APPENDIX I

PRELIMINARY DESIGN
FOR URGENT PROTECTION MEASURES

<This Appendix has been removed
because of confidential information.>

APPENDIX J

PRELIMINARY COST ESTIMATE

<This Appendix has been removed
because of confidential information.>

APPENDIX K

RESULT OF FREQUENCY ANALYSIS

Table K.1: Result of Frequency Analysis (1/2)

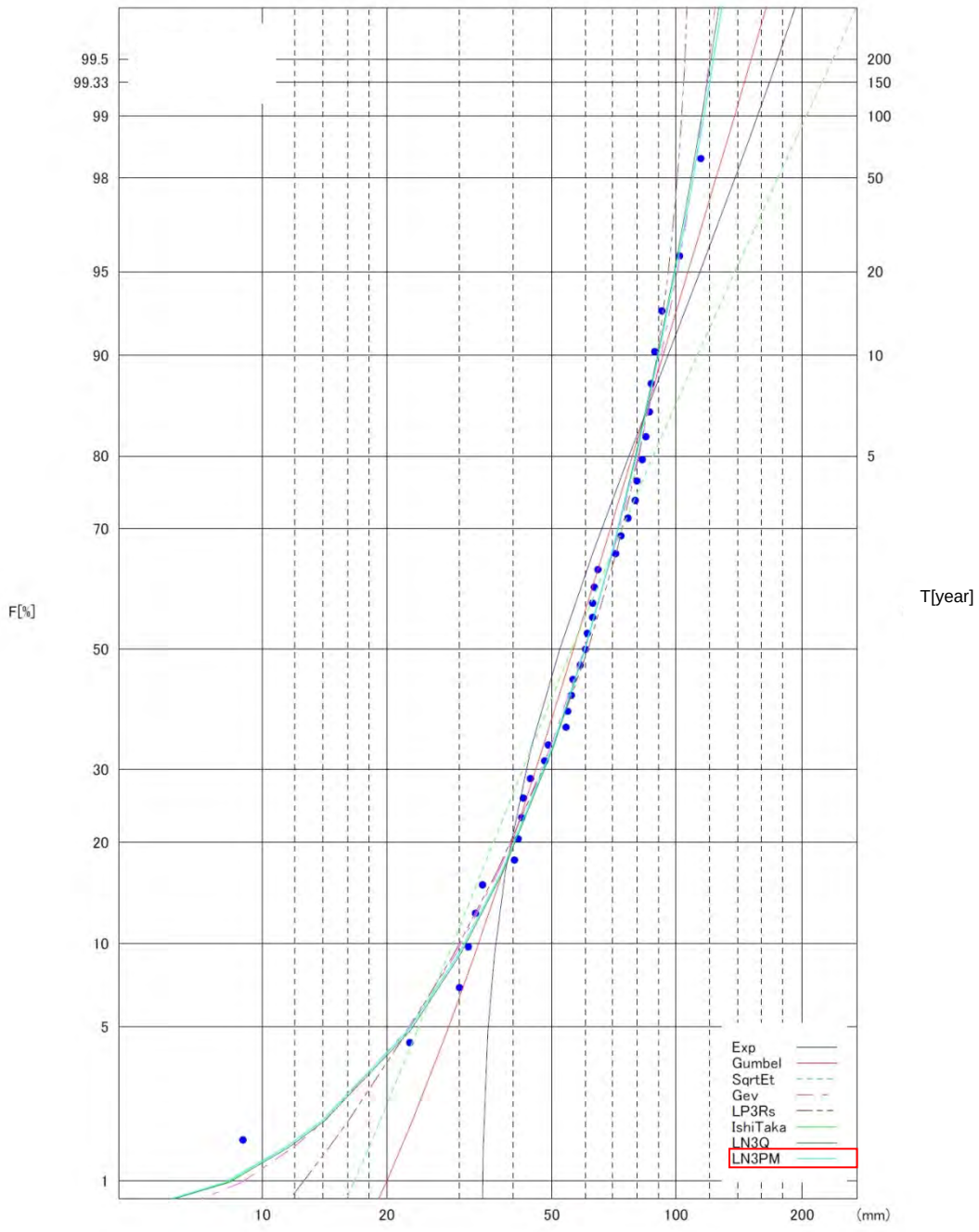
Station ID		9535005	9535006	9536000	9536002	9536004	9536005	9536011	9536017	9635001	9635012	9635014	9636000	9636002	9636004	9636006	9636008	9636013	9636018	9636020
No. of Sample		6	5	37	14	34	6	6	38	76	24	24	32	5	6	28	44	34	30	50
Type		Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall
Method		-	-	LN3PM	-	Gumbel	-	-	Gev	Gev	LogP3	Gev	LogP3	-	-	LogP3	Gev	Gev	Gev	LogP3
SLSC(99%)		-	-	0.019	-	0.026	-	-	0.032	0.02	0.028	0.045	0.037	-	-	0.036	0.032	0.037	0.043	0.025
Probability	2	-	-	60.0	-	57.3	-	-	55.8	68.3	61.8	60.0	54.0	-	-	67.7	55.2	56.5	67.8	54.4
Hydrological	3	-	-	70.0	-	67.2	-	-	62.2	76.8	69.3	70.5	60.8	-	-	79.5	63.2	64.6	79.3	61.4
Value in	5	-	-	79.8	-	78.3	-	-	68.1	85.7	76.8	82.6	67.9	-	-	92.1	72.6	73.4	90.8	68.8
Return Period	10	-	-	90.3	-	92.2	-	-	74.2	95.9	85.2	98.5	76.1	-	-	106.9	85.3	84.0	103.4	77.3
	20	-	-	99.2	-	105.5	-	-	78.9	104.9	92.4	114.3	83.4	-	-	120.3	98.5	93.8	113.9	84.9
	30	-	-	103.9	-	113.2	-	-	81.1	109.7	96.2	123.7	87.3	-	-	127.6	106.5	99.3	119.3	89.1
	50	-	-	109.3	-	122.8	-	-	83.5	115.4	100.7	135.8	92.1	-	-	136.4	117.0	106.0	125.4	94.1
	80	-	-	114.0	-	131.6	-	-	85.5	120.3	104.5	147.2	96.4	-	-	144.3	127.1	112.0	130.5	98.6
	100	-	-	116.1	-	135.7	-	-	86.3	122.6	106.3	152.7	98.4	-	-	147.9	132.1	114.8	132.8	100.6
	150	-	-	119.9	-	143.3	-	-	87.6	126.5	109.4	162.8	101.9	-	-	154.4	141.4	119.8	136.7	104.3
	200	-	-	122.5	-	148.6	-	-	88.4	129.1	111.5	170.2	104.3	-	-	158.9	148.2	123.3	139.2	106.8
	400	-	-	128.4	-	161.5	-	-	90.2	135.1	116.3	188.3	110.0	-	-	169.4	165.5	131.4	144.8	112.8
JackKnife	2	-	-	60.9	-	57.3	-	-	55.7	68.3	61.5	59.7	53.7	-	-	67.4	55.2	56.5	67.8	54.3
Estimate in	3	-	-	71.0	-	67.2	-	-	62.3	76.8	69.3	70.6	60.9	-	-	79.5	63.2	64.7	79.4	61.4
Return Period	5	-	-	80.4	-	78.3	-	-	68.3	85.7	77.2	83.3	68.4	-	-	92.3	72.7	73.5	91.1	68.9
	10	-	-	90.2	-	92.2	-	-	74.4	96.0	86.0	99.7	77.1	-	-	107.5	85.6	84.3	103.7	77.5
	20	-	-	98.0	-	105.5	-	-	78.9	105.0	93.6	115.5	84.6	-	-	121.0	98.7	94.0	114.0	85.1
	30	-	-	101.9	-	113.2	-	-	81.0	109.7	97.5	124.5	88.5	-	-	128.3	106.7	99.4	119.1	89.3
	50	-	-	106.5	-	122.8	-	-	83.0	115.3	102.1	135.5	93.2	-	-	137.1	117.0	105.8	124.8	94.3
	80	-	-	110.2	-	131.6	-	-	84.6	120.1	106.0	145.2	97.1	-	-	144.7	126.8	111.4	129.3	98.7
	100	-	-	111.9	-	135.7	-	-	85.2	122.3	107.7	149.6	98.8	-	-	148.2	131.6	113.9	131.3	100.7
	150	-	-	114.8	-	143.3	-	-	86.1	126.0	110.8	157.2	101.8	-	-	154.3	140.4	118.4	134.5	104.3
	200	-	-	116.7	-	148.6	-	-	86.6	128.5	112.8	162.3	103.8	-	-	158.5	146.8	121.4	136.5	106.7
	400	-	-	121.0	-	161.5	-	-	87.6	134.1	117.3	173.1	108.3	-	-	168.1	162.7	128.1	140.6	112.5
JackKnife	2	-	-	4.5	-	3.7	-	-	2.3	2.3	3.7	4.5	2.7	-	-	5.9	2.6	2.8	6.6	2.5
Estimate	3	-	-	4.7	-	4.5	-	-	2.6	2.6	4.0	5.9	2.9	-	-	6.6	3.3	3.4	6.8	2.8
Error in	5	-	-	4.8	-	5.7	-	-	2.9	3.0	4.6	7.9	4.0	-	-	6.9	4.4	4.5	6.3	3.0
Return Period	10	-	-	4.9	-	7.5	-	-	3.4	3.6	6.2	11.5	6.8	-	-	7.0	6.3	6.1	5.3	3.4
	20	-	-	5.2	-	9.3	-	-	4.3	4.4	8.6	16.7	10.4	-	-	7.6	8.8	8.2	5.5	4.0
	30	-	-	5.5	-	10.3	-	-	5.1	5.0	10.1	20.7	12.7	-	-	8.4	10.8	9.7	6.6	4.5
	50	-	-	6.0	-	11.7	-	-	6.2	6.0	12.3	26.8	15.9	-	-	10.2	13.8	12.0	8.8	5.3
	80	-	-	6.6	-	12.9	-	-	7.3	7.0	14.4	33.8	18.9	-	-	12.5	17.1	14.4	11.1	6.2
	100	-	-	6.9	-	13.5	-	-	7.9	7.6	15.5	37.5	20.4	-	-	13.7	18.9	15.7	12.4	6.6
	150	-	-	7.6	-	14.6	-	-	8.9	8.6	17.4	45.0	23.2	-	-	16.3	22.6	18.2	14.7	7.6
	200	-	-	8.1	-	15.3	-	-	9.7	9.4	18.8	50.9	25.2	-	-	18.4	25.6	20.1	16.4	8.3
	400	-	-	9.5	-	17.2	-	-	11.5	11.5	22.3	67.6	30.2	-	-	23.9	33.9	25.2	20.7	10.3

Source: JICA Study Team

Table K.1: Result of Frequency Analysis (2/2)

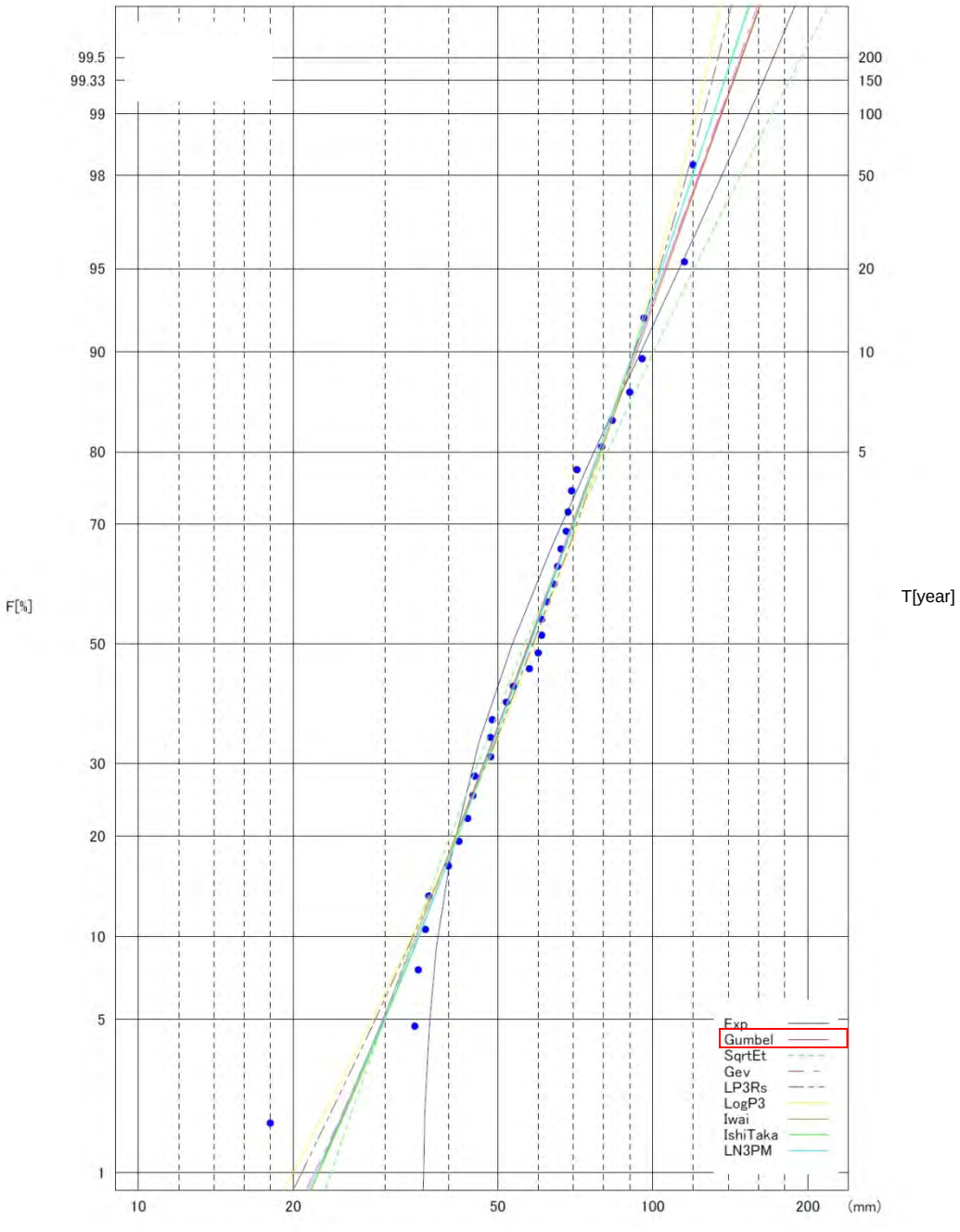
Station ID		9636026	9636027	9636029	9636030	9636031	9636032	9636033	9636034	9636037	9636038	9736007	Azimio	Chihanga	Ibwaga	Kikombo	Mayamaya	1GD2	1GD2
No. of Sample		13	12	15	6	5	5	5	6	4	6	23	6	5	4	6	6	76	20
Type		Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	CA Rainfall	Discharge
Method		-	-	Gev	-	-	-	-	-	-	-	LN2LM	-	-	-	-	-	Iwai	Iwai
SLSC(99%)		-	-	0.036	-	-	-	-	-	-	-	0.034	-	-	-	-	-	0.018	0.038
Probability	2	-	-	59.1	-	-	-	-	-	-	-	73.4	-	-	-	-	-	27.5	55
Hydrological	3	-	-	65.5	-	-	-	-	-	-	-	82.9	-	-	-	-	-	31.1	74
Value in	5	-	-	70.8	-	-	-	-	-	-	-	93.1	-	-	-	-	-	34.9	98
Return Period	10	-	-	75.7	-	-	-	-	-	-	-	105.4	-	-	-	-	-	39.4	130
	20	-	-	78.9	-	-	-	-	-	-	-	116.8	-	-	-	-	-	43.6	165
	30	-	-	80.3	-	-	-	-	-	-	-	123.2	-	-	-	-	-	45.9	186
	50	-	-	81.7	-	-	-	-	-	-	-	131.1	-	-	-	-	-	48.8	214
	80	-	-	82.6	-	-	-	-	-	-	-	138.2	-	-	-	-	-	51.3	240
	100	-	-	83.0	-	-	-	-	-	-	-	141.6	-	-	-	-	-	52.5	253
	150	-	-	83.6	-	-	-	-	-	-	-	147.6	-	-	-	-	-	54.7	278
	200	-	-	84.0	-	-	-	-	-	-	-	151.9	-	-	-	-	-	56.2	296
	400	-	-	84.7	-	-	-	-	-	-	-	162.1	-	-	-	-	-	59.8	342
JackKnife	2	-	-	59.1	-	-	-	-	-	-	-	73.3	-	-	-	-	-	27.4	54
Estimate in	3	-	-	65.6	-	-	-	-	-	-	-	82.8	-	-	-	-	-	31.0	74
Return Period	5	-	-	71.0	-	-	-	-	-	-	-	92.9	-	-	-	-	-	34.9	97
	10	-	-	75.8	-	-	-	-	-	-	-	105.2	-	-	-	-	-	39.5	130
	20	-	-	78.8	-	-	-	-	-	-	-	116.5	-	-	-	-	-	43.8	164
	30	-	-	80.0	-	-	-	-	-	-	-	122.8	-	-	-	-	-	46.2	184
	50	-	-	81.1	-	-	-	-	-	-	-	130.6	-	-	-	-	-	49.1	211
	80	-	-	81.9	-	-	-	-	-	-	-	137.7	-	-	-	-	-	51.7	237
	100	-	-	82.1	-	-	-	-	-	-	-	141.0	-	-	-	-	-	52.9	249
	150	-	-	82.5	-	-	-	-	-	-	-	146.9	-	-	-	-	-	55.1	272
	200	-	-	82.7	-	-	-	-	-	-	-	151.2	-	-	-	-	-	56.7	289
	400	-	-	83.0	-	-	-	-	-	-	-	161.3	-	-	-	-	-	60.4	332
JackKnife	2	-	-	4.6	-	-	-	-	-	-	-	4.2	-	-	-	-	-	1.1	11
Estimate	3	-	-	4.2	-	-	-	-	-	-	-	4.8	-	-	-	-	-	1.2	14
Error in	5	-	-	3.6	-	-	-	-	-	-	-	5.7	-	-	-	-	-	1.4	16
Return Period	10	-	-	3.1	-	-	-	-	-	-	-	7.2	-	-	-	-	-	1.7	19
	20	-	-	3.1	-	-	-	-	-	-	-	8.8	-	-	-	-	-	2.2	25
	30	-	-	3.4	-	-	-	-	-	-	-	9.8	-	-	-	-	-	2.5	30
	50	-	-	3.9	-	-	-	-	-	-	-	11.1	-	-	-	-	-	2.9	37
	80	-	-	4.4	-	-	-	-	-	-	-	12.3	-	-	-	-	-	3.3	45
	100	-	-	4.6	-	-	-	-	-	-	-	12.9	-	-	-	-	-	3.6	49
	150	-	-	5.0	-	-	-	-	-	-	-	14.0	-	-	-	-	-	4.0	58
	200	-	-	5.3	-	-	-	-	-	-	-	14.8	-	-	-	-	-	4.3	65
	400	-	-	5.9	-	-	-	-	-	-	-	16.8	-	-	-	-	-	5.0	84

Source: JICA Study Team



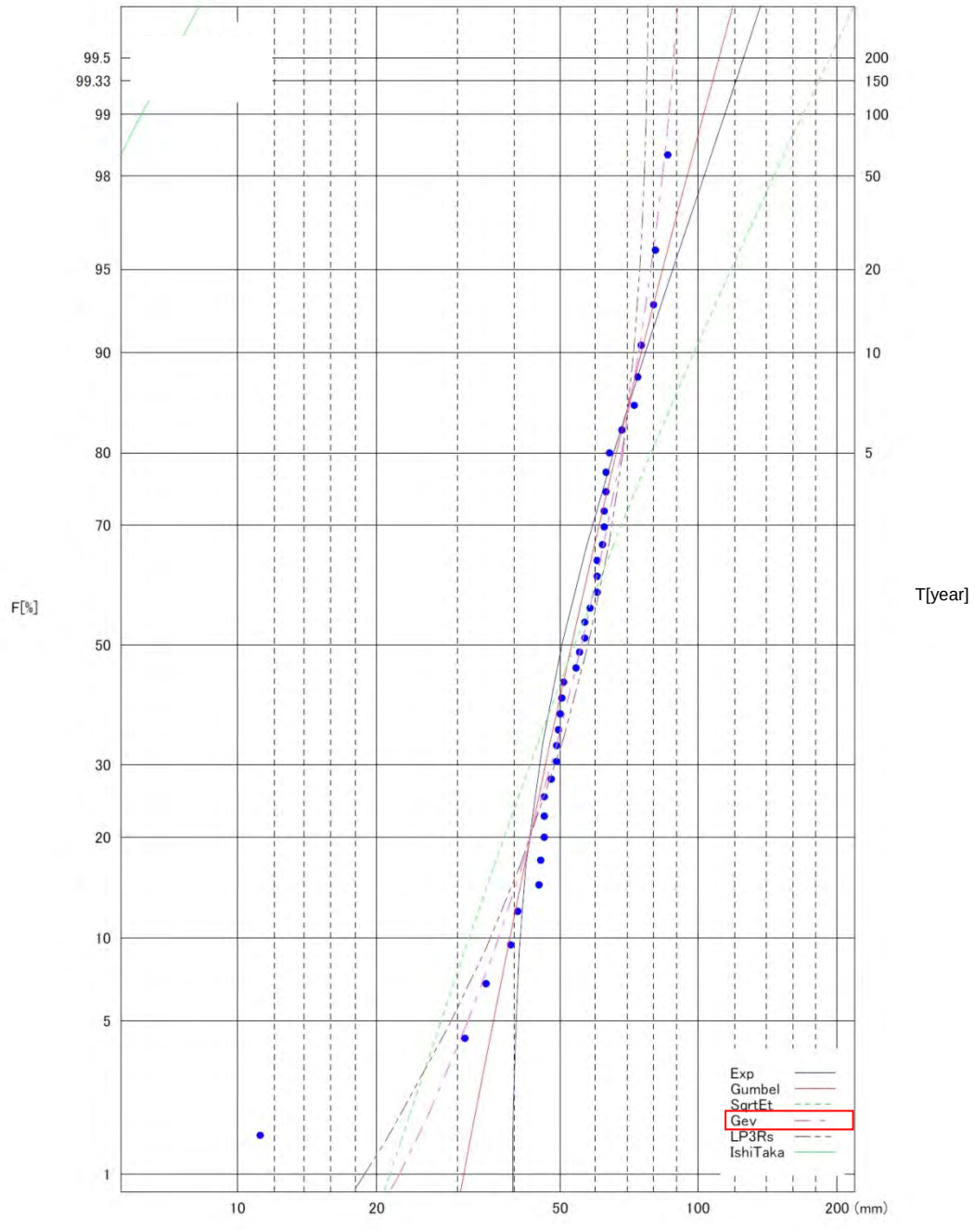
Source: JICA Study Team

Figure K.1: Result of Frequency Analysis (Point Rainfall at 9536000)



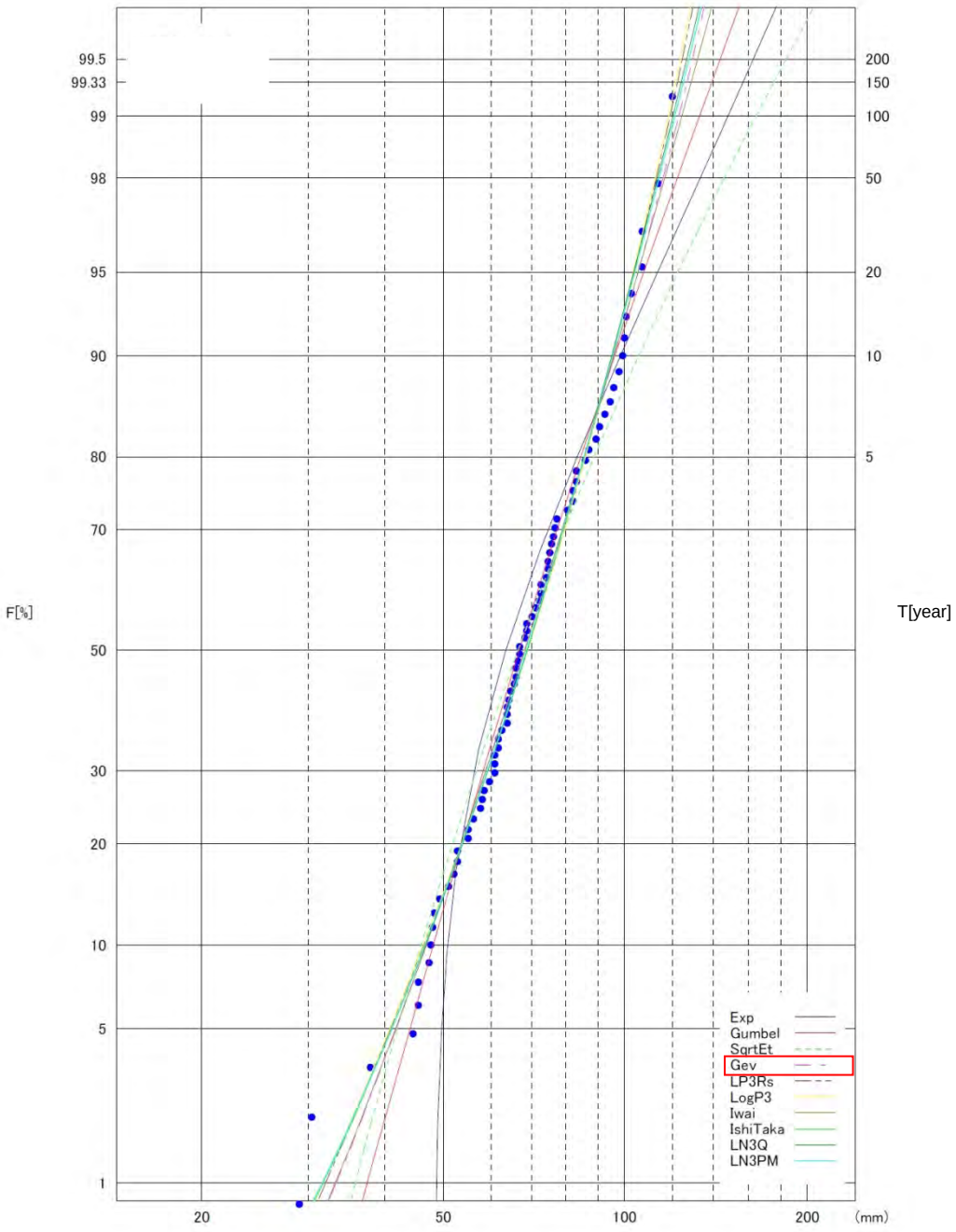
Source: JICA Study Team

Figure K.2: Result of Frequency Analysis (Point Rainfall at 9536004)



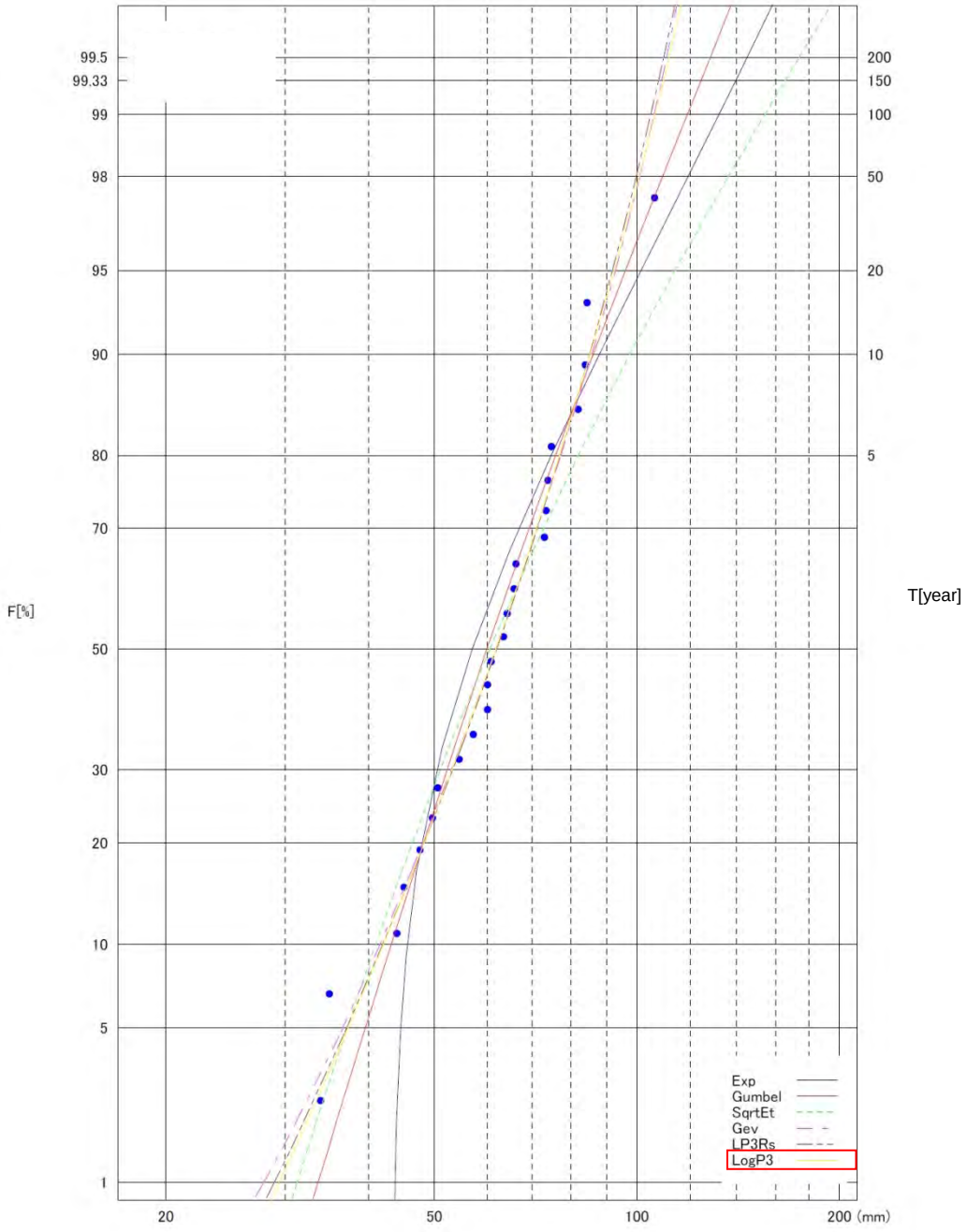
Source: JICA Study Team

Figure K.3: Result of Frequency Analysis (Point Rainfall at 9536017)



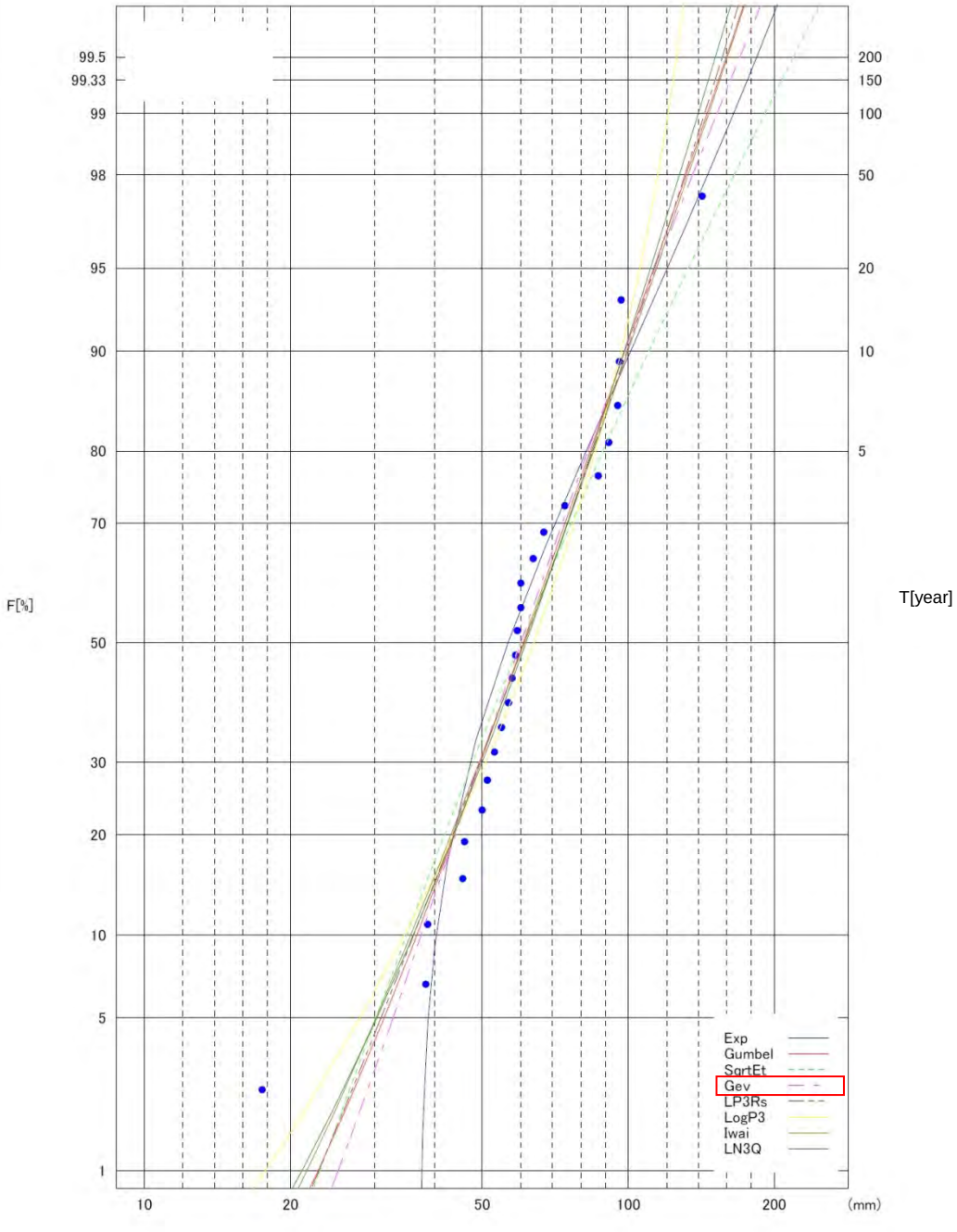
Source: JICA Study Team

Figure K.4: Result of Frequency Analysis (Point Rainfall at 9635001)



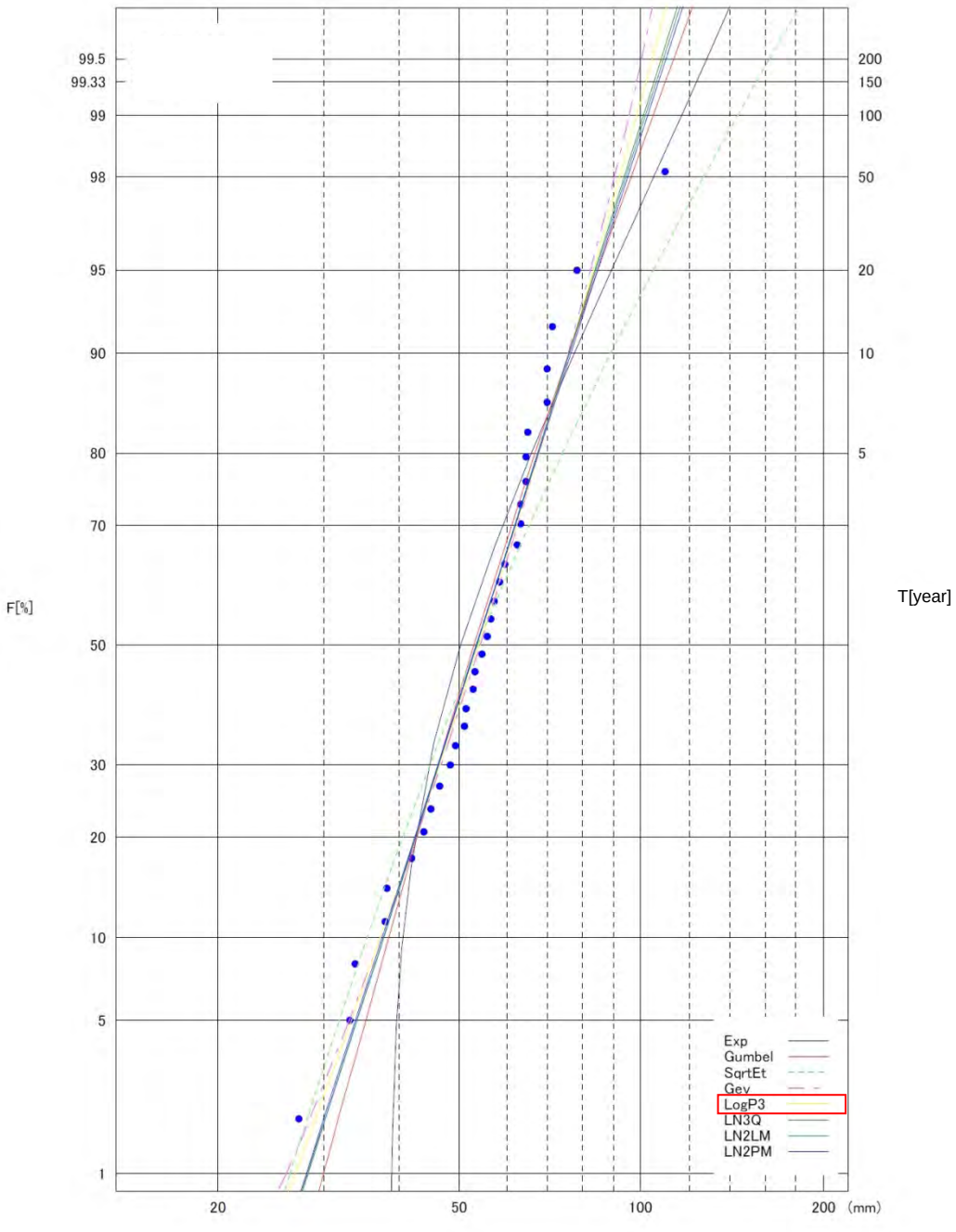
Source: JICA Study Team

Figure K.5: Result of Frequency Analysis (Point Rainfall at 9635012)



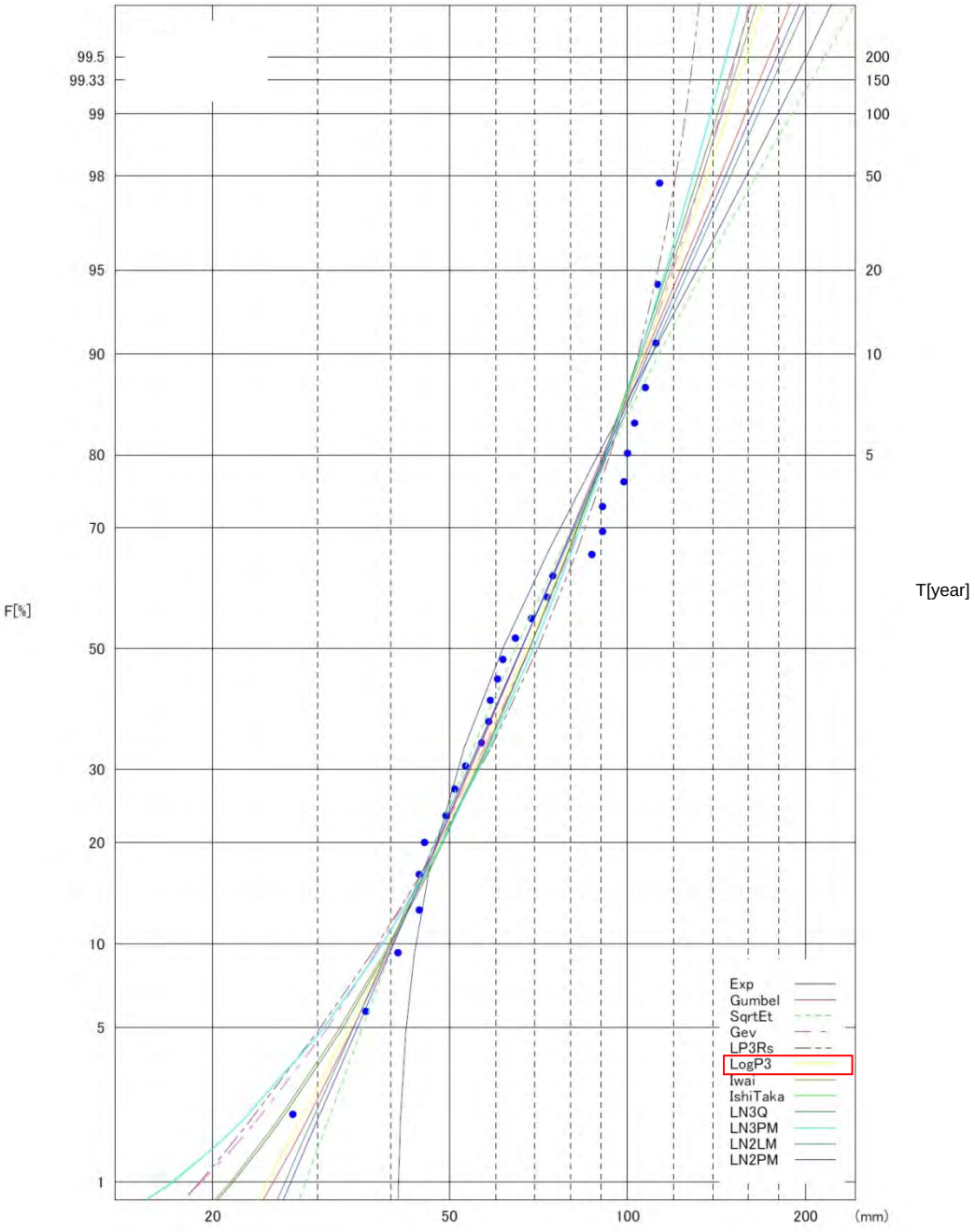
Source: JICA Study Team

Figure K.6: Result of Frequency Analysis (Point Rainfall at 9635014)



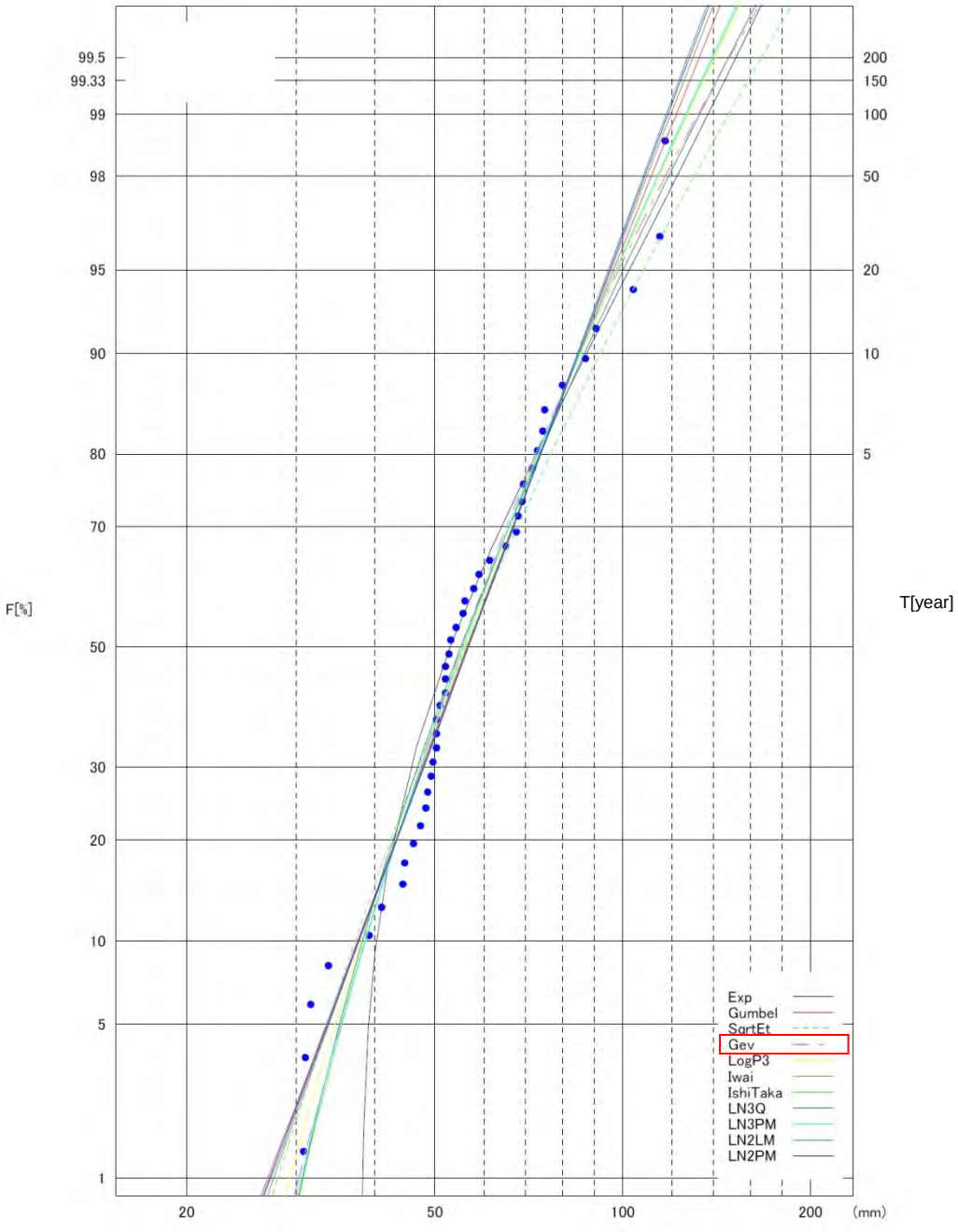
Source: JICA Study Team

Figure K.7: Result of Frequency Analysis (Point Rainfall at 9636000)



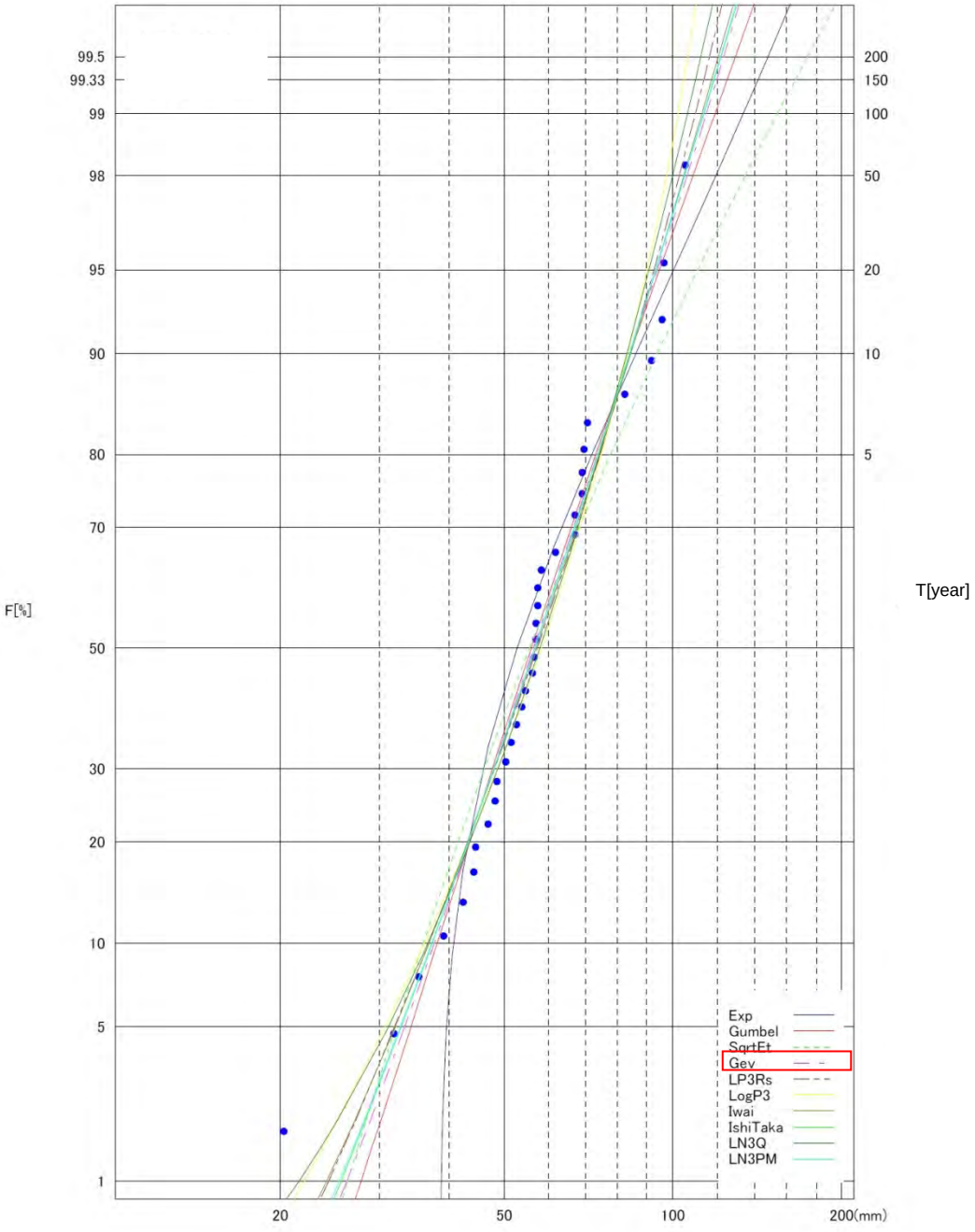
Source: JICA Study Team

Figure K.8: Result of Frequency Analysis (Point Rainfall at 9636006)



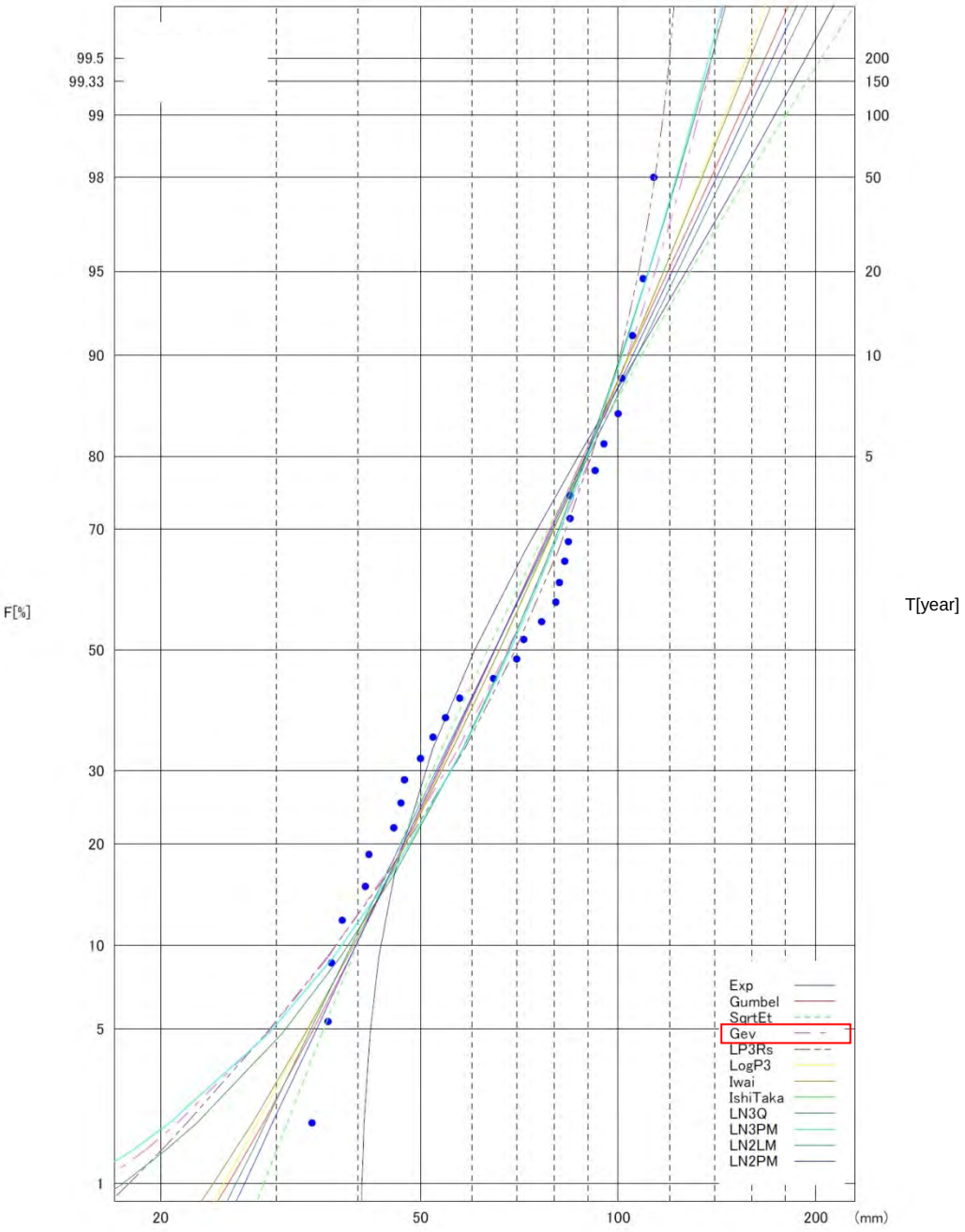
Source: JICA Study Team

Figure K.9: Result of Frequency Analysis (Point Rainfall at 9636008)



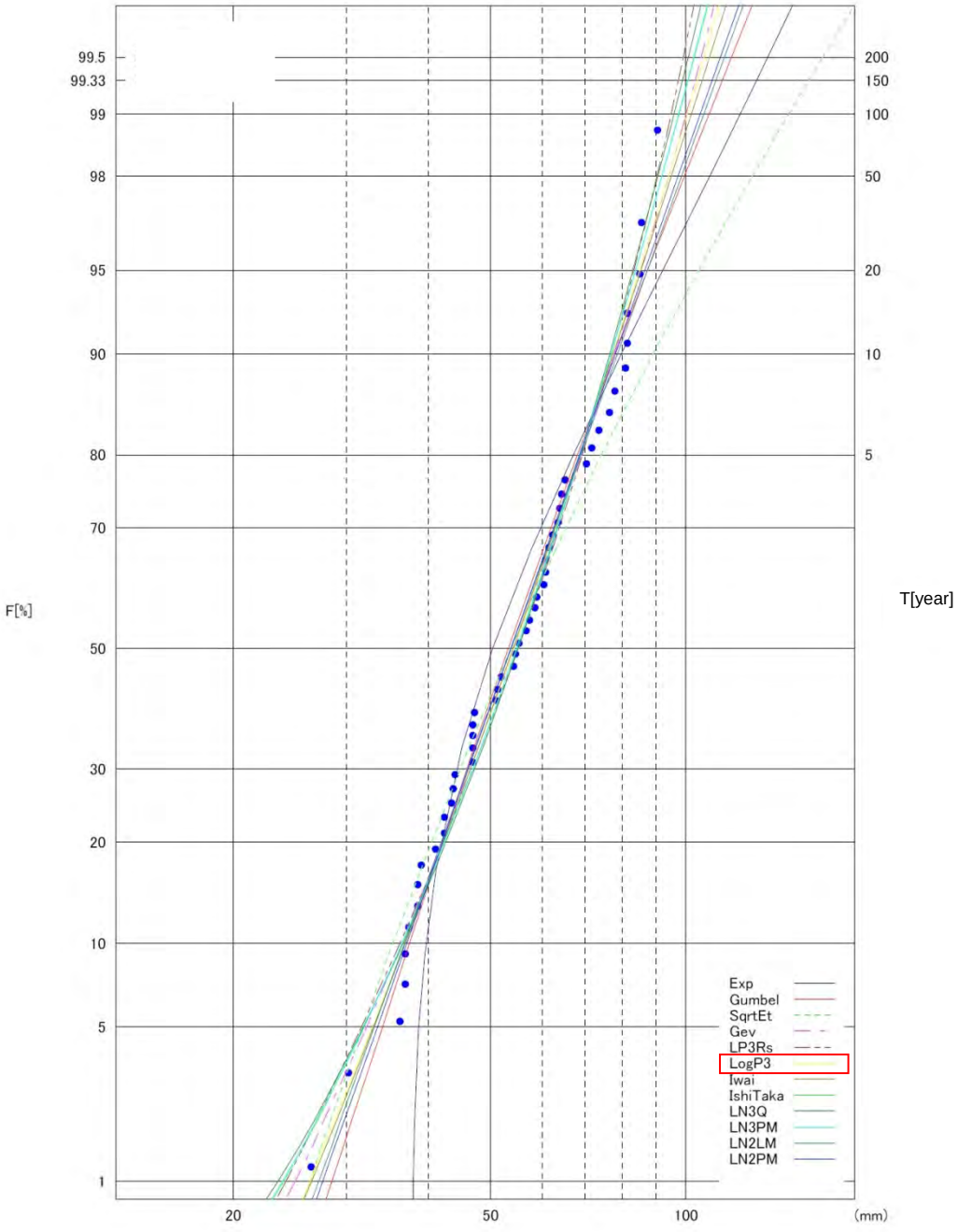
Source: JICA Study Team

Figure K.10: Result of Frequency Analysis (Point Rainfall at 9636013)



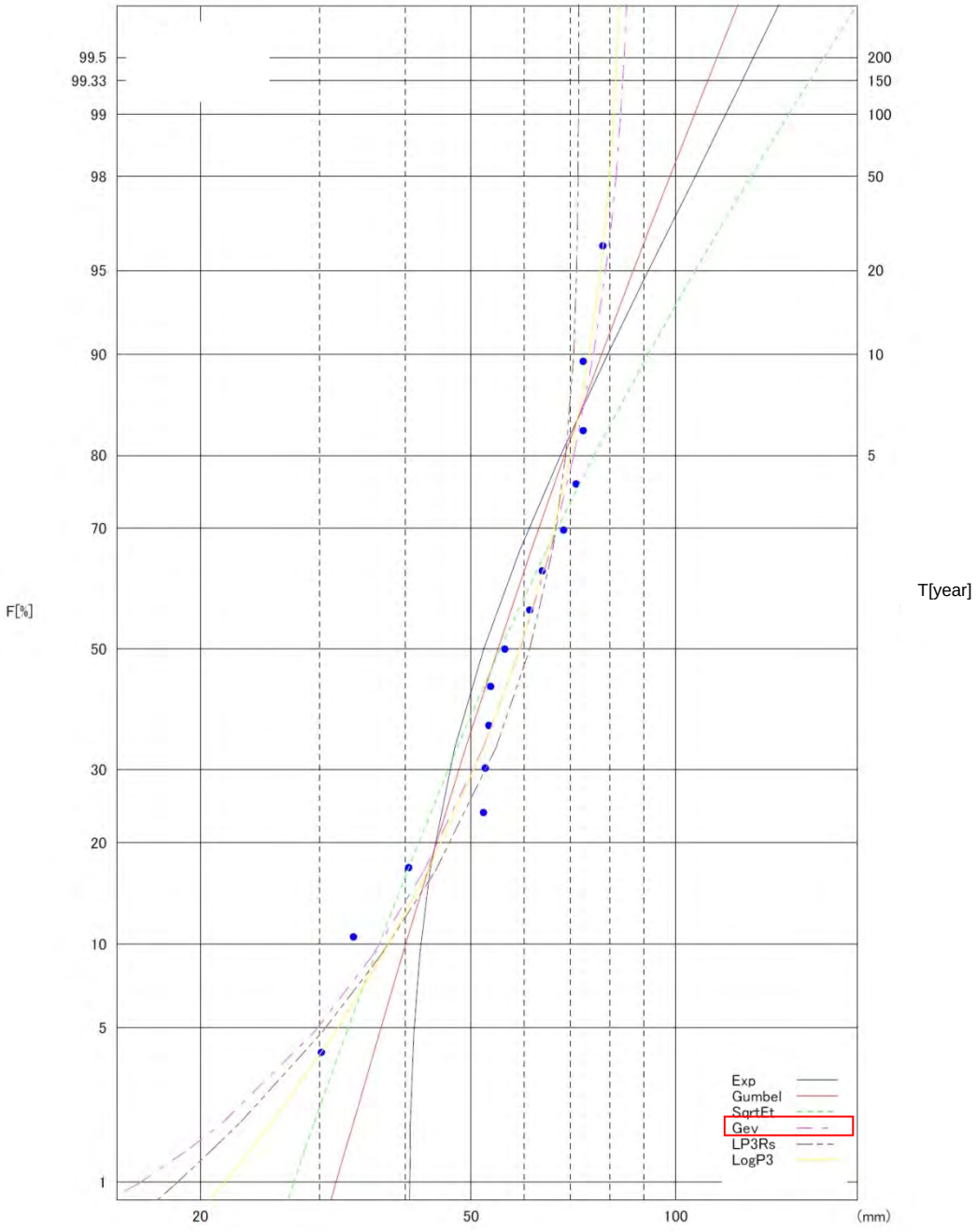
Source: JICA Study Team

Figure K.11: Result of Frequency Analysis (Point Rainfall at 9636018)



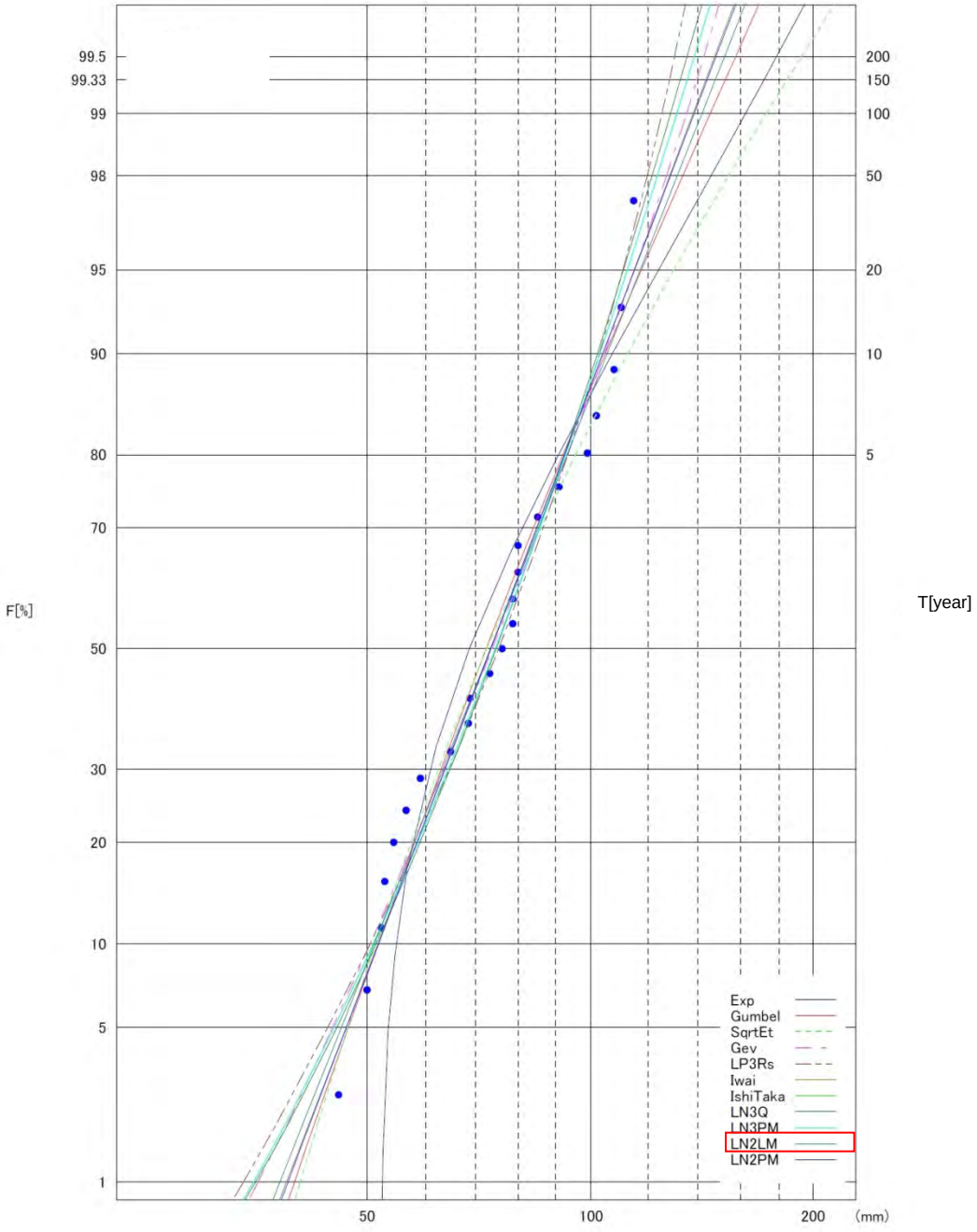
Source: JICA Study Team

Figure K.12: Result of Frequency Analysis (Point Rainfall at 9636020)



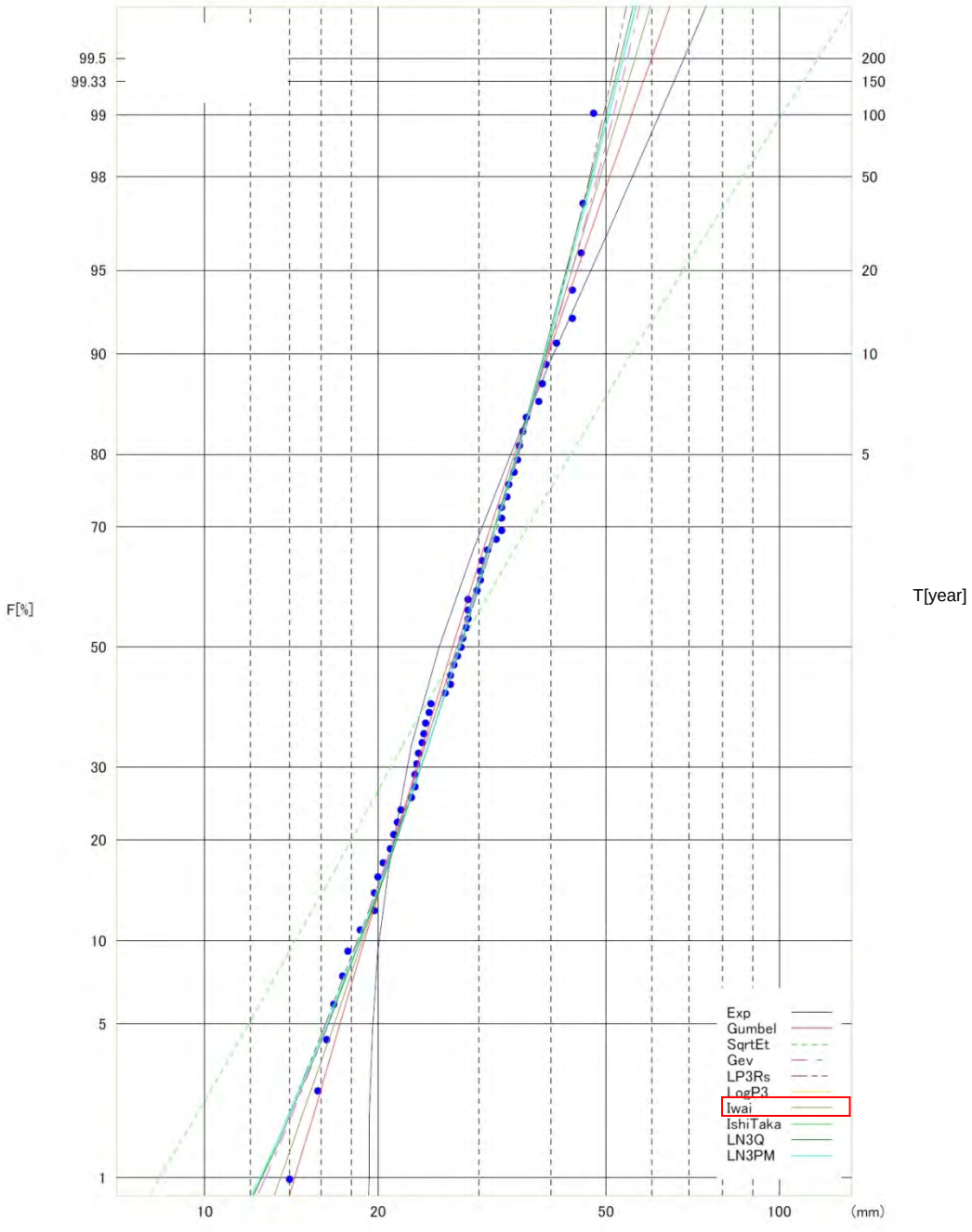
Source: JICA Study Team

Figure K.13: Result of Frequency Analysis (Point Rainfall at 9636029)



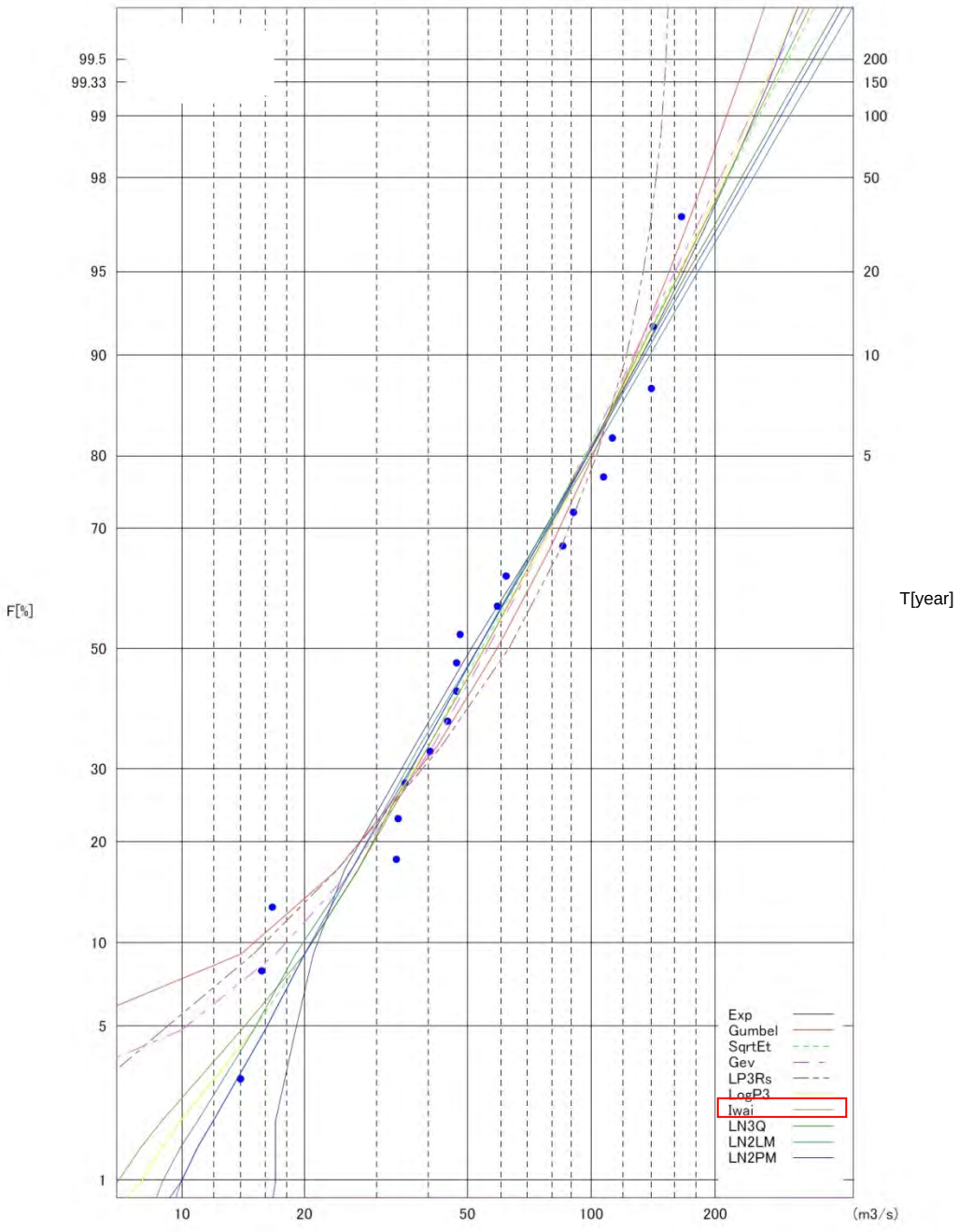
Source: JICA Study Team

Figure K.14: Result of Frequency Analysis (Point Rainfall at 9736007)



Source: JICA Study Team

Figure K.15: Result of Frequency Analysis (Catchment Average Rainfall at 1GD2)



Source: JICA Study Team

Figure K.16: Result of Frequency Analysis (Daily Discharge at 1GD2)

APPENDIX L

PARAMETERS FOR
THE TRRL EAST AFRICAN FLOOD MODEL

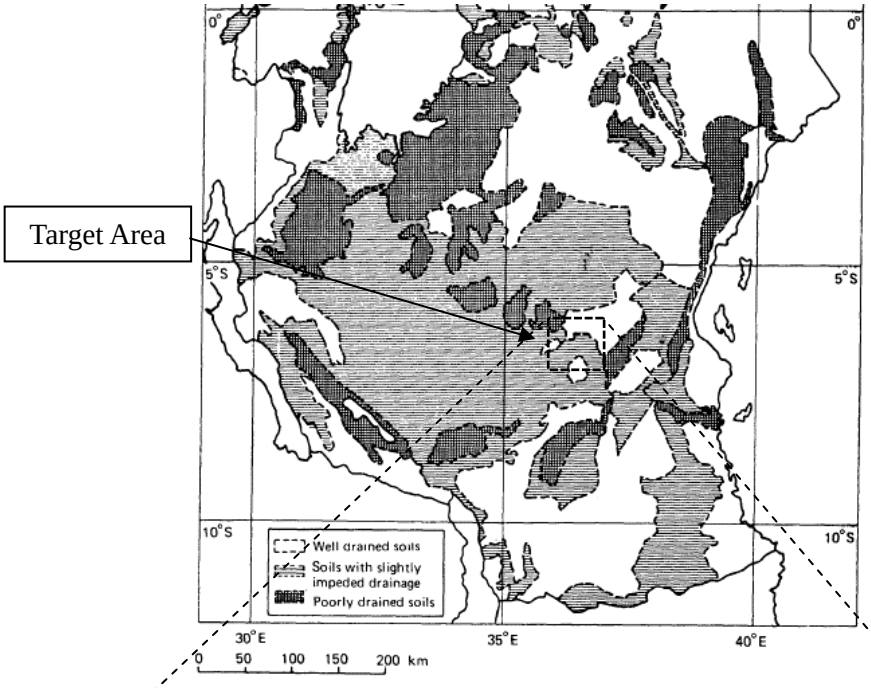
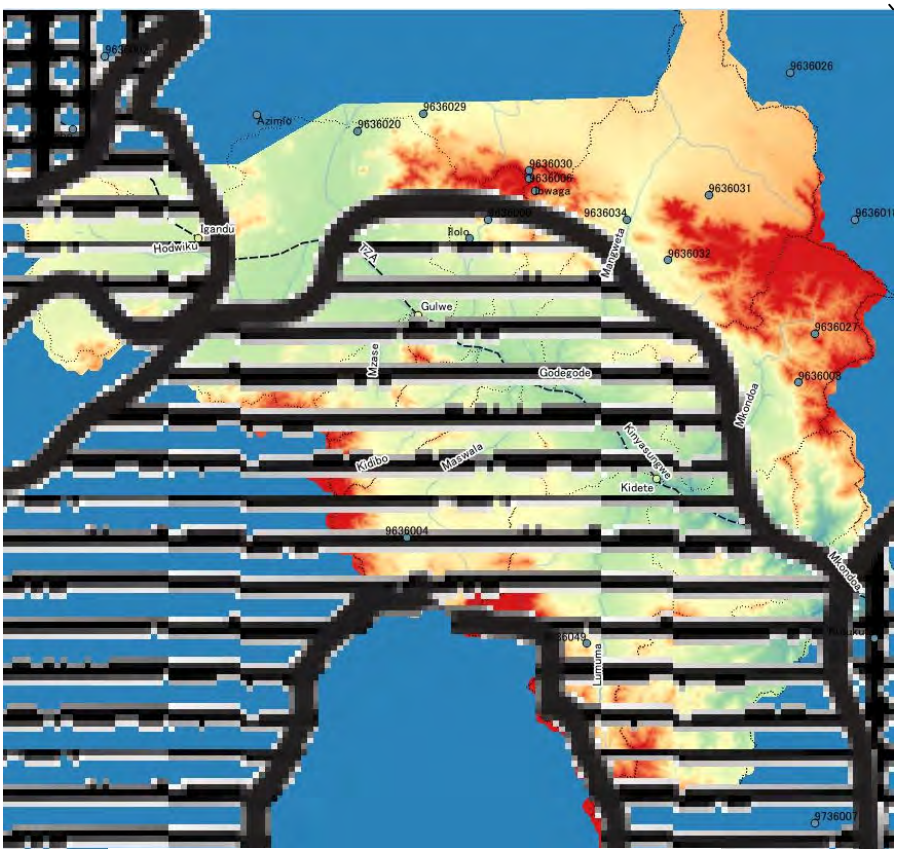


Fig. 15 SOIL ZONES



Close-up of Target Area of Fig. 15

Source: D. Fiddes, The TRRL East African Flood Model, Department of the Environment, TRRL Laboratory Report 706, Crowthorn, 1975

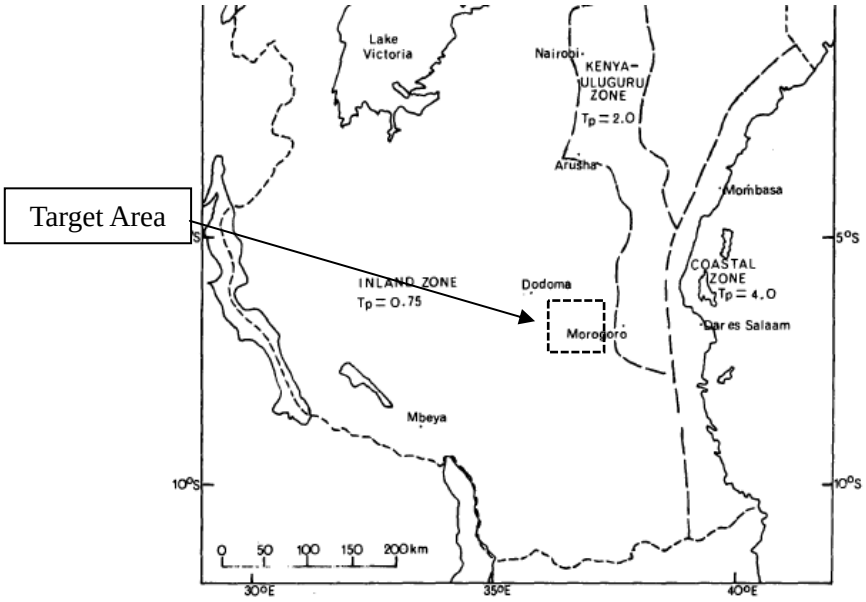


Fig. 16 RAINFALL TIME (Tp) ZONES

TABLE 3

Antecedent catchment conditions for storms of greater than 50mm

	Potential Evaporation mm/day	2 day antecedent Rainfall (mm)		7 day antecedent Rainfall (mm)		Soil moisture Recharge (mm)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
SEMI ARID							
North Eastern Kenya	6.9	20.4	32.0	46.5	56.5	45.0	62.6
DRY ZONES							
Western Uganda	5.2	10.2	14.6	32.6	28.3	40.2	39.0
Central Uganda	4.6	10.0	15.6	42.9	44.1	66.9	61.0
Northern Uganda	5.3	12.0	16.3	39.5	31.9	65.3	57.0
Nyanza	5.6	21.1	29.0	48.4	46.0	60.9	53.0
Central Tanzania	5.6	23.6	38.5	68.5	70.2	54.0	59.0
WET ZONES							
Kenya Coast	5.9	32.9	40.6	76.9	85.5	81.1	76.0
Tanzania Coast	6.0	25.6	45.5	56.9	58.4	90.1	64.0
Kitui	5.2	31.4	42.1	83.4	84.6	101.8	84.5
Nairobi	4.9	21.2	27.8	81.7	67.1	117.0	67.0
Lake Malawi	4.4	41.0	49.8	125.5	121.0	170.3	74.0

Source: D. Fiddes, The TRRL East African Flood Model, Department of the Environment, TRRL Laboratory Report 706, Crowthorn, 1975

TABLE 4

Standard contributing area coefficients
(Wet zone catchment, short grass cover)

Catchment slope		Soil type		
		Well drained	Slightly impeded drainage	Impeded drainage
Very Flat	< 1.0%		0.15	0.30
Moderate	1-4%	0.09	0.38	0.40
Rolling	4-10%	0.10	0.45	0.50
Hilly	10-20%	0.11	0.50	
Mountainous	> 20%	0.12		

Note:

The soil types are as in Fig 16 and are based on the soils map contained in the Handbook of Natural Resources of East Africa (see ref 13).

TABLE 5

Catchment wetness factor

Rainfall zone	Catchment wetness factor (C_w)	
	Perennial streams	Ephemeral streams
Wet zones	1.0	1.0
Semi arid zone	1.0	1.0
Dry zones (except West Uganda)	0.75	0.50
West Uganda	0.60	0.30

Source: D. Fiddes, The TRRL East African Flood Model, Department of the Environment, TRRL Laboratory Report 706, Crowthorn, 1975

TABLE 6

Land use factors (C_L)

(Base assumes short grass cover)

Largely bare soil	1.50
Intense cultivation (Particularly in valleys)	1.50
Grass cover	1.00
Dense vegetation (particularly in valleys)	0.50
Ephemeral stream, sand filled valley	0.50
Swamp filled valley	0.33
Forest	0.33

TABLE 7

Catchment lag times

Catchment type	Lag time (K) hrs
Arid	0.1
Very steep small catchments (slopes > 20%)	0.1
Semi arid scrub (large bare soil patches)	0.3
Poor pasture	0.5
Good pasture	1.5
Cultivated land (down to river bank)	3.0
Forest, overgrown valley bottom	8.0
Papyrus swamp in valley bottom	20.0

Table 8 Rainfall Time(Tp)for East African 10 year storms

TABLE 8

Rainfall time (Tp) for East African 10 year storms

Zone	Index "n"	Rainfall time (Tp) (h)
Inland zone	0.96	0.75
Coastal zone	0.76	4.0
Kenya-Aberdare Uluguru Zone	0.85	2.0

Source: D. Fiddes, The TRRL East African Flood Model, Department of the Environment, TRRL Laboratory Report 706, Crowthorn, 1975

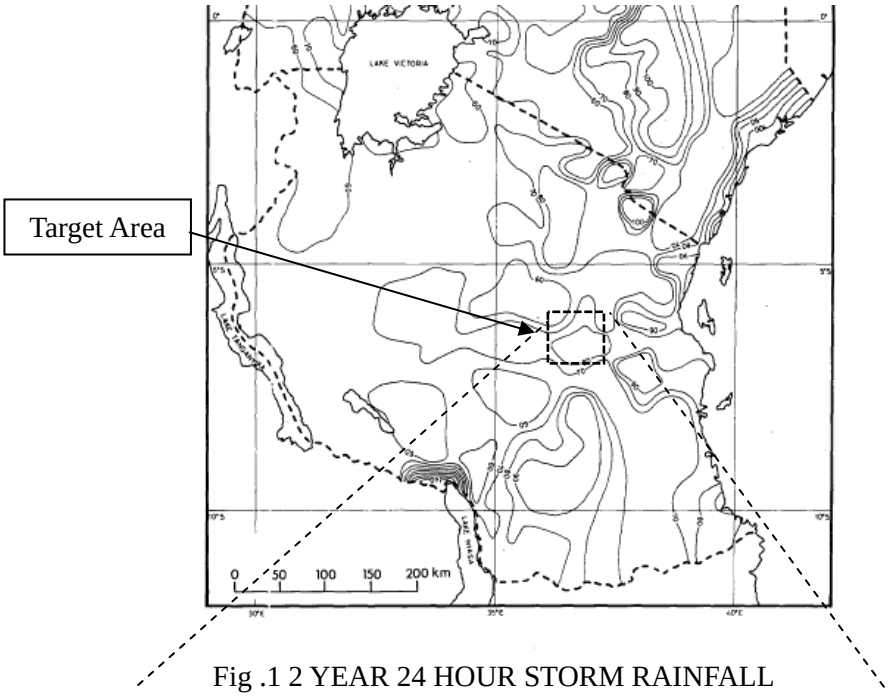
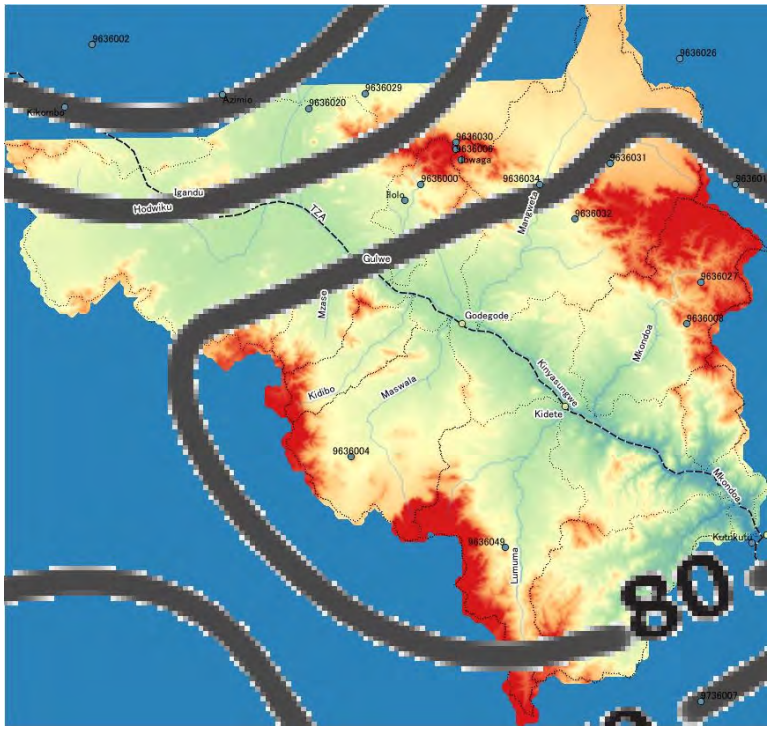


Fig .1 2 YEAR 24 HOUR STORM RAINFALL



Source: D. Fiddes, J. A. Forsgate and A. O. Grigg, The prediction of storm rainfall in East Africa, Department of the Environment, TRRL Laboratory Report 623, Crowthorn, 1974

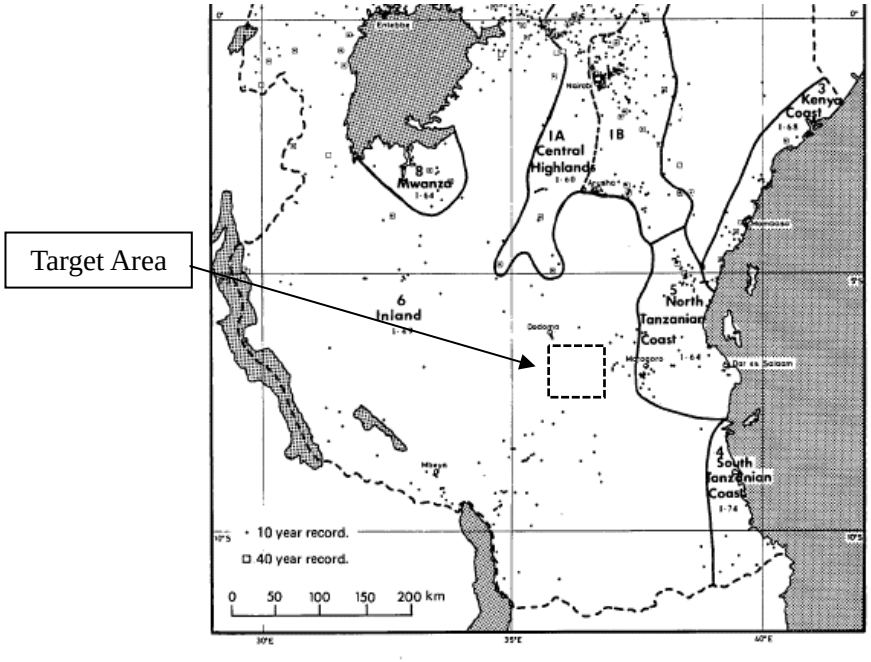


Fig. 4 10YEAR RATIO

Source: D. Fiddes, J. A. Forsgate and A. O. Grigg, The prediction of storm rainfall in East Africa, Department of the Environment, TRRL Laboratory Report 623, Crowthorn, 1974

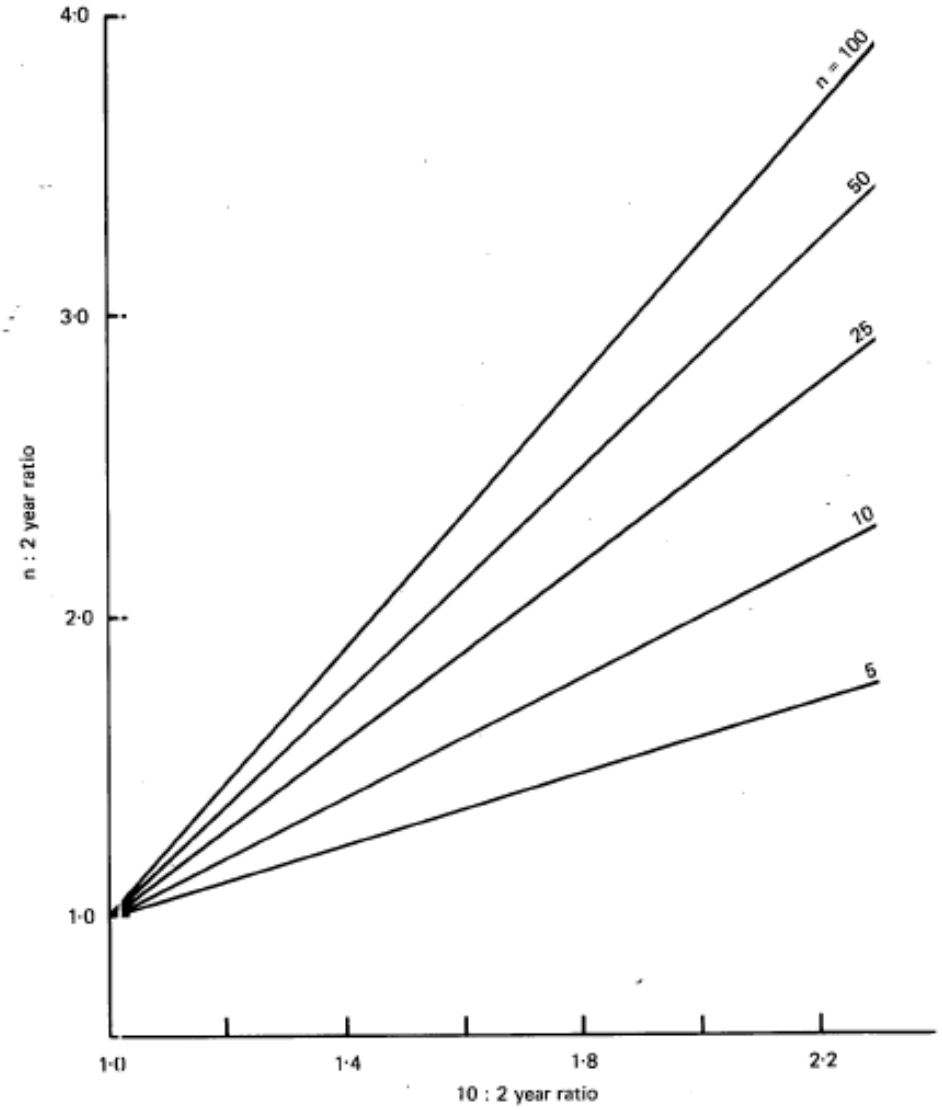


Fig. 5 FLOOD FACTORS

Source: D. Fiddes, J. A. Forsgate and A. O. Grigg, The prediction of storm rainfall in East Africa, Department of the Environment, TRRL Laboratory Report 623, Crowthorn, 1974

APPENDIX M

THE LIST OF CULVERTS

The List of Culverts and Bridge of Concerned Area (1/6)

S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
1	Km 283.6	36.977306	-6.830056	Field Survey	PCL 283.6	
2	Km 283.9	36.975306	-6.827333	Field Survey	BCL 283.9	
3	Km 284.47	36.97175	-6.824611	Field Survey	BCL 284.47	
4	Km 285.3	36.969059	-6.81804	Aerial Photo		
5	Km 285.45	36.968	-6.81675	Field Survey	BCL 285.45	
6	Km 285.65	36.967361	-6.815111	Field Survey	BCL 285.65	
7	Km 286.15	36.967333	-6.810722	Field Survey	PCL 286.15	
8	Km 286.4	36.967444	-6.808333	Field Survey	PCL 286.4	
9	Km 286.65	36.9665	-6.806472	Field Survey	PCL 286.65	○
10	Km 286.88	36.965472	-6.804528	Field Survey	PCL 286.88	
11	Km 287.15	36.964472	-6.801778	Field Survey	PCL 287.15	
12	Km 287.25	36.964111	-6.801139	Field Survey	BCL 287.25	
13	Km 287.3	36.963444	-6.800417	Field Survey	PCL 287.3	○
14	Km 287.7	36.961889	-6.797694	Field Survey	BCL 287.7	○
15	Km 288	36.959418	-6.79587	Aerial Photo		
16	Km 288.35	36.956583	-6.795972	Field Survey	PCL 288.35	○
17	Km 289	36.950139	-6.759556	Field Survey	BCL 289	
18	Km 289.1	36.89975	-6.745389	Field Survey	BCL 289.1	
19	Km 289.3	36.9495	-6.790333	Field Survey	PCL 289.3	
20	Km 289.6	36.949528	-6.787639	Field Survey	PCL 289.6	
21	Km 289.9	36.949583	-6.785139	Field Survey	PCL 289.9	
22	Km 290.4	36.948333	-6.781111	Field Survey	BCL 290.4	○
23	Km 290.6	36.947583	-6.7795	Field Survey	PCL 290.6	
24	Km 290.9	36.945944	-6.77625	Field Survey	BR 290.9	○
25	Km 291.2	36.944	-6.774556	Field Survey	PCL 291.2	
26	Km 291.5	36.942083	-6.772639	Field Survey	PCL 291.5	
27	Km 291.5B	36.941806	-6.772333	Field Survey	PCL 291.5b	
28	Km 291.7	36.940972	-6.771472	Field Survey	PCL 291.7	
29	Km 291.9	36.93975	-6.769861	Field Survey	PCL 291.9	
30	Km 292.2	36.938389	-6.767639	Field Survey	BCL 292.2	
31	Km 292.6	36.937556	-6.7645	Field Survey	BCL 292.6	○
32	Km 292.7	36.936944	-6.763361	Field Survey	PCL 292.7	
33	Km 292.8	36.936472	-6.762917	Field Survey	BCL 292.8	
34	Km 293.0	36.935111	-6.762083	Field Survey	BCL 293	
35	Km 293.1	36.93375	-6.761806	Field Survey	BCL 293.1	
36	Km 293.8	36.927333	-6.76061111	Field Survey	PCL 293.8	
37	Km 294.2	36.92375	-6.7595	Field Survey	PCL 294.2	
38	Km 294.5	36.920667	-6.75863889	Field Survey	BCL 294.5	○
39	Km 295.1	36.918167	-6.75541667	Field Survey	BCL 295.1	
40	Km 295.3	36.918111	-6.75319444	Field Survey	BCL 295.3	○

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

The List of Culverts and Bridge of Concerned Area (2/6)

S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
41	Km 295.7	36.917889	-6.76647222	Field Survey	BCL 295.7	
42	Km 295.9	36.916972	-6.74752778	Field Survey	BCL 295.9	
43	Km 296.4	36.91425	-6.74452778	Field Survey	BCL 296.4	
44	Km 296.7	36.911694	-6.74363889	Field Survey	BCL 296.7	
45	Km 297.1	36.908167	-6.74311111	Field Survey	BCL 297.1	
46	Km 297.6	36.904306	-6.74455556	Field Survey	BCL 297.6	○
47	Km 299.3	36.889556	-6.74288889	Field Survey	PCL 299.3	○
48	Km 299.7	36.885972	-6.74283333	Field Survey	PCL 299.7	
49	Km 300.1	36.881889	-6.74191667	Field Survey	PCL 300.1	
50	Km 300.2	36.880861	-6.742	Field Survey	PCL 300.2	
51	Km 300.5	36.879083	-6.74222222	Field Survey	BCL 300.5	
52	Km 300.6	36.877528	-6.74261111	Field Survey	BCL 300.6	
53	Km 300.8	36.875381	-6.7432672	Aerial Photo		○
54	Km 301.3	36.87131	-6.7445	Aerial Photo		
55	Km 302.0	36.8655	-6.74630556	Field Survey	PCL 302	
56	Km 302.2	36.863694	-6.74644444	Field Survey	BCL 302.2	
57	Km 302.7	36.859534	-6.7454478	Aerial Photo		○
58	Km 303.3	36.854194	-6.74258333	Field Survey	BCL 303.3	
59	Km 303.4	36.853694	-6.74155556	Field Survey	BCL 303.4	
60	Km 303.7	36.851233	-6.740696	Aerial Photo		○
61	Km 304.1	36.847797	-6.739059	Aerial Photo		○
62	Km 305.2	36.843973	-6.7314553	Aerial Photo		
63	Km 305.5	36.843099	-6.728833	Aerial Photo		
64	Km 305.6	36.84258	-6.72727	Aerial Photo		○
65	Km 306.1	36.841249	-6.7232918	Aerial Photo		
66	Km 306.7	36.839652	-6.7185877	Aerial Photo		
67	Km 306.9	36.837915	-6.7169553	Aerial Photo		
68	Km 307.2	36.835281	-6.7160301	Aerial Photo		○
69	Km 307.4	36.834398	-6.7155739	Aerial Photo		
70	Km 308.1	36.831722	-6.71058333	Field Survey	BCL 308.1	
71	Km 308.3	36.830417	-6.70919444	Field Survey	BCL 308.3	
72	Km 308.4	36.829778	-6.70863889	Field Survey	PCL 308.4	
73	Km 308.9	36.826417	-6.70652778	Field Survey	PCL 308.9	
74	Km 309.4	36.822083	-6.70566667	Field Survey	BCL 309.4	○
75	Km 309.9	36.8175	-6.70427778	Field Survey	BCL 309.9	
76	Km 310.5	36.812056	-6.70533333	Field Survey	BCL 310.5	○
77	Km 310.8	36.809472	-6.70502778	Field Survey	PCL 310.8	
78	Km 311.0	36.807806	-6.70458333	Field Survey	PCL 311	
79	Km 311.2	36.805667	-6.70375	Field Survey	BR 311.2	○
80	Km 312.2	36.798056	-6.70069444	Field Survey	BCL 312.2	

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

The List of Culverts and Bridge of Concerned Area (3/6)

S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
81	Km 312.3	36.797083	-6.70041667	Field Survey	BCL 312.3	
82	Km 312.4	36.795667	-6.70038889	Field Survey	BCL 312.4	
83	Km 312.8	36.792556	-6.70008333	Field Survey	BCL 312.8	
84	Km 312.9	36.791222	-6.69986111	Field Survey	BCL 312.9	
85	Km 313.3	36.787917	-6.69891667	Field Survey	BCL 313.3	○
86	Km 313.4	36.787611	-6.69891667	Field Survey	BCL 313.4	
87	Km 314.1	36.782	-6.69622222	Field Survey	BCL 314.1	
88	Km 314.4	36.779778	-6.69558333	Field Survey	PCL 314.4	
89	Km 314.5	36.778417	-6.69458333	Field Survey	PCL 314.5	
90	Km 314.9	36.775083	-6.69283333	Field Survey	BCL 314.9	
91	Km 315.5	36.77016	-6.6901483	Aerial Photo		○
92	Km 316.1	36.765728	-6.6883398	Aerial Photo		
93	Km 316.5	36.762327	-6.6877778	Aerial Photo		
94	Km 316.9	36.75929	-6.685824	Aerial Photo		
95	Km 317.3	36.756346	-6.6847862	Aerial Photo		
96	Km 317.8	36.752132	-6.682251	Aerial Photo		○
97	Km 318.5	36.750064	-6.6765288	Aerial Photo		
98	Km 319.1	36.745758	-6.674652	Aerial Photo		○
99	Km 319.4	36.744169	-6.672208	Aerial Photo		
100	Km 319.9	36.739973	-6.670753	Aerial Photo		
101	Km 320.3	36.73623	-6.670679	Aerial Photo		
102	Km 320.8	36.731688	-6.670561	Aerial Photo		○
103	Km 321.0	36.731285	-6.6656163	Aerial Photo		
104	Km 321.4	36.730944	-6.669162	Aerial Photo		
105	Km 321.8	36.729766	-6.6628492	Aerial Photo		
106	Km 322.1	36.72672	-6.662327	Aerial Photo		○
107	Km 322.6	36.723757	-6.6601103	Aerial Photo		
108	Km 322.8	36.721515	-6.6600699	Aerial Photo		
109	Km 323.0	36.720119	-6.660452	Aerial Photo		
110	Km 323.8	36.712478	-6.6595869	Aerial Photo		
111	Km 324.2	36.709578	-6.6572188	Aerial Photo		○
112	Km 324.8	36.706764	-6.65286	Aerial Photo		
113	Km 325.7	36.705722	-6.64608333	Field Survey	PCL 325.7	
115	Km 325.75	36.705694	-6.64533333	Field Survey	PCL 325.75	
114	Km 326.1	36.704111	-6.642512	Aerial Photo		
116	Km 326.9	36.696861	-6.63905556	Field Survey	PCL 326.9	
117	Km 327.4	36.694306	-6.63638889	Field Survey	BCL 327.4	
118	Km 327.8	36.694058	-6.633591	Aerial Photo		
119	Km 327.9	36.694111	-6.63194444	Field Survey	PCL 327.9	
120	Km 328.8	36.691278	-6.62655556	Field Survey	PCL 328.8	

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

The List of Culverts and Bridge of Concerned Area (4/6)

S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
121	Km 329.1	36.68817	-6.626388	Aerial Photo		
122	Km 329.6	36.684406	-6.6241803	Aerial Photo		
123	Km 329.9	36.681912	-6.622983	Aerial Photo		
124	Km 330.2	36.679844	-6.622351	Aerial Photo		○
125	Km 330.5	36.677075	-6.621494	Aerial Photo		
126	Km 330.9	36.673884	-6.619901	Aerial Photo		
127	Km 331.2	36.672614	-6.618083	Aerial Photo		
128	Km 331.4	36.671538	-6.616289	Aerial Photo		
129	Km 331.6	36.670256	-6.614794	Aerial Photo		
130	Km 331.9	36.667914	-6.613915	Aerial Photo		
131	Km 332.2	36.665504	-6.613606	Aerial Photo		
132	Km 332.4	36.66381	-6.612512	Aerial Photo		
133	Km 332.8	36.662875	-6.607115	Aerial Photo		
134	Km 333.0	36.662562	-6.6086736	Aerial Photo		○
135	Km 333.1	36.662889	-6.60425	Field Survey	BCL 333.1	
136	Km 333.6	36.661942	-6.6023743	Aerial Photo		
137	Km 333.6	36.661139	-6.60169444	Field Survey	BCL 333.6	○
138	Km 334.1	36.658361	-6.59808333	Field Survey	BCL 334.1	○
139	Km 334.3	36.65875	-6.59591667	Field Survey	PCL 334.3	
140	Km 334.6	36.660607	-6.5934247	Aerial Photo		
141	Km 334.7	36.65875	-6.59591667	Field Survey	BCL 334.7	
142	Km 334.8	36.660861	-6.5925	Field Survey	BCL 334.8	
143	Km 335	36.660139	-6.59055556	Field Survey	BCL 335	
144	Km 335.1	36.6595	-6.58983333	Field Survey	BCL 335.1	
145	Km 335.3	36.658056	-6.58888889	Field Survey	BCL 335.3	
146	Km 335.5	36.65625	-6.58763889	Field Survey	BCL 335.5	
147	Km 335.8	36.655511	-6.585498	Aerial Photo		
148	Km 335.8	36.949472	-6.78397222	Field Survey	BCL 335.8	
149	Km 336.1	36.653472	-6.58344444	Field Survey	BCL 336.1	
150	Km 336.3	36.651678	-6.582953	Aerial Photo		
151	Km 336.3	36.650306	-6.58291667	Field Survey	BCL 336.3	
152	Km 336.7	36.648361	-6.58138889	Field Survey	BCL 336.7	○
153	Km 337	36.646417	-6.57947222	Field Survey	PCL 337	○
154	Km 337	36.646389	-6.5795	Field Survey	BCL 337	
155	Km 338	36.639523	-6.574122	Aerial Photo		
156	Km 338.4	36.63678	-6.574515	Aerial Photo		
157	Km 338.4	36.636622	-6.574499	Aerial Photo		
158	Km 338.4	36.636365	-6.574451	Aerial Photo		
159	Km 338.7	36.634105	-6.573273	Aerial Photo		
160	Km 338.9	36.632373	-6.571891	Aerial Photo		

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

The List of Culverts and Bridge of Concerned Area (5/6)

S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
161	Km 339.2	36.629966	-6.5703989	Aerial Photo		
162	Km 339.6	36.627149	-6.5689419	Aerial Photo		○
163	Km 340	36.624137	-6.5671354	Aerial Photo		
164	Km 340	36.623808	-6.5668167	Aerial Photo		
165	Km 340.3	36.622529	-6.5649696	Aerial Photo		○
166	Km 340.9	36.620573	-6.5595615	Aerial Photo		
167	Km 341.4	36.617612	-6.5563263	Aerial Photo		
168	Km 341.5	36.616976	-6.5557491	Aerial Photo		
169	Km 341.8	36.614818	-6.5543282	Aerial Photo		
170	Km 341.9	36.613857	-6.5537413	Aerial Photo		○
171	Km 342.6	36.609562	-6.5493696	Aerial Photo		
172	Km 342.8	36.60801	-6.5481939	Aerial Photo		○
173	Km 343.5	36.603124	-6.544798	Aerial Photo		
174	Km 343.7	36.601721	-6.543116	Aerial Photo		
175	Km 344.8	36.597917	-6.54138889	Field Survey	BCL 344.8	
176	Km 344.8B	36.595861	-6.54283333	Field Survey	BCL 344.8B	
177	Km 345.0	36.591722	-6.54336111	Field Survey	BCL 345.0	○
178	Km 345.5	36.587361	-6.54261111	Field Survey	PCL 345.5	
179	Km 345.6A	0	0	Field Survey	PCL 345.6a	
180	Km 345.6B	36.586111	-6.54283333	Field Survey	PCL 345.6b	○
181	Km 346	36.582917	-6.54336111	Field Survey	PCL 346	
182	Km 346.2	36.581778	-6.54308333	Field Survey	PCL 346.2	
183	Km 346.6A	36.586944	-6.54263889	Field Survey	BCL 346.6a	
184	Km 346.6	36.586634	-6.5428206	Aerial Photo		
185	Km 346.6B	36.577333	-6.54319444	Field Survey	BCL 346.6b	
186	Km 347.5	36.570389	-6.54194444	Field Survey	BCL 347.5	○
187	Km 347.8	36.566041	-6.5404689	Aerial Photo		○
188	Km 348	36.564222	-6.5395	Field Survey	BCL 348	
189	Km 348.3	36.564222	-6.5395	Field Survey	PCL 348.3	
190	Km 348.8	36.560028	-6.53644444	Field Survey	BCL 348.8	
191	Km 349.4	36.556	-6.53358333	Field Survey	BCL 349.4	○
192	Km 349.0B	36.551444	-6.53019444	Field Survey	PCL 349.0B	
193	Km 349.4B	36.548528	-6.52811111	Field Survey	BCL 349.4B	○
194	Km 349.5B	36.547861	-6.52763889	Field Survey	BCL 349.5B	
195	Km 349.6B	36.547083	-6.52705556	Field Survey	BCL 349.6B	
196	Km 349.8	36.545246	-6.5256913	Aerial Photo		
197	Km 349.8B	36.544556	-6.52522222	Field Survey	BCL 349.8B	
198	Km 349.9B	36.544583	-6.52522222	Field Survey	BCL 349.9B	
199	Km 350.2	36.541893	-6.523261	Aerial Photo		
200	Km 350.3	36.541316	-6.522839	Aerial Photo		

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

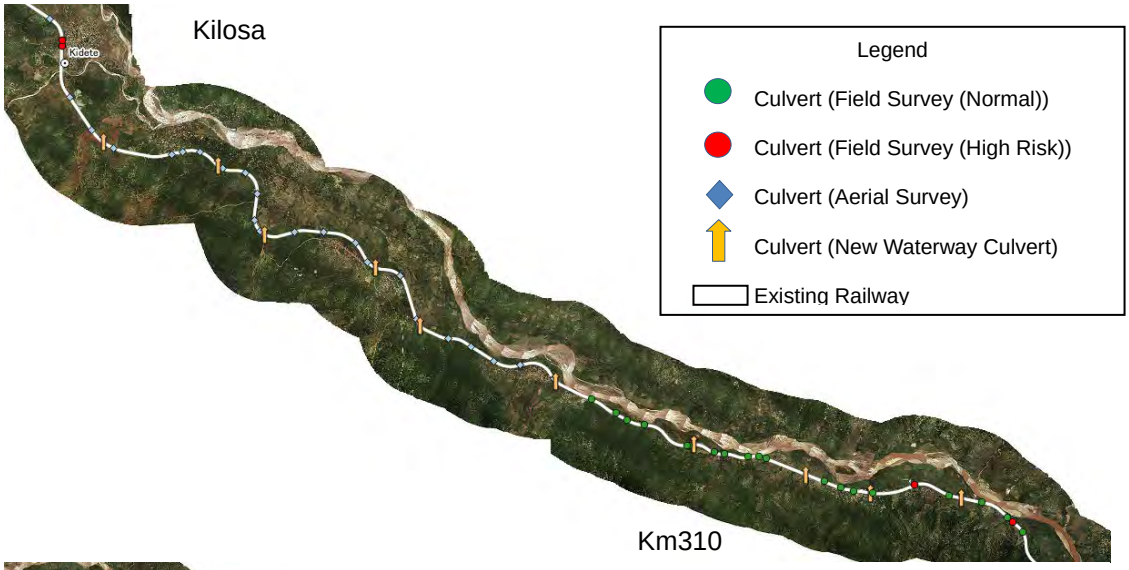
The List of Culverts and Bridge of Concerned Area (6/6)

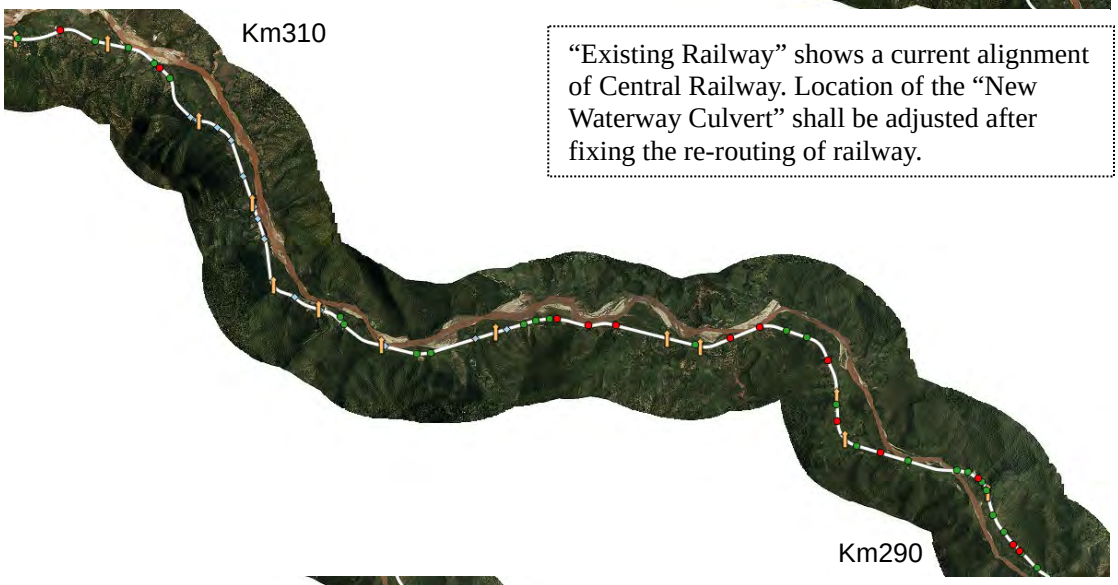
S/N	Station Km	Longitude	Latitude	Confirmation Method	Sheet Number (Progress Report)	W/C
201	Km 350.5	36.539542	-6.52155	Aerial Photo		○
202	Km 352.1	36.527342	-6.514776	Aerial Photo		
203	Km 352.7	36.522104	-6.513051	Aerial Photo		○
204	Km 352.9	0	0	Field Survey	BCL 352.9	
205	Km 352.9B	36.51125	-6.49869444	Field Survey	BCL 352.9B	
206	Km 353.6	36.518188	-6.505662	Aerial Photo		○
207	Km 354.3	36.506972	-6.49622222	Field Survey	BCL 354.3	○
208	Km 355.6	36.503667	-6.49372222	Field Survey	BCL 355.6	
209	Km 355.9	36.499879	-6.493347	Aerial Photo		○
210	Km 356.1	36.499806	-6.49338889	Field Survey	BCL 356.1	
211	Km 357	36.490526	-6.4899394	Aerial Photo		
212	Km 357.2	36.488627	-6.4892458	Aerial Photo		
213	Km 357.7	36.484893	-6.488927	Aerial Photo		
214	Km 358.1	36.481258	-6.489797	Aerial Photo		
215	Km 358.8	36.475073	-6.487282	Aerial Photo		
216	Km 359+0.3	36.471237	-6.488029	Aerial Photo		
217	Km 359+0.7	36.467257	-6.487649	Aerial Photo		○
218	Km 359+1.4	36.464321	-6.486841	Aerial Photo		
219	Km 359+2.3	36.45938	-6.484266	Aerial Photo		
220	Km 359+2.8	36.457985	-6.48265	Aerial Photo		
221	Km 359+3.5	36.455677	-6.480101	Aerial Photo		○
222	Km 360	36.45375	-6.47894444	Field Survey	BCL 360	
223	Km 360.6	36.4495	-6.47594444	Field Survey	BCL 360.6	○
224	Km 360.9	36.44875	-6.47283333	Field Survey	BCL 360.9	
225	Km 361.1	36.447889	-6.47125	Field Survey	BCL 361.1	
226	Km 361.9	36.443444	-6.46902778	Field Survey	BCL 361.9	
227	Km 362.1	36.440583	-6.46622222	Field Survey	BCL 362.1	○
228	Km 362.5	36.438361	-6.46277778	Field Survey	PCL 362.5	○
229	Km 362.9	36.438333	-6.46263889	Field Survey	BCL 362.9	
230	Km 363.3	0	0	Field Survey	BCL 363.3	
231	Km 363.7	36.429861	-6.45919444	Field Survey	BCL 363.7	
232	Km 364.2	36.425361	-6.45641667	Field Survey	BCL 364.2	
233	Km 364.4	36.42375	-6.45541667	Field Survey	BCL 364.4	
						○
						○
						○

Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

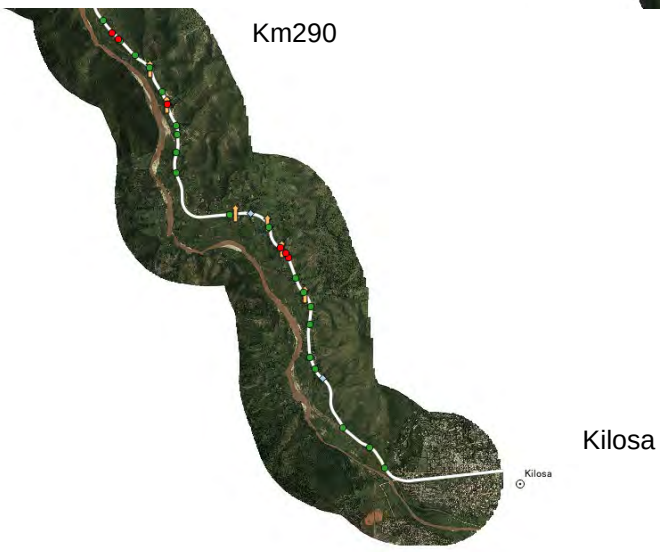
APPENDIX N

THE LOCATION OF CULVERTS

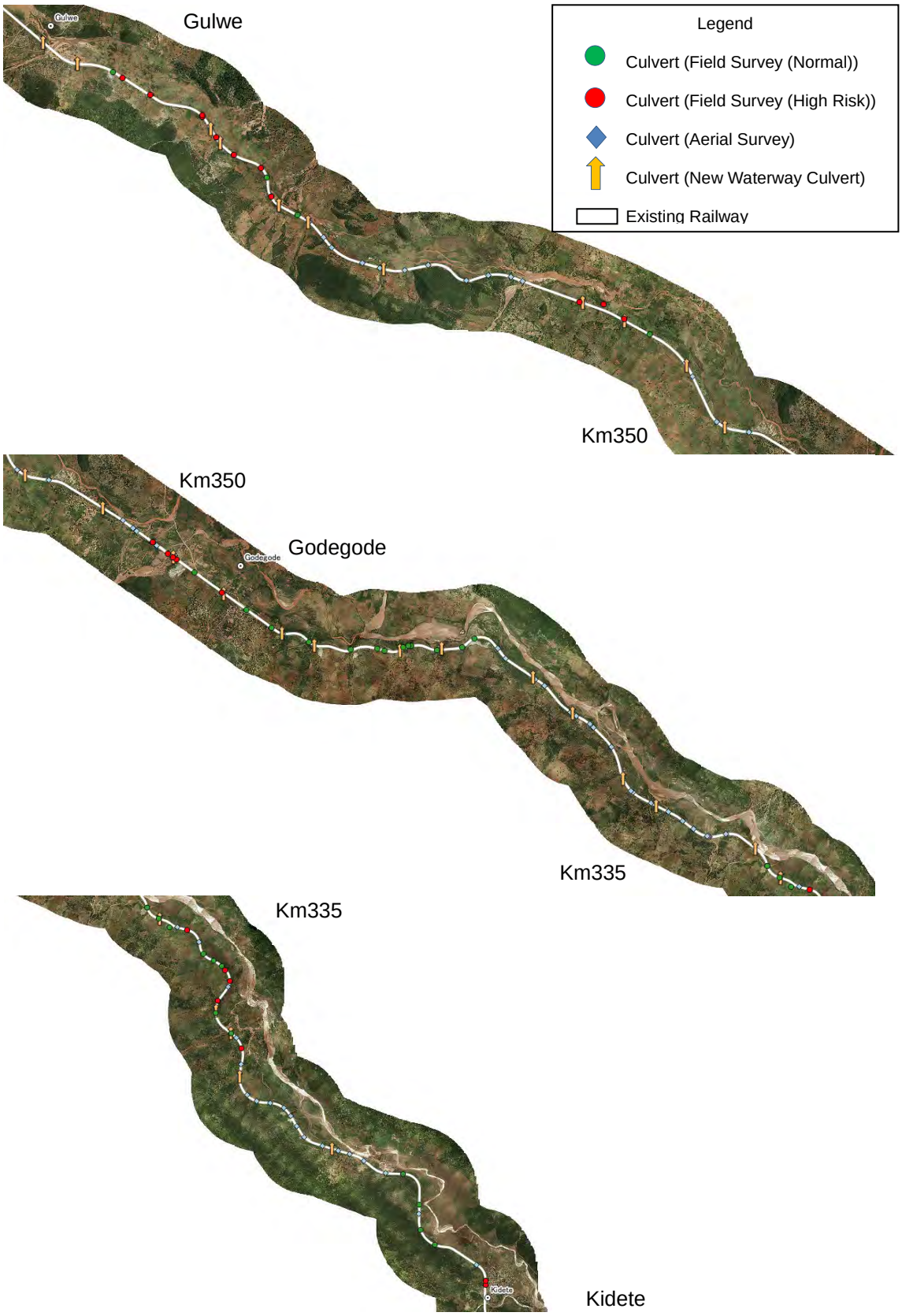




"Existing Railway" shows a current alignment of Central Railway. Location of the "New Waterway Culvert" shall be adjusted after fixing the re-routing of railway.



The location of culvert from Kilosa to Kidete



The location of culvert from Kidete to Gulwe

APPENDIX O

RIVERBED MATERIAL SAMPLING AND GRAIN SIZE ANALYSIS

O.1 The Objective

The objective of this investigation is to grasp the real condition of the material of discharged sediment. For that purpose, investigation is conducted at the mainstream, tributaries, and for the comparison, at cultivated lands along the river.

O.2 Actual Work Schedule

The schedule of planned activities shows the series of activities undertaken for a period starting late week of February 2015 to May 2015 (See Figure).

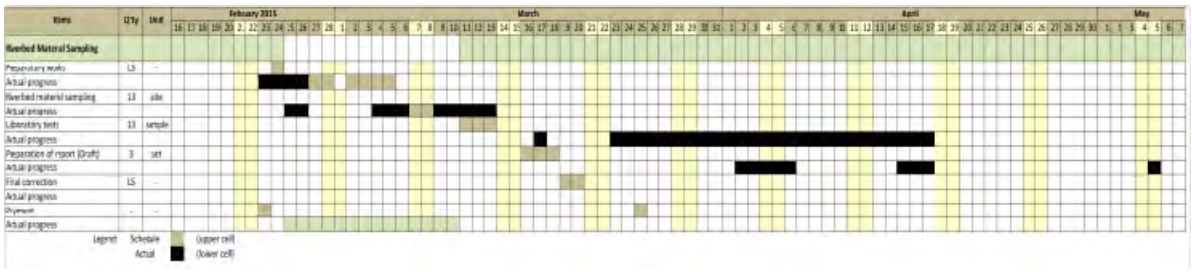


Figure O.1: Actual Schedule

O.3 Existing Agency

The following persons and institutions are gratefully acknowledged for assisting with information presented in this report:

- **DUNNY GEOINFOMATICS CONSULTANCY & SERVICES**
  Boma Road, P.O. Box 371, Morogoro, Tanzania

Table O.1: Persons and Institutions

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Dr. Muhaiki	SUA-Laboratory	Head SUA Soil Laboratory-TSS and River bed analysis	konsolatha@yahoo.com

O.4 Methodology and Location of Sampling

O.4.1 Method of Sampling and Laboratory Test

The riverbed material sampling is conducted at the 13 sites by taking materials on the surface of riverbed and cultivated land. Sampled material should be 0.20 m in depth, 0.30 m in width and length. And laboratory test is conducted about a total of 26 sampling.

O.4.2 Sampling of Riverbed Material

The locations of riverbed material sampling are as shown in Figure O.2 and Table O.2.

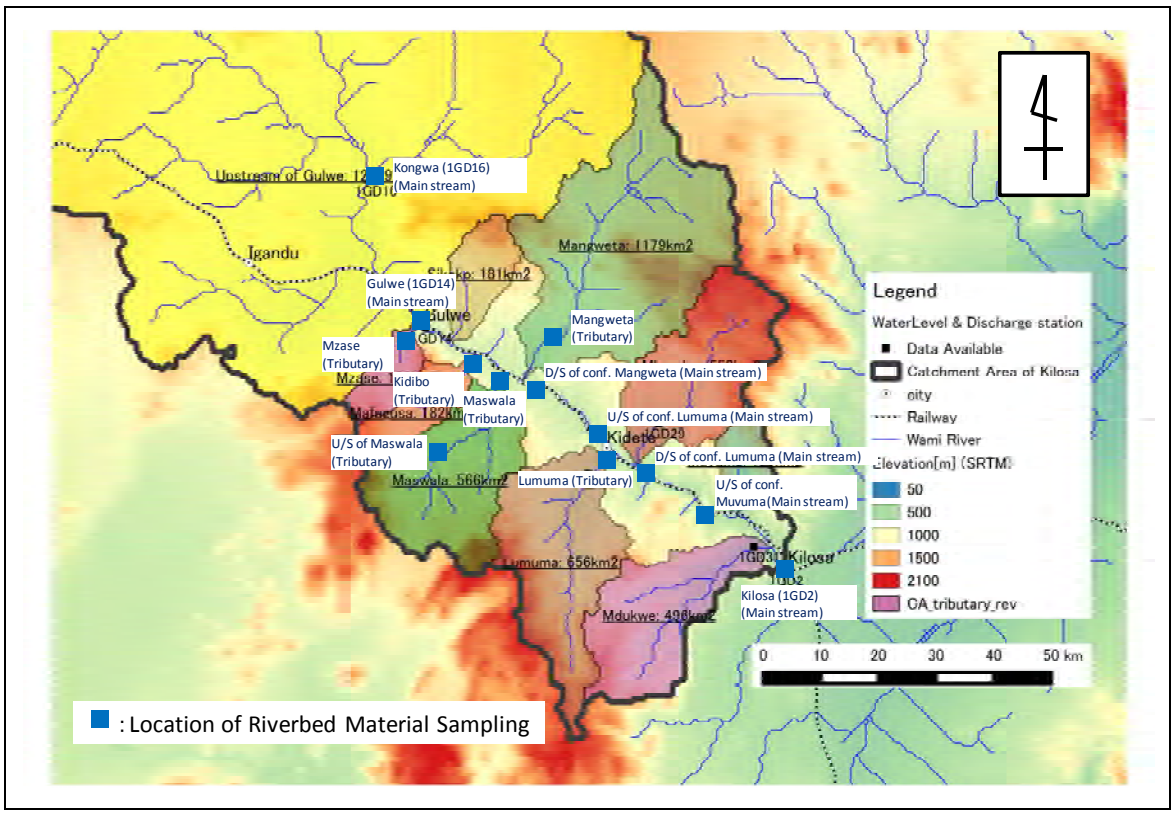


Figure O.2: Location of Riverbed Material Sampling

Table O.2: Site Location

	Site	Latitude (S)	Longitude (E)	Ana No	Remarks
1	Kongwa (1GD16) (Main stream)	6°13'02.25"	36°19'37.41"	1083	LB
				1084	Middle of river
2	Gulwe (1GD14) (Main stream)	6°26'57.78"	36°24'48.91"	1068	RB
				1070	Middle of river
3	Mzase (Tributary)	6°27'22.20"	36°24'10.96"	1067	LB
				1069	Cult land
4	Kidibo (Tributary)	6°31'33.11"	36°32'56.93"	1065	RB
				1066	Cult land
5	Maswala (Tributary)	6°34'51.06"	36°31'36.79"	1080	LB
				1082	Middle of river
6	U/S of Maswala (Tributary)	6°35'10.52"	36°31'37.35"	1079	LB
				1081	Cult land
7	Mangweta (Tributary)	6°26'30.85"	36°38'25.93"	1071	RB
				1072	Cult land
8	D/S of conf. Mangweta (Main stream)	6°32'27.71"	36°34'54.92"	1073	RB
				1074	Cult land
9	U/S of conf. Lumuma (Main stream)	6°38'59.72"	36°42'15.13"	1060	RB
				1061	Cult land
10	Lumuma (Tributary)	6°38'56.82"	36°42'19.56"	1063	Cult land
				1064	RB
11	D/S of conf. Lumuma (Main stream)	6°38'59.23"	36°42'28.19"	1059	RB
				1062	LB
12	U/S of conf. Muvuma (Main stream)	6°44'36.64"	36°54'8.60"	1077	LB
				1078	RB
13	Kilosa (1GD2) (Main stream)	6°49'51.84"	36°59'5.05"	1075	RB
				1076	RBUB

Ana No: Analysis No, U/S of conf:Upstream of confluence, D/S of conf: Downstream of confluence, LB:Left Bank, RB:Right Bank, Cult: Cultivated land, RBUB:Right bank upstream of bridge

The specific investigations are shown as follows.
This site is located at Kongwa of the Kinyasungwe River. In this site, two samples were taken on the left bank and the middle of the river (Date: 26 Feb. 2015). And Analysis number of each site is shown in Figure O.3 (Ex: Ana 1083).

Sampling on the left bank (Ana No. 1083)

Sampling on the middle of the river (Ana No. 1084)

Figure O.3: Site No. 1

This site is located at Gulwe of the Kinyasungwe River. In this site, two samples were taken on the right bank and the middle of the river (Figure O.4, Date: 26 Feb. 2015).

Sampling on the right bank(Ana No. 1068)

Sampling on the middle of the river (Ana No. 1070)

Figure O.4: Site No. 2

This site is located at Gulwe of the Mzase River. In this site, two samples were taken on the left bank and on the cultivated land (Figure O.5, Date: 26 Feb. 2015).

Sampling on the left bank (Ana No. 1067)

Sampling on the cultivated land (Ana No. 1069)

Figure O.5: Site No. 3

This site is located at the downstream of the Kidibo River. In this site, two samples were taken on the right bank and on the cultivated land (Figure O.6, Date: 11 Mar. 2015).


Sampling on the right bank (Ana No. 1065)


Sampling on the cultivated land (Ana No. 1066)

Figure O.6: Site No. 4

This site is located at Godegode of the Maswala River. In this site, two samples were taken on the left bank and the middle of the river (Figure O.7, Date: 11 Mar. 2015).


Sampling on the left bank (Ana No. 1080)


Sampling on the middle of the river (Ana No. 1082)

Figure O.7: Site No. 5

This site is located at the upstream of the Maswala River. In this site, two samples were taken on the left bank and on the cultivated land (Figure O.8, Date: 11 Mar. 2015).


Sampling on the left bank (Ana No. 1079)


Sampling on the cultivated land (Ana No. 1081)

Figure O.8: Site No. 6

This site is located at Mbori of the Mangweta River. In this site, two samples were taken on the right bank and on the cultivated land (Figure O.9, Date: 06 Mar. 2015).


Sampling at the right bank (Ana No. 1071)


Sampling on cultivated land (Ana No. 1072)

Figure O.9: Site No. 7

This site is located at the downstream of confluence of the Mangweta River. In this site, two samples were taken on the right bank and on the cultivated land (Figure O.10, Date: 13 Mar. 2015).


Sampling at the right bank (Ana No. 1073)


Sampling on cultivated land (Ana No. 1074)

Figure O.10: Site No. 8

This site is located at the upstream of confluence of the Lumuma River. In this site, two samples were taken on the right bank and on the cultivated land (Figure O.11, Date: 11 Mar. 2015).


Sampling at the right bank (Ana No. 1060)


Sampling on cultivated land (Ana No. 1061)

Figure O.11: Site No. 9

This site is located at Kidete of the Lumuma River. In this site, two samples were taken on the right bank and on the cultivated land (Figure O.12, Date: 05 Mar. 2015).


Sampling on the cultivated land (Ana No. 1063)


Sampling on the right bank (Ana No. 1064)

Figure O.12: Site No. 10

This site is located at the downstream of confluence of the Lumuma River. In this site, two samples were taken on the left bank and the right bank of the river (Figure O.13, Date: 11 Mar. 2015).


Sampling on the right bank (Ana No. 1059)


Sampling on the left bank (Ana No. 1062)

Figure O.13: Site No. 11

This is located at the upstream of confluence of the Muvuma River. In this site, two samples were taken on the left bank and the right bank of the river (Figure O.14, Date: 12 Mar. 2015).


Sampling on the left bank (Ana No. 1077)


Sampling on the right bank (Ana No. 1078)

Figure O.14: Site No. 12

This site is located at Kilosa of the Mkondoa River. In this site, two samples were taken on the right bank and the right bank upstream of the bridge (Figure O.15, Date: 25 Feb. 2015).


Sampling on the right bank (Ana No. 1075)


Sampling on the right bank upstream of the bridge (Ana No. 1076)

Figure O.15: Site No. 13

O.5 Laboratory Test of Material

O.5.1 Methodology of Test

Samples obtained at the sites are brought in the laboratory for analysis of grain size distribution. Sieve analysis was conducted as analysis of particle size distribution of the sampled riverbed materials.

From the result of the size analysis of each sample, a particle size gradation curve with an accumulated percentage finer as the ordinate and a sediment diameter in the logarithm scale as abscissa is described.

O.5.2 Result of Grain Size Analysis

(1) Comparison of Each River

Table O.3 shows the grain size distribution of the riverbed materials in the Kinyasungwe mainstream, tributaries and on the cultivated land along these rivers. Classification of the grain size is as follows.

- clay = <0.002 mm
- silt = 0.002–0.02 mm
- fine sand = 0.02–0.20 mm
- coarse sand = 0.20–2.0 mm
- gravel = >2.0 mm

Table O.3: Grain Size Distribution

Distribution		Lumuma Ms D RB (1059)	Lumuma Ms U RB (1060)	Lumuma Ms U Cult (1061)	Lumuma Ms D LB (1062)	Lumuma Tr Cult (1063)	Lumuma Tr RB (1064)	Kidibo Tr RB (1065)
Clay	**0.002**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silt	**0.02**	3.44	4.36	10.00	7.00	19.69	5.26	7.57
Very fine sand/coarse silt	**0.075**	4.00	5.00	11.95	12.69	22.94	5.26	10.00
Medium sand	**0.25**	8.26	8.36	21.95	20.91	51.20	80.80	25.29
Granule/very coarse sand	**2**	91.42	92.44	95.26	94.78	93.57	83.90	100.00
Pebble	**4**	99.75	98.87	99.44	98.74	99.40	84.91	100.00
Total (%)		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Distribution		Kidibo Tr Cult (1066)	Mzase Tr LB (1067)	Gulwe Ms RB (1068)	Mzase Tr Cult (1069)	Gulwe Ms Md (1070)	Mangweta Tr RB (1071)	Mangweta Tr Cult (1072)
Clay	**0.002**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silt	**0.02**	2.74	22.00	25.04	9.00	1.00	5.04	7.00
Very fine sand/coarse silt	**0.075**	4.00	27.04	30.00	10.04	8.04	6.00	12.98
Medium sand	**0.25**	7.74	52.04	55.04	19.04	9.04	11.04	29.98
Granule/very coarse sand	**2**	93.28	96.68	100.00	100.00	100.00	100.00	96.58
Pebble	**4**	97.68	99.72	100.00	100.00	100.00	100.00	99.90
Total (%)		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Distribution		Mangweta Ms D RB (1073)	Mangweta Ms D Cult (1074)	Kilosa Ms RB (1075)	Kilosa Ms RBUB (1076)	Muvuma Ms U LB (1077)	Muvuma Ms U RB (1078)	Maswala Tr U LB (1079)
Clay	**0.002**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silt	**0.02**	4.78	9.99	1.04	2.00	3.00	1.72	1.00
Very fine sand/coarse silt	**0.075**	5.00	24.17	6.00	6.79	4.04	5.00	5.56
Medium sand	**0.25**	16.55	36.11	11.04	9.79	7.04	6.72	6.56
Granule/very coarse sand	**2**	97.10	97.54	100.00	97.21	100.00	95.51	93.19
Pebble	**4**	99.38	99.89	100.00	98.93	100.00	99.45	97.64
Total (%)		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Distribution		Maswala Tr LB (1080)	Maswala Tr U Cult (1081)	Maswala Tr Md (1082)	Kongwa Ms LB (1083)	Kongwa Ms Md (1084)
Clay	**0.002**	0.00	0.00	0.00	0.00	0.00
Silt	**0.02**	1.82	1.41	2.00	10.00	4.00
Very fine sand/coarse silt	**0.075**	5.00	20.00	3.99	13.98	4.16
Medium sand	**0.25**	6.82	43.31	5.99	23.98	10.16
Granule/very coarse sand	**2**	96.92	95.07	85.15	88.67	91.98
Pebble	**4**	99.79	99.19	97.78	99.49	96.10
Total (%)		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Ms:Main stream, U:Upstream of confluence, D: Downstrea of confluence, LB:Left Bank, RB:Right Bank, Cult: Cultivated, RBUB:Right bank upstream of bridge

Figure O.16 shows the grain size accumulation curve of riverbed deposition at Gulwe site in mainstream of the Kinyasunguwe River and that of riverbed deposition in the Mzase, Kidibo, Maswala, Mangweta and Lumuma Rivers.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of riverbed deposition in Mzase and Gulwe which consists of materials from Mzase River is almost the same composition. And these materials mainly consist of silt, medium sand and granule. The ratio accounts for about 50%.
- Materials in Kidibo, Maswala, Mangweta River almost consist of granule.
- Material in Lumuma River mainly consists of medium sand.

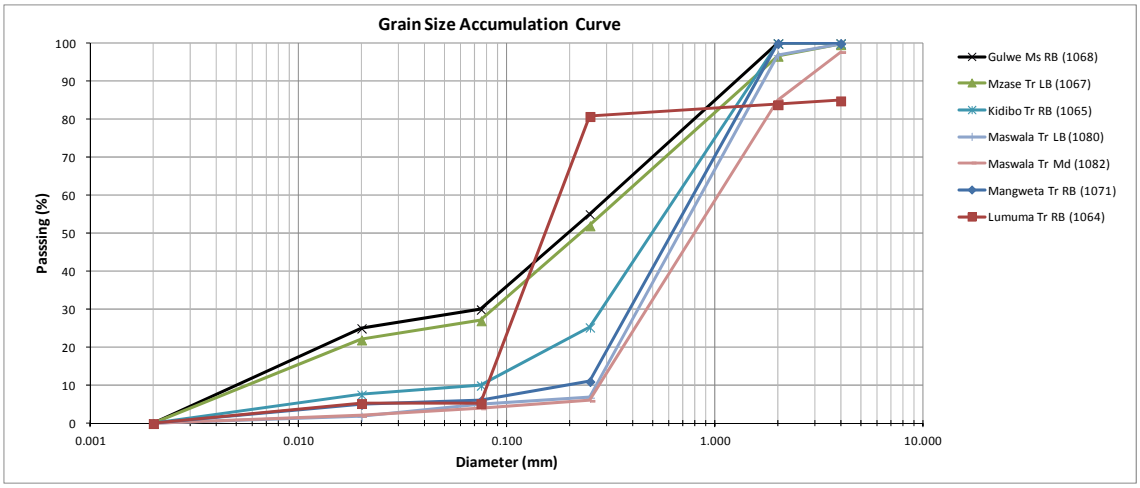


Figure O.16: Grain Size Accumulation Curve

Figure O.17 shows the grain size accumulation curve of riverbed deposition in the Maswala River and that of the cultivated land along the river.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of riverbed deposition in Maswala mainly consists of granule.

On the other hand, that of the cultivated area shows that the composition ration of very find sand and medium sand accounts for a high ratio compared with the riverbed one. The ratio account for about 40%.

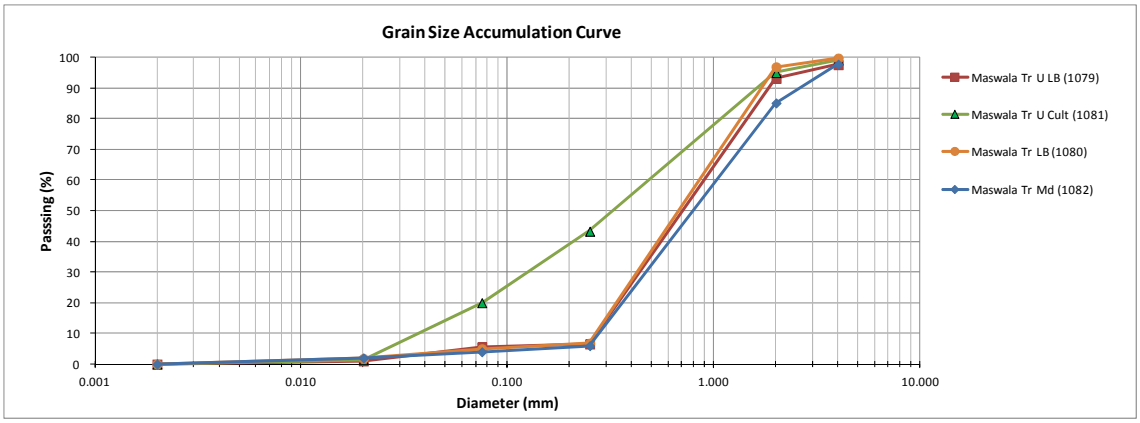


Figure O.17: Grain Size Accumulation Curve

Figure O.18 shows the grain size accumulation curve of riverbed deposition and cultivated area at downstream of confluence of the Mangweta River and that of riverbed deposition and cultivated area in the Mangweta River.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of riverbed deposition in both the Kinyasungwe and the Mangweta River mainly consists of granule.

- On the other hand, that of cultivated land shows that the composition ration of very find sand and medium sand accounts for a high ratio compared with the riverbed. The ratio accounts for about 30%.

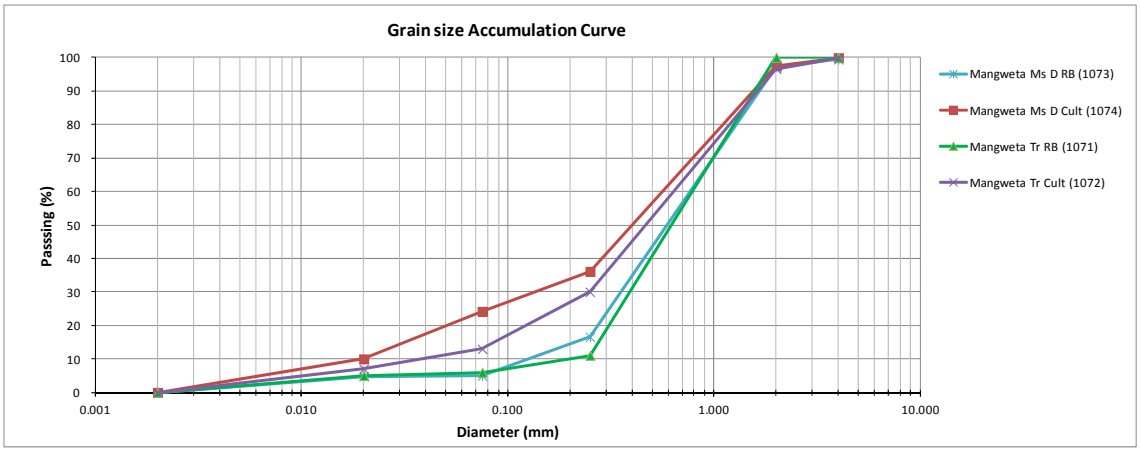


Figure O.18: Grain Size Accumulation Curve

Figure O.19 shows the grain size accumulation curve of riverbed deposition and cultivated land at downstream of confluence of the Lumuma River and that of riverbed deposition and cultivated area in the Lumuma River.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of riverbed deposition in the Kinyasungwe River mainly consists of granule.
- On the other hand, that of riverbed deposition in the Lumuma River shows that the composition ration of medium sand accounts for a high ratio compared with the riverbed one. The ratio accounts for about 75%.
- And that of cultivated land in the Lumuma River shows a high ratio of very find sand and medium sand.

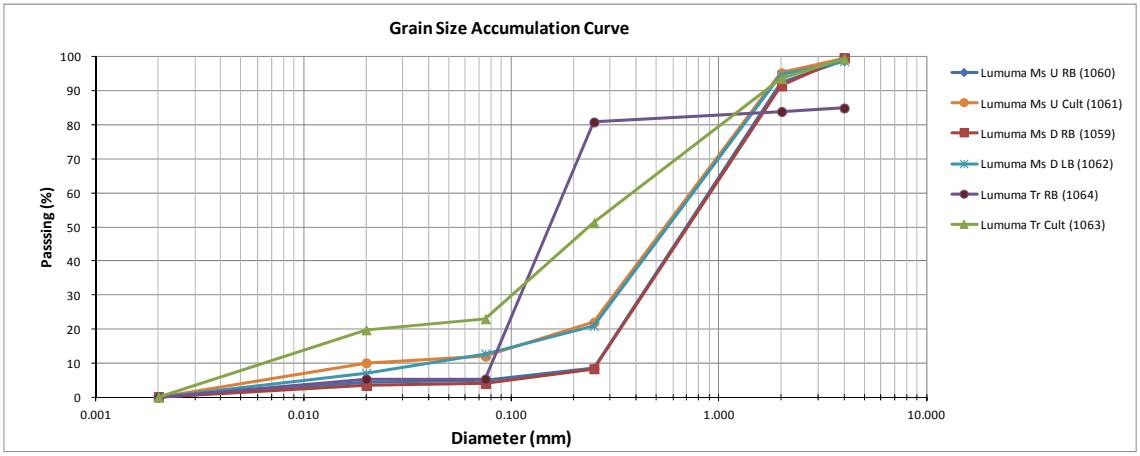


Figure O.19: Grain Size Accumulation Curve

Figure O.20 shows the grain size accumulation curve of riverbed deposition at upstream and downstream sites of confluence of each river.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of riverbed deposition in the Kinyasungwe River mainly consists of granule. The ratio accounts for about 70%–90%.
- But, that of Gulwe site consists of silt, medium sand and granule. Because this is presumed that the material of Gulwe site consists of the discharge materials from the Mzase River as mentioned above. The ratio below medium sand accounts for about 55%.

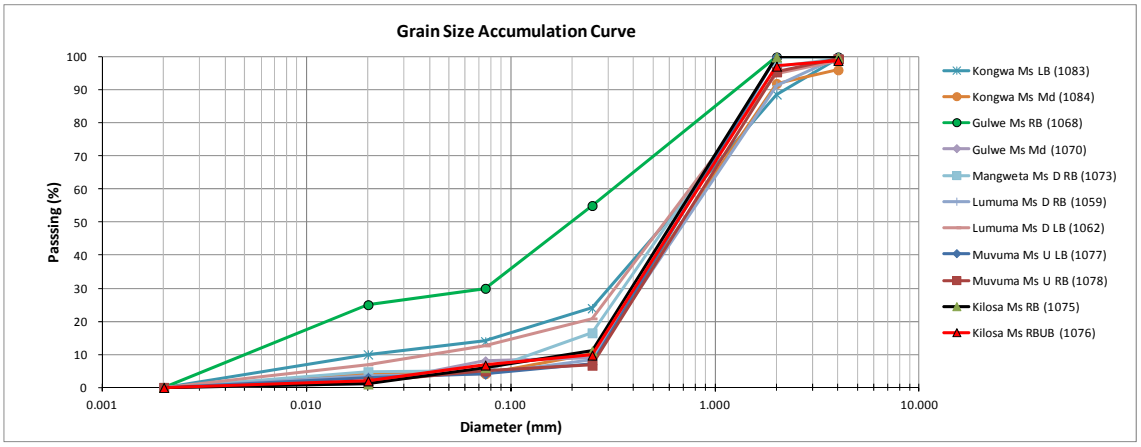


Figure O.20: Grain Size Accumulation Curve

Figure O.21 shows the grain size accumulation curve of cultivated lands along each river.

According to this Figure, the characteristics of the grain size distribution are as follows.

- Material of cultivated land generally consists of silt, very find sand, medium sand and granule.
- This is presumed that cultivated lands are less affected by the stream flow. But the ratio of clay is not observed.

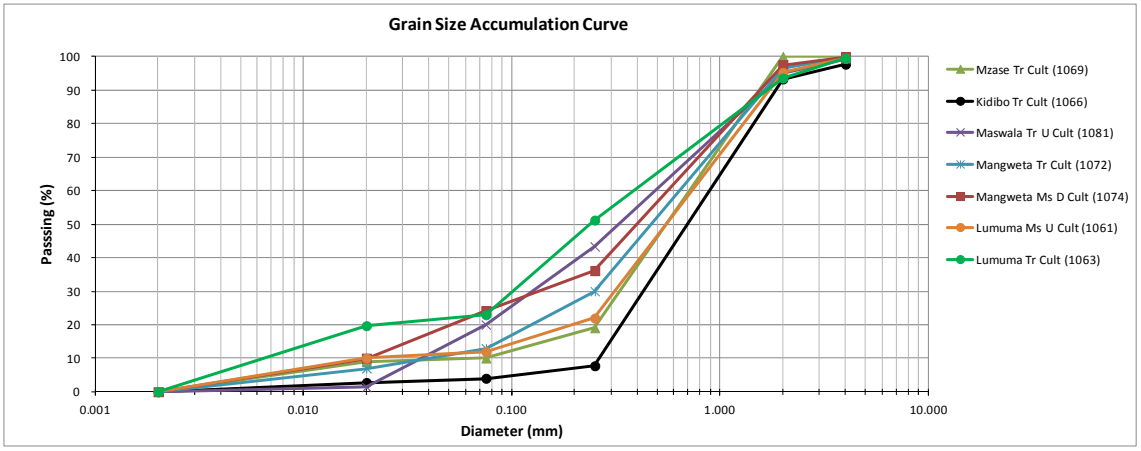


Figure O.21: Grain Size Accumulation Curve

(2) Summary

- The riverbed materials in the Kinyasungwe River and the Mkondoa River consist of granule. The ratio accounts for about 70%–90%.
- That of the cultivated area and the Mzase River shows that the composition ration of very find sand and medium sand accounts for a high ratio compared with the riverbed one. The ratio account for about 40% to 50%.
- Fine materials below medium sand in the main stream are presumed to be flowed out easily to the downstream as wash load.
- The riverbed materials of tributary near the sediment production source consist of the fine material compared with the mainstream of the Kinyasungwe River and the Mkondoa River.
- Materials of cultivated land consist of more fine material such as silt, very fine sand and medium sand.

APPENDIX P

DISCHARGE MEASUREMENT AND SUSPENDED LOAD SAMPLING

P.1 The Objective

P.1.1 Main Objective

The main objective of the work is to measure river discharge and take samples of suspended load during flood in order to understand characteristics of flood flow and sediment transport in the upstream area of Kilosa.

P.1.2 Specific Objective

During the survey work the sub-contractor also observes the importance of the following necessary information;

- To conduct cross-section survey at each gauging station and overlaying with the existing cross section surveyed during the construction and installation of staff gauges.
- To examine the change in River bed (Siltation/Scouring) at the measuring point.
- Collecting rainfall data in the near stations within the catchment.

P.2 Scope of Work

The work covered the following parts:

- Installation of water level gauges
- Monitoring of Water Level
- Discharge Measurements during floods
- Suspended Load Sampling and Laboratory Test

P.3 Actual Work Schedule

The planned schedule of activities as per attached it shows the series of activities for the project undertaken for a period starting late of February 2015 to end of May 2015. The planned early schedule was affected by climatic (weather) condition especially the rain season (Figure P.1).

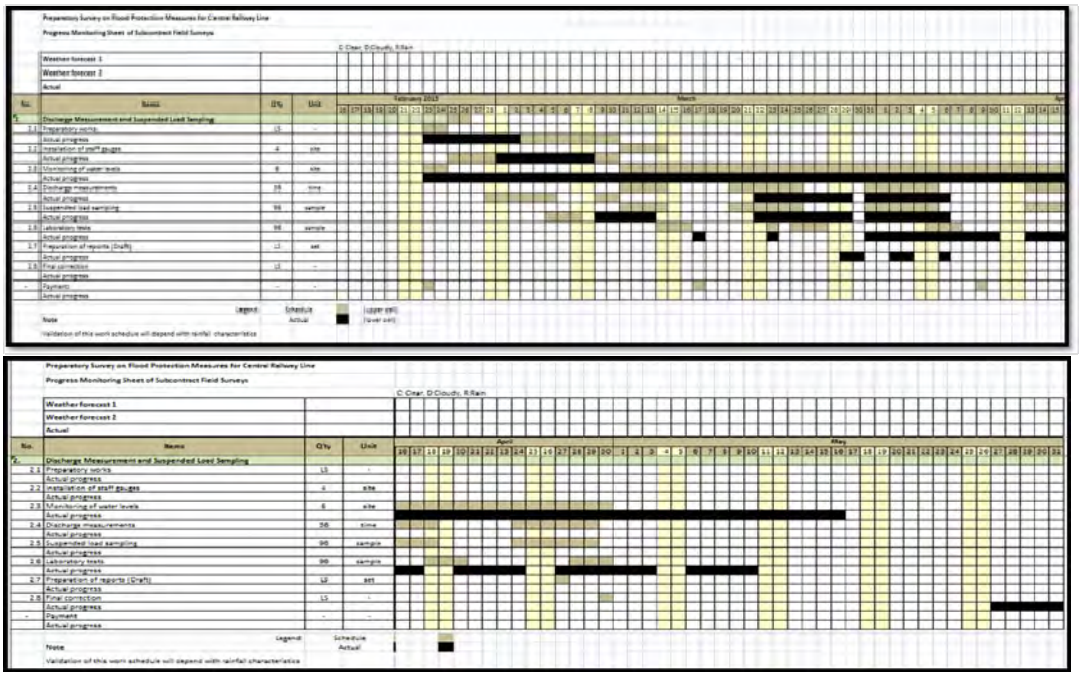


Figure P.1: Actual Work Schedule

P.4 Discharge Measurement and Sampling

P.4.1 Location of Works

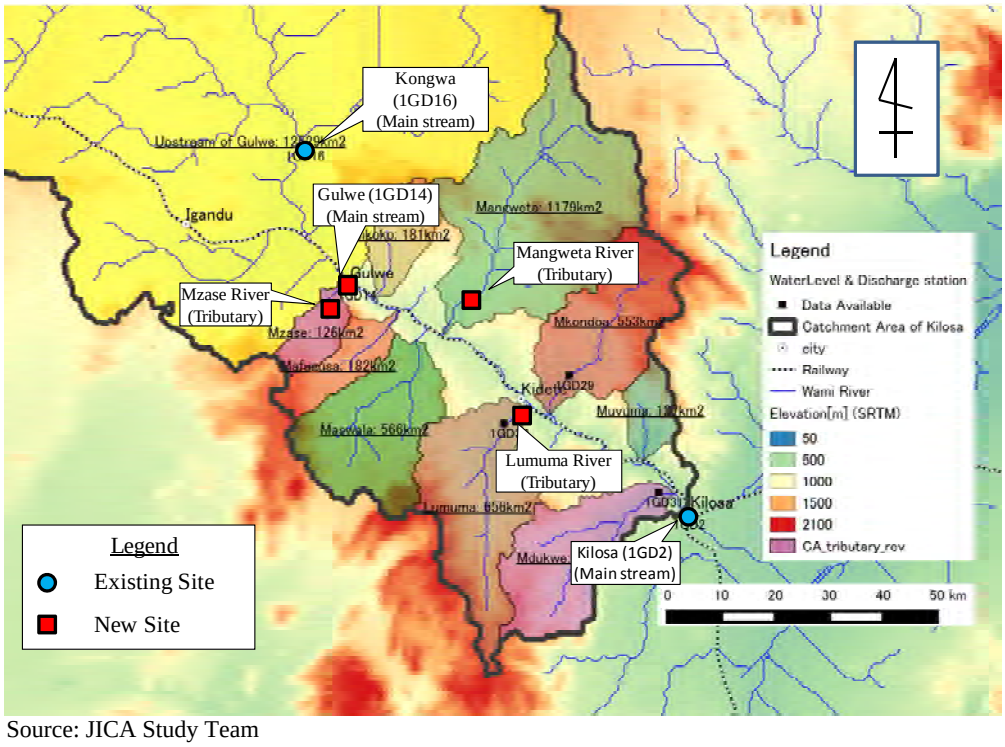
The work was conducted at six gauging stations as shown in the table below. The location for the Work is shown on the location map of the proposed gauging stations in Table P.1. The location is subject to change in the course of the Work depending on site conditions (See Figure P.2). Table P.1 shows the newly constructed station's details namely; Kinyasungwe at Gulwe, Mzase at Gulwe, Lumuma at Kidete and Mangweta at Mbori and existing stations namely Kinyasungwe at Kongwa and Mkondoa at Kilosa.

Also summarizes the newly constructed station's details namely; Kinyasungwe at Gulwe, Mzase at Gulwe, Lumuma at Kidete and Mang'weta/Mbori and existed stations namely Kinyasungwe at Kongwa/Dodoma and Mkondoa at Kilosa for flood monitoring under the project (Preparatory survey on flood protection measures for central railway between Kilosa and Gulwe).

Table P.1: List of Gauging Stations for Flood Monitoring

No.	Station Name	Existing or New	Location GPS		Gauge ranges	No. of gauges	Ways of discharge measurements	Name of gauge reader
			Lat	Long				
1	Mkondoa at Kilosa	Existing	−6.83158	36.97822	1–5	5	Bridge/Float	Salehe Kaombwe
2	Lumuma at Kidete	New	−6.64912	36.70543	1–2	2	Bridge/Float	Nangise Mkuya
3	Mangweta at Mbori	New	−6.4419	36.64054	1–2	2	Float/Boat	Peter Samwel
4	Kinyasungwe at Gulwe	New	−6.44938	36.41359	1–3	3	Bridge/Float/ Current Meter	Fidia George
5	Kinyasungwe at Kongwa	Existing	−6.21729	36.32706	0.5–1 1–4	4	Bridge/Float/boat	Anderson M.
6	Mzase at Gulwe	New	−6.45617	36.40305	1–4	4	Railwaybridge/ Float	Festo Peter

Source: JICA Study Team



Source: JICA Study Team

Figure P.1: Location Map

P.4.2 Installation of Gauges

(1) Cross Section Survey

The river cross-section was preceded by transect walk for suitable site selection and re-surveyed to determine the best site and maximum elevation and the point of zero flow for gauge installation.

The site is located at Gulwe of the Kinyasungwe River. In this site, three gauges were installed at upstream of the bridge (Date: 4 March 2015).

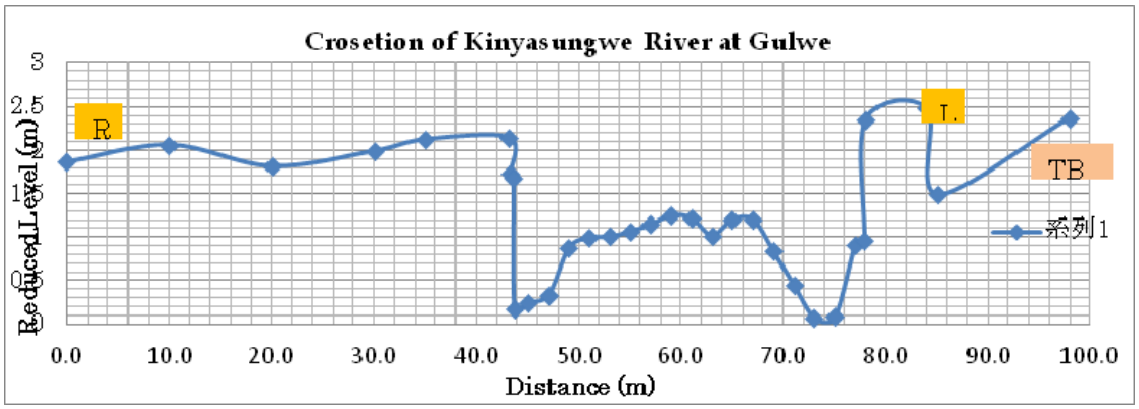


Figure P.2: Cross Section of the Kinyasungwe River at Gulwe

Figure P.3: Construction of the Water Level Gauges at Gulwe

This site is located at Gulwe of the Mzase River. In this site, four gauges were installed (Date: 4 Marchch. 2015).

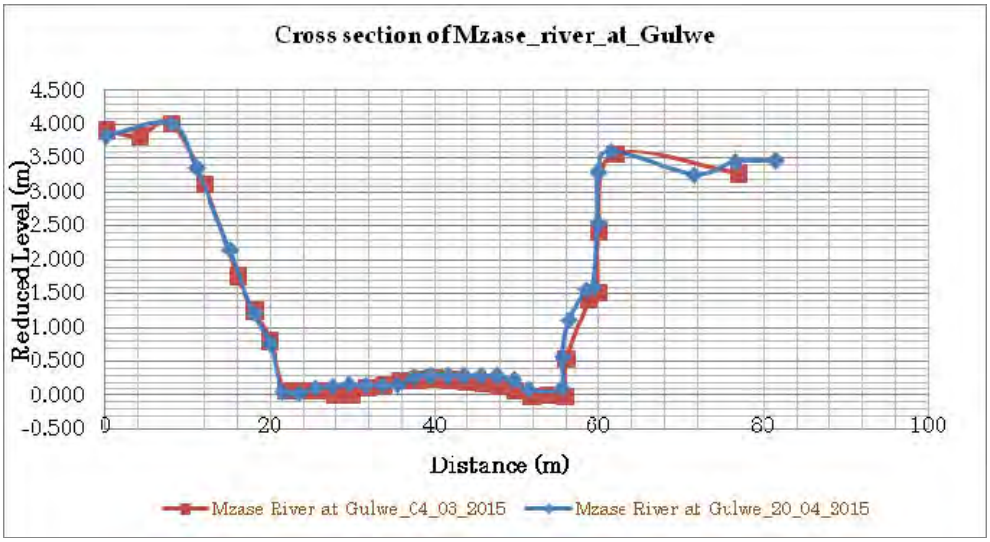


Figure P.4: Cross Section of the Mzase River at Gulwe

Figure P.5: Construction of the Water Level Gauges in the Mzase River at Gulwe

This site is located at Kidete of the Lumuma River. In this site, two water level gauges were installed (Date: 5 March 2015).

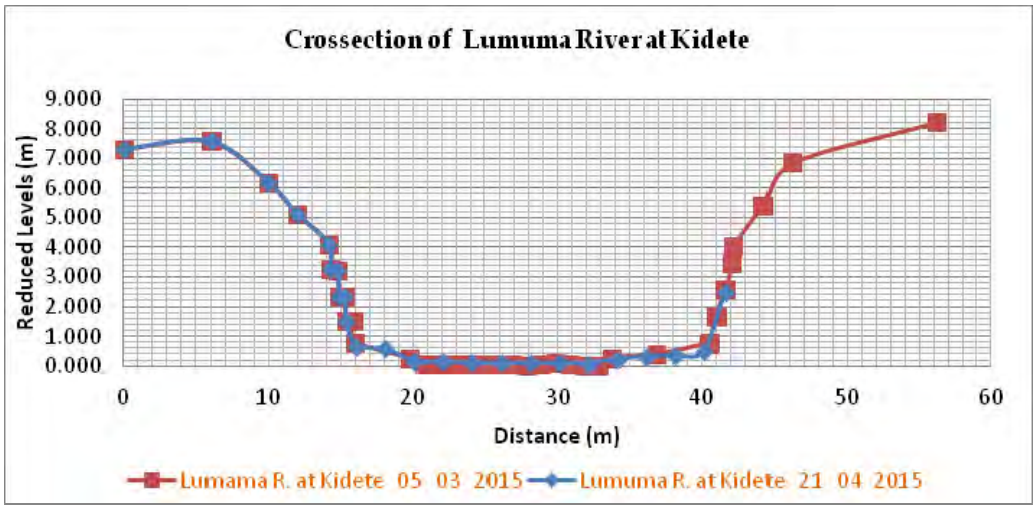


Figure P.6: Cross Section of the Lumuma River at Kidete

Figure P.7: Construction of the Water Level Gauges at Kidete

This site is located at Mbori of the Mangweta River. In this site, two water level gauges were installed (Date: 6 March 2015).

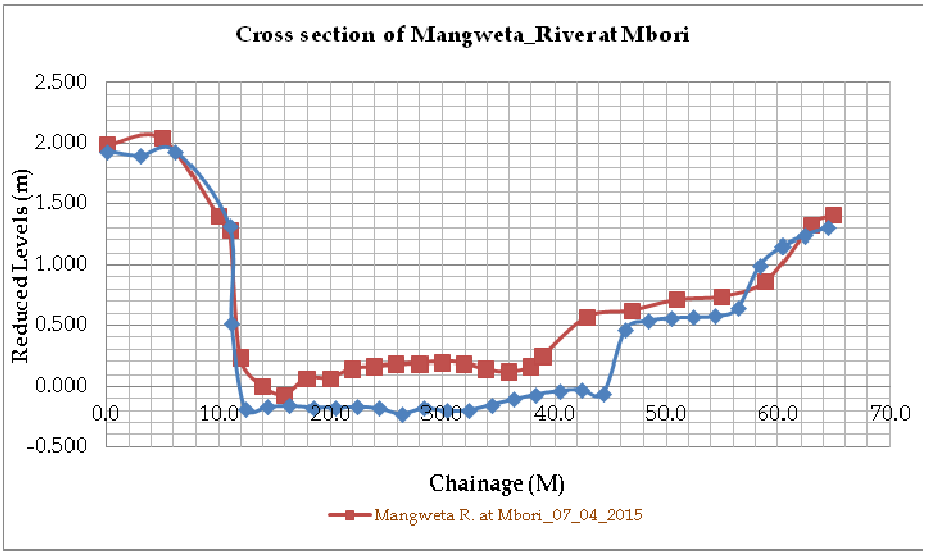


Figure P.8: Cross Section of the Mangweta River at Mbori

Figure P.9: Constructing the Water Level Gauges at Mbori

After the installation of staff gauges the water levels at every gauging station were managed and recorded daily at the intervals of 0600 hrs, 1200 hrs and 1800 hrs respectively by selected local observers.

Next two site are the existing sites.

This site, which is the existing site, is located at Kongwa of the Kinyasungwe River.

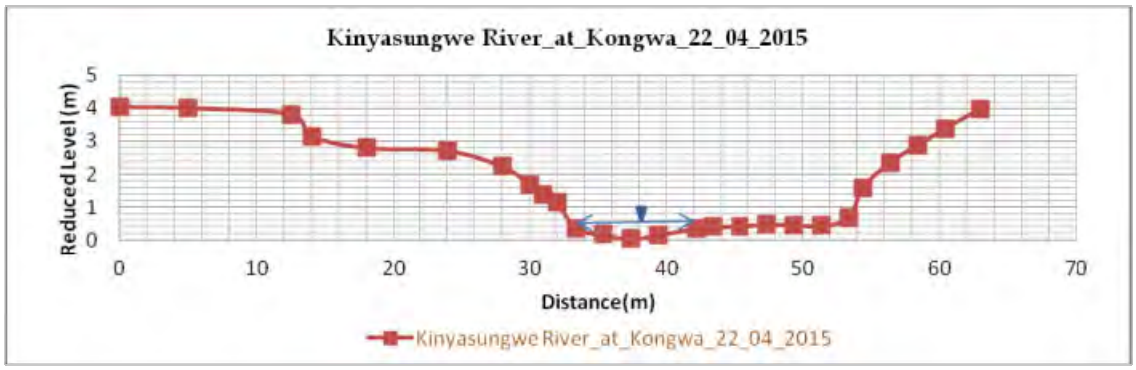


Figure P.10: Cross Section of the Kinyasungwe River at Kongwa

Figure P.11: Existing Gauges at Kongwa

This site, which is the existing site, is located at Kilosa of the Mangweta River.

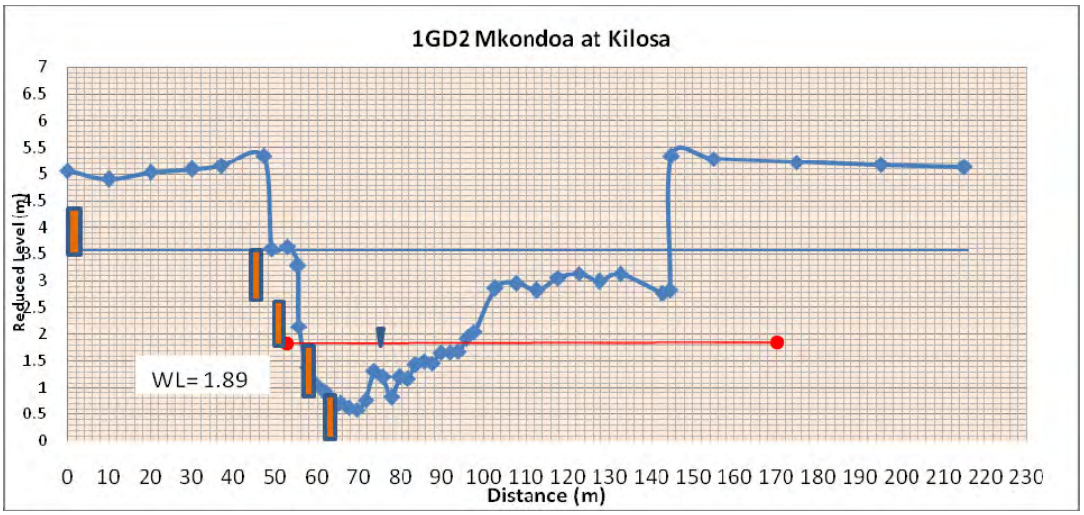


Figure P.12: Cross Section of the Mkondowa River at Kilosa


Figure P.13: Existing Gauges at Kilosa

P.4.3 Discharge Measurements

(1) Methodology of Discharge Measurements

Discharge measurement was done using float method, Current Meter, Leveling and chainage which were used as method to conduct flow campaign in six (6) times at each targeted river gauging station at different water level and the tools used were; Leveling machine and Current meter (Universal and Pygmy).

Also the wetted area depth was determined by sounding depth rod and calculated on field as illustrated in the figure below:

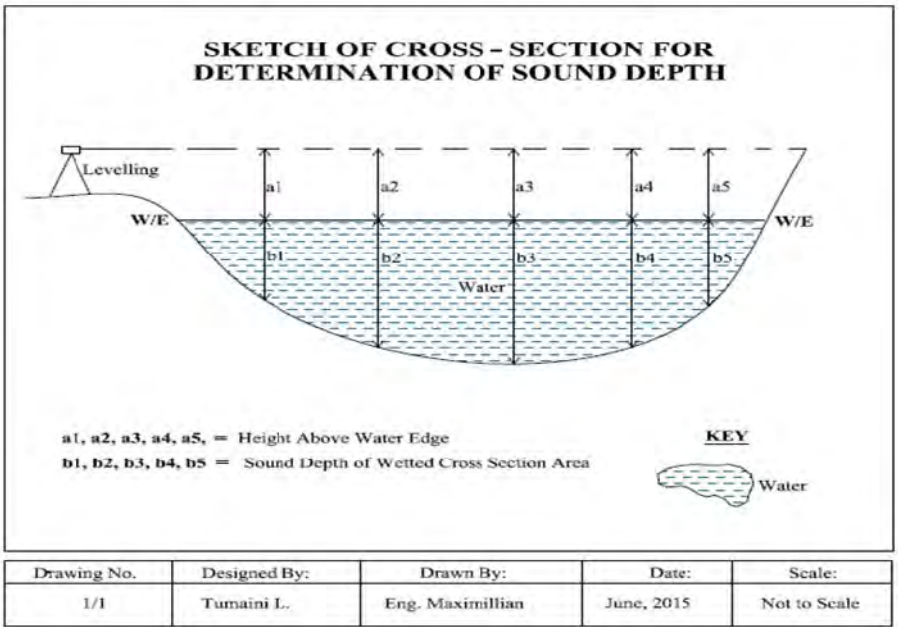


Figure P.14: Sketch of Cross-Section for Determination of the Sound Depth in the Wetted Area

Table P.2 shows the number of flow measurements in each site.

Table P.2: Number of Discharge Measurements Done at Each Station

No.	Station Name	Proposed Measurements No.	Actual Done
1	Mkondoa/Kilosa	6	7
2	Kinyasungwe/Kongwa	6	6
3	Kinyasungwe/Gulwe	6	5
4	Mzase/Gulwe	6	5
5	Mangweta/Mbori	6	6
6	Lumuma/Kidete	6	6
	Total of Measurements	**36**	**35**

(2) Result of Discharge Measurement

Discharge campaign was conducted by different team of experts camping near respective area where measurement sited to be carried. Unfortunately due to climatic condition, it was not possible to capture the full range of expected maximum flood area due to limited amount of rainfall pattern within the catchment during the time of consideration. However several numbers of measurements were carried on but at medium level depth, basically this was associated with small amount of rainfall within the catchments.

Table P.3: Flow Measurements the Mkondoa River at Kilosa

(at Kilosa)

Date	Q (m^3/s)	Area (m^2)	Velocity (m/s)	Avg Depth (m)	WL (m)	Span (m)	Time taken	Video file name
25/03/2015	78.816	37.841	2.083	0.93	1.87	41	1523-1536	Vid_20150325_Mkondoa
26/03/2015	77.486	37.04	2.0919	0.90	1.80	41	1810-1810	Vid_20150326_Mkondoa
26/03/2015	85.00	42.33	2.008	1.00	1.89	41.5	1553-1707	-
27/03/2015	93.961	43.14	2.178	1.08	1.90	41.5	1624-1630	Vid_20150327_Mkondoa
30/03/2015	72.086	35.835	2.012	0.89	1.65	40.4	08:15-08:52	Vid_20150330_Mkondoa
11/4/2015	43.083	30.45	1.415	0.76	1.61	41	0817-0829	Vid_20150411_Mkondoa
3/5/2015	65.064	33.65	1.934	0.84	1.77	41	0824-0842	Vid_20150503_Mkondoa

Table P.4: Flow Measurements Station Number 1GD 16 Kinyasungwe at Kongwa

(1GD 16 at Kongwa)

Date	Q (m^3/s)	Area (m^2)	Velocity (m/s)	Avg Depth (m)	WL (m)	Span (m)	Time taken	Video file name
30/03/2015	0.200	1.603	0.125	0.247	0.38	4.8	1040-1106	-
31/03/2015	0.223	1.605	0.139	0.245	0.38	4.8	1636-1700	-
4/4/2015	0.200	1.585	0.126	0.246	0.38	4.8	0849-0913	-
6/4/2015	0.085	1.71	0.050	0.212	0.37	4.8	0820-0840	-
12/4/2015	0.261	1.75	0.149	0.421	0.6	7	0921-0933	-
3/5/2015	0.559	2.53	0.222	0.513	0.64	9	0856-0910	Vid_20150503_Kongwa

Table P.5: Flow Measurements the Kinyasungwe River at Gulwe

(Kinyasungwe River at Gulwe)

Date	Q (m^3/s)	Area (m^2)	Velocity (m/s)	Avg Depth (m)	WL (m)	Span (m)	Time taken	Video file name
11/4/2015*	0.385	0.668	0.576	0.13	0.85	5.5	0828-0838	-
12/4/2015*	0.162	0.620	0.261	0.12	0.79	5	0806-0817	-
13/04/2015**	0.667	1.427	0.467	0.14	0.89	8	0913-0930	Vid_20150413_Gulwe
20/04/2015*	0.296	1.56	0.189	0.12	0.78	4.8	1423-1433	-
3/5/2015*	0.019	0.255	0.075	0.100	0.66	3	1012-1058	-

Method :* by Pygm Current meter, **Float method

Table P.6: Flow Measurements the Mzase River at Gulwe

								(Mzase River at Gulwe)
Date	**Q (m^3/s)**	**Area (m^2)**	**Velocity (m/s)**	**Avg Depth (m)**	**WL (m)**	**Span (m)**	**Time taken**	**Video file name**
5/4/2015	23.0169	14.891	1.546	0.45	0.58	36	0725-0733	Vid_20150405_Mzase
6/4/2015	32.054	19.21	1.669	0.57	0.70	37	0718-0730	Vid_20150406_Mzase
12/4/2015	1.075	1.23	0.873	0.09	0.10	30	0810-0821	-
13/04/2015	3.808	4.26	0.893	0.17	0.20	36	0645-0655	-
13/04/2015	0.095	0.401	0.238	0.00	0.02	4	1300-1306	-

Table P.7: Flow Measurements the Mangweta River at Mbori

								(Mangweta River at Mbori)
Date	**Q (m^3/s)**	**Area (m^2)**	**Velocity (m/s)**	**Avg Depth (m)**	**WL (m)**	**Span (m)**	**Time taken**	**Video file name**
31/03/2015	23.006	14.767	1.558	0.46	0.04	32.40	0850-0912	Vid_20150331_Mangweta
1/4/2015	23.094	14.967	1.543	0.48	0.04	32.60	0930-0942	Vid_20150401_Mangweta
3/4/2015	24.415	15.676	1.558	0.42	0.04	32.50	1324-1342	Vid_20150403_Mangweta
11/4/2015	31.215	18.833	1.657	0.49	0.08	33.00	0743-0753	Vid_20150411_Mangweta
12/4/2015	23.416	15.040	1.557	0.43	0.04	32.50	0832-0846	Vid_20150412_Mangweta
13/04/2015	20.059	13.800	1.453	0.41	0.03	32.00	0810-0829	Vid_20150413_Mangweta

Table P.8: Flow Measurement the Lumuma River at Kidete

								(Lumuma River at Kidete)
Date	**Q (m^3/s)**	**Area (m^2)**	**Velocity (m^3/s)**	**Avg Depth (m)**	**WL (m)**	**Span (m)**	**Time taken**	**Video file name**
30/03/2015	1.758	2.155	0.816	0.170	0.15	14.00	1140-1200	Vid_20150330_Lumuma
31/03/2015	1.712	2.24	0.764	0.160	0.14	14.10	0811-0825	-
1/4/2015	1.656	2.180	0.759	0.133	0.12	13.20	1200-1220	-
2/4/2015	1.307	1.560	0.838	0.152	0.12	13.1	1730-1747	-
11/4/2015	1.140	1.570	0.726	0.135	0.1	13.00	0816-0825	-
12/4/2015	1.093	1.505	0.73	0.143	0.1	12.20	0753-0803	-

(3) Rainfall

Manual Rainfall data were collected at two rain gauge located within Two Meteorological station (Ilolo met station and Kongwa met station) the data shows for the period from January to mid-May 2015 the total rainfall recorded at Ilolo was 400.3 mm and Kongwa was 329.8 mm. Some areas are completely dry and crops become destroyed by sunlight, according to history of the surrounding people this year they said it purely dry, they are expecting to suffer from fetching water in future. Some have started getting water aside river ponds.

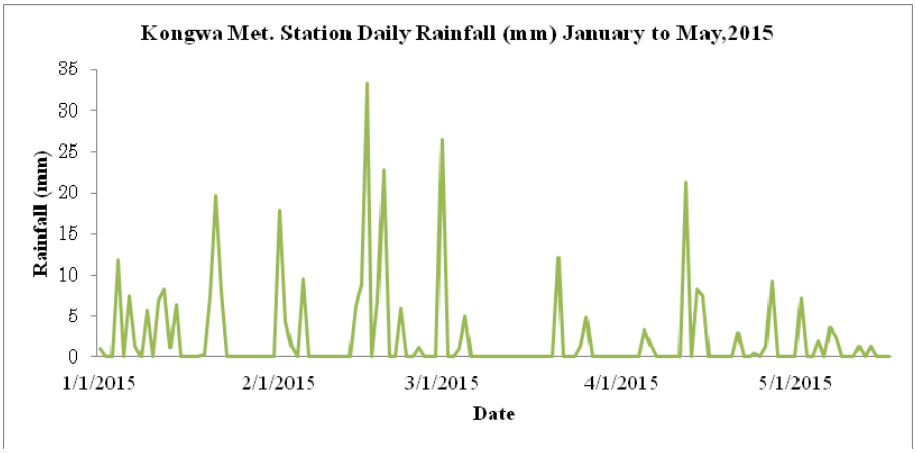


Figure P.15: Kongwa Met. Station Daily Rainfall

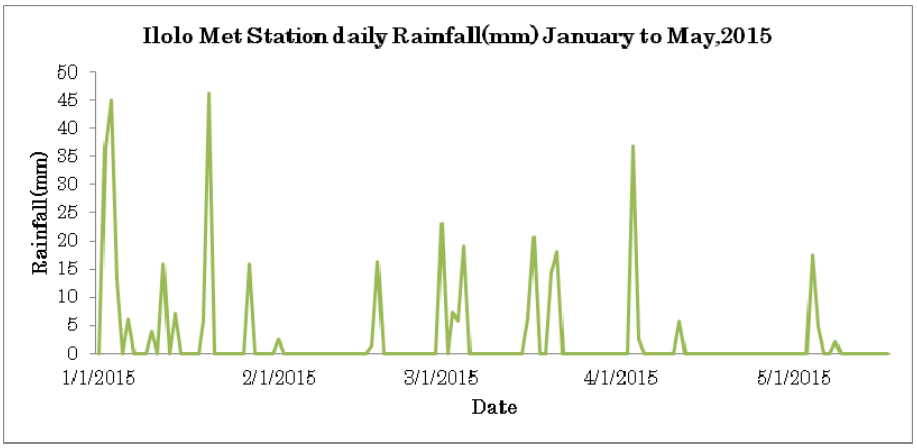


Figure P.16: Ilolo Met. Station Daily Rainfall

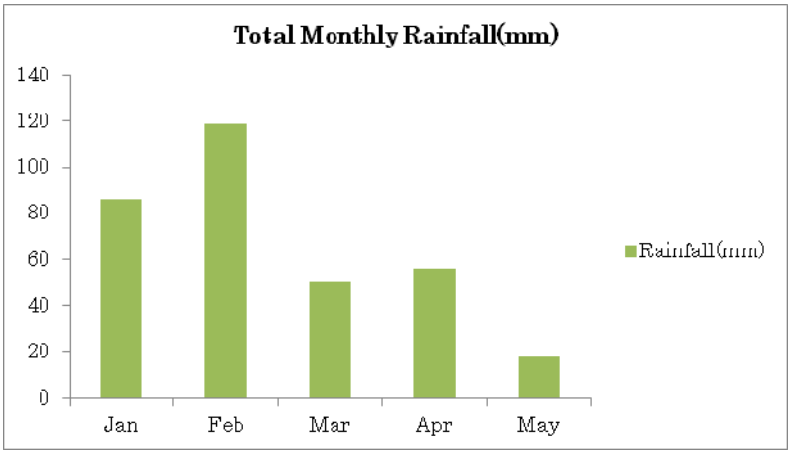


Figure P.17: Rainfall Distribution at Kongwa St. (January to May 2015)

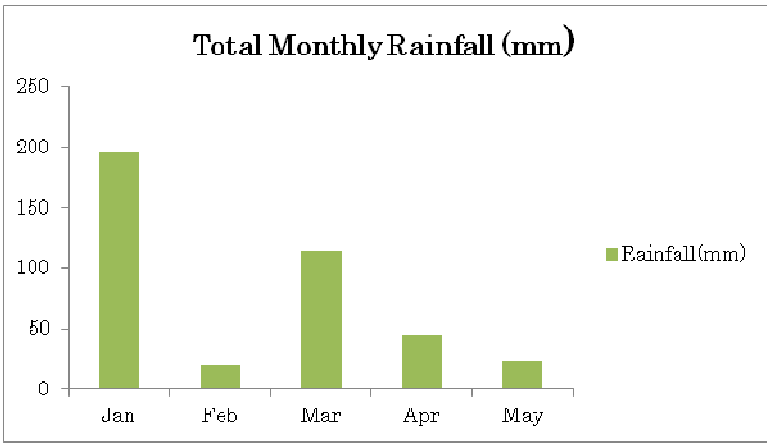


Figure P.18: Rainfall Distribution at Ilolo–Mpwapwa St. (January to May 2015)

Table P.9: Total Rainfall (mm)

Month	Jan.	Feb.	Mar.	Apr.	May	Total
Kongwa St.	86	118.7	50.9	56.3	17.9	329.8
Ilolo–Mpwapwa St.	196	20.3	114.5	45.2	24.3	400.3

(4) Water Level

The data from gauge readers were collected and minor correction was done, some station shows there was no much greater change in water levels, and this implies that water depends much on rainfall patterns.

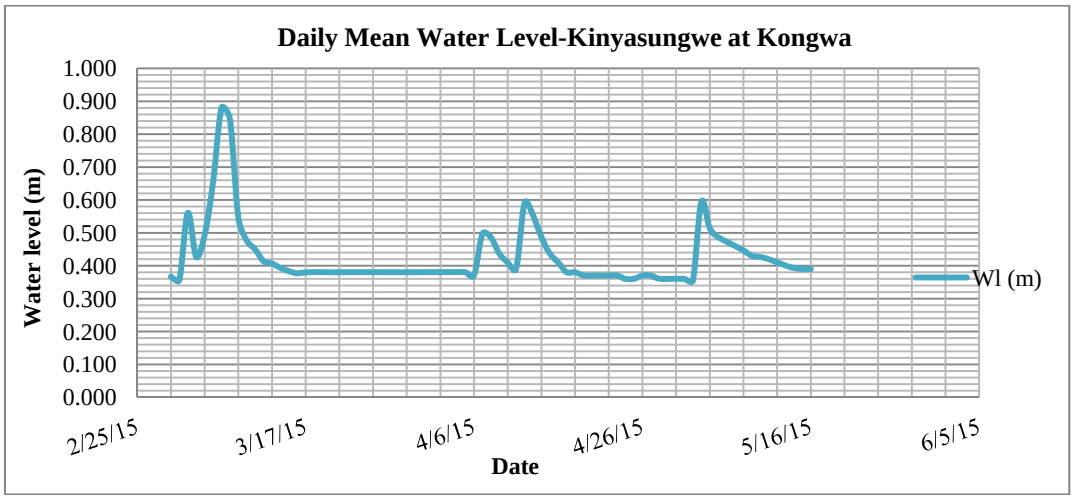


Figure P.19: Water Level at Kongwa

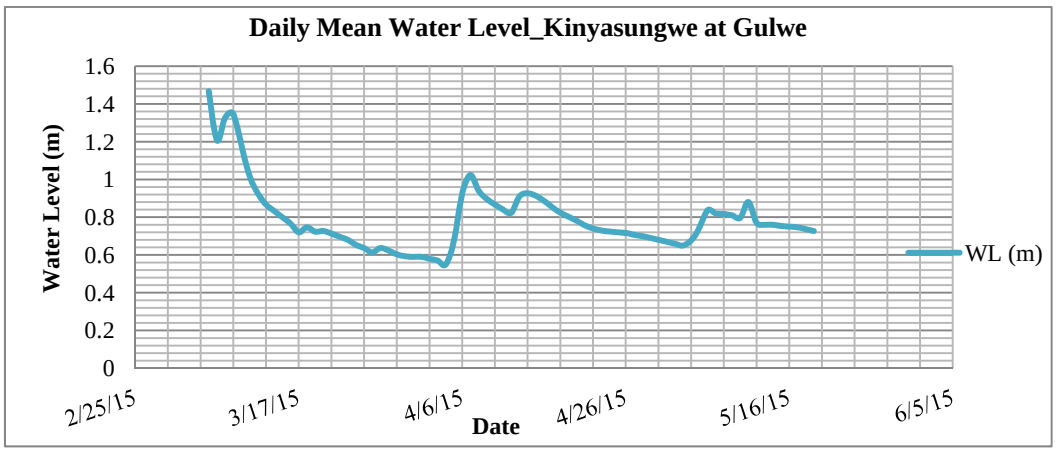


Figure P.20: Water Level at Gulwe

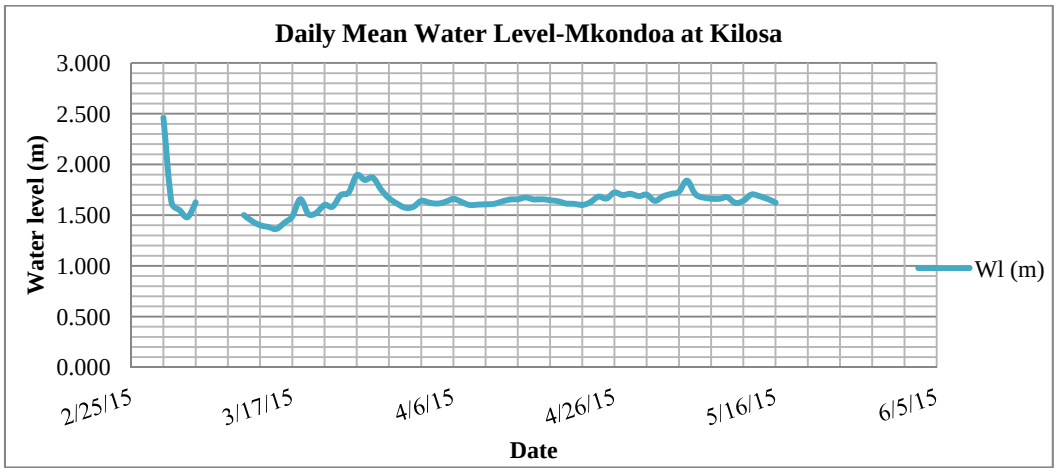


Figure P.21: Water Level at Kilosa

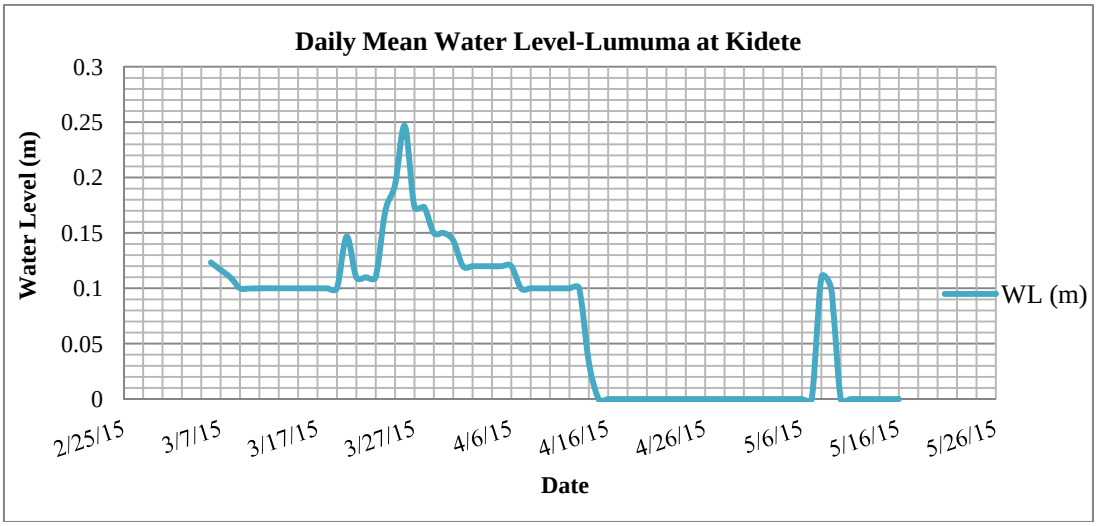


Figure P.22: Water Level at Kidete

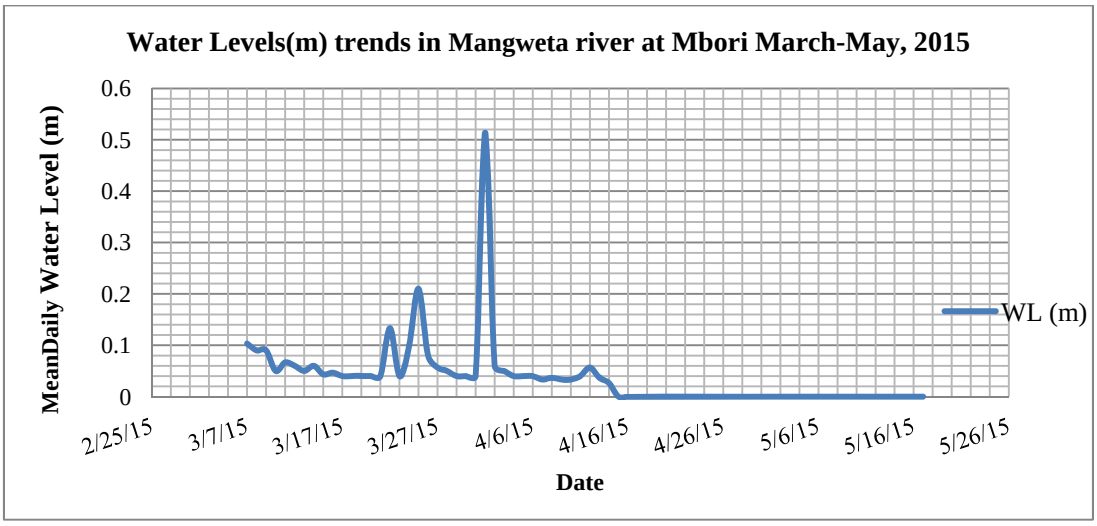


Figure P.23: Water Level at Mbori in the Mangweta River

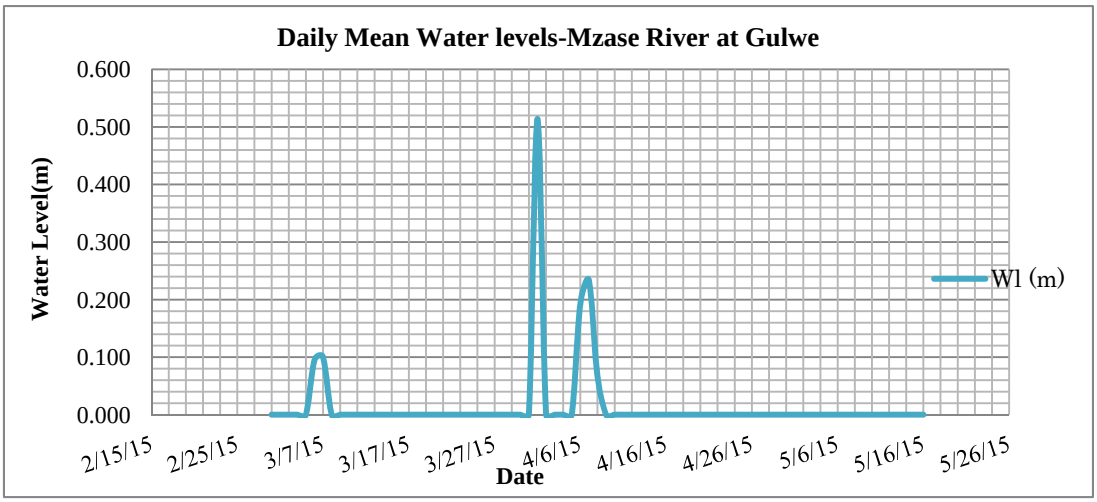


Figure P.24: Water Level at Gulwe in the Mzase River

(5) Monitoring of Water Levels by Staff Gauges

The water levels at every gauging station were managed and recorded daily at the intervals of 0600 hrs, 1200 hrs and 1800 hrs respectively by selected trained local observer.

(6) Location of Suspended Load Sampling

This site is located at Kongwa of the Kinyasungwe River. In this site, two samples were taken on the left side and middle of the river since at the right part of the river there was no water (Date: 10 March 2015).

Figure P.25: Sampling at Kongwa the Kinyasungwe River

This site is located at Gulwe of the Kinyasungwe River. In this site, three samples were taken on the left, middle and right side of the river (Date: 11 March 2015).

Figure P.26: Sampling at Gulwe of the Kinyasungwe River

This site is located at Kidete of the Lumuma River. In this site, only one sample was taken because on that day there was little water in the River (Date: 11 March 2015).


Figure P.27: Sampling at Kidete of the Lumuma River

This site is located at Kilosa of the Mkondoa River. In this site, three samples were taken on the left, middle and right side of the river (Date: 12 March 2015).


Figure P.28: Sampling at Kilosa of the Mkondoa River

This site is located at Mbori of the Mangweta River. In this site, three samples were taken on the left, middle and right side of the river (Date: 13 March 2015).

Figure P.29: Sampling at Mbori of the Mangweta River

P.4.4 Laboratory Test of Sampled Material

(1) Laboratory procedures

Laboratory procedures were as follows;

- Filtration of water samples for suspended solids was done by using an electrical
- Total Suspended Solids (TSS) operated vacuum pressure-pump fitted with glass fiber 0.45μm diameter membrane filters which were initially treated in the oven at 70°C for 24 hours. Before being used the original weight in grams of the filter membranes were taken by using a sensitive balance and then recorded. 500 ml of water sample was

filtered, and then the wet filters were dried in an oven at 103°C–105°C for 1 hour. The weights in grams of the filters with dried residue were noted.

(2) Calculations

After the laboratory analysis, the amount of suspended solids in each sample was calculated using the formula;

$$\text{Suspended solids} = \frac{[F_R\,(g) - F_E\,(g)\ ] * 1000}{\text{Sample volume (ml)}} \quad (g/l)$$

Where;
F_R = weight of filter with dry residue in (g)
F_E = dry weight of filter in (mg)

(3) Sieving and Hydrometer Analysis

Hydrometer Bouyoucos method was used for sediments/soils. Part of the sediment was separated into various size fractions and the proportion of these fractions was determined. Theoretically, the particles are assumed to be spherical having a specific gravity of 2.65 g/cm^3.

If all other factors are constant, then the settling velocity is proportional to the square of the radius of the particle. The determination comprises all material, i.e. including gravel and coarser material, but the procedure itself is applied to the fine earth (< 2 mm) only.

The sample was shaken with a dispersing agent (calgon) and sand is separated from clay and silt with a 63-μm sieve. The clay and silt fractions are determined by the hydrometer method. And sand fractions are separated by sieving method as described by standard procedure in attachment. (See Table P.10)

Table P.10: Summary of the samples taken during low and high flow TSS

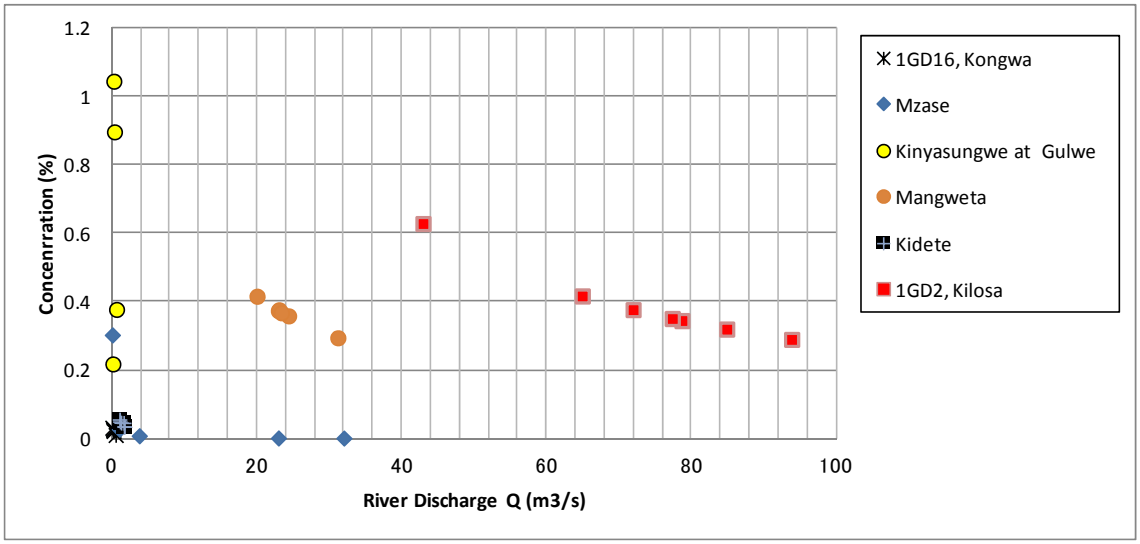
No:	Descriptions of Stations	Sample Taken (Low Flow)	Sample Taken (High Flow)
1	Kinyasungwe/Gulwe	4	15
2	Lumuma/Kidete	1	21
3	Mangweta/Mbori	3	18
4	Kinyasungwe/Kongwa	3	18
5	Mkondoa/Kilosa	3	21
6	Mzase/Gulwe	0	18
	Sub-Total Samples No.	14	111
	Grand Total No.	125 (More than 29 samples collected) in low and high flow	

Total proposed samples (Low and High) flow was 96 but actual collected was 125 samples and analyzed in laboratory of Sokoine University of Agriculture-Morogoro (See Table P.13 to Talbe P.18).

(4) River Discharge and Concentration

Relationship between river discharge and sediment concentration is as shown in Figure P.31 and Table P.11. But, abnormal value, which is a data of 3 May 2015 of the Kinyasungwe at Gulwe, is excluded.

According to Figure P.31, the increase of concentration which is caused by the increase of the river discharge is not observed.



Source: JICA Study Team

Figure P.30: River Discharge and Sediment Concentration

Table P.11: River Discharge and Sediment Concentration

River	Date	Q (m^3/s)	TSS(Max) (g/L)	Sediment Concentration (cm^3/L 1))	Sediment Concentration (%)
1GD16, Kongwa	30/3/2015	0.20	0.70	0.26	0.026
	31/3/2015	0.22	0.64	0.24	0.024
	4/4/2015	0.20	0.74	0.28	0.028
	6/4/2015	0.09	0.82	0.31	0.031
	12/4/2015	0.26	0.57	0.22	0.022
	3/5/2015	0.56	0.26	0.10	0.010
Mzase	5/4/2015	23.02	0.03	0.01	0.001
	6/4/2015	32.05	0.02	0.01	0.001
	12/4/2015	1.08	0.71	0.27	0.027
	13/4/2015-1	3.81	0.20	0.08	0.008
	13/4/2016-2	0.10	8.02	3.03	0.303
Kinyasungwe at Gulwe	13/4/2015	0.67	10.00	3.77	0.377
	11/4/2015	0.39	23.77	8.97	0.897
	12/4/2015	0.16	5.77	2.18	0.218
	20/4/2015	0.30	27.70	10.45	1.045
Mangweta	31/3/2015	23.01	9.90	3.74	0.374
	1/4/2015	23.09	9.97	3.76	0.376
	3/4/2015	24.42	9.50	3.58	0.358
	11/4/2015	31.22	7.80	2.94	0.294
	12/4/2015	23.42	9.74	3.68	0.368
	13/4/2015	20.06	11.02	4.16	0.416
Kidete	30/3/2015	1.76	0.90	0.34	0.034
	31/3/2015	1.71	0.93	0.35	0.035
	1/4/2015	1.66	1.20	0.45	0.045
	2/4/2015	1.31	1.21	0.46	0.046
	11/4/2015-1	1.14	1.30	0.49	0.049
	12/4/2015	1.09	1.46	0.55	0.055
1GD2, Kilosa	25/3/2015	78.82	9.07	3.42	0.342
	26/3/2015-1	77.49	9.23	3.48	0.348
	26/3/2015-2	85.00	8.41	3.17	0.317
	27/3/2015	93.96	7.61	2.87	0.287
	30/3/2015	72.09	9.92	3.74	0.374
	11/4/2015	43.08	16.60	6.26	0.626
	3/5/2015	65.06	10.98	4.14	0.414

1) Rock Density (g/cm^3) 2.65

Table P.12: TSS Results during Low Flow and High Flow

SOKOINE UNIVERSITY OF GRICULTURE
FACULTY OF AGRICULTURE
DEPARTMENT OF SOIL SCIENCE
WATER ANALYSIS DATA SHEET
Date 22-04-15

NAME OF CLIENT: JICA study Team
NAME OF THE PROJECT: Detailed engineering design of permanent solution for flood-prone railway corridor and recommend control and mitigation measures between Kilosa – Gulwe along the central railway line
Parameter : Total Suspended Solids

S.	FIELD REF			total	wt fp	wtfp + sed	wt sed	TSS	TSS
LAB NOS			DATE	ml	g	g	g	g/ml	g/L
S/72/2015	C	MIDDLE		500	0.129	0.442	0.313	0.00063	0.626
73	GULINE MN STR,MIDDLE	MIDDLE	11-03-15	500	0.133	0.158	0.025	0.00005	0.050
74	LUMUMA MN STR,MIDDLE		11-03-15	500	0.127	0.346	0.219	0.00044	0.438
75	MANGWETA AT MBORI TSS RB	RIGHT	13-03-15	500	0.126	0.699	0.573	0.00115	1.146
76	GULWE MN STR		11-03-15	500	0.128	0.172	0.044	0.00009	0.088
77	KINYASUNGWE AT LEFT BANK EDGE			500	0.131	0.177	0.046	0.00009	0.092
78	C			500	0.13	0.674	0.544	0.00109	1.088
79	MANGWETA AT MBORI TSS LB	LB	13-03-15	500	0.128	2.607	2.479	0.00496	4.958
80	MKONDOA AT KILOSA RIGHT	RIGHT	12-03-15	500	0.126	2.021	1.895	0.00379	3.790
81	GULWE MN STR LEFT	LEFT	11-03-15	500	0.13	0.229	0.099	0.00020	0.198
82	MKONDOA AT KILOSA MDDLE	LEFT	12-03-15	500	0.128	0.511	0.383	0.00077	0.766
83	MKONDOA AT KILOSA LEFT	LEFT	12-03-15	500	0.128	0.187	0.059	0.00012	0.118
84	KINYASUNGWE AT KONGA MIDDLE	MIDDLE	10-03-15	500	0.133	0.142	0.009	0.00002	0.018
85	MANGWETA AT MBORI TSS MIDDLE	MIDDLE	13-03-15	500	0.135	0.160	0.025	0.00005	0.050

DEPARTMENT OF SOIL SCIENCE
SOKOINE UNIVERSITY OF AGRICULTURE
P. O. BOX 3008
MOROGORO

Table P.13: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Kinyasugwe at Kongwa	NOS	ml	g	g	g	g/ml	g/L	mg/L
30/3/15	M	W/201/2015	500	0.123	0.438	0.315	0.00063	0.630	630.000
	L	202	500	0.126	0.426	0.300	0.00060	0.600	600.000
	R	203	500	0.123	0.473	0.350	0.00070	0.700	700.000
31/3/15	M	204	500	0.123	0.408	0.285	0.00057	0.570	570.000
	L	205	500	0.123	0.398	0.275	0.00055	0.550	550.000
	R	206	500	0.125	0.445	0.320	0.00064	0.640	640.000
4/4/15	M	207	500	0.123	0.453	0.330	0.00066	0.660	660.000
	L	208	500	0.123	0.438	0.315	0.00063	0.630	630.000
	R	209	500	0.123	0.493	0.370	0.00074	0.740	740.000
6/4/15	M	210	500	0.123	0.488	0.365	0.00073	0.730	730.000
	L	211	500	0.125	0.475	0.350	0.00070	0.700	700.000
	R	212	500	0.125	0.535	0.410	0.00082	0.820	820.000
12/4/15	M	213	500	0.123	0.378	0.255	0.00051	0.510	510.000
	L	214	500	0.123	0.363	0.240	0.00048	0.480	480.000
	R	215	500	0.123	0.408	0.285	0.00057	0.570	570.000
3/5/15	M	216	500	0.123	0.243	0.120	0.00024	0.240	240.000
	L	217	500	0.123	0.238	0.115	0.00023	0.230	230.000
	R	218	500	0.123	0.253	0.130	0.00026	0.260	260.000

Table P.14: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Mzase at Gulwe	NOS	ml	g	g	g	g/ml	g/L	mg/L
5/4/15	R	W/219/15	500	0.124	0.139	0.015	0.00003	0.030	30.000
	L	220	500	0.121	0.136	0.015	0.00003	0.030	30.000
	M	221	500	0.125	0.140	0.015	0.00003	0.030	30.000
6/4/15	R	222	500	0.123	0.133	0.010	0.00002	0.020	20.000
	L	223	500	0.123	0.133	0.010	0.00002	0.020	20.000
	M	224	500	0.124	0.134	0.010	0.00002	0.020	20.000
11/4/15	R	225	500	0.123	0.123	0.000	0.00000	0.000	0.000
	L	226	500	0.123	0.123	0.000	0.00000	0.000	0.000
	M	227	500	0.126	0.126	0.000	0.00000	0.000	0.000
12/4/15	R	228	500	0.125	0.450	0.325	0.00065	0.650	650.000
	L	229	500	0.123	0.488	0.365	0.00073	0.730	730.000
	M	230	500	0.123	0.478	0.355	0.00071	0.710	710.000
13/4/15	R	231	500	0.124	0.214	0.090	0.00018	0.180	180.000
	L	232	500	0.123	0.228	0.105	0.00021	0.210	210.000
	M	233	500	0.124	0.224	0.100	0.00020	0.200	200.000
14/4/15	R	234	500	0.125	3.805	3.680	0.00736	7.360	7360.000
	L	235	500	0.124	4.244	4.120	0.00824	8.240	8240.000
	M	236	500	0.123	4.133	4.010	0.00802	8.020	8020.000

Table P.15: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Lumuma at Kidete	NOS	ml	g	g	g	g/ml	g/L	mg/L
30/3/15	R	W/237/15	500	0.123	0.573	0.450	0.00090	0.900	900.000
	L	238	500	0.123	0.573	0.450	0.00090	0.900	900.000
	M	239	500	0.123	0.573	0.450	0.00090	0.900	900.000
31/3/15	R	240	500	0.126	0.591	0.465	0.00093	0.930	930.000
	L	241	500	0.123	0.588	0.465	0.00093	0.930	930.000
	M	242	500	0.123	0.588	0.465	0.00093	0.930	930.000
1/4/15	R	243	500	0.123	0.723	0.600	0.00120	1.200	1200.000
	L	244	500	0.124	0.724	0.600	0.00120	1.200	1200.000
	M	245	500	0.123	0.723	0.600	0.00120	1.200	1200.000
2/4/15	R	246	500	0.125	0.730	0.605	0.00121	1.210	1210.000
	L	247	500	0.125	0.730	0.605	0.00121	1.210	1210.000
	M	248	500	0.125	0.730	0.605	0.00121	1.210	1210.000
11/4/15	R	249	500	0.123	0.818	0.695	0.00139	1.390	1390.000
	L	250	500	0.123	0.818	0.695	0.00139	1.390	1390.000
	M	251	500	0.122	0.817	0.695	0.00139	1.390	1390.000
12/4/15	R	252	500	0.122	0.852	0.730	0.00146	1.460	1460.000
	L	253	500	0.123	0.853	0.730	0.00146	1.460	1460.000
	M	254	500	0.125	0.855	0.730	0.00146	1.460	1460.000
3/5/15	R	255	500	0.124	0.125	0.001	0.00000	0.000	0.000
	L	256	500	0.123	0.124	0.001	0.00000	0.000	0.000
	M	257	500	0.123	0.124	0.001	0.00000	0.000	0.000

Table P.16: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Mangweta at Mbori	NOS	ml	g	g	g	g/ml	g/L	mg/L
31/3/15	R	W/258/15	500	0.124	1.274	1.150	0.00230	2.300	2300.000
	L	259	500	0.123	5.073	4.950	0.00990	9.900	9900.000
	M	260	500	0.125	0.175	0.050	0.00010	0.100	100.000
1/4/15	R	261	500	0.124	1.284	1.160	0.00232	2.320	2320.000
	L	262	500	0.124	5.109	4.985	0.00997	9.970	9970.000
	M	263	500	0.124	0.174	0.050	0.00010	0.100	100.000
3/4/15	R	264	500	0.123	1.228	1.105	0.00221	2.210	2210.000
	L	265	500	0.123	4.873	4.750	0.00950	9.500	9500.000
	M	266	500	0.124	0.164	0.040	0.00008	0.080	80.000
11/4/15	R	267	500	0.126	1.031	0.905	0.00181	1.810	1810.000
	L	268	500	0.123	4.023	3.900	0.00780	7.800	7800.000
	M	269	500	0.124	0.164	0.040	0.00008	0.080	80.000
12/4/15	R	270	500	0.123	1.253	1.130	0.00226	2.260	2260.000
	L	271	500	0.123	4.993	4.870	0.00974	9.740	9740.000
	M	272	500	0.124	0.174	0.050	0.00010	0.100	100.000
13/4/15	R	273	500	0.125	1.405	1.280	0.00256	2.560	2560.000
	L	274	500	0.123	5.633	5.510	0.01102	11.020	11020.000
	M	275	500	0.124	0.179	0.055	0.00011	0.110	110.000

Table P.17: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Mkondoa at Kilosa	NOS	ml	g	g	g	g/ml	g/L	mg/L
25/3/15	R	W/27615	500	0.124	4.659	4.535	0.00907	9.070	9070.000
	M	277	500	0.125	4.140	4.015	0.00803	8.030	8030.000
	L	278	500	0.125	2.475	2.350	0.00470	4.700	4700.000
26/3/15	R	279	500	0.125	4.740	4.615	0.00923	9.230	9230.000
	M	280	500	0.123	4.208	4.085	0.00817	8.170	8170.000
	L	281	500	0.122	2.482	2.360	0.00472	4.720	4720.000
26/3/15	R	282	500	0.123	4.328	4.205	0.00841	8.410	8410.000
	M	283	500	0.123	3.848	3.725	0.00745	7.450	7450.000
	L	284	500	0.124	2.304	2.180	0.00436	4.360	4360.000
27/3/15	R	285	500	0.123	3.928	3.805	0.00761	7.610	7610.000
	M	286	500	0.124	3.494	3.370	0.00674	6.740	6740.000
	L	287	500	0.122	2.092	1.970	0.00394	3.940	3940.000
30/3/15	R	288	500	0.122	5.082	4.960	0.00992	9.920	9920.000
	M	289	500	0.125	4.515	4.390	0.00878	8.780	8780.000
	L	290	500	0.123	2.693	2.570	0.00514	5.140	5140.000
11/4/15	R	291	500	0.123	8.423	8.300	0.01660	16.600	16600.000
	M	292	500	0.124	7.474	7.350	0.01470	14.700	14700.000
	L	293	500	0.123	4.423	4.300	0.00860	8.600	8600.000
3/5/15	R	294	500	0.124	5.614	5.490	0.01098	10.980	10980.000
	M	295	500	0.122	4.982	4.860	0.00972	9.720	9720.000
	L	296	500	0.122	2.967	2.845	0.00569	5.690	5690.000

Table P.18: TSS Data Sheet

Date	FIELD REF	LAB	total	wt fp	wtfp + sed	wt sed	TSS	TSS	TSS
	Kinyasungwe at Gulwe	NOS	ml	g	g	g	g/ml	g/L	mg/L
11/4/15	M	297	500	0.126	5.126	5.000	0.01000	10.000	10000.000
	L	298	500	0.126	0.326	0.200	0.00040	0.400	400.000
	R	299	500	0.125	0.225	0.100	0.00020	0.200	200.000
12/4/15	M	300	500	0.125	12.010	11.885	0.02377	23.770	23770.000
	L	301	500	0.125	4.880	4.755	0.00951	9.510	9510.000
	R	302	500	0.126	2.501	2.375	0.00475	4.750	4750.000
13/4/15	M	303	500	0.123	3.008	2.885	0.00577	5.770	5770.000
	L	304	500	0.122	1.277	1.155	0.00231	2.310	2310.000
	R	305	500	0.123	0.698	0.575	0.00115	1.150	1150.000
20/4/15	M	306	500	0.125	13.975	13.850	0.02770	27.700	27700.000
	L	307	500	0.125	5.665	5.540	0.01108	11.080	11080.000
	R	308	500	0.123	2.893	2.770	0.00554	5.540	5540.000
30/4/15	M	309							
	L	310							
	R	311							
3/5/15	M	312	500	0.125	52.443	52.318	0.09026	90.263	90263.000
	L	313	500	0.125	40.650	40.525	0.08105	81.050	81050.000
	R	314	500	0.123	20.388	20.265	0.04053	40.530	40530.000

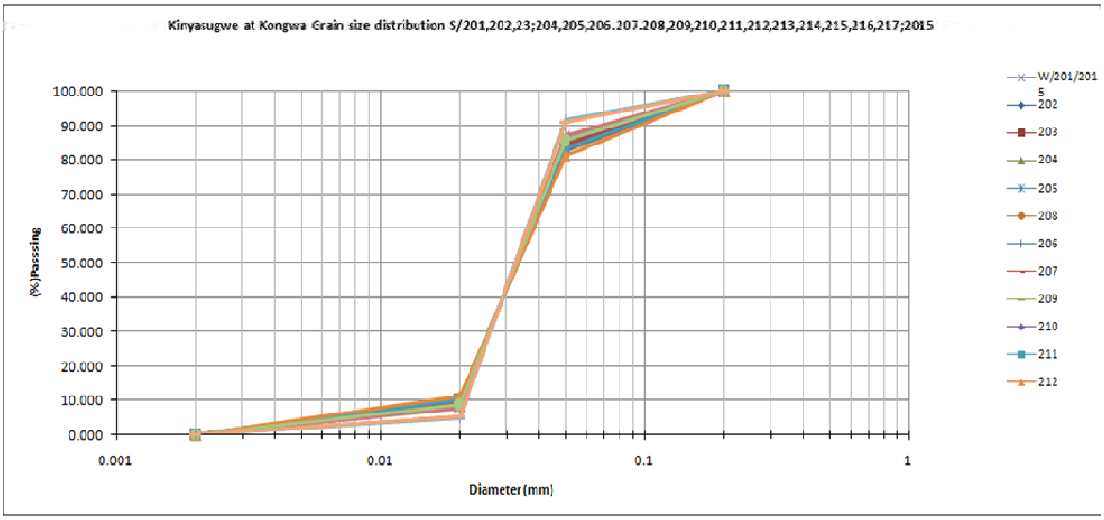


Figure P.31: Grain Size Distribution Analysis Graphs (Kinyasungwe/Kongwa)

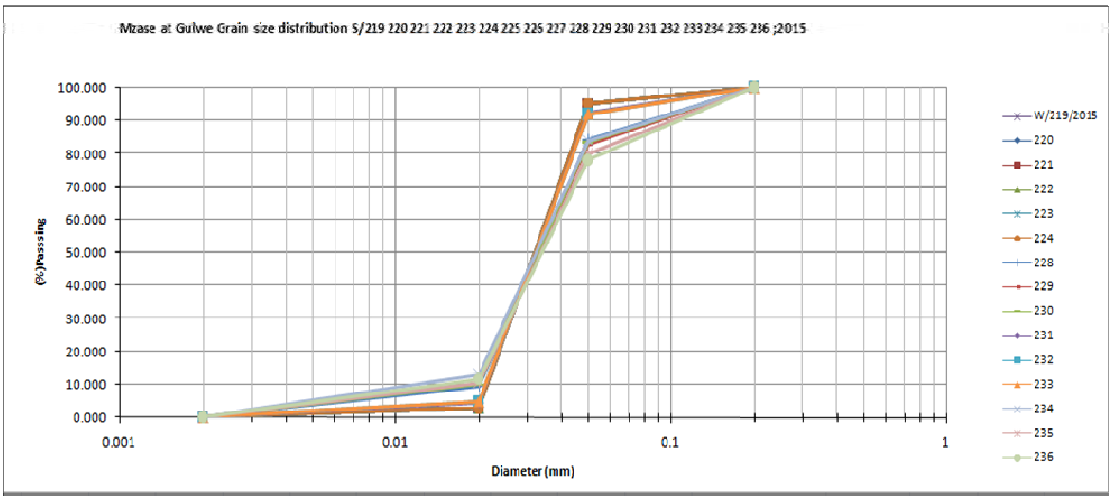


Figure P.32: Grain Size Distribution Analysis Graphs (Mzase/Gulwe)

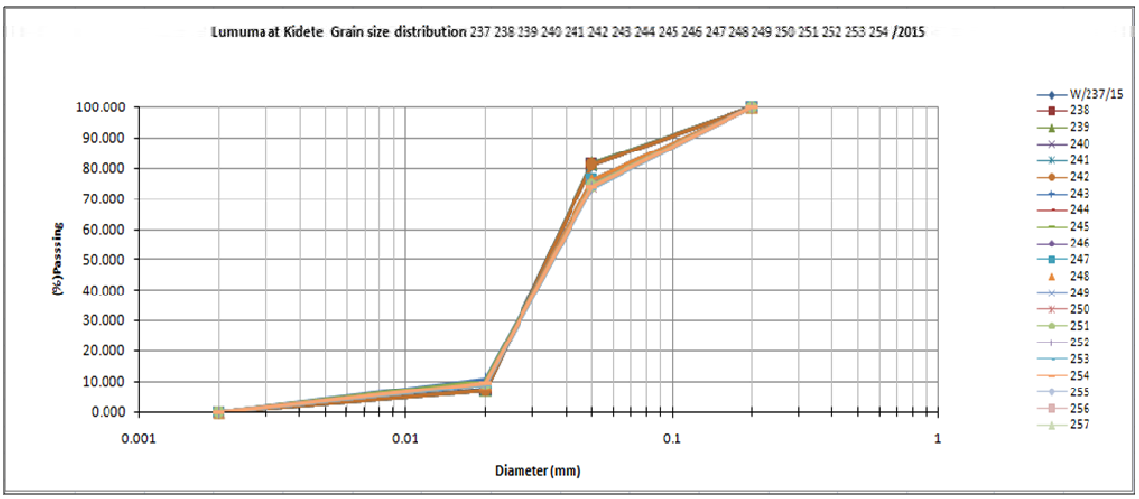


Figure P.33: Grain Size Distribution Analysis Graphs (Lumuma/Kidete)

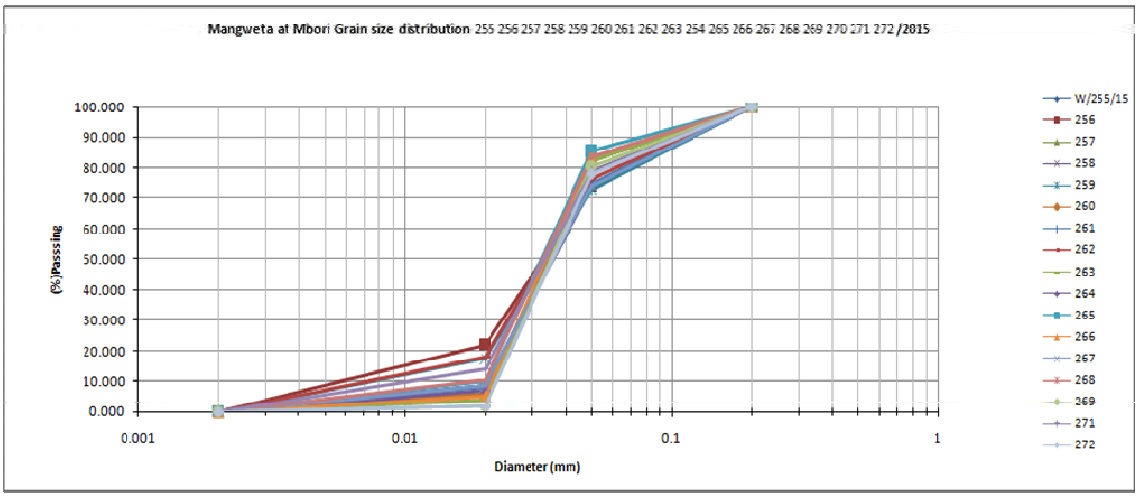


Figure P.34: Grain Size Distribution Analysis Graphs (Mangweta/Mbori)

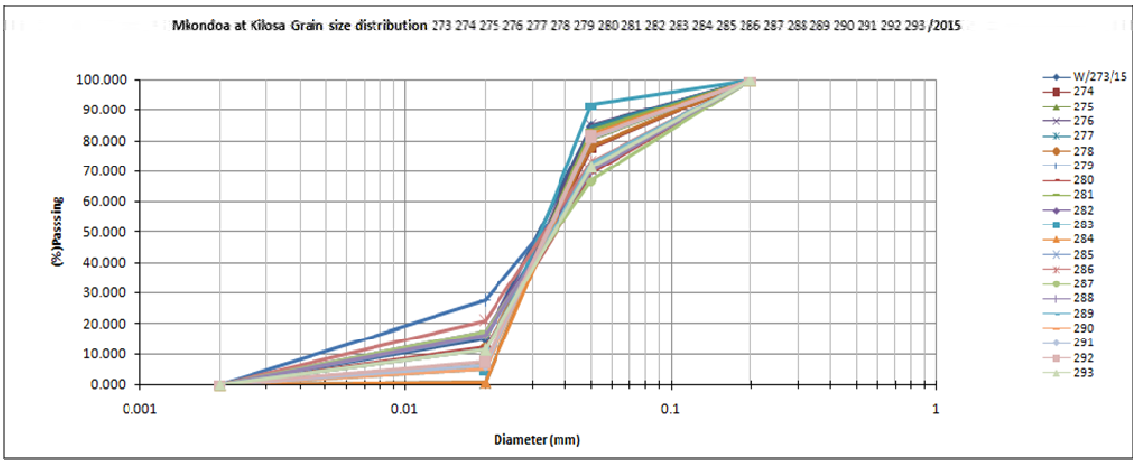


Figure P.35: Grain Size Distribution Analysis Graphs (Mkondoa/Kilosa)

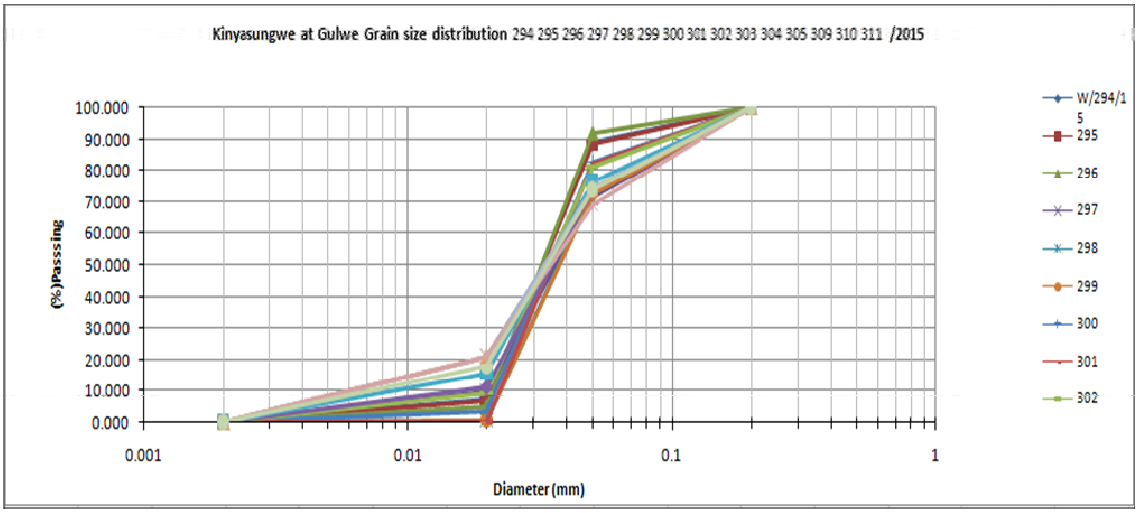


Figure P.36: Grain Size Distribution Analysis Graphs (Kinyasungwe/Gulwe)

Appendix 1: Discharge Floats Sheet at Mangweta

DISCHARGE CALCULATION FORM

(USING FLOAT METHOD)

Station Name		Date:	31 March 2015				Weather		Computed by:		FT
Mangweta		Start Time:	8:50	AM	Obs. Duration		Cloudy				
Observers:		End Time:	9:12	AM	0:22	hr			Checked by:		TL, JK
		Start WL:	0.04	m	Start Width:		32.60	m			
		End WL:	0.04	m	End Width:		32.40	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.20	m			
		Average WL:	0.04	m	Average Width:		32.50	m			

No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.0	1	19	2.11	1.943	0.850	1.651	4.710	4.970	4.840	7.992
		2	21	1.90							
		3	22	1.82							
2	18.0	1	22	1.82	1.741	0.850	1.480	4.930	5.120	5.025	7.438
		2	24	1.67							
		3	23	1.74							
3	27.0	1	22	1.82	1.818	0.850	1.545	4.454	5.350	4.902	7.576
		2	22	1.82			1.559				
		3	22	1.82							
						Total		14.094	15.440	14.767	23.006

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	1 April 2015				Weather		Computed by:		FT
Mangweta		Start Time:	9:30	AM	Obs. Duration		Cloudy				
Observers:		End Time:	9:42	AM	0:12	hr			Checked by:		TL, JK
		Start WL:	0.04	m	Start Width:		32.60	m			
		End WL:	0.04	m	End Width:		32.60	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.04	m	Average Width:		32.60	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.0	1	24	1.67	1.768	0.850	1.503	4.910	4.970	4.940	7.422
		2	22	1.82							
		3	22	1.82							
2	18.0	1	22	1.82	1.741	0.850	1.480	4.930	5.120	5.025	7.438
		2	24	1.67							
		3	23	1.74							
3	27.0	1	21	1.90	1.937	0.850	1.646	4.654	5.350	5.002	8.233
		2	20	2.00			1.543				
		3	21	1.90							
						Total		14.494	15.440	14.967	23.094

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	3 April 2015				Weather		Computed by:		FT
Mangweta		Start Time:	13:24	AM	Obs. Duration		Cloudy				
Observers:		End Time:	13:42	AM	0:18	hr			Checked by:		TL, JK
		Start WL:	0.04	m	Start Width:		32.50	m			
		End WL:	0.04	m	End Width:		32.50	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.04	m	Average Width:		32.50	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.0	1	19	2.11	1.943	0.850	1.651	4.610	5.560	5.085	8.397
		2	21	1.90							
		3	22	1.82							
2	18.0	1	22	1.82	1.741	0.850	1.480	4.930	5.750	5.340	7.904
		2	24	1.67							
		3	23	1.74							
3	27.0	1	22	1.82	1.818	0.850	1.545	5.141	5.360	5.251	8.114
		2	22	1.82			1.559				
		3	22	1.82							
						Total		14.681	16.670	15.676	24.415

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	11 April 2015				Weather		Computed by:		FT
Mangweta		Start Time:	7:43	AM	Obs. Duration		Cloudy				
Observers:		End Time:	7:53	AM	0:10	hr			Checked by:		TL, JK
		Start WL:	0.08	m	Start Width:		33.00	m			
		End WL:	0.08	m	End Width:		33.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.08	m	Average Width:		33.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.0	1	19	2.11	2.038	0.850	1.733	6.125	6.200	6.163	10.678
		2	19	2.11							
		3	21	1.90							
2	21.0	1	22	1.82	1.847	0.850	1.570	6.500	6.650	6.575	10.323
		2	21	1.90							
		3	22	1.82							
3	30.0	1	21	1.90	1.972	0.850	1.676	6.090	6.100	6.095	10.214
		2	21	1.90			1.660				
		3	19	2.11							
						Total		18.715	18.950	18.833	31.215

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	12 April 2015				Weather		Computed by:		FT
Mangweta		Start Time:	8:32	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:46	AM	0:14	hr			Checked by:		TL, JK
		Start WL:	0.04	m	Start Width:		32.50	m			
		End WL:	0.04	m	End Width:		32.50	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.04	m	Average Width:		32.50	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.2	1	22	1.82	1.943	0.850	1.651	4.730	4.970	4.850	8.009
		2	21	1.90							
		3	19	2.11							
2	18.0	1	23	1.74	1.765	0.850	1.501	5.000	5.120	5.060	7.593
		2	22	1.82							
		3	23	1.74							
3	27.0	1	23	1.74	1.792	0.850	1.523	4.910	5.350	5.130	7.813
		2	22	1.82			1.558				
		3	22	1.82							
						Total		14.640	15.440	15.040	23.416

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	13 April 2015				Weather		Computed by:		FT
Mangweta		Start Time:	8:10	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:29	AM	0:19	hr			Checked by:		TL, JK
		Start WL:	0.03	m	Start Width:		32.00	m			
		End WL:	0.03	m	End Width:		32.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.03	m	Average Width:		32.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.5	1	24	1.67	1.691	0.850	1.437	4.200	4.600	4.400	6.324
		2	23	1.74							
		3	24	1.67							
2	19.0	1	23	1.74	1.741	0.850	1.480	4.900	4.900	4.900	7.253
		2	22	1.82							
		3	24	1.67							
3	28.0	1	22	1.82	1.695	0.850	1.441	4.300	4.700	4.500	6.483
		2	25	1.60			1.453				
		3	24	1.67							
						Total		13.400	14.200	13.800	20.059

Appendix 2: Discharge Float Sheet at Mzase

DISCHARGE CALCULATION FORM												
(USING FLOAT METHOD)												
Station Name		Date:	5 April 2015				Weather		Computed by:		FT	
Mzase		Start Time:	7:25	AM	Obs. Duration		Cloudy					
Observers:		End Time:	7:33	AM	0:08	hr			Checked by:		TL, JK	
		Start WL:	0.70	m	Start Width:		36.00	m				
		End WL:	0.68	m	End Width:		36.00	m	Approved by:		MS	
		Diff.:	0.02	m	Diff.:		0.00	m				
		Average WL:	0.69	m	Average Width:		36.00	m				
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange		Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)		Upstream section	Downstream section	Average	
1	9.0	1	20	2.00	1.908	0.850	1.622		4.750	4.972	4.861	7.882
		2	21	1.90								
		3	22	1.82								
2	18.0	1	22	1.82	1.741	0.850	1.480		6.100	5.110	5.605	8.296
		2	24	1.67								
		3	23	1.74								
3	27.0	1	22	1.82	1.818	0.850	1.545		4.000	4.850	4.425	6.839
		2	22	1.82			1.549					
		3	22	1.82								
						Total			14.850	14.932	14.891	23.017

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	6 April 2015				Weather		Computed by:		FT
Mzase		Start Time:	12:00	AM	Obs. Duration		Cloudy				
Observers:		End Time:	12:20	AM	0:20	hr			Checked by:		TL, JK
		Start WL:	0.12	m	Start Width:		37.00	m			
		End WL:	0.12	m	End Width:		37.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.12	m	Average Width:		37.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		40.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	9.3	1	19	2.11	2.003	0.850	1.703	5.980	5.916	5.948	10.128
		2	21	1.90							
		3	20	2.00							
2	18.5	1	19	2.11	2.038	0.850	1.733	6.650	6.250	6.450	11.176
		2	21	1.90							
		3	19	2.11							
3	27.8	1	20	2.00	1.857	0.850	1.579	6.630	6.990	6.810	10.750
		2	21	1.90			1.671				
		3	24	1.67							
						Total		19.260	19.156	19.208	32.054

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	12 April 2015				Weather		Computed by:		FT
Mzase		Start Time:	8:10	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:21	AM	0:11	hr			Checked by:		TL, JK
		Start WL:	0.10	m	Start Width:		28.00	m			
		End WL:	0.10	m	End Width:		28.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.10	m	Average Width:		28.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		30.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.0	1	30	1.00	1.023	0.850	0.870	0.510	0.490	0.500	0.435
		2	29	1.03							
		3	29	1.03							
2	19.0	1	30	1.00	1.001	0.850	0.851	0.052	0.500	0.276	0.235
		2	29	1.03							
		3	31	0.97							
3	30.0	1	27	1.11	1.049	0.850	0.891	0.450	0.460	0.455	0.406
		2	29	1.03			0.870				
		3	30	1.00							
						Total		1.012	1.450	1.231	1.075

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	13April 2015				Weather		Computed by:		FT
Mzase		Start Time:	6:45	AM	Obs. Duration		Cloudy				
Observers:		End Time:	6:55	AM	0:10	hr			Checked by:		TL, JK
		Start WL:	0.20	m	Start Width:		35.00	m			
		End WL:	0.20	m	End Width:		35.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.20	m	Average Width:		35.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		30.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.0	1	29	1.03	1.072	0.850	0.911	1.300	1.450	1.375	1.253
		2	27	1.11							
		3	28	1.07							
2	20.0	1	29	1.03	1.059	0.850	0.900	1.520	1.500	1.510	1.359
		2	28	1.07							
		3	28	1.07							
3	30.0	1	30	1.00	1.023	0.850	0.870	1.400	1.350	1.375	1.196
		2	29	1.03			0.894				
		3	29	1.03							
						Total		4.220	4.300	4.260	3.808

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	13 April 2015				Weather		Computed by:		FT
Mzase		Start Time:	13:00	PM	Obs. Duration		Cloudy				
Observers:		End Time:	13:06	PM	0:06	hr			Checked by:		TL, JK
		Start WL:	0.02	m	Start Width:		3.80	m			
		End WL:	0.02	m	End Width:		3.80	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.02	m	Average Width:		3.80	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		10.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.5	1	40	0.25	0.257	0.850	0.218	0.140	0.130	0.135	0.029
		2	39	0.26							
		3	38	0.26							
2	3.0	1	34	0.29	0.303	0.850	0.258	0.130	0.140	0.135	0.035
		2	32	0.31							
		3	33	0.30							
3	4.0	1	35	0.29	0.280	0.850	0.238	0.132	0.129	0.131	0.031
		2	36	0.28			0.238				
		3	36	0.28							
						Total		0.402	0.399	0.401	0.095

Appendix 3: Discharge Float Sheet at Kongwa 1GD16

DISCHARGE CALCULATION FORM											
Station Name		Date:	30 March 2015				Weather		Computed by:		FT
1GD16, Kongwa		Start Time:	10:40	AM	Obs. Duration		Cloudy				
Observers:		End Time:	11:06	AM	0:26	hr			Checked by:		TL, JK
		Start WL:	0.38	m	Start Width:		4.80	m			
		End WL:	0.38	m	End Width:		4.80	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.38	m	Average Width:		4.80	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	39	0.13	0.132	0.850	0.112	0.520	0.560	0.540	0.060
		2	37	0.14							
		3	38	0.13							
2	2.4	1	32	0.16	0.176	0.850	0.149	0.670	0.580	0.625	0.093
		2	26	0.19							
		3	28	0.18							
3	3.6	1	38	0.13	0.134	0.850	0.114	0.455	0.420	0.438	0.050
		2	37	0.14			0.125				
		3	37	0.14							
						Total		1.645	1.560	1.603	0.204

DISCHARGE CALCULATION FORM											
Station Name		Date:	31 March 2015				Weather		Computed by:		FT
1GD16, Kongwa		Start Time:	16:36	PM	Obs. Duration		Cloudy				
Observers:		End Time:	17:00	PM	0:24	hr			Checked by:		TL, JK
		Start WL:	0.38	m	Start Width:		4.80	m			
		End WL:	0.38	m	End Width:		4.80	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.38	m	Average Width:		4.80	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	34	0.15	0.152	0.850	0.129	0.520	0.560	0.540	0.070
		2	33	0.15							
		3	32	0.16							
2	2.4	1	30	0.17	0.175	0.850	0.149	0.670	0.580	0.625	0.093
		2	27	0.19							
		3	29	0.17							
3	3.6	1	30	0.17	0.163	0.850	0.139	0.450	0.430	0.440	0.061
		2	32	0.16			0.139				
		3	30	0.17							
						Total		1.640	1.570	1.605	0.223

DISCHARGE CALCULATION FORM											
Station Name		Date:	4 April 2015				Weather		Computed by:		FT
1GD16, Kongwa		Start Time:	8:49	AM	Obs. Duration		Cloudy				
Observers:		End Time:	9:13	AM	0:24	hr			Checked by:		TL, JK
		Start WL:	0.38	m	Start Width:		4.80	m			
		End WL:	0.38	m	End Width:		4.80	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.38	m	Average Width:		4.80	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	37	0.14	0.134	0.850	0.114	0.520	0.510	0.515	0.059
		2	36	0.14							
		3	39	0.13							
2	2.4	1	33	0.15	0.170	0.850	0.144	0.670	0.480	0.575	0.083
		2	28	0.18							
		3	28	0.18							
3	3.6	1	36	0.14	0.139	0.850	0.118	0.450	0.540	0.495	0.058
		2	35	0.14							
		3	37	0.14							
						Total		**1.640**	**1.530**	**1.585**	**0.200**

DISCHARGE CALCULATION FORM											
Station Name		Date:	6 April 2015				Weather		Computed by:		
1GD16, Kongwa		Start Time:	8:20	AM	Obs. Duration		Cloudy				FT
Observers:		End Time:	8:40	AM	0:20	hr			Checked by:		
		Start WL:	0.37	m	Start Width:		4.80	m			TL, JK
		End WL:	0.37	m	End Width:		4.80	m	Approved by:		
		Diff.:	0.00	m	Diff.:		4.80	m			MS
		Average WL:	0.37	m	Average Width:		4.80	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	80	0.06	0.059	0.850	0.050	0.550	0.420	0.485	0.024
		2	85	0.06							
		3	89	0.06							
2	2.4	1	89	0.06	0.056	0.850	0.048	0.680	0.510	0.595	0.028
		2	97	0.05							
		3	82	0.06							
3	3.6	1	81	0.06	0.060	0.850	0.051	0.780	0.480	0.630	0.032
		2	86	0.06							
		3	82	0.06							
						Total		2.010	1.410	1.710	0.085

DISCHARGE CALCULATION FORM											
Station Name		Date:	12-Apr-15				Weather		Computed by:		FT
1GD16, Kongwa		Start Time:	9:21	AM	Obs. Duration		Cloudy				
Observers:		End Time:	9:33	AM	0:12	hr			Checked by:		TL, JK
		Start WL:	0.60	m	Start Width:		7.00	m			
		End WL:	0.60	m	End Width:		7.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.60	m	Average Width:		7.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	30	0.17	0.173	0.850	0.147	0.560	0.570	0.565	0.083
		2	29	0.17							
		3	28	0.18							
2	2.4	1	30	0.17	0.173	0.850	0.147	0.600	0.580	0.590	0.087
		2	29	0.17							
		3	28	0.18							
3	3.6	1	27	0.19	0.181	0.850	0.154	0.620	0.565	0.593	0.091
		2	29	0.17							
		3	27	0.19							
						Total		**1.780**	**1.715**	**1.748**	**0.261**

DISCHARGE CALCULATION FORM											
Station Name		Date:	3-May-15				Weather		Computed by:		FT
1GD16, Kongwa		Start Time:	8:56	AM	Obs. Duration		Cloudy				
Observers:		End Time:	9:10	AM	0:14	hr			Checked by:		TL, JK
		Start WL:	0.64	m	Start Width:		8.20	m			
		End WL:	0.64	m	End Width:		8.20	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.64	m	Average Width:		8.20	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		5.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	1.2	1	18	0.28	0.283	0.850	0.241	0.900	0.820	0.860	0.207
		2	17	0.29							
		3	18	0.28							
2	2.5	1	20	0.25	0.250	0.850	0.213	0.790	0.760	0.775	0.165
		2	21	0.24							
		3	19	0.26							
3	3.6	1	18	0.28	0.248	0.850	0.211	0.880	0.900	0.890	0.187
		2	22	0.23							
		3	21	0.24							
						Total		**2.570**	**2.480**	**2.525**	**0.559**

Appendix 4: Discharge Float Sheet at Kidete

DISCHARGE CALCULATION FORM												
Station Name		Date:	30 March 2015				Weather		Computed by:		FT	
Kidete		Start Time:	11:40	AM	Obs. Duration		Cloudy					
Observers:		End Time:	12:00	PM	0:20	hr			Checked by:		TL, JK	
		Start WL:	0.15	m	Start Width:		14.00	m				
		End WL:	0.15	m	End Width:		14.00	m	Approved by:		MS	
		Diff.:	0.00	m	Diff.:		0.00	m				
		Average WL:	0.15	m	Average Width:		14.00	m				
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange		Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average		
1	3.5	1	23	0.87	0.910	0.850	0.774	0.780	0.710	0.745		0.576
		2	21	0.95								
		3	22	0.91								
2	7.0	1	20	1.00	1.035	0.850	0.880	0.620	0.720	0.670		0.589
		2	19	1.05								
		3	19	1.05								
3	10.5	1	21	0.95	0.941	0.850	0.800	0.760	0.720	0.740		0.592
		2	20	1.00			0.818					
		3	23	0.87								
						Total		2.160	2.150	2.155		1.758

DISCHARGE CALCULATION FORM											
Station Name		Date:	31 March 2015				Weather		Computed by:		FT
Kidete		Start Time:	8:11	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:25	AM	0:14	hr			Checked by:		TL, JK
		Start WL:	0.14	m	Start Width:		14.10	m			
		End WL:	0.14	m	End Width:		14.10	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.14	m	Average Width:		14.10	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange	Area (m²)			Discharge (m³/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	3.5	1	24	0.83	0.898	0.850	0.764	0.780	0.710	0.745	0.569
		2	21	0.95							
		3	22	0.91							
2	7.0	1	22	0.91	0.914	0.850	0.777	0.700	0.750	0.725	0.563
		2	20	1.00							
		3	24	0.83							
3	10.5	1	21	0.95	0.885	0.850	0.752	0.770	0.770	0.770	0.579
		2	23	0.87			0.764				
		3	24	0.83							
						Total		2.250	2.230	2.240	1.711

DISCHARGE CALCULATION FORM											
Station Name		Date:	1 April 2015				Weather		Computed by:		FT
Kidete		Start Time:	12:00	AM	Obs. Duration		Cloudy				
Observers:		End Time:	12:20	AM	0:20	hr			Checked by:		TL, JK
		Start WL:	0.12	m	Start Width:		13.20	m			
		End WL:	0.12	m	End Width:		13.20	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.12	m	Average Width:		13.20	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.1	1	24	0.83	0.898	0.850	0.764	0.660	0.710	0.685	0.523
		2	21	0.95							
		3	22	0.91							
2	20.2	1	22	0.91	0.871	0.850	0.740	0.690	0.750	0.720	0.533
		2	24	0.83							
		3	23	0.87							
3	30.3	1	21	0.95	0.910	0.850	0.774	0.780	0.770	0.775	0.600
		2	22	0.91			0.759				
		3	23	0.87							
						Total		2.130	2.230	2.180	1.656

DISCHARGE CALCULATION FORM											
Station Name		Date:	2 April 2015				Weather		Computed by:		FT
Kidete		Start Time:	17:30	AM	Obs. Duration		Cloudy				
Observers:		End Time:	17:47	AM	0:17	hr			Checked by:		TL, JK
		Start WL:	0.12	m	Start Width:		13.10	m			
		End WL:	0.12	m	End Width:		13.10	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.12	m	Average Width:		13.10	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.1	1	20	1.00	1.021	0.850	0.868	0.490	0.490	0.490	0.425
		2	21	0.95							
		3	18	1.11							
2	20.2	1	21	0.95	1.002	0.850	0.851	0.530	0.550	0.540	0.460
		2	20	1.00							
		3	19	1.05							
3	30.3	1	21	0.95	0.938	0.850	0.797	0.540	0.520	0.530	0.423
		2	22	0.91			0.839				
		3	21	0.95							
						Total		1.560	1.560	1.560	1.308

DISCHARGE CALCULATION FORM											
Station Name		Date:	11 April2015				Weather		Computed by:		FT
Kidete		Start Time:	8:16	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:25	PM	0:09	hr			Checked by:		TL, JK
		Start WL:	0.10	m	Start Width:		13.00	m			
		End WL:	0.10	m	End Width:		13.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.10	m	Average Width:		13.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	5.0	1	24	0.83	0.822	0.850	0.699	0.510	0.520	0.515	0.360
		2	25	0.80							
		3	24	0.83							
2	10.0	1	23	0.87	0.883	0.850	0.750	0.520	0.530	0.525	0.394
		2	22	0.91							
		3	23	0.87							
3	15.0	1	24	0.83	0.857	0.850	0.729	0.540	0.520	0.530	0.386
		2	23	0.87			0.726				
		3	23	0.87							
						Total		1.570	1.570	1.570	1.140

DISCHARGE CALCULATION FORM											
Station Name		Date:	11 April2015				Weather		Computed by:		FT
Kidete		Start Time:	7:53	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:03	PM	0:10	hr			Checked by:		TL, JK
		Start WL:	0.10	m	Start Width:		12.00	m			
		End WL:	0.10	m	End Width:		12.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.10	m	Average Width:		12.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		20.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	5.0	1	24	0.83	0.822	0.850	0.699	0.510	0.490	0.500	0.349
		2	25	0.80							
		3	24	0.83							
2	10.0	1	23	0.87	0.883	0.850	0.750	0.490	0.500	0.495	0.371
		2	22	0.91							
		3	23	0.87							
3	15.0	1	24	0.83	0.857	0.850	0.729	0.520	0.500	0.510	0.372
		2	23	0.87			0.726				
		3	23	0.87							
						Total		1.520	1.490	1.505	1.093

Appendix 5: Discharge Float Sheet at Mkondoa

DISCHARGE CALCULATION FORM											
Station Name		Date:	25 March 2015				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	15:23	PM	Obs. Duration		Cloudy				
Observers:		End Time:	15:36	PM	0:13	hr			Checked by:		TL,JK
		Start WL:	1.87	m	Start Width:		41.00	m			
		End WL:	1.86	m	End Width:		41.00	m	Approved by:		MS
		Diff.:	0.01	m	Diff.:		0.00	m			
		Average WL:	1.87	m	Average Width:		41.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		50.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.3	1	22	2.27	2.385	0.850	2.027	11.990	10.360	11.175	22.650
		2	21	2.38							
		3	20	2.50							
2	20.5	1	22	2.27	2.240	0.850	1.904	13.700	13.970	13.835	26.339
		2	22	2.27							
		3	23	2.17							
3	30.8	1	19	2.63	2.735	0.850	2.325	12.312	13.350	12.831	29.826
		2	19	2.63			2.085				
		3	17	2.94							
						Total		38.002	37.680	37.841	78.816

DISCHARGE CALCULATION FORM											
Station Name		Date:	26 March 2015				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	18:10	PM	Obs. Duration		Cloudy				
Observers:		End Time:	18:25	PM	0:15	hr			Checked by:		TL, JK
		Start WL:	1.80	m	Start Width:		41.00	m			
		End WL:	1.70	m	End Width:		41.00	m	Approved by:		MS
		Diff.:	0.10	m	Diff.:		0.00	m			
		Average WL:	1.75	m	Average Width:		41.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		**50.00**	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.3	1	20	2.50	2.460	0.850	2.091	11.590	9.780	10.685	22.345
		2	21	2.38							
		3	20	2.50							
2	20.5	1	18	2.78	2.408	0.850	2.047	13.190	13.670	13.430	27.490
		2	22	2.27							
		3	23	2.17							
3	30.8	1	20	2.50	2.517	0.850	2.139	12.150	13.700	12.925	27.651
		2	18	2.78			2.092				
		3	22	2.27							
						Total		36.930	37.150	37.040	77.486

DISCHARGE CALCULATION FORM											
Station Name		Date:	26 March 2015				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	15:53	AM	Obs. Duration		Cloudy				
Observers:		End Time:	16:07	AM	0:14	hr			Checked by:		TL,JK
		Start WL:	1.90	m	Start Width:		41.50	m			
		End WL:	1.89	m	End Width:		41.50	m	Approved by:		MS
		Diff.:	0.01	m	Diff.:		0.00	m			
		Average WL:	1.90	m	Average Width:		41.50	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		50.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.4	1	21	2.38	2.345	0.850	1.993	13.960	13.500	13.730	27.366
		2	22	2.27							
		3	21	2.38							
2	20.8	1	23	2.17	2.528	0.850	2.149	14.560	14.740	14.650	31.477
		2	19	2.63							
		3	18	2.78							
3	30.2	1	22	2.27	2.207	0.850	1.876	15.660	12.230	13.945	26.158
		2	23	2.17			2.006				
		3	23	2.17							
						Total		44.180	40.470	42.325	85.001

DISCHARGE CALCULATION FORM											
Station Name		Date:	27 March 2015				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	16:24	PM	Obs. Duration		Cloudy				
Observers:		End Time:	16:30	PM	0:06	hr			Checked by:		TL, JK
		Start WL:	1.90	m	Start Width:		41.50	m			
		End WL:	1.90	m	End Width:		41.50	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	1.90	m	Average Width:		41.50	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		**50.00**	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.4	1	19	2.63	2.548	0.850	2.166	13.700	13.500	13.600	29.455
		2	21	2.38							
		3	19	2.63							
2	20.8	1	20	2.50	2.636	0.850	2.241	14.420	14.740	14.580	32.674
		2	19	2.63							
		3	18	2.78							
3	30.2	1	21	2.38	2.504	0.850	2.129	15.150	14.760	14.955	31.832
		2	20	2.50			2.178				
		3	19	2.63							
						Total		43.270	43.000	43.135	93.961

DISCHARGE CALCULATION FORM											
Station Name		Date:	30 March 2015				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	8:15	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:52	AM	0:37	hr			Checked by:		TL, JK
		Start WL:	1.89	m	Start Width:		40.40	m			
		End WL:	1.89	m	End Width:		40.40	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	1.89	m	Average Width:		40.40	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		50.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	10.1	1	23	2.17	2.276	0.850	1.934	11.190	11.660	11.425	22.101
		2	21	2.38							
		3	22	2.27							
2	20.2	1	20	2.50	2.500	0.850	2.125	12.360	11.600	11.980	25.458
		2	20	2.50							
		3	20	2.50							
3	30.3	1	21	2.38	2.321	0.850	1.973	12.160	12.700	12.430	24.527
		2	20	2.50			2.011				
		3	24	2.08							
						Total		35.710	35.960	35.835	72.086

DISCHARGE CALCULATION FORM											
Station Name		Date:	11-Apr-15				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	8:17	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:29	AM	0:12	hr			Checked by:		TL, JK
		Start WL:	1.61	m	Start Width:		41.00	m			
		End WL:	1.61	m	End Width:		41.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	1.61	m	Average Width:		41.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		50.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	11.0	1	28	1.79	1.708	0.850	1.451	9.500	10.000	9.750	14.152
		2	29	1.72							
		3	31	1.61							
2	25.0	1	28	1.79	1.745	0.850	1.483	10.000	10.200	10.100	14.978
		2	29	1.72							
		3	29	1.72							
3	37.0	1	31	1.61	1.549	0.850	1.316	11.000	10.200	10.600	13.953
		2	32	1.56			1.417				
		3	34	1.47							
						Total		30.500	30.400	30.450	43.083

DISCHARGE CALCULATION FORM											
Station Name		Date:	3-May-15				Weather		Computed by:		FT
1GD2, Mkondoa		Start Time:	8:24	AM	Obs. Duration		Cloudy				
Observers:		End Time:	8:42	AM	0:18	hr			Checked by:		TL, JK
		Start WL:	1.77	m	Start Width:		41.00	m			
		End WL:	1.77	m	End Width:		41.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	1.77	m	Average Width:		41.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		50.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	12.0	1	23	2.17	2.240	0.850	1.904	11.000	10.200	10.600	20.181
		2	22	2.27							
		3	22	2.27							
2	25.0	1	22	2.27	2.345	0.850	1.993	11.000	11.400	11.200	22.323
		2	21	2.38							
		3	21	2.38							
3	38.0	1	22	2.27	2.240	0.850	1.904	11.700	12.000	11.850	22.560
		2	23	2.17			1.934				
		3	22	2.27							
						Total		33.700	33.600	33.650	65.064

Appendix 6: Discharge Float Sheet at Gulwe

DISCHARGE CALCULATION FORM											
(USING FLOAT METHOD)											
Station Name		Date:	13 April 2015				Weather		Computed by:		FT
Kinyasungwe at Gulwe		Start Time:	9:13	PM	Obs. Duration		Cloudy				
Observers:		End Time:	9:23	PM	0:10	hr			Checked by:		TL, JK
		Start WL:	0.89	m	Start Width:		8.00	m			
		End WL:	0.89	m	End Width:		8.00	m	Approved by:		MS
		Diff.:	0.00	m	Diff.:		0.00	m			
		Average WL:	0.89	m	Average Width:		8.00	m			
No. of partial section	Distance of center line from left bank (m)	Reach Length (m)		10.00	Type of float:		orange	Area (m^2)			Discharge (m^3/s)
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	
1	2.0	1	20	0.50	0.492	0.850	0.418	0.478	0.472	0.475	0.199
		2	21	0.48							
		3	20	0.50							
2	4.0	1	17	0.59	0.590	0.850	0.501	0.489	0.466	0.478	0.239
		2	16	0.63							
		3	18	0.56							
3	6.0	1	17	0.59	0.568	0.850	0.482	0.468	0.481	0.475	0.229
		2	19	0.53			0.467				
		3	17	0.59							
						Total		1.435	1.419	1.427	0.667

Appendix 7: Discharge Sheet by Using Current Meter

Station Name; Kinyasungwe at Gulwe — date of measurements 11/4/2015 — BODY N0 C2170020 — Gauge height 0.85

Station Number ;local PRPPELLOR NO I-171646 — n=<1.78 V=0.0678*n+0.016, 1.78=<n=<7.65 V=0.0571*n+0.035,7.65=<n=<17.551 V=0.0537*n+0.061 — at 1358-1431 — Span 5.5

distance from initial point	sounded depth	revised depth	unrevised depth of obs	revised depth of obs	revs.	time	revs./time (n)	vel.at point	velocity multiplier		mean vel. in vert	mean vel. in section	area of sect	discharge in section	discharge accum
0.0	0.00							0.000			0.000				
												0.298	0.007	0.002	0.002
0.1	0.13		0.08		398	40	9.950	0.595			0.595				
												0.589	0.257	0.151	0.153
2.0	0.14		0.08		389	40	9.725	0.583			0.583				
												0.589	0.145	0.085	0.239
3.0	0.15		0.09		398	40	9.950	0.595			0.595				
												0.595	0.130	0.077	0.316
4.0	0.11		0.07		398	40	9.950	0.595			0.595				
												0.589	0.105	0.062	0.378
5.0	0.10		0.06		388	40	9.700	0.582			0.582				
	0.13											0.299	0.025	0.007	0.385
5.5	0.00		0.00		0	40	0.000	0.016			0.016				
												0.008	0.000	0.000	0.385
													0.668		

Station Name; Kinyasungwe
at Gulwe
Station
Number ;local PRPPELLOR NO I-171646

date of measurements 12/4/2015 BODY N0 C2170020 Gauge height 0.79
n=<1.78 V=0.0678*n+0.016, 1.78=<n=<7.65 V=0.0571*n+0.035,7.65=<n=<17.551
V=0.0537*n+0.061 at 0806-0817 Span 5

distance from initial point	sounded depth	revised depth	unrevised depth of obs	revised depth of obs	revs.	time	revs./time (n)	vel.at point	velocity multiplier		mean vel. in vert	mean vel. in section	area of sect	discharge in section	discharge accum
0.0	0.00							0.000			0.000				
												0.137	0.090	0.012	0.012
1.0	0.18		0.11		168	40	4.200	0.275			0.275				
												0.276	0.160	0.044	0.056
2.0	0.14		0.08		169	40	4.225	0.276			0.276				
												0.311	0.135	0.042	0.098
3.0	0.13		0.08		217	40	5.425	0.345			0.345				
												0.332	0.150	0.050	0.148
4.0	0.17		0.10		199	40	4.975	0.319			0.319				
	0.12											0.160	0.085	0.014	0.162
5.0	0.00		0.00		0	40		0.000			0.000				
												0.000	0.000	0.000	0.162
													0.620		

Station Name; Kinyasungwe at Gulwe | date of measurements | 20/04/2015 | BODY N0 C2170020 | Gauge height 0.78

n=<1.78 V=0.0678*n+0.016, 1.78=<n=<7.65 V=0.0571*n+0.035,7.65=<n=<17.551

Station Number ;local | PRPPELLOR NO I-171646 | V=0.0537*n+0.061 | at 1358-1431 | Span 5.8

distance from initial point	sounded depth	angle	revised depth	unrevised depth of obs	revised depth of obs	revs.	time	revs./time (n)	vel.at point	velocity multiplier		velocity mean vel. in vert	mean vel. in section	area of sect	discharge in section	discharge accum
0.0	0.00								0.000			0.000				
													0.097	0.200	0.019	0.019
2.0	0.20			0.12		111	40	2.775	0.193			0.193				
													0.216	0.540	0.116	0.136
4.0	0.34			0.20		142	40	3.550	0.238			0.238				
													0.236	0.540	0.128	0.263
6.0	0.20			0.12		140	40	3.500	0.235			0.235				
	0.247												0.117	0.280	0.033	0.296
8.8	0.00					0	0					0.000				
													0.000	0.000	0.000	0.296
														1.560		

Station Name; Kinyasungwe at Gulwe — date of measurements 3/5/2015 — BODY N0 C2170020 — Gauge height 0.66

Station Number ;local — PRPPELLOR NO I-171646 — n=<1.78 V=0.0678*n+0.016, 1.78=<n=<7.65 V=0.0571*n+0.035,7.65=<n=<17.551 V=0.0537*n+0.061 — at 0826-0833 — Span 5.8

distance from initial point	sounded depth	revised depth	unrevised depth of obs	revised depth of obs	revs.	time	revs./time (n)	vel.at point	velocity				area of sect	discharge in section	discharge accum
									multiplier		mean vel. in vert	mean vel. in section			
0.0	0.00							0.000			0.000				
												0.029	0.025	0.001	0.001
0.5	0.10		0.06		25	40	0.625	0.058			0.058				
												0.074	0.053	0.004	0.005
1.0	0.11		0.07		44	40	1.100	0.091			0.091				
												0.102	0.055	0.006	0.010
1.5	0.11		0.07		57	40	1.425	0.113			0.113				
												0.096	0.053	0.005	0.015
2.0	0.10		0.06		37	40	0.925	0.079			0.079				
												0.068	0.048	0.003	0.018
2.5	0.09		0.05		24	40	0.600	0.057			0.057				
	0.10											0.036	0.023	0.001	0.019
3.0	0.00		0.00		0	50	0.000	0.016			0.016				
												0.008	0.000	0.000	0.019
													0.255		

APPENDIX Q

FLOOD MARK SURVEY

Q.1 Introduction

Q.1.1 Overview

This final report is about the survey work of Flood Marks along the Kinyasungwe - Mkondoa Rivers in connection with the "Preparatory Survey on Flood Protection Measures for Central Railway Line" undertaken by JICA Study Team. The Flood Mark Survey was carried out between Gulwe/Mpwapwa (Dodoma District) and Kilosa Township (Kilosa District). The purpose of the Flood Mark Survey is to measure the spot elevation of the flood marks along the target river sections in order to utilize the records to understand the magnitude of past flood events and also to be used for subsequent analysis of hydraulic computation for the said river valleys.

Q.1.2 Objectives of the Report

This report describes the whole survey work operation for the Flood Mark Survey. As such, its main objective is to describe the methodology employed to carry out the work, instrumentation used, challenges faced in the field during the execution of the various tasks and finally present the results obtained.

The execution of the whole survey work was largely guided by the specifications provided for bidding purposes and as discussed in various meetings held between the Client (JICA Study Team) and the Consultant. The key elements of the project are structured such that a logical work flow follows, with clear inputs and outputs between inter-related activities.

Q.2 Project Location

The location of the Work is along the river stretches of the Kinyasingwe and Mkondoa Rivers between Kilosa (Km283) and Igandu (Km 402). Between this section 42 Flood Marks were surveyed.

Q.3 Scope of the Work

The "Flood Mark Survey" covered the following work items in accordance with the Technical Specifications:

(1) Preparation of work plan and schedule with analyses of existing data and information
(2) Field reconnaissance to identify the flood marks that could be marked between Kilosa and Gulwe before flood marking activities.
(3) Interview to local people residing near the identified site so as to pinpoint the locations of the highest level reached and on which particular year the event of the flood occurred.
(4) Marking of flood marks on the buildings/ architecture/ walls, etc. identified by the local residents. This was followed by taking measurement of height from the ground surface nearby including measurement of elevation of the painted flood marks by connecting with bench marks established by the "River Cross Section Survey" or other registered bench mark in Tanzania.
(5) A record of the interviews as well as the measurements and pictures showing the location of the flood mark and level information were filled up in the "Inventory Sheet for Flood Mark Survey" prepared by the JICA Study Team.
(6) Preparation of work outputs

Q.4 Work Schedule

The whole work was to be carried out as per original agreed schedule and to follow the scope of work as described in part 3. above. However the actual work did not fully follow the schedule due to unavoidable circumstances, the actual schedule followed is as shown in Table.1 below:

Table Q.1: Original and Actual Schedule of Work

Work Item	Feb. 2015				Mar. 2015				Apr. 2015				May 2015			
1) Preparatory Works																
2) General Reconnaissance to Identify the Flood Marks																
3) Marking of Flood Marks and Measurements of Elevation																
4) Interview to Local People on Past Flood Events																
5) Preparation of Work Outputs																
Draft Report																
Final Report																

Legend: Proposed Time Schedule
Actual Time Schedule

Q.5 Personnel Involved in the Field Work

The following people were involved in the execution of the Flood Mark Survey Tasks:

- Main Work Supervisor - (Mr. Abdallah Bawazir) who was fully involved in the reconnaissance work, planning of the field operations and preparation of the works output.
- Main Surveyor - (Mr. Miraji Mandia) who was fully involved in all the aspect of the task from start to finish.
- 2 Technicians – (Mr. Sylvester Adrian and Mr. Muhsin) who were involved in all field operations.
- A number of Casual Labourers hired on site

Q.6 Methodology

The methodology for executing the task was as follows:

(1) A general reconnaissance of the whole work area was carried out between Gulwe and Kilosa. This assisted in identifying the condition of the site, transport issues, places where the survey team could be accommodated during the execution of the survey and all other logistical issues. During this time also the survey team was introduced to the village authorities so as to seek cooperation with the local people as well as the RAHCO authorities so as to get assistance on transport matters when the need arose. The time was also utilized to identify nearby control points established by the Cross-Section Survey Team (Dunny Geoinformatics, Morogoro, Tanzania) and to ensure that information on levels was obtained so as to use this data for the Flood Mark survey.

(2) Interview surveys were conducted to the residents who were residing along the river stretches nearby the identified flood marks. The interview question and information filled in the questionnaire sheets, as specified by the JICA Study Team, generally followed this procedure:

- Evacuation (if they had eva General Information on when the highest flood was experienced to the knowledge of the interviewee.
- The Surveyors then took information on Location (coordination and distance from road or river)
- Inundation (maximum depth, date and time at peak level, inundation period, flow direction)

- cuated or not. If so, where and how long).
- Sketch of the location was made and photographs were taken to show the general surrounding of the areas.

(3) Some of the Flood marks were marked on structures (bridges, stations, gang camps, buildings, etc.), others were marked on natural features such as tree trunks and on places where it was not possible to mark on the structures or tree trunks, the flood marks were marked on information boards placed on the ground and the elevation from the ground was measured. The work of marking the flood marks started in Gulwe and proceeded to Kilosa. In addition to the marking of the flood mark, the elevation measured was also indicated on the flood mark as shown below:

Photographs of the flood mark or information board were taken together with the surrounding areas so that it is easier to find or re-establish the mark if required.

(4) The coordination of the flood mark was measured and recorded using a hand held GNSS receiver for the Latitude and Longitude information while the elevation information was obtained by spirit leveling from the nearest benchmark established during the River Cross Section survey. Instruments used for this tasks included the following:

- ProMark III GNSS receiver for the positioning (Latitude and Longitude)
- Sokkia C32 Automatic Level for elevation measurements.

(5) A list of the coordinates and elevations of the flood marks as determined in the field is included in Table 2. The coordinates given are in WGS84 coordinate system while the elevations are above mean sea level as determined from tying the levels to the bench marks. This is an abridged output of the result as the complete set of results is submitted as an external Appendix together with other field data and maps and interview forms.

Q.7 Work Output

As per Technical Specifications and requirements the final output includes the following:

- Weekly Report on the field work progress, data processing and report preparation.
- This main report which contains the results of the flood mark survey
- Drawing showing the locations of the flood marks plotted on the background of the 1:50,000 topographic map sheets for that area and prepared on A3 format.
- Original interview forms as filled in the field and those prepared in the office with all filed records typed in by computers. The interview forms prepared and completed in the office also incorporates pictures of the flood mark location as taken in the field.

Q.8 Challenges and Achievements Encountered in the Field.

During the execution of the survey work the survey team faced a number of challenges; the critical ones are elaborated below:

- The work was carried out during a seasonal rainy period and this frequently disrupted the work progress.
- The rain also resulted in flooding in some areas and this severely limited access to these areas.

- Transportation to some part was extremely difficult as there was no access by 4 wheel vehicles. The only viable access was to use motorcycles, a service provided commercially by local residents. In some cases transportation was provided by the RAHCO people using their trolley and railway engines.

In spite of the challenges mentioned above the survey team also had a number of notable achievements that helped to secure the completion of the survey work and on time. These achievements included:

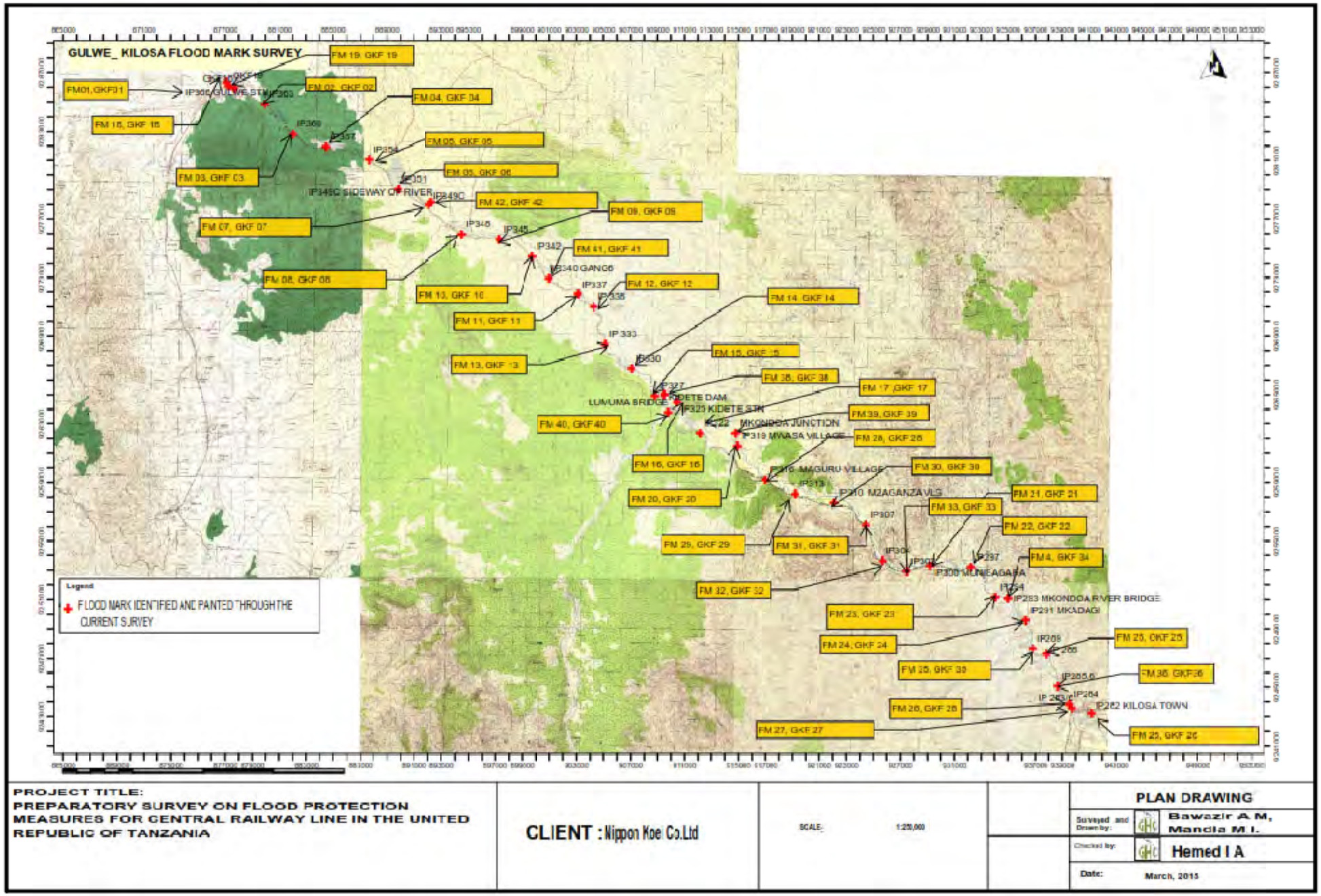
- Remarkably good cooperation from the local people who were willing to be interviewed and provided important information on the flood events, when they occurred and showed us the location of maximum flooding.
- Good cooperation from RAHCO people in terms of assistance on transportations by trolleys and other means at their disposal when needed.
- In total 42 flood marks were determined, marked and measured as required by the terms of the Technical Specifications.
- All flood marks were surveyed and their elevations determined and tied to the bench marks established by the River Cross-Section survey as required.

Q.9 Conclusion

The planning of the work, methodologies employed and the commitment of the Survey Team led to a successful completion of the tasks as specified in the Scope of Work.

Table Q.2: Coordinates of the Flood Mark Locations (WGS84 Coordinate System)

Flood Mark Number	WGS 84		Flood Mark Elevation (m)	Flood Mark Field - ID	Bench Mark Tied TO	Elevation of Bench Mark Used (m)
	Longitude (E) – (dms)	Latitude (S) – (dms)				
FM01	36 24 32.29375	6 26 51.63560	783.208	GKF01	A5/05	782.839
FM02	36 26 04.84809	6 27 40.34508	777.025	GKF02	IP 363	777.203
FM03	36 27 02.63032	6 58 17.26945	772.097	GKF03	IP 360	772.385
FM04	36 28 32.92967	6 29 12.80253	766.210	GKF04	IP 357	769.475
FM05	36 30 16.66043	6 29 39.89111	756.788	GKF05	IP 354	757.692
FM06	36 31 25.00728	6 30 45.95712	750.880	GKF06	IP 351	751.321
FM07	36 32 41.98800	6 31 21.78599	748.784	GKF07	IP 349C	751.261
FM08	36 33 59.91002	6 32 25.09802	736.058	GKF08	IP 348	738.148
FM09	36 35 31.94402	6 32 35.57400	726.575	GKF09	IP 345	729.157
FM10	36 36 50.05512	6 33 13.94603	708.076	GKF10	IP 342	708.872
FM11	36 38 41.43600	6 34 37.03799	697.712	GKF11	IP 337	694.795
FM12	36 39 19.21800	6 35 04.88399	688.506	GKF12	IP 336	690.006
FM13	36 39 46.76619	6 36 26.44674	675.750	GKF13	IP 333	678.772
FM14	36 40 50.19845	6 37 21.14750	668.297	GKF14	IP 330	671.056
FM15	36 41 48.85615	6 38 19.49448	661.924	GKF15	IP 327	670.329
FM16	36 42 41.19595	6 38 35.12471	664.048	GKF16	A4/28	676.571
FM17	36 43 38.04380	6 39 44.21051	647.954	GKF17	IP 322	651.970
FM18	36 24 49.48360	6 27 06.16491	784.210	GKF18	A5/05	782.839
FM19	36 24 56.53399	6 26 59.93535	782.100	GKF19	A5/05	782.839
FM20	36 44 50.77477	6 27 10.56502	628.390	GKF20	IP 319	629.884
FM21	36 52 52.32000	6 44 35.04847	544.830	GKF21	IP 300	544.530
FM22	36 54 31.53600	6 44 35.80080	530.930	GKF22	IP 297	530.790
FM23	36 55 32.09156	6 45 41.06148	524.760	GKF23	IP 294	520.335
FM24	36 56 43.19883	6 46 32.53888	511.750	GKF24	IP 291	512.421
FM25	36 57 34.30782	6 47 46.99663	505.370	GKF25	IP 288	506.392
FM26	36 58 33.95168	6 49 48.43699	493.440	GKF26	IP 284	494.730
FM27	36 58 40.7917	6 49 56.62762	493.810	GKF27	IP 284	494.730
FM28	36 46 14.68473	6 41 23.70673	614.230	GKF28	IP 316	616.318
FM29	36 47 27.35013	6 41 55.80319	599.220	GKF29	IP 313	606.290
FM30	36 49 01.43276	6 42 14.88974	584.510	GKF30	IP 310	585.060
FM31	36 50 18.30700	6 43 02.82021	572.260	GKF31	IP 307	571.320
FM32	36 50 58.53339	6 44 24.45438	559.990	GKF32	IP 304	561.460
FM33	36 51 56.65099	6 44 46.03246	550.770	GKF33	IP 302	552.450
FM34	36 56 03.30337	6 45 43.34451	519.760	GKF34	IP 293	520.335
FM35	36 57 00.64590	6 47 35.01384	504.330	GKF35	IP 289	505.947
FM36	36 58 02.57629	6 48 57.51631	495.820	GKF36	IP 286	500.327
FM37	36 59 24.71873	6 49 56.32702	486.510	GKF37	IP 282	487.680
FM38	36 42 10.06951	6 38 16.99070	662.510	GKF38	IP 326	674.722
FM39	36 45 02.98752	6 39 41.56908	633.419	GKF39	IP 320	637.170
FM40	36 42 20.70225	6 38 57.69518	670.790	GKF40	A4/28	676.571
FM41	36 37 31.17601	6 34 01.38599	701.250	GKF41	IP 340	704.060
FM42	36 32 46.81727	6 31 14.53880	745.620	GKF42	IP 349C	751.261



PROJECT TITLE:
PREPARATORY SURVEY ON FLOOD PROTECTION MEASURES FOR CENTRAL RAILWAY LINE IN THE UNITED REPUBLIC OF TANZANIA

CLIENT : Nippon Koei Co.Ltd

SCALE: 1:25,000

PLAN DRAWING

Surveyed and Drawn by:	Bawazir A M, Mandia M I.
Checked by:	Hemed I A
Date:	March, 2015

APPENDIX R

RIVER CROSS SECTION AND LONGITUDINAL PROFILE SURVEY

R.1 Introduction

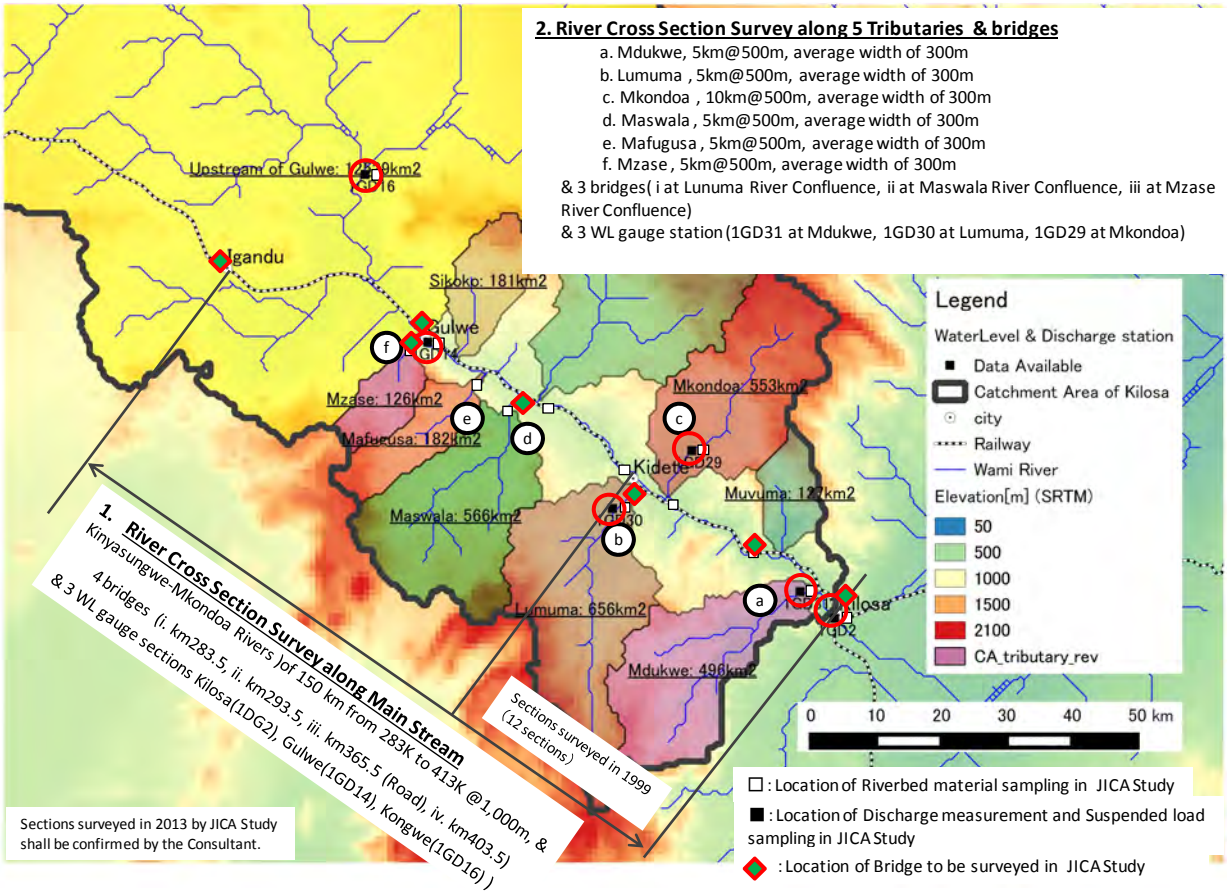
R.1.1 Main Objective

The purpose of the work is to measure the current conditions of river cross-sections and riverbed slopes that will be used for the hydraulic simulation of the Kinyasungwe/Mkondoa River and seven major tributaries.

R.1.2 Survey Contract

Through competitive bidding of least-cost proposals, the following subcontractor was selected of three who submitted their bids by the deadline. Key information on the subcontractor is summarized below:

- Date of contract signed: 23 December 2014
- Survey period: 23 December 2014 to 31 March 2015 (contract); 25 February to 25 July 2015 (actual)
- Contractor: Dunny Geoinformatics Consultancy & Services
- Address: P.O. Box 371, Plot No. 14 Boma Road, Morogoro, Tanzania
- Representative/Contact: Mr. Dunford Mateso; Tel: +252-21-754372851; e-mail: dunnygca@gmail.com

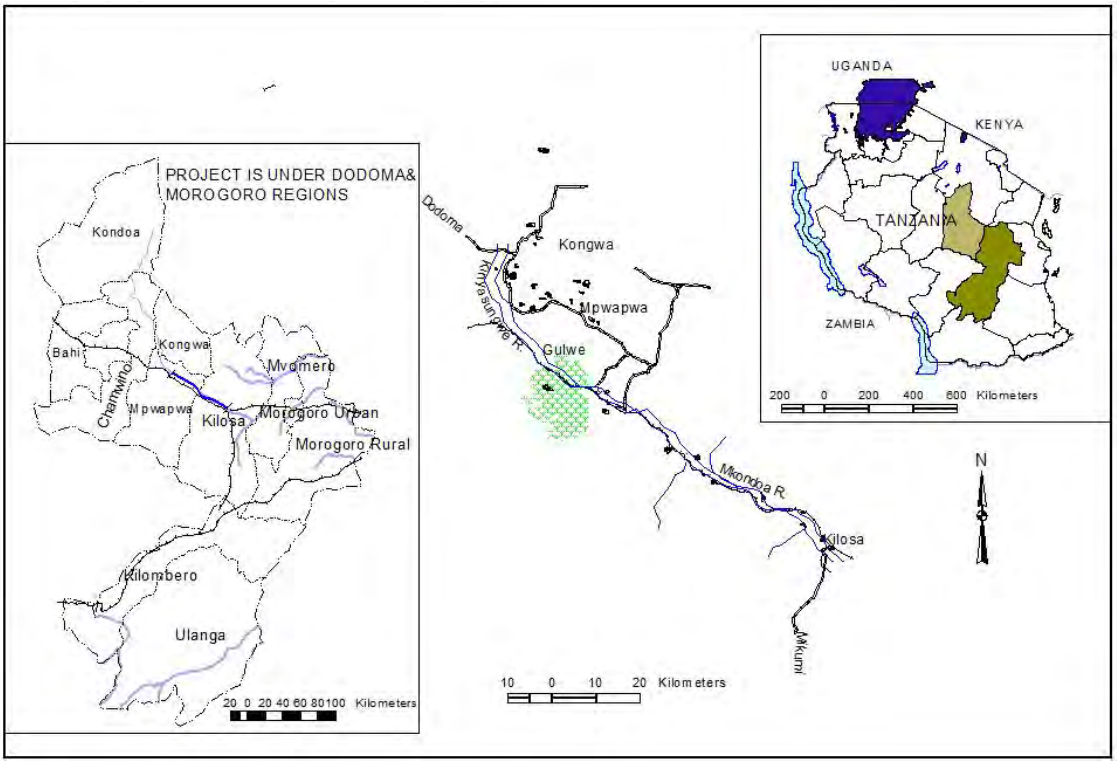


Source: JICA Study Team

Figure R.1: Map of River Cross-Section and Longitudinal Profile Survey

R.1.3 Survey Area

The survey area is a corridor of approximately 1.0 km width of the Kinyasungwe/Mkondoa River from Kilosa to Gulwe along the Central Railway line and is shown on the location map in Figure R.2.



Source: Danny Informatics

Figure R.2: Location Map of Surveyed Area

R.1.4 Work Schedule

Actual work schedule is shown in Figure R.3 in next page:

No.	Activity	2015																											
		Febr				March				April				May				June				July							
1.0	**Mobilization**																												
1.1	Work preparation:- Procurement of field materials, Purchase of signal corrections, Mobilization of field teams& Camp shift																												
2.0	**Ground Control Points extension**																												
2.1	Points identification (Team_1)																												
2.2	Points monument at every 5km (along railway) (Team_1)																												
	Point description (Team_1)																												
2.3	Spirit levelling& Search for National BM (Team_4)																												
2.4	Points monument at every 1km (along railway) (Team_1, 2& 3)																												
2.5	GPS-RTK Observations for 5km interval points (Team_1)																												
3.0	**River Cross Section readings**																												
3.1	Lines clearance																												
3.2	GPS-RTK Observations, along cross sections (Team_1,2&3)																												
3.3	Data processing (Team_1,2&3)																												
3.4	Report writing (Team_1,2&3)																												
	Omnistar observation																												
4.0	**Preparation of drawings and compile a draft report (Team_1,2&3) and Office team**																												
5.0	**Demobilization (Team_1,2&3)**																												
6.0	**Submission of final draft report (Team leader)**																												
7.0	**Submission of final report (Team leader)**																												
8.0	**Re-submission of final report (Team leader)**																												

Source: Dunny Geoinformatics

Figure R.3: Actual Work Schedule

R.2 Methodology

R.2.1 Installation of Bench Marks and Field Measurement

The bench marks and stake pins of the work were installed together along the railway line at interval of approximately 5 km and 1 km, respectively. These Bench marks and stake pins of the work used to control measurements of all cross sections along the Kinyasungwe/Mkondoa River together with selected tributaries and bridges.

All alignments for the Kinyasungwe/Mkondoa River and selected tributaries were identified and scanned. This helped to calculate the number of bench marks and stake pins to be installed and number of bench marks were placed on the ground at every 20 km (approx.) from Kilosa to Gulwe. The process of alignment identification was carried out in the office using GIS techniques with Arc View software.

Handheld GPS was used in the field to navigate the approximate positions of points along the railway line and to select positions where by residents not easier to damage the monuments. The coordinates of these points were digitized from the geo-referenced topographic maps Nos. 163/1, 3&4, 164/3 and 181/1–4.

Monuments of pillars were placed by using bucket of 10 litres of 25 cm diameter and height of 30 cm. The bucket placed in the trench for 20 cm down and remaining part of 10 cm is above the ground surface.

Later, bucket was filled up with mortar including remaining spaces on the trench to strengthen the pillar (See photo below). Centre of the bucket placed a small iron bar of 10 mm diameter and height of 23 cm to define a centering point of instrument. Monument of pillars (bench marks) at the top is marked with name as shown below:

(a) Plan view

(b) Side view

Source: Dunny Geoinformatics

Figure R.4: Monument of Bench Mark

Placement of the stake pins were followed by having 10–15 mm diameter and height of 1.0 meter. The iron pin was placed for 70–90 cm deep and just few10-30 cm above surface line and rounded with mortar on small trench to strengthen a pin.

Layout of all iron pins are indicated on map sheets of 1:50,000 at interval of 1 km along railway and other pins for the bridges with staff gauge and old cross sections, which were surveyed in 1999, placed the same.

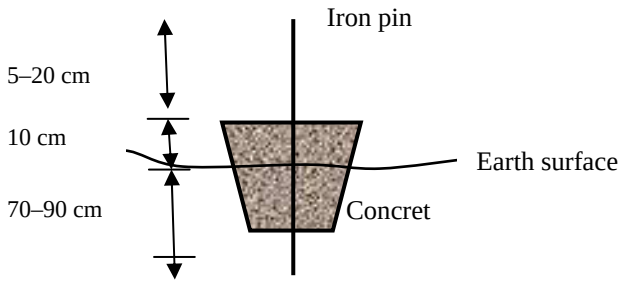


Figure R.5: Iron Pin in Concrete

R.2.2 Coordination of Bench Marks

(1) Ordinary (Spirit) Leveling

A horizontal line of sight is established by an observer with aid of a spirit bubble, plumb line or freely suspended compensator system. Enables line is to be sighted through a telescope in a horizontal direction.

Methods (differential leveling, rise & fall, height of collimation); (dH = BS - FS) the survey was conducted based on rise and fall method. Reasonable accuracies was achieved, but the requirement to close all leveling circuits remains to avoid gross errors and to control misclosure limits.

Leveling of all points along railway line was started from known National Bench Marks and traversing through newly established stake pins at every 1km along the railway line. Spirit levelling survey based to the Rise and Fall method, its traverse were started to a known National Bench Marks, which height values are known and closed to the another bench mark, which could be checked itself and confirmed to be in-situ.

The Instruments used for the survey were Automatic Levels, Tripod stands, leveling staffs, ranging rods, steel tape, Iron blade (*Panga*). The accuracy specified is per loop ±10 mm√D (D: leveled distance in km) were achieved (Ref: Appendix 4).

(2) Coordination of Horizontal Positions

The horizontal positions (N, E) with coordination of all the bench marks and the section stakes points were surveyed by using of the satellite positioning techniques instead of Total Station traversing. This process was carried out in two stages by the first being the coordination of the main bench marks at 20 km intervals basing on the National Bench Marks. This was secondly followed by the coordination of the Section Stake points with this coordination being based on the 20 km bench mark points as references.

The coordination of the bench marks was verified by using the Trimble ProXRT GNSS receiver (See figure below). All GNSS receivers are able to receive signals from the current available satellite positioning systems including the United States Global Positioning System (GPS), the Russian Global Navigation Satellite System (GLONASS), the European Galileo. Currently some systems can also receive signals from the Chinese BDS system. This lead to a rapid and relatively high accuracy positioning compared to using only one system.

Figure R.6: Trimble Pro-XRT GNSS Receiver

In addition, using the signals from multiple satellite systems for improved positioning, the accuracy is further improved to centimeter level by applying differential corrections to the observed position. This involves getting corrections from a reference fixed station which is simultaneously making observations on a known location and computes differences to observed and the known coordinates on that reference points. The theory is that the differences are due to un-modelled errors from the satellite systems which reduce the accuracy of the observed positions. These differences are then sent to the observer as corrections to the observed

positions and results in the final observed position to have accuracy of ±3 cm or less. The differential corrections can be sent to the observer via orbiting satellites systems such as the OmniSTAR system or via direct radio link or cellular GSM systems in a mode known as Real Time Kinematic (RTK or GPS-RTK or GNSS-RTK).

Using the Trimble ProXRT GNSS receiver with corrections from OmniSTAR system six benchmarks namely CSS001, IP285 CSS002, CSS003, CSS004 and CSS005 were coordinated. In order to have all coordinates referred to the National Coordinate system, the OmniSTAR corrections were initialized by using a known point in Kilosa.

Based on the six bench marks as reference controls, the stake pins at one km interval were coordinates by using the GNSS-RTK technique. Two survey groups were involved. One group used the X900 GNSS-RTK instrument from the Chinese CHC company, while the other group used the V30Pro GNSS-RTK instrument from the Chinese Hi-Target company. GNSS-The RTK technique was also used for observing the cross sections once the stake pin has been coordinated. The observation of the cross section was based on the coordinates of the stake pin. As for cross section observations, the elevation value used was that obtained from spirit leveling.

Figure R.7: X900 GNSS- RTK Instrument Set

Figure R.8: V30 Pro GNSS- RTK Instrument Set

Using the GNSS-RTK methods Stake pins at every cross section in the main river of Kinyasungwe/ Mkondoa coordinated. Namely, these were IP282, IP283, IP284, IP285, IP286, IP287, IP288, IP289, IP290, IP291, IP292, IP293, IP294, IP295, IP296, IP297, IP298, IP299, IP300, IP301, IP302, IP303, IP304, IP305, IP306, IP307, IP308, IP309, IP310, IP311, IP312, IP313, IP314, IP315, IP316, IP317, IP318, IP319, IP320, IP321, IP322, IP323, IP324, IP325, IP326, IP327, IP328, IP329, IP330, IP331, IP332, IP333, IP334, IP335, IP336, IP337, IP338,

IP339, IP340, IP341, IP342, IP343, IP344, IP345, IP346, IP347, IP348, IP349A, IP349A1, IP249B, IP349C, IP349, IP350, IP351, IP352, IP353, IP354, IP355, IP356, IP357, IP358, IP359, IP360, IP361, IP362, IP363, IP364, IP365 and IP366.

In addition to the above, stake pins that were established on historical sections, which were previously measured in 1999, were re-surveyed. These are named as Sect_284.38, Sect_289.37, Sect_290.74, Sect_291.70, Sect_292.30, Sect_292.70, Sect_296.50, Sect_298.30, Sect_302.18, Sect_306.80 and Sect_314.60 respectively.

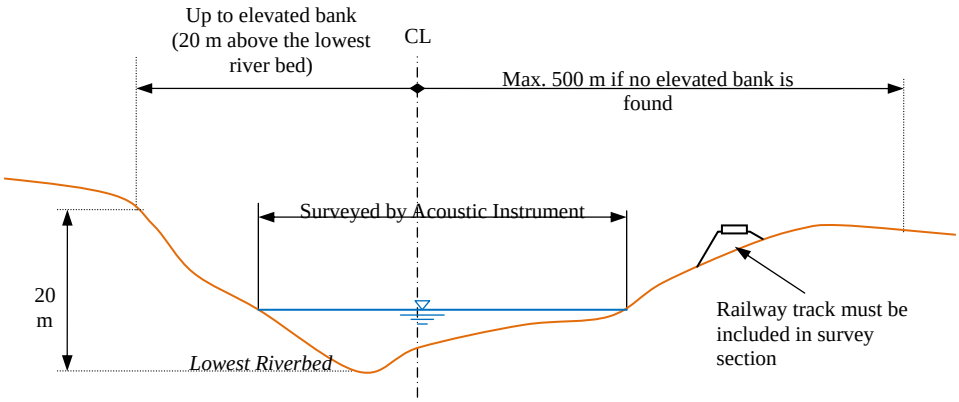
Additional sections were also measured on selected bridges and these include two bridges at Kilosa, near Km293.5 (New bridge) Kidete, Kidibo, Gulwe and at Kongwa.

R.2.3 River Cross Section Survey for the Kinyasungwe–Mkondoa Rivers and Seven Tributaries

Setting up of the cross sections for Kinyasungwe/Mkondoa River were conducted after all points were monumented along the railway. Two points more were fixed besides of the river along the same line using tracking alignment set up of GPS-RTK.

The Surveyors were responsible to make sure the cross section meet approximately at perpendicular to the direction of water flow. The width and interval of each cross section were maintained as requirements in the specification, unless there limitation which does not fit the intention, but another option was adapted to fulfill the specifications.

During the time of setting out of cross sections, observations by using Real Time Kinematic RTK method was continued to coordinates in terms of Northings, Eastings and height of all desirable points simultaneously (section width 1000 m and interval 1000 m). The accuracy of Differential GPS is 5–10 cm.



Source: JICA Study Team

Figure R.9: Cross Section Layout

Cross sections for tributaries were fixed of 500 m interval with 300 m width and reading of each section was started at rivers confluence to the direction to upstream for 5 km. The two marks of iron pins with concrete were placed at each safe side of the river. Thereafter, reading of points along the section was carried out by using RTK- GPS.

R.2.4 Certification of Existing Control Points (Datum Points)

The Director of Survey and Mapping in the Ministry of Lands, Housing and Human Settlements Development has approved the survey to adopt methodology of using Trimble ProXRT receiver that has capacity to operate in real time and without the need for local base stations or telemetry links and permit of using bench marks that are existing along or near the railway line. The used instruments of Trimble ProXRT No. 85360-10 with Activation code No. 14-0053568 of signal corrections as Omnister Id and are known worldwide that is operating in Tanzania.

R.2.5 Consultations Meeting

The survey contractor had meetings several times with JICA Study Team to modify, update and change the number of activities in order to make sure the work to accomplish under the specified standards.

R.2.6 Survey Personnel and Tasks Allocated

Team No.1

Tasks: (1) To install Bench marks of our work of 20 km interval and 5 km interval.
(2) Monumentation of bench marks and stake pins
(3) GPS- RTK observations in cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Samuel Mwanga	Geomatician	BSc. Geomatics
2.	Daniel Mnkeni	Survey Tech.	Diploma in Geomatics
3.	Andrew Lungo	Survey Tech (Experienced)	Std VII
4.	Daliki A. Dalikia	Survey Tech (Experienced)	Form IV
5.	Emmanuel Kanuti	Driver	Form IV

Team No. 2

Tasks: (1) To install Stake pins along railway line at every 1 km
(2) Monumentation of stake pins
(3) GPS- RTK observations along cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Katete Enock	Geomatician	BSc. Geomatics
2.	Saleh Khamis	Survey Tech	–
3.	Sabinus Tilia	Survey Tech	–
4.		Driver	–

Team No. 3

Tasks: (1) To install Stake pins along railway line at every 1 km
(2) Monumentation of stake pins
(3) GPS- RTK observations along cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Jaffari Lindonde	Geomatician	BSc. Geomatics
2.	Muhsin Ally	Survey Tech	–
3.	Hemedi Ally Buguza	Survey Tech	–
4.	Hamisi Namanka	Geomatician	BSc. Geomatics

Team No. 4

Tasks: (1) To install Stake pins along railway line at every 1km
(2) Monumentation of stake pins
(3) Levelling of all points along Railway line from Kilosa to Gulwe
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Athumani Shehoza	Surveyor	BSc-Geomatics
2.	Kamtwanje Hussein	Surveyor	BSc-Geomatics
3.	Salum Mohamed	Surveyor	Diploma Land Surveying

Office team

Tasks: (1) Administration& Management
(2) Data compilation& computations
(3) Preparation of drawings

Sr. No.	Names	Position(s)	Education
1.	Dunford Mateso	Leader	MSc. LUP& BSc. Geomatics
2.	Hassan Mdimu	Land Surveyor	Diploma in Land Surveying
3.	Yassin Kabandika	Sen. Land Surveyor	Diploma in Land Surveying

R.3 Survey Results

R.3.1 Bench Marks and Stake Pins

A total of five stations were established along the railway line. These points were qualified as bench marks, thereafter 89 points were established in each kilometer from Kilosa to Gulwe and also qualified as stake pins nearby cross sections lined.

Purposely of determining deposition of materials on the riverbed also 12 points were approximately installed at the positions where another sections measured in 1999. The size, shape and name of all points listed on previous chapter 2.

Some of the dedicated points were prepared its description cards (Appendix 1) which will help other surveyors to approach the points easily.

R.3.2 Spirit Leveling

Leveling instruments occupied to the new installed bench marks along railway line from IP282 to IP366 (Traverse route indicated on Appendix 5) and make a total of 24 Bench marks of our work and 84 Stake pins. The fixations of these points were assured at a level of misclosure not greater than ±0.025 m, this fact you can get from Appendix 3. Table below illustrates Names of occupied Bench marks and Stake pins and the column for elevation values.

The National Bench marks used to fix the height of new points were as follows: A4/6, A4/10, A4/25, A4/25, A4/28 and A4/42. The points abstracted from the list of National Bench Marks on Appendix 3.

The lowest value along the route of new Bench marks and Stake pins is 487.680 m and highest is 782.457 m determined at IP282 and IP366 respectively, which make a difference in height of 294.777 m.

The approximately middle height can be found at IP319 and IP320 where its values are 629.884 m and 637.170 m respectively, the locality of the middle elevation along the railway can be found near Mwasa settlements.

Table R.1: Summary of Levels

SR	STN ID	ADJ RL	Remarks
1	**IP 282**	**487.680**	Stake pin
2	**CSS001**	**489.359**	BM of our work
3	**IP 283**	**489.277**	Stake pin
4	**IP 284**	**494.726**	Stake pin
5	**IP 285**	**497.900**	BM of our work
6	**IP 286**	**500.327**	Stake pin
7	**IP 287**	**503.124**	Stake pin
8	**IP 288**	**506.391**	Stake pin
9	**IP 289**	**505.947**	Stake pin
10	**IP 290**	**510.170**	BM of our work
11	**IP 291**	**512.469**	Stake pin
12	**IP 292**	**515.785**	Stake pin
13	**SECT 292.30**	**516.856**	Stake pin
14	**SECT 292.70**	**519.365**	Stake pin
15	**IP 293**	**520.143**	Stake pin
16	**IP 294**	**520.335**	Stake pin
17	**IP 295**	**523.218**	BM of our work
18	**IP 296**	**527.807**	Stake pin
19	**SECT 296.50**	**529.869**	Stake pin
20	**IP 297**	**530.786**	Stake pin
21	**IP 298**	**536.165**	Stake pin
22	**SECT 298.30**	**535.968**	Stake pin
23	**IP 299**	**538.470**	Stake pin
24	**IP 300**	**544.533**	Stake pin
25	**IP 301**	**549.155**	Stake pin
26	**IP 302**	**552.445**	Stake pin
27	**CSS002**	**554.755**	BM of our work
28	**IP 303**	**555.573**	Stake pin
29	**IP 304**	**561.459**	Stake pin
30	**IP 305**	**564.947**	BM of our work
31	**SECT 289.37**	**506.797**	Stake pin
32	**SECT 290.74**	**511.679**	Stake pin
33	**IP 306**	**567.324**	Stake pin
34	**SECT 306.80**	**570.503**	Stake pin
35	**IP 307**	**571.693**	Stake pin
36	**IP 308**	**576.286**	Stake pin
37	**SECT 308.84**	**578.664**	Stake pin
38	**IP 309**	**578.845**	Stake pin
39	**IP 310**	**585.058**	BM of our work
40	**IP 311**	**590.355**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks.

SR	STN ID	ADJ RL	Remarks
41	**IP 312**	**595.714**	Stake pin
42	**IP 313**	**602.292**	Stake pin
43	**IP 314**	**606.241**	Stake pin
44	**SECT 314.60**	**607.480**	Stake pin
45	**IP 315**	**610.009**	BM of our work
46	**IP 316**	**616.318**	Stake pin
47	**IP 317**	**620.057**	Stake pin
48	**IP 318**	**623.918**	Stake pin
49	**IP 319**	**629.884**	Stake pin
50	**IP 320**	**637.170**	BM of our work
51	**IP 321**	**643.095**	Stake pin
52	**IP 322**	**651.969**	Stake pin
53	**IP 323**	**660.781**	Stake pin
54	**IP 324**	**670.249**	Stake pin
55	**IP 325**	**675.829**	BM of our work
56	**IP 326**	**674.722**	Stake pin
57	**IP 327**	**670.329**	Stake pin
58	**IP 328**	**670.192**	Stake pin
59	**IP 329**	**670.633**	Stake pin
60	**IP 330**	**671.056**	BM of our work
61	**IP 331**	**671.367**	Stake pin
62	**IP 332**	**676.265**	Stake pin
63	**IP 333**	**678.772**	Stake pin
64	**IP 334**	**685.490**	Stake pin
65	**IP 335**	**688.649**	BM of our work
66	**IP 336**	**690.007**	Stake pin
67	**IP 337**	**694.795**	Stake pin
68	**IP 338**	**700.725**	Stake pin
69	**IP 339**	**701.982**	Stake pin
70	**IP 340**	**704.060**	BM of our work
71	**IP 341**	**704.846**	Stake pin
72	**IP 342**	**708.872**	Stake pin
73	**CSS004**	**713.731**	BM of our work
74	**IP 343**	**714.695**	Stake pin
75	**IP 344**	**722.607**	Stake pin
76	**IP 345**	**729.157**	BM of our work
77	**IP 346**	**734.343**	Stake pin
78	**IP 347**	**736.304**	Stake pin
79	**IP 348**	**738.148**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks.

SR	STN ID	ADJ RL	Remarks
80	**IP 349/1A**	**739.490**	Stake pin
81	**IP 349A**	**739.729**	Stake pin
82	**IP 349B**	**743.354**	Stake pin
83	**IP 349C**	**751.261**	Stake pin
84	**IP 350**	**752.142**	BM of our work
85	**IP 351**	**751.321**	Stake pin
86	**IP 352**	**754.388**	Stake pin
87	**IP 353**	**755.374**	Stake pin
88	**IP 354**	**757.692**	Stake pin
89	**IP 355**	**765.882**	BM of our work
90	**IP 356**	**768.310**	Stake pin
91	**IP 357**	**769.475**	Stake pin
92	**IP 358**	**770.314**	Stake pin
93	**IP 359**	**771.221**	Stake pin
94	**IP 360**	**772.385**	BM of our work
95	**IP 361**	**774.189**	Stake pin
96	**IP 362**	**774.292**	Stake pin
97	**CSS005**	**777.752**	BM of our work
98	**IP 363**	**777.203**	Stake pin
99	**IP 364**	**777.549**	Stake pin
100	**IP 365**	**781.691**	BM of our work
101	**IP 349**	**753.546**	Stake pin
102	**IP 366**	**783.277**	Stake pin
103	**IP 366/5**	**782.457**	Stake pin
104	**SECT 284.38**	**495.113**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks
Source: Dunny Geoinformatics

R.3.3 Measurements of Cross sections

Cross sections in our project are the lines running approximately perpendicular to the Main River and selected tributaries.

To set these lines we used GPS- RTK to fix the position of each point at any change of gradient along specified line.

To make sure line is straight at any point, the GPS-RTK instruments setup was automatic not to read position in Northings, Eastings and Height till it reach within 3 cm allowable error.

Before carrying out measurements the GPS-RTK should have two receivers, one is set at known station in position wise and another is roaming along sections line to determine new positions. The two receivers they link to each other through radio waves.

Cross sections data sample (Table R.2) were listed in terms of Offset, Elevation and Descriptions, the data were abstracted from coordinates of Northings, Eastings, Elevations and Descriptions which processed direct from the software after downloading from GPS- RTK controller.

Cross sections details sketch for bridges is indicated on Appendix 6.

Table R.2: River Cross Section Data

IP322			IP323		
Offset	Eleva	Description	Offset	Eleva	Description
423.4052	657.1322	SH	565.7042	660.354	SH
418.3545	651.965	SH	638.0018	662.315	SH
415.7619	652.4128	CRL322	625.4196	660.44	SH
413.3934	651.97	IP322	602.6077	656.192	SH
402.764	657.6654	SH	584.6743	654.633	SH
361.9957	655.208	SH	572.4312	660.668	SH
309.0032	653.114	SH	569.2765	660.841	RL
257.3459	651.4415	SH	567.2066	660.575	IP323
226.0828	647.3995	SH	555.5353	654.532	SH
201.345	647.4754	SH	525.0898	654.794	SH
144.2205	647.3511	SH	492.5978	655.225	SH
89.0366	648.3255	XIP322/1	422.7103	655.218	SH
80.82334	648.0481	RB	369.2219	654.213	SH
61.39231	639.2339	RBO	363.5568	653.12	SH
0	640.135	Criver	326.6521	653.131	SH
-135.18	640.856	SH	296.9185	653.975	SH
-196.076	641.573	SH	257.2293	655.511	SH
-247.937	641.9078	LBO	209.0607	654.97	SH
-260.874	646.4381	LB	154.2609	654.566	SH
-277.858	647.1563	XIP322/2	124.881	654.797	SH
-333.036	646.4778	SH	113.5425	654.766	IP323/1 BANK
-525.774	645.6612	SH	104.5989	645.347	SH
-766.092	648.4664	SH	98.82636	642.775	WATER FLOOR
-785.227	654.3099	SH	88.47241	642.735	SH
-807.854	661.4751	SH	77.79019	642.709	SH

Source: Dunny Geoinformatics

Lack of reliable horizontal National bench marks the Ministry of Land allowed our project to base on Static GPS of Integrated Omnistar signal corrections.

The entire work its coordinates system were transformed from GPS-RTK to adopt the Static GPS system, it is not possible to have the same transformation parameters because our project is in linearity character which their distortion in scale, rotation and transition it starts to change in large values beyond 5 km. So in our particular project we break portions of 10–15 km and transform the coordinates with different parameters which were desired.

The transformation process produces ±0.5–1 meter accuracies in positioning horizontally and this vary depending on the distances. Shorter distance, error is small and longer distances having big error.

We have experienced the UTM coordinates system used in mapping in Tanzania is based on Arc 1960 Datum which is not fitting well on determined ellipsoid compared to WGS84 Datum.

Here we revised readings to improve the accuracy attained earlier by occupying more Bench Marks of our work and stake pins.

We used Trimble Pro XRT to revisit some points which control revised cross section readings, their readings listed down on Table R.3. In the table you can find accuracies attained by instrument.

Table R.3: Static GPS Observations

Pt_name	Location	Max_PDOP	Max_HDOP	Corr_Type	GPS_Date	Filt_Pos	Horz_Prec	Std_Dev	Northing	Easting
IP366	GULWE	2.2	1.3	Real-time Code	6/22/2015	30	9.2	0.037735	9286700.368	213542.189
IP364	GULWE	2.2	1.0	Real-time Code	6/22/2015	30	9.2	0.027707	9285808.606	215265.731
IP363	GULWE	3.1	1.1	Real-time Code	6/22/2015	30	9.3	0.012856	9285404.442	216168.572
css 005	GULWE	2.3	1.0	Real-time Code	6/22/2015	30	9.2	0.011541	9285361.960	216364.428
IP366/5	GULWE	2.3	0.9	Real-time Code	6/23/2015	30	9.2	0.029786	9287013.387	213150.932
IP362	GULWE	2.5	1.0	Real-time Code	6/23/2015	30	9.4	0.019881	9284766.341	216870.545
IP361	GULWE	2.1	1.2	Real-time Code	6/23/2015	30	9.4	0.018639	9284229.948	217691.177
IP360	GULWE	2.0	1.0	Real-time Code	6/23/2015	30	9.1	0.019949	9283449.770	218272.793
IP359	GULWE	2.2	1.0	Real-time Code	6/23/2015	30	9.3	0.040670	9282775.122	218997.271
IP358	GULWE	2.1	0.9	Real-time Code	6/23/2015	30	9.2	0.070559	9282441.107	219929.148
IP357	GULWE	2.4	1.1	Real-time Code	6/23/2015	30	5.6	0.023463	9282516.322	220923.309
IP356	GULWE	1.9	0.9	Real-time Code	6/23/2015	30	9.3	0.027361	9282374.113	221816.395
IP354	GULWE	1.6	0.8	Real-time Code	6/23/2015	30	9.6	0.012106	9281764.676	223715.912
IP350	GULWE	2.2	0.9	Real-time Code	6/24/2015	30	9.3	0.016413	9279459.162	226727.188
IP346	Godegode	2.2	1.3	Real-time Code	6/24/2015	30	9.3	0.018305	9276378.326	232656.904
IP343	GODEGODE	2.1	1.0	Real-time Code	6/24/2015	30	9.3	0.021454	9275928.541	235300.023
IP342	GODEGODE	4.6	1.3	Real-time Code	6/24/2015	30	9.3	0.061287	9275254.756	236043.378
IP338	GODEGODE	2.3	1.0	Real-time Code	6/24/2015	30	9.1	0.016947	9273014.274	239000.916
IP337	GODEGODE	2.3	1.0	Real-time Code	6/24/2015	30	9.2	0.033980	9272343.975	239686.436
IP333	GENGE5	2.1	1.0	Real-time Code	6/25/2015	30	9.1	0.045751	9269474.336	241508.689
IP329	GENGE5	2.1	1.0	Real-time Code	6/25/2015	30	9.8	0.018898	9267258.111	244325.068
IP324	KIDETE	2.0	1.0	Real-time Code	6/25/2015	30	9.2	0.041804	9263677.813	246862.013
IP317	MWASA	5.5	1.7	Real-time Code	6/25/2015	30	9.8	0.047106	9260746.408	252152.366
IP312	MZAGANZA	2.4	1.1	Real-time Code	6/25/2015	30	9.1	0.034054	9259028.534	256642.721
IP310	MZAGANZA	2.2	1.4	Real-time Code	6/26/2015	30	9.2	0.018342	9258661.521	258557.003
IP305	MZAGANZA	4.6	1.3	Real-time Code	6/26/2015	30	9.7	0.026327	9255441.102	261624.938
IP300	MUNISAGARA	2.4	1.0	Real-time Code	6/26/2015	30	9.3	0.038771	9254543.662	265931.764
IP295	MUNISAGARA	2.0	0.9	Real-time Code	6/26/2015	30	9.4	0.020893	9253037.211	269814.107
IP282	KILOSA	2.1	1.0	Real-time Code	6/27/2015	30	8.8	0.022695	9244803.072	277886.999
IP283	KILOSA	2.1	1.3	Real-time Code	6/27/2015	30	9.2	0.034049	9244708.916	276896.629
IP290	KILOSA	3.1	1.1	Real-time Code	6/27/2015	30	9.3	0.046017	9249912.226	273283.706
IP 285	KILOSA TOWN	1.9	0.8	Real-time Code	4/25/2015	30	9.4	0.053919	9245932.764	275568.439
IP 302	MUNISAGARA	2.3	0.9	Real-time Code	4/25/2015	30	9.7	0.014211	9254092.191	263993.433
CSS002	MUNISAGARA	2.1	0.8	Real-time Code	4/25/2015	30	9.5	0.084359	9254200.076	263189.625
IP 323	KIDETE	4.2	1.2	Real-time Code	4/25/2015	30	9.4	0.017076	9263515.416	247824.266
CSS004	GODEGODE	1.5	0.8	Real-time Code	4/26/2015	30	9.3	0.013520	9275816.128	235466.925
MORGA	GULWE	2.3	0.8	Real-time Code	4/26/2015	30	9.6	0.092836	9287107.542	212941.678
KN03A	KONGWA	2.7	1.1	Real-time Code	4/26/2015	30	9.8	7.058889	9312285.609	204104.404
BASE	KONGWA	2.2	1.0	Real-time Code	4/26/2015	30	8.9	0.025089	9312292.130	204107.821

Note: Pt_name= Point name, Max_PDOP= Maximum Precision Dilution of Positions, Max_HDOP= Maximum of Height Dilution of Positions, Corr_Type= Signal correction type, Rcvr_Type= Receiver type, GPS_date= Global Positioning System date, Vrt_Prec= Vertical precision, Hrz_Prec= Horizontal precision, Std_Dev= Standard deviation.
Source: Dunny Geoinformatics

R.3.4 Data Processing of GPS- RTK (Real Time Kinematic)

The raw data collected by a receiver were processed in order to determine the differential relationship between the points during data collection. The results of processing GPS raw data were vectors defining this relationship. Computation of these vectors was the role of the data processing module done within GNSS (Glonass Network Satellite System) Solutions software.

The purpose of data processing module was to analyze the quality of the raw data files and adjust processing parameters to produce the best vectors. In GNSS Solutions software, the actual processing of data is limited to a simple press of the process button.

In this stage of data processing, three steps were done as follows:

- **Pre-process data analysis**: Point and observation properties were verified and/or entered
- **Processing**: GNSS vectors were produced from raw data.
- **Post-process data analysis**: Produced GNSS vectors were analyzed using supplied analysis tool to determine the quality of processed data.

R.3.5 Coordinate System Summary

Coordinate system	
Name:	UTM/ARC1960/UTM zone 37S
Type:	Projected
Unit name:	Meters
Meters per unit:	1
Vertical datum:	EGM96
Vertical unit:	Meters
Meters per unit:	1
Datum	
Name :	ARC 1960
Ellipsoid Name:	CLARK1880
Semi-major Axis:	6378249.149 m
Inverse Flattening:	293.465
DX to WGS84:	−160.0000 m
DY to WGS84:	−6.0000 m
DY to WGS84:	−302.0000 m
RX to WGS84:	0.000000 "
RY to WGS84:	0.000000 "
RZ to WGS84:	0.000000 "
ppm to WGS84:	0.000000000000
Projection	
Projection Class:	Transverse_Mercator
Latitude of origin	0° 00' 00.00000"N
Central meridian	39° 00' 00.00000"E
Scale factor	0.999600000000
False easting	500000.000 m
False northing	10000000.000 m

R.3.6 Output

(1) Layout map of main river cross sections, tributary and bridge positions were plotted on physically on the ground. The surveyed cross sections were overlaid on the topographic maps in scale of 1:50000.
(2) Plan view drawn to scale of 1:50000 and two sheets of A1 size covered to all cross sections
(3) Longitudinal section was drawn in scale of 1: 50000 for horizontal and vertical to and covered with two sheets of A1.
(4) Cross sections were drawn in scale of 1:500 for horizontal and vertical to 1:100 view to all of main river and tributaries
(5) Bridges cross section were shown with large scale this made to explore more details especially bridge size and height between bridge level and river bed.

R.4 Recommendations

As for combined observation method using GPS based on Omnistar signal corrections and GPS-RTK, surveyors should take care of the distance limit for getting proper accuracy. If distance of fixing position is beyond 5 km, the accuracy starts decreasing due to distortions of scale and rotation. Therefore, it is advised that surveyors on using both instruments should take care of the distance limits not to fix points beyond radius of 5 km.

Appendices

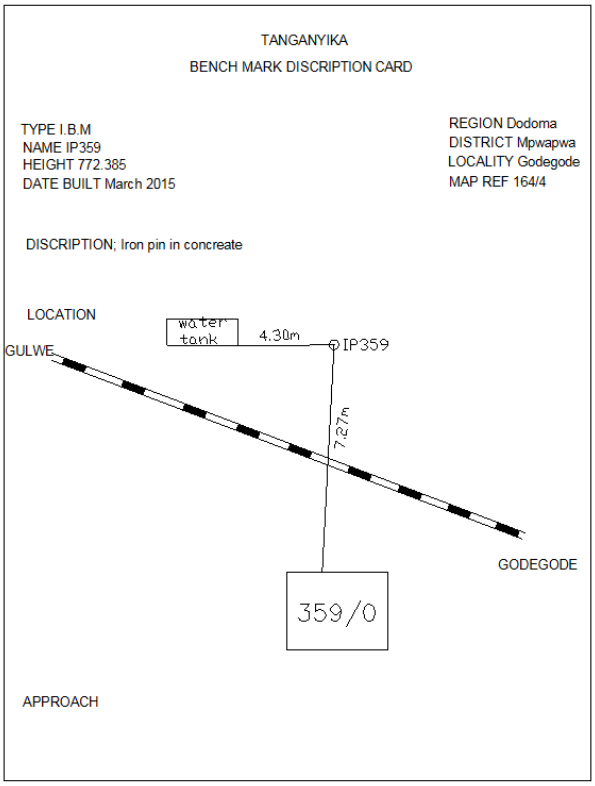
Appendix 1: Drawings

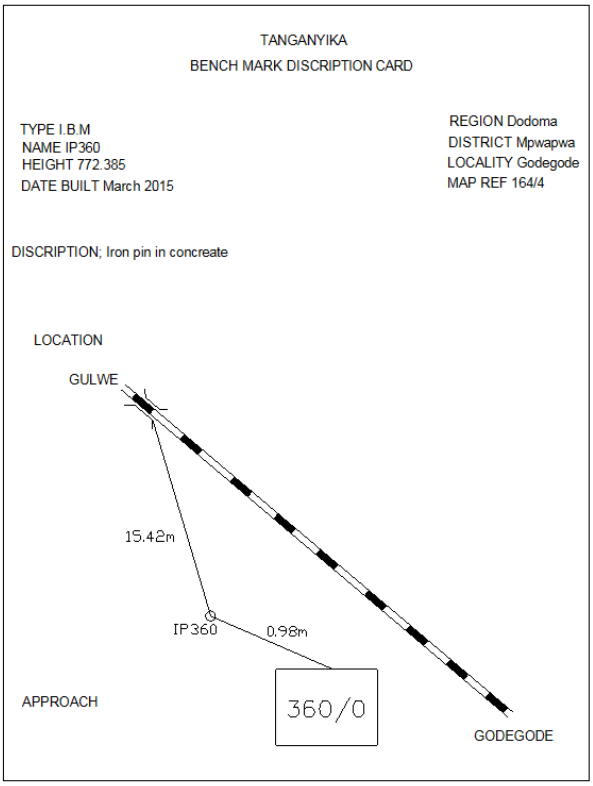
List of Survey Drawings

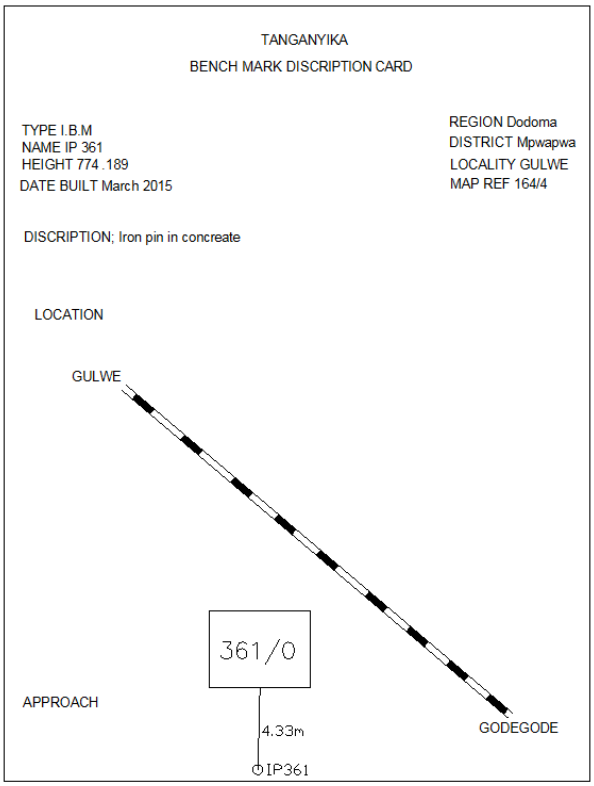
Id	List of survey drawings	Copies	Scale
1.	General location map		
2.	Location map of bench mark and cross sections (1/2)	3	1:50000
3.	Location map of bench mark and cross sections (1/2)	3	1:50000
4.	Plan view (1/2)	3	1:50000
5.	Plan view (2/2)	3	1:50000
6.	Longitudinal profile of main stream	3	Vertical 1:1500 Horizontal 1:7500
7.	Longitudinal profile of Mzase tributary	3	Vertical 1:1500 Horizontal 1:7500
8.	Longitudinal profile of Sikoko tributary	3	Vertical 1:1400 Horizontal 1:7000
9.	Longitudinal profile of Kidibo tributary	3	Vertical 1:1400 Horizontal 1:7000
10.	Longitudinal profile of Maswala tributary	3	Vertical 1:1000 Horizontal 1:5000
11.	Longitudinal profile of Mangweta tributary	3	Vertical 1:1400 Horizontal 1:7000
12.	Longitudinal profile of Lumuma tributary	3	Vertical 1:7500 Horizontal 1:15000
13.	Longitudinal profile of Mkondoa tributary	3	Vertical 1:1600 Horizontal 1:8000
14.	Cross sections tributaries	21	Vertical1:100 Horizontal 1:500
15.	Cross sections of main river		Vertical1:200 Horizontal 1:1000 Horizontal 1:1500

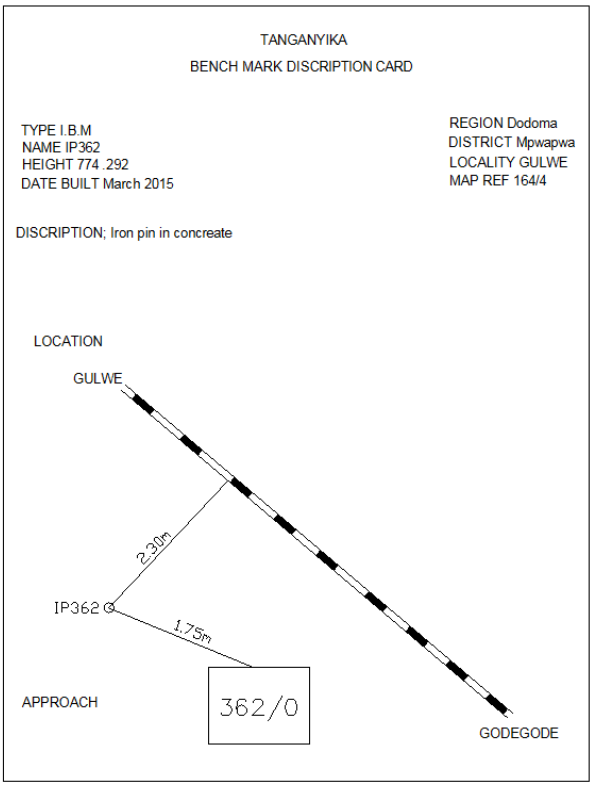
Source: Dunny Geoinformatics

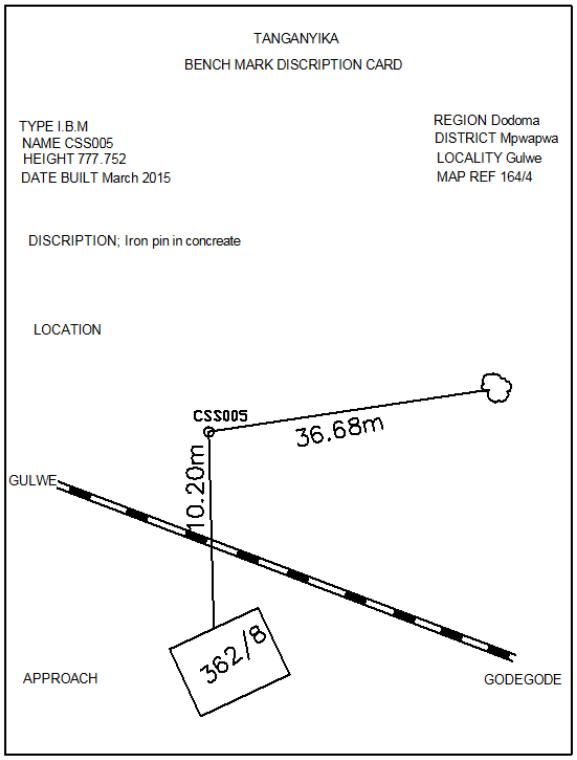
Appendix 2: Control Points Description Cards

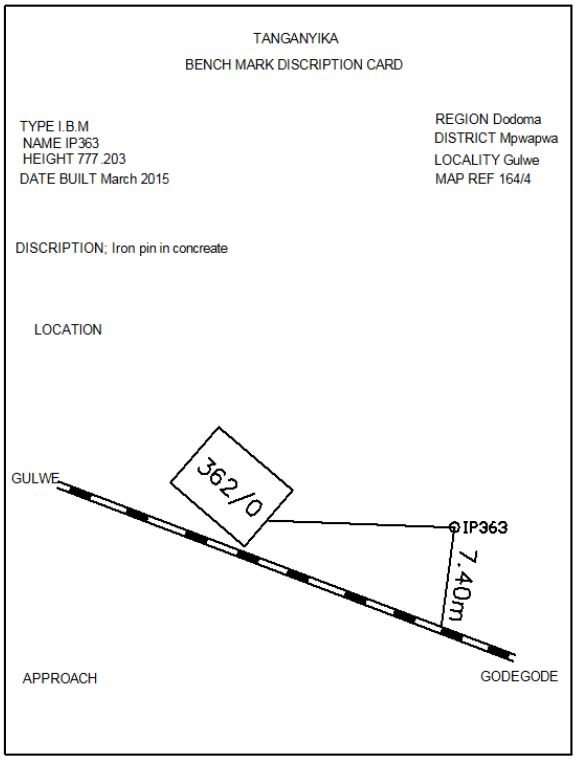


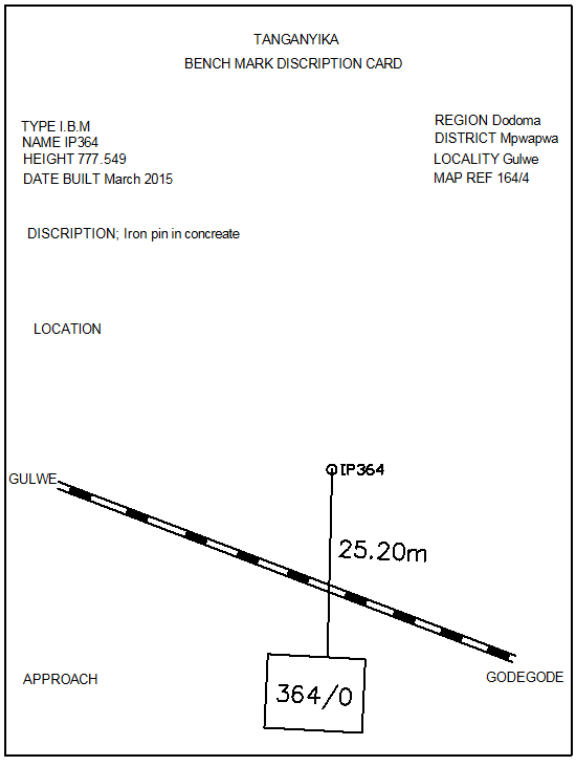


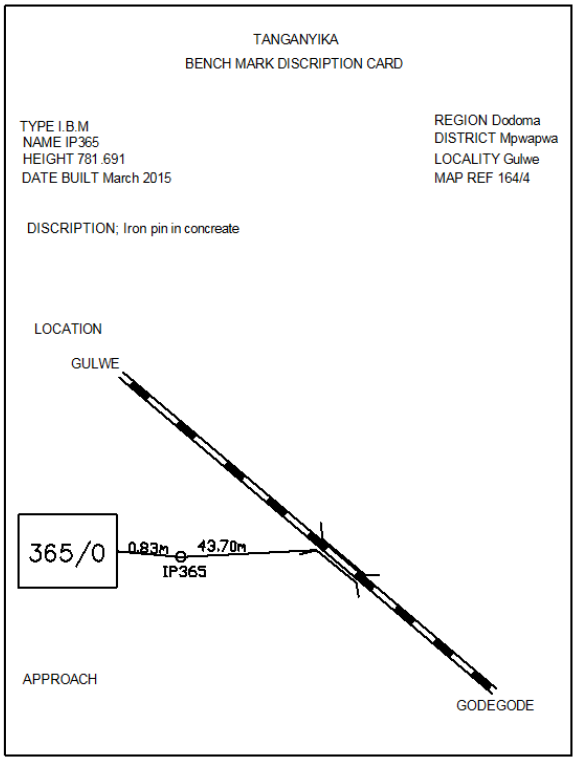





TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME CSS005
HEIGHT 777.752
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
CSS005
36.68m
10.20m
GULWE
362/8
APPROACH
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP363
HEIGHT 777.203
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
362/0
IP363
7.40m
APPROACH
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP364
HEIGHT 777.549
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP364
25.20m
APPROACH
364/0
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP365
HEIGHT 781.691
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
365/0
0.83m
43.70m
IP365
APPROACH
GODEGODE

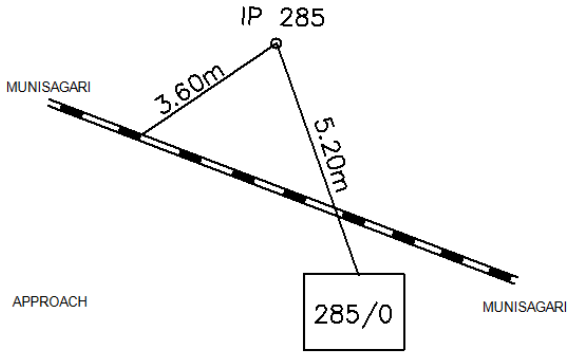
TANGANYIKA
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP 285
HEIGHT 497.900
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/4

DISCRIPTION; Iron pin in concreate

LOCATION



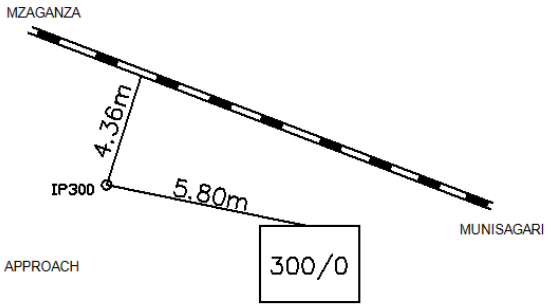
TANGANYIKA
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP300
HEIGHT 544.533
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



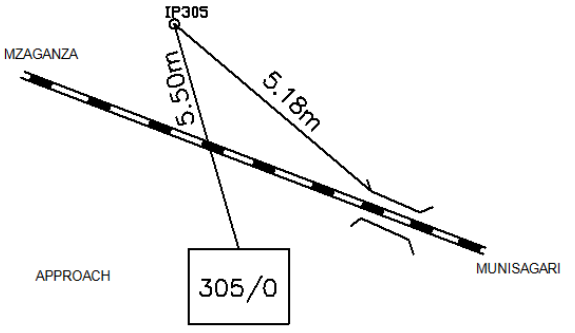
TANGANYIKA
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP305
HEIGHT 564.947
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



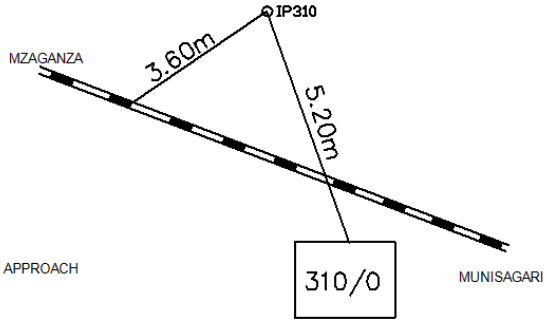
TANGANYIKA
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP310
HEIGHT 585.058
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

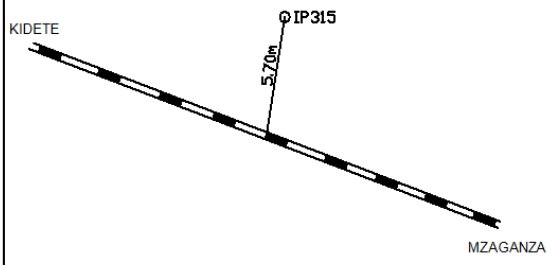
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP 315
HEIGHT 610.009
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Mwasa
MAP REF 181/1

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

TANGANYIKA

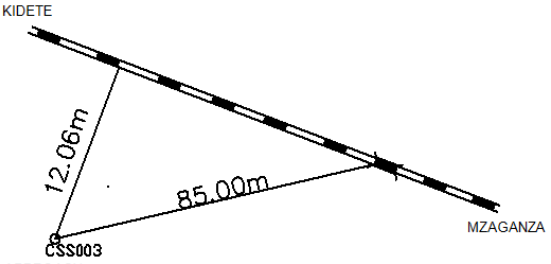
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME css 003
HEIGHT 661.751
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Mzaganza
MAP REF 181/1

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

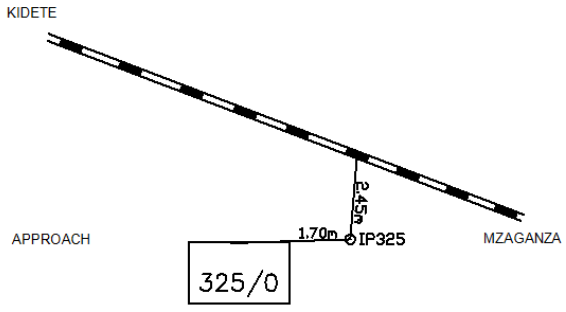
TANGANYIKA

BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP325
HEIGHT 675.829
DATE BUILT March 2015
DISCRIPTION; Iron pin in concreate

REGION Morogoro
DISTRICT Kilosa
LOCALITY Kidete
MAP REF 181/1

LOCATION



TANGANYIKA

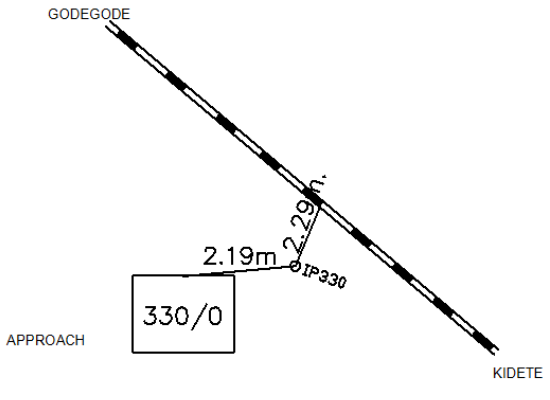
BENCH MARK DISCRIPTION CARD

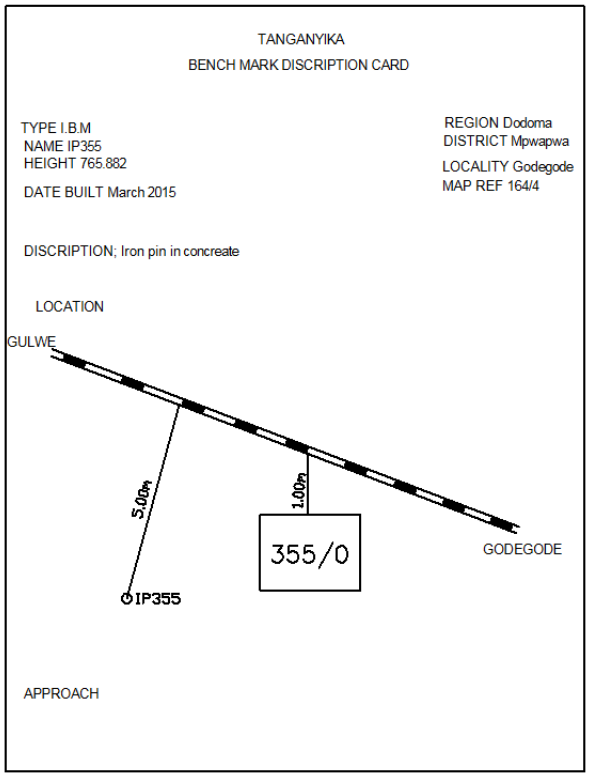
TYPE I.B.M
NAME 330
HEIGHT 671.056
DATE BUILT March 2015

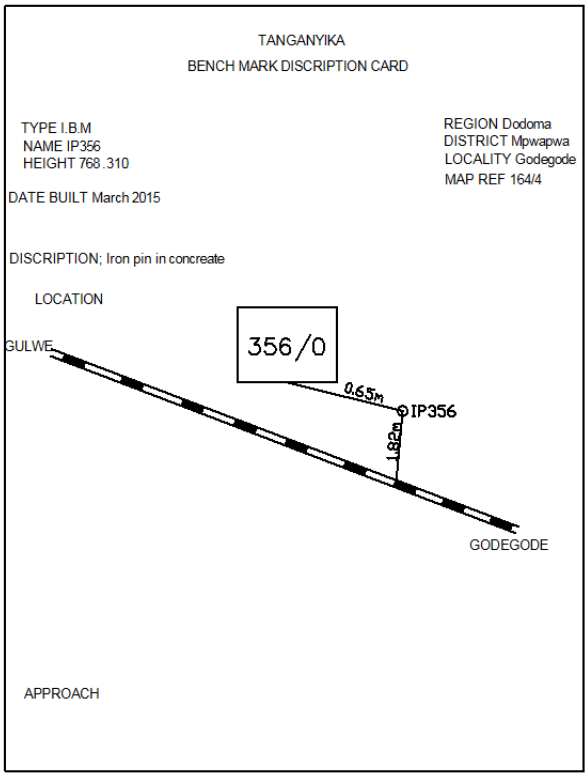
REGION Morogoro
DISTRICT Kilosa
LOCALITY Kidete
MAP REF 181/1

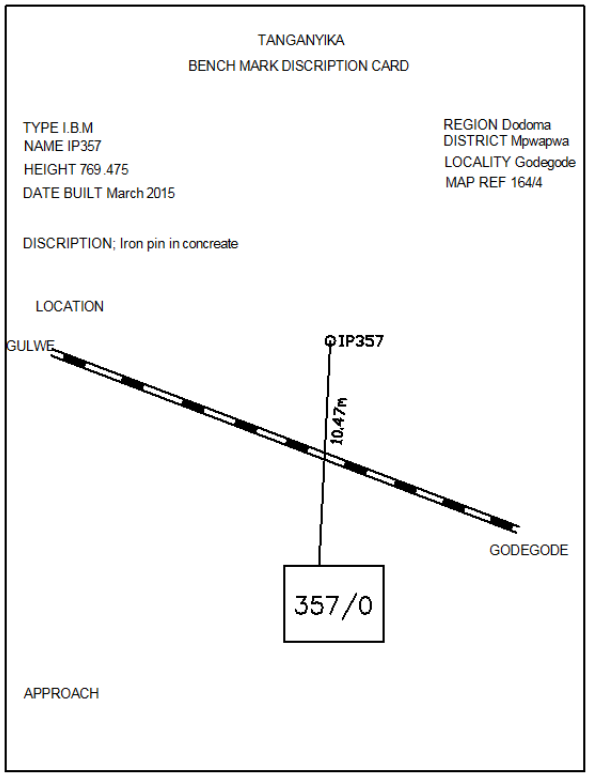
DISCRIPTION; Iron pin in concreate

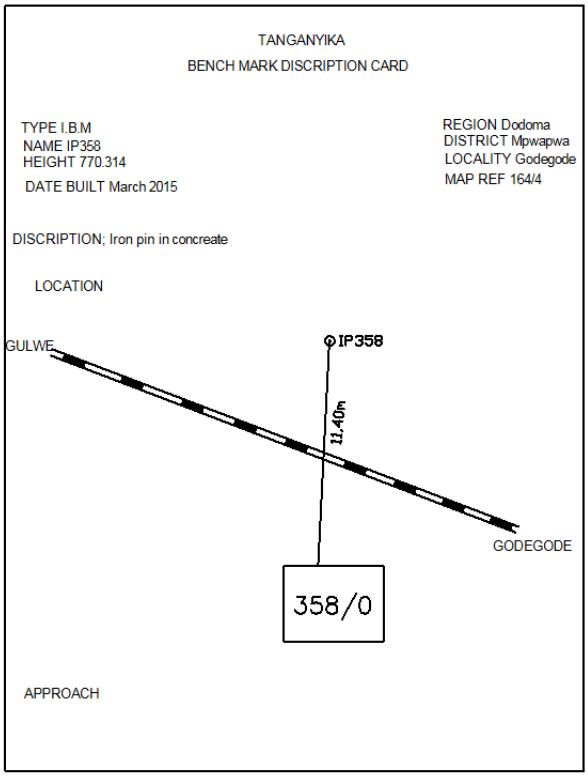
LOCATION




TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP355
HEIGHT 765.882
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
5.00m
1.00m
355/0
IP355
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP356
HEIGHT 768.310
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
356/0
0.65m
IP356
1.82m
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP357
HEIGHT 769.475
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP357
10.47m
GODEGODE
357/0
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP358
HEIGHT 770.314
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP358
11.40m
GODEGODE
358/0
APPROACH

TANGANYIKA

BENCH MARK DISCRIPTION CARD

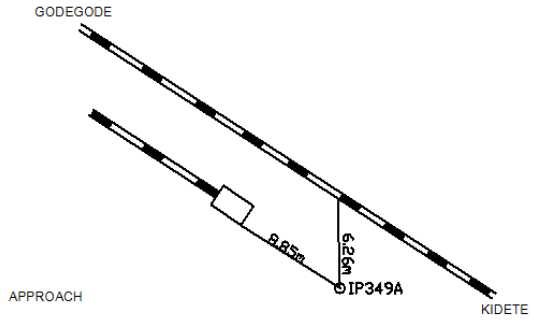
TYPE I.B.M
NAME 349 A
HEIGHT 739 .729

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Kidete
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

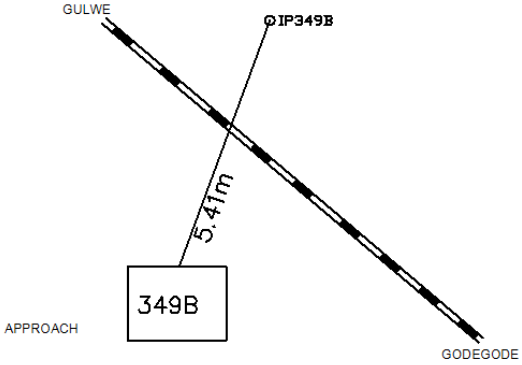
TYPE I.B.M
NAME 349 B
HEIGHT 743.354

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

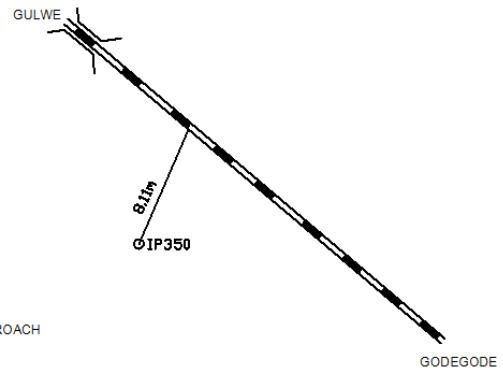
TYPE I.B.M
NAME 350
HEIGHT 752 .142

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

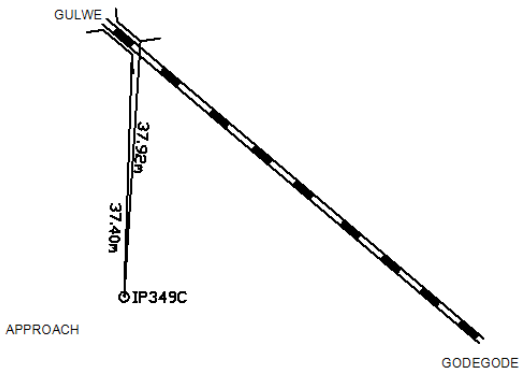
TYPE I.B.M
NAME 349 C
HEIGHT 751.261

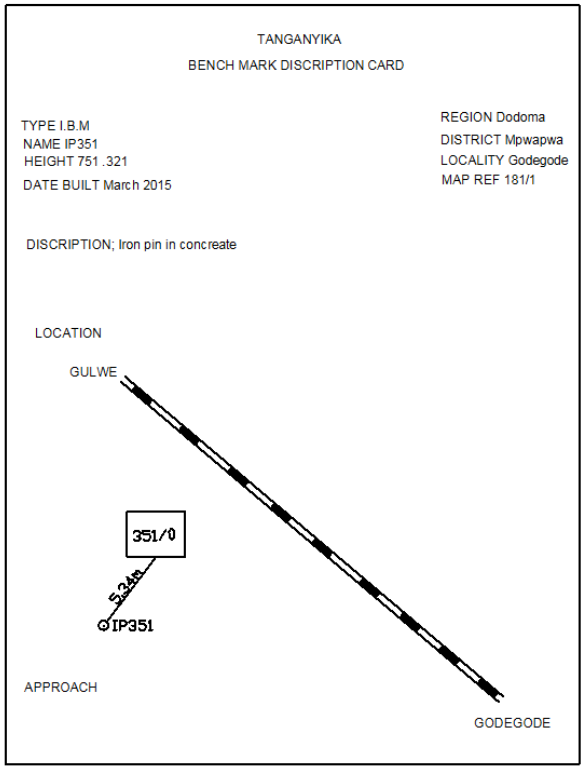
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

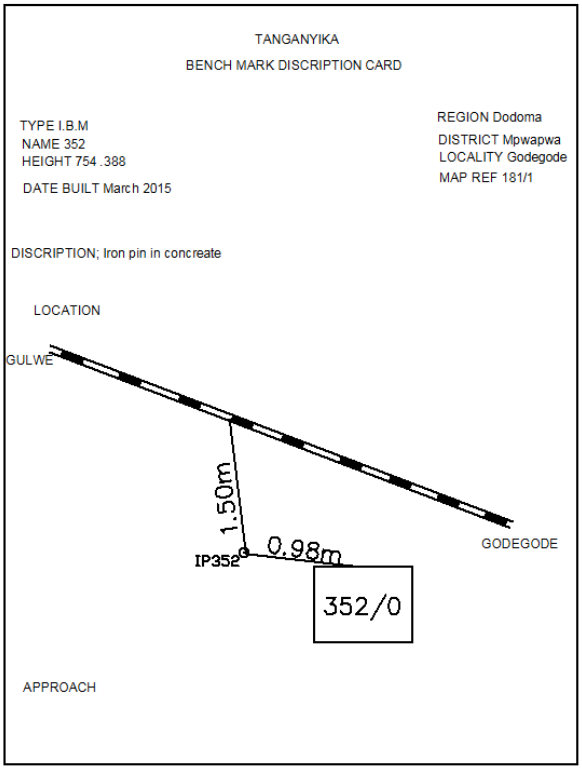
DATE BUILT March 2015

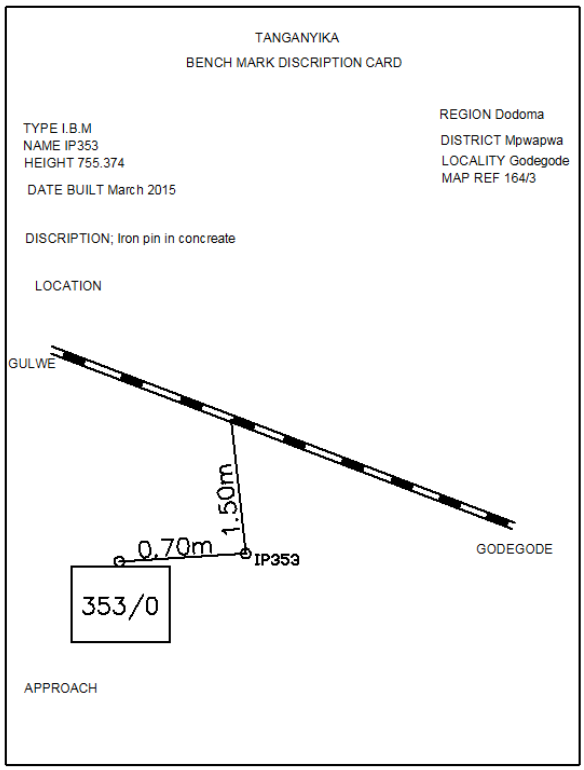
DISCRIPTION; Iron pin in concreate

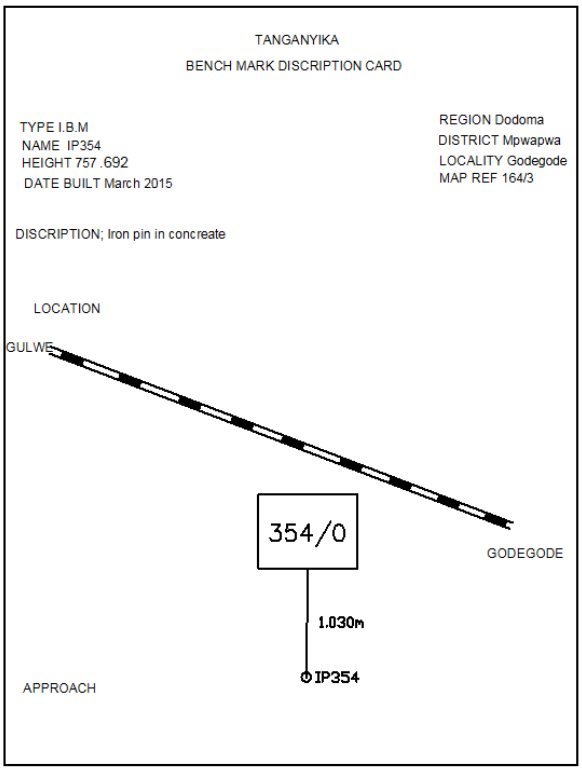
LOCATION

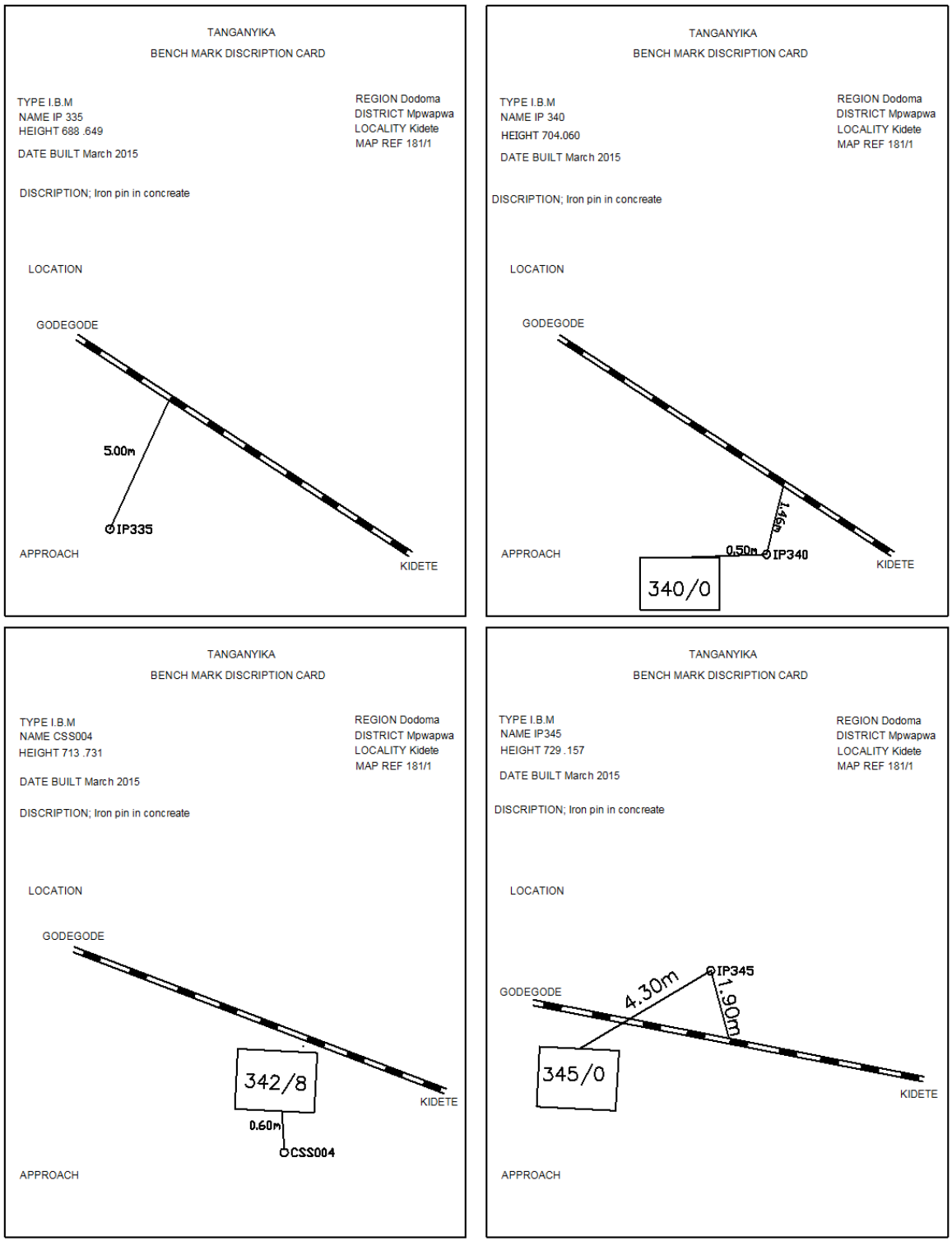



TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP351
HEIGHT 751 .321
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
351/0
5.24m
IP351
APPROACH
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME 352
HEIGHT 754 .388
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
1.50m
0.98m
IP352
352/0
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP353
HEIGHT 755.374
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/3
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
1.50m
0.70m
IP353
353/0
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP354
HEIGHT 757 .692
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/3
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
354/0
GODEGODE
1.030m
IP354
APPROACH



Source: Dunny Geoinformatics

Appendix 3: List of National Bench Marks

FROM		F.B.M KILOSA	
TO		F.B.M GULWE	
		HEIGHT	
SR	POINT ID	IN feet	IN meters
1	F.B.M KILOSA	1640.48	500.018
2	SURFACE MARK	1645.76	501.628
3	A4/1	1630.37	496.937
4	A4/2	1639.65	499.765
5	A4/3	1662.44	506.712
6	A4/4	1663.37	506.995
7	A4/5	1685.17	513.640
8	A4/6	1702.51	518.925
9	A4/7	1706.95	520.278
10	A4/8	1731.21	527.673
11	A4/9	1742.76	531.193
12	A4/10	1759.44	536.277
13	A4/11	1789.80	545.531
14	A4/12	1813.40	552.724
15	A4/13	1827.47	557.013
16	A4/14	1852.82	564.740
17	A4/15	1872.34	570.689
18	A4/16	1893.48	577.133
19	A4/17	1918.78	584.844
20	A4/18	1939.21	591.071
21	A4/19	1975.87	602.245
22	A4/20	1988.17	605.994
23	A4/21	2015.34	614.276
24	A4/22	2029.32	618.537
25	A4/23	2047.21	623.990
26	A4/24	2075.51	632.615
27	A4/25	2108.62	642.707
28	A4/26	2139.24	652.040
29	A4/27	2196.57	669.515
30	A4/28	2219.72	676.571
31	A4/29	2195.70	669.249
32	A4/30	2201.95	671.154
33	A4/31	2202.96	671.462
34	A4/32	2231.46	680.149
35	A4/33	2255.37	687.437
36	A4/34	2268.83	691.539
37	A4/35	2300.37	701.153
38	A4/36	2302.85	701.909
39	A4/37	2310.63	704.280
40	A4/38	2340.39	713.351
41	A4/39	2383.17	726.390
42	A4/40	2400.00	731.520
43	A4/41	2412.27	735.260
44	A4/42	2427.81	739.996
45	A4/43	2449.24	746.528
46	A4/44	2470.61	753.042
47	A4/45	2471.31	753.255
48	A4/46	2474.36	754.185
49	A4/47	2478.91	755.572
50	A4/48	2514.18	766.322
51	A4/48.5	2521.11	768.434
52	A4/49	2519.76	768.023
53	A4/50	2520.77	768.331
54	A451	2540.51	774.347
55	A4/51.5	2541.09	774.524
56	A4/52	2538.98	773.881
57	A4/53	2548.02	776.636
58	F.BM. GULWE	2570.08	783.360
59	SURFACE MARK	2571.61	783.827

KEY
Bench Marks used

Source: Dunny Geoinformatics

APPENDIX U

BREAKDOWN OF COST ESTIMATE

<This Appendix has been removed
because of confidential information.>

APPENDIX X

ALIGNMENT STATEMENT OF REROUTING LINE

<This Appendix has been removed
because of confidential information.>

APPENDIX Z

Geotechnical Investigation

Geotechnical Investigation Works on the Preparatory Survey on Flood Protection Measures for Central Railway Line in the United Republic of Tanzania

Kilosa – Gulwe Section

Ground Investigation Report

May 2015

C.Labs(Tz)
Draw, Build, Test

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REPORT TITLE:

Geotechnical Investigation for the Preparatory Survey on Flood Protection Measures for the Central Railway Line between Kilosa and Gulwe

Report No:	**PROJECT LOCATION:**	**DATE:**
CL-S083/S0820	Kilosa – Gulwe Section of Centraql Railway	18th May 2015
CLIENT: PADECO COMPANY LTD. (JICA study team)		**AUTHOR:** Jotham Ntensibe Yustino Kwingwa Victor Salema

Background:

In February 2015, PADECO Company Limited of 6-17-19 Shinbashi, Minato-ku, Tokyo, 105-0004, JAPAN requested C-Labs to carry out a Geotechnical Investigation for the Preparatory Survey on Flood Protection Measures for the Central Railway Line between Kilosa and Gulwe in the United Republic of Tanzania. The Investigation was a component of a JICA study team.

This report contains the findings of the geotechnical investigation.

This report is presented as a purely factual report of the tests results as required by the terms of reference.

SECTION	
●Geotechnical Soils Bitumen Asphalt Chemistry Cement Concrete	

List of Symbols

MSL	Mean Sea Level
SPT	Standard Penetration Test – with a 63.5kg hammer
N, N_{60}	SPT value, corrected SPT value
USCS	Unified Soil classification system
BSCS	British soil classification system
LL, PL, PI	Liquid Limit, Plastic Limit, Plasticity Index
NMC, w	Natural Moisture Content, moisture content
SG, G	Specific Gravity
U4 / U100	Undisturbed sample – 4 inches / 100mm diameter
DS	Disturbed Sample
GWT	Ground Water Table
γ, γ_w	Unit weight of soil (gamma), Unit weight of water
c	Soil cohesion. Units of pressure, kPa
s_u	Undrained shear strength. Units of pressure, kPa
ϕ	Angle of friction (phi)
α	Adhesion Factor
Ks	Coefficient of Earth Pressure
k	permeability
OCR	Over consolidation ratio
m_v	Coefficient of volume compressibility
Es	Elasticity Modulus
μ	Poisson's Ratio
e, e_0	Void Ratio, Initial void ratio
c_r	Compression / Compressibility index
c_s	Recompression index
s_e	settlement
S	Degree of saturation
σ, p	Overburden pressure, soil pressure
u	Pore pressure

CONTENTS

1.0 TERMS OF REFERENCE

In summary, the investigation was tasked to carry out the following.

1) Drilling Site: 10 sites between Kilosa and Igandu along the Central Corridor Railway

2) Core Drilling including Standard Penetration Test (SPT) including sampling and Laboratory Tests, to a depth of 30m or to a depth where 5.0 meter thickness of more than 50 N values of STP can be confirmed

SPT's were envisaged in all the boreholes and samples for laboratory tests were envisaged for boreholes 3, 6 and 10 as shown in the following table – based on expected soil / rock profile indicated.

Depth	Ground formations	Drilling site No.1, 2, 4, 5, 7, 8, 9		Drilling site No.3, 6, 10		
		STP	Sampling	STP	Sampling	Rock tests
0m	Cohesive soil (clay, semi clay, sandy clay)	o		o		
2m		o		o	o	
4m		o		o	o	
6m		o		o	o	
8m	Non-Cohesive soil (sand, pebbles)	o		o	o	
10m		o		o	o	
12m		o		o	o	
14m		o		o	o	
16m	Weathered rock of less than 50 N values	o		o		
18m		o		o		
20m		o		o		
22m		o		o		
24m		o		o		
26m	Weathered and/or un-weathered rock of more than 50 N values	o		o		o
28m		o		o		
30m		o		o		

On exploration, it was found that the depth of rock was quite different. The depth to rock was found to be as follows:

Table 2: Depth of soil, weathered rock and intact rock investigated in each borehole

	Depth of Soil - to Weathered Rock	Depth of Weathered Rock	Depth of intact Rock
BH 1	0 - 30m	--	--
BH 2	0 - 30m	--	--
BH 3	0 – 1m	1.0 – 14.0m	14.0 – 26.2m
BH 4	0 – 3m	3.0 – 13.5m	13.5 – 22.4m
BH 5	0 – 13.5m	13.5 – 21.0m	21.0 – 26.7m
BH 6	0 – 2.0m	2.0 – 17.0m	17.0 – 22.0m
BH 7	0 – 11.0m	12.0 – 13.0m	13.0 – 18.0m
BH 8	0 – 15.7m	15.7 – 20.0m	20.0 – 26.8m
BH 9	0 – 9.5m	9.5 – 28.0m	28.0 – 33.0m
BH 10	0 – 12.0m	12.0 – 23.7m	23.7 – 30.8m

Boreholes 3 and 6 had a very shallow soil profile. The highlighted boreholes had at least 5m of soil before encountering rock. No rock was encountered in boreholes 1 and 2. U4 Soil samples were taken at about 2m intervals in each borehole and visual and strength assessment made of the rock in each borehole. Considerably more was done than was required in the ToR so as to present a better understanding of the soil and rock types along the investigated route.

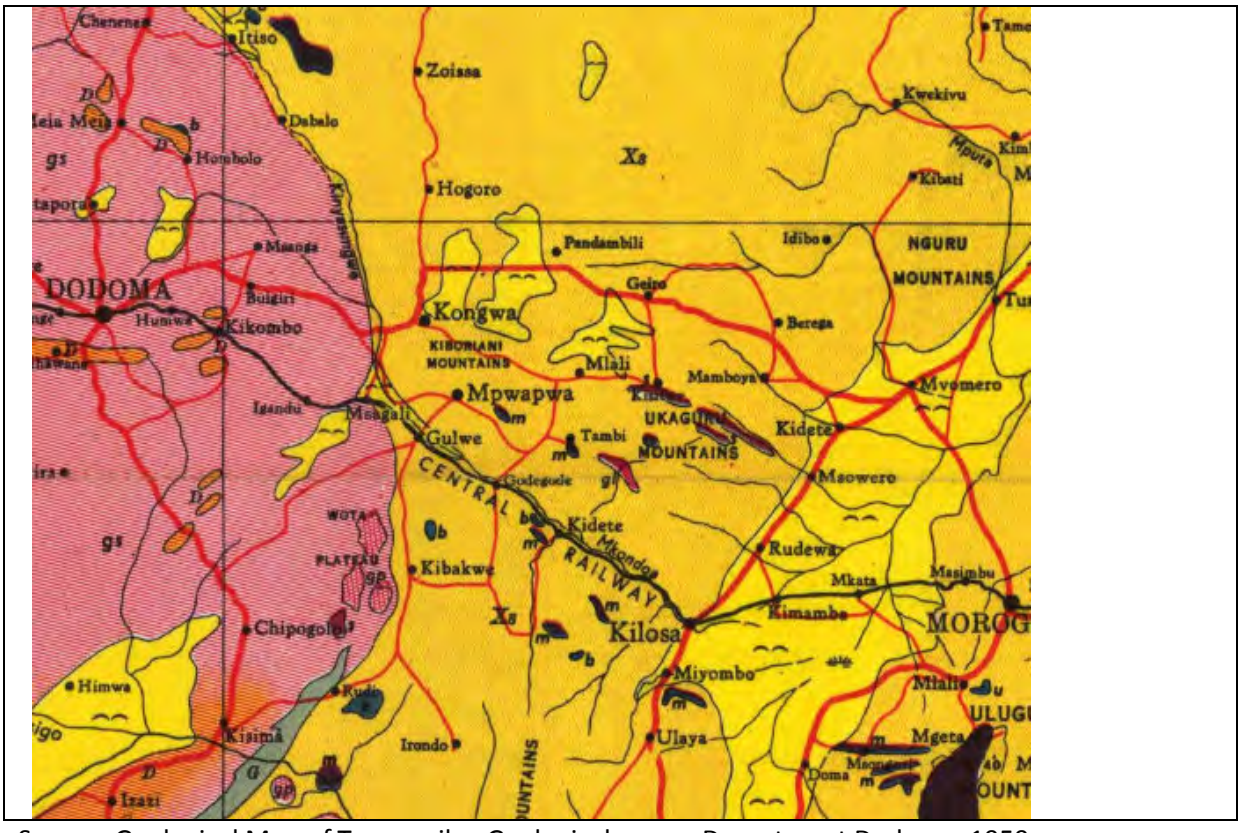
2.0 SITE LOCATION

The Central Railway Line between Kilosa and Gulwe runs in the valley of the NW-SW flowing river Mkondoa along which the altitude falls from about 790m in Gulwe to 520m in Kilosa. The river collects from the mountains including Ukaguru, Kiboriani, Ulugaro mountains at the western fringes of the Wami/Ruvu catchment. Many rock outcrops are found on the Kilosa end of the project and past Gode Gode towards Gulwe. The hydraulics of the tributaries from the surrouinding mountains have caused disruptions on the operation of the existing central railway line. The railway runs general south of the river.

Figure 1: Topography of the Project area

3.0 GEOLOGY

The two maps below illustrate the general geology of the project route.



Source: Geological Map of Tanganyika, Geological survey Department Dodoma, 1959

Figure 2a. Typical Geology between Kilosa and Gulwe

Xs = Usagaran Archean formations. Marble; Quartzite; Graphite Schist;, Chlorite, Amphiboles, Mica and Kyanite Schist; Hornblende, Biotite and garnet gneiss; acid gneiss; granulite; charnockite.

m= metagabbros (Archean)

b= un-metamorphorsed gabbroic and anorthositic rocks, as well as more or less metamorphosed peridotite, pyroxenite, and serpentine (mainly Pre-Cambrian)

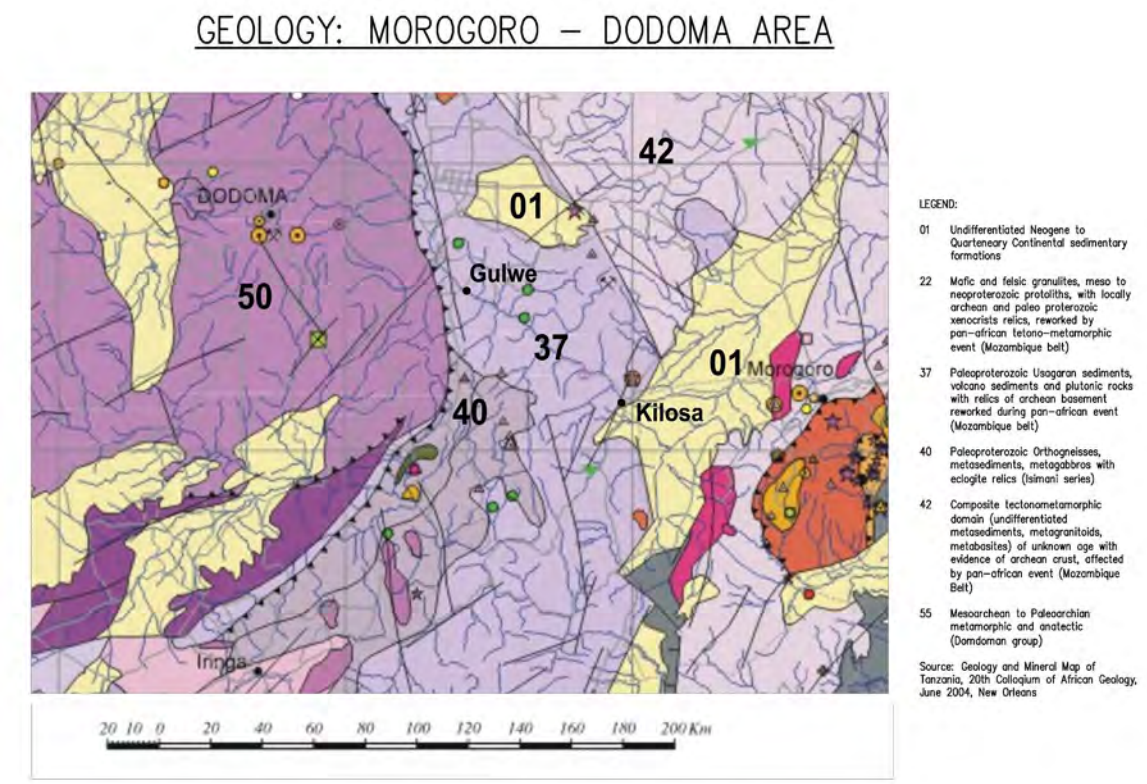


Figure 2b. Typical Geology between Kilosa and Gulwe.

3.1 Key geological formations.

Metapsammitic granulites of the Usagara Archean formations.

The Archean rocks in Central Tanzania (2.5 – 4 billion years old) consist of belts of greenstone (volcano-sedimentary) sequences, found within a larger region of predominantly younger granitic rocks.

But in the Usagaran formations found in Central and Eastern Tanzania including the project area, a later Pan African tectonic-thermal Pretorozoic event occurred (0.5 to 2.5 billiom years), and a variety of high grade metamorphic rocks of both sedimentary and igneous origin were formed from the Archean . Amphibolite grade metamorphic assemblages predominate related to the granitization amd migmatization of the event, the same that effected the Mozambican Belt[1]. The structural trends are mostly North to South.

[1] A brief Introduction to the Geology and Mining Inductry of Tanzania, SIKA Resources Inc, Oct 2011 Toronto Ontario

4.0 INVESTIGATION METHODOLOGY:

4.1 Location of the boreholes:

The location of the boreholes was selected by the client. A total of ten boreholes were drilled close to bridge locations, on the side opposite to the river. The GPS locations and a map of the physical locations is found in Table 1 and figure 3 below . The boreholes are numbered from Kilosa to Gulwe. BH10 is at the highest altitude on the Gulwe end. BH1 is at the lowest altitude on the Kilosa end.

Table 1: Location of the Boreholes

Label	Easting*	Northing	Distance from previous point, km**	Height with respect to Railway	Approximate Elevation***
BH01	268587.5	9254399.7	0	-0.762	534.2
BH02	263190.7	9254193.7	5.40	-0.492	557.0
BH03	256366.8	9259116.3	8.41	-0.660	604.7
BH04	253383.1	9260250.5	3.19	-1.295	618.4
BH05	242421.1	9268380.1	13.64	-1.875	675.2
BH06	239638.8	9272439.0	4.92	+0.150	697.0
BH07	232655.0	9276368.3	8.01	-1.143	733.8
BH08	222325.4	9282245.6	11.88	-0.425	769.1
BH09	217353.6	9284422.9	5.42	-0.762	778.8
BH10	213838.6	9286420.2	4.04	-0.462	785.0

*UTM Arc 1960 Zone 37

**straight line distances. Not measured along rail.

***elevations provided by client

Figure 3: Locations of the boreholes

4.2 Boring Methods

The primary method used was rotary drilling using 120mm and 150mm bits and bentonite fluid. Before SPT and sampling, the boreholes were cleaned and sufficient length of sample was taken to ensure an uncontaminated undisturbed sample was obtained in each U100 sampler. The SPT's were carried out immediately after sampling in clean boreholes.

Boreholes 1 and 2 had no rock formations. They were investigated to 30m depth. All the other holes had rocks at various depths as illustrated in Table 2 above. These boreholes were drilled through hard weathered rock with SPT > 50 but with poor rock recovery, and into intact rock with good rock recovery for at a depth of at least 5m. Intact rock was found between 13 and 28m deep. Single HQ (61mm nominal diameter cores) and NQ (47mm nominal diameter cores) core barrels were used. The latter was used after about 2m of drilling in hard intact rock.

4.3 Sampling:

The following samples were taken as boring progressed:

- 100mm dia undisturbed soil samples were taken every 2m in boreholes 1 and 10 wherever possible. Undisturbed soil samples were taken every 4m in all other boreholes. Sampling was only required @2m to a depth of 15m in Boreholes 3, 6 and 10 in the terms of reference. However it was found that boreholes 3 and 6 had very shallow soil profiles less than 2m deep. The soil samples were spread out over boreholes 2,5, 7 and 9.
- Disturbed samples were taken from the SPT sampler but they were mostly used for visual classification on site rather than Laboratory tests.

- Continuous samples of the rock were taken for visual descriptions and strength testing. The recovery in highly weathered rock was generally poor – as expected.

4.4 In-situ Tests

SPT sounding was carried out every 2m in each borehole to refusal (taken as N > 50blows). Thereafter drilling continued without SPT's .

4.5 Laboratory Tests Carried Out

Laboratory tests on the undisturbed soil samples have been carried out as follows.

Table 2: Laboratory Tests carried out on soil samples

On the Undisturbed Samples	• Particle Size Analysis on all samples, including hydrometer method on selected samples	BS 1377 Part2: 1990
	• Atterberg's limits on all samples	BS 1377 Part2: 1990
	• Bulk Density on all samples	BS 1377 Part2: 1990
	• Natural Moisture Content	BS 1377 Part2: 1990
	• Determination of undrained shear strength Su on clay samples, UU tests	BS 1377 Part7: 1990
	• Direct shear on predominantly sandy samples	BS 1377 Part7: 1990
	• One dimensional Consolidation Properties on clay samples	BS 1377 Part5: 1990
On disturbed SPT Samples	No Lab tests. Only a visual assessment.	

Classification testing (grading and plasticity) was carried out on undisturbed samples so as to show progression of the classification of soil with depth in each borehole.

The Sandy Clay soils were tested using the direct shear apparatus to obtain angle of friction ϕ'. The cohesive soils were tested for Total stress (UU) to determine the undrained cohesive strength s_u of the soil.

A number of additional soil properties have been obtained from the test results including estimates of Elastic modulus, Coefficient of volume compressibility, the compression and unloading /recompression indices and the over-consolidation ratio. These can be found in the summarized test results in **Appendix A** and the detailed test results in the following appendices.

6 samples of ground water were tested for pH, Chloride content and Sulphate content.

A visual assessment of the Rock cores was carried out to determine Rock Quality designation index and in addition, the bulk density, porosity and UCS strength and point load index were determined at about 1 – 2m interval depths for each borehole. Tests were carried out in accordance with the recommendations of the International Society of Rock Mechanics ISRM.

5.0 SOIL TEST RESULTS

5.1 Soil summaries

A summary of the findings in each borehole can be found on the borehole logs in **Appendix B**. The logs contain:

- Field Soil descriptions,
- SPT results,
- A summary of the Classification Results,

5.2 Detailed Results

A summary of the laboratory tests on each sample can be found in **Appendix B**. Detailed results of the testing can be found in **Appendix C to E**. The results for each borehole include
:

- Results of the Particle size analysis including hydrometer tests results
- Results of the Atterberg's limits test including Linear Shrinkage
- Results of the Shear tests including Direct shear, Unconsolidated Undrained Triaxial Tests (UU).
- The Consolidation test results. One dimensional consolidation tests were only carried out on undisturbed cohesive samples.

In the summaries, the soil has been classified to the British Soil Classification System (BSCS) found in BS 5930 – *Code of practice for site investigations*, but also to the Unified Soil Classification System (USCS). The former has clearer **descriptions** of the plasticity of the clays and silts and in our experience, correlates more closely to the field descriptions. But the USCS classification is more widely used for **analysis** and has appropriately been used in this report

Boreholes 2, 3, 4, 7 and 10 have predominantly granular material consisting of clayey sands, clayey gravels and sand. Borehole 8 has low plasticity fines and clays and Borehole 5 has potentially expansive clays and silts of high plasticity.

6.0 OBSERVATIONS AND TEST RESULTS ON THE ROCK CORES:

6.1 Lithology:

Field descriptions of the Lithology can be found in Appendix A3 to A10. The descriptions include pictures of the rock cores and an estimation of the Rock Quality Designation.

- No rock was encountered in Boreholes 1 and 2 up to 30m drill depth
- Boreholes 3 and 4 consists predominantly of metamorphosed sandstone.
- Boreholes 5 to 10 consist of complex gneiss formations from both sedimentary and igneous protoliths.

6.2 Lab Tests on Rocks

Tests on the rocks included UCS and Point Load Index tests for strength, Bulk density, moisture and porosity. These results can be found in **Appendix F** and **Appendix G.**

The density of the rocks varies from 2.4 to 3.0. The least porous rocks (<0.7) are found in the lower portions of Boreholes 3 (below 14m) and borehole 4 (below 13.5m) and at various levels in borehole 10. The strongest rocks are also found in these three boreholes with average UCS values greater than 55MPa. Borehole 4 however had weak rock at its bottom.

.Relatively porous rocks (>1.5) were found in Boreholes 8, and on the upper portions of boreholes 5 (above 25m) and Borehole 1 (above 14m). The weakest rock is found in Borehole 5 with a UCS average less than 25MPa.

These figures highlight the large variation and observed complexity of the rock formation,

7.0 CHEMICAL TESTS ON WATER

The table below has a summary of the chemical tests on water collected from the boreholes. No ground water was encountered in Boreholes 3, 4 and 10.

Table 3 : Results of Chemical Tests on Ground Water

	pH	Chloride content Cl^- , mg/l	Sulphate Content SO_4^- , mg/l
BH1	7.62	92.2	311.7
BH2	7.56	74.4	365.9
BH 3	-	-	-
BH 4	-	-	-
BH5	7.26	42.5	280.0
BH6	7.72	85.1	209.7
BH7	7.73	88.6	219.5
BH8	7.71	95.7	286.9
BH9	7.53	85.1	382.7
BH 10	-	-	-

It can be seen that the sulphate content in the water is quite high. Detailed test result sheets can be found in **Appendix H**

END

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LIST OF APPENDICES

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PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH01 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH01 **PROJECT NO:** S0820
BORE DATE: 06-09/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9 254 399.7 **SURFACE ELEVATION:** 532
EASTING: 268 587.5 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
532	0.0				(0.0 to 0.5) Organic soil			
531	1.0	U4	GC G.S.F = 42.36.22 PI = 14		(0.5 to 4.0) Riverine SAND	3,5,5	0 50	
530	2.0							
529	3.0	U4	SW G.S.F = 30.68.03 PI = NP			3,4,6		
528	4.0				(4.0 to 9.9) Black Cotton CLAY			
527	5.0	U4	SC G.S.F = 40.18.43 PI = 40			7,7,8	0 50	
526	6.0							
525	7.0	U4	MH G.S.F = 00.00.100 PI = 25			9,18,14		Drilling stopped at 7.0m. Resumed 7/04
524	8.0							
523	9.0	U4	CL G.S.F = 18.18.64 PI = 26			5,6,8		
522	10.0				(9.9 to 13.0) Brown Silty SAND + layers of CLAY			
521	11.0	U4	SC G.S.F = 05.69.26 PI = 13			10,19,16	0 50	Drilling stopped at 11.5m. Resumed 8/04
520	12.0							
519	13.0				(13.0 to 23.0) Dark brown Silty CLAY			
518	14.0					10,11,10		
517	15.0	U4	SC G.S.F = 07.58.35 PI = 14					

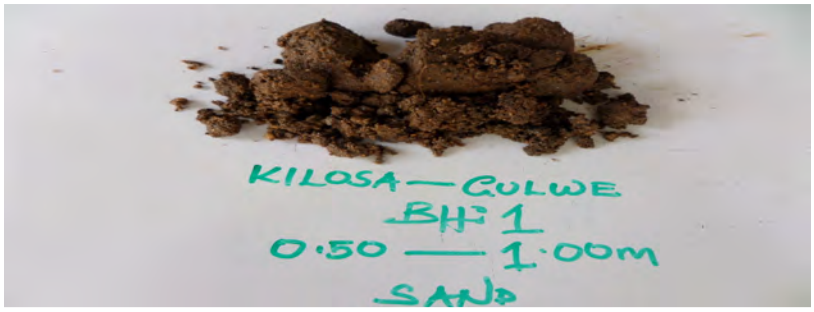
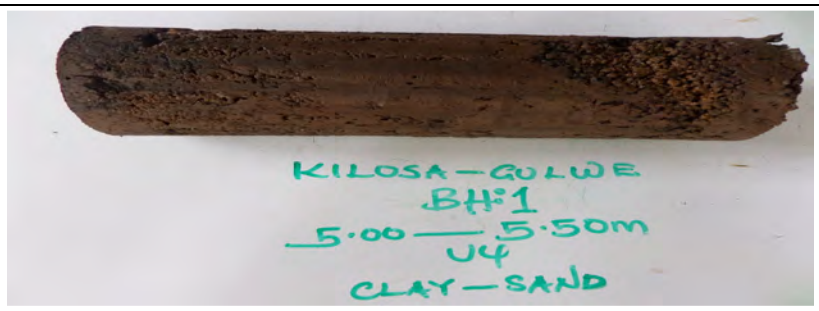
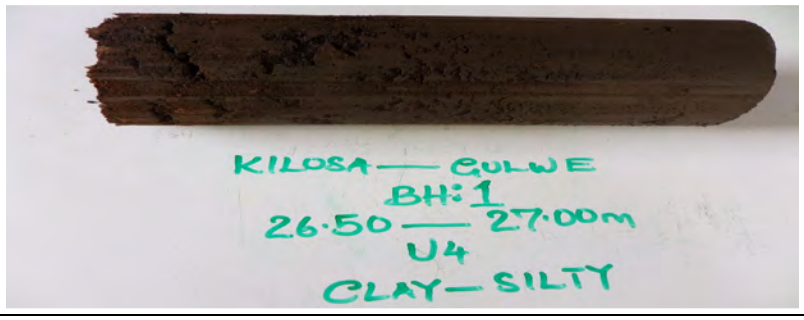
C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH01 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH01 **PROJECT NO:** S0820
BORE DATE: 06-09/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9 254 399.7 **SURFACE ELEVATION:** 532
EASTING: 268 587.5 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
516	16.0					5,16,21	0 50	
515	17.0					7,9,13		
514	18.0							
513	19.0	U4	SC G.S.F = 10.53.37 PI = 18			10,8,10		Drilling stopped at 18.5m Resumed 9/04
512	20.0							
511	21.0					8,16,20	0 50	
510	22.0							
509	23.0	U4	SC G.S.F = 06.54.40 PI = 24		(23.0 to 29.5) Brown Silty CLAY	8,12,15		
508	24.0							
507	25.0					18,17,12		
506	26.0						0 50	
505	27.0	U4	CL G.S.F = 02.48.50 PI = 23			13,16,19		No Sample recovered in SPT
504	28.0							
503	29.0					17,19,24		

PHOTOS BH1

0.00m-3.50m	
3.50m-9.50m	
9.95m-13.00m	
13.00m-23.00m	
23.00m-29.45m	

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PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH02 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH02 **PROJECT NO:** S0820
BORE DATE: 06-08Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9254 193.7 **SURFACE ELEVATION:** 554
EASTING: 263 190.6 **CHECKED BY:** J.N

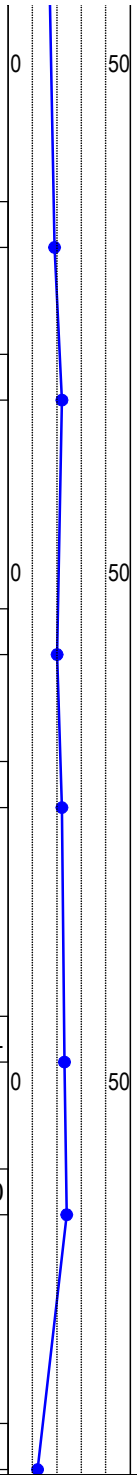
ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
554	0.0				(0.0 to 29.0) Brown Silty SAND			
553	1.0	U4	SW-SM G.S.F = 52.39.09 PI = NP			3,2,1	0 50	
552	2.0							
551	3.0					6,5,6		
550	4.0							
549	5.0	U4	SW-SM G.S.F = 42.51.07 PI = NP			7,7,10	0 50	
548	6.0							
547	7.0					10,13,15		
546	8.0							
545	9.0	U4	CL G.S.F = 20.21.59 PI = 25			5,5,7		Drilling stopped at 9.0m. Resumed 07/04
544	10.0							
543	11.0					8,11,11	0 50	
542	12.0							
541	13.0							
540	14.0					6,7,6		
539	15.0					9,9,8		

C.Labs(Tz)
Draw, Build, Test

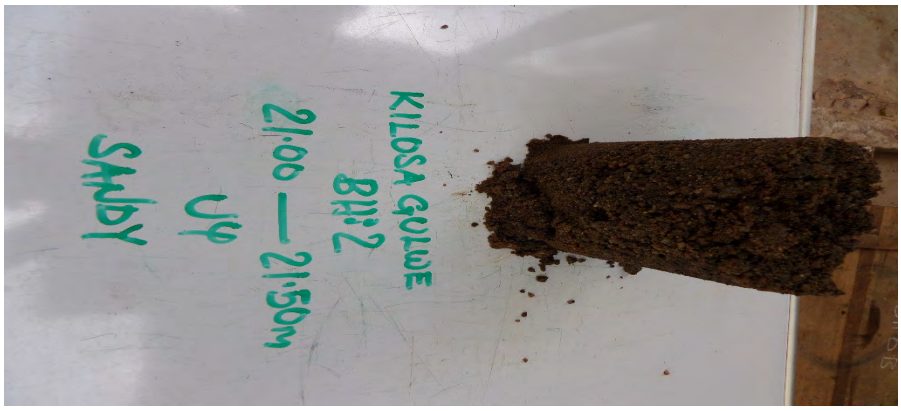
PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH02 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH02 **PROJECT NO:** S0820
BORE DATE: 06-08Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9254 193.7 **SURFACE ELEVATION:** 554
EASTING: 263 190.6 **CHECKED BY:** J.N

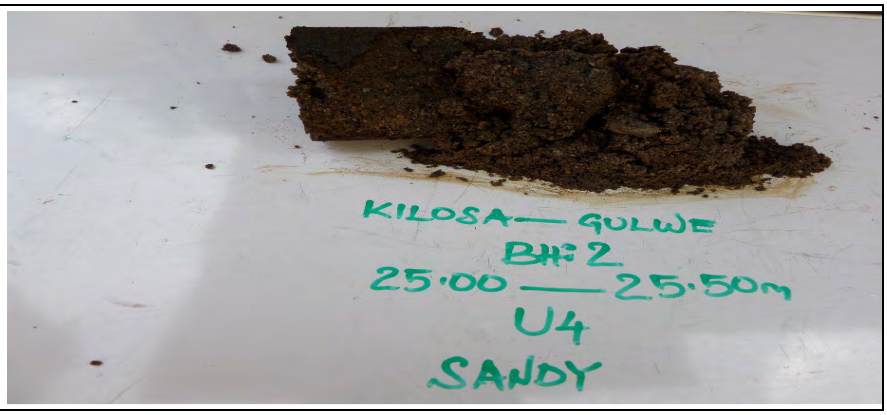
ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
538	16.0							
537	17.0	U4	SW G.S.F = 73.24.03 PI = NP			7,9,10		
536	18.0							
535	19.0					9,12,10		Drilling stopped at 19.5m. Resumed 8/04
534	20.0							
533	21.0	U4	SW-SM G.S.F = 22.72.07 PI = NP					
532	22.0					8,8,12		
531	23.0					8,7,15		
530	24.0							
529	25.0	U4	SW-SM G.S.F = 30.61.09 PI = NP					
528	26.0					11,12,11		
527	27.0					12,14,10		
526	28.0							
525	29.0				(29.0 to 30.0) Grey SAND			
524	30.0					6,4,8		



PHOTOS BH2

0.00m	
	
	
	

PHOTOS BH2

29.95m	

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Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH03 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH03 **PROJECT NO:** S0820
BORE DATE: 01-03/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9259 116.34 **SURFACE ELEVATION:** 599
EASTING: 256 366.7 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
599	0.0				(0.0 to 2.0) Dry Brown Silty SAND		0 50	High rate of percoaltion from 1 to 19.2m during drilling suggesting rock with large fractures
598	1.0	U4	GW-GM G.S.F = 66.25.09 PI = NP					
597	2.0				(2.0 to 13.5) Quartzite / Gneiss. Various degree of weathering .			
596	3.0							
595	4.0							
594	5.0							
593	6.0						0 50	
592	7.0							
591	8.0							
590	9.0							
589	10.0							Drilling stopped at 9.4m. Resumed 2/4/15
588	11.0						0 50	
587	12.0							
586	13.0							
585	14.0				(13.5 to 19.2) Moderately weathered Gneiss			
584	15.0							Drilling stopped at 14.9m. Resumed 3/4/15

C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH03 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH03 **PROJECT NO:** S0820
BORE DATE: 01-03/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9259 116.34 **SURFACE ELEVATION:** 599
EASTING: 256 366.7 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
583	16.0						0 50	
582	17.0							
581	18.0							
580	19.0							
579	20.0				(19.2 to 26.2) Intact Rock.			Reduced rate of percolation during drilling indicating intact rock
578	21.0						0 50	
577	22.0							
576	23.0							
575	24.0							
574	25.0							
573	26.0							

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 03
Location	KILOSA GULWE	**Elevation**	599m
Coordinates	9259116.3N	**Date**	03 Apr 2015
	256366.7E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
2	597		(2 - 9) Hornfels. Quartzites	IV		27	R1					51	0	0
3	596										3.0			
4	595			IV			R4					95	62	57
5	594										5.5			
6	593													
7	592			IV			R4				7.4	68	19	13
8	591													
9	590													
10	589		(9 - 13) Quartzites and Feldspathoids	IV		69	R3				9.4	42	0	0
11	588										11.1			
12	587			IV			R3					43	30	13
13	586		(13 - 17) Weathered green and dark grey gneiss	IV			R2				12.5	97	82	80
14	585										13.9			
				III			R2					99	76	75

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 03
Location	KILOSA GULWE	**Elevation**	599m
Coordinates	9259116.3N	**Date**	03 Apr 2015
	256366.7E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
15	584													
16	583										15.9			
			(17 - 26) Hornfels. Granulitic Amphibolites. Quartz intrusions	III			R4					79	70	55
17	582										17.1			
18	581			II			R4					94	41	38
19	580										19.2			
				II			R4					100	36	36
20	579										20.1			
				II			R4					100	86	87
21	578										21.1			
				II			R4					100	97	97
22	577										22.1			
				II			R4					100	80	80
23	576										23.1			
				II			R4					100	68	68
24	575										24.1			
25	574			II			R2					100	62	62
											25.9			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

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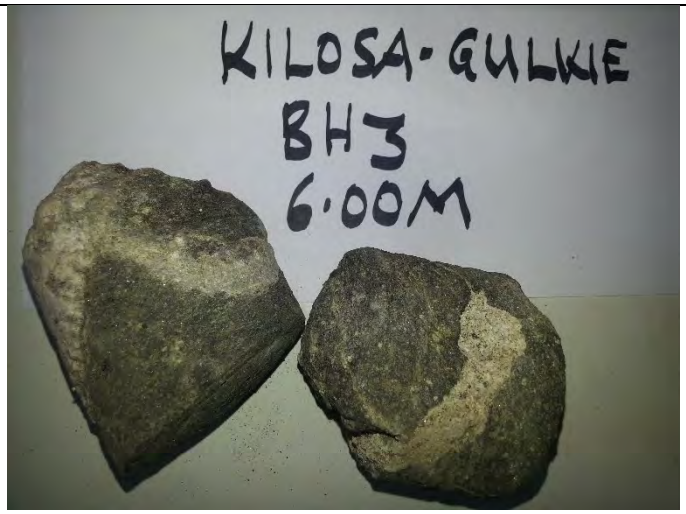
0.00m-1.50m	
1.50m-2.60m	
3.00m-4.40m	
5.50m-6.50m	

9.40m-10.40m	
11.10m-12.10m	
12.50m-13.50m	
13.90m-14.90m	

15.90m-16.90m	
17.10m-18.90m	
19.20m-20.10m	
20.10m-21.10m	

21.10m-22.10m	
22.10m-23.10m	
23.10m-24.10m	
24.10m-25.90m	

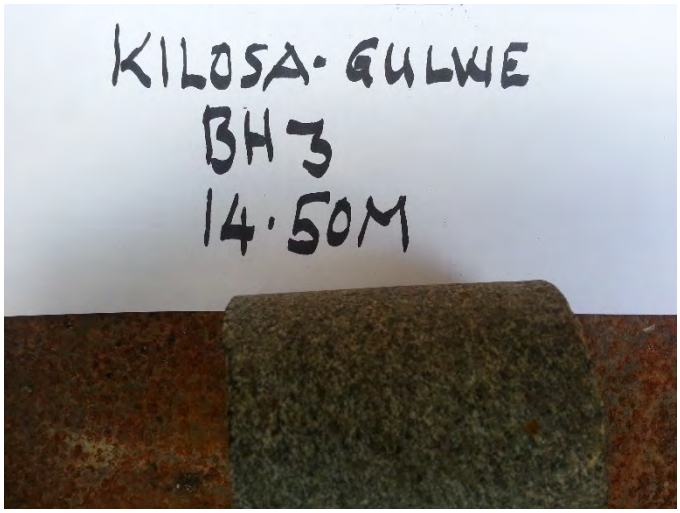
BOREHOLE 3 PICS

Depth	Observations	Picture
1.5 - 2.6	• Dark grey, fine to medium grained • No foliation apparent. Metamorphosed igneous rock. Hornfels • Intrusive Silica band about 30-40mm • Some mica • Shiny lustre	
3.0 – 4.4	• Dark grey, fine to medium grained • No foliation apparent. Metamorphosed igneous rock. Hornfels. • Some mica	
5.5 – 6.5	• Dark grey, fine to medium grained • No foliation apparent. Metamorphosed igneous rock • Fracture 10mm wide, filled with cemented sand and weak white to pink silica band about 20mm	

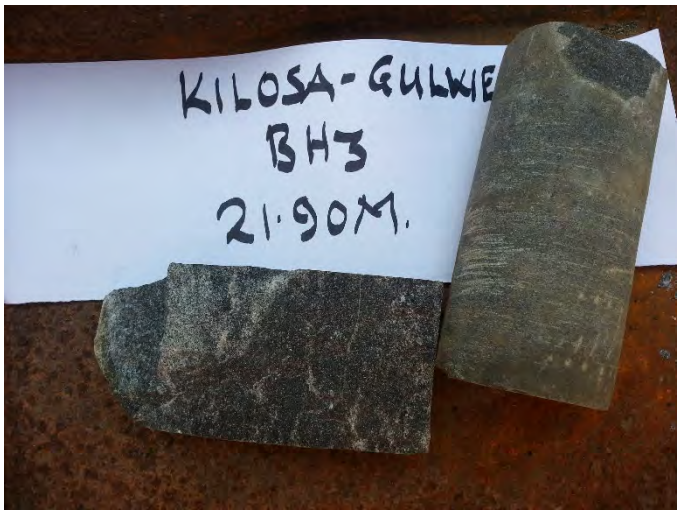
BOREHOLE 3 PICS

Depth	Observations	Picture
9.4 – 12.1	• Contact discontinuity at about 9.8m between fine dark grey rock and white quartzitic rock. • Pink rock with some brown discoloration. • Crystals not distinct. Feldspar and Quartz	 

BOREHOLE 3 PICS

Depth	Observations	Picture
12.5 – 16.9	• Dark grey, and green weathered rock. Abrades easily into sand grains. Weathered. • Intercrossing hairline veins. Possibly chemical deposits as water seeps through relatively porous rock. • Larger vein with cemented sand infill dipping about 45 – 60 deg Weathered rock described above improves to a uniform medium grained dark grey rock.	  

BOREHOLE 3 PICS

Depth	Observations	Picture
17.1 – 18.9	• High concentration of mica • Dark and light grey • Pink siliceous intrusion about 50mm thick dipping about 60deg	
19.2 22.1	• Dark grey fine rock. Mafic. Hard but slaty • Foliations not distinct. • Similar to rock found in between 2 and 9m • Mica present	 

BOREHOLE 3 PICS

Depth	Observations	Picture
22.1 – 25.9	• The Dark fine to medium grained grey rock in a shear zone, foliated. • Metamorphosed : Bands of steeply dipping dark rock and pink siliceous rock. • Granulitic at 25m depth	 

C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH04 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH04 **PROJECT NO:** S0820
BORE DATE: 30Mar - 01/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9260 250.5 **SURFACE ELEVATION:** 614
EASTING: 253 383.1 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
614	0.0				(0.0 to 5.0) Brown clayey SAND			
613	1.0	U4	SC G.S.F = 26.53.21 PI = 16				0 50	
612	2.0					18,27,26		SPT N=53
611	3.0					45/5cm		SPT refusal (N>50)
610	4.0							
609	5.0				(5.0 to 13.5) Weathered rock	45/5cm		SPT refusal (N>50)
608	6.0						0 50	
607	7.0							
606	8.0							
605	9.0							
604	10.0							Drilling stopped at 8.6m. Resumed 31/03
603	11.0						0 50	
602	12.0							
601	13.0							
600	14.0				(13.5 to 22.4) Intact Rock. Sandstone			
599	15.0							Drilling stopped at 14.6m. Resumed 01/04

C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH04 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH04 **PROJECT NO:** S0820
BORE DATE: 30Mar - 01/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9260 250.5 **SURFACE ELEVATION:** 614
EASTING: 253 383.1 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
598	16.0						0 50	
597	17.0							
596	18.0							
595	19.0							
594	20.0							
593	21.0						0 50	
592	22.0							

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 04
Location	KILOSA GULWE	**Elevation**	614m
Coordinates	9260250.5N	**Date**	31Mar2015
	253383.1E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
5	609		(5 - 14) Weathered	IV		3.6	R0					3	0	0
6	608			IV		7.4	R0				6.8			
7	607					3.9								
8	606			IV	●		R4				8.5	100	27	27
9	605													
10	604					7.5					10.2			
11	603			IV			R1					15	0	0
12	602					4.8					11.5			
				IV			R1					17	0	0
13	601			IV		9.3	R1					33	0	0
14	600		(14 - 20) Metamorphosed Sandstone	IV			R3				13.8	88	19	19
15	599													
16	598			II	●		R3				15.7	89	73	73
17	597													
18	596			II	●		R4				17.4	100	86	86
											18.4			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

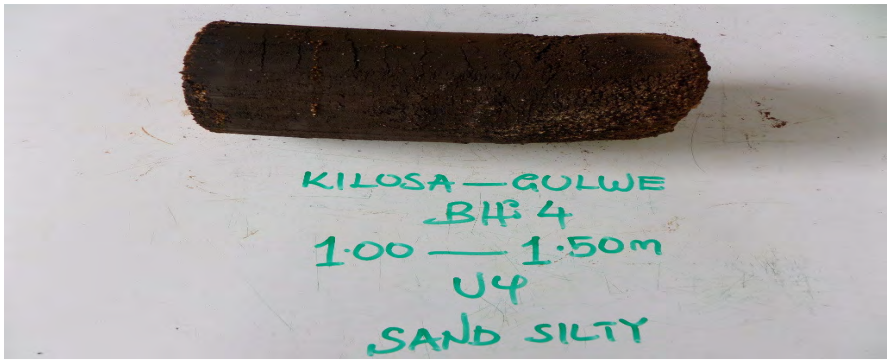
Client	PADECO Co. Ltd	**B/Hole No.**	BH 04
Location	KILOSA GULWE	**Elevation**	614m
Coordinates	9260250.5N	**Date**	31Mar2015
	253383.1E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
19	595			II			R5					100	97	97
											19.4			
20	594		(20 - 22) Semipelite	II			R5					100	58	58
											20.4			
21	593			III			R3					100	33	33
											21.4			
22	592			III			R2					100	40	40
											22.4			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

PHOTOS BH4

0.00m-3.00m	
5.00m-5.50m	
6.50m-6.80m	
6.80m-8.60m	

PHOTOS BH4

10.20m-10.50m	
12.020m-1050m	
13.20m-15.50m	
13.80m-14.60m	

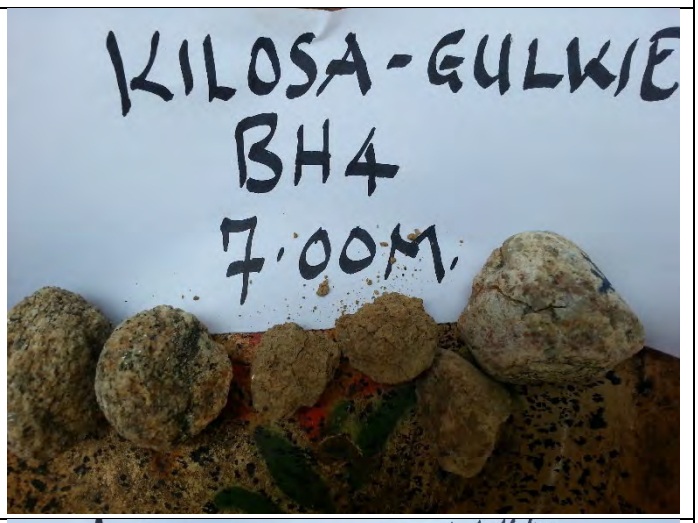
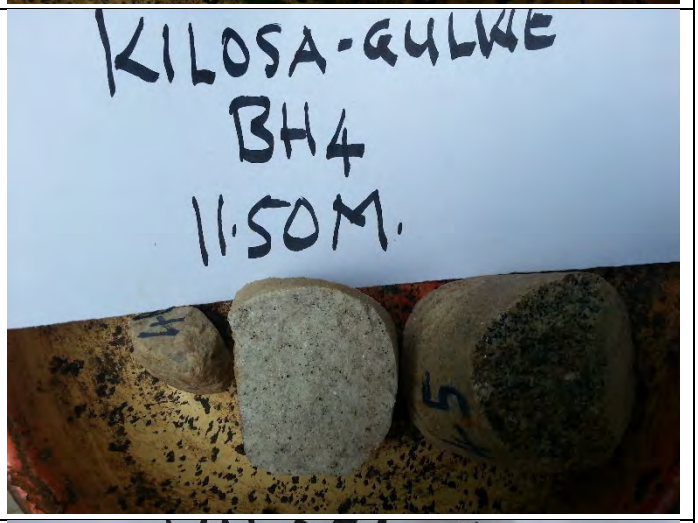
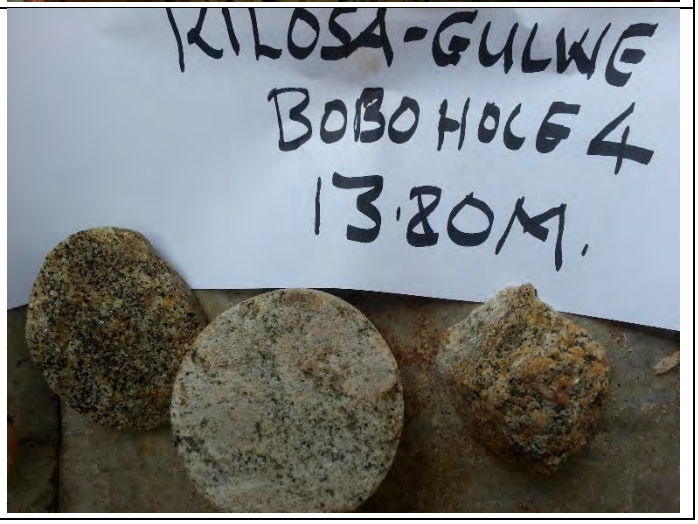
PHOTOS BH4

15.70m-16.60m	
17.40m-18.40m	
18.40m-19.40m	
19.40m-20.40m	

PHOTOS BH4

20.40m-21.40m	
21.40m-22.40m	

BOREHOLE 4 PICS

Depth	Observations	Picture
5.00 – 8.60	• Highly weathered metasediments. • Medium grained • High mica content • Mottled light grey, black and pink.	
10.2 – 11.7	• Light gray to white • Metasediment • High mica content • Medium grained • Small intrusions of light pink quartz	
13.2 – 14.6	• Light grey with pink spots • Weathered metasediment • Black translucent mica (Biotite) and quartz • Medium grained	

BOREHOLE 4 PICS

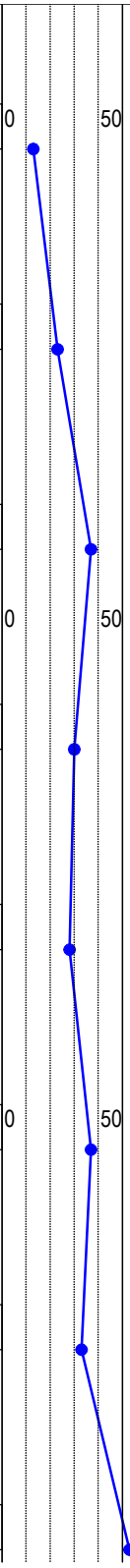
Depth	Observations	Picture
15.7 – 20.4	• Metasediment • Mottled Pink and grey • Uniform Medium grained. Sand • **Metasandstone** • High concentration of mica • Little signs of weathering • Very hard rock • Strength decreases approaching 20.4m	
20.4 – 22.4	• Light grey metasediment. Semipelite • High mica concentration • Moderately weathered • Light pink quartz intrusion • Medium grained	

C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH05 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH05 **PROJECT NO:** S0820
BORE DATE: 22 - 24Mar/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9260 250.5 **SURFACE ELEVATION:** 672
EASTING: 242 421.1 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
672	0.0							
		U4	CH G.S.F = 00.02.98 PI = 39		(0.0 to 1.5) Clayey organic soil	2,6,7		
671	1.0							
					(1.5 to 5.0) Stiff Reddish brown CLAY			
670	2.0							
						6,8,15		
669	3.0							
668	4.0							
		U4	CH G.S.F = 00.00.100 PI = 52					
667	5.0				(5.0 to 7.5) Reddish brown Silty CLAY	9,17,20		
666	6.0							
665	7.0					10,13,17		Drilling stopped at 7m. Resumed 23/03
					(7.5 to 11.4) Light Grey Silty SAND			
664	8.0							
		U4	MH G.S.F = 02.09.89 PI = 25					
663	9.0					11,13,15		
662	10.0							
661	11.0					16,18,19		
660	12.0				(11.4 to 13.5) Reddish brown silty CLAY			
		U4	MH G.S.F = 03.10.86 PI = 21					
659	13.0					36,13,20		
658	14.0				(13.5 to 15.5) Light grey soft Rock. Sand grains			
657	15.0					23,29,24		Drilling stopped at



C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH05 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH05 **PROJECT NO:** S0820
BORE DATE: 22 - 24Mar/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9260 250.5 **SURFACE ELEVATION:** 672
EASTING: 242 421.1 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
656	16.0				(15.5 to 21.0) Weathered rock		0 50	15.4m. Resumed 24/03
655	17.0							High rate of percolation of drilling fluid in weathered rock indicating large discontinuities
654	18.0							
653	19.0							
652	20.0							
651	21.0				(21.0 to 26.7) Intact rock. Sandstone		0 50	
650	22.0							Low rate of percolation of dilling fluid.
649	23.0							
648	24.0							
647	25.0							
646	26.0						0 50	

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 05
Location	KILOSA GULWE	**Elevation**	672m
Coordinates	9260250.5N	**Date**	24Mar2015
	242421.1E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
20	652		(20 - 27) Metamorphosed Sandstone	II			R3					45	100	45
21	651										21.9			
22	650			II			R3					100	95	95
23	649			III			R2				22.9	100	90	90
24	648			II			R2				23.9	100	92	92
25	647			II			R3				24.9	100	94	94
26	646			II			R3				25.9	100	82	82
											26.9			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

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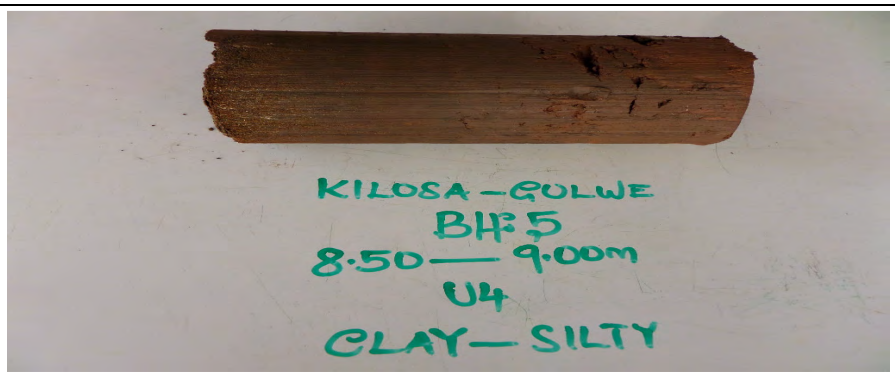
PHOTOS BH5

0.00m-1.00m	
1.00m-5.00m	
5.00m-11.45m	
11.45m-13.45m	

PHOTOS BH5

17.00m-18.00m	
20.00m-21.00m	
21.90m-22.90m	
22.90m-23.90m	

PHOTOS BH5

23.90m-24.90m	
24.90m-25.90m	
25.90m-26.90m	

BOREHOLE 5 PICS

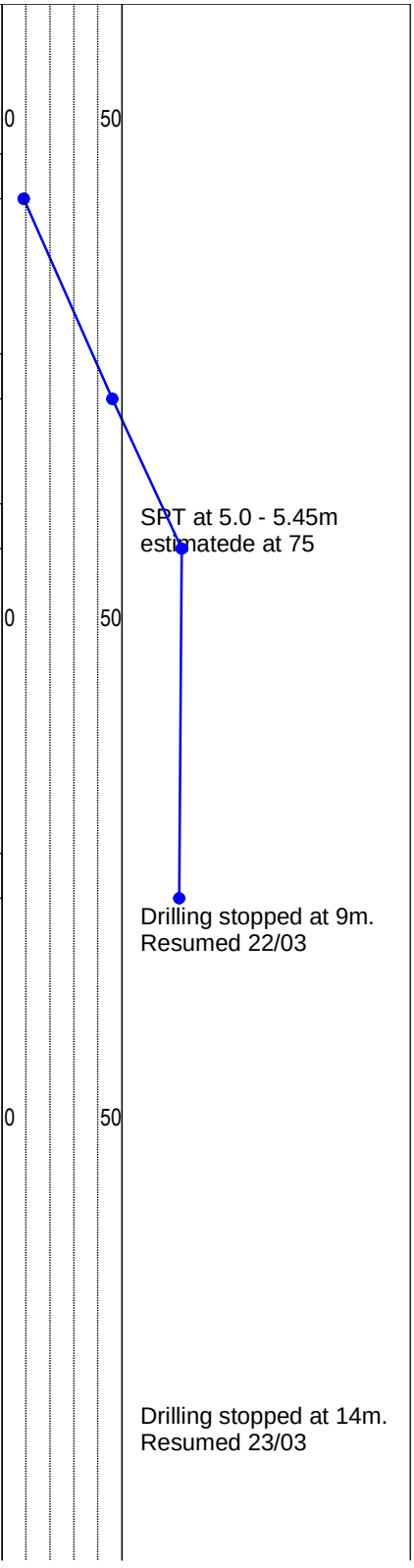
Depth	Observations	Picture
20 – 24.9m	• Dark grey and brown • Moderately Weathered • No foliation • Fine to medium grained • Like a Metamorphosed sandstone • **Metasandstone** • Randomly oriented, closed and open joints.	
24.9 – 26.9m	• Dark grey metasediments • No foliation - granular • Fine to medium grained • **Metasandstone** • Mica present • 10-20mm quartzitic veins	

C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH06 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH06 **PROJECT NO:** S0820
BORE DATE: 21 - 23Mar/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9272 439.0 **SURFACE ELEVATION:** 695
EASTING: 239 638.8 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
695	0.0				(0.0 to 1.0) Sandy organic soil			
694	1.0	U4	CL G.S.F = 02.27.71 PI = 22		(1.0 to 2.0) Dark brown CLAY	2,4,5		
693	2.0				(2.0 to 4.0) Silty Sand			
692	3.0	U4	SM G.S.F = 23.62.14 PI = NP			32,22,24		
691	4.0				(4.0 to 17.0) Weathered dark grey rock			
690	5.0					30/3cm		SPT at 5.0 - 5.45m estimatede at 75
689	6.0							
688	7.0							
687	8.0							
686	9.0					35,38,36		Drilling stopped at 9m. Resumed 22/03
685	10.0							
684	11.0							
683	12.0							
682	13.0							
681	14.0							Drilling stopped at 14m. Resumed 23/03
680	15.0							



C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH06 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH06 **PROJECT NO:** S0820
BORE DATE: 21 - 23Mar/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9272 439.0 **SURFACE ELEVATION:** 695
EASTING: 239 638.8 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
679	16.0						0 50	
678	17.0				(17.0 to 22.0) Intact rock			
677	18.0							
676	19.0							
675	20.0							
674	21.0						0 50	
673	22.0							

Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 06
Location	KILOSA GULWE	**Elevation**	695m
Coordinates	9272439N	**Date**	22 Mar 2015
	239638.8E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
7	688		(7 - 15) quartzites and Gneissiose rocks in weak rock matrix	V		15	R2					25	8	0
8	687					13					8.0			
9	686			V			R2					30	11	0
10	685					14					9.9			
11	684			V			R2					30	10	0
12	683					13					11.9			
13	682			IV			R2					40	25	28
14	681			IV		22	R2				13.5	40	25	28
15	680		(15 - 22) Amphibolite Gneiss			21					14.7			
16	679			III			R3					75	50	38
17	678										17.0			
18	677			III			R5					99	95	95
19	676			III			R5				18.0	99	95	95
20	675			III			R4				19.0	99	98	98
											20.0			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
UCS = Unconfined compressive Strength, Is(50) = Adjusted Point Load Strength

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Project PREP. SURVEY ON FLOOD PROTECTION FOR CENTRAL RAILWAY

Client	PADECO Co. Ltd	**B/Hole No.**	BH 06
Location	KILOSA GULWE	**Elevation**	695m
Coordinates	9272439N	**Date**	22 Mar 2015
	239638.8E	**Logged By**	VS

C.Labs(Tz) Draw, Build, Test

Down Hole Depth (m)	Elevation	Lithology	LITHOLOGIC DESCRIPTION	Degree of Weathering	Strength Data: UCS MPa (50)	Strength Data: Is (50)	Strength Data: Hardness	Discontinuity Data: Dip Angles (30 60)	Discontinuity Data: Type	Discontinuity Data: Spacing (cm)	Core Run depth, m	TCR %	SCR %	RQD %
20	675			III			R4					99	87	77
21	674			III			R2				21.0	99	77	25
22	673										22.0			

Hardness: R0 = Extremely weak, R1 = Very weak, R2 = Weak, R3 = Medium Strong, R4 = Strong, R5 = Very Strong, R6 = Extrmely Strong
Weathering: I = Fresh, II = Slightly, III = Moderately, IV = Highly, V = Completely, VI = Residual
TCR = Total Core Recovery, SCR = Solid core recovery, RQD = Rock Quality Designation,
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