DE STEELT I OF O			Replaced by					



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

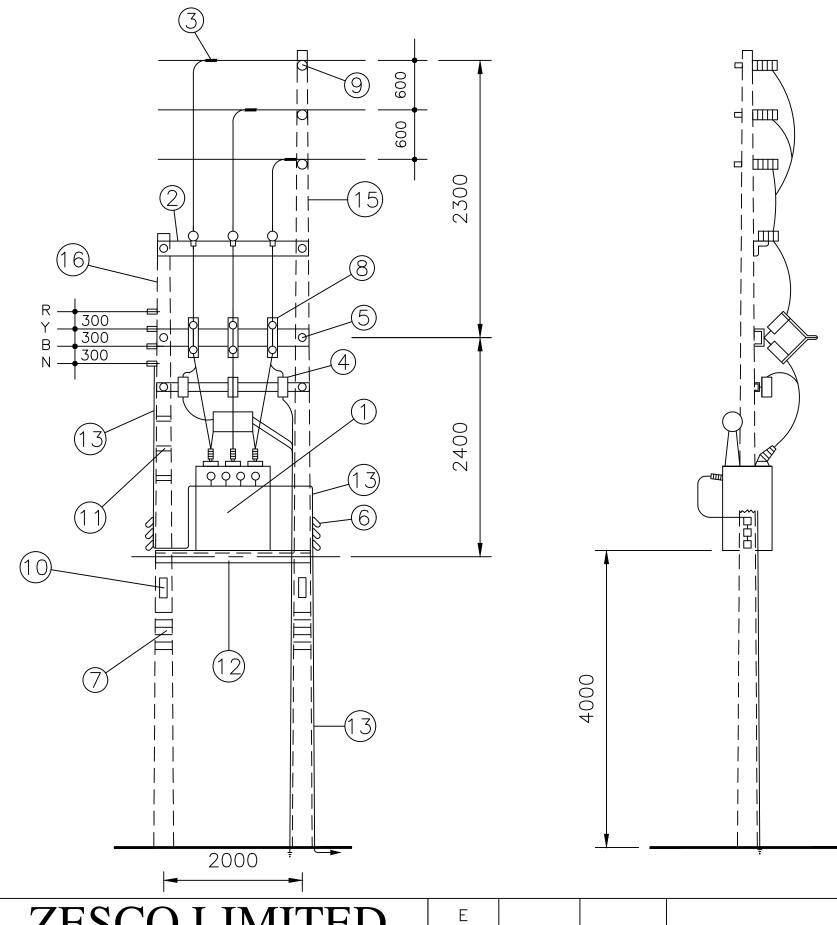
LUSAKA DISTRIBUTION
REHABILITATION PROJECT

ZESCO
GREAT EAST ROAD
P.D.BDX 30040
LUSAKA
TEL:228084/9

ELECTROWATT - EKONO
FINLAND 00 358 9 46911

FILENAND 00 358 9 46911

Title TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION 21.01.2002 Drawn Nyirenda M. Date: Drawing No: ZAM-GEN-DE-41-E-11661 Checked P.VLAHAKIS Date: xxxx Scale Approved: P.VLAHAKIS Date xxxx Replaces ZAM.GEN-DE.41-232 SHEET 1 of 6 Replaced by:



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 LIMIT

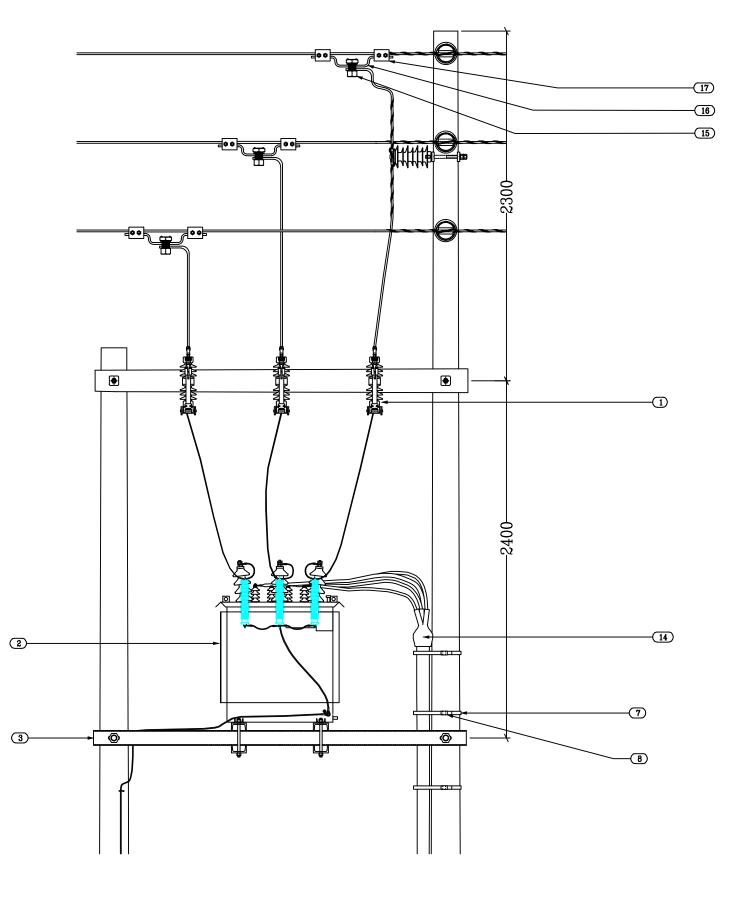
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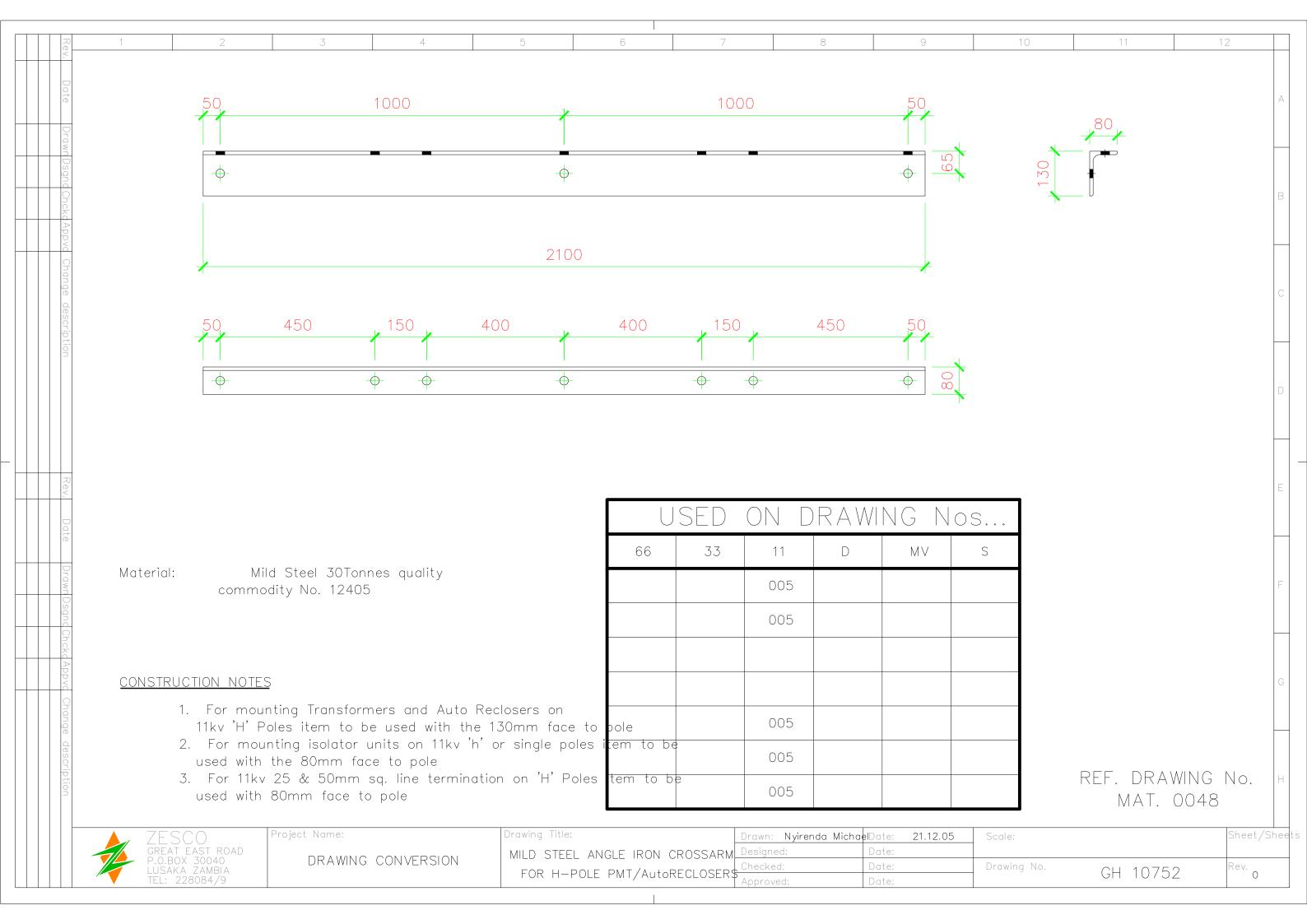
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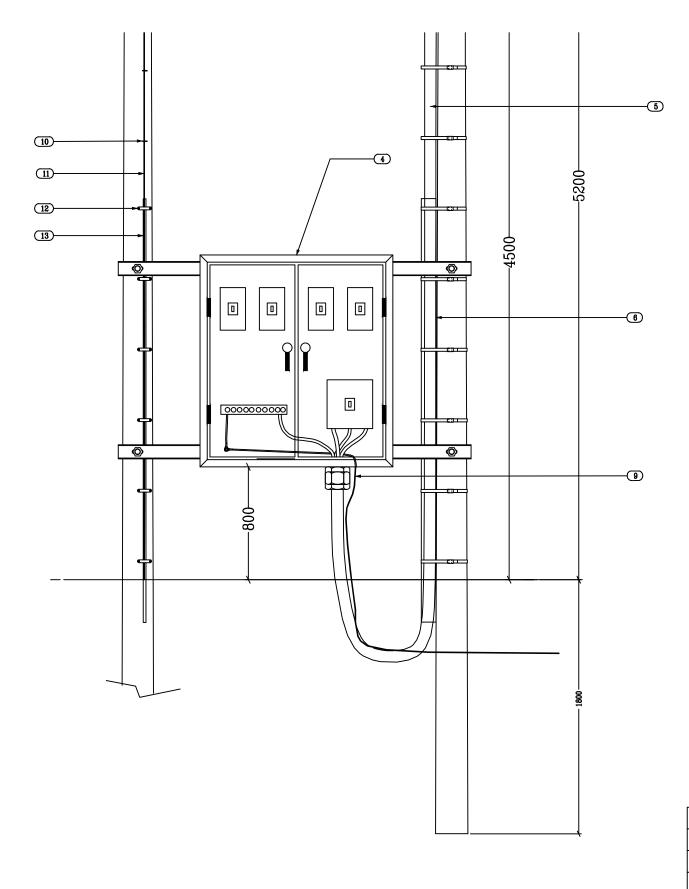
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Rev.No.	Description	Date

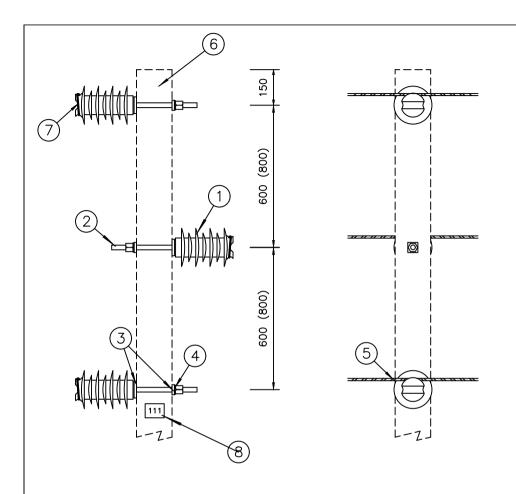
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A DISTRIBUTION ILITATION PROJECT	ELECTROWATT - EKONO FINLAND 00 358 9 46911	Title: TF	RANSFORMER POLE MOUNTED	SUBSTATION	H-POLE FORM	ATION	
ZESCO		Drawing No:	ZAM-GEN-DE-41-E-11662	Drawn:	Nyirenda M.	Date:	22.01.2002
GREAT EAST ROAD	Filename:		ZAM GEN DE 41 E 11002	Checked:	P.VLAHAKIS	Date:	xxxx
P.□.B□X 30040 LUSAKA	Same as Drawing No.	Scale:	NTS	Approved:	P.VLAHAKIS	Date:	xxxx
TEL:228084/9		Replaces:	ZAM-GEN-DE-41-232 SHEET 2 of	of 6		Replaced by:	





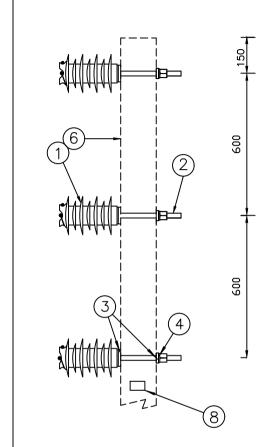
Rev.No.	Description	Date

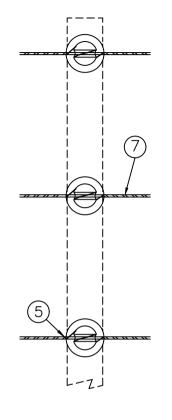
ELECTROWATT - EKONO LUSAKA DISTRIBUTION Title: TRANSFORMER POLE MOUNTED SUBSTATION H-POLE FORMATION REHABILITATION PROJECT FINLAND 00 358 9 46911 Drawing No: ZESCO Nyirenda M. 23.01.2002 Drawn Date: ZAM-GEN-DE-41-E-11663 GREAT EAST ROAD P.O.BOX 30040 Checked: P.VLAHAKIS Date: xxxx Filename: Scale: Same as Drawing No. P.VLAHAKIS Date: ×××× Approved: LUSAKA TEL:228084/9 Replaces: ZAM.GEN-DE.41-232 SHEET 3 of 6 Replaced by:



			Fixed at 1.5M above ground
8	1	POLE NUMBER	
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
Part No.	QTY	Description	Remarks/Ref.

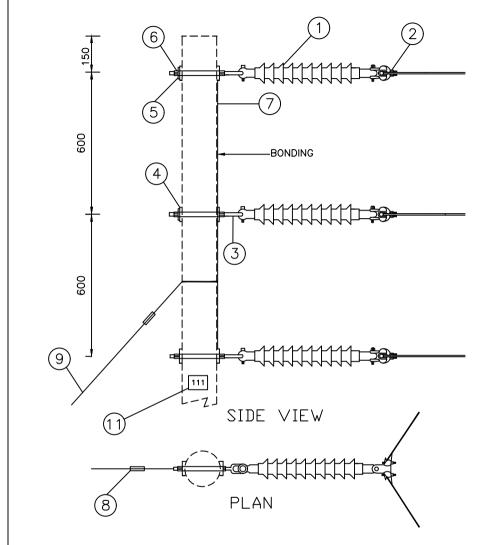
ZESCO LIMITED		Ε				MV □/H	LINE POLE TO	JP STRUCTURE
		D					TERMEDIATE	
<b>A</b> .		C				Drawing No.	Drawn: Nyirenda M.	Date: 07.11.98
	GREAT EAST ROAD P.O.BOX 30040	В				MV0001	Checked:	Date:
	LUSAKA ZAMBIA	Α	8.4.99	MN	Outer line removed	Scale: NTS	Approved:	Date:
	TEL: 228084-9	Rev.	Date	Rev. by	Description	Replaces:		Orig.Layt: G—siz.





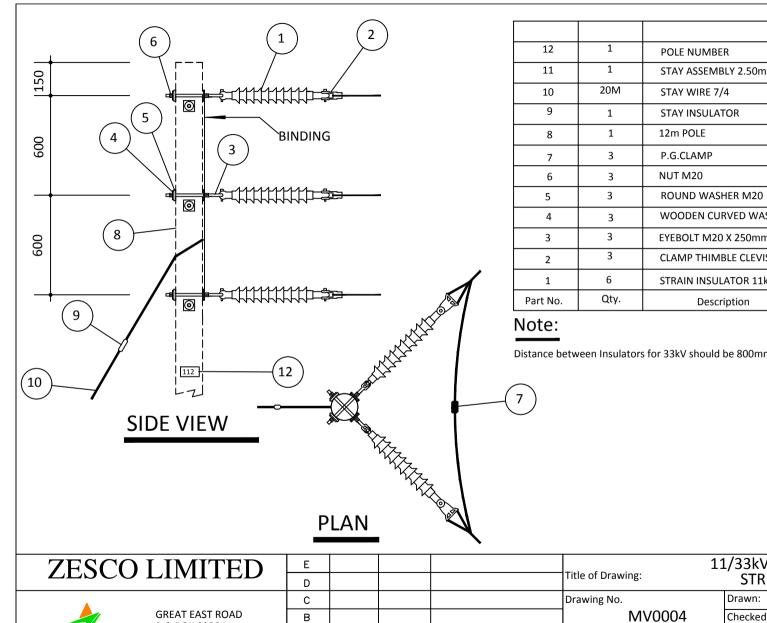
8	1	POLE NUMBER	
7	0.25	AL. BENDING WIRE 3.60mm2	
6	1	12m POLE	
5	9	SIDE TIE	
4	3	WASHER	
3	6	CURVED WASHER	
2	3	SPINDLE M20 X 250	
1	3	POST INSULATOR 11kV & 33kV	Ref. PT0003
Part No.	Qty.	Ref.PT0003	Remarks/Ref.

ZESCO LIMITED		Е						/ CYCHLINE F	POLE TOP
		D				Title of Drawi	<sup>ng:</sup> STR	RUCTURE ANG	GLE 1° - 5°
		C				Drawing No.		Drawn: Changwe S.	Date: October,1998
	GREAT EAST R□AD P.□.B□X 33304	В				] M∨≀	0002 [	Checked:	Date:
	LUSAKA ZAMBIA	Α	8.4.99	MN	Outer line removed	Scale: N	TS	Approved:	Date:
<u> </u>	TEL: 363636	Rev.	Date	Rev. by	Description	Replaces			Orig.Layt: G—siz.



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.
Part No.	Qty.	Description	Remarks/Ref.

ZESCC	LIMITED	E D				I	MV D/H LINE F Tructure angl	
	GREAT EAST ROAD	С				Drawing No.	Drawn: Changwe S.	Date: October,1998
	P.O.BOX 33304 LUSAKA ZAMBIA	B A	8.4.99	MN	Outer line removed	MV0003 Scale: NTS	Checked: Approved:	Date:
	TEL: 363636	Rev.	Date	Rev. by	Description	Replaces:		Orig.Layt: 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.		

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

11/33kV STAGGERD O/H LINE POLE STRUCTURE ANGLE 30° - 90° Drawn: Changwe S. Date: October,1998 Checked: Date:

Replaces:



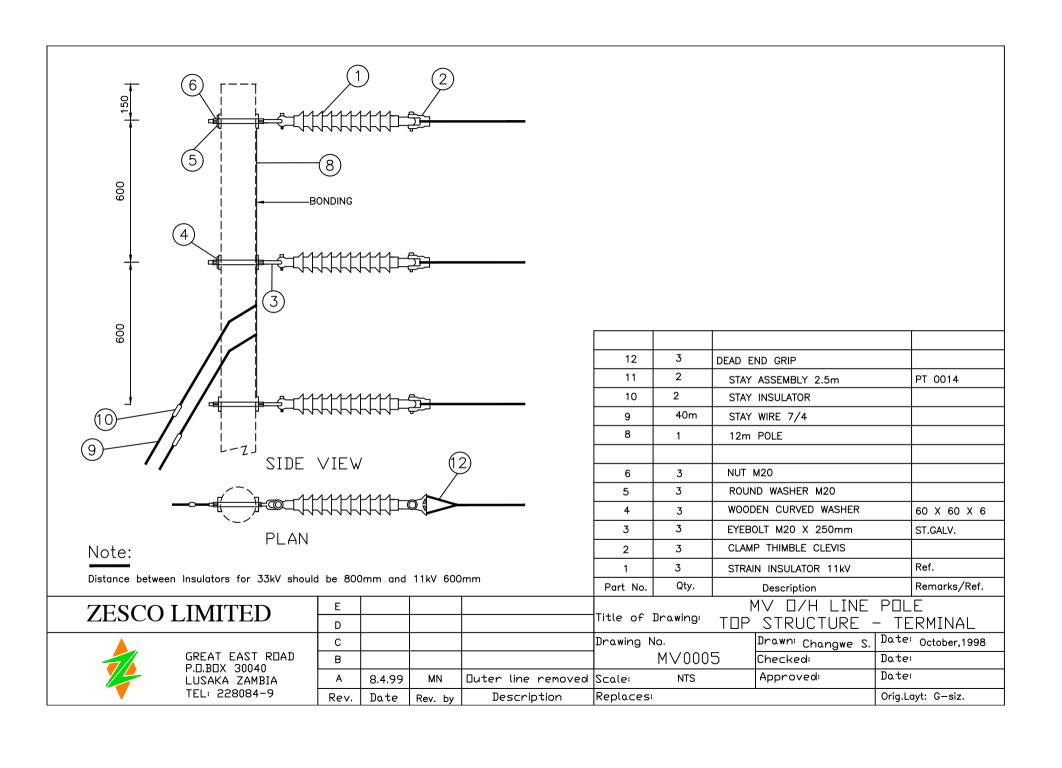
P.O.BOX 33304 LUSAKA ZAMBIA TEL: 363636

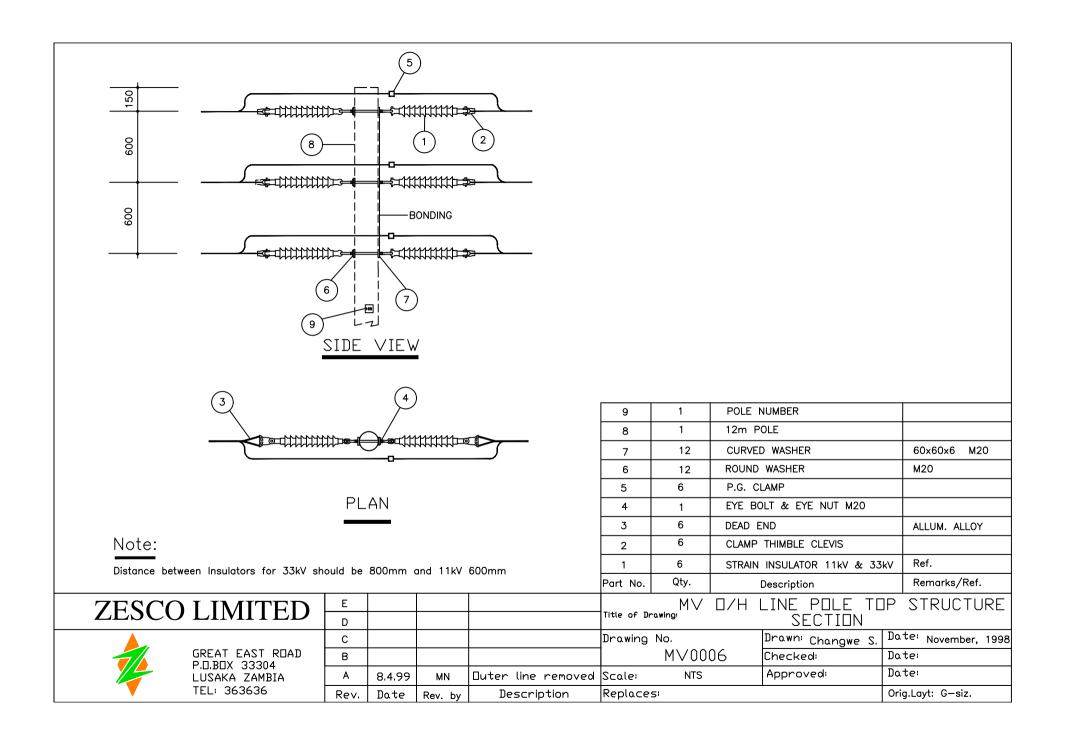
MN Outer line removed 8.4.99 Α Rev. Date Description Rev. by

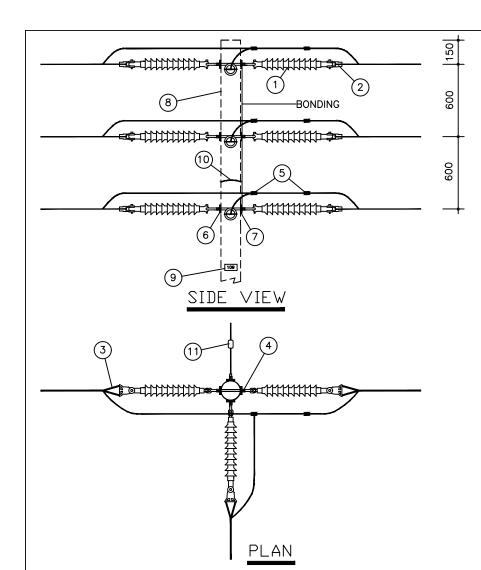
NTS Scale:

Date: Approved:

Orig.Layt: G—siz.

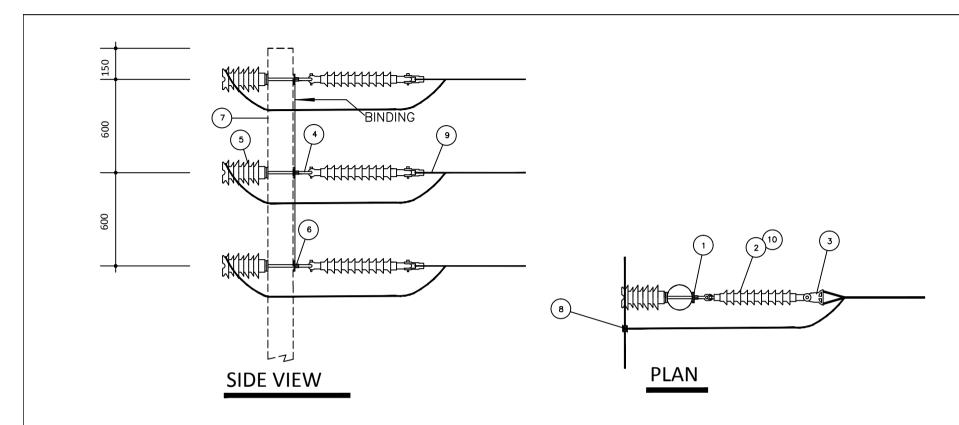






11	1	STAY INSULATOR	
10		STAY WIRE 7/4	
9	1	POLE NUMBER	
8	1	12m POLE	
7	12	CURVED WASHER	60x60x6 M20
6	12	ROUND WASHER	M20
5	6	P.G.CLAMP	
4	12	NUT M20	
3	9	DEAD END A/ALLOY	Depending on conductor size
2	9	CLAMP THIMBLE CLEVIS	PT0001
1	9	STRAIN INSULATOR 11kV & 33kV	Ref.
Part No.	Qty.	Description	Remarks/Ref.

ZESCO LIMITED		Ε				M∨ □/H	LINE POLE TO	IP STRUCTURE
		D					CTION WITH	
<b>A</b> .		С				Drawing No.	Drawn: Nyirenda M.	Date: 07.11.98
	GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA TEL: 228084-9	В				M∨0007	Checked:	Date:
		Α	8.4.99	MN	Outer line removed	Scale: NTS	Approved:	Date:
		Rev.	Date	Rev. by	Description	Replaces:		Orig.Layt: G—siz.



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

Title:

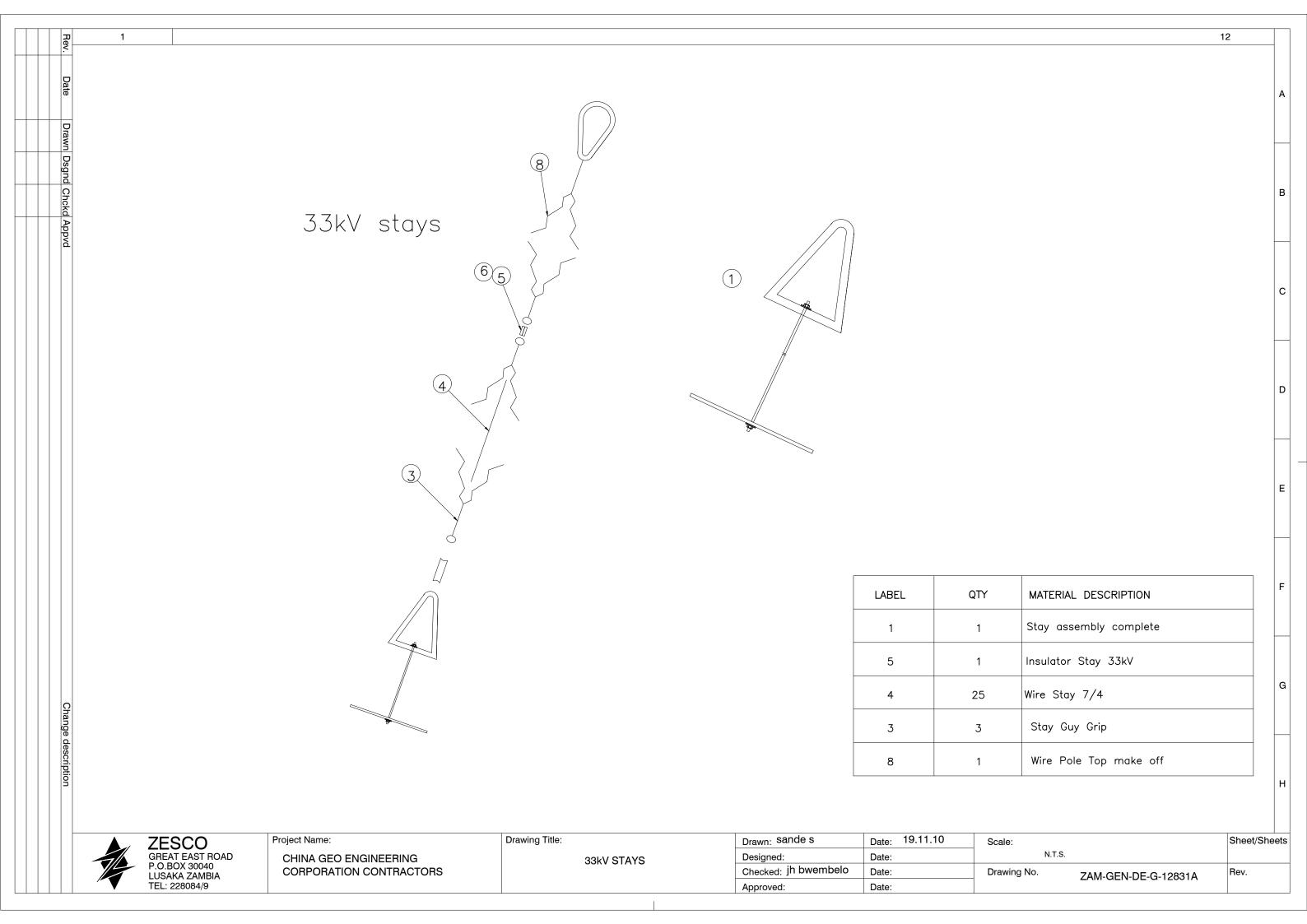
11/33kV STAGGERED O/H LINE POLE TOP

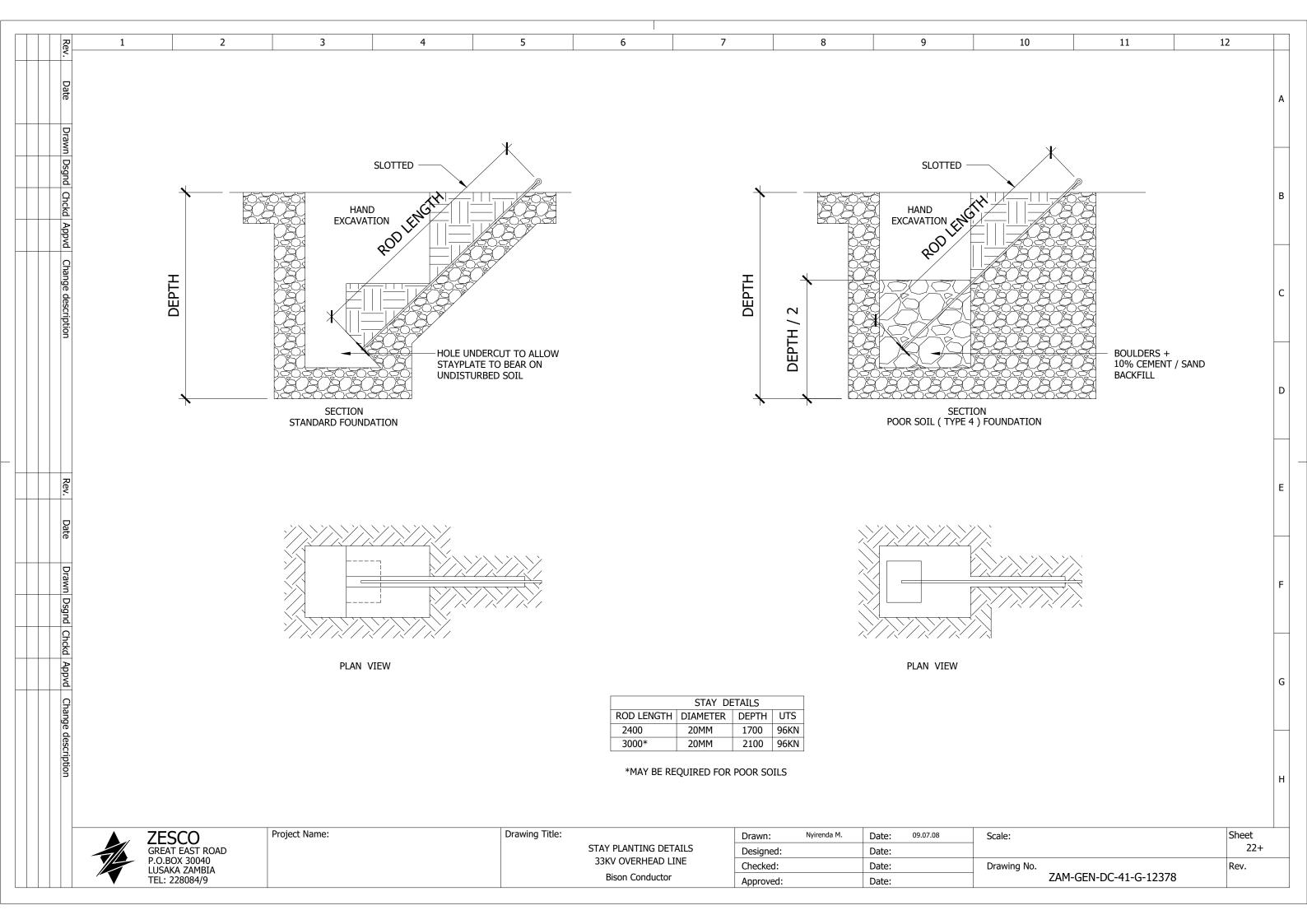
STRUCTURE TEE-OFF

DRG No.

Drawn:
Scale:
Checked:
Approved:
Date:
Date:

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.

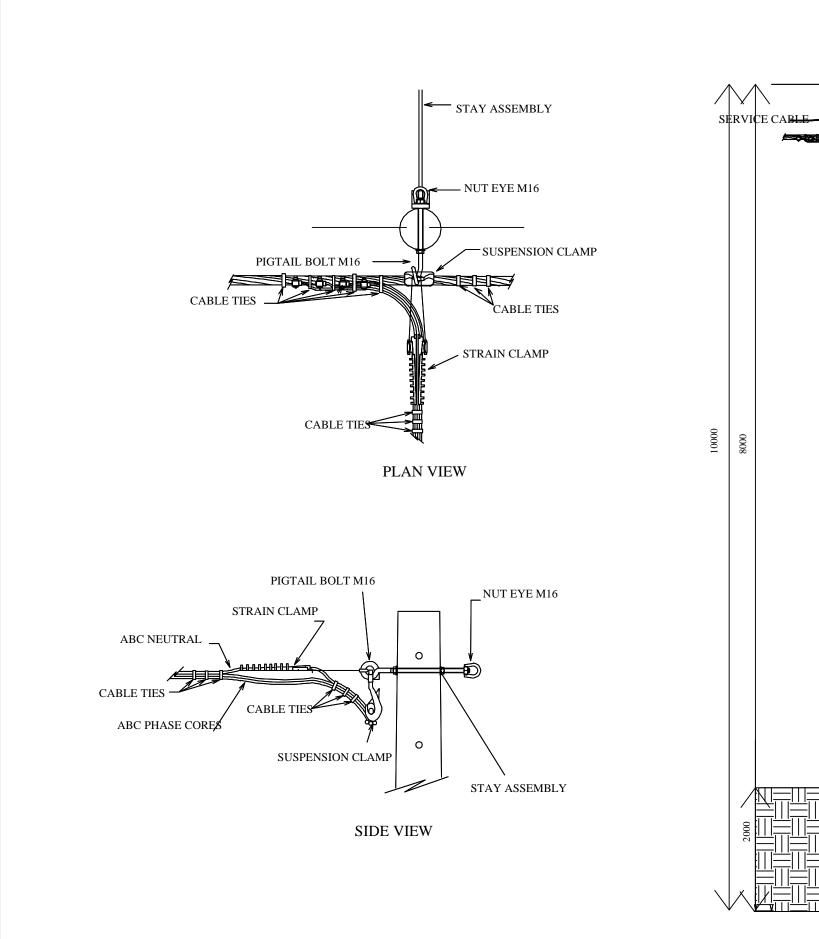


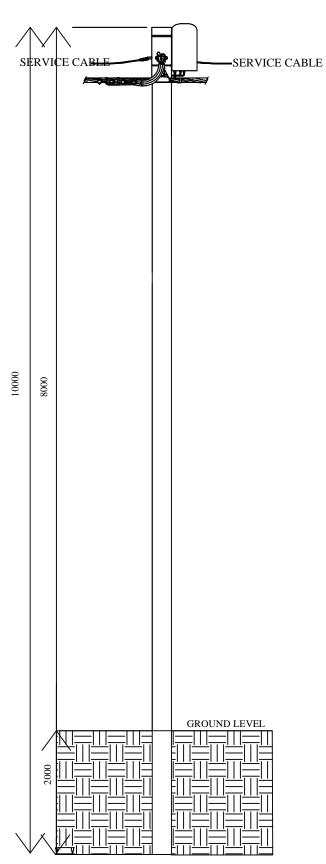


Annex 4

### **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			





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:



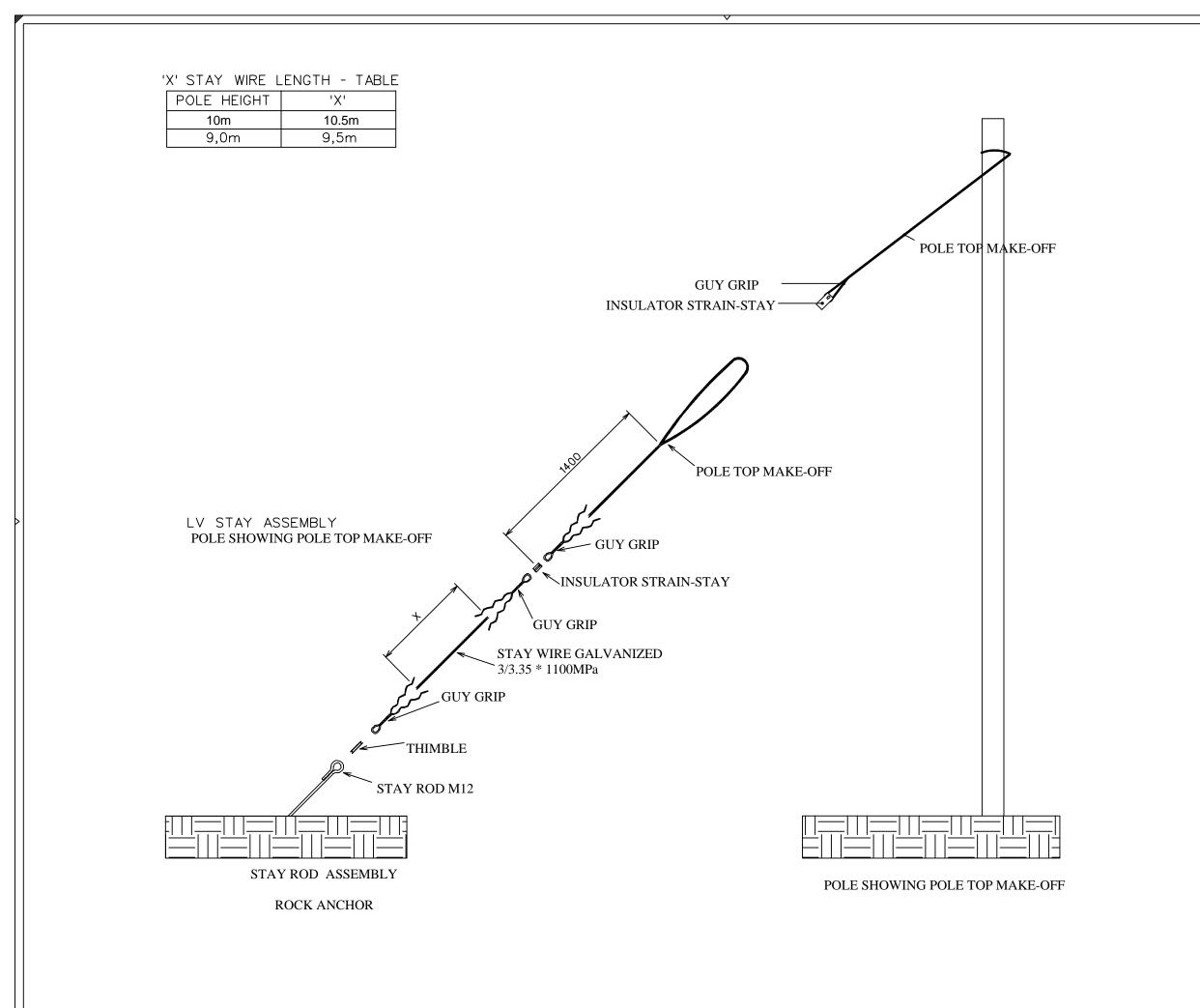
Project:

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

Drawing Title:

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

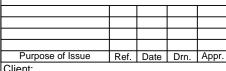
Date:	Drawn:	Checked:	Appr.:	Format:
2019/10/9	NM	HAY	HAY	A3
Drawing Number:				
	NTS			



LEGEND:	
Symbols	Description
1	

Notes:

For Tender Purposes Only



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

Consultant:



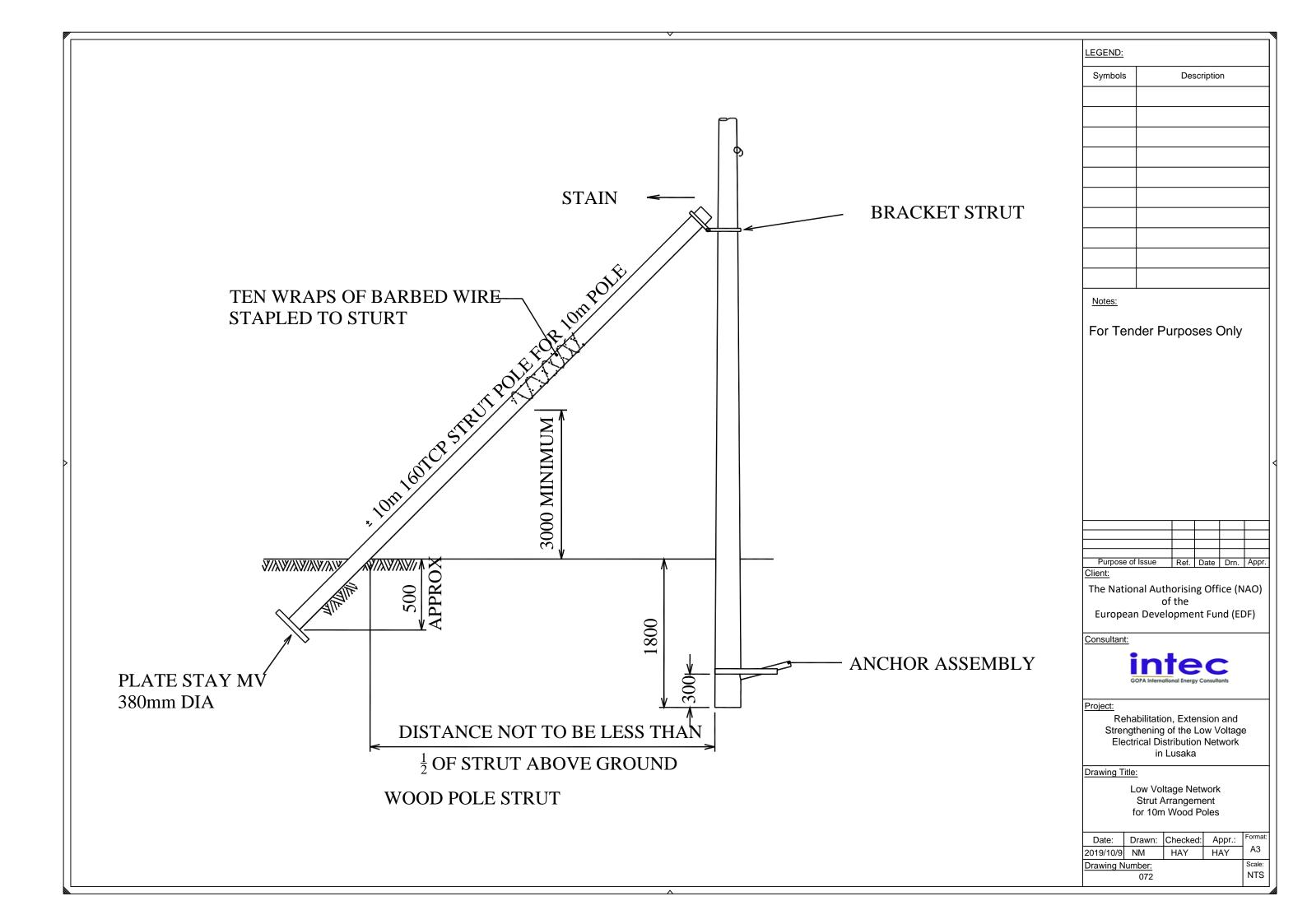
Project:

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

Drawing Title:

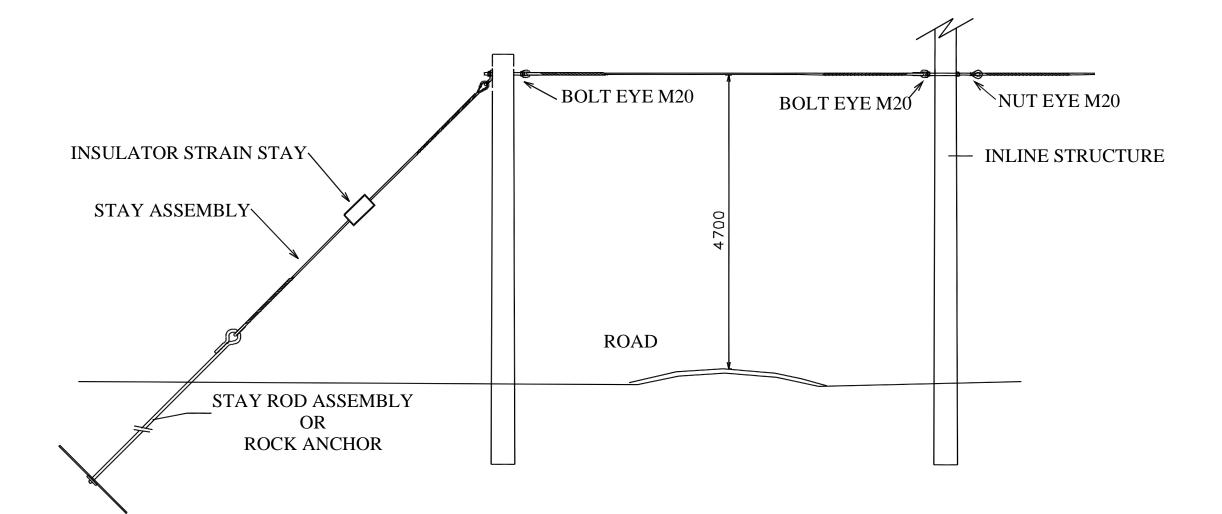
Low Voltage Network Wood Pole Stay Assembly

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



# 'X' STAY WIRE LENGTH - TABLE

POLE HEIGHT	1X1
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) European Development Fund (EDF)

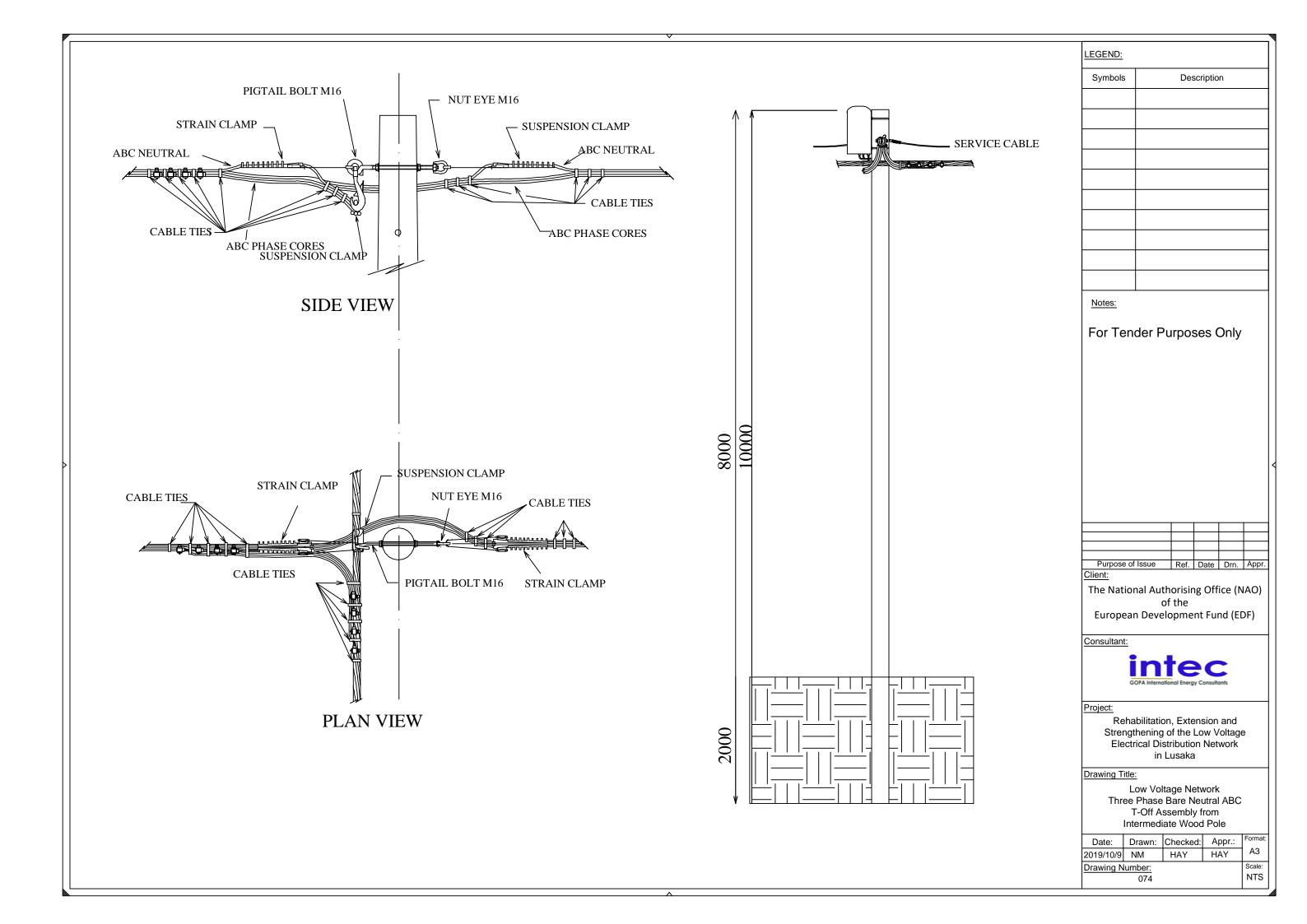


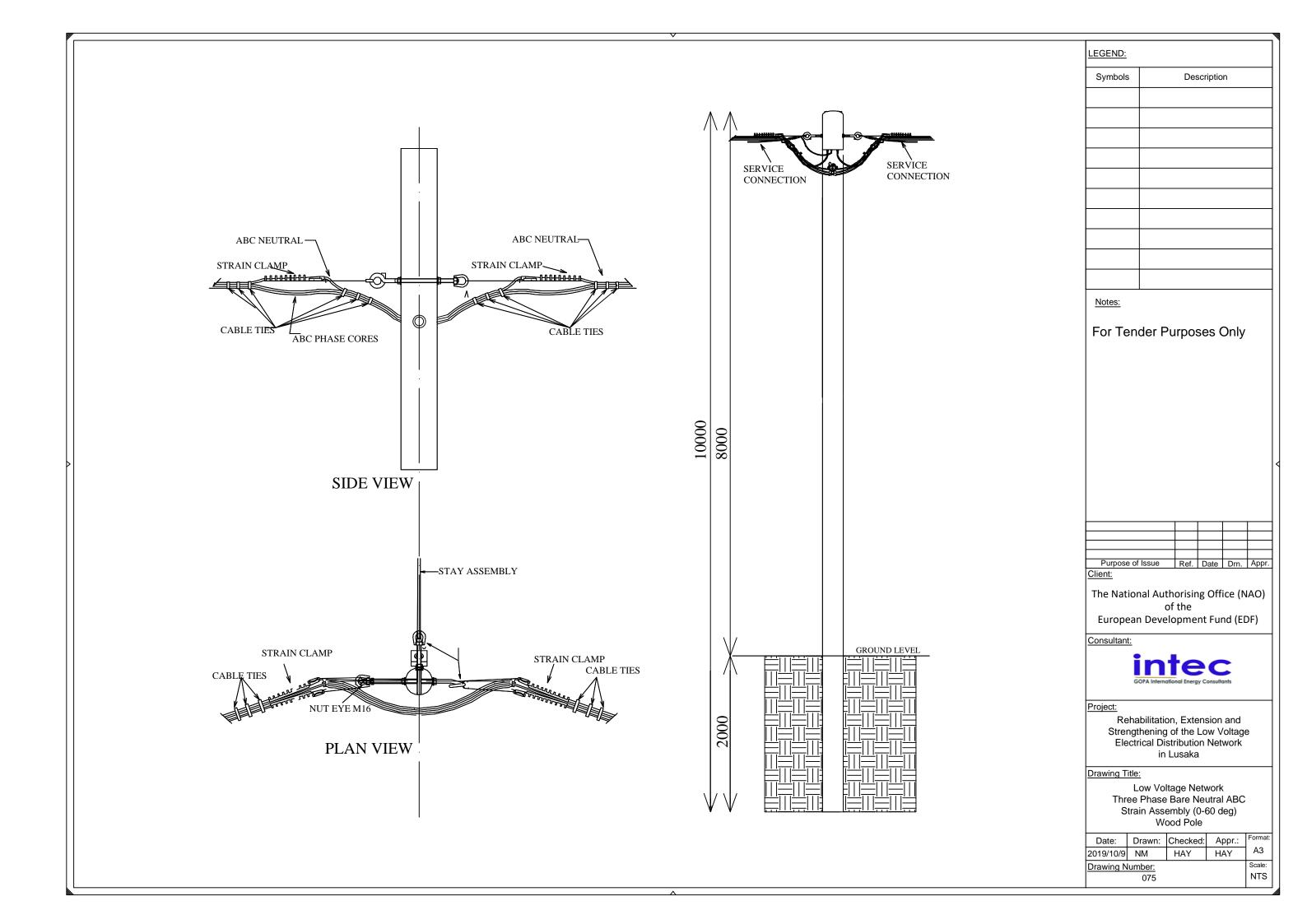
Rehabilitation, Extension and Strengthening of the Low Voltage Electrical Distribution Network in Lusaka

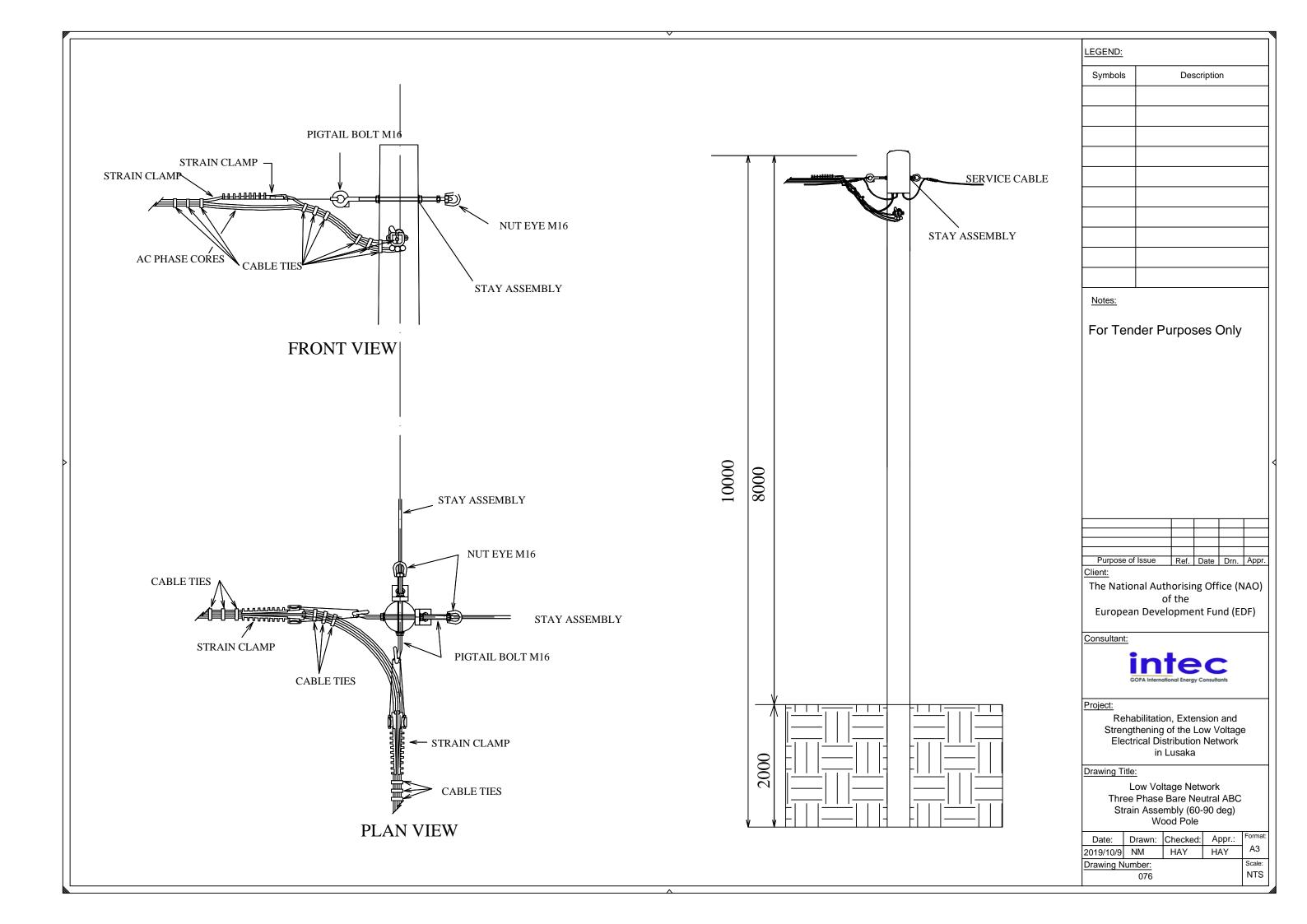
Drawing Title:

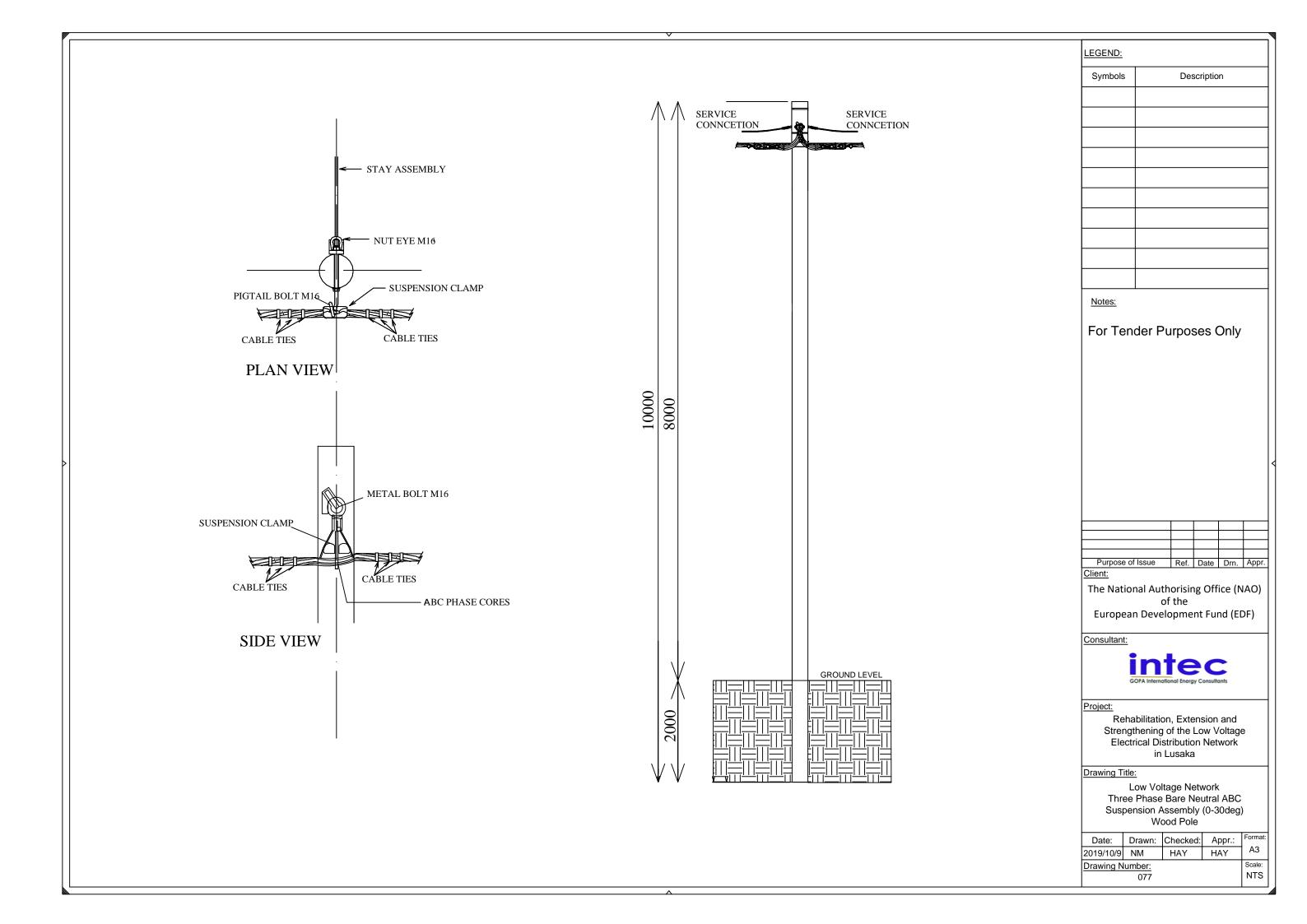
Low Voltage Network Overhead (flying) Stay Arrangement for Wood Poles

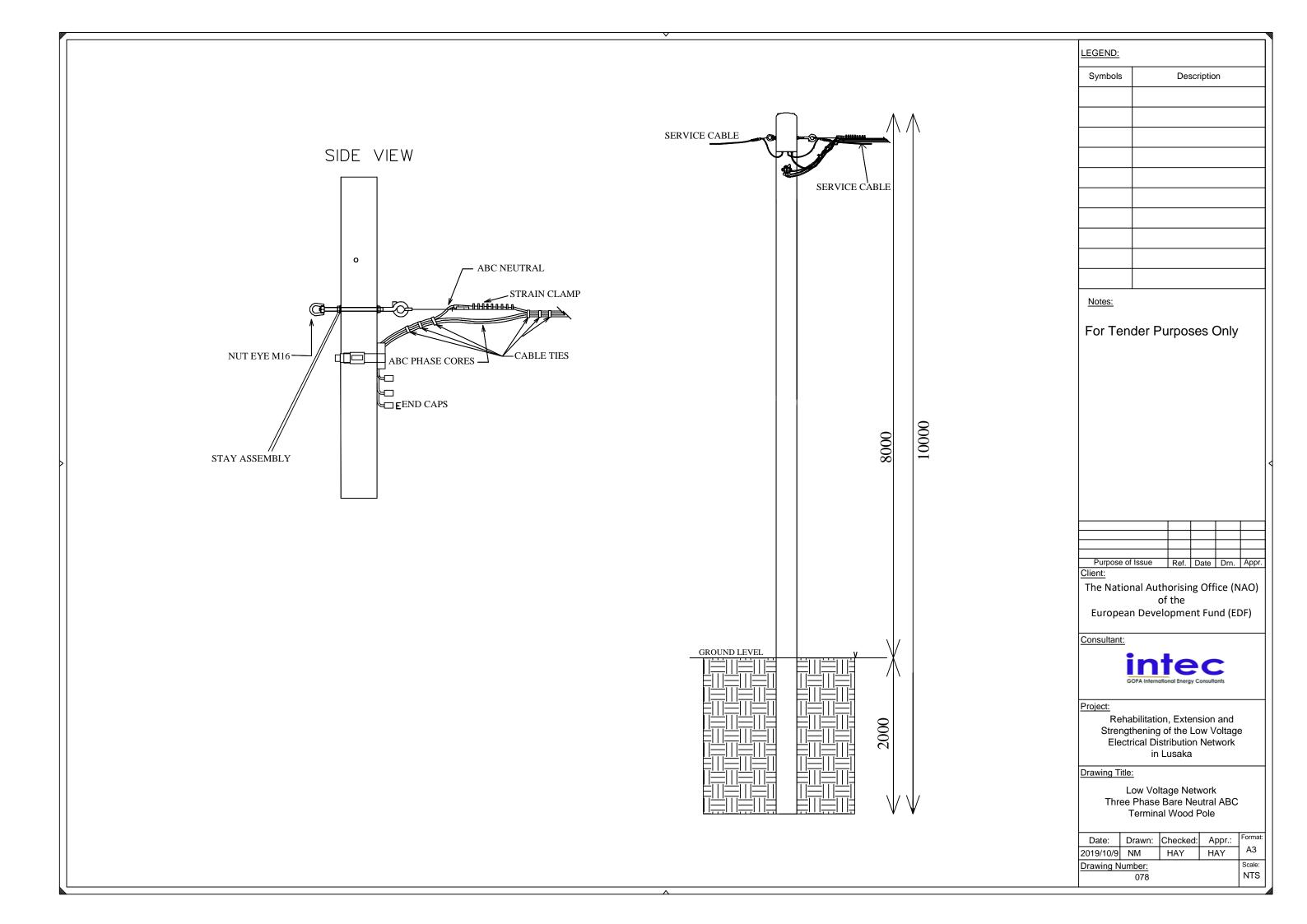
Date:	Drawn:	Checked:	Appr.:	Forma	
2019/10/9	NM	HAY	HAY	A3	
Drawing Number:					
073					

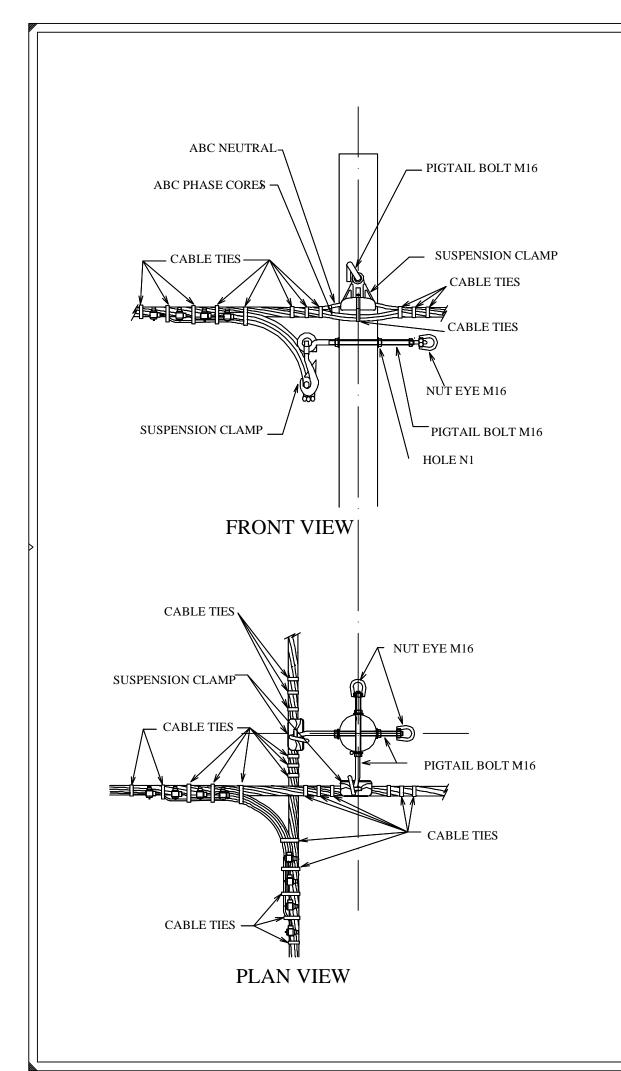


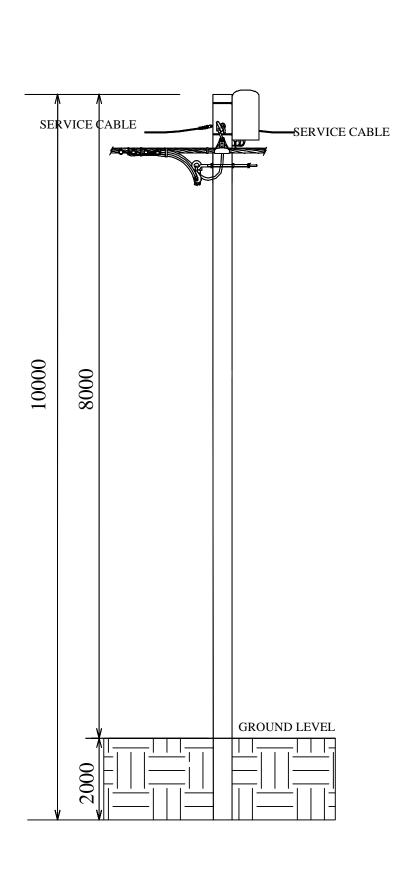












Symbols	Description
-	·

Notes:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	App
O				

Client:

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

Consultant:



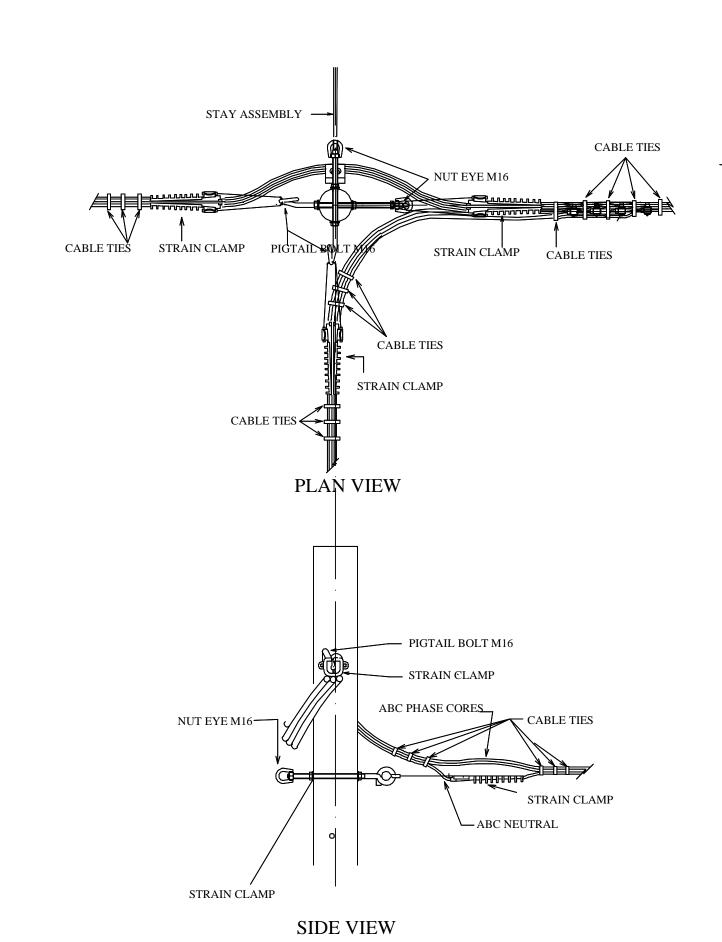
Project:

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

**Drawing Title:** 

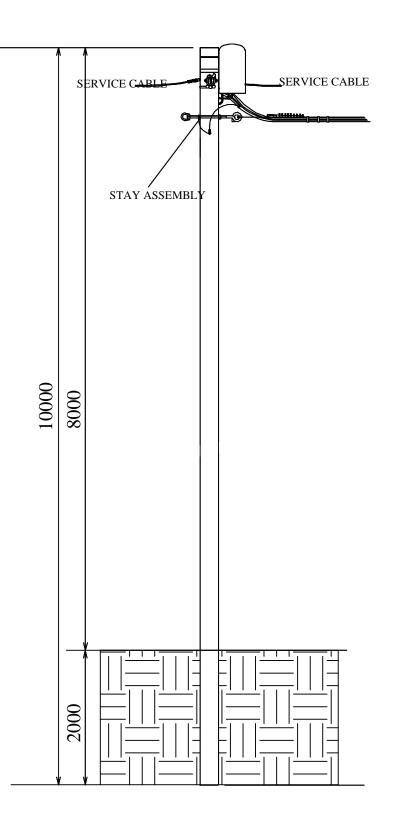
Low Voltage Network
Three Phase Bare Neutral ABC
Cross Intermediate Assembly
Wood Pole

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



### 'X' STAY WIRE LENGTH - TABLE

POL	E HEIGHT	'X'		
	10m	10.5m		
	9,0m	9,5m		



Symbols	Description

### Notes:

LEGEND:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	App
Client				

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

### Consultant:



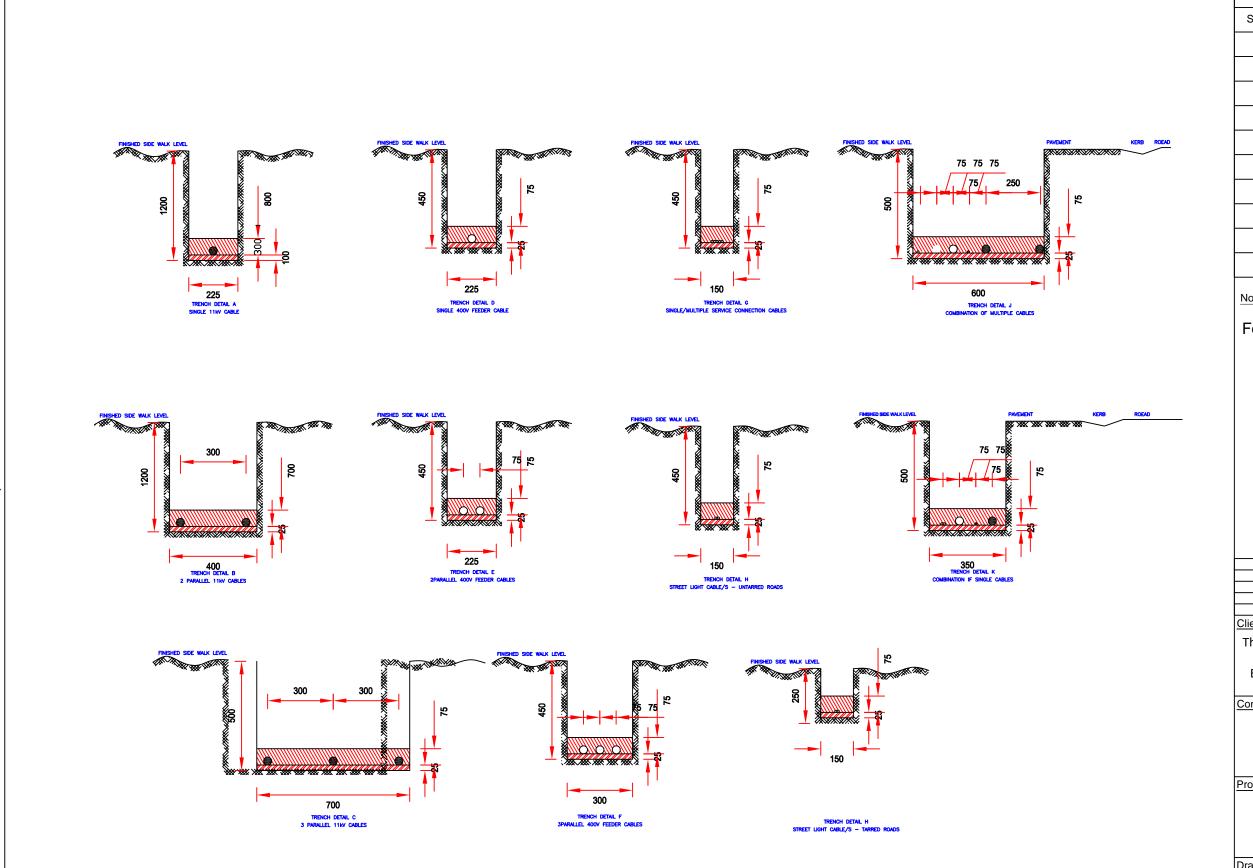
### Project:

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:							
	NTS						



LEGEND:	
Symbols	Description
	Sand Bed Cover
	Cans Bed
	11 kVA Cable
0	400 V Feeder Cable
•	400 V Street Light Cable
۰	230 V Service Connection Cable

Notes:

For Tender Purposes Only

Purpose of Issue	Ref.	Date	Drn.	Appr.

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:

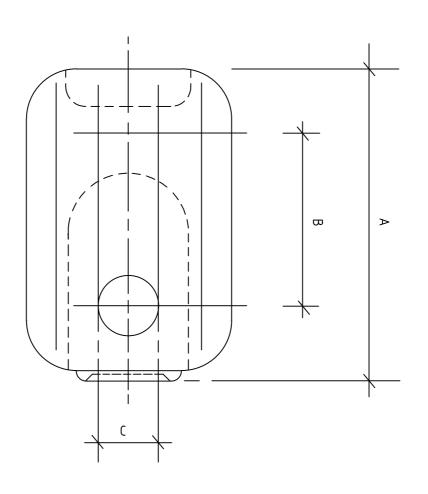
Standard Cable Trench Details and Dimensions for Electricity Distribution Networks

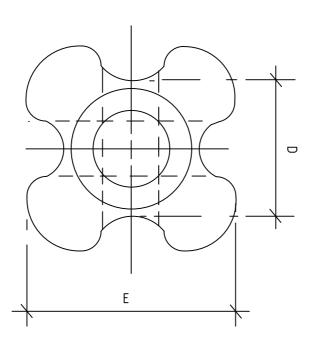
Date:	Drawn:	Checked:	Appr.:	Format:		
2019/10/9	NM	HAY	HAY	A3		
Drawing N	Scale:					
085						

Annex 5

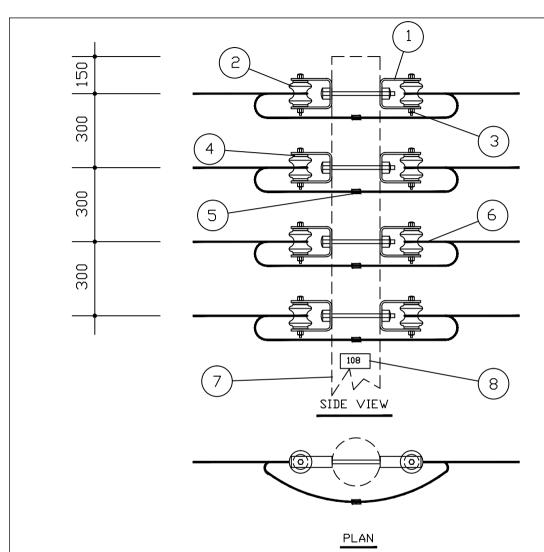
# **Low-Voltage Drawings (ACSR)**

<b>Drawing No.</b>	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





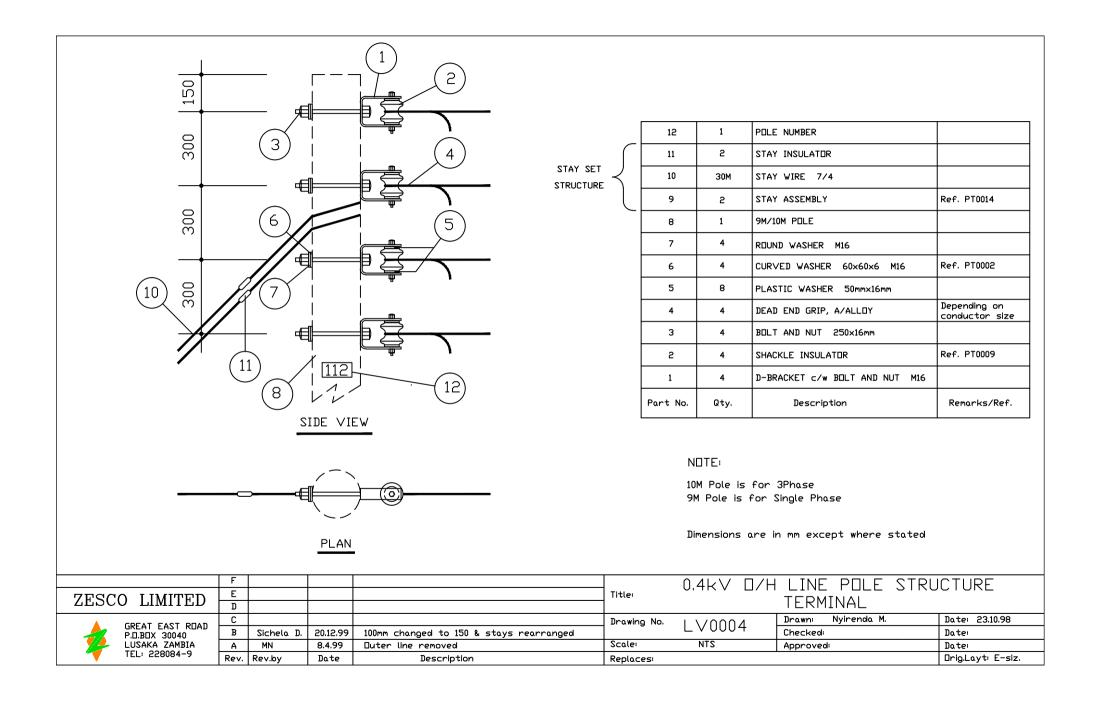
7F\$(	Ε				Title of Drawing: ,	0 4137 9.11137 6	TAV INCLILATOR	
ZESCO LIMITED		D				•	0.4kV &11kV STAY INSULATO	
<b>A</b> .	GREAT EAST ROAD	C				Drawing No.	Drawn: Nyirenda M	Date: 28.12.00
	P.O.BOX 33304	В				E11387	Scale: NTS	Orig.Lyt.A4P
	LUSAKA ZAMBIA	Α				L11307	Checked:	Date:
	TEL: 228084-9	Rev.	Date	Rev.by	Desription	Replaces	Approved:	Date:

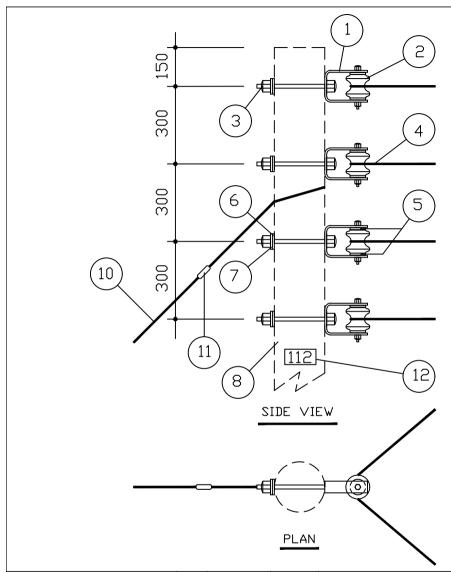


8	1	POLE NUMBER	
7	1	9M/10M POLE	
6	8	DEAD END GRIP, A/ALLDY	
5	4	P.G. CLAMP	
4	16	PLASTIC WASHER 50mm×15mm	
3	4	BOLT AND NUT 250×16mm	
2	8	SHACKLE INSULATOR	
1	8	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

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

ZES	CO LIMI	TE D	D			Title:	0.4kV	LINE SECT	POLE STRU ION	CTURE
_		С				Drawing No.	1 \ / 0005	Drawn:	Nyirenda M.	Date: 03.08.99
	P.D.BDX 34504	В	Sichela D.	20.12.99	100mm changed to 150mm	J	LV 0005	Checked:		Date
	LUSAKA ZAMBIA	Α	MN	8.4.99	Outer line removed	Scalei	NTS	Approved	lı .	Date:
		Rev.	Rev.by	Date	Description	Replaces	•		_	Orig.Layt: E-siz.

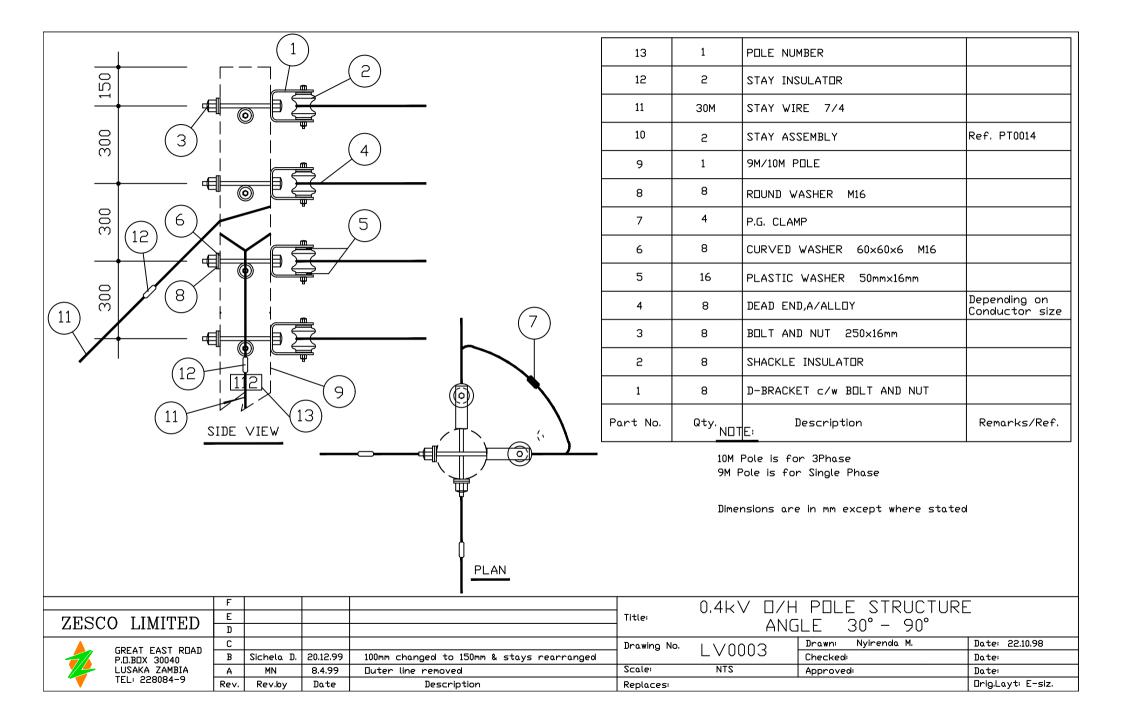


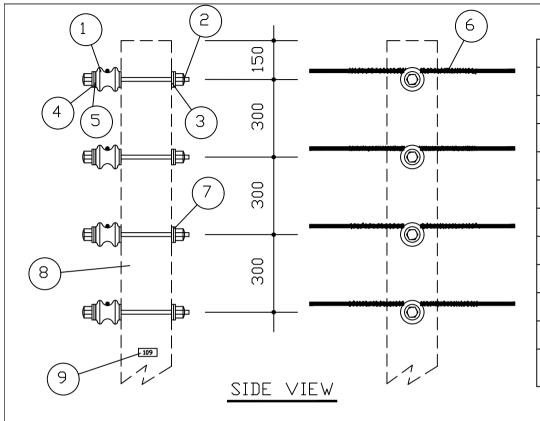


12	1	POLE NUMBER	
11	1	STAY INSULATOR	
10	15M	STAY WIRE 7/4	
9	1	STAY ASSEMBLY	Ref. PT0014
8	1	9M/10M PDLE	
7	4	ROUND WASHER M16	
6	4	CURVED WASHER 60x60x6 M16	Ref. PT0002
5	8	PLASTIC WASHER 50mmx16mm	
4	0.4Kg	BINDING WIRE 3.60mm	
3	4	BOLT AND NUT 250×16mm	
2	4	REEL INSULATOR EP194	Ref. PT0008
1	4	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

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

	F					0.4kV <b>D</b> /H	POLE STRUCTUR	2F
ZESCO LIMITED	E				Title:			``
ZESCO LIMITED	D				ANGLE 5° - 30°		ILE 5 - 30	
GREAT EAST ROAD P.O.BOX 30040	С				Drawing No.	LV0002	Drawn: Nyirenda M.	Date: 22.10.98
	В	Sichela D.	20.12.99	100mm changed to 150mm & stay wire rearranged			Checked	Date:
LOSAKA ZAMBIA	Α	MN	8.4.99	Outer line removed	Scale:	NTS	Approved:	Date:
TEL: 228084-9	Rev.	Rev.by	Date	Description	Replaces			Orig.Layt: E-siz.



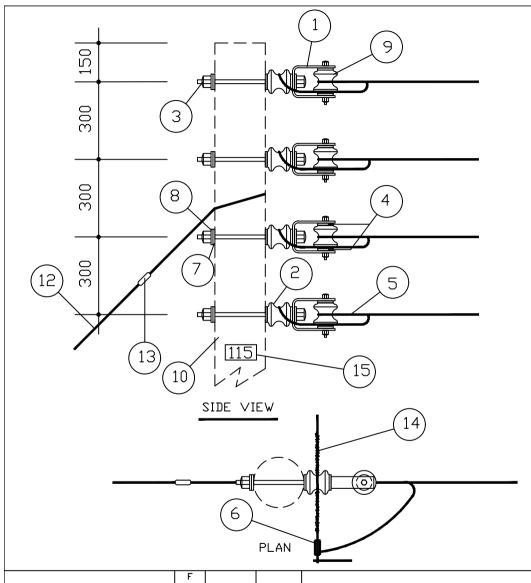


9	1	POLE NUMBER	
8	1	9M/10M PDLE	
7	4	ROUND WASHER M16	
6	0.4Kg	BINDING WIRE 3.60mm	
5	4	PLASTIC WASHER 50mmx15mm	
4	4	FLAT WASHER 50mm×16mm	
3	4	CURVED WASHER	
2	4	BOLT AND NUT 300×16mm	
1	4	REEL INSULATOR	
Part No.	Qty.	Description	Remarks/Ref.

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

PLAN

	F					0.4kV	POLE STRUCTUR	<del>_</del> =	
ZESCO LIMITED	Ε				Title:				
ZESCO LIMITED	D					-INTERMEDIATE-			
GREAT EAST ROAD P.O.BOX 30040 LUSAKA ZAMBIA	С				Drawing No.	LV0001	Drawn: Nyirenda M.	Date: 22.10.98	
	В	Sichela D.	20.12.99	100mm changed to 150mm	]	L V 0001	Checked	Date:	
	Α	MN	8.4.99	Outer line removed	Scale:	NTS	Approved	Date:	
TEL: 228084-9	Rev.	Rev.by	Date	Description	Replaces:			Orig.Layt: E-siz.	



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 60×60×6 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 300×16mm	
2	4	REEL INSULATOR EP194	Ref. PT0008
1	4	D-BRACKET c/w BOLT AND NUT M16	
Part No.	Qty.	Description	Remarks/Ref.

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

		F					0.4kV D/H	LINE POLE STRU	ICTURE
ZESCO LIMITED		E				Title:			
		D					TEE-OFF		
CDEAT FAST DEAD	GREAT EAST ROAD	С				Drawing No.	LV0006	Drawn: Nyirenda M.	Date: 26.10.98
		В	Sichela D	20.12.99	100mm changed to 150mm & stay wire rearranged	_	L V 0000	Checked	Date:
LUSAKA ZAMBIA TEL: 228084-9	Α	MN	8.4.99	Outer line removed	Scale:	NTS	Approvedi	Date:	
	Rev.	Rev.by	Date	Description	Replaces			Orig.Layt: E-siz.	

Annex 6

**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: Chainda, Kamanga (Nkoloma), Chawama, John Howard, Garden and Kanyama

Financier:



European Union under the 11<sup>th</sup> 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



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3.	Aim of the Investigation							
4.	Investigations Carried Out							
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5.	Fai		Used on Site	5				
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Figure 4: Kamanga (Nkoloma) Trial Pits

Figure 5: Location of Test Points in Chawama

Figure 6: Chawama Trial Pits

Figure 7: Location of Test Points in John Howard

Figure 8: John Howard Trial Pits

Figure 9: Location of Test Points in Garden

Figure 10: Garden Trial Pit

Figure 11: Location of Test Points in Kanyama

Figure 12: Kanyama Test Points

#### **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

TP Test Point / Trial Pit
P Soil Resistivity value

 $\Omega$  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  $\Omega$  in Garden Township to 4236 cm  $\Omega$  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 NATES	TEST POINT	LOCATION COORDI-		
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	PT Eastings Northing								
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	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 (TP3) 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 ρ(cmΩ)	Bearing Capacities kN/m²
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 grounding/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.

#### Sample/Core Measuring and Labelling 9.

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.



#### Annex 1

**Chainda Site and Lab Results** 



## STANDARD PENETRATION TEST (SPT) RESULTS

Droject: I	ucaka Transm	iccion and Distri	Consultants Lo bution Rehabilitat	ion		Date Tested: 04/01/19 Tested by: W. Mumbe	
rioject. L	usaka Iransm	ission and Distri	Dution Renabilitat	ION		rested by: w. midmb	
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. E	Bearing Pressure kN/m2	
		150	15				
1	1	300	14	24		280	
		450	10				
		150	8				
2	1	300	11	21		240	
		450	10				
		150	9				
3	1	300	11	20		260	
		450	9	-			
		150	13				
4	1	300	12	27		390	
		450	15				



## DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Project: Lusa	roject: Lusaka Transmission and Distribution Rehabilitation						
Test Pit N	Test Pit No. 1		No. 2	Test Pit	No. 3	Test Pit No. 1	
Penetration	Blows	Penetration	Blows	Penetration	Blows	Penetration	Blows
(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)	(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	



									ct o
				PART	ICLE SI	ZE DISTR	RIBUTION	L	4 6
					AAS	HTO T-27			
SIDE	:	7				SAMPLE N	0		
	RESE	NTATIVE	CHAIN	IDA TP-1	1.5 m	SAMPLING	DATE:		05/01/2019
LOC	OITA	<b>J</b> :				TESTING (	DATE:		12/01/2019
Weig	ht Afte	r Washing (g)	99	4.0	g		n fine :	1482.0	g
Weig	ht Befo	ore Washing (g)	247	6.0	q	loss in line	percentage :	149%	9
		Sieve	Weight	%	%	Speci	fication	Sample prepar	ration : Oven-dried sample
	size	e (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit		d of sieving:
		50	0.0	0.0	100.0			)	Wet sieving ✓
		37.5	0.0	0.0	100.0				Dry sieving
	-	26.5	0.0	0.0	100.0		6	See to some one	
		19	0.0	0.0	100.0	_		GRADING MOD	
		13.2	0.0	0.0	100.0				0.5
		9.5	0.0	0.0	100.0	_		GRADING COE	FFICIENT (GC) =
		6.7	0.0	0.0	100.0				2.1
		4.75	0.0	0.0	100.0		9		
		2.00	52.0	2.1	97.9	-			
_		1.18	44.0	1.8	96.1	_	-	-	
		0.6	53.0	2.1	94.0			1	
_		0.425	80.0	3.2	90.8	<del> </del>		1	
		0.3	133.0 543.0	5.4 21.9	85.4 63.4	+		1	
		0.15	89.0	3.6	59.9	_			
		Pan	1482.0	59.9	0.0			1	
_	Contract of	raii	1402.0	33.3	0.0			1,	
	100.0								
	90.0	1 1			,-				
	80.0		- Series 1	1					
	70.0	7 8	1 ( ) ( )	1					
sing	60.0		-						
% of Pass	50.0								
90	40.0			-					
	30.0								
	20.0								
	10.0					Щ.			
	0.0								
	0	01	0	.1	Sie	eve Size, mm		10	100
Rem	arks:				3				
		A.KASOKA		Checked B	y: S.T.PHIRI			Approved By:	
1	-0			Date: 12/01				Date	



		PART	ICLE SI	ZE DISTR	RIBUTION	i)	
	650		AAS	HTO T-27		164	
SIDE:				SAMPLE N	o		
REPRESENTATIVE STATION:	CHAIN	NDA TP-2	1.5 m	SAMPLING	DATE:		05/01/2019
LOCATION:				TESTING D	DATE:		12/01/2019
Weight After Washing (g)	270	06.0	g		n fine :	1648.0	g
Mainht Bafara Manhing (	424	54.0	2	loss in fine	percentage	61%	g
Weight Before Washing (	Weight	%	g %	Speci	fication	Cample prepar	refer : Oran deed cometa
size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Charles prompt to the		ation: Oven-dried sample
50	0.0	0.0	100.0		1	10	Wet sieving
37.5	0.0	0.0	100.0			] ,	Dry sieving
26.5	0.0	0.0	100.0		1		
19	0.0	0.0	100.0			GRADING MOD	OULUS (GM) =
13.2	0.0	0.0	100.0				0.9
9.5	0.0	0.0	100.0	1	2	GRADING COE	FFICIENT (GC) =
6.7	0.0	0.0	100.0				0.0
4.75	0.0	0.0	100.0			8	
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	<u> </u>	y .		
0.3	269.0	6.2	61.8	-			
0.15	396.0	9.1	52.7		-5	9	
0.075	647.0	14.9	37.9	-			
Pan	1648.0	37.9	0.0		<u></u>	R	
100.0							
90.0	+++++	-		/			
80.0		-		/			
70.0	- Series 1		1				
<b>2</b> 60.0			1				
50.0							
S-2-51 (122-903)							
30.0	40 (14 000) - 174 (00 pm.						
20.0	1 310 1 777 101	1		S1 100 0			
10.0							
0.01		1		1		10	100
	0.00	1611	Sie	eve Size, mm		200	888
Remarks:							
Tested By: A.KASOKA		Checked B	y:			Approved By:	
10		Date:12/01/	2019			Date	



			PART	ICLE SI	ZE DISTR	IBUTION	ı	
		in .		AAS	HTO T-27		554.4	
SIDE:					SAMPLE N	0		
REPR	RESENTATIVE ION:	CHAIN	NDA TP-3	1.5 m	SAMPLING	DATE:		05/01/2019
LOCA	TION:				TESTING D	DATE:	32	12/01/2019
Weigh	t After Washing (g)	335	53.0	g	loss in	fine:	1648.0	g
Majah	Defer Machine (a)	EN	110		loss in fine	percentage	49%	g
vveign	t Before Washing (g) Sieve	Weight	1.0	g %	Speci	fication	Country areas	
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	0.000.000	aration: Oven-dried sample and of sieving:
	50	0.0	0.0	100.0				Wet sieving
	37.5	0.0	0.0	100.0			]	Dry sieving
	26.5	0.0	0.0	100.0				
	19	0.0	0.0	100.0			GRADING MO	DULUS (GM) =
	13.2	0.0	0.0	100.0				0.9
	9.5	0.0	0.0	100.0			GRADING COE	EFFICIENT (GC) =
	6.7	0.0	0.0	100.0				0.0
	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			1	
_	0.425	202.0	4.0	72.7	-		-	
_	0.3	406.0	8.1	64.6 59.0	<del>                                     </del>		1	
	0.15	276.0 1305.0	5.5 26.1	33.0	1		1	
	Pan	1648.0	33.0	0.0	<del>                                     </del>		1	
		1040.0	33.0	0.0	I I I I I I I I I I I I I I I I I I I		J.	
	100.0				1			
	90.0				/			
	80.0	- Series 1	<u> </u>					
	70.0	A		1				
Bui	60.0		1-					
358	50.0		1					
% of Passing	40.0							
%	30.0	1						
	20.0							
	10.0							
	0.01	C	.1	91	eve Size, mm		10	100
Rema	rke.							
	By: A.KASOKA	-	Checked B	у:			Approved By:	
	The second second second		Date: 12/01				Date	



			PART	ICLE SIZ	ZE DISTR	IBUTION	L.	
				AAS	HTO T-27			
SIDE:					SAMPLE N	0		
REPRES STATIO	SENTATIVE N:	CHAIN	IDA TP-4	1.5 m	SAMPLING	DATE:		05/01/2019
LOCATION	ON:				TESTING D	ATE:		12/01/2019
Weight A	fter Washing (g)	710	5.0	q	24.4.4.4.	fine:	1372.0	g
91100	- 500000			200	loss in fine	percentage	192%	g
Veight B	efore Washing (g) Sieve	208 Weight	%	g %	Specif	fication		
s	size (mm)	Retained (gm)	76 Retained	Passing	Lower Limit	(SW 10000-000		ation: Oven-dried sample of sieving:
	50	0.0	0.0	100.0			Wetsieving	
	37.5	0.0	0.0	100.0				bry sieving
	26.5	0.0	0.0	100.0				
	19	0.0	0.0	100.0			GRADING MODI	ULUS (GM) =
	13.2	0.0	0.0	100.0				0.4
	9.5	0.0	0.0	100.0			GRADING COEF	FICIENT (GC) =
	6.7	0.0	0.0	100.0				1.1
	4.75	4.0	0.2	99.8				
	2.00	20.0	1.0	98.9			]	
	1.18	29.0	1.4	97.5		ž.		
	0.6	62.0	3.0	94.5			]	
	0.425	58.0	2.8	91.7		4		
	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			]	
100	100							
90	0.0	1111	-					
80		Series 1	,					<del></del>
70	0.0	-	-					<del></del>
g 60	0.0							
go of Passing	0.0		-	+++				
to 40	0.0							
	0.0							3 10 101 131
11000	0.0							
	1.0							
000	0.0				10101010			
	0.01	0	1	er	eve Size, mm	F2 - 22 - 21 - 21	10	100
				31	ere oize, min			
Zomodia								
Remarks Tested B	y: A.KASOKA		Checked B	y:			Approved By:	



		RBERG LIMIT			
	AASH"	TO T-89 & T- 9	0		
SIDE		Random Sam	ple Yes	□ No	
	AINDA TP-1 1.5 m	100000-0000-0000	SAMPLE NO.		1.70
	YELLOWISH SOIL		DATE SAMPLED		/2019
MUTTERIOR GOOTIOE	AINDA TP-1 1.5 m		DATE TESTED	13/01	/2019
MATERIAL DESRIPTION			SAMPLED BY		
REPRESENTATIVE STATION			TESTED BY		
SAMPLING DEPTH			TEST NO.		
	LIQUID	LIMIT		dp.	
Container No.		U	D-2	E	0
Wt of wet soil + container, gm	8	27.78	25.78	23.41	
Wt of dry soil + container, gm		24.16	22.61	21.05	0.
Wt of water		3.62	3.17	2.36	1
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	
44.00					
43.00			S	ample preparation	9
41.00			As received		
40.00			Washed on 0.425mmsieve  Air dried at		
39.00					
\$ 7.00					
\$ ×.00	+++++				
8.00 H			r reportor retained or o. s	Contra del Contra	140
Ŭ 31.00					
Mater Content,					
31.00				Test Result	
20.00	•		Liquid Limit	35.90 %	
28.00			Plastic Limit	17.44 %	
27.00			Plasticity Index	18.5 %	
0 5 10	15 20 25	30 36		2220-00	
	No of Blows	J	Shrinkege =	14.0 mm	
			Shrinkege =	9.3 %	
	PL	ASTIC LIMIT			gy
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	2	0.78	0.85		
Wt of container		16.02	15.59		
Wt of dry soil, gm	4.45	4.90		1	
Water content, %	17.53	17.35		17.44	
Remarks:			4		
Tested By: A.KASOKA	Checked By	: S.T.PHIRI	Approved By:		
CONTROL OF STATE AND AND STATE OF STATE	Company of the Compan				
	Date: 13/01/2	2019	Date		



			ERBERG LIMIT				
		AASI	HTO T-89 & T- 9	0			
SIDE		\(\frac{1}{2}\)	Random Sam	ple Yes	□ No		
LOCA.	TION	CHAINDA TP-2 1.5 m		SAMPLE NO.		X.50-	
	RIAL TYPE	FINE REDDISH SOIL		DATE SAMPLED	05/01/2019		
	RIAL SOURCE	CHAINDA TP-2 1.5 m		DATE TESTED	13/01	/2019	
	RIAL DESRIPTION			SAMPLED BY			
	ESENTATIVE STATION LING DEPTH		-	TEST NO.			
SAMP	LINGUEFIN	(		TEST NO.			
		A CONTRACTOR	Western W. W. W. W.				
	700	LIQUID					
Contain			10	7	51		
	et soil + container, gm		27.38	26.54	24.77		
	ry soil + container, gm		24.76	24.26	23.11	_	
Wt of w	12.30 Promotor		2.62	2.28	1.66	_	
_	ontainer		14.74	13.97	14.06		
	ry soil, gm content, %		10.02 26.15	10.29 22.16	9.05		
No. of b			17	25	18.34	-	
140. 01 1	DIOWS		16	23	33		
	30.00						
	29.00				ample preparation	ĺ	
	28.00			As received	П		
	27.00			Washed on 0.425mms	ieve	ĺ	
	25.00			Air dried at	.30°C		
1,%	24.00	++++++++++++++++++++++++++++++++++++		Oven dried at	°C	ĺ	
len	23.00	X		Proportion retained on 0.4	25mm sieve	***	
Water Content,	21.00			E	1500000-0.37440-0.00	5.40	
ig.	20.00						
×	19.00						
	18.00				Test Result		
	17.00			Liquid Limit	22.20 %		
	15.00			Plastic Limit	0.00 %		
	14.00	10 15 20 2	5 30 36	Plasticity Index	N/P %		
		No of Blows		Shrinkege =	0.0 mm		
				Shrinkege =	0.0 %		
		P	LASTIC LIMIT				
Contain						Average	
Wt of w	et soil + container, gm						
Wt of d	ry soil + container, gm						
Wt of w							
	ontainer					_	
	lry soil, gm			1			
Water	content, %					0.00	
D	-1						
Rema	rks:	T T		-			
Tested	By: A.KASOKA	Checked E	Зу:	Approved By:			
		Date: 13/0	1/2019	Date			



		TERBERG LIMIT			
	AAS	HTO T-89 & T- 9	0		
SIDE	v	Random Sam	ple Yes	□ No	
LOCATION	CHAINDATP-3 1.5 m		SAMPLE NO.		
MATERIAL TYPE	FINE REDDISH SOIL		DATE SAMPLED		1/2019
MATERIAL SOURCE	CHAINDA TP-3 1.5 m	110	DATE TESTED	13/01	1/2019
MATERIAL DESRIPTION			SAMPLED BY		
REPRESENTATIVE STATION			TESTED BY		
SAMPLING DEPTH		10 10	TEST NO.		
	X				
	LIQUII	DLIMIT		Y	
Container No.		F-24	J-11	0-3	
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	
X.00 X.00 X.00 X.00 X.00 X.00 X.00 X.00	10 15 20 No of Blows	PLASTIC LIMIT	As received Washed on 0.425mms Air dried at Oven dried at Proportion retained on 0.4  Liquid Limit Plastic Limit Plasticity Index Shrinkege = Shrinkege =	.30°C	
Container No.					Average
Wt of wet soil + container, gm				8	
Wt of dry soil + container, gm					
Wt of water					
Wt of container			8	* **	
Wt of dry soil, gm					
Water content, %		1			0.00
Remarks:					
Tested By: A.KASOKA	Checked	Ву:	Approved By:		
	Date:13/0	1/2019	Date		



			ΔTTF	RBERG LIMI	T			
				TO T-89 & T-				
SIDE			AAOII	Random Sar			о П	
LOCA	TION	CHAINDA TP-4	1.5 m	Trainson Ca	SAMPLE NO.			
	RIAL TYPE	FINE REDDIS			DATE SAMPLED	05/01/2019		
	RIAL SOURCE	CHAINDA TP-4			DATE TESTED		01/2019	
	RIAL DESRIPTION				SAMPLED BY	7,72		
	ESENTATIVE STATION			7	TESTED BY			
	LING DEPTH				TEST NO.			
	-2	X.	LIQUID	LIMIT	XIII	- 500	49	
Contair	ner No.			М	P	H		
Wt of v	vet soil + container, gm			30.43	27.76	25.76		
Wt of c	try soil + container, gm		Ĉ	26.28	23.74	23.10		
Wt of v	vater			4.15	4.02	2.66		
Wt of c	container			16.77	13.57	15.57		
Wt of c	try soil, gm			9.51	10.17	7.53		
Water	content, %		(1)	43.64	39.53	35.33		
No. of	blows			17	24	32		
	46.00		I TALISH LANDA - MARKA		1			
	45.00				8	amole omparatio	on	
	44.00				Sample preparation			
	43.00	$\square$			As received			
	42.00							
8	41.00		$\mathbb{N}$		Air dried at		<u> </u>	
	40.00				Oven dried at			
of the	39.00				Proportion retained on 0.4	25mm sieve	44.6446	
ပိ	38.00			$\sim$				
Water Content,	37.00							
>	36.00					Test Result		
	36.00				Liquid Limit	39.20 %		
	34.00				Plastic Limit	18.82 %	<u>8</u>	
	33.00		*		Plasticity Index	20.4 %	N.	
	2.00	10 15 No of Blow	20 25 NB	30 36	Shrinkege =	16.0 m	n	
		NO OI DIO	••		J	10.0 111		
					Shrinkege =	10.7 %	\$	
			PL	ASTIC LIMIT				
-	ner No.			5	8		Average	
	vet soil + container, gm			19.57	20.34			
	fry soil + container, gm			18.67	19.36			
Wt of v				0.90	0.98			
-	container			13.90	14.14			
	try soil, gm			4.77	5.22			
Water	content, %			18.87	18.77		18.82	
Rema	irke.							
1101110	10000114	T			0.507			
Toch	4 Put A KASOKA	1/	Chacked D.		Approved Du			
Teste	d By: A.KASOKA	C	Checked By	:	Approved By:			



	DETERMINATI				SHTO 18		OTION		
SIDE	3	I IVIII	MATTIC	NATIONAL CONTRACTOR	Random Sa		П	No	П
LOCATION	*				•	AMPLE NO.		140	
MATERIAL TYPE	¥-	Gravel			•	E SAMPLED		05/01/2019	
MATERIAL SOURCE	CHAIN	-	TP-1 1.5 m			TE TESTED		10/01/2019	
MATERIAL DESRIPTION	No.	ELLOWI			17.00	AMPLED BY		1010111110110	
REPRESENTATIVE STAT	to the second se	IDA TP-1			• 1	TESTED BY			
SAMPLING DEPTH	5				Š	TEST NO.			
No of blace	55.4					Mainht of h			
No. of blows : No. of layers :	55+1					Weight of h	mold,cm <sup>3</sup>		
Proportion retained on 19rr ( pass 50mm sieve and ret	nm sieve size:	_		• <u>@</u>		pple / Separate Apparent spec	batches:		
	Mold		No.	M 4	M 4	M 4	M 4	M 4	
A	WATER		%	9	11	13	15	17	
В	Wt. of Mold + Wet So	il	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	
Е	Volume of Mold		cm3	2374	2374	2374	2374	2374	
F	Wet Density		g/cm3	1.904	2.027	2.104	2.086	2.036	
G	Container		No.	N-70	M-300	VM-2	I-18	L-P	
Н	Wt. Cont + Wet soil		grams	773.0	776.0	759.0	728.0	770.0	
l 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	
**			0/		440	40.4	45.0	47.0	
M N	Moisture Content	_	% g/cm3	8.9 1.747	1.823	13.1	15.0	17.0	
N	Dry Density		g/cms	1.747	1.023	1.001	1.014	1.740	$\overline{}$
Maximum Dry Density (M	IDD):	1.870							<b>]</b> [
	30-73-500							+	-
MDD =	1.861 g/cm3								<b>1</b>
11.00	grans	900			//				4
Optimum Moisture Conte	ort (OMC) :	Dry density, give	++++		/		1		- 1
Optimum moisture come	rik (OMO).	9							]
OMC =	12.1 0/	6							4
OMC =	13.1 %	70428						4	1
		1.770							
								$\perp$	-
								+	$H \perp$
		1.720							
		1.720	8 9	10 1	11 12	13 14	15	16 17	18
					Mode	ture content.%			
	(					and contains a			_)
Remarks:									
Tested By: A.KASOKA	Checked	By: S.T PI	HIRI			Approved By:			



	DETERMINAT		NAME AND ADDRESS OF TAXABLE PARTY.	The second secon	NAME AND ADDRESS OF TAXABLE PARTY.	NAME OF TAXABLE PARTY.	ACTION		
		(TMH 1	MATH	OD A7,AA	SHTO 18	30)		,	
SIDE					Random Sa	ample Yes		No	
LOCATION						SAMPLE NO.			100000
MATERIAL TYPE		Gravel			DAT	TE SAMPLED		05/01/2019	
MATERIAL SOURCE						ATE TESTED		11/01/2019	
MATERIAL DESRIPTION		E REDDIS			_	SAMPLED BY			
REPRESENTATIVE STAT	I CHA	INDA TP-2	1.5 m		-0:	TESTED BY	-		
SAMPLING DEPTH						TEST NO.			
No. of blows :	55+1					Weight of	hammer,kg:	4.5	
No. of layers :	5						of mold.cm <sup>3</sup>		5
Proportion retained on 19m ( pass 50mm sieve and ret	nm sieve size:	) -		-0		mple / <u>Separa</u> Apparent spe			N.
	Mold		No.	M 44	M 44	M 44	M 44	M 44	0
Α	WATER		%	3	5	7	9	11	0
В	Wt. of Mold + Wet S	oil	grams	8462	8732	8890	8876	8794	Si
С	Wt. of Mold		grams	4087	4087	4087	4087	4087	
D	Wt. Wet Soil		grams	4375	4645	4803	4789	4707	0
E	Volume of Mold		cm3	2345	2345	2345	2345	2345	
F	Wet Density		g/cm3	1.866	1.981	2.048	2.042	2.007	2
10					1	1		1	
G	Container	- 1	No.	I-18	L-P	U-45	FR-2	M-61	
н	Wt. Cont + Wet soil		grams	775.0	751.0	764.0	733.0	762.0	
T.	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 L	Weight of Dry Soil		grams	506.0	472.0	479.0	447.0	462.0	
-	Weight of Diy oon		granis	500.0	472.0	410.0	441.0	402.0	
М	Moisture Content		%	3.4	5.1	7.1	9.2	11.0	
N	Dry Density		g/cm3	1.805	1.885	1.912	1.871	1.808	
		1.930							
Maximum Dry Density (M	IDD):	1.00							
3 22.00	100		-		+			+	+
MDD =	1.912 g/cm3				1/1				
	grano	§ 1.880	, Lund						
Optimum Moisture Conte	M (OMC)	4			4				4
Optimum moisture Conte	TIL (OMC).	ools, than density to		/					
0140 -	74	60		//				1	+
OMC =	7.1 %	1.830							
		1,000		//					
				7					
			11111	1	+			++++++	+1
		1.780						111111111	
		1.794	2 3	4	5 6	7 8	9	10 11	12
					Mod	sture content.%			
						sum consent n			_)
Remarks:									
Tested By: A. KASOKSA	Checked	і Ву:				Approved B	y:		
	25 2 0 222					0.4			
	Date: 11	01/2019				Date			



	DETERMINATIO			D A7,AA			NO FIOR		
SIDE	<u>U</u>	MIVI DE BELL	MAIN	D AT,AA	Random Sa			No	
LOCATION						SAMPLE NO.		NO	
MATERIAL TYPE		Gravel			-	TE SAMPLED		05/01/2019	
MATERIAL SOURCE	CHAINI	-	P-3 1.5 m			ATE TESTED		11/01/2019	
MATERIAL DESRIPTION		REDDIS	_		•	SAMPLED BY		THOREGIO	
REPRESENTATIVE STAT	A. T. Control of the	DA TP-3				TESTED BY	-		
SAMPLING DEPTH					TÅ	TEST NO.			
	3.24892							x 1992	
No. of blows :	55+1					Total State of the Control	hammer,kg:	-	
No. of layers : Proportion retained on 19m	5				Single sar	mple / Separa	of mold,cm <sup>3</sup> :	2345	
pass 50mm sieve and ret		200		9		Apparent spe			
The same of the sa		-	Setation			4			
	Mold		No.	M 44	M 44	M 44	M 44	M 44	
A	WATER		%	4	6	8	10	12	
В	Wt. of Mold + Wet Soil		grams	8449	8751	8976	8940	8796	
С	Wt. of Mold	0	grams	4087	4087	4087	4087	4087	
D	Wt. Wet Soil	- 1	grams	4362	4664	4889	4853	4709	
E	Volume of Mold		cm3	2345	2345	2345	2345	2345	
F	Wet Density		g/cm3	1.860	1.989	2.085	2.070	2.008	
•	Container		No	D.44	FF 46	N 70	11.44	0.67	
G	Wt. Cont + Wet soil		No.	D-14	EE-16	N-70	M-41	G-67	
H	Furnities and a company of the company	-	grams	776.0	762.0	764.0	775.0	777.0	
J	Wt. Cont + Dry soil	-	grams	756.0	732.0	725.0	726.0	719.0	
	Weight of Water	-	grams	20.0	30.0	39.0	49.0	58.0	
K L	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	
М	Moisture Content	_	%	4.0	6.2	8.3	10.2	12.4	
N	Dry Density		g/cm3	1.789	1.873	1.925	1.877	1.786	
00.20		1.930							
Maximum Dry Density (M	IDD):			*					
					+-				
MDD =	1.925 g/cm3								
		1.880			//				4
Optimum Moisture Conte	ont (OMC):	Û			*				
STANDARD CONTRACTOR STANDARD CONTRACTOR		60			1				
OMC =	8.3 %	ă		7					$\Box$
		1.830							
				- X					+
									4
		1.780	3 4	5	6 7	8 9	10	11 12	13
			, ,	9		0 9	10	11 12	13
					Moi	is ture content,%			
Remarks:									
turnerna.	Para areas					SEC.	- The sa		
Tested By: A.KASOKA	Checked B	y:				Approved By	r:		
	Date: 11/01	2019				Date			
	Date: 11/01	12019				Date			



	DETERMINAT		1 MATHO				011011		
SIDE		1 111111	MAINE	D ATTO	Random Sa	_	П	No	П
LOCATION						AMPLE NO.	-		
MATERIAL TYPE		Grave	el		DAT	E SAMPLED		05/01/2019	
MATERIAL SOURCE	CHA		-4 1.5 m			TE TESTED		10/01/2019	
MATERIAL DESRIPTION		NE REDDISH SOIL			500	AMPLED BY			
REPRESENTATIVE STAT			-4 1.5 m		0.0	TESTED BY			
SAMPLING DEPTH	X	mullioner,	3000000		*20	TEST NO.			
No. of blows :	55+1					Weight of h	ammar ka	: 4.5	
No. of layers :	5						f mold,cm <sup>3</sup>		
Proportion retained on 19m pass 50mm sieve and ret	nm sieve size:	)				Apparent spec	batches:	- 74	
	Mold		No.	M 4	M 4	M 4	M 4	M 4	
Α	WATER		%	8	10	12	14	16	
В	Wt. of Mold + Wet S	oil	grams	8526	8822	9012	8932	8868	
C	Wt. of Mold		grams	4085	4085	4085	4085	4085	
D	Wt. Wet Soil	i i	grams	4441	4737	4927	4847	4783	
Е	Volume of Mold		cm3	2374	2374	2374	2374	2374	
F	Wet Density		g/cm3	1.871	1.995	2.075	2.042	2.015	
		- 1			10				
G	Container		No.	M-22	N-17	F-21	U-14	J-6	
н	Wt. Cont + Wet soil		grams	761.0	770.0	750.0	720.0	769.0	
1	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	
М	Moisture Content	-	%	8.0	10.2	12.0	14.0	16.0	
N	Dry Density		g/cm3	1.732	1.810	1.853	1.790	1,737	
1111	2.700.00	$\overline{}$	grania	11.02	11010				
Maximum Dry Density (M	IDD):	1.8	70						7
								+	H
MDD =	1.853 g/cm3	Steen							7
		99,0			/	+			41
Optimum Moisture Conte	nt (OMC):	Dry dencity, gloo	20						1
		9							7
OMC =	12.0 %	8		/			$\rightarrow$		41
	76	1.7	70						]
							+		- 1
			-	$\mathcal{A}$		*			41
								7-4	<b>]</b>
		1.7	20	шш					_
			7 8	9 1	10 11	12 13	14	15 16	17
					Mois	ture content %			
Remarks:									
Tested By: A.KASOKA	Checked	By:				Approved By			
	DO-DAY COMES	1000 1130 Little				200000			
	Date: 10/	01/2019				Date			



			CALIFO	RNIA B	EARING RA	TIO			
					D T 193	110			
SAMPLE STATION		CHAINDA	TP-1 1.5 n		Random Sam	ple Yes	П	No	
LOCATION					- 8	AMPLE NO.			
MATERIAL TYPE		FINE YELL	OWISH SO	IL	DAT	E SAMPLED		05/01/2019	12
MATERIAL SOURCE		CHAINDA	TP-1 1.5 n	n	DATE TESTED 11/01/2019				
MATERIAL DESRIPTION		G	ravel		S	AMPLED BY			
REPRESENTATIVE STAT	ION	CHAINDA	TP-1 1.5	m	-	TESTED BY			
SAMPLING DEPTH			1000		_	TEST NO.	-11		
ENGINEERS AND PROPERTY OF THE PARTY OF THE P			DEN		ERMINATION	I HRVERY SES			
SOAKING CONDITION					ayer Blows (4,5kg) Before		s Blows (4,5kg) efore		s Blows (2,5kg efore
MOLD NUMBER	v.c.				M-7	17.0	M-8		1-22
WEIGHT OF SOIL + MOI	LD, g				9056		841	27.	518
WEIGHT OF MOLD, g					4098		109		089
WEIGHT OF SOIL, g VOLUME OF MOLD, g					4958 2341		732 359		429 347
WET DENSITY OF SOIL	a/cm <sup>3</sup>				2.118		.006		887
DRY DENSITY OF SOIL.					1.875	1.	776	1.	671
	V-10.000.		MOIS		TERMINATION	27 20	10	TO.	
				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg
SOAKING CONDITION				1	Before	Be	efore	Be	efore
CONTAINER NUMBER					VM-32	N	1-39	3	
WET SOIL + CONTAINE	R, g				706		795		
DRY SOIL + CONTAINER	, g				654		732	<u> </u>	
WEIGHT OF CONTAINE WEIGHT OF WATER, a					249 52		250 63	Ú.	
WEIGHT OF DRY SOIL,	g				405		482		
MOISTURE CONTENT					12.8		3.1	1	
MOISTUR	RE CONTE	NT AV=				1.	3.0	-10	
100					BOTTOM TEST			500	1,000
Р	ENETRAT	ION DATE	/4 Fl =>	15/01/20			RING FACTOR		.00
PENETRATION (mm)	Dial	5 Layer Blo		Dial	y 5 layers Blows		55 by 3	layers Blows	
reaction (initi)	reading	Load (KN)	C.B.R(%)	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	1.81			1.32			0.89	\$
1.91 2.54	1	2.34	21.5		1.78 2.20	16.5		1.20	10.6
3.18		3.26	21.0		2.65	10.0		1.65	10.0
3.81		3.72	3		3.10			1.82	3
4.45		4.02	00.4		3.34	47.0		2.06	44.0
5.08 5.72	+	4.41	22.1		3.46 3.69	17.3		2.20	11.0
6.35		4.75	-		3.83			2.39	
6.99	9 9	4.95			3.98	i i	2	2.48	Ü,
7.62		5.09			4.10			2.67	J
8.26 8.89		5.11 5.17			4.27			2.81	10
9.55	1	5.23	3 5		4.42			3.10	8
2700	-					Blows	55	25	55
	SWE	LL			rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date					Initial reading (m		1.111.0000-10-05		0
Time					Final reading (m Height of specir			· · · · · ·	
					Percent Swell (				Ĭ
Remarks:						25)	de vi	- N	O.
CLASSO CHERTOSTANISMO	0	Charles	Dur C T DI	UDI		Annessa	D		
Tested By: W.MUMBA		Спескеа	By: S.T.PI	IIKI		Approved	by.		
		D-1- 445	4/0040			Data			
		Date:11/0	1/2019			Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	2			
			AASHTO	T 10	2				
SAMPLE STATION		CHAINDA TP-	1 1.5 m	_	Randon	Sample	YES	NO [	
LOCATION		CHAINDA TP-		SAMPLE NO.  DATE SAMPLED 05/01/201  DATE TESTED 15/01/2019					
MATERIAL TYPE MATERIAL SOURCE	- 1	INE YELLOW	VISHSOIL						
MATERIAL DESRIPTION	-	Grave	d		DATE TESTED 15/01/2 SAMPLED BY				13
REPRESENTATIVE STATION	-	Oldic			TESTED		89 <del>6</del>		
SAMPLING DEPTH	[3]			_	TEST NO	),	9		
	- 10	10:	1		т				
	Number of	% Moisture	Day Donoite	CBR	% Moisture	C11 0/	Average %	Standard Lo	ad (KN)
M.D.D (gm/cm <sup>3</sup> )	blows	before soak	Dry Density	%	after 96 hours	Swell %	Swell	2.54 mm	5.08 mm
1.861	55 by 5	12.8	1.875	21.5	0.0	0.00		13.24	20.00
O.M.C. %	30 by 5	13.1	1.776	16.5	0.0	0.00	0.00	13.24	20.00
13.1	55 by 3	0.0	1.671	10.6	0.0	0.00	0,00	13.24	20.00
13.1	33 by 3	0.0	1.0/1	0.01	0.0	0.00		13.24	20.00
PENETRAT	ION CURV BOT	TOM	)(						)
6.0				1.900 T	To To To		1 1 1	1 1	
		+i+							•
				1.850					
	+	4	H II.						
				1.800					
4.0		1	H     \$	1.000			/		
000 000	$\rightarrow$			4.750		$\rightarrow$	7		
3			1 8	1.750					
2.0	1			1.700					
					•				
	8 4 5		8 8 8	1.650				CBR V	ALUE AT
									6%
				1.600		14.0		19.0	1 3
0.0	$\Box$	$\perp \perp \perp$						.100	
0.00 1.27 2.54 3.81	5.08 6.35	7.62 8.	89			So	aked CBR %		
PENETRAT	ION(nm)					~	and obit is		
CBR Value	nt 90% MD	D = 1.675	5	CBR	Value at 90%	from the grap	oh =	10	.7
CBR Value	it 95% MD	D = 1.768	1	CBR	Value at 95%	from the grap	sh =	1	5.9
CBR Value	at 98% MD	D = 1.824	5	CBR	Value at 98% f	rom the grapl	1=	19	9.0
Comments:			.0 .0						
Checked By: W.MUMBA			APROV	ED BY:					
				Date:	V.				
Test Results Within I	Engineering I	Limits:		Yes	✓ No				1.0



			CALIEO	DAIIA D	EADING DA	TIO			
					EARING RA D T 193	<del>(110</del>			
SAMPLE STATION		CHAINDA	TP-2 1.5 n		Random Sam	ple Yes		No	
LOCATION	20				-	SAMPLE NO.			2.5
MATERIAL TYPE	-	FINE REI	DDISH SOIL		-	E SAMPLED		05/01/2019	
MATERIAL SOURCE			TP-2 1.5 n		D/	ATE TESTED		12/01/2019	
MATERIAL DESRIPTION	H.		ravel		-	AMPLED BY			10
REPRESENTATIVE STAT	ION	CHAINDA	TP-2 1.51	m	-	TESTED BY	ē		
SAMPLING DEPTH	0.	N. S.		25	7	TEST NO.			
			DEN		ERMINATION				95
SOAKING CONDITION					ayer Blows (4,5kg) Before		s Blows (4,5kg) efore		s Blows (2,5kg) efore
MOLD NUMBER			-		B-31		3-33		3-34
WEIGHT OF SOIL + MOL	D, g				8106	7	856	7.	546
WEIGHT OF MOLD, g					3300		333	7.1	293
WEIGHT OF SOIL, g VOLUME OF MOLD, g					4806 2326		523 314		253 305
WET DENSITY OF SOIL,	a/cm³		-		2.066		955		845
DRY DENSITY OF SOIL.	g/cm <sup>3</sup>				1.929		825		722
			MOIS		TERMINATION	No.	No.		
				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION				- 50	Before	1	efore	Ве	efore
CONTAINER NUMBER WET SOIL + CONTAINER					F-26		3-70 738		
DRY SOIL + CONTAINER			-		711 680		706		
WEIGHT OF CONTAINER					247		255		- 3
WEIGHT OF WATER, g					31		32		
WEIGHT OF DRY SOIL, OM	9				433 7.2		151		
MOISTUR	E CONTE	NT AV=			1.2		7.1		
			DENE	TRATION I	BOTTOM TEST				
P	ENETRAT	ION DATE		16/01/20		F	ING FACTOR	0	0.00
LINEAU PROSPERATOR CONTRACTOR AND A PROSPERATOR CONTRACTOR CONTRAC		5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	(2,5kg)
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00			0.00			0.00	
0.64 1.27		0.96 1.82			0.82 1.36		-	0.60 1.10	
1.91		2.47	9 9		1.86			1.46	
2.54		3.20	24.0		2.52	18.9		1.91	14.3
3.18		3.65	3 9		2.91			2.29	
3.81 4.45		3.96 4.20			3.26 3.47			2.45	-
5.08	-	4.48	22.4		3.78	18.9		2.71	13.6
5.72	8 8	4.71	8 8		3.92	5		2.87	
6.35		4.96			4.12	ii.		2.96	
6.99 7.62		5.18 5.36			4.25 4.42		-	3.06	
8.26		5.48			4.58			3.27	
8.89		5.69			4.83			3.40	72
9.55		5.81	2		5.06	Diame		3.54	
	SWE	11			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3
Soaking Date	0116				Initial reading (n	nm)	Tiong of o	Jong of 5	ajong of o
Time	ĝ				Final reading (m	m)		- 1	22
		0			Height of specia		2		
Domodra					Percent Swell	76)			-
Remarks:									
Tested By: W.MUMBA		Checked	Ву:			Approved	Ву:		
		Date: 12/0	01/2019			Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	0				
la (		O'ALII C				_				
SAMPLE STATION LOCATION MATERIAL TYPE MATERIAL SOURCE MATERIAL DESRIPTION REPRESENTATIVE STATION SAMPLING DEPTH	C	HAINDA TP- HAINDA TP- FINE REDDI Grave	2 1.5 m SH SOIL	O T 19	Random Sample SAMPLE NO. DATE SAMPLED DATE TESTED SAMPLED BY TESTED BY TEST NO.			YES NO 05/01/2019 16/01/2019		
MDD ( ) A	Number of blows	% Moisture before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Lo	ad (KN)	
M.D.D (gm/cm³) 1.912	55 by 5	7.2	1.929	24.0	0.0	0.00		13.24	20.00	
O.M.C. %	30 by 5	7.1	1.825	18.9	0.0	0.00	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	
2.0 0.0 1.27 2.54 3.81 FENETRA	5.08 6.35 HON(ma)	7.62 8.1		1,950 1,900 1,900 1,800 1,750 1,750 1,650 1,650		18.0	paked CBR %		NIAE AT	
CBR Value			•	2	R Value at 90%  R Value at 95%	acero monorale a	7000	14.	3.6	
CBR Value	at 98% MDI	) = 1.874	9	CBR	Value at 98%	from the grap	h =	21	1.2	
Comments:										
Checked By: W.MUMBA			-	ED BYy:	() 0 <u>3 c</u>					
Test Results Within	Engineering L	imits:		Date: Yes	No					



					EARING RA	TIO			
				AASHT	O T 193	10			
SAMPLE STATION		CHAINDA	TP-3 1.5 r	n	Random Sam	ple Yes	П	No	
LOCATION			W. W		-	SAMPLE NO.			100
MATERIAL TYPE		FINE REI	DDISH SOIL		DATE SAMPLED 05/01/2				
MATERIAL SOURCE	24	CHAINDA	TP-3 1.5 r	n	DATE TESTED 12/01/2019				
MATERIAL DESRIPTION		Gi	ravel		S	AMPLED BY			
REPRESENTATIVE STAT	ION	CHAINDA	TP-3 1.5	m	5 <u>2</u> 1	TESTED BY			
SAMPLING DEPTH						TEST NO.	į.		
CA CONTRACTOR MANAGEMENT OF THE MANAGEMENT OF THE CONTRACTOR OF TH			DEN		ERMINATION ayer Blows (4,5kg)	25 by 5 lover	e Diane (4 Eka)	EE by 2 layer	e Plane (2 Ek
SOAKING CONDITION					Before		efore		efore
MOLD NUMBER					B-20		3-23		3-25
WEIGHT OF SOIL + MO	.D, g			3	8110		969		533
WEIGHT OF MOLD, g WEIGHT OF SOIL, g					3275 4835		565		215 318
VOLUME OF MOLD, g					2310		300		325
WET DENSITY OF SOIL	g/cm <sup>3</sup>				2.093		.985		857
DRY DENSITY OF SOIL,	a/am³			-	1.937	1.	.837	1.	719
			MOIS		TERMINATION	I			
SOAKING CONDITION					ayer Blows (4,5kg)	100		1/6	Market Control
SOAKING CONDITION					Before	Be	efore	Be	efore
CONTAINER NUMBER					H-70		GT	î	
WET SOIL + CONTAINE			- 8	Š	744		764	Şi	
DRY SOIL + CONTAINER WEIGHT OF CONTAINE				-	707 240		72.5 246	2	
WEIGHT OF WATER, g	', y				37		39		
WEIGHT OF DRY SOIL,		467		479					
MOISTURE CONTENT	E CONTE	NIT AV			7.9		8.1		
MOISTUR	RE CONTE	NI AV=	-2000			8	.0		
	ENETDAT	ION DATE		16/01/20	BOTTOM TEST		RING FACTOR		.00
-		5 Layer Blo			y 5 layers Blows			layers Blows	
PENETRATION (mm)	Dial	and Williams	No. of the last of	Dial	. Washington and a com-	Listan M. Harrison	CHANGE CONTROL OF CONT	0.0	Transcription of the second
	reading	Load (KN)	C.B.R(%)	reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00	8 7	8	0.00			0.00	(6)
0.64 1.27		1.13			0.87 1.86			0.62 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	12	4.02	Y		3.22			2.42	
3.81 4.45		4.82 5.38			3.47			2.72	
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 7.62		7.47 7.97		8	4.87 5.10			3.66	8
8.26		8.34			5.21			3.88	3
8.89	9	8.71			5.34			3.99	ly .
9.55		9.10	is 5		5.44	Diama	55	4.12	
	SWE	11.			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3
Soaking Date	SHE	- Laboratoria			Initial reading (n	nm)	4,ong by 5	4,ong by 5	Z, JANY DY 3
Time	ý.				Final reading (m	m)		(a )	(d
		/			Height of specia				š.
5					Percent Swell	%)		15	· ·
Remarks:									
Tested By: W.MUMBA		Checked	Ву:			Approved	By:		
TEOL			1111			00000			



		CALIFO	ORNIA BI	EARIN	IG RATIO	<u>0</u>				
SAMPLE STATION	-	CHAINDA TP-	AASHTO	1 19		n Sample	YES	□NO □	7	
OCATION	-	CHAINDA TP-	The Sections	-	Random Sample SAMPLE NO.				_	
MATERIAL TYPE	-	FINE REDDI	DATE SAMPLED			-80	05/01/2019			
MATERIAL SOURCE	1	2.000		DATE TESTED			16/01/201	9		
MATERIAL DESRIPTION REPRESENTATIVE STATION	-	Grave	H	-	SAMPLED BY TESTED BY			-		
SAMPLING DEPTH	19-			TEST NO.			5			
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	ad (KN)	
M.D.D (gm/cm <sup>3</sup> )	blows	before soak	20 200	70	hours		Sweii	2.54 mm	5.08 mm	
1.925	55 by 5	7.9	1.937	25.4	0.0	0.00		13.24	20.00	
O.M.C. %	30 by 5	8.1	1.837	20.7	0.0	0.00	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	
	RATION(mm)	17 4334977 1331	Dry Density amilo	1.750 1.700 1.650 1.600			paked CBR %	2.0	ZB.O	
CBR Value at 90% MDD = 1.733					CBR Value at 90% from the graph =				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:				2						
Checked By: W.MUMBA			APROVE		180					
Test Results With	in Engineering I	.imits:		Date: 'es	✓ No					



			CALIFO	RNIAB	EARING RA	TIO			
					O T 193				
SAMPLE STATION	W	CHAINDA	TP-4 1.5 r	n	Random Sam	ple Yes	П	No	П
LOCATION					SAMPLE NO.				
MATERIAL TYPE		FINE REI	DDISH SOIL		DAT	05/01/2019			
MATERIAL SOURCE		CHAINDA	TP-4 1.5 r	DATE TESTED				11/01/2019	
MATERIAL DESRIPTION	SRIPTION Gravel				S				
REPRESENTATIVE STA	TION	CHAINDA	TP-4 1.5	m	70	TESTED BY			
SAMPLING DEPTH			_ 700			TEST NO.	v.		
			DE		ERMINATION ayer Blows (4,5kg)	25 by 5 layer	e Playe (4 Ekg)	55 by 3 layer	e Blowe /2 5kg
SOAKING CONDITION					Before		efore		efore
MOLD NUMBER					M-20	4.0	1-29		1-11
WEIGHT OF SOIL + MO	LD, g				9003		732	8502	
WEIGHT OF MOLD, g WEIGHT OF SOIL, g			-		4079 4924	4103 4629		4101 4401	
VOLUME OF MOLD, g					2352	2340		2335	
WET DENSITY OF SOIL					2.094	1.978		1.885	
DRY DENSITY OF SOIL	g/am³		****	T	1.867	1	.764	1.	681
			MOIS		TERMINATION	25 by 5 layer	e Plane /4 Eka\	EE by 2 lavan	e Dlove /2 Eko
SOAKING CONDITION					- Name of the second	-	photograph CALCY MAD	55 by 3 layers Blows (2,5kg	
28				Before		Before		Before	
CONTAINER NUMBER				MG-71		M-56			
WET SOIL + CONTAINE DRY SOIL + CONTAINER				818 757		841 777			
WEIGHT OF CONTAINER, g				253		250			
WEIGHT OF WATER, g				61		64			
WEIGHT OF DRY SOIL, g				504		527 12.1			
MOISTURE CONTENT MOISTUR	RE CONTE	NT AV=	-		12.1		2.1	(h)	
moioro	IL OOM	IVI PW	DENE	TDATION I	BOTTOM TEST				
F	PENETRAT	ION DATE		15/01/20		F	RING FACTOR	0	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(%)	Dia1 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	
1.91		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 4.45		1.32			0.89		-	0.48	
5.08		1.46	7.3		1.05	5.3		0.58	2.9
5.72		1.57	1000	-	1.10			0.64	1000
6.35		1.60			1.18		1	0.69	
6.99 7.62		1.68 1.76			1.24			0.74 0.78	
8.26	-	1.85		-	1.36			0.78	
8.89	0 9	1.96	d 3	O T	1.42		13	0.86	
9.55		2.04			1.48	PI-		0.89	
	SWE	11			rammar	Blows	55 4.5kg by 5	25 4,5kg by 5	55 2,5kg by 3
Soaking Date					Initial reading (n	am)	4,ong by 5	4,ong by 5	z, okg by 3
Time					Final reading (mm)		- 0	0	
	- 6	3			Height of specir				
Damada					Percent Swell (	%)			<u> </u>
Remarks:									
Tested By: W.MUMBA Checked By:  Date:					Approved Date	ed By:			
		Date.				Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	2				
			AASHTO	O T 19	2					
SAMPLE STATION	С	HAINDA TP-		0 1 13		n Sample	YES	NO [	1	
LOCATION	C	HAINDA TP	4 1.5 m		SAMPLE NO. DATE SAMPLED 05/01/201					
MATERIAL TYPE		FINE REDDI	SH SOIL	- 0						
MATERIAL SOURCE		0		_	DATE TE	No. of Contract of	-	15/01/201	19	
MATERIAL DESRIPTION REPRESENTATIVE STATION		Grave	1	_	SAMPLE		10			
SAMPLING DEPTH	( <del>)</del>			_	TEST NO		10-			
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	oad (KN)	
M.D.D (gm/cm <sup>3</sup> )	Ulows	octore soak	A CONTRACTOR OF THE CONTRACTOR	100	hours	CHANGACHERS	Swell	2.54 mm	5.08 mm	
1.853	55 by 5	12.1	1.867	8.6	0.0	0.00	21/20/200	13.24	20.00	
O.M.C. %	30 by 5	12.1	1.764	5.7	0.0	0.00	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	
0.0 0.00 1.27 2.54 3.81 PENETR	5.08 6.35 YION(mp)	7.62 8.	Service and an analysis of the service analysis of the service and an analysis of the service analysis of the service and an analysis of the service analysis of the service analysis of the service analysis of the service and an analysis of the service analysis	1.850 1.800 1.750 1.700 1.650		s	5.0 baked CBR %	1.00	ALLE AT JOSN 10.0	
	at 90% MD	NAME OF THE PERSON		2000	R Value at 90%	500 - 1000	100	2.	000	
CBR Value	at 95% MD	D = 1.760	,	CBI	R Value at 95%	from the gra	ph =		5.4	
CBR Value	at 98% MD	D = 1.810	5	CBR	Value at 98%	from the grap	h=	7	7.2	
Comments:										
Checked By: W.MUMBA				ED BYy:						
				Date:			10			
Test Results Within	Engineering L	imits:	64	Yes	✓ No					



#### SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	Lo	cation: Chainda	Date Tested: 04/01/19		
Project: Lusaka Transmission and Distribution Rehabilita	Resistivity Ohm-Centimetre				
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



#### Annex 2

Kamanga (Nkoloma) Site and Lab Results



# STANDARD PENETRATION TEST (SPT) RESULTS

		national Energy	l H	ocation: Camanga	Date Tested: 04/01/19
Project: I	Lusaka Transm	ission and Distri	bution Rehabilita	tion	Tested by: W. Mumba
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m2
		150	38		
1	1	300	43	86	>600
		450	43		
		150	39		
2	1	300	43	84	>600
		450	41		
		150	27		
3	1	300	32	68	>600
		450	36		
		150	44		
4	1	300	39	79	>600
		450	40		



## DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA	-ITEC Int	ernational Ene	ion: inga	Date Tested:	04/01/19		
Project: Lusa	ka Trans	mission and Dis	stribution	Rehabilitation		Tested by: W	. Mumba
Test Pit N	lo. 1	Test Pit N	lo. 2	Test Pit	No. 3	Test Pit N	o. 1
Penetration	Blows	Penetration	Blows	Penetration	Blows	Penetration	Blows
(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)	(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	5	3.9		3.9	
4.2		4.2	X	4.2		4.2	
4.5		4.5	11	4.5		4.5	
4.8		4.8	X	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	11	6.9		6.9	
7.0		7.0		7.0	)	7.0	



PARTICLES	IZE DISTRIBUTION	N
A	SHTO 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 Weight % %	Specification	Sample preparation : Oven-dried sample
size (mm) Retained Retained Passin	Lower Limit Upper Limit	
50 0.0 0.0 100.0	u E	Wet sieving  ✓
37.5 283.0 12.1 87.9		Dry sieving
26.5 251.0 10.8 77.1		
19 153.0 6.6 70.5		GRADING MODULUS (GM) =
13.2 180.0 7.7 62.8		2.1
9.5 124.0 5.3 57.5		GRADING COEFFICIENT (GC) =
6.7 88.0 3.8 53.7		21.2
4.75 98.0 4.2 49.5		
2.00 356.0 15.3 34.2		-
1.18 40.0 1.7 32.5		4
0.6 14.0 0.6 31.9		_
0.425 5.0 0.2 31.7		4
0.3 4.0 0.2 31.5		4
0.15 50.0 2.1 29.4		4
0.075 156.0 6.7 22.7		-
Pan 528.0 22.7 0.0		
100.0		
90.0		
80.0 Series1		
70.0		
g eo		
\$ 50.0		
\$ 50.0 6 40.0		
8 30.0		
20.0		
10.0		
0.01 0.1	Sievo Size mm	10 100
Remarks:	Sieve Size, mm	
Tested By: A.KASOKA Checked By:S.T.PHI	91	Approved By:
Date:11/01/2019		Date



		PART	ICLE SI	ZE DISTR	IBUTION	ı			
			AAS	HTO T-27					
SIDE:				SAMPLE N	o				
REPRESENTATIVE STATION:	KAMA	NGA TP-2	1.1 m	SAMPLING	DATE:		03/01/2019		
LOCATION:				TESTING D	DATE:		11/01/	2019	
Weight After Washing (g)	306	37.0	g		n fine :	561.	0 g		
Weight Before Washing (g)	36	28.0	a	loss in fine	percentage .	189	6 g		
Sieve	Weight	%	%	Speci	fication	Cassola	numeration : Oran d	riad annula	
size (mm)	Retained		Passing				Sample preparation: Oven-dried san Method of sieving:		
50	0.0	0.0	100.0				Wetsieving	~	
37.5	153.0	4.2	95.8	9			Dry sieving		
26.5	380.0	10.5	85.3						
19	425.0	11.7	73.6			GRADING	MODULUS (GI	M) =	
13.2	434.0	12.0	61.6				2.4		
9.5	382.0	10.5	51.1			GRADING	COEFFICIENT	(GC) =	
6.7	423.0	11.7	39.4				19.9		
4.75	273.0	7.5	31.9						
2.00	321.0	8.8	23.1			3			
1.18	44.0	1.2	21.9						
0.6	30.0	0.8	21.0			0.			
0.425	12.0	0.3	20.7		-				
0.3	8.0	0.2	20.5			8			
0.15	72.0	2.0	18.5	-		1			
0.075	110.0	3.0	15.5						
Pan	561.0	15.5	0.0	<u> </u>					
100.0							,-		
90.0				-			1		
80.0	- Series1	-					,		
70.0	-						/		
E 60.0						/			
\$ 50.0						/			
Passes 50.0						/			
30.0									
20.0									
10.0									
2,555									
0.01	(	11	e).	eve Size, mm		10		100	
Remarks:			- Oil	o Le, mill					
Tested By: A.KASOKA		Checked B	y: S.T.PHIR	1		Approved B	v:		
. soled by . rethoorth		- Commission	Stationers.			223	,.		
A I		Date:11/01/	2019			Date			



			DADT	ICI E SI	ZE DISTR	IRLITION	13						
			PARI	ICLE SI	LE DISTR	NOTION	î.						
				AAS	HTO T-27								
SIDE:					SAMPLE N	0							
REPF STAT	RESENTATIVE ION:	KAMAI	NGA TP-3	1.5 m	SAMPLING	DATE:		03/01/2019					
LOCA	TION:				TESTING D	DATE:		11/01/2019					
Neigh	t After Washing (g)	320	0.00	g		n fine :	496.0	g					
Weigh	t Before Washing (g)	369	96.0	g	loss in fine	percentage :	16%	g					
	Sieve	Weight	%	%	Speci	fication	Sample pre par	ration : Oven-drie	ed sample				
	size (mm)	ze (mm) Retained (gm) Retain		Passing	Lower Limit	Upper Limit							
	50	0.0	0.0	100.0			4	Wetsieving	4				
	37.5	162.0	4.4	95.6				Dry sieving					
	26.5	362.0	9.8	85.8									
	19	502.0	13.6	72.2			GRADING MOD	Marine -	) =				
	13.2	450.0	12.2	60.1				2.5					
	9.5	391.0	10.6	49.5			GRADING COE	G COEFFICIENT (GC) =					
	6.7	433.0	11.7	37.8				19.6					
	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	_		1						
_	Pan	496.0	13.4	0.0			1						
1	100.0							,					
	90.0	- 1-1-1-1-1		111				1					
	80.0	- Series1					,						
	70.0	7 7 7 7 7	3 2		DR 1.70 A		/						
Bui	60.0						/						
% of Passing	50.0						,						
Jo e	40.0						1						
	30.0												
	20.0												
	10.0		W-17 S										
	0.0	70 000 G											
	0.01	C	1.1	ei,	eve Size, mm		10		100				
Rema	rke			Sil	re oize, mili								
veillid	ino.		(-2)										
	By: A.KASOKA	1	Checked B	y:S.T.PHIRI			Approved By:						



			RBERG LIMI					
		AASH	TO T-89 & T-					
SIDE			Random Sa		□ No			
LOCATION	KAMANGA 1			SAMPLE NO.	22.01	2010		
MATERIAL TYPE	REDDISH COA			DATE SAMPLED		/2019		
MATERIAL SOURCE	KAMANGA T	IP-1 1.3 m	DATE TESTED 11/01/2019					
MATERIAL DESRIPTION REPRESENTATIVE STATI	ONI			SAMPLED BY TESTED BY				
SAMPLING DEPTH	JN			TEST NO.				
SAMPLING DEPTH				TEST NO.				
		LIQUID L	IMIT	1				
Container No.		LIQUID	C6	T 1	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				
35.00				)				
34.00				s	ample preparation	(0		
33.00				As received				
32.00				Washed on 0.425mms				
31.00				Air dried at				
\$ 30.00				Oven dried at	- teach			
29.00				Proportion retained on 0.4	College Control Control Control			
28.00				Proportion retained on 0.4	Zomm sieve			
26.00								
28.00 Up 28.								
24.00					Test Result			
23.00		1		Liquid Limit	28.30 %			
22.00				Plastic Limit	14.49 %			
21.00				Plasticity Index	13.8 %			
20.00 6 5	10 15	20 25	30 35					
Į.	No of I	Blows		Shrinkege =	11.0 mm			
				Shrinkege =	7.3 %			
		PLA	ASTIC LIMIT	- 51 - 12		63211		
Container No.			17	13		Average		
Wt of wet soil + container, gm		10	20.16	21.52				
Wt of dry soil + container, gm			19.30	20.85	ajj			
Wt of water		1	0.86	0.67	240			
Wt of container		5.	13.40	16.20	i D			
Wt of dry soil, gm		i i	5.90	4.65				
Water content, %			14.58	14.41		14.49		
Remarks:				200				
Tested By: A. KASOKA		Checked By:	By:S.T.PHIRI Approved By:					
		Date:11/01/2	019	Date				



						TE												
	-			- 10	AAS	SHI	0				_							
SIDE						-		F	land	lom :	Sam		Yes		$\perp$	No		L
LOCATION	_		NGA TE		1.1 m	-		_					AMPLE NO			00/04/00	40	
MATERIAL TYP		REDDIS											ESAMPLE	_		03/01/20		
MATERIAL SOU		KAMA	NGA TI		1.1 m	8		_					TE TESTEL		_	11/01/20	119	_
MATERIAL DES		2				$\rightarrow$							AMPLED BY					_
REPRESENTAT SAMPLING DEF		2				-	TESTED BY TEST NO.							_				
SAMPLING DEP	10					+							TEST NO	1				
				1.10	QUIE	211	міт											
Container No.					ZOIL	1			11			1	35	1 3	38	1	1	
Wt of wet soil + co	ontainer, gm					7			28.6	4		9	26.2		.21		2	
Wt of dry soil + co						$\pm$	25.57					1	24.22	_	2.76	1	1	
Wt of water	3								3.07				1.98	1	45	1		_
Wt of container								_	14.3				16.34	1000	.40	1		_
Wt of dry soil, gm							_		11.1			1		7.88 6.36				_
Water content, %						+	_		27.4			7	25.13	7.000	22.80 33			
No. of blows						+		_	18			7	25	_				
												ele:	7935		-5-	-	•	_
2.00		11111	1111		ш			TT	TT	ш	1							
31.00		++++	₩	+	₩	н	+	+	H	+				Sample	prep	paration		_
20,00		+++	₩	#	₩	₩	+	+	+	Н		As re	oeived					
29.00			ш		Ħŧ	H	+	Ħ	H	Н			ed on 0.425mr	nsieve		Ħ		
28.00	+++++	+++	Ш	#	₩	H	+	+	H	H			ied at			Ħ		
\$ 27.00	8 2.00		H	#	+	Ħ	$^{+}$			dried at			H					
# ×.00		+++	₩		7	Н	+	+	H	H	Proportion retained on 0.425mm sieve							
E 25.00		****	###		Ħ		$\blacksquare$	+	H	Н		Fidpo	reon retained on	Trade of C. Ester Services				
2 24.00 H		+++	+		+	$\blacksquare$	1	$\forall$	#	H		-						_
Water Content, % 200 200 200 200 200 200 200 200 200 2		++++	++++		+	H	+	H	7	+								
22.00		++++	ш		ĦĦ	H	$\pm$	+	Ħ	H				To	st Res	endf		_
21.00			Ш		ĦĦ	Ħ	Ħ	Ħ	Ħ	Ħ		Lioude	Limit			20 %		_
20.00			###		Ħ			Ħ	Ħ	Ħ			c Limit			00 %		_
19.00			1111		Ħŧ	Ħ		Ħ	Ħ	П			Control (		_	WP %		_
18.00	6	10	15	20		25		30		3	5	3	city Index		-	NF 70		_
			No of B	lows								S	hrinkege =		0.	.0 mm		
												S	hrinkege =		0	.0 %		
					F	PLA	\ST	ГІС	LI	MI.	Г			NA.			59	
Container No.												7				1	Aver	age
Wt of wet soil + co	ontainer, gm																	
Wt of dry soil + co	ntainer, gm					- 1						4		1			11	
Wt of water														0			]	
Wt of container												200						
Wt of dry soil, gm	1											2					18	
Water content, %																		
Remarks:												7			_			_
Tested By: A.KASOKA Checked E					By:	S.T.	PHI	RI			Approved By:							
				Det	to: 44	10112	010				Data							
				Dat	te: 11/	0 1/2	019	5				Date			_			_
							_	_										_



						200			
			ATTI	ERBE	RG LIMI	T			
			AASH	TO T-	89 & T-	90			
SIDE		9	3	8	Random Sa	mple Yes	П	Vo	
LOCA	TION	KAMANGA TI	2-3 1.5 m	ž.		SAMPLE NO.			
MATE	RIAL TYPE	COARSE	GRAVEL	Š		DATE SAMPLED		/01/201	
MATE	RIAL SOURCE	KAMANGA TI	P-3 1.5 m			DATE TESTED	11	/01/201	9
	RIAL DESRIPTION			6		SAMPLED BY			
REPR	ESENTATIVE STATION					TESTED BY			
SAMP	LING DEPTH	J.				TEST NO.			
ų.									
y.		12							
			LIQUID	LIMIT		· · · · · · · · · · · · · · · · · · ·	- XX	- 122	
Contai	ner No.			it.	F-23	RR-5	Y-47		
Wt of v	vet soil + container, gm				27.84	27.62	28.55		
Wt of o	dry soil + container, gm			9	24.90	25.24	26.01	- 8	
Wt of v	vater			2	2.94	2.38	2.54	- 8	
Wt of c	container			2	14.49	16.28	15.74	- 8	
Wt of c	dry soil, gm				10.41	8.96	10.27		
Water	content, %		Ť	2	28.24	26.56	24.73	- 8	
No. of	blows		Ť	E	18	25	33	- 4	
				Ž.					
l f	32.00		ППП	ш		)			
	31.00						Sample prepara	tion	
	30.00					As received  Washed on 0.425mmsieve  Air dried at°C  Oven dried at°C  Proportion retained on 0.425mm sieve			
	29.00								
	28.00								
%	27.00	•							
Water Content,	26.00								
l o	25.00					LANGE CONTRACTOR OF THE PARTY O			
er C	24.00					P			
Nat	23.00								
20	22.00						Test Result		
	21.00					Liquid Limit	26.60	%	
	20,00		•			Plastic Limit	19.35		
	18.00					Plasticity Index	7.2 0		
	0 5	10 15	20 25	3	0 35		405.0		
		No of B	lows			Shrinkege =	6.0 r	nm	
						Shrinkege =	4.0 %	%	
			DI	ASTI	LIMIT		55000	780	
Carte	nee No.		EL	AUTI		114 1	F	1	Augman
Contai	100000			0.	V-66	H-1			Average
	vet soil + container, gm			0.	27.11	25.68	9	- 4	
Charles to the same	dry soil + container, gm			0.	25.20	24.00	-		
Wt of v	2.1554.00			0.	1.91	1.68	2		
	container			2	15.42	15.24			
	dry soil, gm				9.78	8.76	-	-	
Water	content, %				19.53	19.18	98	57	19.35
Davis	ardi a i								
Rema			Ž.		0000000011/				
Teste	d By: A.KASOKA		Checked B	y:S.T.PF	IIRI	Approved By:			
8			Date:11/01/	2019		Date			
0									



	DETERMINAT	ION	OF MOD	IFIED PF	ROCTOR	COMPA	CTION			
		(TMH	1 MATHO	DD A7,AA	<b>SHTO 18</b>	(0)				
SIDE	0				Random Sa	imple Yes		No		
LOCATION		10001111			39	SAMPLE NO.				
MATERIAL TYPE	W	Grav		DATE SAMPLED				A THE RESIDENCE OF THE PARTY OF		
MATERIAL SOURCE	KAM	ANGA TE	2-1 1.3 m		DATE TESTED 10/01/2019					
MATERIAL DESRIPTION	100 000 000 000 000	A STATE OF THE STA	DARSE GRAVEL			SAMPLED BY				
REPRESENTATIVE STAT	1 KAM	ANGA TE	2-1 1.3 m		-33	TESTED BY				
SAMPLING DEPTH						TEST NO.				
No. of blows :	55+1					Weight of	hammer,kg	4.5	<u>.83</u>	
No. of layers :	5						of mold,cm <sup>3</sup> :	2374	30	
Proportion retained on 19m ( pass 50mm sieve and ret		)	ā	-63		nple / <u>Separat</u> Apparent spe				
	Mold		No	M 4	M 4	M 4	M 4	M 4		
Α.	WATER		No.	2	4	6	1000	2000	8:	
A B	Wt. of Mold + Wet S	oil	57,000,000	8872	9217	9518	9381	10 9187	33	
C	A STANCE SYSTEM	UII	grams	- CONTRACTOR	0 1923/25 1	5 THE RESERVE OF		- 100000	9	
15655	Wt. of Mold		grams	4085	4085	4085	4085	4085	9	
D	Wt. Wet Soil		grams	4787	5132	5433	5296	5102	Th.	
E	Volume of Mold		cm3	2374	2374	2374	2374	2374	72	
F	Wet Density		g/cm3	2.016	2.162	2.289	2.231	2.149	93	
G	Container		No.	E-2	B-11	M-7	V-5	Y-8	i i	
Н	Wt. Cont + Wet soil		grams	729.0	768.0	772.0	789.0	758.0	27	
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		
i.	Weight of Dry Soil		grams	472.0	504.0	500.0	493.0	459.0		
-	Troight of Dily Con		granio	372.0	004.0	000,0	400,0	700.0	00	
М	Moisture Content		%	2.1	4.0	6.2	8.3	10.2	8	
N	Dry Density		g/cm3	1.975	2.079	2.155	2.060	1.949	8	
	18 ( <u>2.2.5.</u> )									
Maximum Dry Density (M	IDD):	2.1	70							
				4					100 mg	
MDD =	2.155 g/cm3	0 21	20							
		oolg, glood					$\overline{}$			
Optimum Moisture Conte	ent (OMC) :	and or	70		/					
		b vio								
OMC =	6.2 %		20				$++\lambda$			
		2.0	20							
				/						
		1.5	70							
								*	10 10 10 10	
		1.5	20 1 2	3	4 5	6 7	8	9 10	11	
			1	3	* 3	9		9 10	30	
					Moi	sture content,%				
Remarks:										
Tested By: A.KASOKA	Checked	By: W.M	IUMBA			Approved By	r:			
	Date: 10	/01/2019				Date				



	DETERMINATION	ON C	F MODI	FIED PF	ROCTOR	COMPA	CTION		
					SHTO 18				
SIDE LOCATION MATERIAL TYPE MATERIAL SOURCE MATERIAL DESRIPTION REPRESENTATIVE STATI	KAMAN REDDISH	Grave GA TP- COAR			Random Sa S DAT DA	The state of the s		No 03/01/2019 10/01/2019	
No. of blows ; No. of layers : Proportion retained on 19m ( pass 50mm sieve and ret		2		22		Weight of		2374	
0	Mold	- 3	No.	M 4	M 4	M 4	M 4	M 4	Ŷ î
A	WATER	- 50	%	1	3	5	7	9	Î
В	Wt. of Mold + Wet Soil		grams	8762	9078	9322	9243	9070	Î
С	Wt. of Mold		grams	4085	4085	4085	4085	4085	Î
D	Wt. Wet Soil		grams	4677	4993	5237	5158	4985	Î
Е	Volume of Mold		cm3	2374	2374	2374	2374	2374	Î
F	Wet Density		g/cm3	1.970	2.103	2.206	2.173	2.100	
5*12	T	- 1		0;	22 8			20	
G	Container		No.	M-2	J-3	M-10	G-7	A-1	
Н	Wt. Cont + Wet soil	- 4	grams	754.0	778.0	731.0	763.0	794.0	4
	Wt. Cont + Dry soil	- 2	grams	748.0	762.0	708.0	730.0	749.0	4
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	3	grams	504.0	514.0	457.0	480.0	502.0	8 8
1000			- 25	8.5	1772788	7/2/25	10.000	8/2	
M	Moisture Content	- 8	%	1.2	3.1	5.0	6.9	9.0	0 0
N	Dry Density		g/cm3	1.947	2.040	2.100	2.033	1.927	
Maximum Dry Density (M  MDD =  Optimum Moisture Conte  OMC =	2.100 g/cm3	2.12 0000 2.07 2.02 1.97	0	\$	1 Main	5 6	7		
5									
Remarks:	Marine and the second	D 190000	1942-195 NO						
Tested By: A.KASOKA	y: T.S.F	PHRI							
	Date: 10/01	.20 10				Date			



	DETERMINATI	ON O	F MOD	IFIED PR	ROCTOR	COMPA	CTION			
		TMH 1	MATHO	D A7,AA	SHTO 18	0)				
SIDE LOCATION					Random Sa			No		
MATERIAL TYPE	7 <u>6.</u>	Gravel	ý.		DATE SAMPLED 03/01/2019					
MATERIAL SOURCE	KAMAN	Contract Contract Contract	3 1.5 m			TE TESTED		11/01/2019		
MATERIAL DESRIPTION		ARSE GE	21111040215		- CO.	AMPLED BY		1110110010	i i	
REPRESENTATIVE STAT	The state of the s	No. of Control of Control	3 1.5 m		TESTED BY					
SAMPLING DEPTH	300					TEST NO.				
No, of blows :	55+1					Weight of I	nammer,kg	: 4.5		
No. of layers : Proportion retained on 19m ( pass 50mm sieve and ret		(( <del>)</del>		29		Volume on nple / Separat Apparent spe				
	Mold	- 3	No.	M 44	M 44	M 44	M 44	M 44		
A	WATER	8	%	2	4	6	8	10	8	
В	Wt. of Mold + Wet Soil	1	grams	8773	9106	9320	9286	9062	8	
С	Wt. of Mold	- 0	grams	4087	4087	4087	4087	4087		
D	Wt. Wet Soil	- 0	grams	4686	5019	5233	5199	4975		
E	Volume of Mold		cm3	2345	2345	2345	2345	2345	i i	
F	Wet Density	- 1	g/cm3	1.998	2.140	2.232	2.217	2.122		
	To contract	700	NI.	14.40	140		10	0.7	/ <del>4</del>	
G	Container	- 4	No.	M-10	M-2	A-1	J-3	G-7		
H	Wt. Cont + Wet soil	- 4	grams	761.0	779.0	756.0	788.0	774.0		
I I	Wt. Cont + Dry soil	- 4	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	9	grams	500.0	514.0	480.0	501.0	476.0		
М	Moisture Content		%	2.0	4.1	6.0	7.8	10.1	i i	
N	Dry Density	e e	g/cm3	1.959	2.056	2.104	2.057	1.927	8	
Maximum Dry Density (M  MDD =  Optimum Moisture Conte	2.104 a/cm3	2.120 2.070 2.070 2.020								
OMC =	6.0 %	1,970 1,920			4 5	6 7		9 10	11	
						sture content%	308.74		٦	
Remarks:										
Tested By: A.KASOKA	Checked E	By:S.T.PF	IIRI		1	Approved By			12	
	Date: 11/01		-4.86			Date	ned.			



			CALIFO	RNIAR	EARING RA	TIO			
					D T 193	(IIO			
SAMPLE STATION	- 1	KAMANGA	TP-1 1.3 i	O'SPINE DO THOU	Random Sam	ple Yes		No	
LOCATION	(E		on place			SAMPLE NO.			EST-SIC
MATERIAL TYPE	R	EDDISH CO	ARSE GRA	VEL	-27) 2V-3420	E SAMPLED		03/01/2019	
MATERIAL SOURCE	2		TP-1 1.3 i		- 13 / - 1/ / ·	ATE TESTED	*	11/01/2019	
MATERIAL DESRIPTION	-		ravel		<b>-</b> 25	AMPLED BY		1110112010	
REPRESENTATIVE STA			A TP-1 1.3	m	-9	TESTED BY			
SAMPLING DEPTH	TION	IVAINAINO	A 11-1 1.0		-10	TEST NO.	100		
SAMPLING DEF III			DEN	ISITY DET	ERMINATION	TEST NO.			
SOAKING CONDITION					ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg
			,		Before		efore	0	efore
MOLD NUMBER WEIGHT OF SOIL + MO	ID a				M-04 9548		1-30 209		1-43 016
WEIGHT OF MOLD, g	LD, g				4085	100	081		115
WEIGHT OF SOIL, g			Ÿ		5463	- 1	128	The state of the s	901
VOLUME OF MOLD, g	- 4				2374		349		374
WET DENSITY OF SOIL DRY DENSITY OF SOIL	g/cm°				2.301		183 060		064 948
DRY DENSITY OF SOIL	, g/cm		MOIS	TUDE DE	TERMINATION	6.	000	I.	740
(			MOIS	Control of the Contro	ayer Blows (4,5kg)	25 by 5 layer	e Blowe (4 5kg)	55 by 3 layer	e Blowe (2 5kg
SOAKING CONDITION					Before			The state of the s	efore
3				9		8	efore	Be	этоге
CONTAINER NUMBER	0 -				M-70		M-3	λ.	
WET SOIL + CONTAINE DRY SOIL + CONTAINER					848 815		812 780	8	
WEIGHT OF CONTAINE	R. a				253		252	0.	
WEIGHT OF WATER, a	1000000			Ĺ	33	8	32		
WEIGHT OF DRY SOIL,	g		,		562		528	X.	
MOISTURE CONTENT	RE CONTE	NT AV=			5.9		.0		
WOISTO	NE CONTE	NI AV-	DEVIE			0	.0		
	DENETRAT	ION DATE		15/01/20	BOTTOM TEST		ING FACTOR		0.00
		5 Layer Blo			y 5 layers Blows		55 by 3	layers Blows	
PENETRATION (mm)	Dial	and the same		Dial	P. Sammerana	PSS. 3835	Vancous Control Vices	200	Walter Share Share to warm
	reading	Load (KN)	C.B.R(%)	reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00			0.00			0.00	111
0.64 1.27	48 - 8	2.18 3.86	- 3		1.28 2.49	8	5	1.00	ÿ.
1.91	*	5.26	-		4.22		V	3.05	
2.54		7.20	54.0		5.64	42.3		4.48	33.6
3.18		8.48			6.78			5.56	6
3.81 4.45		10.67			8.02 9.59			6.47 7.54	
5.08	1	14.55	72.8		10.75	53.8		8.51	42.6
5.72		16.50	7 2010		11.63	00.0		9.64	72.0
6.35	- 0. 9	18.01	,		12.93		и -	10.32	Į.
6.99		20.53			13.85			11.00	
7.62 8.26	1	22.39 24.35	- 3		15.14 16.29			11.42 12.06	
8.89	1 0	26.19			17.84			12.40	Ü
9.55	- N	27.50	,		18.81	H. 2000	G 20110C -	12.85	cy 20019g
						Blows	55	25	55
Soaking Date	SWE	:LL			rammar Initial reading (n	200)	4,5kg by 5	4,5kg by 5	2,5kg by 3
Time	- 5				Final reading (n		N i	N .	G.
/ Anton		ž.			Height of specin	men (mm)			8
					Percent Swell	(%)			
Remarks:									
Tested By: A,KASOKA	Δ .	Checked	By: S.T.PH	IIRI		Approved	Bv:		
	•	Jilounou	_j. J. I.			. ipp.orou	-1.		
		Date: 11/0	1/2010			Date			
		Date. 11/0	31/2019			Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	<u> </u>			8
			AASHT	O T 19	3				
SAMPLE STATION	K	AMANGA TP				n Sample	YES	□NO [	
LOCATION	K	AMANGA TP	2-1 1.3 m	76	SAMPLE NO. DATE SAMPLED		03/01/201		Access 5
MATERIAL TYPE	RED	DISHCOAR	RSE GRAVEL	1					THE PERSON NAMED IN
MATERIAL SOURCE	86	0	7		DATE TE	Control of the Contro	· ·	15/01/201	19
MATERIAL DESRIPTION REPRESENTATIVE STATION	( <del>)</del>	Grave	el		SAMPLE		\$ <del>}</del>		-
SAMPLING DEPTH	( <del>)</del>			<del>- 9</del> 8	TEST NO		8 <del>7</del>		
	( <del>)</del>	ec .		<del></del> %			- ST		
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96 hours	Swell %	Average % Swell	Standard Lo	
M.D.D (gm/cm <sup>3</sup> )		202000-00-00-00		***	1 Contract		7.569CU50	2.54 mm	5.08 mm
2.155	55 by 5	5.9	2.172	54.0	0.0	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		13.24	20.00
26.0 24.0 22.0 20.0 38.0 36.0 34.0 12.0 10.0 8.0 6.0 4.0 2.0 0.00 1.27 2.54 3.81 PENETE	5.08 6.35 710N(ms)	7.62 8.	89	2.200 2.200 2.200 2.000 1.800 1.700 1.600 30.0	35.0	40.0	45.0		MUE AT 95% 55.0
CBR Value		2022 WALLS	6	Sewon	R Value at 90%			33	
CBR Value	at 95% MD	D = 2.04	7	CBF	R Value at 95%	from the grap	oh =	4:	2.2
CBR Value	at 98% MD	D = 2.11:	2	CBR	Value at 98%	from the grap	h =	4	7.5
Comments:			3						
Checked By:			100000	ED BYy:	19				
				Date:			1		
Test Results Within	Engineering l	.imits:	8	Yes	No	Ш			



9			CALIEO	DNIA D	EARING RA	TIO			
					D T 193	MIO.			
SAMPLE STATION		KAMANGA	SURVEYAL STATES		Random Sam	ple Yes		No	П
LOCATION	8			500		SAMPLE NO.			57 56
MATERIAL TYPE	R	EDDISH CO	ARSE GRA	VEL	DAT	E SAMPLED	7	03/01/2019	N.
MATERIAL SOURCE	X .	KAMANGA	TP-2 1.1	m	100	ATE TESTED		11/01/2019	
MATERIAL DESRIPTION	30		avel		_	AMPLED BY	300		
REPRESENTATIVE STAT	ION		A TP-2 1.1	m	- 5	TESTED BY			
SAMPLING DEPTH		10 1110 1101	.,,		_	TEST NO.	7		
O WIII CHILO DEL TIT			DEI	NSITY DET	ERMINATION	1201110			
SOAKING CONDITION					ayer Blows (4,5kg)				
					Before	N. Company	efore	100000	efore
MOLD NUMBER WEIGHT OF SOIL + MOL	Da				M-32 9287		M-1 0039	- F	1-37 744
WEIGHT OF MOLD, g	, 9				4116	100	105		107
WEIGHT OF SOIL, g				N .	5171		1934		637
VOLUME OF MOLD, g	-/3				2343	1.0	.094		337 984
WET DENSITY OF SOIL, DRY DENSITY OF SOIL.					2.104	_	.996		891
DICT DENSITT OF SOIL	Q/GII		MOIS	-	TERMINATION		.,,,,		001
O Security seems with an interest in the contract of the contr					ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION					Before		efore	Water States	efore
CONTAINER NUMBER					M-34	8	4-68		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
WET SOIL + CONTAINER	R a				854	S (3)	857	3	
DRY SOIL + CONTAINER	g				825	100	829	9	
WEIGHT OF CONTAINER	R, g				242	8	251		
WEIGHT OF WATER, g WEIGHT OF DRY SOIL,					29 583	8	28 578	É	
MOISTURE CONTENT	4			V.	5.0		4.8	3	
MOISTUR	E CONTE	NT AV=		8	3.00		.9	2.0	
			PENE	TRATION E	BOTTOM TEST				
Р	200100000000000000000000000000000000000	ION DATE	50000 D	15/01/20			RING FACTOR		.00
DENETRATION ()	-	5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	(2,5kg)
PENETRATION (mm)	Dial	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00	reading	0.00		reduing	0.00			0.00	1
0.64	8	2.20		8	1.80	3	8	1.10	3
1.27	2 9	3.92		ų į	2.48	C.		1.87	av.
1.91	8 8	5.55 7.16	53.7		3.67 5.21	39.1		2.68 3.70	27.7
3.18		9.78	00.1		6.79	00.1		4.26	
3.81		12.35		N /	8.30		8	4.76	7
4.45 5.08	8 8	15.28 17.42	87.1		10.58	63.7	8	5.20 5.67	28.4
5.72	8 8	20.31	07.1	9	15.01	03.7	8	6.02	20.4
6.35		22.82			17.06			6.45	
6.99		24.37			19.18			7.10	
7.62 8.26		25.78 27.42			21.15 22.94			7.58 8.18	¥
8.89	3 3	28.64			24.19		Ē	8.69	9
9.55	8 8	29.44			25.86	V5 7.5009	K Roome	9.06	
S. SAGARAGO					Telegraphic Communication of the Communication of t	Blows	55	25	55
Soaking Date	SWE	LL			rammar Initial reading (n		4,5kg by 5	4,5kg by 5	2,5kg by 3
Time	- E			-	Final reading (n		0	5	ii.
8	- 3				Height of specia	men (mm)		8	8
					Percent Swell	%)			
Remarks:									
Tested By: W.MUMBA	i i	Checked	By: S.T.PI	HIRI		Approved	Ву:		
9		Date:11/0	1/2019			Date			



2		041.150	201114 0	E 4 DIA	IO DATI	•			
ļ.		CALIFO			IG RATIO	<u> </u>			
SAMPLE STATION	V	AMANGA TP	AASHT(	) T 19		n Sample	YES	NO F	_
LOCATION		AMANGA TP		-33	SAMPLE	entire ill	IES	LINO	-
MATERIAL TYPE			SE GRAVEL	<del>-</del> 83	DATE SA			03/01/20	19
MATERIAL SOURCE				DATE TESTED			36	15/01/201	9
MATERIAL DESRIPTION		Grave	ravel		SAMPLE	D BY	55		- 20 90
REPRESENTATIVE STATION				<u>-</u> 80	TESTED		W		
SAMPLING DEPTH	×-			<u>-9</u> 9	TEST NO	<b>D</b> .	10		- 96
4					0/34:-		ř		72
- 100	Number of	% Moisture	Dry Density	CBR	% Moisture after 96	Swell %	Average %	Standard Lo	ad (KN)
M.D.D (gm/cm <sup>3</sup> )	blows	before soak	Dij Denskj	%	hours	3,104,70	Swell	2.54 mm	5.08 mm
2.100	55 by 5	5.0	2.104	53.7	0.0	0.00		13.24	20.00
O.M.C. %	30 by 5	4.8	1.996	39.1	0.0	0.00	0.00	13.24	20.00
5.0	5.0 55 by 3 0.0					0.00		13.24	20.00
32.0 30.0 28.0 26.0 24.0 22.0 30.0	TION CURV BOT		Solven and and	2.200 2.100 2.000 1.900 1.800 1.700 1.600 25.0	30.0	35.0 40.0 S	0 45.0 aaked CBR %		MUE AT 5%
CBR Value	at 90% MD	D = 1.890	)	CBR	R Value at 90%	from the gra	ph =	27.	6
CBR Value		Berry However		CBF	R Value at 95%	from the gra	ph =	39	0.0
CBR Value	at 98% MD	D = 2.058	3	CBR	Value at 98% i	from the grap	h =	47	7.5
Comments:									160
Checked By:				ED BYy:	16				1
				Date:					
Test Results Within	Engineering I	imits;		Yes	No				



<u> </u>					EARING RA	TIO				
				AASHT	D T 193	4 <del>4.00</del> .001.				
SAMPLE STATION		KAMANGA	TP-3 1.5	m	Random San	ple Yes		No		
LOCATION	**					SAMPLE NO.			,	
MATERIAL TYPE	MA.	COARS	E GRAVEL		DAT	E SAMPLED	Y .	03/01/2019	C.	
MATERIAL SOURCE	W1	KAMANGA	TP-3 1.5	m DATE TESTED				12/01/2019		
MATERIAL DESRIPTION		G	ravel		S	AMPLED BY				
REPRESENTATIVE STAT	ION	KAMANG	A TP-3 1.5	5 m		TESTED BY				
SAMPLING DEPTH			0.500			TEST NO.	111			
- Province on the control of the control of the control of			DEI		ERMINATION	Teer as		I e e e e e		
SOAKING CONDITION					ayer Blows (4,5kg Before		s Blows (4,5kg) efore		s Blows (2,5kg) efore	
MOLD NUMBER					CC-5		C-6	A	C-8	
WEIGHT OF SOIL + MO	LD, g				10028		926	190	426	
WEIGHT OF MOLD, g					4840	- 7	030	100	804	
WEIGHT OF SOIL, g VOLUME OF MOLD, g					5188 2314		896 303		622 307	
WET DENSITY OF SOIL	g/cm <sup>3</sup>				2.242	17	126	A COLUMN	003	
DRY DENSITY OF SOIL	g/cm <sup>3</sup>				2.113	11	004		889	
			MOIS		TERMINATION					
				55+1 by 5 L	ayer Blows (4,5kg	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)	
SOAKING CONDITION					Before	Be	efore	Be	efore	
CONTAINER NUMBER					F-74	k	C-11			
WET SOIL + CONTAINE	R, g				772		780	V.		
DRY SOIL + CONTAINER					742		749			
WEIGHT OF CONTAINE					241		247			
WEIGHT OF WATER, g WEIGHT OF DRY SOIL,	0				30 501		31 502	5		
MOISTURE CONTENT	9			-	6.0		6.2	V.		
MOISTUR	RE CONTE	NT AV=		Ž.		6	.1	S.		
			PENE	TRATION E	BOTTOM TEST					
P		ION DATE		16/01/20			RING FACTOR		.00	
DELETE ( TOU ( )		5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	(2,5kg)	
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)	
0.00 0.64		0.00 2.37			0.00 1.97			0.00	111	
1.27		4.06			2.92			1.78		
1.91	Ť i	6.27			4.16			2.87		
2.54		8.02	60.1		5.76	43.2		3.86	28.9	
3.18 3.81		10.28			7.47 8.96	7		4.47		
4.45		15.47			10.87	2	6	5.32	8	
5.08		18.32	91.6		12.64	63.2		5.84	29.2	
5.72		21.34			14.20	3		6.14	8	
6.35		23.87			16.08	9		6.47	S	
6.99 7.62		25.69 27.48			18.12 20.16			7.18 7.69		
8.26		29.72			21.86			8.28		
8.89		31.14			22.89	S		8.47	) }	
9.55		32.62			23.67		0 2018	8.88	g 2005	
10	SWE	11			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3	
Soaking Date	3445				Initial reading (r	nm)	4,ong by 5	-t, ong by 5	2,5kg by 5	
Time	- 0				Final reading (n	nm)	W.	N .		
7	- 0	Ż			Height of speci				ß	
Remarks:					Percent Swell	(%)	110	6	i.e	
Tested By: W.MUMBA		Checked	By:S.T.PH	IIRI		Approved	Ву:			
u.		Date:12/0	1/2019	Date						



			CALIEO	DNIA DI	EARING RA	TIO			
				AASHTO		<del>(110</del>			
SAMPLE STATION	10	KAMANGA	TP-3 1.5	m	Random Sam	ple Yes	П	No	
LOCATION	0			1997.		SAMPLE NO.			A8005
MATERIAL TYPE		COARS	E GRAVEL	2	DAT	E SAMPLED	\$ - T	03/01/2019	
MATERIAL SOURCE	0	KAMANGA	TP-3 1.5	m	D/	ATE TESTED	4	12/01/2019	
MATERIAL DESRIPTION	*	COLUMN TWO DOLLS	avel	110	-	AMPLED BY	<del>).</del>		
REPRESENTATIVE STAT	ION	Contract Con	A TP-3 1.5	m	-0	TESTED BY			
SAMPLING DEPTH		14 111 1101			-8	TEST NO.			
Ortin Ento DEI III			DEN	NSITY DET	ERMINATION	TEO I NO.			
SOAKING CONDITION					ayer Blows (4,5kg)				
MOLD NUMBER					Before	and the second second	efore	77.0	efore
WEIGHT OF SOIL + MOL	Da				CC-5 10028	40	C-6 926		C-8 426
WEIGHT OF MOLD, g	.D, 9		-		4840	- N	030		804
WEIGHT OF SOIL, g					5188		896		622
VOLUME OF MOLD, g					2314	0.0	303	0.000	307
WET DENSITY OF SOIL, DRY DENSITY OF SOIL.	g/cm <sup>3</sup>				2.242 2.113		126 004		003 889
DRT DENSITT OF SOIL.	gran		MOIS		TERMINATION	4.	004	, de	003
			more		ayer Blows (4,5kg)	25 by 5 layer	s Blows (4.5kg)	55 by 3 layer	s Blows (2.5kg)
SOAKING CONDITION					Before	ALTERNATION OF THE PARTY OF THE	efore		efore
						A	A STATE OF	De	elole
CONTAINER NUMBER WET SOIL + CONTAINER	2 0				F-74 772		780		
DRY SOIL + CONTAINER				1	742		749		
WEIGHT OF CONTAINER					241	0.5	247		
WEIGHT OF WATER, g					30		31		
WEIGHT OF DRY SOIL, O	9				501		502		
MOISTURE CONTENT	E CONTE	NT AV=	-	5	6.0		5.2		
moloro.	LOOME		DENE	TDATION E	SOTTOM TEST				
P	ENETRAT	ION DATE	PENE	16/01/20		R	ING FACTOR	0	.00
200		5 Layer Blo	ws (4,5kg)		y 5 layers Blows			layers Blows	
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00	AND CONTRACTOR	0.00		. maogranaco	0.00		·	0.00	
0.64 1.27		2.37 4.06			1.97 2.92		1	0.96 1.78	8
1.91	. 8	6.27			4.16		. 3	2.87	8
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 5.08	- 1	15.47 18.32	91.6		10.87	63.2	- 9	5.32 5.84	29.2
5.72		21.34	51.0		14.20	00.2		6.14	20.2
6.35		23.87			16.08			6.47	
6.99	. 8	25.69	3		18.12			7.18	
7.62 8.26	- 1	27.48 29.72	<del>ii</del>		20.16 21.86	· ·		7.69 8.28	
8.89		31.14			22.89			8.47	
9.55	Ĭ	32.62	1		23.67		27.00.00	8.88	4
3000		- 112141			(A)	Blows	55	25	55
Soaking Date	SWE	LL			rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3
Time					Initial reading (n Final reading (n		7		
1,012					Height of speci				
					Percent Swell	(%)	· //		
Remarks:									
Tested By: W.MUMBA		Checked	By:S.T.PH	IRI		Approved	Ву:		
	-	Date:12/0	1/2019			Date			



#### SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consultants	(Nkoloma)	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Rehal	oilitation	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 SYS-TEMS MUST BE EMPLOYED FOR EFFECTIVE EARTH CONDUCTIVITY



**Chawama Site and Lab Results** 



### STANDARD PENETRATION TEST (SPT) RESULTS

Client: G	OPA-ITEC Inter	national Energy		ocation: hawama	Date Tested: 04/01/19
Project: I	usaka Transm	ission and Distrib			Tested by: W. Mumba
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m2
		150	5		
1	1	300	4	8	80
		450	4		
		150	6		
2	1	300	8	15	210
		450	7		
	3	150	9		
3	1	300	8	16	210
		450	8		
		150	13		
4	1	300	11	23	280
	.2	450	12	8	
		150	9		
5	300		13	24	280
		450	11		



## DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA	-ITEC Int	Date Tested: 0	04/01/19				
Project: Lusa	ka Trans	Chawama n	Tested by: W. Mumba				
Test Pit N	lo. 1	it No. 3	Test Pit N	o. 1			
Penetration	Blows	Penetration	Blows	Penetration	Blows	Penetration	Blows
(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)	(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	80
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	8 3	6.9		6.9		6.9	
7.2		7.2		7.2		7.2	
7.5		7.5		7.5		7.5	1
7.8	8 3	7.8		7.8		7.8	
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	n-
8.7	8 8	8.7		8.7		8.7	
9.0		9.0		9.0		9.0	
9.3		9.3		9.3		9.3	
9.6	8 3	9.6		9.6		9.6	
9.9		9.9		9.9		9.9	



## DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA	-ITEC Int	ernational Ene	rgy Consu	Iltants Locati Kanya		Date Tested: 0	4/01/19	
Project: Lusa	ka Trans	Tested by: W. Mumba						
Test Pit N	lo. 5	Test Pit N	No. 6	Test Pit	No. 7	Test Pit No. 8		
Penetration (m)	Blows (No.)	Penetration (m)	Blows (No.)	Penetration Blows (m) (No.)		Penetration (m)	Blows (No.)	
0.3	15	0.3	()	0.3	1	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	i i	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	- 1	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	Î	9.9		9.9		9.9		



			PART	ICLE SIZ	ZE DISTR	IBUTION	İ	
8				AAS	HTO T-27		-	
SIDE:					SAMPLE N	0		
REPR	RESENTATIVE ION:	CHAWAM	A TP-1 1.	5 m (387)	SAMPLING	DATE:	è	06/01/2019
LOCA	TION:	0			TESTING D	DATE:		13/01/2019
Weigh	t After Washing (g)	187	75.0	9	loss in fine :		784.0	g
Weigh	t Before Washing (g)	265	59.0	a	loss in fine percentage		42%	g
	Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	0.000-0.000	of sleving:
7	50	0.0	0.0	100.0	0 3		v	Vet sieving ✓
	37.5	0.0	0.0	100.0			1	Ory sieving
	26.5	0.0	0.0	100.0			1	
	19	10.0	0.4	99.6			GRADING MOD	ULUS (GM) =
	13.2	0.0	0.0	99.6			27.	1.4
	9.5	0.0	0.0	99.6			GRADING COE	FFICIENT (GC) =
	6.7	0.0	0.0	99.6				27.9
	4.75	86.0	3.2	96.4				
	2.00	674.0	25.3	71.0			1	
	1.18	126.0	4.7	66.3			1	
	0.6	152.0	5.7	60.6			1	
	0.425	47.0	1.8	58.8			1	
	0.3	98.0	3.7	55.1			1	
	0.15	485.0	18.2	36.9			1	
	0.075	197.0	7.4	29.5			1	
	Pan	784.0	29.5	0.0	0		1	
	100.0	30 205007/00		20 50 2022	200	0 0 9 0		
	73/19/190	10 000-1000		20 M- 2000		1		I was something
	00000	te fototati	100			/		
		Series1	100			,		
	70.0	r remain	2:	6 0 668		0 0 0 00		
sing	60.0			,				
% of Passing	50.0		/			- 4 4		
o of	40.0		1					
8	30.0							
	20.0							
	10.0		100	++++				
	0.01		.1		1		10	100
				Sie	eve Size, mm			
Rema			12			0	202	
Tested	By: A.KASOKA		Checked B	y: T.S.PHIRI			Approved By:	
Date: 13/01/2019							Date	



			PART	ICLE SI	ZE DISTR	BUTION	D.	
				AAS	HTO T-27			
SIDE:					SAMPLE N	0	*	
REPF STAT	RESENTATIVE ION:	CHAW	AMA TP-2	1.5 m	SAMPLING	DATE:		06/01/2019
LOCA	TION:				TESTING D	DATE:		12/01/2019
Weigh	t After Washing (g)	246	88.0	g	- 100 March 1980	n fine :	334.0	g
Weigh	t Before Washing (g)	280	02.0	a	loss in fine	percentage	14%	g
	Sieve	Weight	%	%	Speci	fication	Sample pre par	ration : Oven-dried sample
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	to the state of th	ofsieving:
	50	0.0	0.0	100.0			,	Wet sieving ✓
	37.5	0.0	0.0	100.0				Dry sieving
	26.5	0.0	0.0	100.0				
	19	263.0	9.4	90.6			GRADING MOD	ULUS (GM) =
	13.2	183.0	6.5	84.1				2.0
	9.5	190.0	6.8	77.3	ļ		GRADING COE	FFICIENT (GC) =
	6.7	232.0	8.3	69.0				32.7
	4.75	217.0	7.7	61.3				
	2.00	409.0	14.6	46.7				
	1.18	66.0	2.4	44.3			e e	
	0.6	45.0	1.6	42.7			0	
	0.425	86.0	3.1	39.7			8	
	0.3	128.0	4.6	35.1			9	
	0.15	521.0	18.6	16.5			8	
	0.075	128.0	4.6	11.9			18	
	Pan	334.0	11.9	0.0			é	
1	100.0						/	
	90.0	+++++	1	70 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -	01000	- 0		<del></del>
	80.0	-Series1		76 (8 76)				
	70.0		į.	05 10 055				
Bui	60.0		<b>-</b>					
335	50.0	W- 12000 HI		<del></del>				
% of Passing	40.0							
%	30.0			,	grege :	1 89		
	20.0		1					
	10.0							
	2000			1 1	io (Cloren Y		P-107	A4
	0.01	(	1	10 U C.1	1	o no bond	10	100
	18700020			Si	eve Size, mm			
Rema								
Tested	By: A.KASOKA		Checked B	y: T.S.PHIR	l		Approved By:	
			Date: 12/01	/2019			Date	



Ö											
				PART	ICLE SI	ZE DISTR	BUTION	I			
					AAS	HTO T-27					
SIDE	i:		8			SAMPLE N	0				
	RESE	NTATIVE	CHAW	AMA TP-3	1.5 m	SAMPLING	DATE:		06/01/2019		
LOC	ATION	V:			**	TESTING D	DATE:	12 81	12/01/2019		
Weigl	ht Afte	r Washing (g)	179	91.0	g		n fine :	271.0	g		
Weigl	ht Befo	re Washing (g)	206	32.0	g	loss in fine	percentage :	15%	g		
		Sieve	Weight	%	%	Speci	fication	Sample pre pa	ration : Oven-dried sample	8	
	siz	e (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	Metho	d ofsieving:		
		50	0.0	0.0	100.0			4	Wet sieving ✓	l	
	- 9	37.5	0.0	0.0	100.0			19	Dry sieving		
	- 3	26.5	21.0	1.0	99.0						
		19	19.0	0.9	98.1	-		GRADING MOD	OULUS (GM) =		
	- 19	13.2	34.0	1.6	96.4				1.3		
Č.		9.5	24.0	1.2	95.2			GRADING COE	FFICIENT (GC) =		
		6.7	23.0	1.1	94.1				11.6		
8	- 5	4.75	34.0	1.6	92.5	6		-			
		2.00	125.0	6.1	86.4			-			
-	100	1.18	75.0	3.6	82.8			1			
		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	X.	-	-			
		0.075	175.0	8.5	13.1			1			
		Pan	271.0	13.1	0.0			]			
	100.0			ř I	7-7-7-7-7-			=			
	90.0			0. 02					<del></del>		
	80.0		- Series1	£ 8							
	70.0		3611631	2	/				<u> </u>		
Bu	60.0			v v.	,	14.000					
3551	50.0			,	9.0						
% of Passing	40.0					21			s 22 - 50 - 50 0 5 0 0 0 0 0		
%				,		8888					
	30.0			,							
	10.0		1   1-								
	0.0										
1	0	.01		2.1	Sie	1 eve Size, mm		10	100		
Rema	arke.					was mult					
A CORPORT A PR	2000	A. KASOKA		Checked B	y: T.S.PHIR	ı		Approved By:			
				- CO. 1-8-V-5.				Date			
				Date: 12/01	12019			Date			



		PART	ICLE SI	ZE DISTR	IBUTION	Ř				
			AAS	HTO T-27						
SIDE:				SAMPLE N	0					
REPRESENTATIVE STATION:	CHAW	AMA TP-4	1.5 m	SAMPLING	DATE:		06/0	1/2019		
LOCATION:				TESTING D	ATE:	100	11/0	1/2019		
Weight After Washing (g)	188	30.0	g	0.0258055000	fine :	344.0	) g			
Weight Before Washing (g)	22	24.0	a	loss in fine	percentage	18%	g			
Sieve	Weight	%	%	Specif	fication	Cample	reparation : Ov		200	
size (mm)	Retained (gm)	Retained	Passing	Lower Limit		U DEPTENDENCE	ethod of sievir		pie	
50	0.0	0.0	100.0				Wetsievir		4	
37.5	0.0	0.0	100.0				Dry sieving			
26.5	0.0	0.0	100.0						Sec - 133	
19	10.0	0.4	99.6			GRADING N	MODULUS	(GM) =		
13.2	28.0	1.3	98.3				2.2	100		
9.5	181.0	8.1	90.2			GRADING O	OEFFICIE	NT (GC) =	=	
6.7	328.0	14.7	75.4			(). ().	39.1	85 49		
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	2						
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							
100.0	C) 18/0/20 CO	3 77	9 7 94	CONTRACTOR C	171 -1071		7		)	
90.0	4 1040 10	1	A - 53 A - 42 A		- 0 100	1	4 4 4			
80.0	di Aliabe b					,				
70.0	- Series1					/				
200 mark 201 (c) (c)					/			coloriste.		
issi eo c	Al- POSTA DE		N- 92 N-93	10.1010400	/	10-100-1010				
60.0 58 50.0 40.0				0 - 0 /	,					
XXXXXXX										
30.0					8 28	7613161816	8 8 6			
20.0										
10.0	4-1-1-1		4			0-101-1010	<del> </del>			
0.01		0.1		1		10		100	0.	
0.01	,	M(#S)	Sic	eve Size, mm		- IV		2100		
Remarks:									/	
Tested By: A.KASOKA		Checked B	y: T.S.PHIR	l .		Approved By	r:			
		Date: 11/01	/2019			Date				



												LIN					
						AA	SI	HT	0	T-8	39	& T	- 9	0	40 00		
SIDE		10000		10635						R	and	lom S	Sam	ple Yes		No	
LOCATION		CHAV	VAMA	ATP-	1 1	5 m	(387	7)		- 0.0				SAMPLE NO.		525 /5-5/6000	2000
MATERIAL TYPE						E SO								DATE SAMPLED		06/01/20	
MATERIAL SOURCE	NAME OF THE OWNER, WHEN THE OW	CHAV	VAMA	ATP-	1 1	5 m	(387	7)						DATE TESTED		13/01/20	119
MATERIAL DESRIPTION								L						SAMPLED BY	**		
REPRESENTATIVE S	TATION							_						TESTED BY	-		
SAMPLING DEPTH								855						TEST NO.	7		
0															72		
					L	IQL	IID	LI	M	IT					2		
Container No.								302			L-3	¥.		H-82	R-17		
Wt of wet soil + container	, gm							200		12	27.4	8		29.47	26.26		
Wt of dry soil + container	gm							Ĭ.		12	24.9	8		26.34	24.20		
Wt of water	196700							1			2.50	)		3.13	2.06		
Wt of container								0		339	15.8	1		13.58	14,77		
Wt of dry soil, gm								1			9.17			12.76	9.43	i.	
Water content, %								2		2	27.2	6		24.53	21.85		Ĵ.
No. of blows											18			24	30		
30.00		Ш		П		П		H			П			22		_	
28.00			П									П	1		Sample pre	paration	
7.00														As received		$\sqcup$	
26.00														Washed on 0.425mms			
\$ 25.00						$\setminus$								Air dried at		_	
t 34.00		•			ш		`				Ш	Ш		Oven dried at			
Water Content, 00.02														Proportion retained on 0.4	425mm sieve		
S 22.00			Ш							V		ш		Š.			
te 21.00								H			H	H					
30,00		Ш	$\blacksquare$					H		H	H					- 44	
19.00		Ш	$\blacksquare$				H	+	H	Ħ	H	H	8		Test Re	March 1	
18.00		ш	$\blacksquare$	Ħ	Н			H	H	Ħ	Ħ	Ħ	1	Liquid Limit	5715	10 %	
17.00		Ш	$\blacksquare$							Ħ	Ħ	Ħ		Plastic Limit	17.3	30 %	
96.00	,	10	16	5	20		-	25		30	Ш	36		Plasticity Index		2.8 %	
			N	lo of	Blows	63								Shrinkege =	2	2.5 mm	
														Shrinkege =	1	1.7 %	
							P	LA	ST	IC	LI	MI	Г				
Container No.											50			M-26			Average
Wt of wet soil + container								550		2	21.0	6		22.75	9	98	8
Wt of dry soil + container	gm							335		1	20.2	0		21.34	8	348	
Wt of water								34			0.86	;		1.41	4	3.5	
Wt of container								1		305	16.1	5		14.74	ĺ		
Wt of dry soil, gm								1			4.05	,		6.60	İ		
Water content, %										2	21.2	3		21.36	25		21.30
<u> </u>																	
Remarks:					100	W 19	(g)i	2011	258		0.000			7,02			
Tested By: A.KASOK	A				CI	neck	ed l	Ву:	T.S	PHI	IRI			Approved By:			
F					Da	ate: 1	3/0	1/20	19	Ó				Date			



		ATTE	DDE	20	INAL-	-			
	-								
200	,	AASHT							
SIDE	CHAWAMA TO 2		- 1	and	om San		_	No	8
LOCATION	CHAWAMA TP-2 1 YELLOWISH COARSE G	1.5 m				SAMPLE NO		06/01/20	110
MATERIAL TYPE MATERIAL SOURCE	Programmer Age of the Alberta Comment	1.5 m				DATE SAMPLE DATE TESTE		12/01/20	
MATERIAL DESRIPTION	CHAVAIVIA IF-2	1.5 111				SAMPLED B		12/01/20	119
REPRESENTATIVE STATION	ν. Γ					TESTED B	_		
SAMPLING DEPTH	V.	-				TEST NO	_		
OAMIFEING DEF III	Y	1/2				TEST NO	64 L		
	LIC	QUID L	IMIT				50		
Container No.		10.0		12		19	3	Î	1
Wt of wet soil + container, gm		3	iii	31.10	ķ	28.3	26.65		
Wt of dry soil + container, gm				28.24		26.34	25.08		
Wt of water		- 3	-	2.86		1.96	1.57		
Wt of container				13.80	ii e	15.46	15.38		
Wt of dry soil, gm				14.44	_	10.88	9.70		
Water content, %				19.81	_	18.01	16.19	1	
No. of blows				17		25	33		
		*********	Harasar region						
24.00				$\Pi$		8	Sample prep		
23.00						2	Sample prep	aration	
22.00						As received	0022000		
21.00						Washed on 0.425m			
20.00						Air dried at		$\square$	
t 19.00						Oven dried at			
18.00						Proportion retained on	0.425mm sieve		
S 17.00			$\mathbf{A}$						
Water Content, %				/					
15.00							Test Res	ult	
14.00						Liquid Limit	18.1	0 %	
13.00						Plastic Limit	0.0	00 %	
12.00						Plasticity Index	N	P %	
	10 15 20 No of Blows	25	30		36	Shrinkege =	0	.0 mm	
						Shrinkege =	0	.0 %	
		PLA	ASTIC	: LII	MIT	4.0			
Container No.		3				13	13		Average
Wt of wet soil + container, gm									
Wt of dry soil + container, gm									1
Wt of water						re-	r.		
Wt of container							(a)	1	
Wt of dry soil, gm							Ve.	1	6
Water content, %						g.	5		6
Remarks:	Ŷ					22			
Tested By: A.KASOKA	Che	cked By:	T.S PH	IIRI		Approved By:			
	Date	e: 12/01/2	019			Date			
l-	Date		THE						



		RBERG LIMIT			
	AASHT	O T-89 & T- 9	0		
SIDE		Random Samp	ole Yes	No	
	AWAMA TP-3 1.5 m		SAMPLE NO.	2504000	
	OWNISH FINE SOIL		DATE SAMPLED	06/01/	
	AWAMA TP-3 1.5 m		DATE TESTED	11/01/	2019
MATERIAL DESRIPTION			SAMPLED BY		
REPRESENTATIVE STATION			TESTED BY		
SAMPLING DEPTH			TEST NO.		
952	LIQUID L	IMIT			
Container No.		3	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	
23.00				3300 31	*
22.00				Sample preparation	
21.00 21.00			As received Washed on 0.425mms Air dried at Oven dried at Proportion retained on 0.4	ieve°C	1
15.00 N are ter			1	Test Result	
94.00			Liquid Limit	17.70 %	
			Plastic Limit	V 5105 7 (15)	
13.00				0.00 % N/P %	
12.00	15 20 25	30 36	Plasticity Index	N/P 70	
	No of Blows		Shrinkege =	0.0 mm	
			Shrinkege =	0.0 %	
	PLA	ASTIC LIMIT	*	281	
Container No.	2		5		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, %	) ph		] ]		1
Po marka:					
Remarks:	Checked Du	T S DUIDI	Approved Bu		
Tested By: A.KASOKA	Checked By:		Approved By:		
	Date:12/01/20	019	Date		



					RG LIMI						
			AASI	_	89 & T-	2000					
SIDE					Random Sar			No	10		
LOCA	ACTION.	CHAWAMA T				SAMPLE NO.		00/04/004/	•		
	RIAL TYPE	GREYISH COAL		1		DATE SAMPLED		06/01/201			
	RIAL SOURCE RIAL DESRIPTION	CHAWAMA T	P-4 1.5 m	1		SAMPLED BY	357	12/01/201	9		
	ESENTATIVE STATION				TESTED BY						
	LING DEPTH	·		10		TEST NO.	*				
O/ um	EINO DEI III					TEOT NO.					
a .	) )	2	LIQUID	LIMIT			ŧ.				
Contain	ner No.			1	38	18	35	Ï			
20 77	et soil + container, gm			Î	29.20	27.72	25.60				
Ultra Control	ry soil + container, gm				26.53	25.02	23.88				
Wt of w	March 17 and 18			1	2.67	2.70	1.72				
Laboratory of the laboratory	ontainer				16.90	14.19	16.35				
	ry soil, gm				9.63	10.83	7.53				
	content, %				27.73	24.93	22.84				
No. of b	ET SUCCESS TO THE PARTY OF THE				19	25	30				
Water Content, %	28.00 27.00 28.00	15 No of B	27	15 1	0 %	As received Washed on 0.425mms Air dried at Oven dried at Proportion retained on 0.  Liquid Limit Plastic Limit Plasticity Index Shrinkege =	°C 425mm sieve Test Resu 25.00 13.46 11.5	olt 9%			
			P	LASTI	CLIMIT						
Contain					23	50			Average		
	et soil + container, gm				20.74	21.78					
	ry soil + container, gm				19.99	21.11					
Wt of w					0.75	0.67					
	ontainer				14.40	16.15					
100000000000000000000000000000000000000	ry soil, gm				5,59	4.96					
Water	content, %				13.42	13.51			13.46		
Rema	rks:		T			Ť					
Tested	By: A.KASOKA		Checked I	By: T.S PI	HIRI	Approved By:					
			Date: 12/0	1/2019 Date							



,	DETERMINAT						O I I O I I		
		(TMH 1	MATHO	D A7,AA		COLUMN CHICAGO			_
SIDE	2				Random Sa			No	
LOCATION	<u> </u>	0.200.0000		9	-10 unconstill	SAMPLE NO.			
MATERIAL TYPE	21121201	Gravel	111 111 11 11 11 11 11 11 11 11 11 11 1		-15 PAGE 10	E SAMPLED		06/01/2019	
MATERIAL SOURCE	The state of the s		1.5 m (38)	7)	DATE TESTED			11/01/2019	
MATERIAL DESRIPTION		OWISH FI	- Control (1985)	71	. 8	AMPLED BY			
REPRESENTATIVE STATI	CHAWAI	MA IP-1	1.5 m (38)	()	8	TESTED BY			
SAMPLING DEPTH						TEST NO.			
No. of blows :	55+1					Weight of h	nammer,kg	4.5	
No. of layers :	5						f mold,cm3	2345	
Proportion retained on 19m ( pass 50mm sieve and reta		-	3	*		nple / <u>Separate</u> Apparent spec		18	
	Mold	70	No.	M 44	M 44	M 44	M 44	M 44	
Α	WATER		%	4	6	8	10	12	
В	Wt. of Mold + Wet So	oil	grams	8372	8707	8967	8885	8702	
С	Wt. of Mold	- 3	grams	4087	4087	4087	4087	4087	
D	Wt. Wet Soil	- 12	grams	4285	4620	4880	4798	4615	
Е	Volume of Mold	- 1	cm3	2345	2345	2345	2345	2345	
F	Wet Density	ij	g/cm3	1.827	1.970	2.081	2.046	1.968	
	*		400			· ·		7	
G	Container		No.	X-69	G-56	K-11	G-101	F-41	
Н	Wt. Cont + Wet soil	- 1	grams	772.0	715.0	767.0	784.0	775.0	
1	Wt. Cont + Dry soil	44	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	8	grams	236.0	250.0	248.0	250.0	248.0	
L .	Weight of Dry Soil	80	grams	515.0	438.0	480.0	486.0	470.0	
М	Moisture Content	Í	%	4.1	6.2	8.1	9.9	12.1	
N	Dry Density		g/cm3	1.756	1.856	1.925	1.862	1.755	
	4								$\supset$
Maximum Dry Density (M	DD):	0.000							#
		1.920							
MDD =	1.925 g/cm3	7/20							
	200000000000000000000000000000000000000	00 1.870 (1.870							#
Optimum Moisture Conte	nt (OMC) :	neity			/		1		#
		8							
OMC =	8.1 %	1.820					$\pm\pm\lambda$		#
		1.770	шш			*			#
		533340		<del>/                                      </del>				<u> </u>	#
			422223						
		1.720		5	6 7	8 9	10	11 12	13
			<u>**</u>		<u>*</u>		10	11.	2183
					Mois	ture content,%			
									_
Remarks:									
Tested By: A.KASOKA	Checked	By: T.S P	HIRI			Approved By	:		
rested by rains out of		THE PARTY OF THE P				The second second			



	DETERMINAT	ION	OF	F MOL	DIFIF	PR	ОСТОЕ	s co	МРА	CTION		
	DETERMINATION	THE RESIDENCE					HTO 18		LILEE A	011011		
SIDE		1.11		THE RESERVE	00/11		Random Sa	05 MM3 10	Yes		No	-
LOCATION	78							SAMPL			11500	
MATERIAL TYPE	( <del>)</del>	Gn	avel					TE SAM	100000		06/01/2019	9
MATERIAL SOURCE	CHAV	VAMA	TP-2	2 1.5 m				ATE TE			10/01/2019	10
MATERIAL DESRIPTION	YELLOW	ISHC	OAR	SE GRAV	/EL			SAMPLE	D BY			
REPRESENTATIVE STAT	CHAV	VAMA	TP-2	2 1.5 m	27.77			TESTE	D BY			
SAMPLING DEPTH	27	A CONTRACTOR						TES	T NO.			
No. of blows ;	55+1							Wei	aht of h	nammer,kg	4.5	
No. of layers :	5									f mold,cm <sup>3</sup>		-07 -07
Proportion retained on 19m ( pass 50mm sieve and ret		)			<del>-</del> 86					batches: offic gravity		>>
	Mold		T	No.	М	4	M 4	М	4	M 4	M 4	
Α	WATER		-	%	2		4	(	3	8	10	
В	Wt. of Mold + Wet S	oil	330	grams	862	20	8936	92	16	9186	8960	8 8
С	Wt. of Mold		33.0	grams	408	35	4085	40	85	4085	4085	8 3
D	Wt. Wet Soil			grams	453	35	4851	51	31	5101	4875	
E	Volume of Mold		380	cm3	237	74	2374	23	74	2374	2374	9
F	Wet Density			g/cm3	1.9	10	2.043	2.1	61	2.149	2.053	
	7		- 10		100			· ·	- 3		1	16
G	Container		1	No.	Q-9	96	V-12	U	70	D-46	B-16	
Н	Wt, Cont + Wet soil			grams	754		768.0	743.	3.0	770.0	775.0	
1	Wt. Cont + Dry soil			grams	742	Alich M	748.0	714	200 C V	732.0	726.0	- 1
J	Weight of Water		A.	grams	12.	5.92	20.0	29	.0	38.0	49.0	
K	Weight of Container		40	grams	251	6177	244.0	248	5777-01 5 6	252.0	245.0	-
L	Weight of Dry Soil		3	grams	491	,0	504.0	466	5.0	480.0	481.0	
	Moisture Content		33	%	2.4	. 1	4.0	-	2	7.0	10.2	T
M N	Dry Density		-	g/cm3	1.86	2.00	4.0 1.965	2.0	2000	7.9 1.991	1.864	1
IN .	Diy Delisity		_	g/una	1.00	10	1,800	2.0	33	1.551	1.004	
Maximum Dry Density (M	DD):		2.070									$\pm \pm 1$
												#
MDD =	2.035 g/cm3		2.020									
li and	grano	00,0				/						##
Optimum Moisture Conte	nt (OMC) ·	dencity gioo	1.970									
	(0)	8	100		-/							#
OMC =	6.2 %	Dry								+		##
OWO -	0.2 76		1.920								$\overline{\chi}$	##
			1.870	•				*			- \	
												#
			1.820			11111		plate	2888			
				2 :	3 4	S.	5 6	(A)	7	8 9	10	-11
							Moi	sture conte	nt%			}
												- i
Remarks:	- 800							24.2				3
Tested By: A.KASOKA	Checked	By: T	S.PH	IIRI				Appro	ved By			
	Date: 10	/01/201	9					Date				



	DETERMINAT	ION	OF MODI	FIED PF	ROCTOR	COMPA	CTION			
		(TMH	1 MATHO	D A7,AA	SHTO 18	30)				
SIDE	60			5	Random Sa	A CONTRACTOR OF THE PARTY OF TH		No		
LOCATION				-		SAMPLE NO				
MATERIAL TYPE	OUM	Grav				TE SAMPLED_		06/01/2019		
MATERIAL SOURCE MATERIAL DESRIPTION	<del></del>		P-3 1.5 m		-	ATE TESTED		10/01/2019		
REPRESENTATIVE STAT	Add party caves		P-3 1.5 m	3		TESTED BY _				
SAMPLING DEPTH	U CHAW	MIVIA I	P-3 1.0 III		1	TEST NO.				
SAMPLING DEPTH						TEST NO.				
No. of blows :	55+1					Weight of h	ammer,kg			
No. of layers :	5				2,000		mold,cm3	: 2374		
Proportion retained on 19n			<u> </u>	33		mple / Separate				
( pass 50mm sieve and ret	amed on 19mm sieve )					Apparent spec	aric gravity			
	Mold		No.	M 4	M 4	M 4	M 4	M 4		
Α	WATER		%	3	5	7	9	11		
В	Wt. of Mold + Wet So	il	grams	8715	8984	9205	9187	9072		
С	Wt. of Mold		grams	4085	4085	4085	4085	4085		
D	Wt. Wet Soil		grams	4630	4899	5120	5102	4987		
E	Volume of Mold		cm3	2374	2374	2374	2374	2374		
F	Wet Density		g/cm3	1.950	2.064	2.157	2.149	2.101		
G	Container		No.	T-1M	N-J	M-62	D-777	ко		
Н	Wt. Cont + Wet soil		grams	759.0	770.0	746.0	728.0	791.0		
1	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	54.0 252.0		
К	Weight of Container		grams	248.0	255.0	249.0	265.0			
L	Weight of Dry Soil		grams	495.0	490.0	463.0	424.0	485.0		
	10		1			1 1		15 21		
M	Moisture Content		%	3.2	5,1	7.3	9.2	11.1		
N	Dry Density	_	g/cm3	1.889	1.963	2.009	1.968	1.890	_	
a a constitution to the second are recognized from		2.0	020						רו	
Maximum Dry Density (M	IDD):									
	5,55,235,00									
MDD =	2.009 g/cm3	9		/	4		4			
	WARRAGE TO	ony denetty, glos	970	/		<del></del>	1		+	
Optimum Moisture Conte	ent (OMC) :	nett								
		5								
OMC =	7.3 %	(D)		/				<del>\                                    </del>	41	
		1.3	920			+				
			<b>√</b>					<b>\</b>	4	
						88888888	22222		<del>-</del> 1	
		1.0	3 4	5	6 7	8	9 1	0 11	12	
					9 0	i Si			800	
	- (				Moi	sture content,%				
Remarks:										
Tested By: A.KASOKA	Checked	By: T.S	.PHIRI			Approved By:				
	200 0000									
6	Date: 10/0	01/2019				Date				



CATION   SIDE   COCATION   Care   CHAWAMA TP-4   1.5 m   TEST NO.	/TM	LI 4 MATHO	DATAA	CHTO 40	2)				
CACATION   MATERIAL TYPE   Gravel   CHAWAMA TP-4   1.5 m   GREYISH COARSE GRAVEL   SAMPLED   GREYISH COARSE GRAVEL   SAMPLED   GREYISH COARSE GRAVEL   SAMPLED BY TESTED BY TE	SIDE	(114)	IT I WATE	DAI,AM				No	
MATERIAL TYPE  Gravel  CHAWAMA TP-4 1.5 m  GRETISH COARSE GRAVEL  MATERIAL DESRIPTION  GRETISH COARSE GRAVEL  No. of blows:  55+1  No. of blows:  55+1  No. of blows:  Chawama retained on 19mm sieve size:  (pass 50mm sieve and retained on 19mm sieve)  Mold  A WATER % 4 6 8 10 12  B Wit of Mold - Wet Soil grams 8701 9144 9385 9327 9062  C Wit of Mold  C Wit of Mold  C Wit of Mold  C Wit of Mold  C Wit Dennity  F Wet Dennity  G Container  H Wit Cont + Wet soil grams 764.0 750.0 718.0 748.0 713.0  J Weight of Container  H Wit Cont + Wet soil grams 744.0 750.0 718.0 748.0 713.0  J Weight of Container  M Mold C C M M Mold C M C M M M M M M M M M M M M M M M M		<u> </u>					S 50000000	110	1
MATERIAL SOURCE		Gi	ravel		-00 (O		-	06/01/2019	
Chamber   Cham		CHAWAMA	TP-4 1.5 m		-26		-		
No. of blows:   55+1	MATERIAL DESRIPTION	GREYISH CO	ARSE GRAVEL		S	AMPLED BY	9	***************************************	
No. of blows : 55+1	REPRESENTATIVE STATI	CHAWAMA	TP-4 1.5 m	-7.5		TESTED BY	X		
No. of layers : Single sample / Separate batches: Apparent specific gravity : Single sample / Separate batches: Apparent specific gravity :	SAMPLING DEPTH	97	Weeks - 2546.200		8.Y	TEST NO.			
No. of layers : Single sample / Separate batches: Apparent specific gravity : Single sample / Separate batches: Apparent specific gravity :	No. of blows :	55+1				Weight of	hammer ko	4.5	
( pass 50mm sieve and retained on 19mm sieve )  Mold No. M 4 M 4 M 4 M 4 M 4 M 4 M 4 M 4 M 4 M		- Company of the Comp							
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 4085  D Wt. Wel Soil grams 4616 5059 5300 5242 4977  E Volume of Mold cm3 2374 2374 2374 2374 2374  F Wet Density grams 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  Maximum Dry Density (MDD):  MDD = 2.067 g/cm3  Optimum Moisture Content (OMC):  M			W.	īš.					
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 4085  D Wt. Wel Soil grams 4616 5059 5300 5242 4977  E Volume of Mold cm3 2374 2374 2374 2374 2374  F Wet Density grams 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  Maximum Dry Density (MDD):  MDD = 2.067 g/cm3  Optimum Moisture Content (OMC):  M		Mold	No.	M 4	M 4	M 4	M 4	M 4	
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 250.0 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 96 4.0 6.0 8.1 10.1 12.0 Maximum Dry Density (MDD):  MDD = 2.067 g/cm3  Maximum Dry Density (MDD):  MDD = 2.067 g/cm3  Moisture Content 96 4.0 6.0 8.1 10.1 12.0  Maximum Dry Density (MDD):  Moisture Content (OMC):	Α			1000	77 77 75 77	14 (15 (4))	9755532	V. 000 000	
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  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 P G/cm3 1.869 2.011 2.065 2.006 1.871  Maximum Dry Density (MDD):	1555	Wt. of Mold + Wet Soil	grams	8701	9144	9385	9327	9062	
E Volume of Mold cm3 2374 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 764.0 780.0 757.0 796.0 769.0 769.0 F Volume of Water grams 20.0 30.0 39.0 50.0 56.0 F Volume of Weight of Container grams 20.0 30.0 39.0 50.0 56.0 F Volume of Weight of Container grams 20.0 30.0 39.0 50.0 56.0 F Volume of Weight of Dry Soil grams 494.0 502.0 482.0 496.0 465.0 F Volume of Weight of Dry Soil grams 494.0 502.0 482.0 496.0 465.0 F Volume of Weight of Dry Density Maximum Dry Density (MDD):  Maximum Dry Density (MDD):  OMC = 8.0 %  Maximum Dry Density (MDD):  OMC = 8.0 %  Moisture content (OMC):  1,870  Moisture content (Mosture content)  No Dry Density (Model of Province	С	Wt. of Mold	grams	4085	4085	4085	4085	4085	
F   Wet Density   g/cm3   1.944   2.131   2.233   2.208   2.096	D	Wt. Wet Soil	grams	4616	5059	5300	5242	4977	
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 N Gold 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 %  Moisture content (OMC):  Moisture content (OMC):  Moisture content (OMC):  Moisture content (OMC):  Moisture content (MDD):   E	Volume of Mold	cm3	2374	2374	2374	2374	2374	9	
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):   1.520   1.520   1.520   1.520   1.520   1.520   1.520     Moisture Content (OMC) :   1.520	F	Wet Density	g/cm3	1.944	2.131	2.233	2.208	2.096	
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):   1.970   1.		Ta 11	1 46			11.00	0.101	1	
Wt. Cont + Dry soil   grams   744.0   750.0   718.0   746.0   713.0	1990				71 - 72			1 - 2 - 2 - 2	
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):			31 (31)(0)		65			100	
K   Weight of Container   Grams   250.0   248.0   236.0   250.0   248.0			76 16 16 16 16 16 16 16 16 16 16 16 16 16		00			100	
L   Weight of Dry Soil   grams   494.0   502.0   482.0   496.0   465.0	127/	V (50 ) 2.66 (100 V150 CC) (50 V150 C	V - 0.020000000000	7	VA 54-479 S		- 05500	5 ASSESSIVE VI	
M Moisture Content	10-1		V - 20000000000	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	PA 0-00000000000000000000000000000000000	AND THE STATE OF T	· 000000000000000000000000000000000000	2 2000 000 000 VI	
Maximum Dry Density (MDD):  MDD =	L .	vveignt of Dry Soil	grams	494.0	502.0	402.0	490.0	400.0	
Maximum Dry Density (MDD):  MDD =	M	Moisture Content	%	4.0	6.0	8.1	10.1	12.0	
MDD =	N	Dry Density	g/cm3	1.869	2.011	2.065	2.006	1.871	
Optimum Moisture Content (OMC):  OMC =8.0%  1.920  1.820 3	V28/2005	2.067 g/cm3							
OMC =	Optimum Moisture Conte	nt (OMC) :	1.970						
1.820 3 4 5 6 7 8 9 10 11 12 13  Moisture content %	OMC =		1.920						
1.820 3 4 5 6 7 8 9 10 11 12 13  Moisture content %			1870						<b>H</b>
3 4 5 6 7 8 9 10 11 12 13  Moisture content%									8
3 4 5 6 7 8 9 10 11 12 13  Moisture content%									4
			3 4	5	6 7	8 9	10	11 12	13
Remarks:					Mois	ure content,%			
Remarks:									_)
Remarks:									
	Remarks:								



				AASHT	EARING RA D T 193	TIO			
SAMPLE STATION	СН	AWAMA TE	P-1 1.5 m	(387)	Random Sam	ple Yes		No	П
LOCATION	A				- a constitution of the confidence of the confid	SAMPLE NO.	8.219		6.00
MATERIAL TYPE	Ø:	YELLOWIS	SH FINE SO	IL	DAT	E SAMPLED	<i>(</i>	06/01/2019	
MATERIAL SOURCE	СН	IAWAMA TE	P-1 1.5 m	(387)	D/	ATE TESTED		12/01/2019	
MATERIAL DESRIPTION	, P		ravel		-25	AMPLED BY	-		
REPRESENTATIVE STAT	ION		IA TP-1 1.	5 m (387)	-12	TESTED BY	10		
SAMPLING DEPTH	-	200 0 20 20		1/	-17	TEST NO.	-		
			DEI		ERMINATION				
SOAKING CONDITION					ayer Blows (4,5kg) Before		s Blows (4,5kg) efore		s Blows (2,5kg) efore
MOLD NUMBER				0	CC-12	-	CC-4		3-34
WEIGHT OF SOIL + MOL	.D, g				9804	1.00	418	1000	196
WEIGHT OF MOLD, g					4963	L. Comment	826		833
WEIGHT OF SOIL, g VOLUME OF MOLD, g					4841 2322	10.5	320	3.00	363 318
WET DENSITY OF SOIL	a/cm <sup>3</sup>			9	2.085	2	979	A	882
DRY DENSITY OF SOIL.					1.928	1.	.831	1.	741
8			MOIS		TERMINATION				
COALING CONDITION				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION				1	Before	Be	efore	Be	efore
CONTAINER NUMBER	90.00			- 8	W-62		J-6		
WET SOIL + CONTAINER DRY SOIL + CONTAINER					770		764	8	
WEIGHT OF CONTAINER					731 247		725 248	V.	
WEIGHT OF WATER, g	1102				39		39		
WEIGHT OF DRY SOIL,	9				484		477		
MOISTURE CONTENT	RE CONTE	NT A\/=			8.1		.1		
WOISTON	CONTE	NI AV-	DENE	TRATION O	OCTION TOOT	0	ol.	75	
P	ENETRAT	ION DATE	PENE	16/01/20	SOTTOM TEST	F	RING FACTOR		.00
		5 Layer Blo	ws (4,5kg)		y 5 layers Blows			layers Blows	
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00		0 0000000000	0.00			0.00	
0.64 1.27		1.46 2.84			1.08			0.89 1.37	
1,91	8	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 4.45	8	6.69 7.57		k.	5.34 6.18	5		2.78	3
5.08	<b>*</b>	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 7.62		11.87 12.92			8.35 8.74			3.39	
8.26	8	13.97			9.10			3.49	
8.89		14.52			9.67			3.69	
9.55		15.36			10.06			3.77	222
0	SWE	11				Blows	55	25 4,5kg by 5	55 2 Eka bu 2
Soaking Date	SVVE	LL			rammar Initial reading (n	nm)	4,5kg by 5	4,5kg by 5	2,5kg by 3
Time	8				Final reading (n	nm)			8
	8	Ř			Height of specin			y.	
D					Percent Swell	(%)		8	8
Remarks:									
Tested By: W.MUMBA		2001/15 VALUE OF	By: T.S.PI	HIRI		Approved	Ву:		
	Date: 12/01/2019 Date								



CHAWAMA TP-1	,		CALIFO	ORNIA B	EARIN	IG RATIO	<u>0</u>			
Chaywama TP-1				AASHTO	T 19	3				
CANWAMA TP-1	SAMPLE STATION	CHA	WAMA TP-1	The second	7 1 13		n Sample	YES	NO [	7
MATERIAL DESRIPTION   Gravel   SAMPLED BY   TESTED B	LOCATION	CHA	WAMA TP-1	1.5 m (387)	<del>-3</del> 3	SAMPLE	NO.	33 <del> 34</del>		7
Number of blows   Dry Density   CBR   after 96   bours   Swell %   Average % Swell %   Average % Swell %   Average % Swell %   Swell %   Average %   Average % Swell %   Average % Swell %   Average % Swell %   Average %   Average % Swell %   Average % Swell %   Average %   Ave	MATERIAL TYPE	Y	ELLOWISH	FINE SOIL	-0) -0)	DATE SA	MPLED	679		
Number of blows   Number of blows   Dry Density   CBR   % Moisture after 96   Swell %   Swell		94			<del>-2</del> 3			ÿ	16/01/201	9
Number of   % Moisture   blows   before seak   Dry Density   CBR   % Moisture   after 96   bours   Swell   %   Number of   blows   before seak   Dry Density   %   blows   Swell   %   S		10 <u>1</u>	Grave	el	<u>=9</u> 9			11		
Number of blows   Shotsure   Dry Density   Dry Densi		-			<u>-</u> 44			¥ <u> </u>		
M.D.D (gm/cm²)   1.925   55 by 5   8.1   1.928   37.3   0.0   0.00   13.24   20.00	<u> </u>	2007		Dry Density			Swell %	V.013.70321 751	Standard Lo	ad (KN)
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  PENETRITION CURV BOTTOM 1.900 1.	M.D.D (gm/cm <sup>3</sup> )	Diows	Derore Soak		70	hours		Swell	2.54 mm	5.08 mm
8.1 55 by 3 0.0 1.741 17.6 0.0 0.00 13.24 20.00  PENETRATION CURV BOTTOM  18.0  19.0  1.950  1.950  1.950  1.750  1.850  1.750  1.850		55 by 5	8.1	1.928	37.3	0.0	0.00	1	13.24	20.00
PENETRATION C.RV BOTTOM  18.0  1.950	O.M.C. %	30 by 5	8.2	5725	27.3	0.0	0.00	0.00	13.24	20.00
18.0 16.0 14.0 12.0 8.0 1.750 1.700 1.800	8.1	55 by 3	0.0	1.741	17.6	0.0	0.00		13.24	20.00
CBR Value at 95% MDD = 1.829	14.0 12.0 90.0 8.0 6.0 4.0 2.0 0.00 1.27 2.54 3.81		7.62 8.3		1.850 1.800 1.750 1.700 1.650	20.0			9	
CBR Value at 98% MDD = 1.887 CBR Value at 98% from the graph = 33.0	CBR Value	at 90% MD	D = 1.733	ı	CBI	R Value at 90%	from the gra	ph =	17.	5
CDK value at 36% from the graph — 55.0	CBR Value	at 95% MD	D = 1.829	)	CBI	R Value at 95%	from the gra	ph =	26	5.9
Comments:	CBR Value	at 98% MD	D = 1.887	'	CBR	Value at 98%	from the grap	h =	3.	3.0
	Comments:									
Checked By: W.MUMBA APROVED BYy:	Checked By: W.MUMBA			- Control of the Cont						
Date:  Test Results Within Engineering Limits:  Yes  No	Test Results Within	Engineering I	imits:			✓ No				



					EARING RA	TIO			
8		Windows Man	1940/00 PM	AASHT				7240	
SAMPLE STATION	V	CHAWAMA	TP-2 1.5	m	Random Sam	ple Yes		No	П
LOCATION					_	SAMPLE NO.			
MATERIAL TYPE	YE	LLOWISH	OARSE GF	RAVEL	DAT	E SAMPLED		06/01/2019	Ŷ.
MATERIAL SOURCE	100	CHAWAMA	TP-2 1.5	m	DA	ATE TESTED	C.	11/01/2019	
MATERIAL DESRIPTION	3	G	ravel		S	AMPLED BY			
REPRESENTATIVE STAT	TION	CHAWAM	A TP-2 1.	5 m		TESTED BY	Ö		
SAMPLING DEPTH	Service Co.		ATTOMATICAL PROPERTY.			TEST NO.			
			DEI		ERMINATION	Ne sas-resident			
SOAKING CONDITION					ayer Blows (4,5kg) Before		s Blows (4,5kg) efore		s Blows (2,5kg
MOLD NUMBER				· V	M-10	Co.	4-21	-	1-14
WEIGHT OF SOIL + MOI	LD, g				9247		954	2011	743
WEIGHT OF MOLD, g	CONTRACTOR OF THE PARTY OF THE				4084	110	081		176
WEIGHT OF SOIL, g				ķ.	5163 2375		873 370		567 342
WET DENSITY OF SOIL	a/cm <sup>3</sup>				2.174	N1 UT	.056		950
DRY DENSITY OF SOIL					2.047	777	937		837
2			MOIS	STURE DE	TERMINATION		0.2010		10010
				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg
SOAKING CONDITION				1	Before	Be	efore	Be	efore
CONTAINER NUMBER				D.	M-611	1000	-300	-	
WET SOIL + CONTAINE	Ra				882	The state of the s	939	8	
DRY SOIL + CONTAINER				,	845	V	899		
WEIGHT OF CONTAINE	R, g				252		244		
WEIGHT OF WATER, g					37		40 65.5	3	
WEIGHT OF DRY SOIL, MOISTURE CONTENT	g			· N	593 6.2	Tr.	6.1	Ž.	
	RE CONTE	NT AV=		- T	0.2	-	.2		
300000000000000000000000000000000000000		**********	PENE	TRATION I	BOTTOM TEST	-			
P	ENETRAT	ION DATE		15/01/20		F	RING FACTOR	0	.00
PARAMETER SAME SAME SAME SAME SAME SAME SAME SAME	-	5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	(2,5kg)
PENETRATION (mm)	Dial	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00	reading	0.00	PORT IN SPECSOR STATE OF THE	reading	0.00	10000000000000000000000000000000000000	The second second	0.00	No.
0.64		1.56			1.31			0.90	
1.27		2.93			2.06	in the second		1.38	
1.91		4.49	47.0		3.19	20.4		2.01	47.7
2.54 3.18		6.35 8.26	47.6		4.02	30.1	ē.	2.36 2.85	17.7
3.81		9.60			4.92	ii.	į.	3.14	3
4.45	10	11.43	Xessass	ů,	5.49	C 10-00-1407	10	3.39	ely see/fee
5.08		13.16	65.8		6.10	30.5		3.65	18.3
5.72 6.35	16 1	14.24 15.18			6.62 7.12		6.	3.89 4.12	12
6.99		16.37			7.56	C.	ā	4.26	77
7.62	8 8	16.97			8.31	8	8	4.47	8
8.26		17.47			8.94			4.78	
8.89 9.55		18.02 18.59			9.65 10.02		15	4.95 5.20	
9.00	+	10.59			10.02	Blows	55	25	55
	SWE	LL			rammar	0.0110	4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date					Initial reading (n				
Time					Final reading (m		į į	Š	8
					Height of special Percent Swell (				*
Remarks:				3	. CICCIA ON CIII			Š.	d)
							225(9)		
Tested By: W.MUMBA		Checked	By: T.S.PI	HIRI		Approved	By:		
		<u> </u>							
		Date: 11/0	/01/2019 Date		Date				



		CALIFO	ORNIA BI	EARIN	IG RATIO	<u>D</u>			
			AASHTO	T 19	3				
SAMPLE STATION LOCATION MATERIAL TYPE	CH	HAWAMA TE HAWAMA TE DWISH COA	-2 1.5 m	-85 -85	Randon SAMPLE DATE SA	MPLED	YES	□NO □	
MATERIAL SOURCE MATERIAL DESRIPTION REPRESENTATIVE STATION SAMPLING DEPTH		Grave	el		SAMPLE TESTED TEST NO	D BY BY	X <sub>0</sub>	15/01/2019	9
M.D.D (gm/cm <sup>3</sup> )	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96 hours	Swell %	Average % Swell	Standard Los 2.54 mm	ad (KN)
2.035	55 by 5	6.2	2.047	47.6	0.0	0.00	* 4	13.24	20.00
O.M.C. %	30 by 5	6.1	1.937	30.1	0.0	0.00	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
18.0 16.0 14.0	5.08 6.35 710N(m)	7.62 8.	Signal and Aud	2.050 2.000 1.950 1.900 1.850 1.750 1.700 1.650 1.600	21.0	26.0 31 Sc	.0 36.0 baked CBR %		LLE AT 1%
**************************************	at 90% MDI	38-60° KE1000			R Value at 90%			17.	
CBR Value	at 95% MDI	D = 1.933	3.	CBI	R Value at 95%	from the gra	ph =	29	.9
CBR Value	at 98% MDI	D = 1.994		CBR	Value at 98%	from the grap	h =	39	.5
Comments:									
Checked By: W.MUMBA			APROVI	ED BYy: Date:					
Test Results Within	Engineering L	imits:		es	✓ No				



			CALIFO	RNIA B	EARING RA	TIO			
			V-1	AASHT		8			
SAMPLE STATION	No. 33	CHAWAMA	TP-3 1.5	m	Random Sam	nple Yes		No	
LOCATION					- ;	SAMPLE NO.			
MATERIAL TYPE	10	BROWNIS	H FINE SO	IL.	DAT	E SAMPLED		06/01/2019	
MATERIAL SOURCE	1	CHAWAMA	TP-3 1.5	m	D	ATE TESTED		11/01/2019	
MATERIAL DESRIPTION	(A)	Gi	ravel		S	AMPLED BY	<i>(</i> 7		
REPRESENTATIVE STAT	ION	CHAWAM	IA TP-3 1.	5 m	-8	TESTED BY			
SAMPLING DEPTH	40		TVA GOVE	av pecasia un estadora.	-Cy Leannean ann an Landau ann an A	TEST NO.	30		
			DEI		ERMINATION	05 by 6 by	o Chana (4 Cha)	FEE - OI-	Disco (O.Elea)
SOAKING CONDITION					ayer Blows (4,5kg) Before		efore		s Blows (2,5kg) efore
MOLD NUMBER					M-36		4-38	10000	1-41
WEIGHT OF SOIL + MOL	.D, g				9166	-	904		650
WEIGHT OF MOLD, g WEIGHT OF SOIL, g					4098 5068	100	1097 1807		106 544
VOLUME OF MOLD, g					2339		339		340
WET DENSITY OF SOIL,	g/cm <sup>3</sup>				2.167		.055	The state of the s	942
DRY DENSITY OF SOIL,	g/am <sup>3</sup>				2.024	1	.919	1.	814
			MOIS	2,0,000	TERMINATION	05 10 5 10 100	n Diama (A Flor)	EE h. 21	Disco (O.Elea)
SOAKING CONDITION					ayer Blows (4,5kg)	12.00	The state of the s	V 00 00 00 00 00 00 00 00 00 00 00 00 00	1770
					Before	В	efore	Ве	efore
CONTAINER NUMBER					M-34	110	T-10		
WET SOIL + CONTAINER DRY SOIL + CONTAINER					745 712		779 744		
WEIGHT OF CONTAINE					244		251		
WEIGHT OF WATER, g					33		35	0.	
WEIGHT OF DRY SOIL, MOISTURE CONTENT	9				468		493		
	E CONTE	NT AV=			7.1		7.1		
			DENE	TRATION I	BOTTOM TEST	- 1	14		
P	ENETRAT	ION DATE		15/01/20			RING FACTOR		0.00
	55+1 by	5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	s (2,5kg)
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00 0.64		0.00 1.97			0.00 1.17	Š		0.00	li .
1.27	4	3.46			2.48	12		1.62	
1.91	1 8	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 8.09	6		3.78 4.39	0
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		v -	12.34	, 111	- U	5.34	
6.35		18.20			13.37			5.69	
6.99 7.62	1	19.40 20.93			13.86 14.30	10		5.92 6.18	
8.26	9	21.96			14.51	8		6.39	8
8.89		22.39			14.69		<u>.</u>	6.89	9
9.55		23.30		i i	15.02	Blows	55	7.11 25	55
	SWE	LL			rammar	DIOWS	4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date	Auces	201			Initial reading (n	nm)	3-1		
Time	- 3				Final reading (n				8
					Height of special Percent Swell			5	11
Remarks:		·			I GIOGIA OWEI	(70)		8	I ()
Tested By: W.MUMBA		Checked	By: T.S.P	HIRI		Approved	Ву:		
		Date:11/0	1/2019			Date			



	CALIFO	ORNIA BI			<u>0</u>			
SAMPLE STATION LOCATION MATERIAL TYPE MATERIAL SOURCE MATERIAL DESRIPTION REPRESENTATIVE STATION SAMPLING DEPTH	CHAWAMA TI CHAWAMA TI BROWNISH	P-3 1.5 m FINE SOIL	)   19 - - - - -		MPLED STED D BY BY	YES	06/01/201 15/01/201	
M.D.D (gm/cm <sup>3</sup> )	Number of % Moisture blows before soak	Dry Density	CBR	% Moisture after 96 hours	Swell %	Average % Swell	Standard Lo	5.08 mm
2.009	55 by 5 7.1	2.024	53.9	0.0	0.00	S many	13.24	20.00
O.M.C. %	30 by 5 7.1 55 by 3 0.0	1.919	38.2 24.7	0.0	0.00	0.00	13.24	20.00
	ATTON(mm)	S) Mus Alsund O	1.800 1.750 1.700 1.650 1.600 20.0		s	40.0 45.0 balked CBR %	50.0	ALUE AT 195%
	at 90% MDD = 1.80 at 95% MDD = 1.90		20000	R Value at 90%  R Value at 95%			24	7.9
CBR Value	at 98% MDD = 1.96	9	CBR	Value at 98%	from the grap	h =	46	6,0
Comments:								
Checked By: W.MUMBA		APROVI	ED BYy: Date:					
Test Results Within	Engineering Limits:	- 32	es	No				



<u> </u>			CALIFO	RNIAB	EARING RA	TIO				
					T 193					
SAMPLE STATION	ec 2	CHAWAMA	TP-4 1.5	m	Random Sam	nple Yes		No		
LOCATION						SAMPLE NO.				
MATERIAL TYPE	G	REYISH CO	ARSE GRA	VEL	DAT	E SAMPLED	D 06/01/2019			
MATERIAL SOURCE	100	CHAWAMA	TP-4 1.5	m	D	ATE TESTED	TED 11/01/2019			
MATERIAL DESRIPTION		G	ravel		S	AMPLED BY	Q(-			
REPRESENTATIVE STAT	TION	CHAWAN	A TP-4 1.	5 m	<b>-</b> 36	TESTED BY				
SAMPLING DEPTH	-		0.0000		-92 	TEST NO.	·			
			DE		ERMINATION	Lock Class	- Di (4 E) )	leet ol-	- DI /O.F.I	
SOAKING CONDITION					ayer Blows (4,5kg) Before		s Blows (4,5kg) efore		s Blows (2,5kg efore	
MOLD NUMBER					M-16		4-17		1-19	
WEIGHT OF SOIL + MO	LD, g				9320		091	1,000	813	
WEIGHT OF MOLD, g					4092	1.0	1097	1.00	092	
WEIGHT OF SOIL, g VOLUME OF MOLD, g				ķ.	5228 2331	1/2	349	0. 205	721 347	
WET DENSITY OF SOIL	a/cm <sup>3</sup>				2.243	2.7	126	0.00	012	
DRY DENSITY OF SOIL					2.075	1	.967	1.	861	
			MOIS	TURE DE	TERMINATION					
ACALCING CONDITION				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg	
SOAKING CONDITION					Before	Be	efore	Be	efore	
CONTAINER NUMBER	2-00-ma				C-12		-200			
WET SOIL + CONTAINE				į.	789		818	Č.		
DRY SOIL + CONTAINER WEIGHT OF CONTAINE					748 239		775 2 <b>44</b>	V.		
WEIGHT OF WATER , g					41		43			
WEIGHT OF DRY SOIL.					509		531			
MOISTURE CONTENT	or cours	NET ALL			8.1		8.1	N .		
MOISTU	RE CONTE	NI AV=	72/10/59/03				1	70		
	CHETDAT	ION DATE	7411744		BOTTOM TEST		INIC FACTOR			
	55+1 by	5 Layer Blo	ws (4.5kg)	15/01/20	y 5 layers Blows		RING FACTOR	layers Blows	0.00 (2.5kg)	
PENETRATION (mm)	Dial	Samuel Street		Dial	Section and the second	Mary Mary Commerce	The same or control	Parameter and a		
AS LONG BY LANGUAGE CONTRACTOR OF LA	reading	Load (KN)	C.B.R(%)	reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)	
0.00		0.00		Wysiansta.	0.00			0.00		
0.64 1.27	1	1.96 3.72			1.20 2.46	1		0.94 2.02		
1.91	10 10	5.76		-	3.96	2		3.08	G.	
2.54		7.61	57.0		5.62	42.1		3.79	28.4	
3.18		10.43	.,,,,,,,,		6.45			4.36		
3.81	48 8	12.91		ė.	7.94	8		4.89	8	
4.45 5.08		16.63 19.86	99.3		8.67 9.48	47.4		5.62 6.18	30.9	
5.72	1 3	22.85	55.5		10.74			6.59	00.0	
6.35		25.23			11.86			7.22	r-	
6.99		26.84			12.89			7.58		
7.62 8.26	1 8	28.55			14.42 15.69	8		8.07 8.39	8	
8.89		31.37			16.47			8.74		
9.55		32.79			17.24		2000	9.10	The street of	
X 42/94/6/2010	-	Tally land of		2.	AN ONLOWS	Blows	55	25	55	
Soaking Date	SWE	LL			rammar Initial reading (n	nen)	4,5kg by 5	4,5kg by 5	2,5kg by 3	
Time	0				Final reading (n				i.	
	8				Height of speci	men (mm)	u.	u.	ė.	
Domorko:					Percent Swell	(%)				
Remarks:										
Tested By: W.MUMBA	•	T.S.PHIR	a			Approved	ву:			
		D. 1	24 0040			D-1				
	Date: 11/0	01/2019			Date					



<u> </u>		CALIFO	ORNIA B	EARIN	G RATIO	<u> </u>			
3			AASHT	O T 193	3				
SAMPLE STATION	CI	HAWAMA TP	THE WAY TO SEE	0 1 130		Sample	YES	NO [	
LOCATION	CI	HAWAMA TP	-4 1.5 m		SAMPLE	412101	87 80		<del>-</del>
MATERIAL TYPE	GRE	EYISH COAR	SE GRAVEL		DATE SA	MPLED	0-	06/01/20	
MATERIAL SOURCE	( <del>)</del>				DATE TE			15/01/201	19
MATERIAL DESRIPTION	(9-	Grave	el .		SAMPLE		<u> </u>		33
SAMPLING DEPTH	18			_	TESTED TEST NO		3 <del></del>		
	Number of	% Moisture	D- Dit-	CBR	% Moisture	C11 9/	Average %	Standard Lo	oad (KN)
M.D.D (gm/cm <sup>3</sup> )	blows	before soak	Dry Density	%	after 96 hours	Swell %	Swell	2.54 mm	5.08 mm
2.067	55 by 5	8.1	2.075	57.0	0.0	0.00	8 8	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		13.24	20.00
32.0 30.0 28.0 26.0 24.0 22.0 30.0 38.0 16.0 14.0 12.0 10.0 8.0 6.0 4.0 2.0 0.00 1.27 2.54 3.81 PENETM	5.08 6.35 TION(mp)	7.62 8.		2.200 2.100 2.000 1.900 1.800 1.700	31.0	36.0 41.	0 46.0 aked CBR %	-	ALLE AT 35%
CBR Value	at 90% MD	D = 1.860	)	CBR	Value at 90%	from the grap	oh =	28	4
CBR Value	at 95% MD	D = 1.964	ı	CBR	Value at 95%	from the grap	oh =	4	1.9
CBR Value	at 98% MD	D = 2.020	í	CBR	Value at 98%	from the grap	h =	50	0.0
Comments:									
Checked By: W.MUMBA	,		Marie Company	ED BYy:	¥				
				Date:					
Test Results Within	Engineering I	.imits:		Yes	No	Ц	}		



#### SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consult-	Location: Cha-	
ants	wama	Date Tested: 04/01/19
<b>Project: Lusaka Transmission and Distribution Rehal</b>	bilitation	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



### Annex 4

John Howard Site and Lab Results



## STANDARD PENETRATION TEST (SPT) RESULTS

		national Energy	н	ocation: Jol Ioward		Date Tested: 04/01/19			
Project: I	usaka Transm	ission and Distri	bution Rehabilitat	ion	# A0	Tested by: W. Mumba			
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bea	aring Pressure kN/m2			
		150	10						
1	1	300	13	24		280			
		450	11						
		150	13						
2	1	300	14	23		280			
		450	9						
		150	17						
3	1	300	15	30		410			
		450	15						
		150							
4	1	300							
		450			1				



## DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA	-ITEC Int	ernational Ene	rgy Consu	Iltants Locati	ion: John	Date Tested: 0	04/01/19
Project: Lusa	ka Trans	mission and Dis	stribution		ıu	Tested by: W	. Mumba
Test Pit N	lo. 1	Test Pit N	No. 2	Test Pit	No. 3	Test Pit N	o. 1
Penetration	Blows	Penetration	Blows	Penetration	Blows	Penetration	Blows
(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)	(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	- 14
1.5	11	1.5	7	1.5	15	1.5	
1.8	18	1.8	13	1.8	23	1.8	5
2.1	8	2.1	14	2.1	27	2.1	- v.
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	- 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	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	Î	6.3		6.3		6.3	
6.6		6.6		6.6		6.6	
6.9	-	6.9	26	6.9		6.9	· N
7.2	Î	7.2		7.2		7.2	
7.5		7.5		7.5		7.5	
7.8	44	7.8	35,	7.8		7.8	· W
8.1		8.1		8.1		8.1	
8.4		8.4		8.4		8.4	
8.7	¥ň	8.7	7.5	8.7		8.7	- N
9.0	73	9.0	73	9.0		9.0	
9.3		9.3		9.3		9.3	
9.6	28	9.6	70	9.6		9.6	- N
9.9	9	9.9		9.9		9.9	- 18



			PART	ICLE SIZ	ZE DISTR	BUTION				
		15		AASI	HTO T-27					
SIDE:					SAMPLE N	0				
REPRE STATIC	SENTATIVE N:	JOHN HOW	ARD TP-1	1.5 m (399)	SAMPLING	DATE:		07/01/2019		
LOCAT	ION:				TESTING D	DATE:		11/01/2019		
Weight /	After Washing (g)	143	32.0	g	00000000000	n fine :	728.0	g		
Weight E	Before Washing (g)	216	30.0	a	loss in tine	percentage	51%	g		
8011	Sieve	Weight	%	%	Speci	fication	Sample prepa	ration : Oven-dried	sample	
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit		d of sieving:		
	50	0.0	0.0	100.0				Wetsieving	4	
	37.5	0.0	0.0	100.0				Dry sieving		
,	26.5	0.0	0.0	100.0						
	19	0.0	0.0	100.0	2		GRADING MOD	DULUS (GM) =	8	
	13.2	0.0	100.0				1.0			
	9.5	4.3	95.7			GRADING COE	FFICIENT (GC	c) =		
	6.7	87.0	4.0	91.7				12.9	Ø	
	4.75	46.0	2.1	89.6				5.0-41860		
	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						
10	0.00								$\Box$	
S	0.0	+++++					_ +			
8	0.0	10 100101 10			<u></u>				4	
345	0.0	-Series1		,-						
11.5	0.1	1.1111	,							
ssin	0.0		,							
P. S.	0.0		1						#	
% of Passing	0.0		-	1 1 1 1 1 1	<del></del>		0-10-10-0	- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	+	
500	0.0								+ 1	
2	0.0			4 4 42	yeys c					
89	0.0							3	41	
	0.0									
	0.01	(	11	Sie	t ve Size, mm		10		100	
Remark	S:									
	By: A. KASOKA	1	Checked B	y:S.T.PHIRI			Approved By:			
S.		/2019			Date					



				PART	ICLE SIZ	E DISTR	IBUTION	r				
					AASI	HTO T-27						
SIDE						SAMPLE N	0	Î				
REPI STAT		NTATIVE	JOHN HOW	ARD TP-2	1.5 m (400)	SAMPLING	DATE:		07/01/2019			
LOCA	ATION	I:				TESTING [	ATE:		11/01/2019			
Weigh	nt Afte	r Washing (g)	105	60.0	g	0.01451902.033	fine :	697.0	g			
Weigh	nt Befo	re Washing (g)	174	7.0	a	loss in tine	percentage	66%	g			
800		Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried s	ample		
		e (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit		ofsieving:	20-29		
		50	0.0	0.0	100.0			V	Vetsieving	4		
	- 1	37.5	0.0	0.0	100.0			ι	Dry sieving			
		26.5	0.0	0.0	100.0							
,	19 0.0			0.0	100.0			GRADING MOD	ULUS (GM) =	5		
	13.2 0.0			0.0	100.0				0.8			
	9.5 0.0				100.0			GRADING COE	FFICIENT (GC	) =		
4	-	6.7	0.0	0.0	100.0				3.0			
		4.75	11.0	0.6	99.4							
		2.00	42.0	2.4	97.0							
	- 1	1.18	45.0	2.6	94.4			ľ				
		0.6	43.0	2.5	91.9							
	C	.425	70.0	4.0	87.9							
\$		0.3	129.0	7.4	80.5							
		0.15	553.0	31.7	48.9							
	C	0.075	157.0	9.0	39.9							
		Pan	697.0	39.9	0.0							
	100.0	E								$\overline{}$		
			4 - 0 - 100 - 100						as			
	90.0	10 10	16 18:11:11 10									
	80.0		-Series1	119	1			10-101-10-0	19 10 10 10 10			
	70.0	- A 10 T	3 1370 6	,								
% of Passing	60.0		100000000000000000000000000000000000000		SE 8 325	2 (12 (5) )	3 53		50 K KARISE	H		
Pas	50.0			1					<u> </u>	4		
jo e	40.0				W- 01 W-01	0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			A			
3	30.0									4		
	20.0				35 10 3 10	ana s	- v 87					
	10.0				4				0)	4		
	0.0	01	O	1	Sie	1 eve Size, mm		10	ne tertestille	100		
Rema	arke:				Sie	- S GIZO, IIIII				_/		
		A.KASOKA	The state of the s	Checked B	y:S.T.PHIRI			Approved By:				
	Date: 11/01/2019							Date	A CASTO SECRETARIO DE DESCRITO DE CONTROL DE			



			Viatority-90-ph	Wildow Guard Market		anal de constant proper	_			
			PART	ICLE SI	ZE DISTR	IBUTION				
		***		AAS	нто т-27					
SIDE:					SAMPLE N	0				
REPRE STATIO	SENTATIVE N:	JOHN HO	OWARD TP-	3 1.5 m	SAMPLING		07/01/2019			
LOCAT	ION:				TESTING D		13/01/2019			
Weight A	After Washing (g)	231	2.0	g		n fine :	526.0	g		
Weight F	Before Washing (g)	283	88.0	a	loss in fine	percentage	23%	g		
vvoignte	Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample		
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	2000	d of sieving:		
	50	0.0	0.0	100.0			V	Wet sieving		
	37.5	224.0	7.9	92.1			- 1	Dry sieving		
	26.5	186.0	6.6	85.6						
	19	5.3	80.3			GRADING MOD	OULUS (GM) =			
	13.2	5.0	75.3				2.0			
	9.5	6.3	69.0			GRADING COE	FFICIENT (GC) =			
	6.7	196.0	6.9	62.1				20.3		
	4.75	259.0	9.1	52.9	ļ		1			
	2.00	162.0	5.7	47.2						
	1.18	57.0	2.0	45.2			ļ			
	0.6	164.0	5.8	39.4			l			
	0.425	94.0	3.3	36.1			ļ.			
	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						
10	0.0			7 7 77			101111111111111111111111111111111111111			
9	0.0		i 8	N 8 88	fafafaf8 - 8	2 6 2				
8	0.0	- Series1	8	12 9 12	121212 3	8 2 8				
7	0.0	- Contract	-	<del>-111</del>				<u> </u>		
B 6	0.0			4 3 44		- 12 to 12	, 1	<del></del>		
isse 5	0.0									
£	0.0									
0.000	0.0									
	19001							A DESCRIPTION		
	0.0									
	0.0			- 10 11 11 11 11				Y- XV 31 10-1XV-1X		
	0.01	0	.1	Si	10	100				
Remark	6.			Jii	eve Size, mm					
	s: AKASOKA		Checked B	y: S.T.PHIR			Approved By:			
	CONTRACTOR CONTRACTOR		Date: 13/01	The resource of the case			Date			



		RBERG LIMIT	/-			
	AASHT	O T-89 & T- 9	Ô			
SIDE	No.	Random Samp		☐ No	) П	
LOCATION JOHN HOWARD TP-1	1.5 m (399)	Company Company	SAMPLE NO.	200 000	100 100 A	
MATERIAL TYPE GREYISH FINE	SOIL		DATE SAMPLED		1/2019	
MATERIAL SOURCE JOHN HOWARD TP-1	1.5 m (399)	DATE TESTED 13/01/2019				
MATERIAL DESRIPTION			0			
REPRESENTATIVE STATION			TESTED BY			
SAMPLING DEPTH	fi k		TEST NO.			
	360					
ı	IQUID L	IMIT				
Container No.		X	Q	S-6	2	
Wt of wet soil + container, gm		29.46	27.11	29.68		
Wt of dry soil + container, gm		26.28	24.65	26.70	17 7	
Wt of water		3.18	2.46	2.98	10.00	
Wt of container		15.27	15.26	14.23	(V)	
Wt of dry soil, gm	Ÿ.	11.01	9.39	12.47	- N	
Water content, %	Ÿ.	28.88	26.20	23.90	The state of	
No. of blows	ý.	18	25	31	**	
(	<u> </u>		-		55.	
32.00						
31.00			sample preparatio	preparation		
30.00			As received	L	_	
			Washed on 0.425mms	ieve	]	
2.00			Airdried at	.30°C	2	
2 28.00			Oven dried at	℃		
Water Content.			Proportion retained on 0.4	25mm sieve	1110	
S 27.00			A way to be a control of the control			
\$ 26.00						
* 25.00						
2.00				Test Result		
34.00		<del>IIINIII</del> I	Liquid Limit	26.20 %		
23.00		Plastic Limit 14.79 %				
	*		Plasticity Index	11.4 %	i i	
22.00 6 10 15 2	0 25	30 36	Plasticity Index	114 %		
No of Blows			Shrinkege =	8.0 mm	n e	
			Shrinkege =	5.3 %		
	PLA	STIC LIMIT	30 3			
Container No.	300	XZ-2	L-6		Average	
Wt of wet soil + container, gm	30	21.99	20.98			
Wt of dry soil + container, gm		21.18	20.21			
Wt of water		0.81	0.77			
Wt of container	3 4	15.74	14.97			
Wt of dry soil, gm	3	5.44	5.24	12		
Water content, %	- 1	14.89	14.69		14.79	
Trace Street, 12	**	11.00	11100	5 56	77	
Remarks:					-	
Braconson of the Market	hecked By:	r.s.phiri	Approved By:			
272).			3/3 (52)			
D.	ate: 13/01/20	019	Date			
to.						



	T also also have		0				
		RBERG LIMIT					
	AASHI	O T-89 & T- 9	The state of the s				
SIDE		Random Sam		□ No			
	OHN HOWARD TP-2 1.5 m (400)		SAMPLE NO.	07/04/	0.10		
**** ** *** *** *** ***	BROWNISH FINE SOIL		DATE SAMPLED	07/01/2			
	OHN HOWARD TP-2 1.5 m (400)	DATE TESTED 12/01/2019					
MATERIAL DESRIPTION		SAMPLED BY					
REPRESENTATIVE STATION SAMPLING DEPTH	-		TESTED BY TEST NO.				
SAMPLING DEPTH			TEST NO.				
	LIQUIDI	INALT					
Container No.	LIQUID L	NINS STATE	27	30			
Container No.	0.	A 30.48	28.51	26.22			
Wt of wet soil + container, gm	-	27.85	26.04	24.25			
Wt of dry soil + container, gm Wt of water	-	2.63	2.47	7.00			
Wt of water Wt of container	-			1.97			
7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 -	-	16.53 11.32	14.03	13.64	6		
Wt of dry soil, gm Water content, %	-		12.01	10.61	8		
	-	23.23	20.57	18.57 31	0		
No. of blows	1	17	25	31	0,0		
22.00 22.00	15 20 25 No of Blows	ASTIC LIMIT	As received Washed on 0.425mmsi Air dried at Oven dried at	Nashed on 0.425mmsieve			
Container No.	PLA	A STATE OF THE PARTY OF THE PAR	2	Ť	Average		
- F 11 (11 (11 (11 (11 (11 (11 (11 (11 (1	-	19	21.44		Average		
Wt of wet soil + container, gm	1	21.90	21.44	- 1	-		
Wt of dry soil + container, gm	1	21.12	20.66	- 1			
Wt of water		0.78	0.78		<b>-</b> 0		
Wt of container		16.11	15.66				
Wt of dry soil, gm		5.01	5.00		40.00		
Water content, %	1	15.57	15.60	1	15.58		
Remarks:							
Tested By: A.KASOKA	Checked By:		Approved By:				
	Date: 12/01/2	019	Date				



					RG LIMI					
		-11	AASH	TO T-	89 & T-	90	17.000		571874	
SIDE				3	Random Sar	mple Yes		No		
LOCA		JOHN HOWAR	D TP-3 1.5 m			SAMPLE NO.	e 95000.		50000	
MATE	RIAL TYPE	YELLOWISH (	COARSE SOIL			DATE SAMPLED		07/01/20	2.7	
	RIAL SOURCE	JOHN HOWAR	D TP-3 1.5 m			DATE TESTED		13/01/20	19	
	RIAL DESRIPTION			i i		SAMPLED BY				
	RESENTATIVE STATION					TESTED BY	ŝ			
SAMP	LING DEPTH					TEST NO.				
						1	2			
			LIQUID	LIMIT	A .					
Contai	ner No.				D-17	J-69	23	8	8	
Wt of v	wet soil + container, gm				29.78	26.75	27.96	**	è	
Wt of o	dry soil + container, gm		1		26.63	24.06	25.50	Ť.	1	
Wt of v	water		İ		3.15	2.69	2.46	î i	1	
Wt of o	container		j		15.12	13.46	14.78		i)	
Wt of o	dry soil, gm		1		11.51	10.60	10.72		3	
Water	content, %		31		27.37	25.38	22.95		5	
No. of	blows		7		19	24	31			
	30.00	7-7-100 100 110 110 110 110 110 110 110 110				\				
						l r .	Sample prep	aration		
	29.00					As received	annihira birahi			
	28.00				Washed on 0.425mmsieve					
	27.00					Air dried at				
%								4		
int,	28.00					Oven dried at°C				
onte	25,00	****				Proportion retained on 0.425mm sieve				
ű	34.00					1				
Water Content,	200									
5	23,00				<b>\</b>	1 1 2 2	Test Res	ult		
	22.00					Liquid Limit	72761375			
	21.00		1			Plastic Limit	2000000	25.20 % 19.12 %		
							CONTRACT	1 %		
	20.00 5	10 15	20 25	36	) 35	Plasticity Index	0.	.1 %		
		No of I	Blows		2	Shrinkege =	5.	0 mm		
						Shrinkege =	3.	3 %		
			PL	ASTIC	LIMIT	7)). - 100	2	838		
-	ner No.				C-7	D-41		3	Average	
Wt of v	wet soil + container, gm		Į)		22.71	21.96			6	
Wt of o	dry soil + container, gm		Į,		21.60	21.04		ll .		
Wt of v	water				1.11	0.92	É	8	8	
Wt of o	container				15.78	16.24	8	8	8	
Wt of o	dry soil, gm				5.82	4.80	5	8	5	
Water	content, %				19.07	19.17			19.12	
Rema	arks:		_							
Teste	d By: A.KASOKA		Checked By	: S.T.MI	JMBA	Approved By:				
	■ ************************************		Wilder Street Control of the Control			The second secon				
			Date:13/01/2	2019		Date				
			30			**				



	DETERMINAT	101	N 01	MOD	IFIED PI	ROCTOF	R COMPA	CTION		8
		(TIV	H1	MATH	DD A7,AA	SHTO 18	30)			9
SIDE	100					Random Sa	ample Yes		No	
LOCATION	98						SAMPLE NO.			
MATERIAL TYPE	16		ravel			DAT	TE SAMPLED		07/01/2019	
MATERIAL SOURCE	JOHN HOV				399)	D/	ATE TESTED		11/01/2019	
MATERIAL DESRIPTION		11012121	ISH FINE SOIL			_ 8	SAMPLED BY			
REPRESENTATIVE STATI	JOHN HOV	VARE	TP-1	1.5 m (	399)	-33	TESTED BY			
SAMPLING DEPTH							TEST NO.			
No of bloom	EE. 4						Minimum of	kammar ka	4.5	
No. of blows : No. of layers :	55+1 5							hammer,kg of mold,cm <sup>3</sup>		-01
Proportion retained on 19m						Single car	mple / Separat		2345	-59
( pass 50mm sieve and retained		)	0.00		-33		Apparent spe			
								3		
8	Mold		300	No.	M 44	M 44	M 44	M 44	M 44	8 8
Α	WATER		886	%	- 5	7	9	11	13	
В	Wt. of Mold + Wet S	oil		grams	8496	8797	8977	8932	8813	Ĭ ĭ
C	Wt. of Mold	200	335	grams	4087	4087	4087	4087	4087	\$ 9
D	Wt. Wet Soil		330	grams	4409	4710	4890	4845	4726	9 9
E	Volume of Mold		-	cm3	2345	2345	2345	2345	2345	7 3
F	Wet Density		- 1	g/cm3	1.880	2.009	2.085	2.066	2.015	7 3
	Twel Density		48	g/ans	1.000	2.009	2.000	2.000	2.015	35
	Continue		- 17	28022	00.00	K 400	NIM O	0.57	10/4	10 0
G	Container		9	No.	CC-26	K-106	NM-2	O-57	MV-1	4 5
Н	Wt. Cont + Wet soil		37	grams	767.0	773.0	784.0	780.0	764.0	Ny W
	Wt. Cont + Dry soil		8	grams	742.0	737.0	740.0	727.0	705.0	ky vi
J	Weight of Water		- 19	grams	25.0	36.0	44.0	53.0	59.0	4 4
K	Weight of Container		- 19	grams	252.0	247.0	255.0	244.0	262.0	4 4
L	Weight of Dry Soil		38	grams	490.0	490.0	485.0	483.0	443.0	ek e
1000	in the second se		- 88	50%	E 1000	20	0 0	30000000	250 Vice-proper	8
M	Moisture Content		38	%	5.1	7.3	9.1	11.0	13.3	8 0
N	Dry Density	_	- 30	g/cm3	1.789	1.871	1.912	1.862	1.778	
										)
Maximum Dry Density (M	DD):			88888						
			VP25/2/1		*					<del>                                      </del>
MDD =	1.912 g/cm3	.00	1.900							
Accessors	CI SCHOOL HOMEON	dencity ,gloo				+/+-	<del></del>		+	<del></del>
Optimum Moisture Conte	nt (OMC) :	#				/		N .		
		8	1.850	++++		4			+	<del>                                      </del>
0110 -	0.4	00								
OMC =	9.1 %				/				<del></del>	
			1.800							
					44		*		$+\lambda$	180
									1	
			1.750	4 5	6	7 8	9 10	11	12 13	14
										102011
						Moi	sture content,%			
										20
Remarks:										
Tested By: A.KASOKA	Checked	Ву:	r.s.ph	IIRI			Approved By:			**
	Date: 11	(01/20	19				Date			
	Service 11		30%				<del>1,000,000</del>			Ÿ



	DETERMINATIO	and the same of	NO PERSONAL PROPERTY.		The second second	10.00	CTION		
and the state	<u>(</u> T	MH 1	MATHO	D A7,AA	TENNESS OF THE STORY				
SIDE	Vie				Random Sa			No	
LOCATION	÷		22		SAMPLE NO.			07/04/0040	
MATERIAL TYPE		Gravel		100)		E SAMPLED_		07/01/2019	
MATERIAL SOURCE MATERIAL DESRIPTION	JOHN HOWAI		NE SOIL	100)		TE TESTED_		10/01/2019	
REPRESENTATIVE STAT		3. 9.4	N. 10 - 30 00 00 - 10 0	100)	SAMPLED BY_ TESTED BY				
SAMPLING DEPTH	JOHN HOVYA	10 11-	E 1.0 m (-	100)	-0.0	TEST NO.			
OTAMI ENTO DEL TIT						TEOT NO.			
No. of blows:	55+1					Weight of h			
No. of layers :	5				0.	Volume of	mold,cm3	2374	
Proportion retained on 19m ( pass 50mm sieve and retain		88		ī.		nple / <u>Separate</u> Apparent spec		:	
	Mold	T.	No.	M.4	M 4	M 4	M 4	M 4	
Α	WATER		%	3	5	7	9	11	
В	Wt. of Mold + Wet Soil	8	grams	8429	8633	8863	8811	8778	
С	Wt. of Mold	8	grams	4085	4085	4085	4085	4085	8
D	Wt. Wet Soil		grams	4344	4548	4778	4726	4693	
E	Volume of Mold	8	cm3	2374	2374	2374	2374	2374	8
F	Wet Density	3	g/cm3	1.830	1.916	2.013	1.991	1.977	8
		- 2	565	% •	XX X			8	6
G	Container		No.	V-32	T-39	H-27	C-15	T-30	
Н	Wt. Cont + Wet soil		grams	760.0	778.0	747.0	780.0	725.0	
	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	- 4	grams	248.0	251.0	253.0	247.0	244.0	
L	Weight of Dry Soil	33	grams	496.0	502.0	461.0	488.0	433.0	×
M	Moisture Content	Ť	%	3.2	5.0	7.2	9.2	44.4	78
N	Dry Density		g/cm3	1.773	1.825	1.878	1.823	11.1	
	Diy Density	1.900		11110	1.020	1.070	No.	1.130	
Maximum Dry Density (M	DD):	1.300							
						<b>1</b>			#
MDD =	1.878 g/cm3								
		1.850							
Optimum Moisture Conte	ent (OMC) :			/		<u> </u>			<del>                                      </del>
/T-floors and a supplied to the	8			- X			<b>\</b>		
OMC =	7.2 %	100							
		1.800	11111	/			$+\lambda$		
			H	4		<b>.</b>	<u> </u>	$\overline{}$	455
			•						
		1.750	3 4	шшш			9 10		Ш
			3 1	5	6 7	8	9 10	0 11	12
	V				Mois	sture content,%			
Remarks:	9999					1000			
Tested By:	Checked By	r:				Approved By:	290		
	B000000					Date			
	Date:					Date			



	DETERMINATI				SHTO 18		CTION			
SIDE	•				Random Sa			No		
LOCATION						SAMPLE NO				
MATERIAL TYPE	¥	Gravel			DATE SAMPLED 07/01/2019					
MATERIAL SOURCE	JOHN HO	WARD T	P-3 1.5 m	1	DATE TESTED 11/01/2019					
MATERIAL DESRIPTION	And the result of the second o	ISH CO	ARSE SOIL	<u></u>	SAMPLED BY					
REPRESENTATIVE STATI	JOHN HO	WARD T	P-3 1.5 m	1	<u>-</u> ()	TESTED BY_				
SAMPLING DEPTH						TEST NO.				
No. of blows :	55+1					Weight of h	ammer ka	4.5		
No. of layers :	5					200	f mold,cm <sup>3</sup>	U. T. Contraction of the Contrac	7	
Proportion retained on 19m ( pass 50mm sieve and retain		38		29		nple / <u>Separate</u> Apparent spec	batches:			
	Mold	2	No.	M 44	M 44	M 44	M 44	M 44	7	
Α	WATER	80	%	3	5	7	9	11	9 8	
В	Wt. of Mold + Wet Soi	1	grams	8546	8965	9164	9126	8891	9 8	
С	Wt. of Mold		grams	4087	4087	4087	4087	4087	7 8	
D	Wt. Wet Soil		grams	4459	4878	5077	5039	4804	7 8	
Е	Volume of Mold	- 1	cm3	2345	2345	2345	2345	2345	*	
F	Wet Density	- 4	g/cm3	1.901	2.080	2.165	2.149	2.049		
n 36				WE . LESSONAN	50 50 00 00		Decreeses	Mt STAROUST	50 0	
G	Container	Ñ.	No.	T-30	R-95	T-39	V-32	N-115		
н	Wt. Cont + Wet soil		grams	782.0	735.0	766.0	727.0	764.0		
	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	30	grams	521.0	465.0	481.0	439.0	450.0	8 8	
W	Moisture Content		%	3.3	5.2	7.1	9.1	44.4		
M N	Dry Density	30	g/cm3	1.841	1.978	7.1 2.022	1.969	1.844	9 9	
. IN	Diy Density	_	gruno	1.041	1.570	2.022	1.505	1.044		
Maximum Dry Density (M	DD):	2.030	-				+-		$\square$	
	7.99									
MDD =	2.022 g/cm3									
in DD		9 1.980								
Optimum Moisture Conte	nt (OMC) :	opp 1,980								
Optimum Moisture Conte	iit (OMC) .	gene								
0110	7.4	1.930								
OMC =	7.1 %		<del>/</del>			2222222		<b>\</b>		
			++/+					$\rightarrow$	#	
		1.880								
						8888888				
		1.830							10	
		1.030	3 4	5	6 7	8	9 1	0 11	12	
					Mole	ture content.%				
<u>k</u>									-	
Remarks:										
Tested By: A.KASOKA	Checked E	By: S.T.P	HIRI			Approved By:	:0°			
	Date: 11/0	1/2010				Date				
	Date: 11/0	1120 13				Pare				



			CALIEC	DNIA B	EARING RA	TIO				
					T 193	VIIO.				
SAMPLE STATION	JOHN	HOWARD	TP-1 1.5	m (399)	Random Sam	ple Yes		No		
LOCATION	-			900 - 177	_	SAMPLE NO.		250.07 200.07		
MATERIAL TYPE	70	GREYISH	FINE SOIL		-71	TE SAMPLED		07/01/2019		
MATERIAL SOURCE	JOHN	HOWARD	TP-1 1.5	m (399)		12/01/2019				
MATERIAL DESRIPTION		G	avel		S	AMPLED BY				
REPRESENTATIVE STAT	ION	JOHN HOV	VARD TP-1	1.5 m (399)	2	TESTED BY	Œ			
SAMPLING DEPTH	Ø				7/4	TEST NO.				
			DEI		ERMINATION ayer Blows (4,5kg)	OF by F lover	o Diano (4 Eka)	EE hu 2 lavos	o Dlours (2 Else)	
SOAKING CONDITION					ayer blows (4,5kg) Before		efore (4,5kg)		s biows (2,5kg) efore	
MOLD NUMBER					CC-9	770	C-1	C	C-10	
WEIGHT OF SOIL + MOI	_D, g				9678	11.70	426	11.75	258	
WEIGHT OF MOLD, g WEIGHT OF SOIL, g				-	4823 4855	4.0	830 596		884 374	
VOLUME OF MOLD, g					2315	1,07	320	5.05	324	
WET DENSITY OF SOIL					2.097	981	1000	882		
DRY DENSITY OF SOIL,	g/cm <sup>3</sup>				1.925	1.	818	1.	727	
-			MOIS		TERMINATION	1 25 h. 5 le	o Olevo (4 She)	EE h. 21	- Disease (O.Eles)	
SOAKING CONDITION				0	ayer Blows (4,5kg)	757	22.3	1990	200	
				4	Before	Be	efore	B€	efore	
CONTAINER NUMBER				- 8	VB-19		П-2			
WET SOIL + CONTAINE DRY SOIL + CONTAINER				778 734		724 685				
WEIGHT OF CONTAINE					245	247				
WEIGHT OF WATER, g	50,000-704				44		39			
WEIGHT OF DRY SOIL, MOISTURE CONTENT	g				9.0		438 8.9			
	RE CONTE	NT AV=			9.0		.0			
			DENE	TRATION I	BOTTOM TEST					
P	ENETRAT	ION DATE	FLINE	16/01/20			RING FACTOR	0	.00	
		5 Layer Blo	ws (4,5kg)		y 5 layers Blows	(4,5kg)	55 by 3	layers Blows	(2,5kg)	
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)	
0.00	V- V-	0.00 1.10	N/		0.00		-	0.00	5	
1.27		1.76	î l		1.10			0.76	d.	
1.91		2.37			1.62			1.18		
2,54		2.82	21.1		2.12	15.9		1.46	10.9	
3.18 3.81		3.56 4.28		-	2.47		1	1.69	-	
4.45		4.84	7		2.94			2.20	8	
5.08		5.49	27.5		3.20	16.0		2.48	12.4	
5.72		5.81	12		3.48			2.70		
6.35 6.99		6.15 6.66			3.86 4.10			2.86 2.94		
7.62	1 8	6.95	9		4.46		1	3.04	3	
8.26		7.28			4.78	- 0.		3.10	9	
8.89		7.50			5.02			3.16		
9.55		7.59	ji		5.26	Blows	55	3.20 25	55	
6	SWE	LL			rammar	DIUWS	4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date					Initial reading (n		3 - 1 -	3 - 1	-,,-	
Time					Final reading (n					
					Height of special Percent Swell				Š	
Remarks:					reident Swell (	(76)		ļ.		
Tested By: W.MUMBA	)	Checked	By:S.T.Ph	IIRI		Approved	Ву:			
		Date: 12/0	01/2019			Date				



		CALIFO	ORNIA B	EARIN	IG RATIO	<u>0</u>			ý
[			AASHT	O T 19	3				
SAMPLE STATION	JOHN HO	OWARD TP	-1 1.5 m (3			n Sample	YES	NO [	
LOCATION	JOHN HO	OWARD TP	-1 1.5 m (3	99)	SAMPLE	NO.		ATTRICK AT	-Th. 1-2
MATERIAL TYPE	G	REYISH FI	NE SOIL	<u>u</u> g:	DATE SA		03	07/01/20	
MATERIAL SOURCE	3%	2000			DATE TE		03	16/01/201	9
MATERIAL DESRIPTION REPRESENTATIVE STATION	V2	Grave	el .		SAMPLE		<u> </u>		
SAMPLING DEPTH	16 <u>.                                    </u>					TEST NO.			
		% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average %	Standard Lo	ad (KN)
M.D.D (gm/cm <sup>3</sup> )	Ulows	octore soak	750 33	5.29	hours		Swell	2.54 mm	5.08 mm
1.912	55 by 5	9.0	1.925	21.1	0.0	0.00	C MANAGEM	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	<u> </u>	13.24	20.00
8.0 6.0 6.0 4.0 2.0 0.00 1.27 2.54 3.81	5.08 6.35	7.62 8.8		1,950 1,900 1,900 1,850 1,750 1,750 1,650 1,600 9,0		14.0	vaked CBR %		ALUE AT
9000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	at 90% MDD	x ==75/6/1	,	NO.	R Value at 90%	tor one	New York	10.	nov.
CBR Value	at 95% MDD	= 1.816		CBI	R Value at 95%	from the gra	ph =	15	5.5
CBR Value	at 98% MDD	= 1.874		CBR	Value at 98%	from the grap	h =	18	3.7
Comments:			9						Ŷ
Checked By:			APROV	ED BYy:					
Test Results Within	Engineering Li	mits:		Date: Yes	✓ No		(		



CALIFORNIA BEARING RATIO  AASHTO T 193  SAMPLE STATION COUNTY HOWARD TR 2: 15 m (400) Readon Sample Veg No.	
CAMPLE CTATION JOHN HOWARD TO 2 15 m (400) Bondom Comple Voc To No.	
SAMPLE STATION JOHN HOWARD TP-2 1.5 m (400) Random Sample Yes No	SJ - 35
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  55+1 by 5 Layer Blows (4,5kg)   25 by 5 layers Blows (4,5kg)   55 by 3 layers	Rhwe (2 5kg)
	fore
	-B
	329 360
	069
VOLUME OF MOLD, g 2356 2340 2	195
	808
DRY DENSITY OF SOIL, g/cm <sup>3</sup> 1.889 1.789 1.00  MOISTURE DETERMINATION	587
	Blows (2.5kg)
SOAKING CONDITION	fore
	IOIE
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	
	00 (2 Eka)
55+1 by 5 Layer Blows (4,5kg) 25 by 5 layers Blows (4,5kg) 55 by 3 layers Blows PENETRATION (mm) Dial Lead (45h) Dial Lead (45h) 0.8 P.(4) Dial Lead	X
reading reading Load (KN) C.B.R(%) reading Load (KN) C.B.R(%) Dial reading Load (KN)	C.B.R(%)
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	n e
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	š
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	7.2
6.35 3.70 2.39 0.92	
6.99 3.76 2.48 0.97	1
7.62 3.82 2.56 1.04	ş
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           Soaking Date         Initial reading (mm)         4,5kg by 5         4,5kg by 5	2,5kg by 3
Time Final reading (mm)	
Height of specimen (mm)	v v
Percent Swell (%)	
Remarks:	~
Tested By: W.MUMBA Checked By:S.T,PHIRI Approved By:	
Date: 11/01/2019 Date	



		CALIFO	ORNIA BE	ARIN	IG RATIO	<u> </u>			
			AASHTO	T 10	2				
SAMPLE STATION	JOHN I	HOWARD TE	-2 1.5 m (400			n Sample	YES	NO [	7
LOCATION	V		-2 1.5 m (400	-	SAMPLE				i e
MATERIAL TYPE		ROWNISH F	INE SOIL		DATE SA	MPLED	07/01/2019		
MATERIAL SOURCE	( <del>)</del>				DATE TE			15/01/201	9
MATERIAL DESRIPTION REPRESENTATIVE STATION	{{ <del>}</del>	Grave	el .	-0	SAMPLE		<u> </u>		
SAMPLING DEPTH	(f <del>)</del>			-30	TESTED TEST NO		¥ <del></del>		*
OVAIN ENTO DEL TIT	(9	v ·	50 AS	<del>-</del> 0	1201110				*
)	N-16	0/3/-		CDD	% Moisture		/	Standard Lo	ad (KN)
	Number of blows	% Moisture before soak	Dry Density	CBR	after 96	Swell %	Average % Swell	Standard Lo	au (RIII)
M.D.D (gm/cm <sup>3</sup> )	PROMOSA 	STATES AND AREAS		Cr. Th	hours		1.00 (	2.54 mm	5.08 mm
1.878	55 by 5	7.3	1.889	20.1	0.0	0.00	3	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		13.24	20.00
PENETRA'	TION CURV BOT	TOM	$\neg \cap$						$\overline{}$
	Ton cont por	- T - II - I		1.950	22 N N N N				_ <u>(0(0</u> 39
4.0	Brokensk 1		<del>       </del>	1.000					
			228	1.900					<del></del>
		8 8 8 8	2 8 8						
1			Dry Density gm/cc	1.850					
			- I sky	1 000					
(8)			- N	1.800	-		*		
3,0			8°	1.750					
	1900175030	20 20 Mc 3							
				1,700					
			<del>         </del>	500000					
	-		<del>                                     </del>	1.650				CBR VA	LUE AT
	12 19			1.600					38
		20 20 20 20 20		3.0	8	0.0	13.0	18.0	- V- V- XX
0.00 1.27 2.54 3.81	5.08 6.38	7.62 8.	99						- 1
PENETRA	TION(mm)		Ш			So	aked CBR %		72
	2.0-0.4-0.4-0.45		-						
CBR Value	at 90% MD	D = 1.690		CBF	Value at 90%	from the grap	oh =	4.7	i i
			00			CONTROL COSTOR			
CBR Value	at 95% MD	D = 1.784	1	CBF	Value at 95%	from the gran	oh =	11	.9
500000000000000000000000000000000000000		240 0 100 0	9	8000	E-ADENIC MASAN			1.512	16
CBR Value	at 98% MD	D = 1.840	) .	CBR	Value at 98%	from the grap	n =	16	.2
Comments:									
io u E			ago eco.						
Checked By:			APROVE	D BYy:	Y				
· ·			0	ate:	Section.	25	<u> </u>		
Test Results Within	Engineering I	imits:	Ye	15	✓ No				-
Ivo Atouns within	workstone i	and,		nd);	110				



			CALIFO	RNIARI	EARING RA	TIO			
				AASHTO		<u> </u>			
SAMPLE STATION	JO	HOWA	RD TP-3 1		Random Sam	nple Yes		No	
LOCATION	88					SAMPLE NO.			
MATERIAL TYPE	Y	ELLOWISH	COARSE S	SOIL	DAT	TE SAMPLED		07/01/2019	į.
MATERIAL SOURCE	JO	NON NHO	RD TP-3 1	.5 m	D	ATE TESTED		12/01/2019	
MATERIAL DESRIPTION	,00 .00	G	ravel		S	SAMPLED BY			
REPRESENTATIVE STAT	TION	JOHN HOV	VARD TP-3	1.5 m	-77	TESTED BY			
SAMPLING DEPTH			-			TEST NO.			
CONTRICT CONTRICT			DE		ERMINATION ayer Blows (4,5kg	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2.5kg)
SOAKING CONDITION					Before	Be	efore	Be	efore
MOLD NUMBER					B-32		3-02		1-03
WEIGHT OF SOIL + MO WEIGHT OF MOLD, g	LD, g				8346 3318	1.1	330	100	739 249
WEIGHT OF SOIL, g			Ý		5028	-	789		490
VOLUME OF MOLD, g	- 2				2311	100	315	J	302
WET DENSITY OF SOIL					2.176	11	932		950 821
DRY DENSITY OF SOIL,	d/dii		MOIS		TERMINATION	1 1	732	1.	021
V			more	CONTRACTOR OF THE PARTY OF THE	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION				1	Before	Be	efore	Be	efore
CONTAINER NUMBER					D-56	K	L-1	v.	
WET SOIL + CONTAINE					774		747		
DRY SOIL + CONTAINER WEIGHT OF CONTAINE					739 248		714	į.	
WEIGHT OF WATER, g	n, g				35		33	ě	
WEIGHT OF DRY SOIL,	g				491	. 3	167	ů.	
MOISTURE CONTENT	C CONTE	NET ALL			7.1		7.1		
MOISTUR	RE CONTE	NI AV=				· · · · · · · · · · · · · · · · · · ·	.1		
	ENETDAT	ION DATE		16/01/20	BOTTOM TEST		ING FACTOR		.00
		5 Layer Blo			y 5 layers Blows	According to the second		layers Blows	
PENETRATION (mm)	Dial reading	Load (KN)	- a (8) (8) (8) (8) (8)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00	Todding	0.00		rodding	0.00			0.00	
0.64		1.36		Š.	1.01	ė .		0.88	8
1.27		2.84			2.02			1.49	
1.91 2.54		3.68 4.47	33.5		2.86 3.67	27.5		2.20	21.7
3.18		5.42	00.0		4.10	21.0		3.39	2
3.81		6.20			4.76		N -	3.75	
4.45 5.08		7.36 8.20	41.0		5.49 6.39	32.0		4.10	22.4
5.72		9.36	41.0		7.18	32.0		4.47	22.4
6.35		10.47			7.95			5.21	
6.99		11.82			8.74			5.39	
7.62		13.08	3		9.47			5.78	
8.26 8.89		14.18 15.08			10.12 10.58			6.14 6.38	13
9.55		15.87			11.24	DE 2000	C SOUR	6.69	0 3001%
					GA GALLANA	Blows	55	25	55
Soaking Date	SWE	LL			rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3
Time	-				Initial reading (n			Y Y	
	-	tic .			Height of speci				
					Percent Swell	(%)			
Remarks:									
Tested By: W.MUMBA		Checked	By:S.T.ML	JMBA		Approved	Ву:		
		Date:12/0	1/2019			Date			



		CALIFO	ORNIA BI	EARIN	IG RATIO	)			
			400000000000000000000000000000000000000	es Pause 1996s		=-5			
CAMPLECTATION	1011	LLICAVADD	AASHTO	1 19		a Cample	VEC		_
SAMPLE STATION LOCATION	77	20077.000	TP-3 1.5 m	_34		n Sample	YES	□NO □	1
MATERIAL TYPE	77		TP-3 1.5 m DARSE SOIL		DATE SA			10	
MATERIAL SOURCE	100	LOVINOITOC	ANDE SOIL	38	DATE TE		07/01/201		101.01
MATERIAL DESRIPTION	185	Grave	el	39	SAMPLE		100		
REPRESENTATIVE STATION	9/7	1,000	90	765	TESTED	BY	38		10
SAMPLING DEPTH	40 40			- 562 - 765	TEST NO	D.	38		
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	ad (KN)
M.D.D (gm/cm <sup>3</sup> )	DIOWS:	Derore Stak	PERMISHAL KIDGENS	70	hours		Swell	2.54 mm	5.08 mm
2.022	55 by 5	7.1	2.031	33.5	0.0	0.00	8 3	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	8	13.24	20.00
16.0 14.0 12.0 12.0 13.0 14.0 12.0 14.0 12.0 14.0 12.0 14.0 12.0 14.0 15.0 16.0	5, 08 6, 35	7.62 8.	SS SS AND CONTRACTOR OF CONTRA	2.100 2.050 2.000 1.950 1.900 1.850 1.750 1.700 1.650 1.600		23.0	28.0 paked CBR %	9	MALE AT 5%
CBR Value	dan e vezaste	8		1888	R Value at 90%		3	21.	
CBR Value	at 95% MDI	) = 1.921		CBF	Value at 95%	from the gra	ph =	27	7, <mark>4</mark>
CBR Value	at 98% MDI	1.982	2	CBR	Value at 98%	from the grap	h =	30	0.8
Comments:			3						8
Checked By:			APROVI	San Carrier Contract	he:				
				Date:			E		
Test Results Within	Engineering L	imits:	3	es .	No				



#### SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consult-	Location: John	
ants	Howard	Date Tested: 04/01/19
<b>Project: Lusaka Transmission and Distribution Reha</b>	abilitation	Tested by: W. Mumba
Trial Pit No.	Resistivity Ohr	n-Centimetre
1	2908	
2	2509	
3	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



### Annex 5

**Garden Site and Lab Results** 



## STANDARD PENETRATION TEST (SPT) RESULTS

		national Energy		ocation: Ga	rden	Date Tested: 04/01/19
Project: I	Lusaka Transm	ission and Distri	bution Rehabilita	tion		Tested by: W. Mumba
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est.	Bearing Pressure kN/m2
		150	12		28	
1	1	300	17	32		400
		450	15			
		150	20			
2	1	300	19	42		500
		450	23			
		150	20		p.	
3	1	300	26	56		>600
·		450	30			
		150	18			
4	1	300	21	41		500
		450	20			



# DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

		ernational Ener mission and Dis		The state of the s	on: Garden	Date Tested: 0 Tested by: W	
Test Pit N	lo. 1	Test Pit N	No. 2	Test Pit	No. 3	Test Pit N	o. 4
Penetration	Blows	Penetration	Blows	Penetration	Blows	Penetration	Blows
(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)	(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	7	6.3	· W
6.6	F I	6.6	The state of the s	6.6		6.6	
6.9		6.9		6.9		6.9	
7.0	-	7.0	30,	7.0	7	7.0	- N



è																	
					PART	ICLE	SIZ	ZE	DISTR	IBUTIC	N						
			608			1	AAS	нтс	T-27				82				
SIDE:								SA	MPLE N	0							
REPR		NTATIVE	GAR	DEN	TP-1 1.5	m (186	m (1860)		MPLING	DATE:	04/01/2			2019	019		
LOCA	TION	:						ATE:				12/01/2019			9		
Weigh	t After	Washing (g)	52	267	74.0	q			loss ii	n fine :	32.2	85	6.0	g			
			8					los	s in fine	percentag	ge	3:	2%	g			
Weigh		re Washing (g) ieve	Wei		30.0 %	g %			Speci	: fication	+			_			
	=-0100-	e (mm)	Retai (gn	ned	Retained	Pass		Lo	wer Limit	Parameter San	nit	Samp	le prepar Method	ation: O		ned sa	imple
2		50	0.0	20 0	0.0	100	.0							Wet siev			V
	3	37.5	0.0	)	0.0	100							ı	Dry sievi	ng		
	2	26.5	0.0	)	0.0	100	.0										
		19	0.0	0	0.0	100	.0		1			GRADIN	3 MOD	ULUS	(GN	M) =	
	1	3.2	0.0	)	0.0	100	.0							1.2			
		9.5	0.0	)	0.0	100	.0					GRADIN	G COE	FFICIE	NT	(GC)	=
	Ü	6.7	0.0	0	0.0	100	.0							2.7			
	4	1.75	0.0	)	0.0	100	.0										
	2	2.00	96.	0	2.7	97.	3				4						
	1	.18	186	.0	5.3	92.	0		-		- 2						
	- 00	0.6	110	200	31.2	60.	73										
		.425	136		3.9	56.					_						
	90	0.3	236		6.7	50.		_			_						
		).15	406		11.5	38.			-								
		.075	512		14.5	24.					-						
_	1	an	856	.0	24.2	0.0	)	_									
	100.0		7777	TT				П			TT	TITE			Ť	TIT	1
	90.0 -	1 1	+ ++	H		150 da	- 20	5-V 0- 0	1	10.00	<del>1</del> 2223		V.8		40-1	<u> </u>	1
	80.0 -		Series1	33	-	20 30		-/		- 12 14	-1004	10111110	Ã9	+++	78- 1		
	70.0 -		// V-//			10 10		/			1007		92	++	4: 1		1
gui	60.0 -			Н	-		- /		4 8		365	10.000	- 35	-	+		1
ass	50.0 -			S			10.83	2.13.1	18 8		755	2000		10 01	88 8		
% of Passing	40.0 -		12 1/2		-	8-12	-97	3 2 2	ls v		128	week	8			222	
8	30.0 -				1						3000		- 23		4		4
	20.0 -										2005		- 0				1
	10.0 -	A	10 100	Ш							2000	10.10.10.0					
	0.0 -			Ш													].
	0.0	01		0	).1		Sie		i Size, mm			10				1	00
Rema	rks:						200000										
100000000000000000000000000000000000000	(2,555)	BA.KASOKA		9	Checked B	y: T.S.P	HIRI				1	Approved	Ву:				
					Date: 12/01	/2019						Date					



			PART	ICLE SI	ZE DISTR	RIBUTION	ĺ			
		352		AAS	HTO T-27		572			
SIDE:					SAMPLE N	0				
REPRI	ESENTATIVE ON:	GARE	EN TP-2	1.5 m	SAMPLING	DATE:		04/01/20	)19	
LOCAT	TION:	000	TESTING DATE:					12/01/20	)19	
Weight	After Washing (g)	206	88.0	g		n fine :	476.0	g		
Weiaht	Before Washing (g)	254	14.0	a	loss in fine	percentage :	23%	g		
	Sieve	Weight	%	%	Speci	fication	Sample prepar	ration : Oven-drie	d sample	
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	***************************************	d of sieving:		
	50	0.0	0.0	100.0			١.	Wetsleving	<b>✓</b>	
	37.5	172.0	6.8	93.2				Dry sieving		
	26.5	0.0	0.0	93.2						
	19	67.0	2.6	90.6			GRADING MOD	ULUS (GM)	=	
	13.2	61.0	2.4	88.2				1.2		
	9.5	44.0	1.7	86.5			GRADING COE	FFICIENT (C	SC) =	
	6.7	46.0	1.8	84.7				9.6		
	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			ļ			
	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			J			
1	0.00				10000 0				Ⅲ)	
8	0.00		k					-		
98	80.0	- Series 1	N 25	J. + -						
100	70.0	- Series 1	h (1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	1						
Bu	60.0								Щ	
·is	50.0									
of P.	40.0		/						:00462 <b>8</b> :	
8.5	500		, 1						$\square$	
10	30.0	PART   12 W - 21 2	1	-17 11. 71- 170		PA - N - 100		5.0 PAGE 15.00		
9	20.0	*	0. 10						<del>                                      </del>	
	10.0	COS TESTICION	8 8	30 at 30 0	55558 8	2 10 10			entai:	
	0.0		0.1				10		100	
	( - TO TO TO TO TO TO TO TO TO TO TO TO TO	10.3	SC(I)	Si	eve Size, mm		4.50			
Remar	ks:									
DOMESTIC:	By: A.KASOKA		Checked B	y:T.S.PHIRI			Approved By:			
et alma			Date:12/01/				Date			



					PART	ICLE S	IZE	DISTR	IBUTION			
		156				AA:	SHT	O T-27		876		
SIDE:							s	AMPLE N	o			
REPF STAT	RESENTATIVE TON:		G	ARD	EN TP-3	1.8 m	s	AMPLING	DATE:		04/01/2	019
LOCA	ATION:						Т	ESTING (	ATE:	87	12/01/2	019
Weigh	t After Washing (	g)		240	0.0	g		NEED W	fine :	968.0	g	
Weigh	t Before Washing	(a)		336	8.0	a	IC	ss in line	percentage	40%	g	
	Sieve		Weig		%	%		Speci	fication	Sample pres	paration : Oven-drie	ed sample
	size (mm)		Retair (gm		Retained	Passing	L	ower Limit	Upper Limit	100000000000000000000000000000000000000	od of sieving:	
	50	89	0.0	)	0.0	100.0		-		0.0000	Wetsieving	$\checkmark$
	37.5		0.0	)	0.0	100.0					Dry sieving	
	26.5	6	0.0	)	0.0	100.0						
	19	-	0.0	)	0.0	100.0				GRADING MC	DULUS (GM	) =
	13.2	36	0.0	)	0.0	100.0	3 2				1.2	
	9.5		0.0	)	0.0	100.0	1			GRADING CO	EFFICIENT (	GC) =
	6.7	10	0.0	)	0.0	100.0					2.9	0304
	4.75		29.	0	0.9	99.1	1					
	2.00	75	69.	0	2.0	97.1						
	1.18	Ž.	172	.0	5.1	92.0	1			]		
	0.6		1129	0.0	33.5	58.5	-					
	0.425	i	89.	0	2.6	55.8				]		
	0.3		269	.0	8.0	47.8						
	0.15	- N	218	.0	6.5	41.4	1			]		
	0.075		425	.0	12.6	28.7	-					
	Pan		968	.0	28.7	0.0						
	100.0	777	77 7	TTT			717					
	90.0	N- V3	-					1				
	80.0	00 00		deeds			44	/				
	70.0	- · - S	eries 1				1					
	1	1.0	11	ы			1					
% of Passing	60.0					1-						
f Pa	50.0	77	777			-						
%	40.0	4 4			1	777		100 100		00000	A - VA - VI	
- 50	30.0	+		1	0.00		+					
	20.0			+++								
	10.0	8 8	8 8		8 8	8 10 100	22.0	18 S				2829
	0.0	1			4	10 10 10		1				
	0.01			0	.1	s	ieve	Size, mm		10		100
Rema	arks:						100					
RESERVED TO BE	d By: A.KASOKA				Checked B	v: T.S.PHII	RI			Approved By:		
										100 mm		
					Date: 12/01	12019				Date		



			PART	ICLE SI	ZE DISTR	BUTION	L	
8				AAS	HTO T-27			
SIDE:					SAMPLE N	0		
REPR	RESENTATIVE ION:	GARE	EN TP-4	1.5 m	SAMPLING	DATE:	d	04/01/2019
LOCA	TION:				TESTING D	ATE:	d	12/01/2019
Weigh	t After Washing (g)	177	76.0	g	The Company of	n fine :	1139.0	g
Weigh	t Before Washing (g)	29	15.0	a	loss in fine	percentage	64%	g
vvoigii	Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	100000000000000000000000000000000000000	of sieving:
	50	0.0	0.0	100.0			v	Vet sieving
9	37.5	0.0	0.0	100.0			i i	Ory sieving
	26.5	0.0	0.0	100.0				
	19	0.0	0.0	100.0			GRADING MOD	ULUS (GM) =
	13.2	0.0	0.0	100.0				0.9
	9.5	0.0	0.0	100.0			GRADING COE	FFICIENT (GC) =
	6.7	0.0	0.0	100.0				4.7
	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	la di		1	
ſ	100.0	V 6 - 6 10 10 10 1	6 /	10 10 101				
	90.0		8 14	12 12 121	/			
	80.0	- Series 1		1-				
	70.0	001.001		1	1717 V			<del></del>
Bui	60.0			,	13932			
% of Passing	50.0							
of P	40.0		_					
8	30.0				20202 0			
	5500				avav-			
	20.0	*********						
	10.0				1000			
	0.01	(	0.1	Si	eve Size, mm		10	100
Rema	ırks:							
	By: A.KASOKA		Checked B	y: T.S.PHIR	I		Approved By:	
			Date:12/01/	2019			Date	



				ERBE						
			AASH	TO T-	_			-15 -15		-06
SIDE				-	Rando	m San	The state of the s		lo	
LOCAT	ION	GARDEN TP-1					SAMPLE NO.		m. 1 m n 1 n	
	IAL TYPE	GREYISH F	The state of the s				DATE SAMPLED		/01/2019	
	IAL SOURCE	GARDEN TP-1	1.5 m (1860)				DATE TESTED	13	/01/2019	
MATER	IAL DESRIPTION		-	<u> </u>			SAMPLED BY			
	SENTATIVE STATION						TESTED BY			
SAMPL	ING DEPTH						TEST NO.			
8			LIOI	JID LII	MIT					
Containe	ar No		LIQU	וום כוו	G-2		33	69	16	
	et soil + container, gm		-		27.69	V	26.85	24.67	15	
	y soil + container, gm				24.86		24.60	23.20		
Wt of wa					2.83		2.25	1.47	-	
Wt of co	ntainer		3		14.22	5	15.05	16.28		
Wt of dry			9		10.64	9	9.55	6.92		
Water co	Service Control of th		9		26.60	(	23.56	21.24		
No. of bl					18	<u></u>	25	30	-	
Water Content, %	20.00   28.00   27.00   28.00	10 15 No of B				35	As received Washed on 0.425mmsi Air dried at Oven dried at Proportion retained on 0.4  Liquid Limit Plastic Limit Plasticity Index  Shrinkege =  Shrinkege =	.30°C °C		
	00-00 m		PL	ASTIC	LI	TIN				NEWS PA
Containe										Average
	et soil + container, gm									
OO(1) 14,755 1 1	y soil + container, gm									
Wt of wa								1		
Wt of co			]							
	y soil, gm									
Water co	ontent, %		92	è					Į.	
Remark	ks:									
Sa ex av	By: A.KASOKA		Checked B	y: T.S.PH	IIRI		Approved By:			
			Date: 13/01	/2019			Date			



						TER										
				Α	AS	HT	T C		_		_					
SIDE		-						Ra	ndo	m Sa	amp			No		
LOCATION		216 NTS(8710	DEN TP	The state of	500	I						SAMPLE NO.	500,00		200	
MATERIAL TYPE			LOWISH									DATE SAMPLED		04/01/20		
MATERIAL SOU		GAR	DEN TP	2 1.5	m							DATE TESTED		12/01/20	19	
MATERIAL DESI						1						SAMPLED BY				
REPRESENTATI		N										TESTED BY				
SAMPLING DEP	TH	200										TEST NO.				
6		200				500										
0				LIQ	UIE	) LI	МІТ									
Container No.									1			F	Α	3	TS.	
Wt of wet soil + cor	ntainer, gm					1		27	.70	ý.		25.52	23.28	6		
Wt of dry soil + con						1		_	.83	×		23.58	22.12	-2		
Wt of water						1		2	.87			1.94	1.16		15	
Wt of container						Ti -			.46	9		15.06	16.51	-21		
Wt of dry soil, gm						1		_	.37	ģ		8.52	5.61		i e	
Water content, %						1			.24			22.77		e.	i.	
No. of blows						9		_	17			25			i i	
Water Content, % 00.22 00.02 0	6	10	15 No of BI	20 OWS		25		30		35		As received Washed on 0.425mms Air dried at Oven dried at Proportion retained on 0.4  Liquid Limit Plastic Limit Plasticity Index Shrinkege =	.30°C°C°C°C°C°C	30°C ☑ °C ☐		
X					P	LAS	STI	CI	LI	TIN		<del>!</del>				
Container No.						8								9	Average	
Wt of wet soil + cor	ntainer, gm					8								9	ř.	
Wt of dry soil + con	tainer, gm					8								9	Ÿ.	
Wt of water																
Wt of container						89						5		8	Č.	
Wt of dry soil, gm						88						6		8	N.	
Water content, %						88								8	5	
Remarks: Tested By: A.KA	SOKA			Chec	ked	By: 1	ī.S.P	HIR	RI			Approved By:			65	
				Date:	12/0	01/20	19					Date				
5:							and the					1				



		171					
				RG LIMI			
L-		AASH	TO T-	89 & T- 9	90		
SIDE		- 9222		Random Sar			о П
LOCATION	GARDEN TP-	3 1.8 m			SAMPLE NO.		and the second
MATERIAL TYPE	REDDISH FI				DATE SAMPLED		01/2019
MATERIAL SOURCE	GARDEN TP-	3 1.8 m			DATE TESTED	11/0	01/2019
MATERIAL DESRIPTION	7				SAMPLED BY		
REPRESENTATIVE STATION					TESTED BY		
SAMPLING DEPTH					TEST NO.		
6							
,	Ţ.	LIQUID	LIMIT	i.			
Container No.				R-23	D-5	A-47	
Wt of wet soil + container, gm		7	7	28.62	26.78	26.45	iii
Wt of dry soil + container, gm			0	25.80	24.90	24.67	8
Wt of water		0		2.82	1.88	1.78	ii ii
Wt of container				14.26	16.42	15.71	
Wt of dry soil, gm				11.54	8.48	8.96	
Water content, %			- 0	24.44	22.17	19.87	
No. of blows				19	25	32	
						2,000	100
30.00			ш		0.00		
29.00						ample preparation	on
28.00					As received	7	7
27.00					Washed on 0.425mms	ieve	7
28.00					Air dried at	.30°C	5
25.00					Oven dried at	°C Γ	Ħ.
2 34.00 E		$\sim$			Proportion retained on 0.4	25mm sieve	
23.00					10		
D 22.00							
Mater Content 20.00 20.0			$\square$				
20.00						Test Result	
19.00					Liquid Limit	22.30 %	
17.00					Plastic Limit	0.00 %	
16.00					Plasticity Index	N/P %	
	No of Bl	20 25 OWS	30	35	Shrinkege =	0.0 mr	m
					Walds revision of	87300.0000	
					Shrinkege =	0.0 %	
2		PL	ASTIC	LIMIT	507		
Container No.							Average
Wt of wet soil + container, gm		8			8		8
Wt of dry soil + container, gm		6			8	3	9
Wt of water		3			8	3	0
Wt of container							*
Wt of dry soil, gm		10	1				*
Water content, %		10					
80		*			- 10 A	49	303
Remarks:							
Tested By: A.KASOKA		Checked By	y: T.S.PH	IIRI	Approved By:		
2000					82.85 MM		
		Date: 11/01/	2019		Date		



																							LIN							
														1	4/	18	H	T	0	T-	89	3 6	L T	- 9	0		10000			T. Late
SIDE							100													- 3	Ra	nde	om S	Sam				No	1	
LOCA								(	GAI	RDE			7.1		5 n	n								- 35	SAMPLE N		379703.			8080.5
	RIAL T										FIN		0.7	717					_	_					DATE SAMPLE				/2019	
	RIAL S							(	SAI	RDE	N.	TP-	4	1.	5 n	n			_	_					DATE TESTE			12/01	/2019	
	RIAL								_		_	_	_	_	_	_		7.5	_	_	_	_			SAMPLED E					
	ESEN			ST	AT	IOI	N		_	_	_	_	_	_	_	_	- 0	3	_	_					TESTED E					
SAMP	LING	JEP	IH				07 07						_	_	_		8	—	_						TEST N	٥.				
							0					1	L	IC	οι	JII	0	LI	М	IT	O.									
Contair	ner No.	8						_	_			_	100				10				_	71			G-23	ı	D-42	8	48	
Wt of v	vet soil	+ cor	ntair	ner,	gm	1								Т			3				27	.67			26.51	2	7.48	8	322	
Wt of d	try soil +	con	tain	er,	gm	2															23	.68	į.		23.45	2	4.20			
Wt of v														_			1			Т	3.	99	ll.		3.06		3.28	Ť	1	
Wt of o	containe	r															1				13	.78			15.26	1	4.75	T)	100	
Wt of o	lry soil,	gm																			9.	90	1		8.19		9.45			
	content	_																			40	.30	į.		37.36	3	4.71	1		
No. of	blows	9															1				1	8			26		33	ij		
	42.00	1			-	_		_	_	_	_	_		_	_	_	_	_	_	_		_		7						
	41.00						H			$\blacksquare$							1		H			Н			7	Samp	le prep	paration	į.	
	40.00																								As received		1000		1	
	39.00													\											Washed on 0.425n	nmsieve			i	
									I	$\blacksquare$			I		Ì		I		I			П			Air dried at		C	1	1	
%	38.00						*			Ħ			-	H	-		4		Ħ			П	$\blacksquare$		Oven dried at			-	ì	
Water Content, %	37.00						Ħ		I	Ħ	Ħ				Ī	Ħ	Ī	1	\			Ħ			Proportion retained or				1	
out	36.00			H			Ħ			Ħ			Ė			Ħ	#		ď	N		Ħ	$\pm$		r reported retained of	10.42011	il allow.			
l o	35.00			H			H		H	$\blacksquare$	$\blacksquare$	H	H	H	ŧ	H	-		H		1	N			1					
Vat	34.00			Н			Н		H	$\blacksquare$					1	H	1		H			Н								
	33.00			Ш						$\blacksquare$							*					Ш				T	est Re	sult		
	32.00																								Liquid Limit		1000	70 %		
	31.00																								Plastic Limit			40 %		
							П			П				П	I	П			I			П			Plasticity Index			3 %		
	30.00	0	Verte d	5	g <sup>State</sup>	v).dhv	10	Contract of the Contract of th	5000	16		entire torres	2	770	0.000		25	49000	200	30	0	4	36	88					9	
										N	lo of	BI	OWS	8											Shrinkege =		12	.0 mm	d d	
																									Shrinkege =		8	.0 %		
								_	_	_			_	_	_	F	'L	A:	SI	ΓIC			TIN		275 88 	48		-	- 4	
100000000000000000000000000000000000000	ner No.	9			la de la constitución de la cons			_	_	_	_	_	_	_	_	_				_	_	11			56				- 1	Average
3072-PHI 10-01-	vet soil		0.11	-	-	_		_	_	_	_	_	_	_	_	_	1		_			.75			25.45					
AND DESIGNATION OF	try soil :	con	tair	er,	gm			_	_	_	_	_	_	_	_	_	1	_	_	_		.72			23.48					
Wt of v								_	_		_	_	_		_		180	_	_		2.	03	į		1.97	25		8		
-	containe	_							_					_			8	<u>_</u>	_		_	.25			14.26	- 10		8		
111111111111111111111111111111111111111	try soil,													_			8		_		-	47			9.22	20		8	45	100.000
Water	content	, %	_		_	_	_	_	_	_	_	_	_	_	_	_	Ш		_	_	21	.44			21.37					21.40
Rema	007 (DA-107) P.	ye jane	1000	2020	00	_	_	_	—	_	_		120		e731		n Legal	page.	2500	OCCUPATION OF THE PERSON OF TH	10:51	10/10			1					
Teste	d By: A	A.KA	SO	KA	1								C	he	ck	ed	By	<b>/</b> : ]	r.s	.PH	HIR	1			Approved By:					
													D	ate	e: 1	2/	01/	20	19	Agust					Date					
													-												9.6					



					ROCTOR		CHOIL		
OIDE.		(TMH	MATHO	D A7,AA					
SIDE	GARDEN NE	VT TO M	OCTOLIC E	AITH	Random Sa	ample Yes SAMPLE NO.		No	
LOCATION MATERIAL TYPE	GARDEN NE	SAND S	WEIVE	ALLH	0.000	TE SAMPLED		04/01/2019	
MATERIAL SOURCE	GARDE		1.5 m (1860)			ATE TESTED		11/01/2019	
MATERIAL DESRIPTION	, ,	EYISH FII				SAMPLED BY		11/01/2013	
REPRESENTATIVE STAT		The second second	1.5 m (1860)	8	<u> </u>	TESTED BY			
SAMPLING DEPTH	- Orande		1.0 111 (1000)		45	TEST NO.			
ONINI ENTO DEL TIT	0.0000000					TEOT NO.			
No, of blows :	55+1						hammer,kg		
No. of layers :	5				01-1		of mold,cm3	: 2345	
Proportion retained on 19n ( pass 50mm sieve and ret		į 8 <del>.</del>		E)		mple / <u>Separat</u> Apparent spe			
( pass sollilli sieve and rei	direct off Totality Sieve					Apparent spe	One gravity		
	Mold	- 1	No.	M 44	M 44	M 44	M 44	M 44	
A	WATER	-0.	%	1	3	5	7	9	
В	Wt. of Mold + Wet S	oil	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	
	9			2	ř.	3		T /	6
G	Container	9	No.	N-41	L-23	L-98	F-70	M196	
Н	Wt. Cont + Wet soil	- 3	grams	770.0	762.0	758.0	776.0	721.0	
1	Wt. Cont + Dry soil	- 3	grams	765.0	746.0	733.0	742.0	682.0	
J	Weight of Water	8	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	9	grams	510.0	488.0	478.0	494.0	433.0	}
128	100000		607	50.92	202	702020	72.127	8924	
M	Moisture Content		%	1.0	3.3	5.2	6.9	9.0	2
N	Dry Density		g/cm3	1.707	1.785	1.815	1.780	1.691	_
Maximum Dry Density (N	IDD).	1							<b>-</b> 1
waximum bry bensity (w	100).	1.81	0	*					
. Inn	careae reconstru	1020			+A				Н
MDD =	1.815 g/cm3	8			1				
AND CONTROL OF STREET AND CONTROL OF THE	************	00,0° Appure 1.76		++++	4		$\lambda$		
Optimum Moisture Contr	ent (OMC) :	1.76	° — — —						
		940						<del>\                                    </del>	41
OMC =	5.2 %	_							
		1.71				1			
				1111111111	+			+	HI
		7065							41
		1.66	0 1	2	3 4	5 6	7	8 9	10
					Mo	sture content%			
Remarks:									
Tested By: A.KASOKA	Checked	By:T.S.P	HIRI			Approved By	r:		
	SW0,000 C 740								
	Date: 11/					Date			



	DETERMINA	TIO!	N OI	F MOD	IFIED PR	ROCTOR	R COMPA	CTION		
:			A CONTRACTOR OF THE PARTY OF TH	The Control of the Co	DD A7,AA	THE RESERVE TO SERVE THE PARTY OF THE PARTY		· · · · · · · · · · · · · · · · · · ·		
SIDE LOCATION MATERIAL TYPE MATERIAL SOURCE MATERIAL DESRIPTION	GAF	SAI	AR RA ND SO TP-2	ILWAY LIN		Random Sa		<del></del> -	No 04/01/2019 10/01/2019	
REPRESENTATIVE STAT	GAF	DEN	TP-2	1.5 m		o S	TESTED BY TEST NO.	Q.		
No. of blows: No. of layers: Proportion retained on 19m ( pass 50mm sieve and ret.		)	_				Weight of		2374	
	Mold			No.	M 4	M 4	M 4	M 4	M 4	7
A	WATER		Ü	%	1	3	5	7	9	
В	Wt. of Mold + Wet S	oil	j.	grams	8145	8415	8590	8536	8423	
C	Wt. of Mold	-	J.	grams	4085	4085	4085	4085	4085	
۵	Wt. Wet Soil			grams	4060	4330	4505	4451	4338	
E	Volume of Mold		8	cm3	2374	2374	2374	2374	2374	5 5
F	Wet Density			g/cm3	1.710	1.824	1.898	1.875	1.827	8
G	Container		2	No.	К-В	Y-50	R-16	L-12	M-42	¥ - 1
Н	Wt. Cont + Wet soil		Ť	grams	767.0	773.0	780.0	768.0	806.0	7
	Wt. Cont + Dry soil		Ŷ	grams	761.0	756.0	755.0	735.0	760.0	1
J	Weight of Water		Ü	grams	6.0	17.0	25.0	33.0	46.0	1 1
К	Weight of Container	8	Ü	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	
М	Moisture Content		1	%	1.2	3.3	5.0	6.8	9.0	
N	Dry Density		3	g/cm3	1.690	1.765	1.808	1.755	1.677	
Maximum Dry Density (M	DD): 1.808 g/cm3	0,00	1.810							
Optimum Moisture Conte	ent (OMC):	Dry denetty ,g/00	1,760							
OMC =	5.0 %	٥	1.710							
			1,660	0 1	2	3 4	5 6	<i>i</i>	8 9	10
Remarks:										*
Tested By: A.KASOKA	d By:	T.S.PH	IIRI			Approved By	r:		9	



	DETERMINAT	ION	OF	MOE	OIFIE	D PF	ROCI	OR	COMF	PACTIC	N		
		AND DATE OF	VIII COLOR	MATH	SECTION AND ADDRESS OF THE PARTY OF THE PART	ALIEN THE PARTY NAMED IN	GENTLES OF	Commonwed States	88	,,,,,,,			
SIDE							Rando		100	es		No	
LOCATION	GARDEN NE	XTTC	HE	ALTH CE	NTER				AMPLE N	The Contract of the Contract o			25-50
MATERIAL TYPE		SAND					-		SAMPLE	100		04/01/2019	)
MATERIAL SOURCE	GAR		100	1.8 m			-	DA	TE TESTE	D		11/01/2019	
MATERIAL DESRIPTION	RE	DDISH	FINE	ESOIL			-	SA	MPLED E	3Y			
REPRESENTATIVE STAT	GAR	DEN T	P-3	1.8 m			_		TESTED E	3Y			
SAMPLING DEPTH		COLOR ADMINISTRA	31-907	41.000.00					TEST N	0.			
No. of blows :	55+1								Weight	of hamme	,kg:	4.5	_00
No. of layers :	5									e of mold,		2345	
Proportion retained on 19m ( pass 50mm sieve and ret		)	300		-8		Singl			rate batche pecific gra			
	Mold			No.	1	A 44	M	44	M 44	M 4	4	M 44	0.00
A	WATER			%		2	4	ž-	6	8		10	
В	Wt. of Mold + Wet S	oil	- 10	grams	8	136	84	89	8686	861	0	8433	6
C	Wt. of Mold		- 400	grams	4	087	40	87	4087	408	7	4087	: 65
D	Wt. Wet Soil		100	grams	4	1049	44	02	4599	452	3	4346	
E	Volume of Mold			cm3	. 2	345	23	45	2345	234	5	2345	
F	Wet Density			g/cm3	1	.727	1.8	77	1.961	1.92	9	1.853	
G	Container		200	No.	ř a	-90	S-S	55	U-19	M-2	3	C-22	900
Н	Wt. Cont + Wet soil	9		grams	7 50	76.0	727	0.000	779.0	717.	933	762.0	
i i	Wt. Cont + Vvet soil		+	grams	1.00	65.0	708	10.22	750.0	682.		715.0	
j	Weight of Water			grams	7 65	1.0	19.	-	29.0	35.0		47.0	
ĸ	Weight of Container		1	grams	275	52.0	252	2000	259.0	248.	75 m	251.0	
L	Weight of Dry Soil		16	grams	0 37	13.0	456	200	491.0	434.	A 1	464.0	6
	weight of Diy Son		36	grania		10.0	450	.0	451.0	454.	0	404.0	*
М	Moisture Content		- 85	%	115	2.1	4.2	2	5.9	8.1	1	10.1	- 6
N	Dry Density			g/cm3	1	690	1.80	)2	1.852	1.78	5	1.683	
Maximum Dry Density (M	DD):	ſ											₩ Ì
maximum biy bendig (iii													<b>##</b>
MDD =	1.852 g/cm3	123	1.860			-			1				
MDD =	1.852 g/cm3	8									Ш		
0-4		denetty gloo	1.810				/						
Optimum Moisture Conte	ent (OMC):	Je ne					/						
Normal Services	make soo	2	760			1							
OMC =	5.9 %	V.500 20	1.760										
					ш,			-					<del>                                      </del>
		53	1.710		/				1				
					<b>√</b>								
		585											
			1.660	1 2		3	4	5	6	7 8	9	10	11
								Moist	ure content.%				
		_						7000000	**************************************				
Remarks:	- 12												
Tested By: A.KASOKA	Checked	By: T.	S.PH	IIRI					Approved	Ву:			
	Deter 44	(04./204/							Date				
	Date: 11.	01/2013	3					- 1	Date				



	DETERMINAT	ALCO DE LA COLONIA DE LA COLON		FIED PR	CONTRACTOR OF THE PARTY OF THE	6600	CTION		
SIDE	10				Random Sa	Control Control		No	
LOCATION	GARDEN NEAR ZESCO	POLE (OP	POSITE PRES	THE PROPERTY OF THE PROPERTY O		PLE NO.	8		
MATERIAL TYPE	O'NIDENTIAL STEEDOO	SAND SO		JOD! ITHINKS		ESAMPLED		04/01/2019	
MATERIAL SOURCE	GAR	DEN TP-4	No. of the case of			ATE TESTED		11/01/2019	
MATERIAL DESRIPTION		FINESC	10000000			SAMPLED BY		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
REPRESENTATIVE STAT	GAR.	DEN TP-4	Maria de la companya de la companya de la companya de la companya de la companya de la companya de la companya		200	TESTED BY			
SAMPLING DEPTH		Vie Alleriniere	100000			TEST NO.			
	IED/MOVELL							v 2000-	
No. of blows :	55+1					Weight of I		To Carlotte State	
No. of layers :	5				011		f mold,cm <sup>3</sup>		<u>u</u>
Proportion retained on 19m (pass 50mm sieve and retain		. *		80		nple / Separat Apparent spe			
						21 2			
	Mold		No.	M 44	M 44	M 44	M 44	M 44	8
Α	WATER		%	7	9	11	13	15	
В	Wt. of Mold + Wet So	oil	grams	8362	8642	8842	8796	8690	6
С	Wt. of Mold		grams	4087	4087	4087	4087	4087	. Ci
D	Wt. Wet Soil	1	grams	4275	4555	4755	4709	4603	8
E	Volume of Mold		cm3	2345	2345	2345	2345	2345	5
F	Wet Density		g/cm3	1.823	1.942	2.028	2,008	1.963	. A)
100 0	<	95	*0801.004055	00 00000000 000 000 000		W 9		SP	20.
G	Container		No.	V-71	L-69	M-23	C-52	NK	87
Н	Wt. Cont + Wet soil		grams	773.0	731.0	786.0	726.0	748.0	6:
i i	Wt. Cont + Dry soil		grams	738.0	691.0	732.0	670.0	684.0	į.
J	Weight of Water		grams	35.0	40.0	54.0	56.0	64.0	e
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	6
		*		8 8				*	
М	Moisture Content		%	7.1	9.1	11.3	13.3	15.0	8.
N	Dry Density	200	g/cm3	1.701	1.781	1.822	1.773	1.708	10. 10. 10. 10. 10. 10. 10. 10. 10. 10. 10.
Maximum Dry Density (M	8700E3 1171 25	1.830							
WIDD -	1.822 g/cm3	00							
Ontimum Mainters Cont.	nt (OMC)	oolg, than on 1'190	3 2 3 3 3 3 3				1		
Optimum Moisture Conte	nt (OMC):	Janel							
1000000	100 00000 00000	Diy							
OMC =	11.3 %		<del></del>				11111	$\sim$	#
		1.730	+			1			
			4					1	
		5700000						83668888	
		1.680	7 8	9	10 11	12	13 1	4 15	16
									NEAT NO.
					Mos	sture content,%			
Remarks:									
Tested By: A.KASOKA	Checked	By: T.S.Pf	HIRI			Approved By	:		
	12002		market.				25		
	Date: 11/	04/0040				Date			



			CALIFO	RNIAB	EARING RA	TIO			
				AASHT					
SAMPLE STATION	G/	ARDEN TP-			Random Sam	ple Yes		No	
LOCATION	100				- :	SAMPLE NO.	8		
MATERIAL TYPE	140	GREYISH	FINE SOIL		DAT	E SAMPLED		04/01/2019	
MATERIAL SOURCE	G/	ARDEN TP-	1 1.5 m (	1860)	D/	ATE TESTED		12/01/2019	
MATERIAL DESRIPTION	100		D SOIL	100	S	AMPLED BY			
REPRESENTATIVE STAT	TION	GARDEN	TP-1 1.5	m (1860)	<u>-</u> 2	TESTED BY	ő.		
SAMPLING DEPTH	2201	A PART THE PART OF	10.1.111 - 27.00	N. T. T. T.		TEST NO.	00		
			DE		ERMINATION	2700261127601	%		
SOAKING CONDITION					ayer Blows (4,5kg) Before		1 1 41		s Blows (2,5kg) efore
MOLD NUMBER					B-11		efore 3-13		-14
WEIGHT OF SOIL + MO	LD, g				7812	1.5	546	277	269
WEIGHT OF MOLD, g					3406		327		310
WEIGHT OF SOIL, g VOLUME OF MOLD, g					4406 2303	12.0	219 318	77.7	959 309
WET DENSITY OF SOIL	g/cm <sup>3</sup>				1.913		820	1000	715
DRY DENSITY OF SOIL					1.818	1.	729	1,0	629
			MOIS	STURE DE	TERMINATION				
				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION				3	Before	Be	efore	Ве	efore
CONTAINER NUMBER					C-56	1	-45		
WET SOIL + CONTAINE					739		745		
DRY SOIL + CONTAINER					715		720		
WEIGHT OF CONTAINE WEIGHT OF WATER, g					255 24		246 25		
WEIGHT OF DRY SOIL,					460		474		
MOISTURE CONTENT					5.2		5.3		
MOISTU	RE CONTE	NT AV=	20,880,70		TO 100 SOUTH A TO 100 SOUTH	5	.2	2	
	FUETDAT	ON DATE	The Property of the Parket of	A 10 10 10 10 10 10 10 10 10 10 10 10 10	BOTTOM TEST		INIO ELOTOR		00
		5 Layer Blo		16/01/20	y 5 layers Blows		SING FACTOR	layers Blows	.00 (2.5kg)
PENETRATION (mm)	Dial	and the same	ALL STATE OF THE STATE OF	Dial	The Same Company	100000000000000000000000000000000000000	Tages and the second second		100 NATIO
100000000000000000000000000000000000000	reading	Load (KN)	C.B.R(%)	reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00	***		0.00			0.00	
0.64 1.27	1	1.10 2.10	3		0.62 1.19			0.41	8
1.91	4 1	2.63	2.V		1.70	1		1.10	2
2,54	1 0	3.20	24.0		2.22	16.6		1.20	9.0
3.18		3.76	20		2.46			1.37	
3.81 4.45		4.21	0		2.64			1.47	
5.08	1 1	5.10	25.5		3.20	16.0		1.78	8.9
5.72		5.62	3		3.46			1.96	8
6.35 6.99	4	6.17 6.84	N/		3.68 3.90			2.06 2.14	2
7.62	1 -	7.58	7		4.01			2.14	
8.26		8.05			4.11			2.24	¥.
8.89	1 8	8.37	3		4.19			2.26	Š
9.55	4	8.72	2		4.28	Blows	55	2.28	55
	SWE	LL			rammar	Diows	4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date		The state of the s			Initial reading (n		3717	3-1-	3-1-
Time					Final reading (n				8
					Height of special Percent Swell				8
Remarks:					I elcent Swell (	(N)	18 1	25	×.
Tested By: W.MUMBA	. 8	Checked	By:T SDU	IRI		Approved	Rv.		
Tested By: W.MUMBA Checked By:T.SPHII					Approved	-1.			
Date:12/01/2019					Date				
		Jule, 12/0				Date			



8									
		CALIFO	ORNIA B	EARIN	IG RATIO	<u>0</u>			
				40	_				
SAMPLE STATION	040	RDEN TP-1	AASHTO	) 1 19		n Sample	YES	□NO □	_
LOCATION	200 000 0000	RDEN TP-1	1.5 m (1860)	-81	SAMPLE	Charles and the con-	IES		
MATERIAL TYPE	1	GREYISH FI		-37	DATE SA			04/01/20	19
MATERIAL SOURCE	80		The state of the s	-8	DATE TE	STED	185	16/01/201	19
MATERIAL DESRIPTION	100 100	SAND S	OIL		SAMPLE		200 0.07		
REPRESENTATIVE STATION SAMPLING DEPTH	1.0			-20	TESTED		40		
SAMPLING DEPTH	0.0			-30	TEST NO	<i>)</i> .	\$V		8
_	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	oad (KN)
M.D.D (gm/cm <sup>3</sup> )	Diows	before soak	SOUTH CONTROL OF THE	70	hours		Swell	2.54 mm	5.08 mm
1.815	55 by 5	5.2	1.818	24.0	0.0	0.00	S 3	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	8 3	13.24	20.00
A00000	ATION CURV BOT	LLOW		7.633					
10.0				1.850					
	0 18 18 18	3 3 3 5		1					<b>*</b>
8.0				1.800		2 2 2			4
			18/2			3 3 1			
			NO Density am/as	1.750					
S6.0	+		i i i	2000000			-		
3	$\mathcal{L}$		1 8				7		
4.0				1.700					
				- 1				8 8 8	
				1.650					
2.0					<i>-</i>	8 2 8			ALUE AT -
		3 3 3 5		1.600			+		
				8.0		13.0	18.0		23.0
0.00 1.27 2.54 3.81	5.08 6.35	5 7.62 8.1	89						
PENETR	ATION(um)		儿			Sc	aked CBR %		J
CBR Value	at 90% MD	D = 1.634	1	СВІ	R Value at 90%	from the gra	ph =	9.	0
10000 ASO1	-condenses in the condenses in	200					(x —	338	
CBR Value	at 95% MD	end one		CBI	R Value at 95%	from the gra	ph =	10	6.5
CBR Value	at 98% MD	D = 1.779	)	CBR	Value at 98%	from the grap	h =	20	0,9
Comments:									
4									//
Checked By:			APROV	ED BYy:					
				Date:					
Test Results Within	Engineering l	Limits:	,	(es	✓ No		ğ		



			CALIFO	RNIA B	EARING RA	TIO			
					T 193				
SAMPLE STATION	50	GARDEN	TP-2 1.5 n	The state of the s	Random Sam	nple Yes	П	No	П
LOCATION	Th <u>e</u>			101	- contrate the state of the	SAMPLE NO.	. s		- MATERIA
MATERIAL TYPE	15	YELLOWIS	SH FINE SO	IL	DAT	E SAMPLED		04/01/2019	
MATERIAL SOURCE	iii	GARDEN	TP-2 1.5 n	n	D/	ATE TESTED		11/01/2019	
MATERIAL DESRIPTION	27	SAN	ID SOIL		<del>-</del> 0	AMPLED BY			
REPRESENTATIVE STAT	TION	GARDEN	TP-2 1.5 r	n	-	TESTED BY			
SAMPLING DEPTH	-		1000		<del>-</del> 6	TEST NO.			
			DEN		ERMINATION	Miller & Wester	6		
SOAKING CONDITION					ayer Blows (4,5kg)		s Blows (4,5kg) efore		s Blows (2,5kg) efore
MOLD NUMBER			- 1		Before M-12		1-13	2000	[-33
WEIGHT OF SOIL + MO	LD, g		- 8		8592	10.50	336		125
WEIGHT OF MOLD, g					4108		091		112
WEIGHT OF SOIL, g VOLUME OF MOLD, g					2348	4	245 337		013 352
WET DENSITY OF SOIL	o/cm <sup>3</sup>		- 4		1,910	303	816	1007	706
DRY DENSITY OF SOIL			- 8		1.820		732		626
	-5-13-01		MOIS	TURE DE	TERMINATION				)
SEARCH STORY AND AND A				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION					Before	Be	efore	Be	efore
CONTAINER NUMBER			Ţ,	- 1	M-1000	- 70	1-31		
WET SOIL + CONTAINE DRY SOIL + CONTAINER					728 706		727 704		
WEIGHT OF CONTAINE					250		242		-
WEIGHT OF WATER, g					22		23		
WEIGHT OF DRY SOIL,	g				456		162		
MOISTURE CONTENT	DE CONTE	NIT AV			4.8		5.0		
WOISTON	RE CONTE	NI AV=	02000000			4	.9	V	
	ENETDAT	ION DATE	100000000000000000000000000000000000000	15/01/20	BOTTOM TEST		ING FACTOR		.00
		5 Layer Blo			y 5 layers Blows			layers Blows	OFFICE OUT
PENETRATION (mm)	Dial reading	Load (KN)	0 10 10 10 10	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00	redding	0.00	1	rooding	0.00		1	0.00	
0.64		1.28	1 0		0.67			0.42	
1.27	5	1.95	5 14		1.16			0.64	
1.91 2.54		2.42 3.10	23.2		1.68 2.28	17.1		1.02	10.3
3.18		3.83	20.2		2.86	11.1		1.68	10.0
3.81	9	4.78			3.30		9	1.85	
4.45		5.96	20.4		3.89	24.0		2.04	40.6
5.08 5.72	33	7.22 8.60	36.1		4.37 4.92	21.9		2.12	10.6
6.35		9.90			5.37			2.47	
6.99		11.07	1		6.10		- 5	2.69	
7.62		11.98	8		6.69			2.87	
8.26 8.89		12.66 13.05			7.12 7.76	1		3.20 3.48	
9.55		13.29			8.11			3.62	
	34	10 30000000	M: 8		30 10000	Blows	55	25	55
0.11	SWE	LL			rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date Time		111			Initial reading (n				
Time					Height of speci		- 2		2
					Percent Swell				
Remarks:					32	nd4) - 4	× 8	8 9	
Tested By: W.MUMBA	V.	Checked	By: T.S.PI	IIRI		Approved	Ву:		
		Date: 11/0	01/2019			Date			



		CALIE	DNIA D	EA DIN	IG RATIO	2			E
		CALIFO	KNIA D	EARIN	IG KATI	<u>J</u>			
			AASHTO	T 10	2				
SAMPLE STATION	(	SARDEN TP-	The state of the s	)   19		n Sample	YES	NO [	7
LOCATION		SARDEN TP-	TO VISITATION	-23	SAMPLE	The same of the sa			-
MATERIAL TYPE	Y	ELLOWISH	INE SOIL	_% 	DATE SA		5. <del></del>	04/01/20	
MATERIAL SOURCE MATERIAL DESRIPTION	0.00	SAND S	OIL		SAMPLE		4	15/01/201	9
REPRESENTATIVE STATION	26	SAINUS	OIL	-0	TESTED	Water Co.	5.5		- 1
SAMPLING DEPTH	25			-8	TEST NO	O.	Se se		- 0
*	1		1		T		De 19		
	Number of	% Moisture	Day Donoity	CBR	% Moisture after 96	Swell %	Average %	Standard Lo	ad (KN)
M.D.D (gm/cm <sup>3</sup> )	blows	before soak	Dry Density	%	hours	SWEII 76	Swell	2.54 mm	5.08 mm
1.808	55 by 5	4.8	1.820	23.2	0.0	0.00	The state of	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	580/85/05 0	13.24	20.00
DENIETON	TION CURV BOT	PT/W	$\overline{}$						$\overline{}$
PENETIC	TON CORY DO	TOR		1.850 -					AL 480 (1)
18.0				1.000					
16.0					0 1 2 0				^
		2 4 2 2		1.800					
14.0			Solmonison						
gl2.0				1.750	8 48 8	8 18 8	-/		
g2.0 g0.0		/					/		
3"			8	1,700			1		
8.0									
6.0		X		200					
4.0				1.650				C00, 3W	LLUE AT
1 10				- 1	•				5% -
2.0				1.600		14.0	19.0	Sk 10	24.0
0.0				5.0		14.0	19.0		24.0
0.00 1.27 2.54 3.81	5.08 6.35	7.62 8.	89			S	paked CBR %		
PENETR	TION(mm)								
CBR Value	at 90% MD	D = 1.627	,	CBI	R Value at 90%	from the gra	ph =	10.	3
CBR Value	at 95% MD	D = 1.718	ı	CBI	R Value at 95%	from the gra	ph =	16	.2
CBR Value	at 98% MD	D = 1.772	2	CBR	Value at 98%	from the grap	h =	39	.5
Comments:			36						7.
Checked By:			APROV	ED BYy:					
			10	Date:			ii.		
Test Results Within	Engineering I	imits:		Yes	No				
2									8



			CALIFO	RNIAB	EARING RA	TIO			
					D T 193	····o			
SAMPLE STATION		GARDEN	TP-3 1.8 n	VIEW CONTRACTOR	Random Sam	ple Yes	П	No	П
LOCATION	100				- 5	SAMPLE NO.	8		
MATERIAL TYPE	100	REDDISH	FINE SOIL		DAT	E SAMPLED		04/01/2019	Č.
MATERIAL SOURCE		GARDEN	TP-3 1.8 n	n	D/	ATE TESTED		12/01/2019	
MATERIAL DESRIPTION	···	SAN	ID SOIL		S	AMPLED BY			
REPRESENTATIVE STAT	ION	GARDEN	TP-3 1.8 r	n	-x-	TESTED BY	ė.		
SAMPLING DEPTH			CEXTS			TEST NO.	9		
			DEN		ERMINATION ayer Blows (4,5kg)	25 by 5 laver	e Blows (4 5kg)	55 by 3 layer	e Blows (2 5kg)
SOAKING CONDITION					Before		efore		efore
MOLD NUMBER					B-20		3-23		1-25
WEIGHT OF SOIL + MOI WEIGHT OF MOLD, g	LD, g				7838 3275		696 404		299 215
WEIGHT OF SOIL, g					4563	4	292		084
VOLUME OF MOLD, g	- S833;		8		2310	4.00	300	2	325
WET DENSITY OF SOIL	g/cm <sup>3</sup>				1.975 1.865		.866 .762	9.135	757 659
DRY DENSITY OF SOIL,	g/cm*		MOIS	TUDE DE	TERMINATION	1 1	.702	1.	039
			MOIS		ayer Blows (4,5kg)	25 by 5 layer	s Blows (4.5kg)	55 by 3 layer	s Blows (2.5kg)
SOAKING CONDITION					Before	3	efore		efore
CONTAINER NUMBER	OV- THE				G-97	ŀ	C-17		
WET SOIL + CONTAINE					738		771		
DRY SOIL + CONTAINER WEIGHT OF CONTAINE					711 255		742 247		
WEIGHT OF WATER , g					27		29		
WEIGHT OF DRY SOIL,					456	7 0	495		
MOISTURE CONTENT	RE CONTE	NT AV=			5.9		5.9		
WOOTO	C CONTE	INI AV-	DENE	TDATION I	BOTTOM TEST		.7		
P	ENETRAT	ION DATE	April many miner	16/01/20		F	RING FACTOR	0	.00
A STREET COLOR COMMUNICATION CONTRACTOR COLOR		5 Layer Blo			y 5 layers Blows	(4,5kg)		layers Blows	(2,5kg)
PENETRATION (mm)	Dial reading	Load (KN)	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00			0.00			0.00	
0.64 1.27	1	1.46 2.30	8 8		0.86 1.64	<u> </u>		0.42	ġ.
1.91		3.37	2		2.18			1.37	
2,54	0 0	4.21	31.6		2.89	21.7		1.78	13.3
3.18		4.68			3.49			1.94	
3.81 4.45		5.20 5.86	8 8		4.14 4.56	35		2.16 2.28	6
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	2
6.99 7.62		8.02 8.62			6.24			3.16 3.28	
8.26		9.20	7		7.01			3.44	*
8.89		9.45			7.13			3.49	8
9.55		9.68	Į.		7.24	0.000	2 CONT. A	3.56	2 12007
	SWE	11			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3
Soaking Date	3111	LL			Initial reading (n	nm)	4,ong by 5	4,ong by o	2, ong by o
Time	1				Final reading (n	nm)	4		
					Height of specia				
Domodro:					Percent Swell	(%)		3	8
Remarks:		1000		3000		FOX:	Anna		
Tested By: W.MUMBA		Checked	By: T.S.PI	IIRI		Approved	Ву:		
		Date: 12/0	01/2019			Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	<u> </u>			3,	
			AASHTO	T 10	2					
SAMPLE STATION	G	SARDEN TP-		ו ו ופ		n Sample	YES	NO [	7	
LOCATION	- 0	ARDEN TP-	3 1.8 m	—# —#	SAMPLE	T000000 /00	8 <del>-1</del> 8			
MATERIAL TYPE		REDDISH FI	NE SOIL	—66	DATE SAMPLED 04/01/2019					
MATERIAL SOURCE MATERIAL DESRIPTION	200	SAND S	OII	<b>—</b> %6	SAMPLE		16/01/2019		9	
REPRESENTATIVE STATION	9	SANDS	OIL	-37	TESTED	30000	X <del>2</del>			
SAMPLING DEPTH	3				TEST NO		25 <u></u>			
	Number of blows	% Mo isture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average %	Standard Lo		
M.D.D (gm/cm <sup>3</sup> )	S CHECKES			20000	hours		AV A	2.54 mm	5.08 mm	
1.852	55 by 5	5.9	1.865	31.6	0.0	0.00	3	13.24	20.00	
O.M.C. %	30 by 5	5.9	1.762	21.7	0.0	0.00	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	
10.0 8.0 8.0 4.0 2.0 0.00 1.27 2.54 3.81	S. OR 6. 35		25 And Dark Company	1.900 1.850 1.800 1.750 1.760 1.650 1.600	17		22.0 aked CBR %		MUE AT 5% 32.0	
CBR Valu	e at 90% MD	D = 1.667	0	CBR	Value at 90%	from the grap	ph =	13.	4	
CBR Valu	e at 95% MD	D = 1.759	ri e	CBR	Value at 95%	from the grap	ph =	21	1.7	
CBR Valu	e at 98% MD	D = 1.815	5.2	CBR	Value at 98%	from the grap	h =	26	5.7	
Comments:										
Checked By:			APROV	CONTRACTOR OF THE PARTY OF THE						
Test Results Within	n Engineering L	imits:		Date: /es	✓ No				3	



-			CALIFO	RNIA B	EARING RA	TIO					
			_		T 193	125					
SAMPLE STATION	000	GARDEN	TP-4 1.5 n	The state of the s	Random Sam	nple Yes		No			
LOCATION	·			91		SAMPLE NO.	10 10 En		XIS/M		
MATERIAL TYPE	100	FIN	E SOIL		DAT	TE SAMPLED		04/01/2019	i.		
MATERIAL SOURCE	144	GARDEN'	TP-4 1.5 n	n	D	DATE TESTED 12/01/2019					
MATERIAL DESRIPTION	,	SAN	ID SOIL		SAMPLED BY						
REPRESENTATIVE STATE	TION	GARDEN	TP-4 1.5 r	n	-0	TESTED BY					
SAMPLING DEPTH	-		2000		-X	TEST NO.	Ĭ.				
			DE		ERMINATION	Wittenselle is					
SOAKING CONDITION					ayer Blows (4,5kg Before		s Blows (4,5kg) efore		s Blows (2,5kg) efore		
MOLD NUMBER			-		B-35	4.0	3-36	0.000	3-39		
WEIGHT OF SOIL + MO	LD, g				7960		869		486		
WEIGHT OF MOLD, g					3257		335	-	280		
WEIGHT OF SOIL, g VOLUME OF MOLD, g					4703 2311		332		206 295		
WET DENSITY OF SOIL	. a/cm³				2.035	1 A 150	944		833		
DRY DENSITY OF SOIL					1.828	1.	746	1.	646		
			MOIS		TERMINATION						
SOAKING CONDITION				55+1 by 5 L	ayer Blows (4,5kg	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)		
SOAKING CONDITION					Before	Be	efore	Be	efore		
CONTAINER NUMBER	entre s				D-78	(	)-11				
	WET SOIL + CONTAINER, g				745		760				
DRY SOIL + CONTAINER WEIGHT OF CONTAINE			-		695 248		708 255				
WEIGHT OF WATER, g			- 5		50		52				
WEIGHT OF DRY SOIL.					447		453				
MOISTURE CONTENT	OF CONTE	AIT AV			11.2		1.5				
MOISTU	RE CONTE	NI AV=	700 0000000				1.3	χ.			
	ENETDAT	ION DATE		16/01/20	BOTTOM TEST		RING FACTOR		.00		
		5 Layer Blo			y 5 layers Blows			layers Blows			
PENETRATION (mm)	Dial	Load (KN)	San Mariantina	Dial	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)		
	reading	STATE OF THE PARTY.	C. D.N(70)	reading	The Column Colum	C. D.N( 70)	Dial reading	course Money	C.D.N(70)		
0.00		0.00 1.20			0.00			0.00	8		
1.27	1	1.97			1.42			0.96			
1.91	W- //	2.81			2.06	- N		1.37			
2.54		3.67	27.5		2.69	20.2		1.67	12.5		
3.18 3.81		4.36 5.02			3.02			1.96 2.20			
4.45	30	5.78			3.74			2.48			
5.08	1 1	6.27	31.4		4.10	20.5		2.62	13.1		
5.72		6.63			4.49			2.84			
6.35 6.99	4	7.20 7.48			4.86 5.08	-		3.02			
7.62		7.40	2 3		5.36			3.17	6		
8.26	*	8.12			5.64	*		3.32			
8.89		8.32	Ü i		5.87			3.45			
9.55	1	8.54		-	6.10	Diama		3.58			
	SWE	11			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3		
Soaking Date	OTTE				Initial reading (r	nm)	4,ong by 5	4, ong by o	Z, Jing by J		
Time	- 2				Final reading (n	nm)			ŝ		
		9			Height of speci						
Damada					Percent Swell	(%)			<u>.</u>		
Remarks:		Taxa-a		Transaction of the Control of the Co		1	NAME OF TAXABLE PARTY.				
Tested By: W.MUMBA	kë.	Checked	By: T.S.PI	HIRI		Approved	By:				
		STATE OF THE PARTY				1000					
		Date: 12/0	01/2019			Date					



2		CALIFO	ORNIA E	BEARIN	IG RATIO	0			
í Í				O T 19		<del></del> si			
SAMPLE STATION	0	SARDEN TP-	- Charles and the second	0 1 19		n Sample	YES	NO [	1
LOCATION	55.75	SARDEN TP-	M. VSHENIEW	-8	SAMPLE	AND CASE OF THE PARTY OF THE PA	120		
MATERIAL TYPE	- N	FINE S	OIL	- 23	DATE SA	MPLED		04/01/20	19
MATERIAL SOURCE	965 19 <del>5</del>				DATE TE		9W	16/01/2019	)
MATERIAL DESRIPTION	26	SAND S	OIL		SAMPLE	(Mariana)	707 76-		
REPRESENTATIVE STATION SAMPLING DEPTH	25				TESTED TEST NO		h <del>e</del> he		
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Loa	id (KN)
M.D.D (gm/cm <sup>3</sup> )	Olons	octore south		1	hours		Swell	2.54 mm	5.08 mm
1.822	55 by 5	11.2	1.828	27.5	0.0	0.00	7	13.24	20.00
O.M.C. %	30 by 5	11.5	1.746	20.2	0.0	0.00	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
10.0 8.0 8.0 96.0 2.0 0.00 1.27 2.54 3.81	5. 08 6. 35 VTON(mn)	7.62 8.		1.850 1.800 9 Le bisser 1.750 1.750 1.650	12.0		17.0 Daked CBR %	CBR VA 95	
	at 90% MD	0.00	6)	15,000	R Value at 90%		8000	12.4	82
CBR Value	at 95% MD	D = 1.731		CBI	R Value at 95%	from the gra	ph =	19.	3
CBR Value	at 98% MD	D = 1.780	i e	CBR	Value at 98%	from the grap	h =	24.	0
Comments:									8
Checked By:			APRO	VED BYy:	× .				
				Date:					
Test Results Within	Engineering L	imits:		Yes	✓ No		%		



### SOIL RESISTIVITY TEST RESULTS

Client: Intec GOPA International Energy Consult-			
ants	Lo	cation: Garden	Date Tested: 04/01/19
<b>Project: Lusaka Transmission and Distribution Reha</b>	bilit	ation	Tested by: W. Mumba
Trial Pit No.		<b>Resistivity Ohm</b>	-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



## Annex 6

Kanyama Site and Lab Results



## STANDARD PENETRATION TEST (SPT) RESULTS

Client: G	OPA-ITEC Inter	national Energy		Location: Kanyama	Date Tested: 04/01/19
Project: L	usaka Transm	ission and Distri	bution Rehabilita		Tested by: W. Mumba
Trial Pit No.	Base Depth (m)	Penetration (mm)	Blows/150mm	N-Value	Est. Bearing Pressure kN/m2
		150	>55		
1	1	300		>60	>600
		450			
		150	>55		
2	1	300		>60	>600
		450			
		150	>55		
3	1	300		>60	>600
		450			
		150	>55		
4	1	300		>60	>600
		450			



# DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Client: GOPA	-ITEC Int	ernational Ene	rgy Consu	ıltants Locati Kanya		Date Tested: 0	4/01/19	
Project: Lusa	ka Trans	mission and Dis	stribution			Tested by: W	. Mumba	
Test Pit N	o. 1	Test Pit N	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		0		



			PART	ICLE SIZ	ZE DISTR	BUTION	i		
		38		AAS	HTO T-27				
SIDE:					SAMPLE N	0			
REPRESEN STATION:	NTATIVE	KANYAMA T	P-1 1.3 m	(409) (900m	SAMPLING	DATE:		08/01/2019	
LOCATION	1				TESTING D	ATE:		13/01/2019	
Weight After	Washing (g)	189	3.0	g	The same of the sa	n fine :	296.0	9	
Weight Befo	re Washing (g)	218	9.0	g	loss in fine	percentage :	16%	g	
	ieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample	
size	(mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	Method	d of sieving:	20
	50	0.0	0.0	100.0			-	Wet sieving J	
3	37.5	0.0	0.0	100.0				Dry sieving	e e
2	26.5	0.0	0.0	100.0					
190	19	11.0	0.5	99.5			GRADING MOD	ULUS (GM) =	
	3.2	23.0	1.1	98.4				2.1	
	9.5	29.0	1.3	97.1			GRADING COE	FFICIENT (GC) =	_
	6.7	86.0	3.9	93.2				45.9	
72	1.75	187.0	8.5	84.7					
	2.00	850.0	38.8	45.8					
	.18	245.0	11.2	34.6			-		
	0.6	63.0	2.9	31.7			-		
	.425	37.0	1.7	30.1	-		1		
	0.3	57.0	2.6	27.5			1		
187	0.15	184.0	8.4	19.0			1		
	.075 Pan	121.0 296.0	5.5 13.5	13.5 0.0			1		
	all	290.0	13.5	0.0			1		
100.0									
90.0	1 1	E EEE				1			
80.0		- Series 1		A- 8 - 1 - 10-		1			
70.0	X	To a company				1			
.g 60.0						,			
60.0 - 60	4 4	9 322444	2	25 50 55 55	2222 2	1			
o 40.0					/				
30.0	4								
20.0									
10.0		1							
0.0		10 (70) 100							
0.0	01	.0	.1	Sie	eve Size, mm		10	100	
Remarks:									
Tested By:	A.KASOKA		Checked B	y:S.T.PHIRI			Approved By:		
			Date:13/01/	2019			Date		



				PART	ICLE SI	ZE DISTR	BUTION	ĺ	
					AAS	HTO T-27			
SIDE	:					SAMPLE N	0		
REPE		NTATIVE	KANYAM	A TP-2 0.	5 m (410)	SAMPLING	DATE:	8	08/01/2019
LOCA	OITA	<b>N</b> :	% 			TESTING (	DATE:		12/01/2019
Weigh	nt Afte	r Washing (g)	255	9.0	g	II Casacter	n fine :	512.0	9
\\/eigt	t Befr	ore Washing (g)	307	1.0	a	loss in fine	percentage	20%	g
vveigi		Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample
		e (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit		d of sieving:
		50	0.0	0.0	100.0			١	Wet sieving
	- 5	37.5	0.0	0.0	100.0				Dry sieving
	- 5	26.5	0.0	0.0	100.0				
		19	0.0	0.0	100.0			GRADING MOD	ULUS (GM) =
	- 1	13.2	16.0	0.5	99.5				2.1
	- (	9.5	56.0	1.8	97.7			GRADING COE	FFICIENT (GC) =
		6.7	160.0	5.2	92.4				45.2
		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			ļ	
	(	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			J	
f	100.0		100 1000	3 10				-   -   -	
	90.0	+ + +		3 3	30 St 00 S	121212 V	-		
	80.0		Sarion 1	0 00				10.0000	
	70.0		- Series 1	0 20			,		
Bu	60.0						,	10 10 10 10 10 10	
assi	50.0						,		
% of Passing	40.0			s s		/			
8	30.0		(60) - (20)	0 26			16 18 12		
	20.0		1						
	10.0			200		10.10.10.10.		10.10.101	
27822	0.0	0.01	0	.1	e.	1 eve Size, mm		10	100
Rema	arka:				. 31	eve Size, min			
_		A.KASOKA		Checked B	y:T.S.PHIRI			Approved By:	
				Date:12/01/	2019	Date			



			PART	ICLE SIZ	ZE DISTR	IBUTION	L	
		8		AAS	HTO T-27		*	
SIDE:					SAMPLE N	o		
REPR	ESENTATIVE ION:	KANY	AMA TP-3	0.3 m	SAMPLING	DATE:		08/01/2019
LOCA	TION:			96	TESTING (	DATE:	55	13/01/2019
Weigh	t After Washing (g)	250	04.0	g	1957575	n fine :	674.0	g
Weigh	t Before Washing (g)	317	78.0	a	loss in fine	percentage	27%	g
	Sieve	Weight	%	%	Speci	fication	Sample prepar	ation : Oven-dried sample
	size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit	6 911 ROD W. FOR STOCK #8 925	of sieving:
	50	0.0	0.0	100.0			V	Vet sieving ✓
	37.5	0.0	0.0	100.0			t	Dry sieving
	26.5	0.0	0.0	100.0				
8	19	0.0	0.0	100.0			GRADING MOD	ULUS (GM) =
	13.2	22.0	0.7	99.3				1.9
2	9.5	86.0	2.7	96.6			GRADING COE	FFICIENT (GC) =
	6.7	174.0	5.5	91.1				37.9
8	4.75	296.0	9.3	81.8				
	2.00	896.0	28.2	53.6				
Ø.	1.18	303.0	9.5	44.1			1	
	0.6	97.0	3.1	41.0			1	
	0.425	56.0	1.8	39.3				
	0.3	82.0	2.6	36.7			1	
	0.15	310.0	9.8	26.9			1	
	0.075	182.0	5.7	21.2			1	
	Pan	674.0	21.2	0.0				
	100.0	en at sentence	(a) (7)	(0 jes 1/07)	Salara y	2 99 1000		
	2019/200				707035			
						,		
	0.08	- Series 1	0 0	7 4 50	979783 V	1		
	70.0	7 7 7 7			raras a	1		
gui	60.0	8 8 8 8 8	8 8	8 15 68		1	Catalogue B	
% of Passing	50.0				1			
of E	40.0							
8	30.0		,					
	20.0							
	10.0							
	0.0							
	0.01	(	.1	Si	eve Size, mm		10	100
Rema	rks:							
1 X-20 A 10 A 0	By: A.KASOKA		Checked B	y:S.T.PHIRI			Approved By:	
			Date:13/01/	2019			Date	



		PART	ICLE SI	ZE DISTR	IBUTION	i.	
			AAS	HTO T-27			
SIDE:				SAMPLE N	0		
REPRESENTATIVE STATION:	KANY	AMA TP-4	0.3 m	SAMPLING	DATE:		08/01/2019
LOCATION:				TESTING D	ATE:		12/01/2019
Weight After Washing (	g) 210	05.0	g	10 10 10 10 10 10 10 10 10 10 10 10 10 1	fine :	141.0	g
Weight Before Washing	(g) 224	46.0	a	loss in fine	percentage	7%	g
Sieve	Weight	%	%	Speci	fication	Sample prepara	ation : Oven-dried sample
size (mm)	Retained (gm)	Retained	Passing	Lower Limit	Upper Limit		of sieving:
50	0.0	0.0	100.0			v	Vet sieving 🗸
37.5	0.0	0.0	100.0			, c	Ory sieving
26.5	0.0	0.0	100.0				
19	0.0	0.0	100.0			GRADING MOD	ULUS (GM) =
13.2	20.0	0.9	99.1				2.0
9.5	53.0	2.4	96.7			GRADING COEF	FFICIENT (GC) =
6.7	98.0	4.4	92.4				30.3
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				
100.0							
90.0							
80.0	er is telester			New Steel	/		
20040	Series 1				/		
70.0	a regard				,		
60.0				/			
60.0 Lassing 50.0 40.0			3 3 3 8				
\$ 40.0							
30.0			1	V = X = X			<del></del>
20.0	0 0 0 0 0 0 0	-		( - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -			
10.0							
0.0							
0.01	(	0.1		1		10	100
			Si	eve Size, mm			
Remarks:		Charlest	we T DUID	(4)		Annuaus d D.	
Tested By: A KASOKA		SCOOL COLLEGE STATE	y:S.T.PHIRI			Approved By:	
		Date:12/01/	2019			Date	



	ATTI	ERBERG LIMIT				
		TO T-89 & T- 9				
SIDE		Random Sam		П №		
LOCATION	KANYAMA TP-1 1.3 m (409) (900m)		SAMPLE NO.		<u> </u>	
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 DESRIPTION	***********		SAMPLED BY	1777	X-1-1X-2	
REPRESENTATIVE STATION			TESTED BY			
SAMPLING DEPTH			TEST NO.			
	LIQUID	LIMIT		\$		
Container No.	LIGOID	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	70	
24.00	TOOL ENGINEER ENGINEER STREET				15	
23.00				Sample preparation	ii	
22,00			As received			
			Washed on 0.425mms	iove		
21.00			Air dried at	CO		
\$ 20.00			Oven dried at			
19.00			Proportion retained on 0.4	9347		
18.00			reported retained or o	Evilla severiment	****	
17.00						
17.00 - 17.00 - 19.00						
15.00			Ø.	Test Result		
14.00	1		Liquid Limit	18.50 %		
13.00			Plastic Limit	0.00 %		
			Plasticity Index	S/P %		
12.00 0 5	10 15 20 25	30 36	C 4277 (000)	2.0 mm		
	No of Blows	J	Shrinkege =	2.0 mm		
215			Shrinkege =	1.3 %		
	PL	ASTIC LIMIT	76	5. VII.	Pa	
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 B	y:S.T.KASOKA	Approved By:			
			THE RESERVE OF THE PARTY OF THE			
2	Date:12/01/	2019	Date			
		South St				



			ATT		20 1 18	u <del>-</del>			
					RG LIN				
			AASH		89 & T				
SIDE			0.5 (110)		Random S		□ No		
LOCA	11.00	GREYISH F	C 1/5 000 NO 000 NO 000 NO			SAMPLE NO.	00/04	2010	
2000	RIAL TYPE	KANYAMA TP-2				DATE SAMPLED	08/01 13/01		
	RIAL SOURCE RIAL DESRIPTION	KANTAWA IF-2	0.5 (11(410)			DATE TESTED SAMPLED BY	13/01	12019	
	ESENTATIVE STATION	N.	8			TESTED BY			
	LING DEPTH	V.	-			TEST NO.	V		
O TUVII	EMODE! III		-			TEOT NO.			
vi.		8	LIQUID	LIMIT	ji		li W		
Contair	ner No.				14	23	R	T) <sup>3</sup>	
	et soil + container, gm		3	8	29.95	27.66	25.61	8	
	ry soil + container, gm		- 1		27.35	25.47	23.77		
Wt of v	CACIDATA AL CONTRACTOR AND ANALYSIS ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS AND ANALYSIS ANALYSIS ANALYSIS ANALYSIS ANALYSIS ANALYSIS ANALYSIS ANALYSIS ANALY				2.60	2.19	1.84		
	ontainer		j.		15.03	14.34	13.82		
	ry soil, gm				12.32	11.13	9.95		
	content, %			ä	21.10	19.68	18.49		
No. of I				-	18	25	INDIFFE TO SHARES TO THE TOTAL PROPERTY OF THE PARTY OF T		
	25.00			<del></del>	1111	)		• • • • • • • • • • • • • • • • • • • •	
	24.00						Sample preparation		
	23.00					As received	П		
	22.00					Washed on 0.425mms	sieve 🗍		
,=,	21.00					Air dried at	30°C		
Water Content, %	20.00					Oven dried at	° ⊟		
le le	19.00			$\rightarrow$		Proportion retained on 0.	9300	**	
Į	18.00								
i i	17.00								
Wat	16.00								
	15.00						Test Result		
	14.00					Liquid Limit	19.80 %		
	13.00					Plastic Limit	15.76 %		
	12.00					Plasticity Index	4.0 %		
		10 15 No of B	20 25 lows	30	35	Shrinkege =	3.5 mm		
						Shrinkege =	2.3 %		
8			DI	ASTIC	LIMIT	E	2.0 /0		
0	- 11-		FL	40110	Ch	0 10020	s 3		
Contair					X	L-5		Average	
	et soil + container, gm				17.65	16.42			
Table 11 and 12	ry soil + container, gm				17.27	16.05			
Wt of v	1400				0.38	0.37			
	ontainer				14.87	13.69			
7	ry soil, gm		- 2		2.40	2.36		40.00	
Water	content, %		590		15.83	15.68		15.76	
Rema	rks:								
	By: A.KASOKA		Checked By	y:S.T.PHIRI Approved By:					
			Date:13/01/2	1/2019 Date					
,				AWIII O		ACCEPTANCE.			



			ERBE						
		AASH	TO T-	89	& T-	90			
SIDE				Rand	om Sa	mple Yes		No	
LOCATION	KANYAMA TP	-3 0.3 m	e.			SAMPLE NO.			
MATERIAL TYPE	FINES	OIL	i.			DATE SAMPLED	0	8/01/20	19
MATERIAL SOURCE	KANYAMA TP	-3 0.3 m	ė.			DATE TESTED	13/01/2019		
MATERIAL DESRIPTION	*					SAMPLED BY			
REPRESENTATIVE STATION			,			TESTED BY			
SAMPLING DEPTH	rie Vie					TEST NO.			
AND MANY THE STATE OF THE STATE			-0			50e-0 -200			
	oš	LIQUID	LIMIT	8		-			
Container No.			o. V	T-9		J-16	D-12		
Wt of wet soil + container, gm			29.96			27.56	26.70		
Wt of dry soil + container, gm			ů:	27.35	5	25.51	24.90		
Wt of water			ð.	2.61	1	2.05	1.80	8 60	
Wt of container			e e	14.96	5	14.36	13.96		
Wt of dry soil, gm				12.39	)	11.15	10.94	o 1	
Water content, %				21.07	,	18.39 16.45			
No. of blows			ž.	18		25	31	e 83	
<i>C</i>			000000000000000000000000000000000000000		_	\			
25.00							ample prepar	ration	
23.00						AD-2010 CONT.			
22.00						As received		$\exists$	
						Washed on 0.425mmsi	Total and	$\sqcup$	
21.00						Air dried at		$\square$	
g. 20.00						Oven dried at	on dried at°C		
19.00	•	$\longrightarrow$				Proportion retained on 0.4			
S 18.00			$\mathbf{\chi}$						
Water Content, %						200			
¥ 15.00						o			
15.00						Manual Manua	Test Resu	200	
14.00						Liquid Limit	18.60		
13.00						Plastic Limit	16.51	100	
12.00	10 15	20 25	3	0	35	Plasticity Index	2.1		
	No of Blo	OWS				Shrinkege =	2.0	mm	
						Shrinkege =	1.3	%	
		PL	ASTI	CLI	MIT	2,9			
Container No.				U-19		н		S 50	Average
Wt of wet soil + container, gm			0	17.72	2	16.48		2 92	
Wt of dry soil + container, gm			00	17.30	)	16.08		20	
Wt of water			0	0.42		0.40		W 40	
Wt of container		-	Ň	14.71		13.7		5 70	
Wt of dry soil, gm		-	Ň.	2.59		2.38		5 74	
Water content, %			N.	16.22		16.81		5 14	16.51
vvater corners, 70				10.22	•	10.01		<u> </u>	10.01
Remarks:									
		Charled D	V'S T DU	IIDI		Approved But			
Tested By: A.KASOKA		Checked B	y.o. I.Ph	III		Approved By:	ved By:		
		Date:13/01/	2019			Date			



		RBERG LIMIT					
	AASH	TO T-89 & T-9	0				
SIDE		Random Sam	ple Yes	□ No	100		
	ANYAMA TP-4 0.3 m		SAMPLE NO.				
	OWNISH FINE SOIL	ĺ,	DATE SAMPLED	08/01/2			
110 11 11 11 11 11 11 11 11 11 11 11 11	ANYAMA TP-4 0.3 m		DATE TESTED	11/01/2019			
MATERIAL DESRIPTION			SAMPLED BY				
REPRESENTATIVE STATION			TESTED BY				
SAMPLING DEPTH			TEST NO.				
, k	LIQUID	LIMIT	*	192	224		
Container No.		н	С	К			
Wt of wet soil + container, gm		29.70	27.59	25.42	No.		
Wt of dry soil + container, gm		27.50	25.72	23.98	A -		
Wt of water		2.20	1.87	1.44	A -		
Wt of container		15.53	14.34	14.30			
Wt of dry soil, gm		11.97	11.38	9.68	305		
Water content, %		18.38	16.43	27.59			
No. of blows		17	24	30			
C	X - 0000 95 4000 - 87 65 400 W - 0000 950 U						
20.00							
19.00			Vice and American	ample preparation			
			As received				
18.00			Washed on 0.425mmsi				
			A STATE OF THE PROPERTY OF THE PARTY OF THE	anny stated			
17.00 to			Oven dried at				
te #5.00			Proportion retained on 0.4	25mm sieve			
8		$\sim$					
Water Content, %							
S 94.00			1	Test Result			
			Liquid Limit	MICHAEL STATES AND			
13.00			Plastic Limit	A 100 March 1975			
			Plasticity Index	24.2			
0 5 10	15 20 25	30 36	Carry China	1864/30			
	No of Blows	J	Shrinkege =	0.0 mm			
	115 V		Shrinkege =	0.0 %			
	PL	ASTIC LIMIT	*				
Container No.				*	Average		
Wt of wet soil + container, gm			1	j			
Wt of dry soil + container, gm		f	1	1)			
Wt of water							
Wt of container		Î		2	**		
Wt of dry soil, gm							
Water content, %				ij			
Remarks:							
Tested By:A.KASOKA	Checked By	By:S.T.PHIRI Approved By:					
		2010	5				
	Date:11/O1/2	w19	Date				



	DETERMINA	TION	N OI	MOD	IFIED PF	ROCTOR	R COMPA	CTION		,	
					D AT,AA	THE RESERVE					
SIDE						Random Sa			No		
LOCATION							SAMPLE NO.				
MATERIAL TYPE	<i>X</i>	G	ravel		3	DAT	ESAMPLED	0:	08/01/2019		
MATERIAL SOURCE	KANYAMA	TP-1	1.3 r	m (409) (900m)			ATE TESTED	0:	10/01/2019		
MATERIAL DESRIPTION	GRE	/ISH	COAR	RSE SOIL			SAMPLED BY	(k)			
REPRESENTATIVE STAT	I KANYAMA	TP-1	1.3 r	n (409) (90	00m)		TESTED BY	Ş			
SAMPLING DEPTH							TEST NO.				
No. of blows :	55+1						18/-1-14 -6	hammer,kg:	4.5		
No. of layers :	55+1							of mold,cm <sup>3</sup> :			
Proportion retained on 19m ( pass 50mm sieve and ret	nm sieve size: ained on 19mm sieve	)	<u> </u>	3	3		nple / Separa Apparent spe	te batches :		•	
	Mold		ij	No.	M 4	M 4	M 4	M 4	M 4		
Α	WATER		- 33	%	2	4	6	8	10		
В	Wt. of Mold + Wet S	oil	11	grams	8802	9069	9327	9309	9210		
С	Wt. of Mold	- 11	11	grams	4085	4085	4085	4085	4085		
D	Wt. Wet Soil		1	grams	4717	4984	5242	5224	5125		
E	Volume of Mold			cm3	2374	2374	2374	2374	2374		
F	Wet Density		ij	g/cm3	1.987	2.099	2.208	2.201	2.159		
	Trot Donoty		- 101	gronio	1.001	2.000	2.200	2.20	2.,00		
G	Container			No.	V-61	QA-4	B-47	NU-6	X-96		
Н	Wt. Cont + Wet soil		100	grams	767.0	759.0	748.0	781.0	764.0		
T.	Wt. Cont + Dry soil	- 11	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			74	grams	509.0	491.0	467.0	496.0	463.0		
	Troight or bly don		- 50	granio	000.0	107.0	101.0	100.0	100.0		
M	Moisture Content		ĵ.	%	2.0	3.9	6.2	8.1	10.2		
N	Dry Density		89	g/cm3	1.949	2.021	2.079	2.036	1.960		
*****											
Maximum Dry Density (M	IDD):										
			2.070								
MDD =	2.079 g/cm3					$+\mathcal{A}$		$\overline{}$	888888888		
11000		Dry denetty ,0'00									
Optimum Moisture Conte	ent (OMC):	#	2.020			/		<del></del>			
	101,4200,245	8	2.020								
OMC =	6.2 %	8							<del>\                                    </del>		
OMC -	0.2 %										
			1.970	+++++	-/				$+\mathcal{M}$	+	
									•		
				++++						#	
			1.920								
				1 2	3	4 5	6 7	8	9 10	11	
						Moi	sture content,%				
						10140					
Remarks:											
Tested By: A.KASOKA	Checke	d By:S	S.T.PH	IRI			Approved By:				
	Date:10	01/20	19				Date	_			



	DETERMINAT	TION C	F MODI	FIED PE	ROCTOR	R COMPA	CTION			
	-				SHTO 18					
SIDE	0				Random Sa			No		
LOCATION	8					SAMPLE NO.			_	
MATERIAL TYPE	%	Grave	1		DATE SAMPLED			08/01/2019		
MATERIAL SOURCE	KANYA	MA TP-2	0.5 m (410)	)	D/	ATE TESTED		10/01/2019		
MATERIAL DESRIPTION	GR	EYISH FI	ISH FINE SOIL			AMPLED BY	2			
REPRESENTATIVE STAT	TI KANYA	MA TP-2	0.5 m (410)	)		TESTED BY				
SAMPLING DEPTH						TEST NO.	k .			
						101-1-11 -51				
No. of blows :	<u>55+1</u>						hammer,kg: of mold.cm <sup>3</sup> :	-		
No. of layers : Proportion retained on 19r ( pass 50mm sieve and re	nm sieve size:	)		Siri		nple / <u>Separat</u> Apparent spe	e batches :		**	
	Mold		No.	M 4	M 4	M 4	M 4	M 4	8	
A	WATER		%	3	5	7	9	11		
В	Wt. of Mold + Wet S	oil	grams	8846	9132	9348	9312	9220		
С	Wt. of Mold	0018	grams	4085	4085	4085	4085	4085		
D	Wt. Wet Soil		grams	4761	5047	5263	5227	5135		
E	Volume of Mold		cm3	2374	2374	2374	2374	2374	10	
F	Wet Density		g/cm3	2.005	2.126	2.217	2,202	2.163		
	Trot Bollony		gronio	2.000	2.120		Likot	2.100		
G	Container		No.	E-18	R-15	H-14	G-19	H-12		
Н	Wt. Cont + Wet soil	9	grams	752.0	761.0	738.0	770.0	779.0	5	
Ĺ	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	5	
ĸ	Weight of Container	8	grams	242.0	258.0	247.0	238.0	249.0	15	
i i	Weight of Dry Soil	2	grams	494.0	479.0	458.0	487.0	477.0	i i	
	Twengilt of Dily con		grams	757.0	410.0	400.0	401.0	411.0		
М	Moisture Content	Î	%	3.2	5.0	7.2	9.2	11.1		
N	Dry Density		g/cm3	1,943	2.025	2.068	2.016	1,947	W.	
36			22224000000							
Maximum Dry Density (M	ADD):								32	
		2.05								
MDD =	2.068 g/cm3	100	999888	+++/		1			33	
N==	grano	00,0		1						
Optimum Moisture Cont	ent (OMC):	oo, o that also also also also also also also also		-/-		<del>                                     </del>	+			
Optimum Moisture Come	ent (outo).	2.00	0							
0110	70	ba Da	<del>/</del>			<del>                                     </del>	<del></del>			
OMC =	7.2 %									
		1.95	0			*				
			•						+	
						<u> </u>			33	
		1.90	3 4	5	6 7	8	9 10	11	12	
					MOI	sture content,%				
Remarks:										
Tested By:A.KASOKA	Checke	d By:S.T.P	HIRI			Approved By:				
	01/2019				Date					



		_							
	DETERMINAT	ION O	F MODI	IFIED PF	ROCTOR	COMPA	CTION		
		(TMH 1	MATHO	D AT, AA	<b>SHTO 18</b>	0)			
SIDE					Random Sa	mple Yes		No	
LOCATION	ų,					SAMPLE NO.	ž		
MATERIAL TYPE	up	Gravel	į.		DATE SAMPLED 08/01/2019				
MATERIAL SOURCE	KANY	AMA TP-	3 0.3 m		DA	ATE TESTED	Ť	11/01/2019	
MATERIAL DESRIPTION		FINE SC	The Annual Property of the Control o		S	AMPLED BY	-		
REPRESENTATIVE STATI	KANY	AMA TP-	3 0.3 m	Ų	3	TESTED BY			
SAMPLING DEPTH						TEST NO.			
No. of blows :	55+1					Weight of h	nammer.kg	: 4.5	
No. of layers :	5						f mold,cm3		
Proportion retained on 19m ( pass 50mm sieve and reta		11-	Ģ.	=		nple / <u>Separat</u> Apparent spec		:	-
	Mold	- 0	No.	M 44	M 44	M 44	M 44	M 44	
Α	WATER	- 20	%	3	5	7	9	11	7/
В	Wt. of Mold + Wet So	il	grams	8821	9145	9329	9344	9250	
С	Wt. of Mold	33	grams	4087	4087	4087	4087	4087	
D	Wt. Wet Soil	92	grams	4734	5058	5242	5257	5163	
E	Volume of Mold	Vo	cm3	2345	2345	2345	2345	2345	
F	Wet Density	1	g/cm3	2.019	2.157	2,235	2.242	2.202	
G	Container	- 29	No.	H-14	H-12	E-18	G-19	R-15	Ī
Н	Wt. Cont + Wet soil	- 1	10000000000	755.0	768.0	746.0	762.0	786.0	
	Wt. Cont + Dry soil	- 3	grams	740.0	742.0	711.0	718.0	732.0	-
J	Weight of Water	- 8	grams	15.0	26.0	35.0	44.0	54.0	
К	Weight of Container	(8)	grams	247.0	249.0	242.0	238.0	258.0	
L	Weight of Dry Soil	17	grams grams	493.0	493.0	469.0	480.0	474.0	
-	Weight of Diy con	- 25	grama	400.0	430.0	400.0	400.0	474.0	
М	Moisture Content	12	%	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	L
Maximum Dry Density (M	DD): 2.080 g/cm3	2.100							
1		2.050							<b></b>
Optimum Moisture Conte	nt (OMC):	2.050 2.050							
		6							
OMC =	7.5 %							$+$ $\times$ $+$ $-$	
9	A9 89	2.000							
				7					
			<del>                                      </del>	4					
		957023	<b>→</b>						
		1.950	2 3	4	5 6	7 8	9	10 11	12
					Mole	sture content,%			
	1				mote	state content vi			
Remarks:									
Tested By: A.KASOKA	Checked	By:S.T.P	HRI			Approved By	By:		
	Date:11/0	1/2019				Date			
	12.202.100	2000 Table				THE WAY IN			



	DETERMINATIO	Mark Co. Co. Co.	STATE OF THE PARTY		ROCTOR ASHTO 18	277	CTION			
SIDE	7.	ELLIE MEN	IN/ATTIC	אווא	Random Sa		П	No	П	
LOCATION	7					AMPLE NO.		7 1870A		
MATERIAL TYPE		Gravel			DATE SAMPLED 08/01/2019					
MATERIAL SOURCE	KANYA		4 0.3 m		DATE TESTED 10/01/2019					
MATERIAL DESRIPTION			NE SOIL		147000	AMPLED BY				
REPRESENTATIVE STATI			0.3 m			TESTED BY				
SAMPLING DEPTH						TEST NO.				
No. of blows :	55+1					Weight of h	ammerka	: 4.5		
No. of layers :	5						f mold,cm <sup>3</sup>		깱	
Proportion retained on 19m ( pass 50mm sieve and reta	m sieve size:	-		-	Single sam	ple / Separat Apparent spec	e batches :		202	
	Mold	2	No.	M 4	M 4	M 4	M 4	M 4	*	
Α	WATER	2	%	3	5	7	9	11	9	
В	Wt. of Mold + Wet Soil	7	grams	8764	9120	9314	9267	9095	P.	
С	Wt. of Mold	- 1	grams	4085	4085	4085	4085	4085	*	
D	Wt. Wet Soil	- 10	grams	4679	5035	5229	5182	5010	*	
E	Volume of Mold	200	cm3	2374	2374	2374	2374	2374	S.	
F	Wet Density		g/cm3	1.971	2.121	2.203	2.183	2.110	\$.V	
	wet Delisity	2	g/cilio	1.57 1	2.121	2.203	2,103	2.110		
G	Container		No.	S-11	Y-74	B-56	NF-56	HJ-2		
н	Wt. Cont + Wet soil	- 3	grams	770.0	782.0	738.0	758.0	742.0	8	
Î	Wt. Cont + Dry soil		grams	754.0	756.0	707.0	715.0	695.0		
J	Weight of Water	- 8	grams	16.0	26.0	31.0	43.0	47.0	Ŷ	
К	Weight of Container	- 19	grams	247.0	247.0	248.0	241.0	255.0	Ÿ	
L	Weight of Dry Soil	Ĵ	grams	507.0	509.0	459.0	474.0	440.0		
	* ***	100	20 A		4			10	65	
M	Moisture Content		%	3.2	5.1	6.8	9.1	10.7		
N	Dry Density		g/cm3	1.911	2.018	2.063	2.001	1.907		
Maximum Dry Density (M	22725231 (2017)	2.050		4						
MDD =		3		/	1	-				
Optimum Moisture Conte	nt (OMC):	2,000								
OMC =	6.8 %	1.950								
		1.900	3 4	5	6 7	8	9 10	11	12	
					Mois	ture content,%				
	~									
Domarka:										
Remarks:	17	de .				in an an an an an an an an an an an an an				
Tested By:	Checked B	y:	Approved By:							



			CALIEO	DNIAD	EADING DA	TIO				
					EARING RAD T 193	<u>(110</u>				
SAMPLE STATION	KANY	AMA TP-1	1.3 m (409	) (900m)	Random Sam	ple Yes	П	No		
LOCATION						SAMPLE NO.	0.			
MATERIAL TYPE		GREYISH C	COARSE SO	OIL	DAT	E SAMPLED	1	08/01/2019	ir L	
MATERIAL SOURCE	KANY	AMA TP-1	1.3 m (409	) (900m)	DA	ATE TESTED	)	11/01/2019		
MATERIAL DESRIPTION		G	ravel	23	S	AMPLED BY	, and the second			
REPRESENTATIVE STAT	ION	KANYAM	A TP-1 1.3	m (409) (9	C	TESTED BY	(			
SAMPLING DEPTH			207575			TEST NO.				
			DEI		ERMINATION	Teer er			B1 (8.81.)	
SOAKING CONDITION					ayer Blows (4,5kg) Before		efore (4,5kg)		s Blows (2,5kg) fore	
MOLD NUMBER					M-23	0.5	4-24	70.0	-27	
WEIGHT OF SOIL + MOI	.D, g				9264		106		724	
WEIGHT OF MOLD, g WEIGHT OF SOIL, g					4086 5178		1117		101 623	
VOLUME OF MOLD, g					2344		370		337	
WET DENSITY OF SOIL	g/cm <sup>3</sup>				2.209		.105	1,77	978	
DRY DENSITY OF SOIL,					2.083	1	.985	1.	866	
i.			MOIS		TERMINATION					
SOAKING CONDITION				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	rs Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)	
					Before	Be	efore	Be	efore	
CONTAINER NUMBER							1-12			
WET SOIL + CONTAINE			-		884		810	Ž		
DRY SOIL + CONTAINER WEIGHT OF CONTAINER					253	779 247				
WEIGHT OF WATER, g	127.1				37		31			
WEIGHT OF DRY SOIL,	g				594	3 3	532			
MOISTURE CONTENT	RE CONTE	AIT A\/-			6.2		5.8			
MOISTOR	E CONTE	NI AV-				0	0.0			
. p	ENETRAT	ION DATE		15/01/20	BOTTOM TEST		RING FACTOR		.00	
*		5 Layer Blo			y 5 layers Blows		55 by 3	layers Blows		
PENETRATION (mm)	Dial reading	Load (KN)	10 We - 10 W	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)	
0.00		0.00			0.00			0.00		
0.64 1.27	-	2.14 3.67			1.52 2.58			1.12 2.04		
1.91	4	5.94	ik i		3.84	N N		2.81	7	
2.54	8	7.66	57.4		5.42	40.6		3.37	25.3	
3.18		10.20			6.68			3.69	4	
3.81 4.45		12.53	8		7.64 8.82			4.20 4.68	8	
5.08		15.82	79.1		9.47	47.4		5.20	26.0	
5.72	1 0	17.22			10.64			5.76		
6.35 6.99		18.33 19.45	200		11.87 12.86	y .	4	6.12 6.35	7	
7.62	8	20.75			14.32			6.58	2	
8.26		21.60			15.36			6.78		
8.89	. 0	23.04	ġ į		16.69			6.97		
9.55		23.97		fi s	17.42	Blows	55	7.09 25	55	
	SWE	LL			rammar	Diows	4,5kg by 5	4,5kg by 5	2,5kg by 3	
Soaking Date					Initial reading (n	nm)	.,	10.3010	-13-1-	
Time					Final reading (m	nm)				
					Height of special Percent Swell (				2	
Remarks:					reicent swell (	70)		8 3	Š.	
Tested By:W.MUMBA		Checked	By:S.T.ML	JMBA		Approved	Ву:			
		Date:11/0	1/2019			Date	C-F			



	CALIFO	AASHTO			<u> </u>				
SAMPLE STATION	KANYAMA TP-1 1.		1 193		Sample	YES	□NO □	9	
LOCATION	KANYAMA TP-1 1.			SAMPLE		-		-	
MATERIAL TYPE	GREYISH COA	ARSE SOIL		DATE SA		***	ATTA TO STOCK THE	V01/2019	
MATERIAL SOURCE MATERIAL DESRIPTION	Grave	al .		SAMPLE		30	15/01/201	9	
REPRESENTATIVE STATION	Grave	51		TESTED		500			
SAMPLING DEPTH				TEST NO	).	50. 50.			
	Number of % Moisture blows before soak	Dry Density	CBR %	% Moisture after 96 hours	Swell %	Average % Swell	Standard Lo	10-20	
M.D.D (gm/cm³)		2.002	en 4	100000	0.00	0000000	2.54 mm	5.08 mm	
2.079	2.079 55 by 5 6.2 2.083 O.M.C. % 30 by 5 5.8 1.985		57.4	0.0	0.00	0.00	13.24	20.00	
6.2	55 by 3 0.0	1.866	40.6 25.3	0.0	0.00	0.00	13.24	20.00	
0.2	33 by 3 0.0	1.800	63.3	0.0	0.00		13.24	20.00	
22.0 20.0 18.0 16.0 12.0 10.0	5.08 6.35 7.62 a. TION(ms)	Dry Density gm/cc	2.100 2.000 1.900 1.800 1.700 20.0	25.0 30.0	35.0 40.0 So	45.0 50 aked CBR%	9	MLE AT 5%	
CBR Value	at 90% MDD = 1.87	1	CBR	Value at 90%	from the grap	h =	25.	3	
CBR Value	CBR Value at 95% MDD = 1.975					h =	40	0.0	
CBR Value	CBR	Value at 98% f	from the graph	1 <del>=</del>	49	0.5			
Comments:		I,							
Checked By:		APROVED	ВҮу:						
		Da	ate:	100207	Mine				
Test Results Within	Engineering Limits:	Yes		No					
		220	1	2,000					



			CALIEC	PNIA BI	EARING RA	TIO			
				AASHT		(IIIO			
SAMPLE STATION	KA	ANYAMA TE	P-2 0.5 m	(410)	Random Sam	ple Yes		No	
LOCATION				37.		SAMPLE NO.	M 20		3203
MATERIAL TYPE		GREYIS	FINE SOIL	<u> </u>	DAT	E SAMPLED		08/01/2019	12.
MATERIAL SOURCE	K		P-2 0.5 m			ATE TESTED		11/01/2019	
MATERIAL DESRIPTION	- 10		ravel	(110)	<u>→</u> 00 00000	AMPLED BY		1110112010	
REPRESENTATIVE STAT	ION	1,000	A TP-2 0.5	m (410)		TESTED BY			
SAMPLING DEPTH	ION	IVANTAIW	N 1F-2 0.5	/III (410)	70	TEST NO.			
SAMPLING DEPTH			DE	NSITY DET	ERMINATION	IEST NO.			
SOAKING CONDITION			DLI		ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
				1	Before		efore		efore
MOLD NUMBER WEIGHT OF SOIL + MOI	D 6				M-26 9298		1-03		1-25 791
WEIGHT OF MOLD, g	LD, g				4078		075	0.00	098
WEIGHT OF SOIL, g					5220	1.0	031		693
VOLUME OF MOLD, g					2339	10. 00.1	370	1000	335
WET DENSITY OF SOIL					2.232		981		010
DRY DENSITY OF SOIL,	g/cm*		MOIS	A CONTRACTOR OF THE STATE OF TH	2.083		981	L	876
			MOIS	Control of Page 1999	TERMINATION ayer Blows (4,5kg)	25 by 5 layer	e Playe (4 6kg)	EE by 2 layer	e Blowe (2 6kg)
SOAKING CONDITION				-	575	727	25	1000	
SOAKING CONDITION  CONTAINER NUMBER				- 4	Before	Be	efore	Be	efore
CONTAINER NUMBER					V-3		/-10		
WET SOIL + CONTAINE			849 809	890					
DRY SOIL + CONTAINER WEIGHT OF CONTAINER					249		847 246		
WEIGHT OF WATER, g	4.3				40		43		
WEIGHT OF DRY SOIL,					560		601		
MOISTURE CONTENT	C CONTE	AUT AV			7.1		7.2		
MOISTUR	RE CONTE	NI AV=	0.000			1	.1		
	CNICTOAT	TON DATE		15/01/20	BOTTOM TEST		INIC EACTOR		.00
,	55+1 by	5 Layer Bk	ws (4.5kg)		y 5 layers Blows		SING FACTOR	layers Blows	(2.5kg)
PENETRATION (mm)	Dial	Load (KN)	TASASSI - 335/45."	Dial	Load (KN)	C.B.R(%)	Dial reading	as a market service of	C.B.R(%)
0.00	reading	0.00		reading	0.00			0.00	
0.64		2.09	*		1.87			1.47	
1.27	d j	5.30	j i		4.02			2.55	
1.91		9.31			6.03			3.67	
2.54 3.18		12.27 15.19	92.0		8.66 11.24	64.9		4.66 5.21	34.9
3.81	1	18.08	4		12.76			5.71	
4.45		21.76	3		14.11			6.42	ğ
5.08		24.52	122.6		15.18	75.9	-	7.14	35.7
5.72 6.35		27.87 29.68			16.01			8.02	
6.99		31.63	J.		16.67 17.20			8.64 9.10	
7.62		32.91	3		17.67			9.61	8
8.26		33.50	J.		18.08	,		9.96	10
8.89		34.82			18.39			10.20	
9.55		35.45	, i		18.84	Blows	55	10.48 25	55
	SWE	LL			rammar	Diows	4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date					Initial reading (n	nm)	.,	ijeg z j v	
Time					Final reading (n	m)			
					Height of special Percent Swell				ĝ.
Remarks:					reicent Swell	70)			S.
Tested By:W.MUMBA	· ·	Checked	By:T.S.PH	IIRI		Approved	Ву:		
	8	Date:11/0	1/2019			Date			



						_			8
		CALIFO	ORNIA B	EARIN	IG RATIO	<u> </u>			
			A A CUT	T 40	•				
CAMPLE CTATION	LVV	IVAMA TO 2	0.5 m (410)	) 1 19		n Sample	YES	NO [	-
SAMPLE STATION LOCATION	3. <del>1</del>		0.5 m (410)	-Ni	SAMPLE	Carlo Carlo	IES	INO	<u></u>
MATERIAL TYPE	× -	GREYISH FI		76	DATE SA			08/01/20	019
MATERIAL SOURCE	N <del>a</del>	OILE HOITE			DATE TE		87	15/01/201	-
MATERIAL DESRIPTION	No.	Grave	i		SAMPLE	DBY	87		50
REPRESENTATIVE STATION	18				TESTED	BY	98 <del>-</del>		
SAMPLING DEPTH	( <del>)</del>			<del>-</del> 8	TEST NO	).	9 <del>7</del>		
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	oad (KN)
M.D.D (gm/cm <sup>3</sup> )	0.000	Outer Soun	1110-200-00 CV250-20	70	hours		1.50000	2.54 mm	5.08 mm
2.068	55 by 5	7.1	2.083	92.0	0.0	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		13.24	20.00
	5.08 6.38 710N(m)		Section of the Participan and Conf.	1.700	35.0 40.0 45.0	S	paked CBR %		ALLE AT 35%
CBR Value		DOC WARE	9		R Value at 90%  R Value at 95%		ACC.	34	1.0
CONTRACTOR STREET	A THE RESERVE OF THE PARTY OF T	DANCE WORKS	12 22	CBI	value at 5370	nom die gra	fut _	0	8-W
CBR Value	at 98% MD	D = 2.027	li .	CBR	Value at 98% i	from the grap	h =	7	7.0
Comments:			53						
Checked By:			APROV	ED BYy:	(4				
			i i	Date:			ř		
Test Results Within	Engineering I	imits:	8	'es	✓ No		8		
	The second second	- N-C			504.56				90



			CALIEC	DNIAR	EARING RA	TIO			
					O T 193	<del>(110</del>			
SAMPLE STATION	1	KANYAMA	TP-3 0.3	m	Random Sam	nple Yes		No	7/1
LOCATION	100		21 15 15 15 15 15 15 15 15 15 15 15 15 15			SAMPLE NO.	Assi (		1578
MATERIAL TYPE	RIAL TYPE FINE SOIL				DAT	E SAMPLED		08/01/2019	ř.
MATERIAL SOURCE KANYAMA TP-3 0.3 m			m	-01 CASS	ATE TESTED		12/01/2019	***	
MATERIAL DESRIPTION	N.	236.0	avel		-22	AMPLED BY		120112010	
REPRESENTATIVE STAT	ION	A CONTRACTOR OF THE PARTY OF TH	TP-3 0.3	m	-8 · · ·	TESTED BY			
SAMPLING DEPTH	1014	TVAITITION	111-0 0.0		<b>-</b> \$2	TEST NO.	<u> </u>		
CAMIL EINO DEL TIT			DEI	NSITY DET	ERMINATION	TEOT NO.			
SOAKING CONDITION					ayer Blows (4,5kg)				
MOLD NUMBER					Before B-4	11	efore B-9		efore 3-10
WEIGHT OF SOIL + MOL	Da				8458		145	U. 1000	956
WEIGHT OF MOLD, g	, g				3301	2.00	203	6 321	296
WEIGHT OF SOIL, g					5157	1.0	942		660
VOLUME OF MOLD, g	_13				2304	- ST	313 137	2 222	312 016
WET DENSITY OF SOIL, DRY DENSITY OF SOIL,	g/cm <sup>3</sup>				2.084		990	7770	877
DIVI DENOTITION GOIL	W CHI		MOIS	TURE DE	TERMINATION	10 00			
V				55+1 by 5 L	ayer Blows (4,5kg)	25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION					Before	Be	efore	Be	efore
CONTAINER NUMBER					S-51	3	K-17	0.000	20-2000
WET SOIL + CONTAINE	R, g				771	Li .	732		
DRY SOIL + CONTAINER					735		699		
WEIGHT OF CONTAINER WEIGHT OF WATER, a	₹, g				256 36	0.2	33		
WEIGHT OF DRY SOIL,	9				479		455	2	
MOISTURE CONTENT	97				7.5		7.3		
MOISTUR	E CONTE	NT AV=		8		7	.4	8	
5					BOTTOM TEST				
P		5 Layer Blo	and the second second second second	16/01/20	y 5 layers Blows	0.000	ING FACTOR	layers Blows	0.00 (2.5kg)
PENETRATION (mm)	Dial			Dial					
Harris and the contract of the set of	reading	Load (KN)	C.B.R(%)	reading	Load (KN)	C.B.R(%)	Dial reading	Load (KN)	C.B.R(%)
0.00		0.00		- CSAITOCOUGALA	0.00	1		0.00	
0.64 1.27		2.26 4.48			1.89 2.89			1.20 2.02	
1.91	8 8	7.30			4.87	8		3.36	iii
2.54		9.56	71.7		6.76	50.7	,	4.49	33.7
3.18		11.98	2000000		8.51	in the second		5.22	
3.81 4.45		13.72 15.20			9.95 11.62		1	5.79 6.22	
5.08	8	16.28	81.4	-	12.84	64.2		6.52	32.6
5.72		17.32			13.75			6.89	ĝ.
6.35		18.65			14.89			7.42	
6.99 7.62	8 8	20.02	-		15.62 16.20	8		7.92 8.10	ÿ.
8.26	0 0	22.68		-	16.74	1		8.32	
8.89		23.51			17.28	8		8.59	ĝ.
9.55		24.20			17.59	Diame		8.95	55
	SWE	11			rammar	Blows	55 4,5kg by 5	25 4,5kg by 5	55 2,5kg by 3
Soaking Date	0111	- No. No.			Initial reading (n	nm)	4,ong by 5	H,ong by o	z,ong by o
Time					Final reading (m	nm)			
					Height of specia		v ·	y v	re G
Remarks:					Percent Swell	(70)	<u> </u>		
Tested By:W.MUMBA	-	Chacked	By:T.S.PH	IIDI		Approved	Dur		
rested by:W.MUMBA		Спескеа	by: 1.3.PH	IIKI		Approved	by:		
		Date:12/0	1/2019			Date			



		2000		25.57(2.55)00	- 12 / DEZ	2.			9
		CALIFO	ORNIA BI	EARIN	IG RATIO	<u>D</u>			
SAMPLE STATION	200	ANYAMA TP		T 19:		n Sample	YES	NO [	
LOCATION	K	ANYAMA TP	ALC: NO PART OF THE PART OF TH		SAMPLE	NA CONTRACTOR OF THE PARTY OF T	36 St		
MATERIAL TYPE	-	FINES	OIL		DATE SA		3.0	08/01/20	
MATERIAL SOURCE MATERIAL DESRIPTION	2	Grave	i.	-83	SAMPLE		58	16/01/201	19
REPRESENTATIVE STATION	0 <del>0.</del>	Grave	71.	-8	TESTED	10000	( <del>)</del>		*
SAMPLING DEPTH	166 166			—35 —35	TEST NO		( <del>)</del>		*
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96 hours	Swell %	Average % Swell	Standard Lo	
M,D,D (gm/cm³)		000000000000000000000000000000000000000	2004		236.025	0.00	70 0	2.54 mm	5.08 mm
2.080	55 by 5	7.5	2.084	71.7	0.0	0.00	000	13.24	20.00
O.M.C. %	30 by 5 55 by 3	7.3 0.0	1.990	50.7 33.7	0.0	0.00	0.00	13.24	20.00
7.5	55 by 3	0.0	1.877	33./	0.0	0.00		13.24	20.00
24.0 22.0 20.0 18.0 26.0 24.0 12.0 10.0 8.0 6.0 4.0 2.0 0.0 1.27 2.54 3.81 PENETRA	5,08 6,35	7.62 8.1	Sa Day Density am/cc	2.100	35.0 40.0	45.0 50 Sx	.0 55.0 o	9	ALLE A7 55%
CBR Value	at 90% MD	D = 1.872	ij	CBR	Value at 90%	from the gra	ph =	33.	5
CBR Value	at 95% MD	D = 1.976	5	CBR	Value at 95%	from the gra	ph =	50	0.0
CBR Value	at 98% MD	D = 2.038	I.	CBR	Value at 98%	from the grap	h =	62	2.0
Comments:			3						
Checked By:			APROVI	ED BYy:					
				Date:	_		Y:		
Test Results Within	Engineering I	imits:	3	(es	No		2		



>			Section Plants Line No. 100						
					EARING RA	OITA			
SAMPLE STATION	760	KANYAMA	TP-4 0.3 i	William Control	Random San	nple Yes		No	
LOCATION		1.0.00,000,000			- weepstern water	SAMPLE NO.	Asink		9.8
MATERIAL TYPE	S .	BROWNIS	H FINE SOI	L	DA'	TE SAMPLED	8	08/01/2019	Ů.
MATERIAL SOURCE		ACTUAL STATE	TP-4 0.3 i		7.10	ATE TESTED	-	11/01/2019	
MATERIAL DESRIPTION	XI	Gr	ravel		_	SAMPLED BY	-		
REPRESENTATIVE STAT	ION	KANYAMA		m	-	TESTED BY	<u></u>		
SAMPLING DEPTH			200 1 200		_	TEST NO.	<u> </u>		
			DEN		ERMINATION				
SOAKING CONDITION					ayer Blows (4,5kg Before		s Blows (4,5kg) efore		s Blows (2,5kg) efore
MOLD NUMBER				N .	M-2	12	M-5	-	M-6
WEIGHT OF SOIL + MOI	.D, g		3		9360		990		856
WEIGHT OF MOLD, g					4073	310	073	110	129
WEIGHT OF SOIL, g VOLUME OF MOLD, g				ŝ	5287 2379	0.7	917 334	200	727 365
WET DENSITY OF SOIL	a/am³		-	y	2.222	N1 LT	107	1,000	999
DRY DENSITY OF SOIL.					2.078	1.	970	1.	869
8			MOIS		TERMINATION				
SOAKING CONDITION				55+1 by 5 L	ayer Blows (4,5kg	) 25 by 5 layer	s Blows (4,5kg)	55 by 3 layer	s Blows (2,5kg)
SOAKING CONDITION					Before	Be	efore	Be	efore
CONTAINER NUMBER	Total No. 10				MG-3	100	1-50		
WET SOIL + CONTAINE			à	0	772		764	8	
DRY SOIL + CONTAINER WEIGHT OF CONTAINER			-	v.	739 257		730 250	-	
WEIGHT OF WATER, g	-37/-				33		34		
WEIGHT OF DRY SOIL,	9				482	700	180		
MOISTURE CONTENT	RE CONTE	NT A\/=			6.8		7.1		
MOISTOI	L CONTL	INI AV-	DENET	PATION I	BOTTOM TEST		V		
P	ENETRAT	ION DATE	25 to 75 To 11 To 20 To	15/01/20			ING FACTOR	0	.00
September of the control of the cont		5 Layer Blo			y 5 layers Blows			layers Blows	(2,5kg)
PENETRATION (mm)	Dial reading	A Section of the section of	C.B.R(%)	Dia1 reading	Load (KN)	C.B.R(%)	Dial reading	The will be the	C.B.R(%)
0.00		0.00			0.00			0.00	
1,27		2.67 4.58			1.48 3.53			1.36 2.32	L.F
1.91	0	7.49		8	5.12			3.48	27.
2.54	3	10.13	75.9		6.97	52.2	8	4.26	31.9
3.18 3.81	5 2	13.76			8.18 9.60		į.	5.29 5.82	TO THE PARTY OF TH
4.45		19.64	Total Company		11.19	er yearstatel		6.33	en service
5.08		23.60	118.0		12.78	63.9		7.38	36.9
5.72 6.35		27.87 31.67			14.97 16.33		100	8.10 8.69	LE T
6.99		35.34		7	17.69	8	5	9.18	Ż.
7.62	8 8	37.91	3	i i	18.73	8	3	9.74	8
8.26		39.87			19.82			10.26	
8.89 9.55		42.26 43.59			21.18 22.08			10.37 10.65	<u> </u>
W. 100	<u> </u>	6- 1800.0000 Oc				Blows	55	25	55
6 10 7	SWE	LL			rammar		4,5kg by 5	4,5kg by 5	2,5kg by 3
Soaking Date Time					Initial reading (		š	8	
Time		ž			Height of spec		10	10	60) 60)
					Percent Swell				
Remarks:									
Tested By:W.MUMBA		Checked	By:S.T.PH	IRI		Approved	Ву:		
		Date:11/0	1/2019			Date			



		CALIFO	ORNIA B	EARIN	IG RATIO	)			
		07,1217	s ==215=			_			
SAMPLE STATION	k	ANYAMA TE	AASHT(	T 19		n Sample	YES	□NO [	7
LOCATION		ANYAMA TE		-20	SAMPLE	Shipping to Statute	ILO		
MATERIAL TYPE		BROWNISH	Control of the Contro	-37	DATE SA			08/01/20	)19
MATERIAL SOURCE				-5/4	DATE TE	STED	0.4	15/01/201	19
MATERIAL DESRIPTION		Grave	el		SAMPLE				
REPRESENTATIVE STATION				-62	TESTED		***		
SAMPLING DEPTH				100	TEST NO	).	-		
	Number of blows	% Moisture before soak	Dry Density	CBR	% Moisture after 96	Swell %	Average % Swell	Standard Lo	oad (KN)
M.D.D (gm/cm <sup>3</sup> )	Diows	Deloie Stak	200000000000000000000000000000000000000	70	hours	A-60 - 64 - 6 - 64 - 64 - 64 - 64 - 64 -	Swell	2.54 mm	5.08 mm
2.063	55 by 5	6.8	2.078	75.9	0.0	0.00		13.24	20.00
O.M.C. %	30 by 5	7.1	1.970	52.2	0.0	0.00	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
44.0 42.0 40.0 38.0 36.0 34.0 32.0 30.0 38.0	5.08 6.33 710N(ma)	7,62 8.	Sa Dackhomics	2.200 2.100 2.000 1.900 1.800 1.700 1.600	35.0 40.0	45.0 50.0	0 55.0 60 baked CBR %	9	ALUE AT 15%
CBR Value		(C) (C)	8	5900	Value at 90%		No.	31.	<i>8</i> .
CBR Value	at 95% MD	D = 1.960	)	CBF	R Value at 95%	from the gra	ph =	5	1.0
CBR Value	at 98% MD	D = 2.02	2	CBR	Value at 98%	from the grap	h=	64	4.0
Comments:									
Checked By:			APROV	ED BYy:					
				Date:			ř		
Test Results Within	Engineering l	Limits:		res	No		5		



#### **SOIL RESISTIVITY TEST RESULTS**

Client: Intec GOPA International Energy Consult-	Location:	
ants	Kanyama	Date Tested: 04/01/19
Project: Lusaka Transmission and Distribution Reha	bilitation	Tested by: W. Mumba
Trial Pit No.	Resistivity O	hm-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:



Contracting Authority:



Supervisor:



Contractor:



European Union under the 11th European Development Fund

Plot No. 4889, Los Angeles Boulevard, P.O. Box 34871 Lusaka, Zambia

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

**ZESCO Limited** 

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Figure 29:	DCPT in Progress

## **Abbreviations**

**DCPT** Dynamic Cone Penetration Test SPT Standard Penetration Test RHAuxiliary Earth Resistance

RE Earth Resistance

Ohms Ω

Р 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 the  $^1$  pole Wenner test method from the four sites reveal that the soil resistance ranges from 0.8 to 298  $\Omega$ .

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 $\Omega$  in Kabanana area under Mandevu township to 2244.4 m  $\Omega$  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.

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



Cround water information a management

ZMB-5010033-LTDRP-Geotechnical-Report-Part-II-2019-09-07.docx

## 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.



## **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





Test point where both SPT and soil resistivity tests were conducted



Test point where only SPTs were conducted



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Figure 3: Site Location for Ngwerere Test Points



Test point where both SPT and soil resistivity tests were conducted



Test point where only SPTs were conducted

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

**Table 1: Coordinates of the Test Points** 

Site	Test Point	Coord	inates
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.

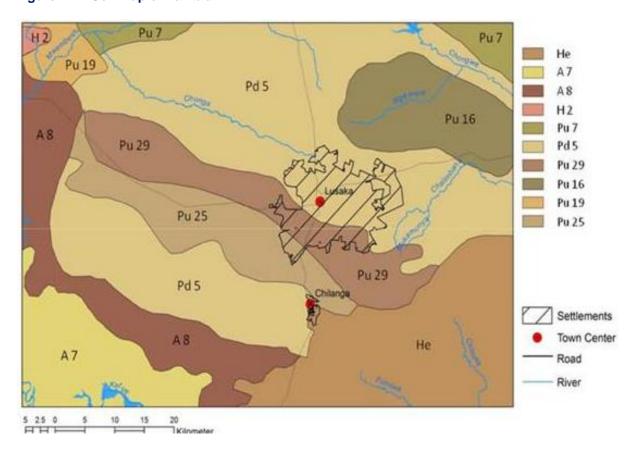


Figure 4: Soil Map of Zambia

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 formation<sup>2</sup>.

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 Chitumbanuma<sup>3</sup> 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 pellitic 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 Map<sup>4</sup> (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 m<sup>2</sup>/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.



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

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

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

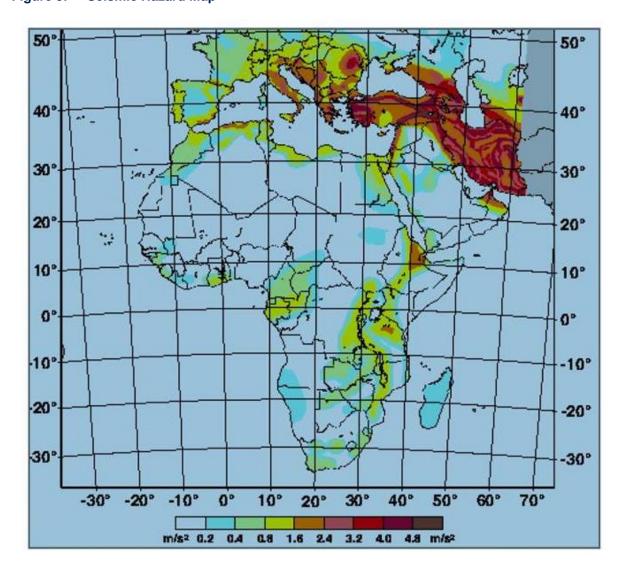


Figure 5: Seismic Hazard Map

## 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)

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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 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



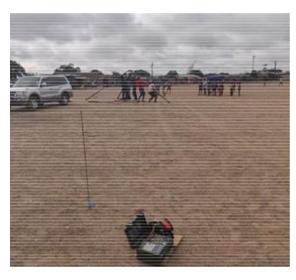


Figure 14: Soil Resistivity Testing at Mandevu

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





in Ngwerere



Figure 16: Rocky Ground at Kabangwe Area 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:

Ncd = 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 Ncd 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 26: Rocky Ground at Ibex Extension in Mtendere

Figure 27: Preparatory works at a work site





Figure 28: DCPT in Progress at Ibex Exten- Figure 29: DCPT in Progress sion in Mtendere







## 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  $\Omega$ . 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  $\Omega$  in Kabanana area under Mandevu township to 2244.4 m  $\Omega$  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  $\Omega$ .

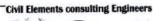
Low soil resistivity values were observed at Kalingalinga ground, ranging from 42.12 to 287.95 m  $\Omega$ . The soil type in this area ranged from gravelly sandy clay to sandy clay.

Table 3: Summary of Soil Resistivity Results

		SOIL RE	ESISTIVITY TEST	Civil Elemen	CECE CECE
LOCATION		DEPTH	EARTH RESISTANCE	SOIL RESISTIVITY	PRESUMPTIVE ROCK
		(m)	RE (Ω)	ρ (mΩ)	
Kalingalinga Ground TP	1	10	3	110	gravelly sandy clay
		6	3.54	68.3	gravelly sandy clay
15°24'19.2"S	28°19'51.7"E	3	4.79	60.2	sandy clay
		2	6.75	42.12	sandy clay
Vallagallaga Mary OL II. I		1	0.83	53	sandy clay
Kalingalinga (Vera Chilul 15°24'14.4"S	28°20'53.3"E	10	1.69	104.345	gravelly sandy
15 24 14.4 S 28 20 53.3 °E	20 20 55.5 E	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
		10	2.835	177.95	gravelly sandy clay
Mutendere (Chitukuko B	asic School) TP4	6	4.66	173.45	gravelly sandy clay
15°23'56.76"S	28°21'34.71"E	3	11.255	211.2	gravelly sandy clay
		2	15.135	190.45	sandy clay
		1	29.085	182.85	sandy clay
		10	28.45	2244.4	Laterite rock
Mutendere East TP5	******	6	15.835	594.05	laterite
15 24 21.3 5	28°22'07.8"E	3	36.05	669.65	laterite
		2	54.35	680.4	laterite
		1	77.45	484.6	laterite
./		10	2.525	156.55	sandy clay
Mutendere East TP6	00000140	6	6.95	266.6	laterite
15°24'01.9"S	28°22'19.3"E	3	19.24	363.05	sandy laterite
		2	33.2	416.35	sandy laterite
		1	52.7	330.8	sandy clay
		10	14.9	829.1	laterite
Mutendere (IBEX EXTE 15°24'11.0"S		6	26	958.5	laterite
10 24 11.0 5	28°22'47.1"E	3	4.4	120.1	shale
		2	11.03	136.8	shale
		1	84	402.3	shale



### SOIL RESISTIVITY TEST









LOCATION	DEPTH	EARTH RESISTANCE	SOIL RESISTIVITY	PRESUMPTIVE ROCK TYPE
	(m)	RE (Ω)	ρ (mΩ)	
	10	1.69	114.8	gravelly sandy
Mandevu Kabanana TP10	6	2.68	100.2	gravelly sandy
15°21'04.1"S 28°18'14.6"E	3	3.62	67.83	sandy clay
	2	4.79	59.9	sandy clay
	1	6.71	42.08	sandy clay
	10	1.425	87.16	laterite soils
	6	3.2	118.85	laterite soils
Mandevu (Chipata Compound) TP11 15°21'45.2"S 28°17'40.6"E	3	6.305	117.7	gravelly sandy clay
	2	9.43	118.45	gravelly sandy clay
	- 11	18.355	115.15	compacted sandy clay



### SOIL RESISTIVITY TEST





LOCATION		DEPTH	EARTH RESISTANCE	SOIL RESISTIVITY	PRESUMPTIVE ROCK
		(m)	RE (Ω)	ρ (mΩ)	
		10	12.1	760.85	Laterite rock
Ngwerere (Kabangwe) TP13		6	40.3	1468	Laterite rock
15°19'58.1"S	28°17'04.2"E	3	90.8	1973.5	Laterite rock
		2	148.15	2190	Laterite rock
		1	195.8	1632	laterite
Ngwerere (Maichola) Tp14		10	5.325	334.25	laterite
15°20'05.3"S	28°17'56.3"E	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		10	14.3	895.4	Laterite soils
15°19'05.6"S	28°17'47.7"E	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	He.	10	8.35	659.2	Laterite
15°19'34.6"S	28°18'43.4"E	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/m²)								
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/m²)						
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/m²)						
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 underlined 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

	Earth Resistance	Soil Resistivity	Bearing Capacity	
Township	RE (Ω)	p (mΩ)	kN/m²	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.



## Annex 1

**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 (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	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

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## 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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	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

11	MVERSE 234 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

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- Kentuluh



# **Civil Elements consulting Engineers**



LOCATION: LUSAKA

SITE: MUTENDERE (CHITUKUKO BASIC SCHOOL)

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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	SOIL RESISTIVITY ρ (mΩ)
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

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

52	125	73.4	4153
		3763000 10	
17.07	3.3	3.5	642.1
	4.8	5.1	676.7
57	5.5	3.4	709.8
83.2		3.3	520.2
	17.07 36.9 57 83.2	36.9 4.8 57 5.5	36.9     4.8     5.1       57     5.5     3.4

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# **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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	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

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# **Civil Elements consulting Engineers**



LOCATION: LUSAKA

SITE: MUTENDERE (IBEX EXTENSION)

TP7

DATE: 08/03/2019

COORDINATES:

-15.403041

28.379753

**ELEVATION** 

FIELD CONDITION

Dry

Dry

**EQUIPMENT** 

MS2308 ADVANCED EARTH RESISTANCE TESTER

**OPERATOR** 

DAN LUPANDILA

**ELECTRODE ARRANGEMENT** 

4 POLE TEST (WENNER METHOD)

# TRAVERSE 270°W

DEPTH (m)	EARTH RESISTANCE	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	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

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# **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	EARTH RESISTANCE	AUXILLARY EARTHING RESISTANCE	PROBE RESISTANCE	SOIL RESISTIVITY
(m)	RE (Ω)	RH (KΩ)	RS (KΩ)	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

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# **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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	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

THE TAX TO THE TAX TO			
2.02	5.7	3.4	123.1
	3.3	3	129.2
THE PROPERTY OF THE PROPERTY O	1.4	3.9	123.1
	4	22.7	119.3
	10.1	2.8	128.7
	2.02 3.5 6.56 9.49 20.5	2.02     5.7       3.5     3.3       6.56     1.4       9.49     4	2.02     5.7     3.4       3.5     3.3     3       6.56     1.4     3.9       9.49     4     22.7

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# **Civil Elements consulting Engineers**





LOCATION: LUSAKA

SITE: NGWERERE (KABANGWE)

**TP13** 

DATE: 10/03/2019

COORDINATES: -15.33281

Dry

28.284491

**ELEVATION** 

FIELD CONDITION

EQUIPMENT

MS2308 ADVANCED EARTH RESISTANCE TESTER

OPERATOR

DAN LUPANDILA

**ELECTRODE ARRANGEMENT** 

4 POLE TEST (WENNER METHOD)

# TRAVERSE 216° SW

DEPTH (m)	EARTH RESISTAN	AUXILLARY EARTHING PROBE RESISTANCE RESISTANCE RH (ΚΩ) RS (ΚΩ)		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	12.0	2-2	
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

- Herrtuluh



# **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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	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

- Kentuluh



# **Civil Elements consulting Engineers**



LOCATION: LUSAKA

SITE: NGWERERE (KABANGWE)

TP15

DATE: 10/03/2019

COORDINATES: -15.318211

28.296593

ELEVATION

FIELD CONDITION

Dry

MS2308 ADVANCED EARTH RESISTANCE TESTER

**EQUIPMENT OPERATOR** 

DAN LUPANDILA

ELECTRODE ARRANGEMENT

4 POLE TEST (WENNER METHOD)

# TRAVERSE 87° E

DEPTH (m)	EARTH RESISTANCE	$ \begin{array}{cccc} \textbf{AUXILLARY} \\ \textbf{EARTHING} & \textbf{PROBE} \\ \textbf{RESISTANCE} & \textbf{RESISTANCE} \\ \textbf{RH} & (\textbf{K}\Omega) & \textbf{RS} & (\textbf{K}\Omega) \\ \end{array} $		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

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# **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	AUXILLARY EARTHING RESISTANCE RH (ΚΩ)	PROBE RESISTANCE RS (ΚΩ)	SOIL RESISTIVITY ρ (mΩ)	
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

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- Henrich

# Annex 2

**Dynamic Cone Penetration Test Results** 



#### Civil Elements consulting Engineers PENETROMETER TEST No of Blows Penetration(m) 0.3 6 0.6 4 0.9 2 9 1.2 **CLIENT:** 10 Project: 18 1.8 Site: **KALINGALINGA** 2.1 11 **Location: KALINGALINGA** 31 2.4 Test position: 1 -15.405342 28.331032 50 Date:13/03/19 54 logging @0 - 7.5m 44 3.3 20 0 10 30 40 50 60 46 3.6 52 3.9 EXCAVATED Number of 43 4.2 Blows per 300mm 41 4.5 38 4.8 2 47 5.1 3 54 5.4 Me 5.7 52 45 41 6.3 47 6.6 51 6.9 48 7.2 56 7.5 PENETROMETER TEST

#### **PENETROMETER TEST** No of Blows Penetration(m) 0.3 34 0.6 44 23 0.9 28 29 1.5 34 1.8 31 2.1 46 2.4 39 44 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 40 6.3 35 6.6 42 6.9 7.2 7.5

# Civil Elements consulting Engineers



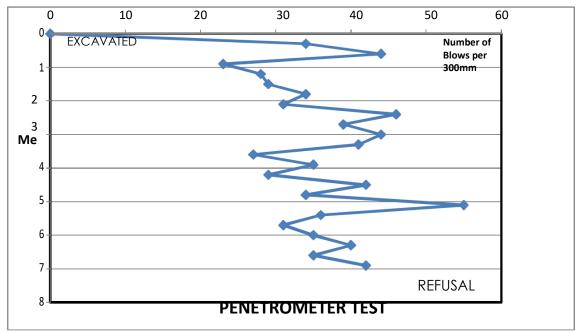


**CLIENT: Project:** 

Site: **Mtendere East Location: Helen Kaunda** 

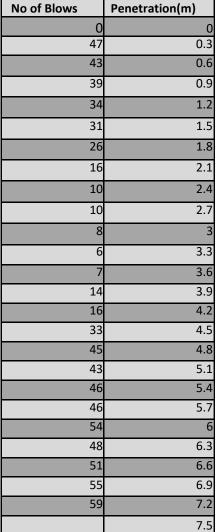
Test position: 2 -15.405299 28.358514

Date:06/03/19 logging @0 - 7.5m



# PENETROMETER TEST









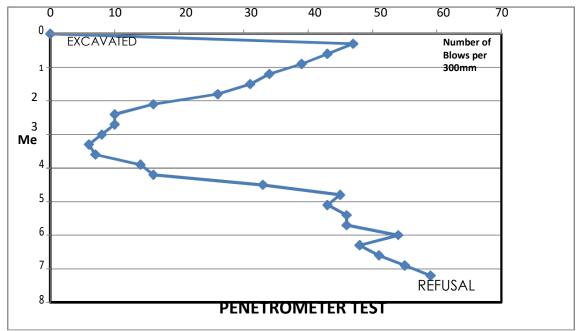
CLIENT: Project:

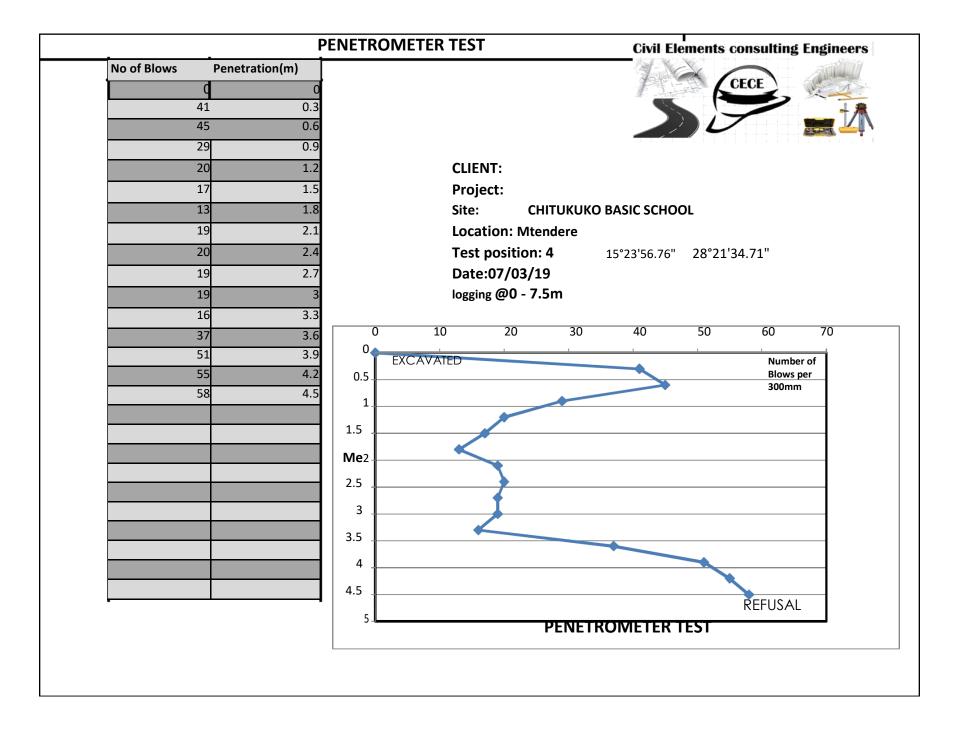
Site: Vera Chiluba Primary School

**Location: Helen Kaunda** 

**Test position: 3** -15.403987 28.348145

Date:13/03/19 logging @0 - 7.5m

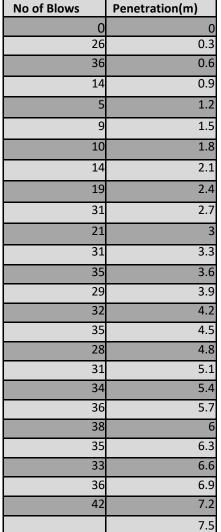




			ENETROMETER TEST	
No of Blows	Penetration	(m)	<del>-</del>	
	q	0		
	55 55	0.3		
	48	0.9		
	52	1.2	CLIENT:	
	41	1.5	Project:	
	44	1.8	Site: Mtendere east	
	55	2.1	Location: Mtendere	
	47	2.4	<b>Test position: 5</b> -15.405923 28.368838	
	58	2.7	Date:08/03/19	
	52	3	logging @0 - 7.5m	
	55	3.3		
	57	3.6	0 10 20 30 40 50 60 70	
	47	3.9	0 EXCAVATED Number of	
	51	4.2	Blows per	
	44	4.5	1 - 300mm	
	49	4.8	2	
	57	5.1	3	
	52	5.4	Me 1	
	59	5.7 6	4	
		6.3		
		6.6	5.	
		6.9	6	
		7.2		
		7.5	7	
-			REFUSAL	
			PENETROMETER TEST	

# PENETROMETER TEST







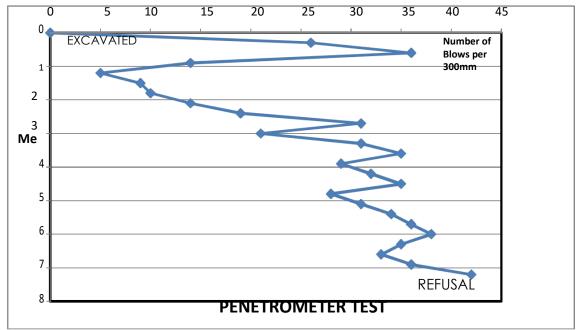


CLIENT: Project:

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) 26 0.3 0.6 24 0.9 **CLIENT:** 27 1.2 **Project:** 32 1.5 Site: Ibex 28 1.8 **Location: Mtendere** 34 2.1 38 2.4 Test position: 7 -15.403041 28.379753 Date:08/03/19 44 2.7 logging @0 - 7.5m 32 28 3.3 0 10 20 30 40 50 60 70 41 3.6 3.9 48 EXCAVATED Number of Blows er 55 4.2 300mn 47 4.5 58 2 4.8 59 5.1 3 53 5.4 Me 59 5.7 6.3 6.6 6.9 7.2 7.5 **REFUSAL** PENETROMETER TEST

# 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

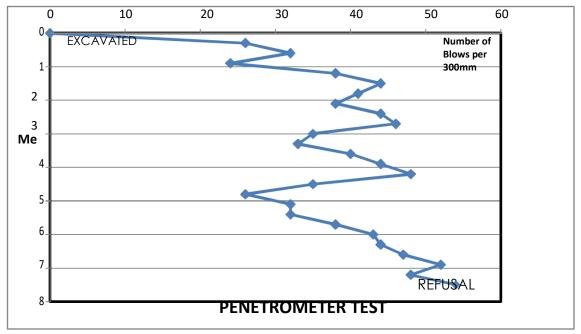
CLIENT: Project:

Site: Mtendere

**Location: Valley View** 

Test position: 8 -15.397451 28.378446

Date:08/03/19 logging @0 - 7.5m



#### PENETROMETER TEST No of Blows Penetration(m) 0.3 31 26 0.6 29 0.9 1.2 23 31 44 1.8 32 2.1 35 2.4 37 2.7 34 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 45 6.3 48 6.6 54 6.9 51 7.2 49 7.5 54 7.8





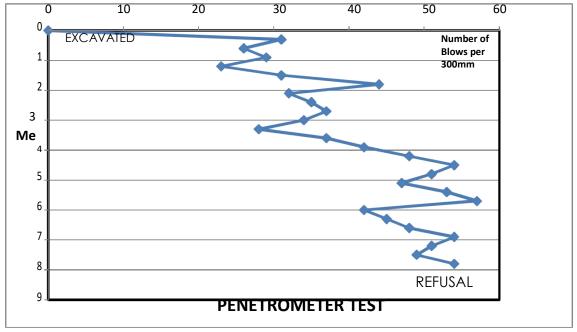


**CLIENT:** Project:

Site: CHAZANGA **Location: MANDEVU** 

**Test position: 9** -15.347278 28.287419

Date:09/03/19 logging @0 - 7.5m



#### Civil Elements consulting Engineers PENETROMETER TEST No of Blows Penetration(m) 0.3 24 38 0.6 54 0.9 1.2 **CLIENT:** 43 33 Project: 35 1.8 Site: KABANANA 2.1 39 **Location: MANDEVU** 49 2.4 Test position: 10 -15.351125 28.304049 2.7 33 Date:09/03/19 35 logging @0 - 7.5m 35 3.3 20 0 10 30 40 44 3.6 38 3.9 **EXCAVATED** 32 4.2 36 4.5 41 4.8 5.1 45 3 46 5.4 Me 49 5.7 53 56 6.3 52 6.6 6.9 48 45 7.2 52 7.5 7.8 PENETROMETER TEST

50

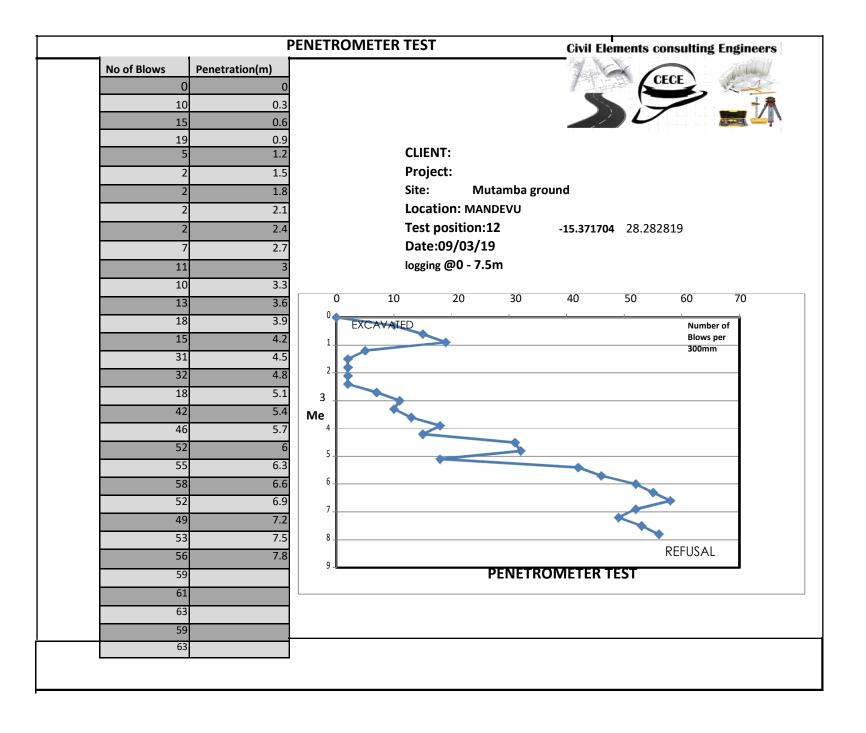
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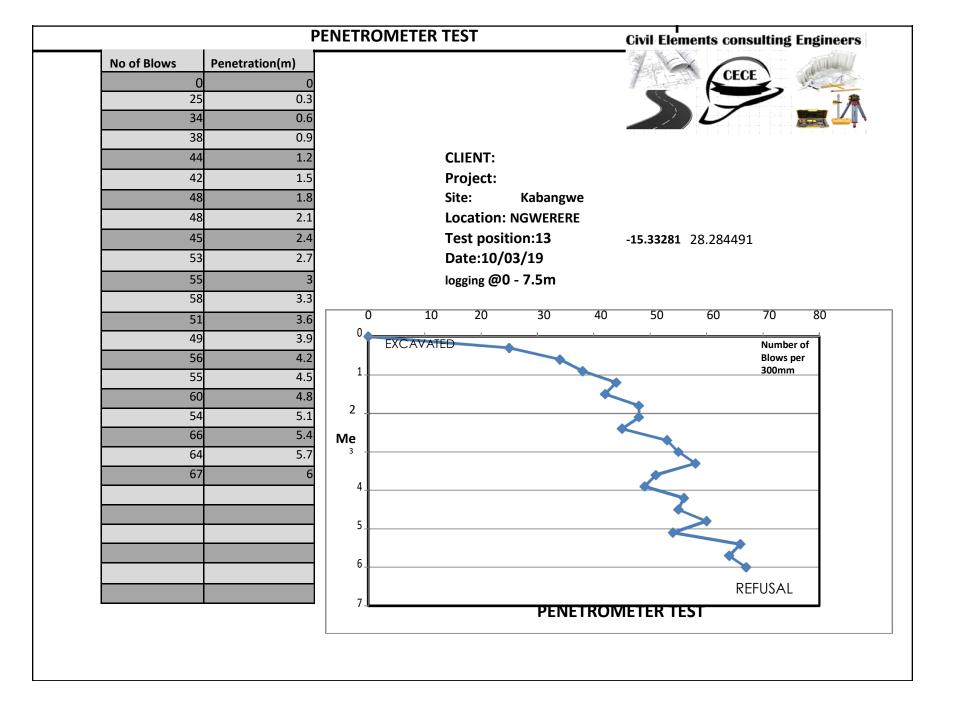
Number of

Blows per 300mm

REFUSAL

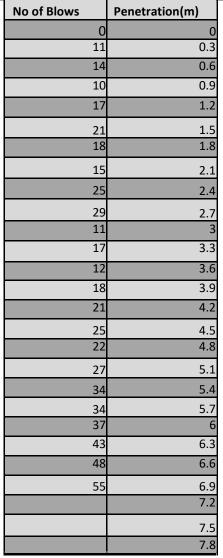
#### Civil Elements consulting Engineers PENETROMETER TEST No of Blows Penetration(m) 21 0.3 15 0.6 10 0.9 1.2 **CLIENT:** Project: 1.5 Site: Chipata compound 24 1.8 **Location: MANDEVU** 43 2.1 47 Test position: 11 2.4 **-15.362542** 28.294598 Date:09/03/19 42 2.7 45 logging @0 - 7.5m 52 3.3 0 10 20 30 60 70 40 50 48 3.6 52 3.9 EXCAVATED Number of 57 4.2 Blows per 300mm 62 4.5 64 4.8 5.1 66 2 Me REFUSAL PENETROMETER TEST





# PENETROMETER TEST

# Civil Elements consulting Engineers







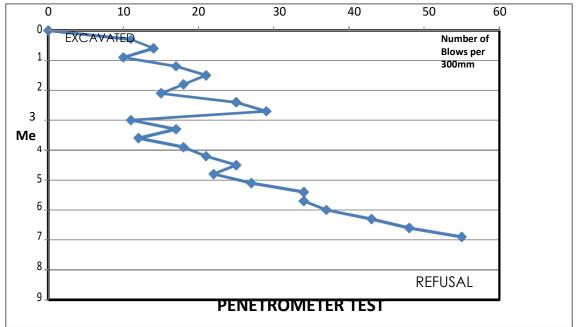
CLIENT: Project:

Site: Kabangwe (MAICHOLA)

**Location: NGWERERE** 

**Test position:14** -15.334801 28.298978

Date:10/03/19 logging @0 - 7.5m



# Civil Elements consulting Engineers

# LOG OF BOREHOLE TP3

# CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION. LOCANA
SITE: KALINGALINGA

	DIAMETER:	N/A		B/H No:	ТР3
DATE STARTED: 06/03/2019	LINING:	N/A			
<b>DATE COMPLETED:</b> 06/03/2019	COORDINATES	-15.403987	28.3481		
		_			

			•			
	PROFILE	DEPTH	SAMPLE	S.P.T	REMARKS	
SOIL DESCRIPTION		M	RECORDS	RESULTS	Allowable bea	aring capacity kN/m2
		0		0	0	
		0.3	<b>↓</b>	14	162	
		0.6	<b>↓</b>	19	217	
		0.9	<b>↓</b>	26	310	
		1.2	<b>↓</b>	23	275	
		1.5	Ţ	21	245	
Firm compacted sandy clay soils		1.8	<b>↓</b>	17	195	
		2.1	Ţ	11	131	
		2.4	Į.	7	75	
		2.7	Į.	7	75	
		3	Ţ	5	45	
		3.3	Ì	4	30	
Coarse gravelly soils		3.6	Ī	5	45	
		3.9	Ì	9	105	
		4.2	Ť	11	131	
		4.5	Ì	22	260	
		4.8	ì	30	380	
		5.1	Ì	29	365	
		5.4	Į.	31	392	
Coarse gravelly soils		5.7	Į.	31	392	
		6	<b>↓</b>	36	452	
		6.3	<b>↓</b>	32	404	
		6.6	<b>↓</b>	34	428	
		6.9	¥	37	464	
		7.2	<b>†</b>	39	488	
		7.5	<b>*</b> / -			
Limestone/Dolomite rock			1 MM			
GROUND LEVEL	BULK SAMP	LE • B		sandy clay loar	my	
WATER TABLE	DISTURB	EDS • D		gravelly clay	1	
WATER TABLE	UNDISTUI	RBED SAMPLE		gravelly san	dy clay	
END OF DRILLING	WATER S	SAMP • W	,	Coarse grave	elly sand	
S.P.T <u>↓</u>				Rock		
	+		Sign:			

# Civil Elements consulting Engineers

# LOG OF BOREHOLE TP4

		CLIEN	T:GOPA-INTI	ERNATION	IAL ENERGY	Y CONSULT	<b>TANTS</b>
LOCATION: LUSAKA							
SITE:MTENDERE (CHITUKUKO BASIC SCHOOL)	)	TYPE O	F BORING:				
	DIAMETE	ER:	N/A		B/H No:	TP4	
<b>DATE STARTED: 07</b> /03/2019	LINING:		N/A				
<b>DATE COMPLETED:</b> 07/03/2019	COORDI	NATES	15°23'56.76"	28°21'34.	71"		
	PROFILE	DEPTH	SAMPLE	S.P.T	REMARKS	-	
SOIL DESCRIPTION		M	RECORDS	RESULTS	Allowable bea	aring capacity	/ kN/m2
		0	121	0	0		
		0.3	<u> </u>	27	325		
compacted sandy clay soils		0.6	<del> </del>	30	380		
		0.9	<u> </u>	19	217		
		1.2	<del>+</del>	13	152		
		1.5	<del>+</del>	11	131		
gravelly sandy clay soils		1.8	<del>*</del>	9	105		
		2.1	<del>*</del>	13	152		
		2.4 2.7	<del>*</del>	13 13	152 152		
			+	13	152		
		3 3.3	<del>*</del>	13 11	131		
slates laterite rocks and soils		3.6	<u>*</u>	25	295		
slates laterite rocks and soils		3.9	<del>*</del>	34	428		
		4.2	<del>1</del>	37	464		
		4.5	<del>*</del> .	39	488		
Limestone/Dolomite rock		7.0	Min 7	7	400		
GROUND LEVEL	BULK SAM	PLE • E	3	sandy clay loa	my		
WATER TABLE	DISTURE	BEDS • D	)	gravelly cla	у		
	UNDISTU	JRBED SAMPLI		gravelly san	dy clay		
END OF DRILLING WAN	WATER	SAMP • W	l	Coarse grav	elly sand		
S.P.T				Rock			

Sign:

# Civil Elements consulting Engineers CECE LOCATION: LUSAKA SITE: MTENDERE (KALIKILIKI GROUND)

# LOG OF BOREHOLE TP5

# CLIENT: GOPA-INTERNATIONAL ENERGY CONSULTANTS

TP5

TYPE OF BORING:

DIAMETER: N/A B/H No:

DATE STARTED: 06/03/2019

LINING: N/A

COORDINATES -15.405923 28.3688

SOIL DESCRIPTION  M RECORDS  RESULTS  Allowable bearing capacity kN/m2  0 0 0 0.3 4 29 365 0.6 4 37 464 0.9 4 32 404 1.2 7 325 1.8 4 29 365 2.1 4 37 464 2.4 31 392 2.7 4 39 488 3 4 35 440 3.3 4 37 464 3.6 4 38 476 3.9 488 3 4 36 40 3.6 4 38 476 3.9 488 3 4 428 4.5 4 29 365 4.8 33 416 5.1 4 38 476 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4 4 48 5.1 4		PROFILE	DEPTH	SAMPLE	S.P.T	REMARKS	1	
0	SOIL DESCRIPTION	1 1101 122					l aring capacity	kN/m2
0.3		<u> </u>					3 - 1 3	
0.6			0.3	1				
1.2				Ţ		464		
1.5			0.9	<del>1</del>	32	404		
1.8			1.2	1	35	440		
2.1			1.5	<b>†</b>	27	325		
2.4			1.8	1	29	365		
2.7			2.1	<b>†</b>	37	464		
3			2.4	<b>↓</b>	31	392		
3.3   37   464   38   476   392   422   34   428   428   425   428   4			2.7	<del> </del>	39	488		
3.6			3	<del>1</del>	35	440		
3.9   31   392			3.3	<del> </del>	37	464		
## A 2	dense Coarse gravelly soils		3.6	<del> </del>	38	476		
## A.5			3.9	<del> </del>	31	392		
### ### ### ### ### ### ### ### ### ##			4.2	<del>1</del>	34	428		
5.1				<del>1</del>				
SP.T  Sandy clay loamy  Bulk SAMPLE  Bulk SA				<u>+</u>				
SP.T  39 488  Sandy clay loamy  DISTURBED S • D gravelly clay  UNDISTURBED SAMPLE gravelly sandy clay  WATER SAMP • W Coarse gravelly sand  Rock				<u> </u>				
GROUND LEVEL  BULK SAMPLE  B  BULK SAMPLE  B  B  BULK SAMPLE  B  B  B  B  BULK SAMPLE  B  B  B  B  B  B  B  B  B  B  B  B  B				<del>*</del>				
BULK SAMPLE   B Sandy clay loamy   DISTURBED S   D Gravelly clay   UNDISTURBED SAMPLE   Gravelly sandy clay   END OF DRILLING   WATER SAMP   WATER SAMP   Rock   Rock	Limestone/Dolomite rock	9	5.7	* Ww	39	488	1	
WATER TABLE  UNDISTURBED S • D  gravelly clay  gravelly sandy clay  MATER SAMP • W  Coarse gravelly sand  Rock	Elificatorio/Bolomic Fock			F WW 1	<u>^</u>			
WATER TABLE  UNDISTURBED S • D  gravelly clay  gravelly sandy clay  MATER SAMP • W  Coarse gravelly sand  Rock								
WATER TABLE  UNDISTURBED SAMPLE gravelly sandy clay  END OF DRILLING WATER SAMP • W Coarse gravelly sand  S.P.T Rock	GROUND LEVEL	BULK SAMPLE	• в		sandy clay loa	my		
UNDISTURBED SAMPLE ■ gravelly sandy clay  END OF DRILLING WATER SAMP • W Coarse gravelly sand  S.P.T Rock	WATED TADI E	DISTURBED	os • D		gravelly cla	y		
S.P.T Rock	WATER TABLE	UNDISTUR	BED SAMPLE		gravelly san	dy clay	200 200 D 4	
	END OF DRILLING WWW	WATER SA	MP • W		Coarse grav	elly sand		
Sign:	S.P.T				Rock			
				Sign:				

# Civil Elements consulting Engineers

# LOG OF BOREHOLE TP6

# CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

# LOCATION: LUSAKA

SIT	E:۸	1tende	ere	east

	PROFILI	E DEPTH	SAMPLE	S.P.T	REMARKS		
SOIL DESCRIPTION		M	RECORDS	RESULTS	Allowable bea	ring capacity	kN/m2
		0	123	0	0		
Compacted sandy clay soils		0.3	<u>↓</u>	17	195		
		0.6	<u>↓</u>	24	280		
		0.9	Į.	9	105		
		1.2	<u>↓</u>	3	20		
		1.5	<b>↓</b>	6	60		
sandy clay soils		1.8	<u>↓</u>	7	75		
		2.1	<u>↓</u>	9	105		
		2.4	<u>↓</u>	13	152		
		2.7	<u>,                                     </u>	21	245		
		3	<b>↓</b>	14	162		
		3.3	<u>Į</u>	21	245		
dense Coarse gravelly soils		3.6	<b>↓</b>	23	275		
		3.9	<u>Į</u>	19	217		
		4.2	<b>↓</b>	21	245		
		4.5	<b>↓</b>	23	275		
		4.8	Ţ	19	217		
		5.1	<del>↓</del>	21	245		
		5.4	<u> </u>	23	275		
		5.7	<u> </u>	24	280		
		6	<del>*</del>	25	295		
		6.3	<del>*</del>	23	275		
		6.6 6.9	<del>*</del>	22 24	260 280		
		7.2	Ť	28			
Slates of laterite rock		7.5	Ĭ	54	340 >600		
Clates of laterite rook	ie .	]	₹ WIN V	J-1	7000		
			y y nyen ∨				
GROUND LEVEL	BULK SAM	IPLE B		sandy clay loamy			
WATER TABLE	DISTUR	BEDS • D		gravelly clay			
WATER TABLE	UNDIST	URBED SAMPLE	1	gravelly sandy o	clay		
END OF DRILLING WWW	WATER	SAMP • W		Coarse gravelly	sand		
s.p.t <u>↓</u>				Rock			
			Cian:				
			Sign:				

#### Civil Elements consulting Engineers LOG OF BOREHOLE TP11 CLIENT: GOPA-INTERNATIONAL ENERGY CONSULTANTS LOCATION: LUSAKA SITE:MTENDERE ( VALLEY VIEW) TYPE OF BORING: TP11 DIAMETER: B/H No: N/A DATE STARTED: 08/03/2019 LINING: N/A **DATE COMPLETED:** 08/03/2019 COORDINATES -15.362542 28.294598 **PROFILE** DEPTH SAMPLE S.P.T REMARKS RECORDS SOIL DESCRIPTION **RESULTS** Allowable bearing capacity kN/m2 M 0 0 14 162 0.3 sandy clay loamy 0.6 10 120 7 75 0.9 5 45 1.2 60 1.5 6 16 184 1.8 29 2.1 365 dense Coarse gravelly soils 2.4 31 392 2.7 28 340 380 30 35 440 3.3 404 3.6 32 35 3.9 440 Slates of laterite rock 38 476 4.2 41 512 4.5 4.8 43 535 44 550 sandy clay loamy **GROUND LEVEL** BULK SAMPLE • DISTURBED S • gravelly clay WATER TABLE UNDISTURBED SAMPLE gravelly sandy clay END OF DRILLING WWW WATER SAMP • W Coarse gravelly sand S.P.T Rock

Sign:

# **Civil Elements consulting Engineers**



# LOG OF BOREHOLE TP8

#### CLIENT: GOPA-INTERNATIONAL ENERGY CONSULTANTS

# LOCATION: LUSAKA

DATE STARTED: 09/03/2019 **DATE COMPLETED**: 09/03/2019

SITE:MANDEVU (MUTAMBA GROUND)

DIAMETER:	N/A	B/H No:	TP12
LINING:	N/A		
COORDINATES	-15 371704 28 282819	)	

				<b>1</b> 1		
	PROFILE		SAMPLE	S.P.T	REMARKS	
SOIL DESCRIPTION		M	RECORDS			aring capacity kN/m2
		0		0		
		0.3	<u> </u>	7		
		0.6	<u> </u>	10		
		0.9	<u>*</u>	13		
		1.2	<u>*</u>	3		
sandy clay loamy		1.5	<u>+</u>	1		
		1.8	<del>*</del>	1		
		2.1	<del>*</del>	1		
		2.4	<del>*</del>	1		
		2.7	<u>*</u>	5		
		3	<u>*</u>	7		
		3.3	<del>*</del>	7		
		3.6	<del>*</del>	9		
		3.9	*	12		
	_	4.2	<u>*</u>	10		
Dense Coarse gravelly soils		4.5 4.8	<del>*</del>	21 21		
Donied dealed gravery cone		5.1	Ť	12		
		5.4	<del>\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ </del>	28	340	
		5.7	Ţ	31	392	
		6	<b>↓</b>	35	440	
Slates of laterite rock		6.3	<u>↓</u>	37	464	
		6.6	<u> </u>	39	488	
		6.9	<u> </u>	35	440	
		7.2 7.5	<del>*</del>	33 35	416 440	
		7.5 8	Ĭ	37	464	
		•	Ť	39	488	
		•	<del> </del>	41	512	
		•	¥	42	525	
		_	<u> </u>	39	488	
			MM /	7 42	525	
	1			I		
GROUND LEVEL ——	BULK SA	MPLE   B	<b>.</b>			П
	52/10/1					Ш
	DISTURE	BEDS • D				
WATER TABLE						
	UNDIST	JRBED SAMPL	E 🏻	gravelly sandy	clay	
END OF DRILLING WWW	WATER S	SAMP • W		Coarse gravelly	sand	
S.P.T				Rock		
<u> </u>				TOOK		Ш
			Sign:			

# **Civil Elements consulting Engineers** LOCATION: LUSAKA

# LOG OF BOREHOLE TP13

# CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS

SITE: NGWERERE

	DIAMETER:	N/A	B/H No:	TP13
DATE STARTED: 10/03/2019	LINING:	N/A		
<b>DATE COMPLETED:</b> 10/03/2019	COORDINATES	<b>-15.33281</b> 28.284491		

	PROFILE	DEPTH		S.P.T	REMARKS		
SOIL DESCRIPTION		M	RECORDS	RESULTS	Allowable be	aring capacity	/ kN/m2
		0	1 <u>2</u> 1	0	0		
		0.3	<u>+</u>	17	195		
laterite soils		0.6	<u>+</u>	23	275		
		0.9	<u>+</u>	25	295		
		1.2	<del> </del>	29	365		
		1.5	<del> </del>	28	340		
		1.8	<del> </del>	32	404		
		2.1	<del> </del>	32	404		
		2.4	<b>↓</b>	30	380		
		2.7	<del> </del>	35	440		
		3	<u>↓</u>	37	464		
		3.3	<del> </del>	39	488		
laterite rock		3.6	<u> </u>	34	428		
		3.9	<del> </del>	33	416		
		4.2	<u>↓</u>	37	464		
		4.5	<u>↓</u>	37	464		
		4.8	<u>+</u>	40	500		
		5.1	<u>+</u>	36	452		
		5.4	+	44	50		
		5.7	+	43	535		
		6	1 141 / 5	45	560	1	
			+ WAM Z	/			
GROUND LEVEL	BULK SAMI	PLE B		sandy clay loamy			
WATER TABLE	DISTURE	EDS • D		gravelly clay			
<del></del>	UNDISTU	IRBED SAMPLE	•	gravelly sandy	clay		
END OF DRILLING WWW	WATER	SAMP • W		Coarse gravell	y sand		
S.P.T				Rock			
			Sign:				

# Civil Elements consulting Engineers

# LOG OF BOREHOLE TP14

# CLIENT: GOPA-INTERNATIONAL ENERGY CONSULTANTS

LOCATION: LUSAKA

SITE: NGWERERE

	DIAMETER:	N/A	B/H No:	TP14
DATE STARTED: 10/03/2019	LINING:	N/A		
<b>DATE COMPLETED:</b> 10/03/2019	COORDINATES	<b>-15.334801</b> 28.298978		

	<u></u>				-		
		I	CAMDI	T		ı	
	PROFILE	DEPTH	SAMPL E	S.P.T	REMARKS		
SOIL DESCRIPTION	1101122	M	RECORDS	RESULTS		aring capacity kN/	m2
COL BECOME FIOR		0	REGORDO	0	0		1112
aandy alay aaila		0.3	I	7	75		
sandy clay soils		0.5	<u>Y</u>		105		
		-	<del>*</del>	9	75		
		0.9	<del>*</del>	7 11			
		1.2	<del>*</del>		131		
		1.5	<u>*</u>	14	162		
		1.8	<u>+</u>	12	142		
		2.1	<u> </u>	10	120		
		2.4	<u>*</u>	17	195		
		2.7	<u>+</u>	19	217		
		3	<u> </u>	7	75		
		3.3	<u> </u>	11	131		
dense Coarse gravelly soils		3.6	<del>↓</del>	8	90		
		3.9	<u>↓</u>	12	142		
		4.2	<del>1</del>	14	162		
		4.5	1	17	195		
		4.8	Ţ	15	180		
		5.1	<del>1</del>	18	206		
		5.4	<del> </del>	23	275		
laterite rock		5.7	<u>+</u>	23	275		
		6	<u>+</u>	25	295		
		6.3	_	29	365		
		6.6	<u> </u>	32	404		
		6.9 ♥	<del>1 111 /</del>	37	464		
		3	+ MM ~		<u> </u>		
<del></del>		_					
GROUND LEVEL	BULK SAMPLE	• в		sandy clay loamy		<u> </u>	
	DISTURBED	S • E	)	gravelly clay			
WATER TABLE			-	J C, C.M.			
	UNDISTURE	BED SAMPLE	0	gravelly sandy	clay		
END OF DRILLING WWW	WATER SAI	MP • W	1	Coarse gravell	y sand		
<b>₩</b>					-		
S.P.T				Rock			
		9	Sign:				

# Civil Elements consulting Engineers



# LOG OF BOREHOLE TP15

	CLIENT:GOPA-INTERNATIONAL ENERGY CONSULTANTS						
LOCATION: LUSAKA							
SITE: NGWERERE	TYPE OF BORING:						
	DIAMETER	i: N	I/A		B/H No:	TP15	
DATE STARTED: 10/03/2019	LINING: N/A						
DATE COMPLETED: 10/03/2019	COORDINATES -15.3182			28.296593			
				1			1
	PROFILE	DEPTH	SAMPL E	S.P.T	REMARKS		
SOIL DESCRIPTION		M	RECORDS	RESULTS		earing capacit	y kN/m2
sandy clay soils		0	News	0		)	-
		0.3	<u> </u>	6	60		
		0.6	<u>↓</u>	5	45		
		0.9	<u>†</u>	5	45		
dense Coarse gravelly soils		1.2	<u>↓</u>	5	45		
		1.5	<del>†</del>	7	75		
		1.8	<del>Į</del>	6	60		
		2.1	<del>†</del>	7	75		
		2.4	<u>+</u>	9	105		
		2.7	<u>+</u>	9	105		
		3	<u>+</u>	7	75		
		3.3	<u>+</u>	11	131		
		3.6	<u>+</u>	10	120		
		3.9	<u> </u>	11	131		
		4.2	<u>+</u>	13	152		
		4.5	<u>+</u>	15	180		
		4.8	<del>*</del>	13	152		
		5.1 5.4	<del>†</del>	15 13	180 152		
		5.4	<del>*</del>	11	131		
		6	<del>Ĭ</del>	12	142		
		6.3	₹	16	184		
		6.6	<u>Ţ</u>	17	195		
		6.9	<del>•</del>	19	217		
Slates of laterite rock		7.2	<u>+</u>	23	275		
		7.5	<u>+</u>	26	310		
		7.8	* WW -	29	365	Ī	
			<b>▼   19/11</b>		<u> </u>		<u> </u>
GROUND LEVEL	BULK SAMPLE B			sandy clay loamy	1		
WATER TABLE ————	DISTURBED S • D			gravelly clay			
	UNDISTURBED SAMPLE			gravelly sandy	clay		
END OF DRILLING WWW	WATER SAMP • W			Coarse gravell	y sand		
S.P.T <u>*</u>				Rock			

Sign:

Annex 7

**HV** Cable Installation, Testing and Commissioning





Document No: DS.13510.TCHI.00081

Title: HV Cable Installation, Testing and Commissioning

Date of Approval: 04/01/2017

Version:

Division:
Distribution and Customer
Services



Document No: DS.13510.TCHI.00081 Version No: 1 Page 1 of 21

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).



Document No: DS.13510.TCHI.00081 Version No: 1 Page 2 of 21

Development, Review and Approval						
Prepared By	Date	Reviewed By	Date	Approved By	Date	
Thomas Sinkamba		At	23.12.16	B	4/01/17	
Technical Services Manager	19112/16	Gyavira M. Bwalya Divisional Manager		Dennis Banda  Director Distribution		



**Document No:** 

DS.13510.TCHI.00081

**Version No: 1** 

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# Contents

1.	PURPOSE	4
2.	SCOPE	4
	REFERENCES	
	RESPONSIBILITIES	
5.	DEFINITIONS AND GENERAL CONTENTS	5
6.	DEVELOPMENT	5
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	APPENDICES	



Document No: DS.13510.TCHI.00081 Version No: 1 Page 4 of 21

#### 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.

ZESCO Powering the Nation	HV Cable Installation, Testing and Commissi	oning	
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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	
	Clear safety document	



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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	
Tools	s and Equipment:	

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	

Excavators, picks & shovels, depth gauges, excavation tapes or warning notices



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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
	•

# **Tools and Equipment:**

Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Jointer's Tool Box



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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	-
T1	and Equipment:	1

# **Tools and Equipment:**

Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Jointer's 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	
Table	and Equipment	

## **Tools and Equipment:**

Cable Rollers, Cable Markers, Picks and shovels, Pressure Testing equipment, Cable Jointer's 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 Jointer's Tool Box

7	7	HV cable Commissioning	Tool	ı
			Time	ı



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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	
Tool	s and Equipment:	1
Cable	e 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 L	ocation 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	s and Equipment:	

## **Tools and Equipment:**

Excavators, picks & shovels, depth gauges, excavation tapes or warning notices



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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 s	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	s and Equipment:	•

# Tools and Equipment:

Pressure Testing Equipment



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	Time
Conduct risk assessment	
Carry appropriate tools, equipment and materials	
Wear correct PPE	
Cancel any previous safety document and obtain a PTW for jointing	
Ensure cable jointing is done only by qualified jointers	
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	
Clean up the work area	
Cancel the PTW	
N:B Ensure the whole cable length is tested as per procedure before restoring into service	
	Carry appropriate tools, equipment and materials  Wear correct PPE  Cancel any previous safety document and obtain a PTW for jointing  Ensure cable jointing is done only by qualified jointers  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  Clean up the work area  Cancel the PTW  N:B Ensure the whole cable length is tested as per procedure before restoring

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	Burry /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 a	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	

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	s 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	s 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	Jointer's 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	Jointer's 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	



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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

# **Tools and Equipment:**

Cable sizing software, Cable datasheets and various manufacturers' manuals, Customer Technical Specifications/Requirements

ZESCO Powering the Nation	HV Cable Installation, Testing and Commissioning			
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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.

Annex 8

**Environmental and Social Management Plan** 





Document No: BD.15100.SPPR.00020

Title: Environmental and Social Management Plan

Date of Approval: 23/05/2016

Version:

Division: Environmental and Social Analysis Unit



Document No: | BD.15100. SPPR.00020

Version No: 1

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Version	Changes from Previous Editions (Section: Documentation Revised or Discarded)	Date Changed MM/Year
1	Document Developed	04/2016

# Distribution

**Controlled Copy No.** 

**Assigned To:** (Register of manual distribution to be kept by the relevant supervisors).



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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	Bestty Phiri Director-Strategy & Corporate Services	23/5/2016			



Document No:

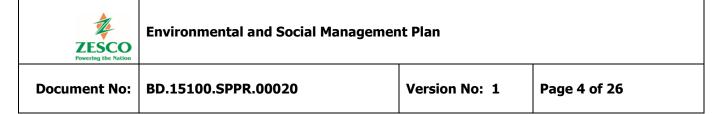
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#### 1. PURPOSE

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.



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## 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



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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



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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.



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## 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

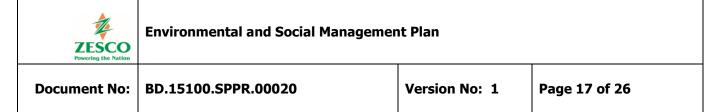
Performance monitoring deals with how well the ESMP is achieving results. After the indicators for the ESMP are identified and means of verification specified, a monitoring plan for each result indicator shall be prepared following steps outlined below:

- 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;



- 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.

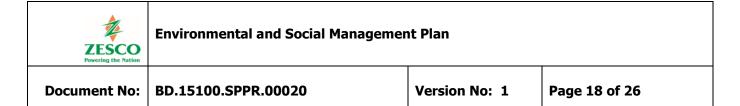
#### 5.40 Control of the ESMP

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.



## 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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## 6. **DEVELOPMENT**

# **6.1 Environmental and Social Management Plan Process**

The following process flowchart from the IBMS shall be adhered to in the execution of this procedure:

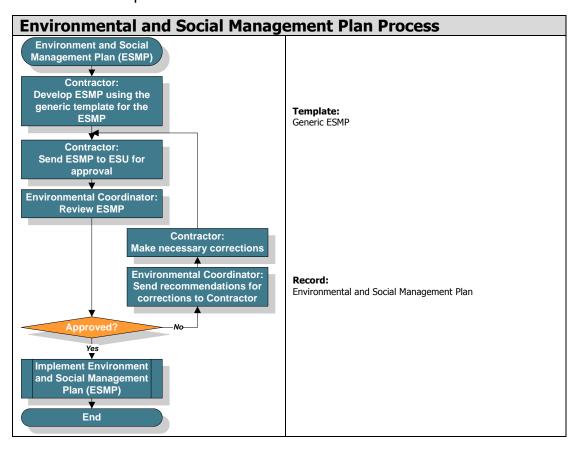


Figure 1: Environmental and Social Management Plan Process

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The following process flowchart from the IBMS shall be adhered to in the execution of this procedure:

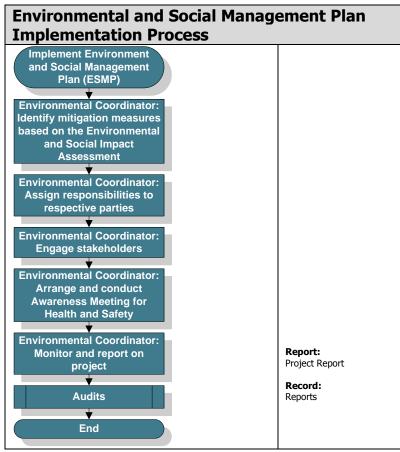


Figure 2: Environmental and Social Management Plan Implementation Process



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# 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 Sedimentatio n 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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Archaeologica I 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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# 8. APPENDICES

# APPENDIX 1: SAMPLE OF A GENERIC MANAGEMENT PLAN

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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



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- 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