

APPENDIX I

PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES



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

**RECOMMENDATION ON
URGENT PROTECTION MEASURES
BETWEEN KILOSA AND GLUWE
(RESULT OF FLOOD RISK ASSESSMENT)**

**APPENDIX I
PRELIMINARY DESIGN
FOR URGENT PROTECTION MEASURES**

DECEMBER, 2014

JICA STUDY TEAM

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

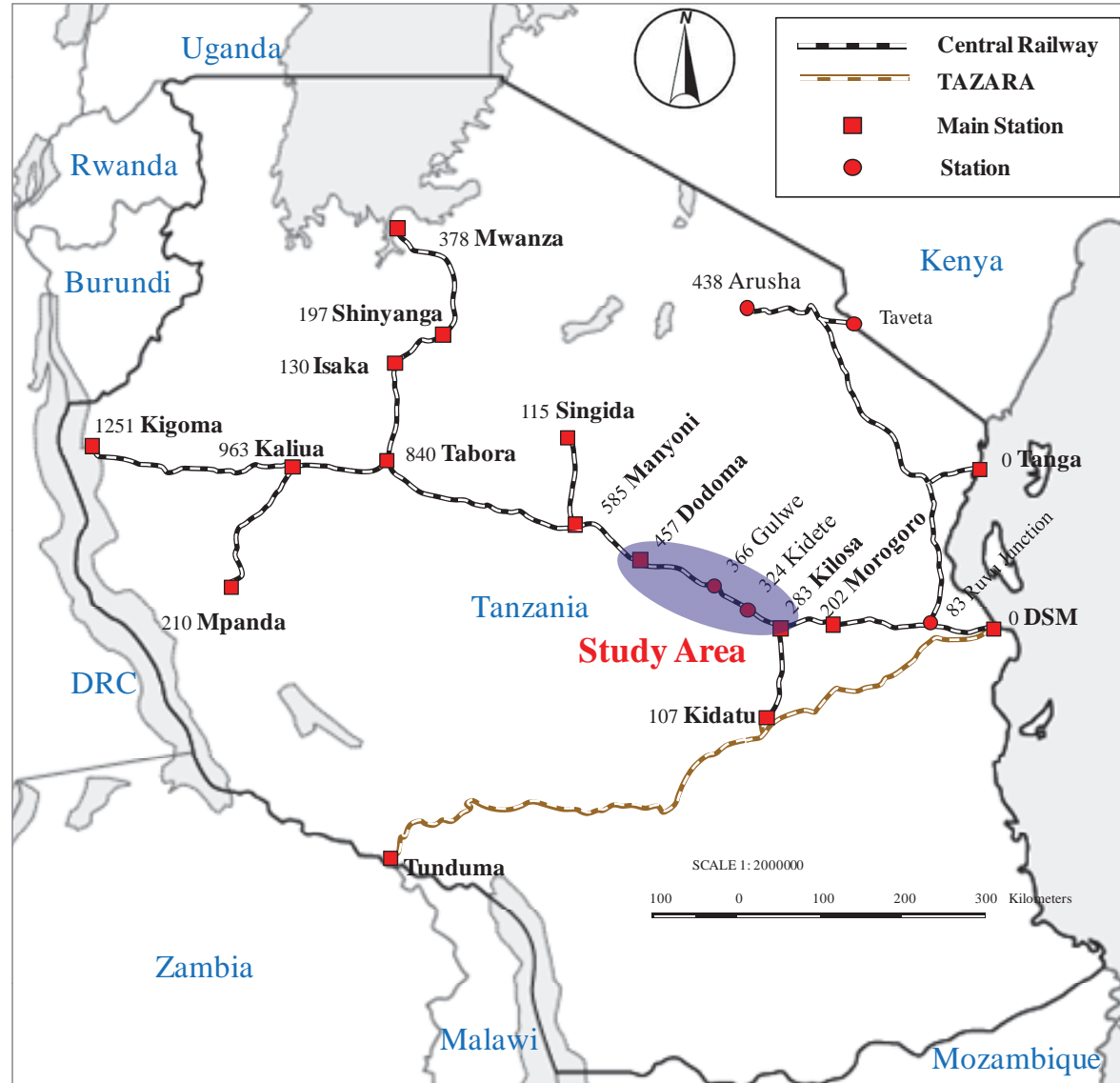
**PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES
(RESULTS OF FLOOD RISK ASSESSMENT)**

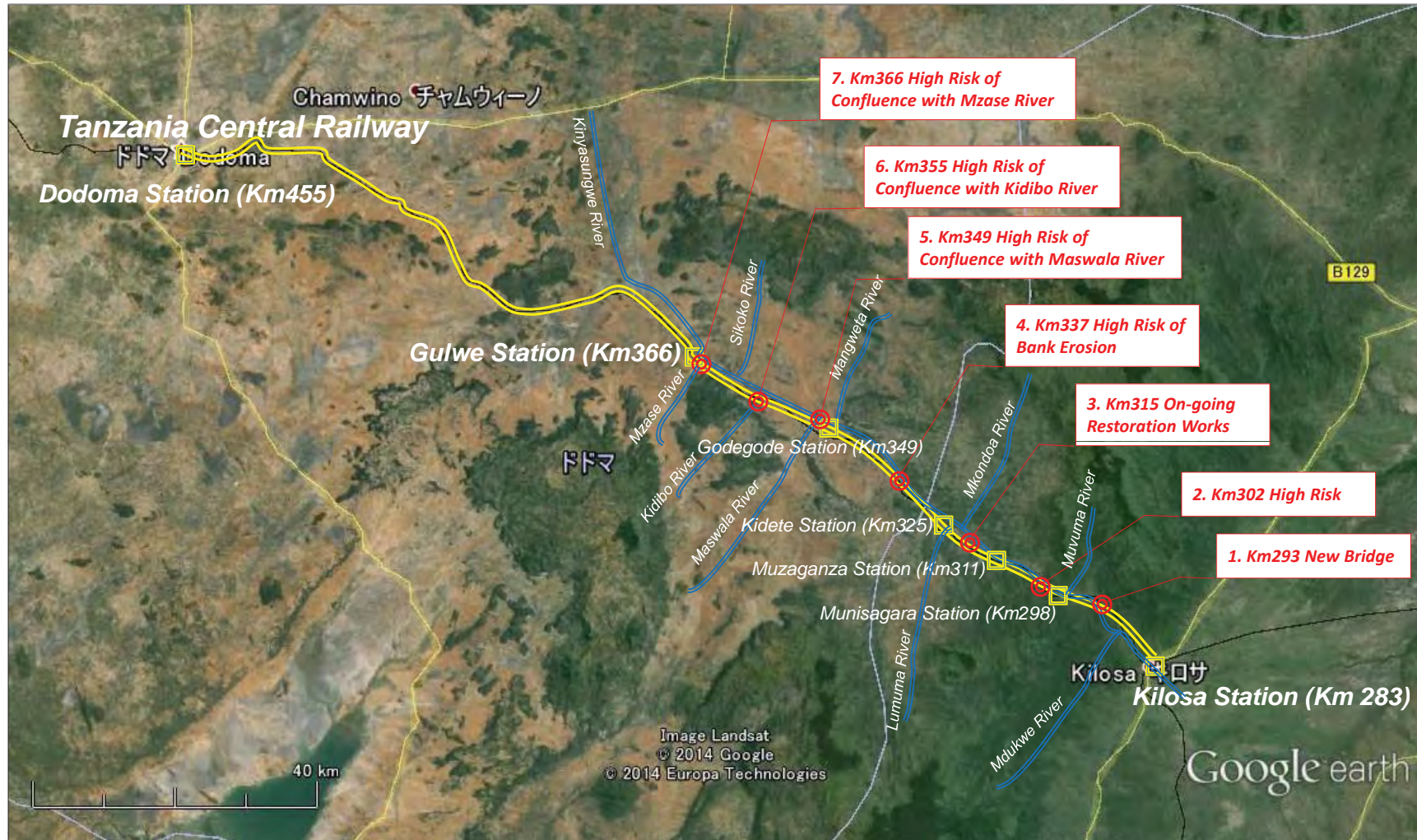
LIST OF DRAWINGS

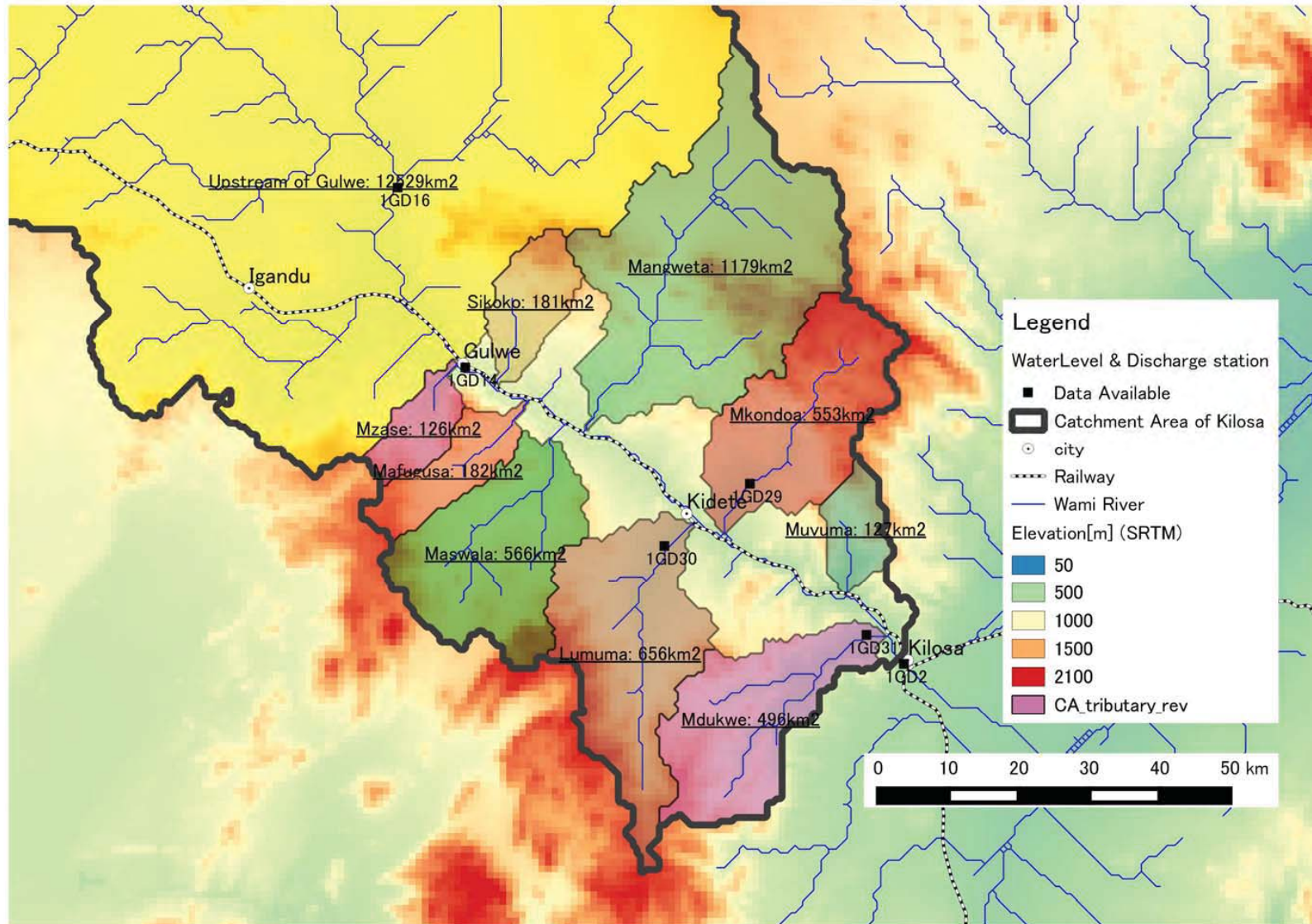
<u>SHEET REF No.</u>	<u>TITLE OF DRAWING</u>
00-01	List of Drawings
01-01	Study Area
02-01	General Plan
03-01	River Basin Map
Urgent Protection Measures	
[04: KM293.0 Bridge]	
04-01	Plan at KM293.0 Bridge
04-02	Cross Section for Heightening of Dike by Gabion at KM293.0 Bridge
04-03	Plan for Rehabilitation of Gabion at KM293.0 Bridge
[05: KM301.7 – KM302.3]	
05-01	Plan Between KM301.7 and KM302.3 (On-going Restoration Works)
05-02	Cross Section for Installation of Gabion Between KM301.7 and KM302.3
[06: KM315.0 – KM315.8]	
06-01	Plan between KM315.0 and KM315.8 (On-going Restoration Works)
06-02	Cross Section for Installation of Gabion Between KM315.0 and KM315.8
[07: KM337.2 – KM337.7]	
07-01	Plan between KM337.2 and KM337.7
07-02	Cross Section for Installation of Gabion Between KM337.2 and KM337.7
07-03	Cross Section for Installation of Spur Dike Between KM337.2 and KM337.7
07-04	Cross Section for River Channel Between KM337.2 and KM337.7
[08: KM349.4B – KM349.9B]	
08-01	Plan between KM349.4B and KM349.9B
08-02	Typical Sections of Restoration Between KM349.4B and KM349.9B
[09: KM350.0 – KM351.0:]	
09-01	Plan between KM350.0 and KM351.0 (On-going Restoration Works in Kidivo River)
09-02	Rehabilitation of Existing Steel Sheet Pile and Removal of Sediment in Middle of River Channel
[10: Restoration of Existing Culverts]	
10-01	Plan of Restoration of Culvert (Example of PCL333.1)
10-02	Typical Section of Restoration of Existing Culverts
10-03	Sketch of Restoration of Culvert (Example of PCL333.1)

I-2











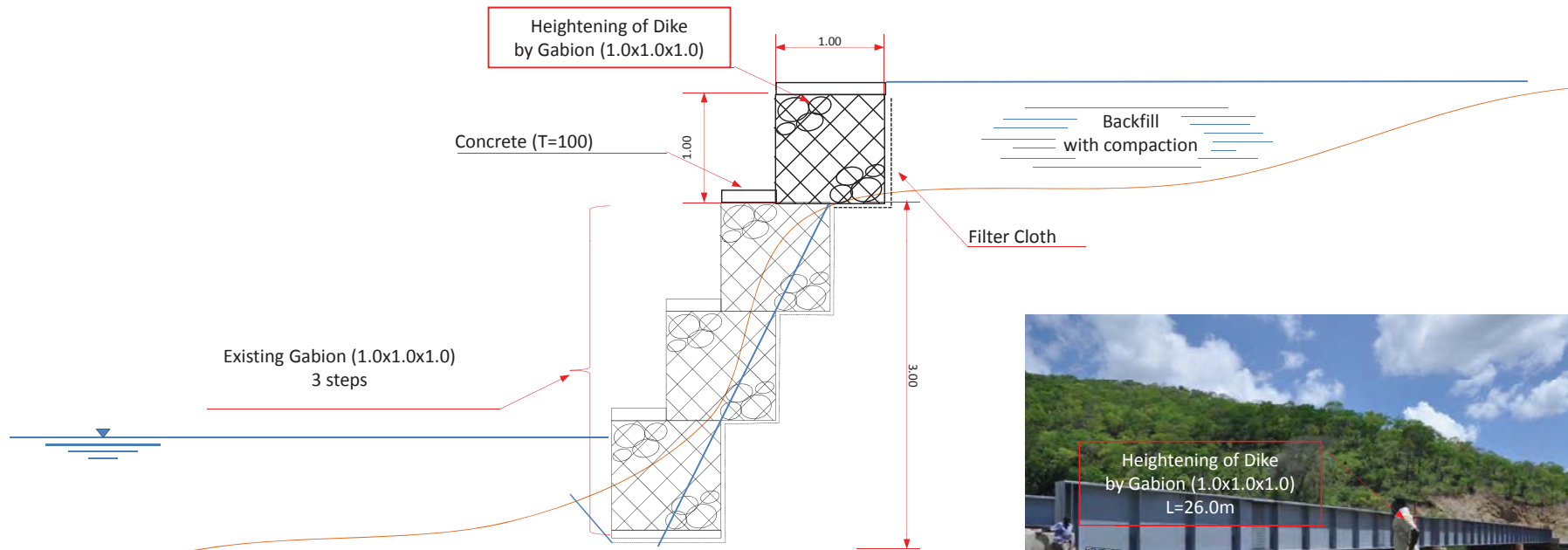
Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 5,2014. Detail of existing bridge and structures shall be confirmed with the As-Built Plan of the Bridge.



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PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES
(RESULTS OF FLOOD RISK ASSESSMENT)
Plan at KM293.0 BRIDGE

SHEET
Ref. No.
(04-01)



Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 5,2014. Detail of existing bridge and structures shall be confirmed with the As-Built Plan of the Bridge.



Present Site Condition



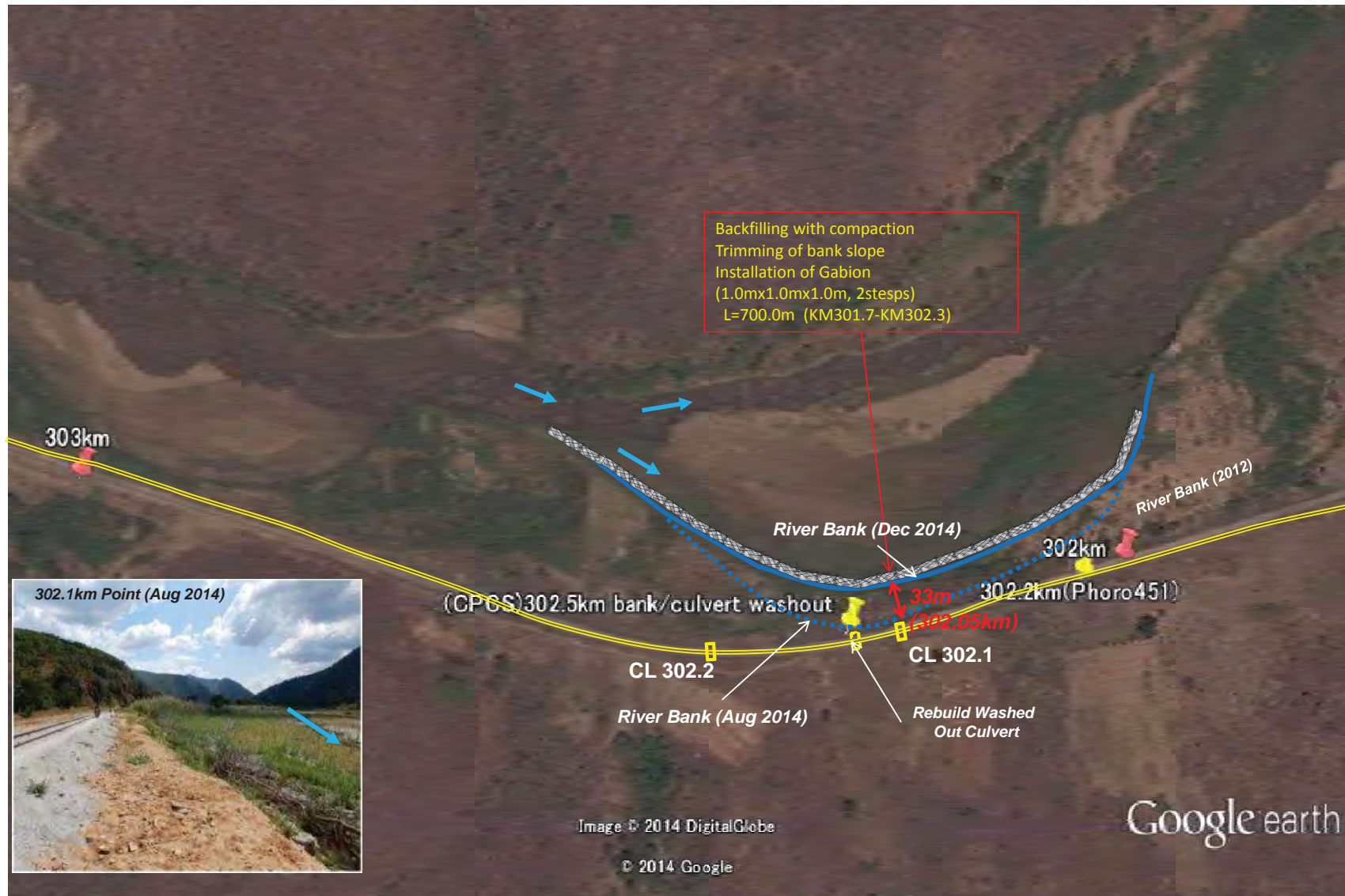
Proposed restoration works



Installation of
Gabion(1.0x1.0x1.0), 2 steps

Backfilling with compaction

Backfill
with compaction



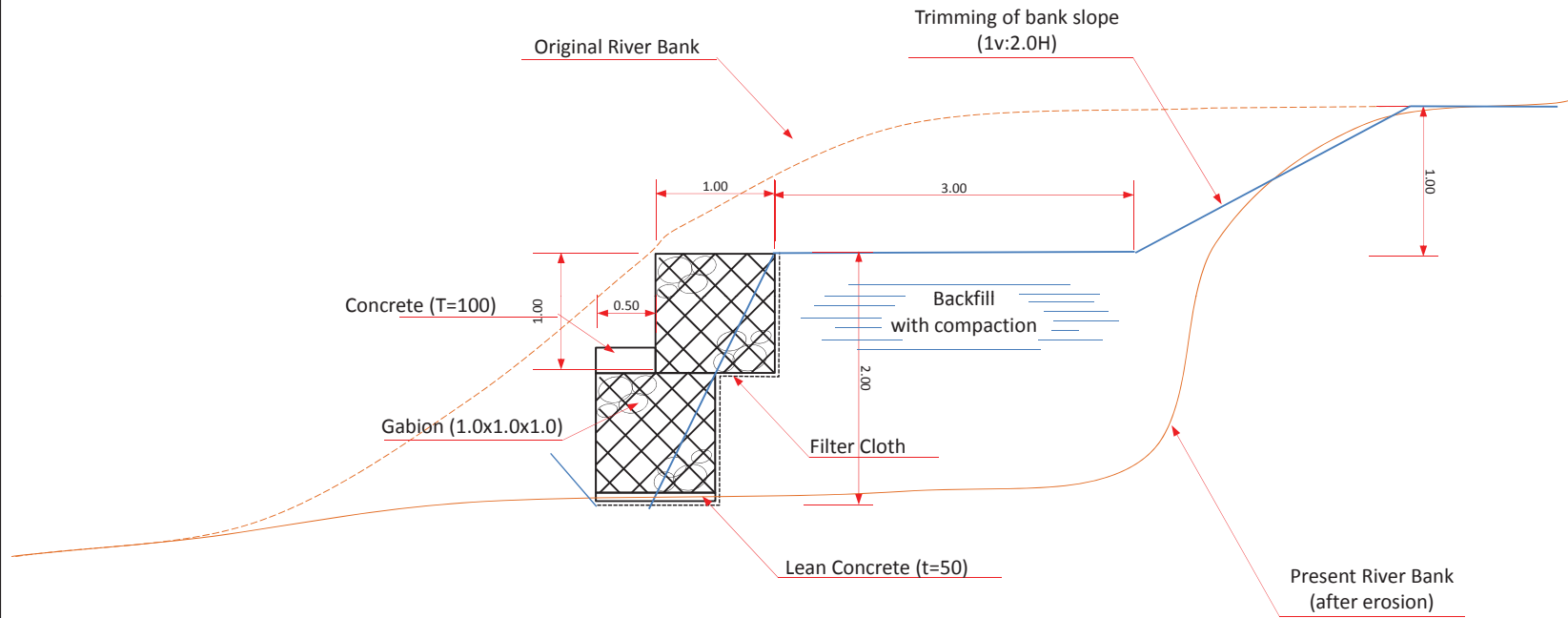
Note: This plan had been designed by rough site survey on 4th Dec 2014 and will be revised after collection of design report of RAHCO.



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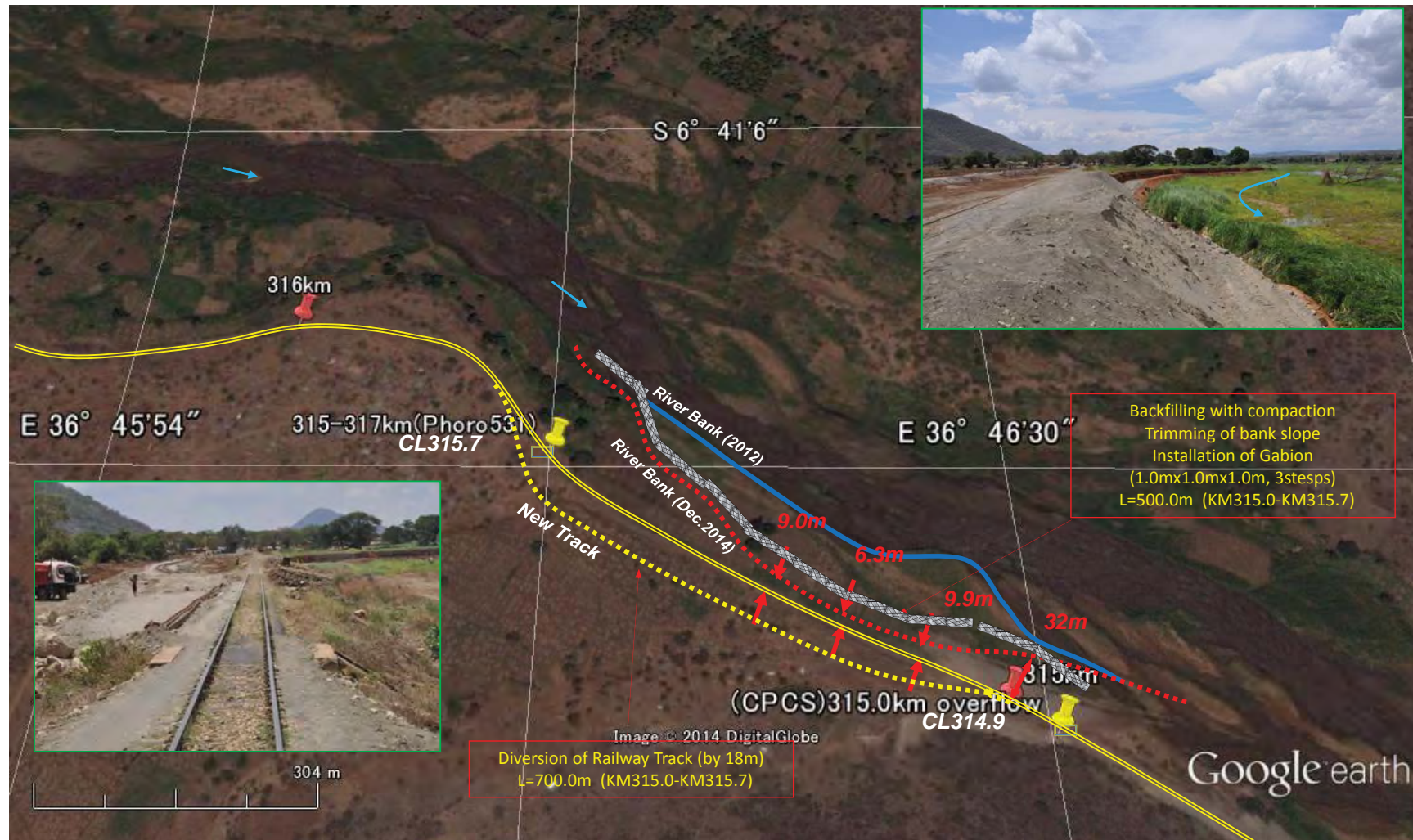
PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES
(RESULTS OF FLOOD RISK ASSESSMENT)
Plan Between KM301.7 and KM302.3 (On-going Restoration Works)

SHEET
Ref. No.
05-01



Note: This plan had been designed by rough site survey on 4th Dec 2014 and will be revised after collection of design report of RAHCO.





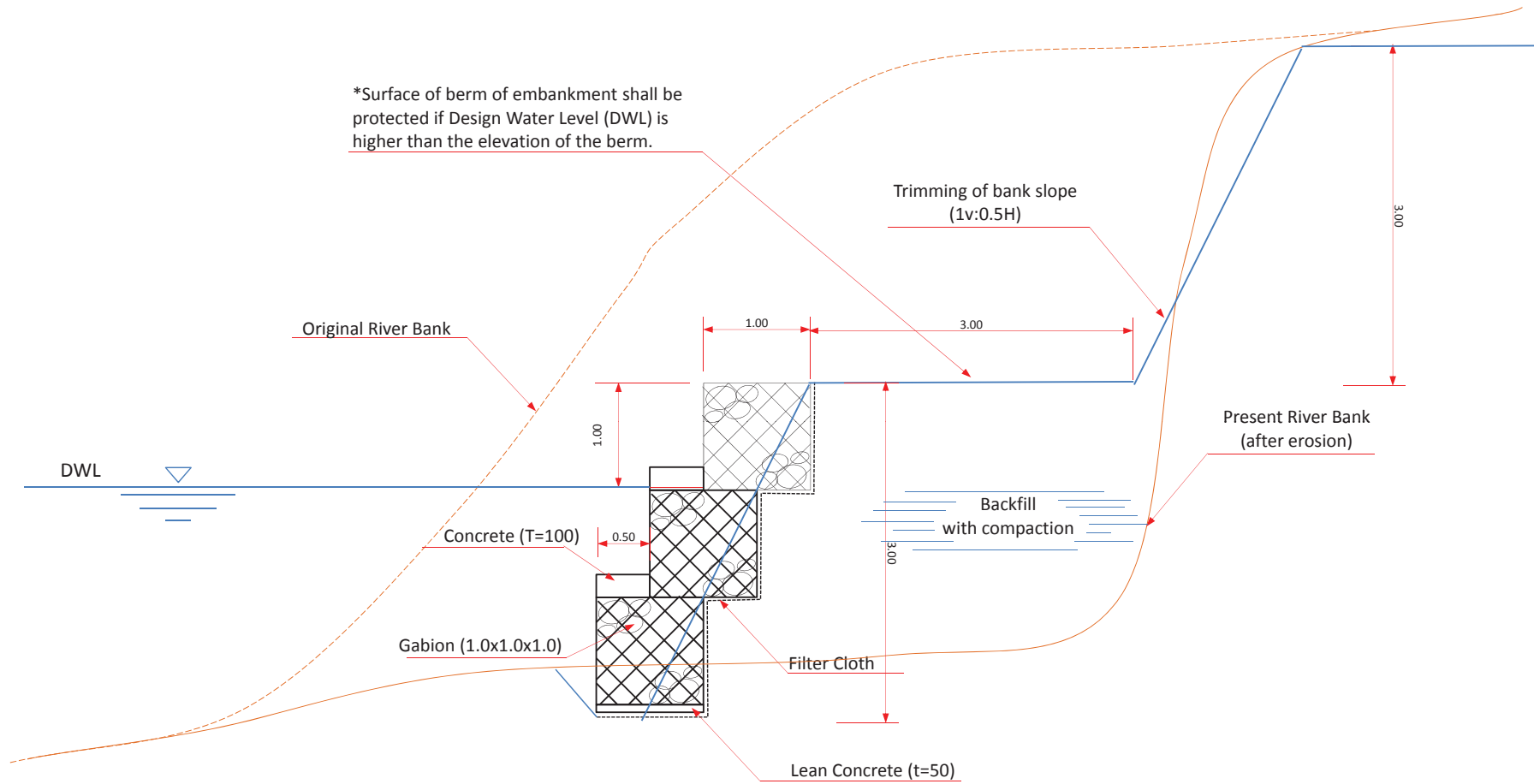
Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 4, 2014. Details of existing structures and on-going construction works shall be confirmed with the As-Built Drawing and Design Drawing, respectively. .



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PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES
(RESULTS OF FLOOD RISK ASSESSMENT)
Plan Between KM315.0 and KM315.8 (On-going Restoration Works)

SHEET
Ref. No.
(06-01)



Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 4, 2014. Details of existing structures and on-going construction works shall be confirmed with the As-Built Drawing and Design Drawing..





Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 3,2014. Details of existing structures and topographic condition shall be confirmed with result of topographic survey and river cross section survey to be conducted.

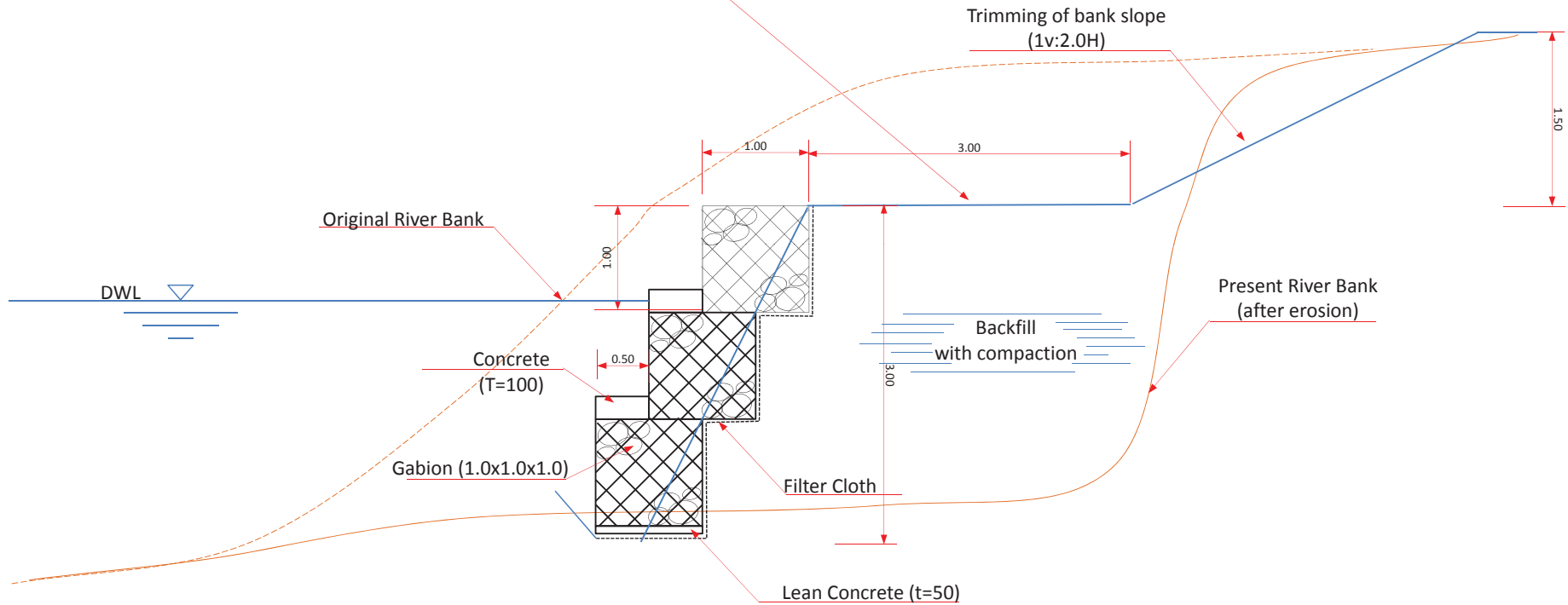


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PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES
(RESULTS OF FLOOD RISK ASSESSMENT)
Plan Between KM337.2 and KM337.7

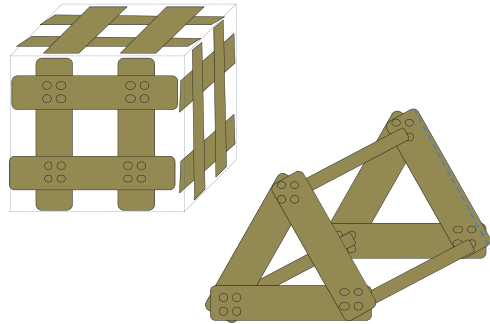
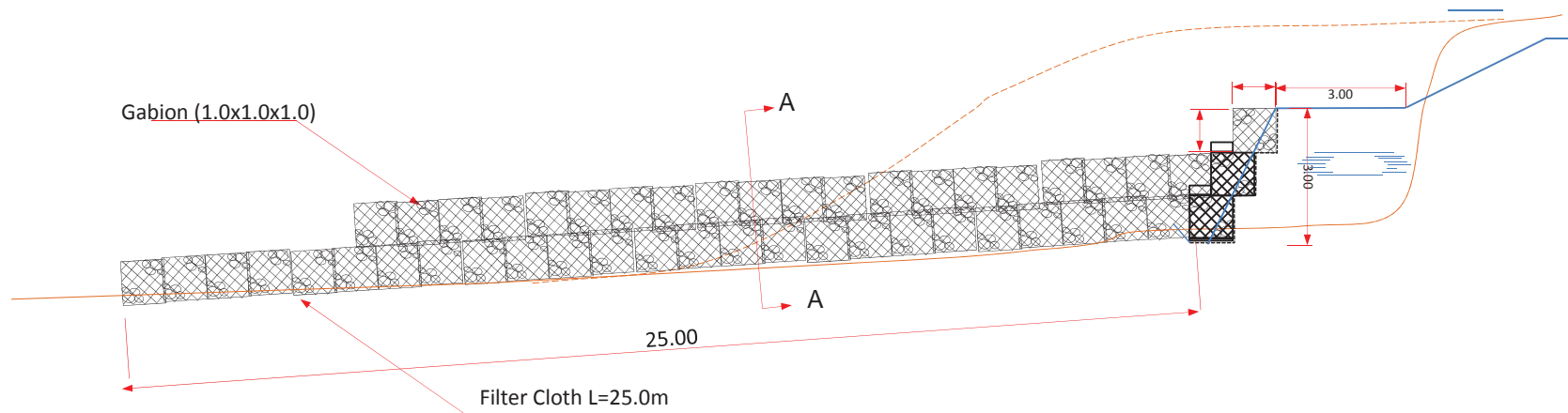
SHEET
Ref. No.
(07-01)

*Surface of berm of embankment shall be protected if Design Water Level (DWL) is higher than the elevation of the berm.

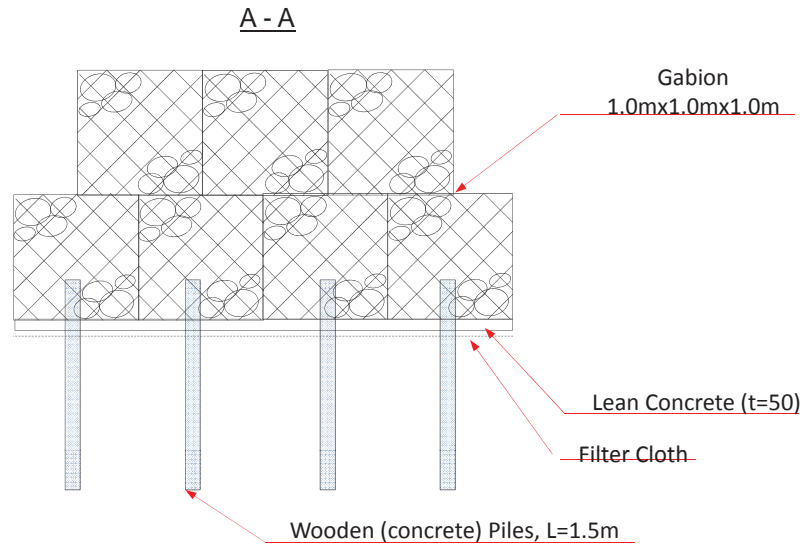


Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 3,2014. Details of existing structures and topographic condition shall be confirmed with result of topographic survey and river cross section survey to be conducted.

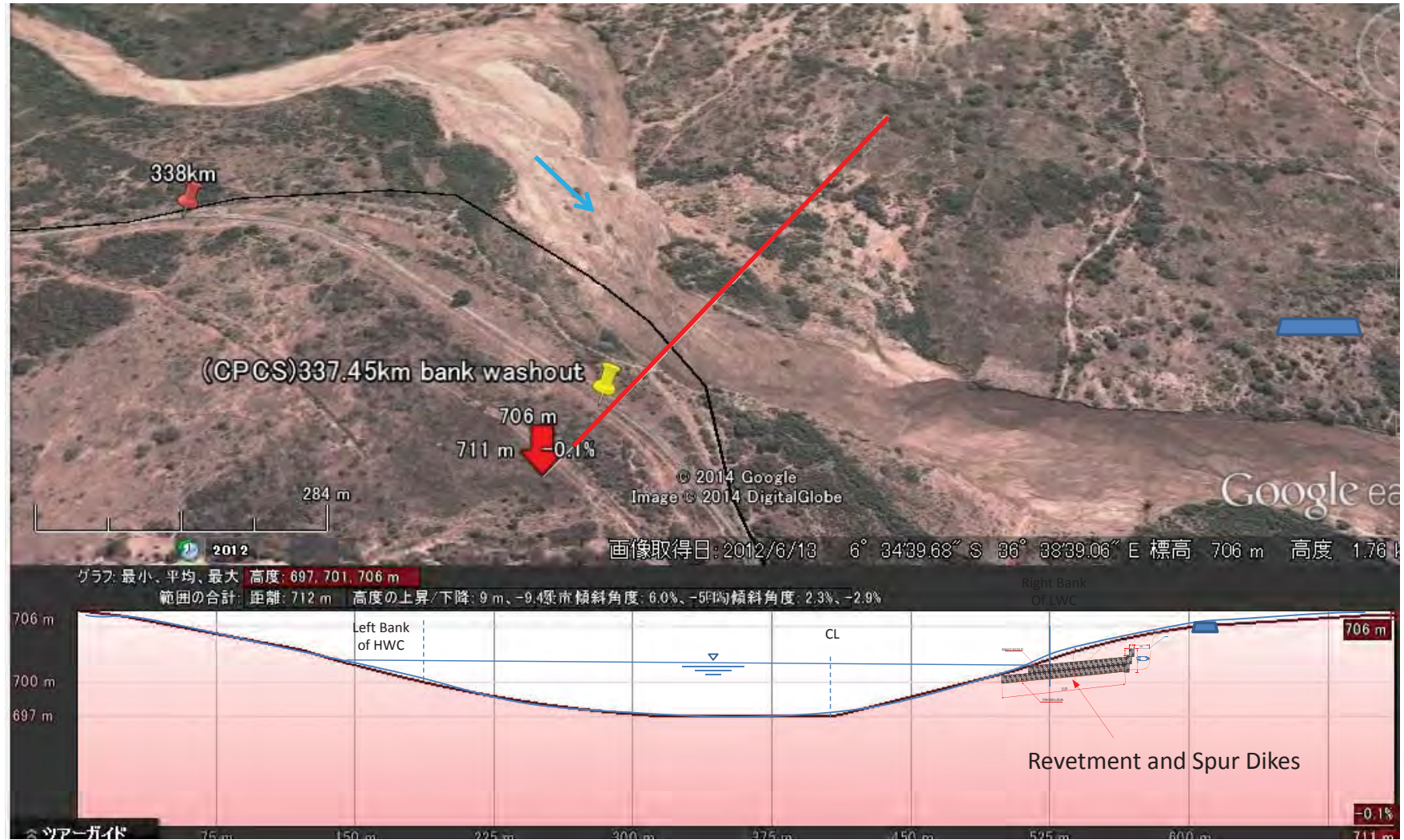




Example of steel frame made with used sleepers



Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 3,2014. Details of existing structures and topographic condition shall be confirmed with result of topographic survey and river cross section survey to be conducted.



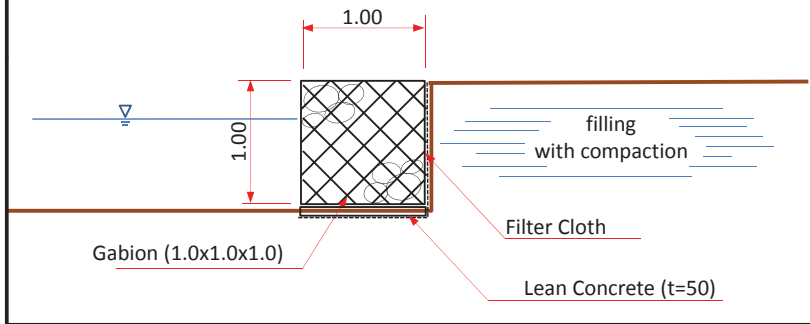


Maintenance Issue

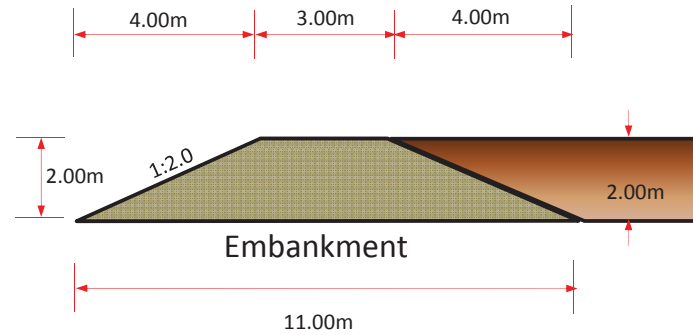
- The dredged sediment had been banked both side of channel.
- It is concerned that the dredged sediment release to channel.



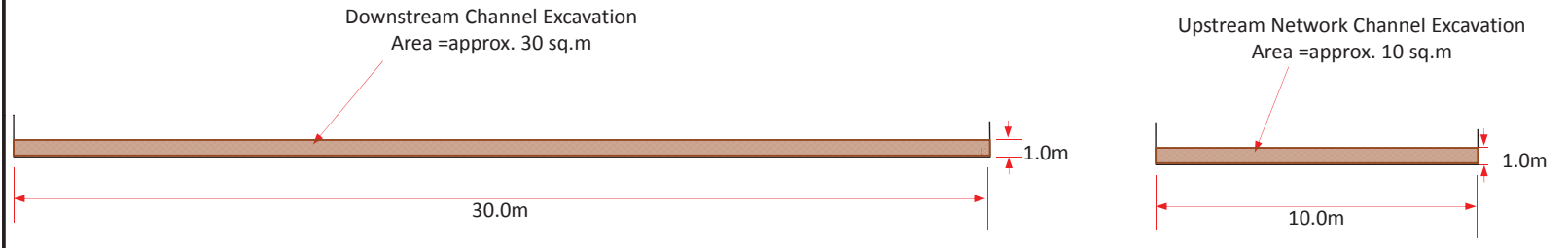
1. Gabion



2. Embankment of Soil Bank Yard



3. Channel Excavation





Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 2,2014. Details of existing structures and topographic conditions, on-going construction works shall be confirmed with result of topographic survey and river cross section survey to be conducted and As-Built Drawing, and Design Drawing..



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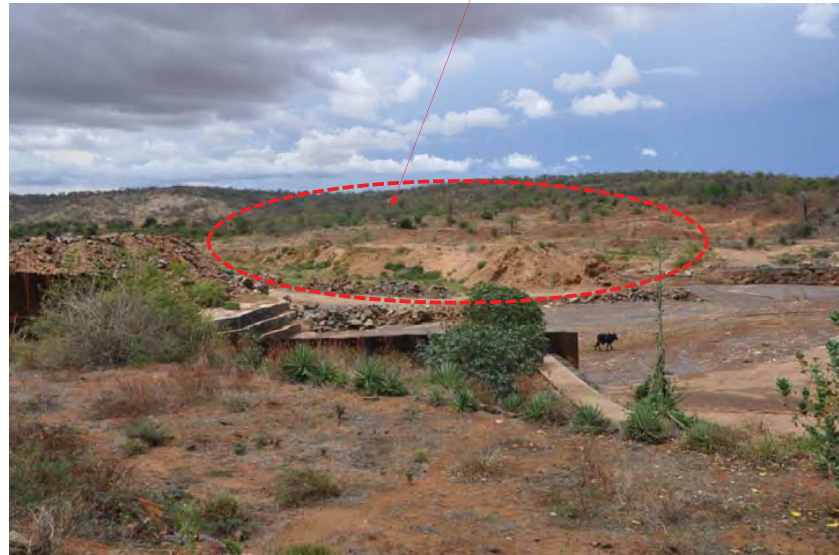
PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES (RESULTS OF FLOOD RISK ASSESSMENT)
Plan Between KM350.0 and KM351.0
(On-going Restoration Works in Kidibo River)

SHEET Ref. No. (09-01)



Rehabilitation of Existing Steel Sheet Pile (H=), L=100 m

Removal Sediment in the middle of river channel/installation of Toe protection of guide dike L= approx. 500 m



Note: The plan is prepared based on the joint field reconnaissance with RAHCO on December 2,2014. Details of existing structures and topographic conditions, on-going construction works shall be confirmed with result of topographic survey and river cross section survey to be conducted and As-Built Drawing, and Design Drawing..

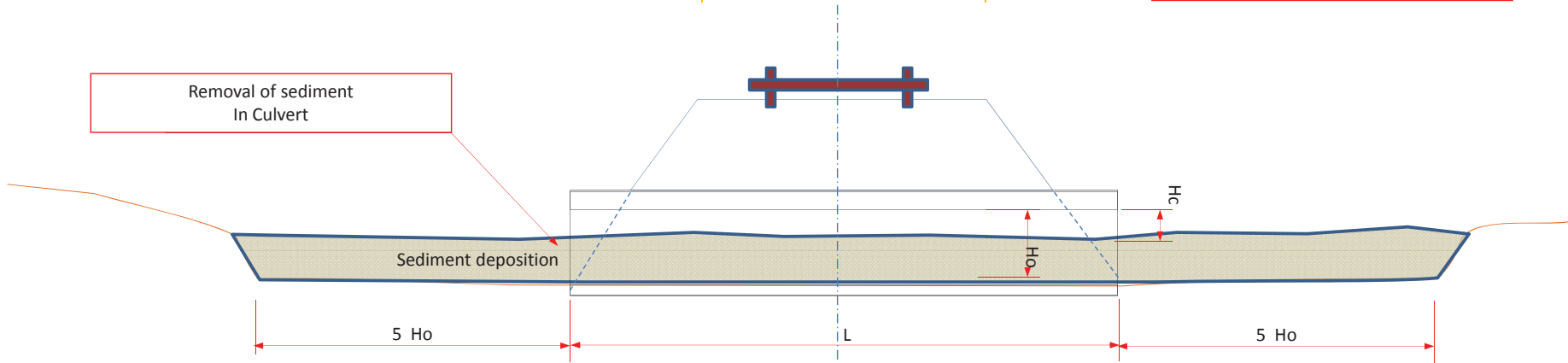
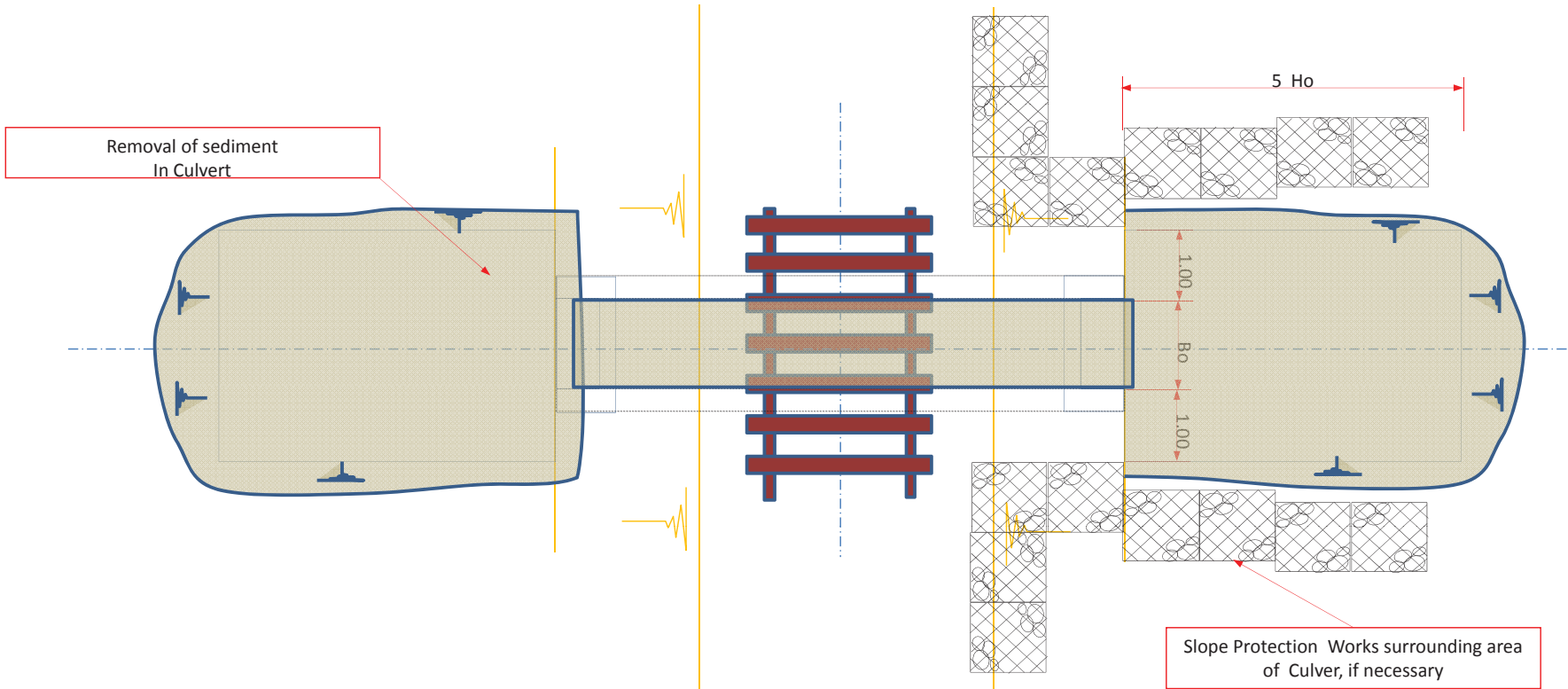


PREPARATORY SURVEY ON FLOOD PROTECTION MEASURES FOR CENTRAL RAILWAY LINE IN THE UNITED REPUBLIC OF TANZANIA
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PRELIMINARY DESIGN FOR URGENT PROTECTION MEASURES (RESULTS OF FLOOD RISK ASSESSMENT)
Plan Between KM350.0 and KM351.0
(On-going Restoration Works in Kidibo River)

SHEET Ref. No. (09-02)







APPENDIX J

PRELIMINARY COST ESTIMATE

JICA Preparatory Survey on Flood Protection Measures for Central Railway Line

Unit Price for Cost Estimate
for Urgent Protection Measures

No.	Work Item	RAHCO's current price		Note	1750 USD	118 JPY
		Unit	Price (TZS)			
1	Excavation (common soil)	m ³	7,500		4.3	506
2	Embankment	m ³	10,000	based on preliminary unit price analysis.		
3	Disposal of soil with transportation (distance to spoil bankyard: D <1 km)	m ³	2,400	based on preliminary unit price analysis.		
4	Disposal of soil with transportation (distance to spoil bankyard: D <5 km)	m ³	7,000	based on preliminary unit price analysis.		
5	Disposal of soil with transportation (distance to spoil bankyard: 5 km <D <10)	m ³	*			
6	Gabion mattress (2m x1mx 1m)	no.	140,000	Stone size is 200mm to 300mm.	80.0	9,440
7	Wet masonry	m ³	75,000		42.9	5,057
8	Disposal of obstacles in river channel	m ³	*	For instance, the debris (Baobabu tree) in Kidibo River, etc.		
9	Transportation of stone material from quarry site	m ³	125,000		71.4	8,429
10	Filter cloth	m ²	9,500		5.4	641
11	Concrete Grade 20	m ³	350,000		200.0	23,600
12	Re-bar	ton	1,500,000		857.1	101,143
13	Steel sheet pile	l.m.	260,000	based on preliminary unit price analysis.		
14	Site clearing	m ²	4,500		2.6	303
15	Concrete pipe (precast D=0.9m)	no.	320,000	L=1.0 m	182.9	21,577
16	Stone pitching/riprap	m ³	35,000		20.0	2,360
17						

Source: RAHCO, Dec. 2014

Construction Equipment

No.	Work Item	RAHCO's current price		Note	1750 USD	118 JPY
		Unit	Price (TZS)			
1	Dump Truck	day	400,000		229	26,971
2	Backhoe	day	800,000		457	53,943
3	Bulldozer	day	800,000		457	53,943

Fuel Consumption Rate

No.	Work Item	RAHCO's current price		Note	1750 USD	118 JPY
		Unit	Qty			
1	Dump Truck	liter	*	depend on driving distance, 2km/liter	-	-
2	Backhoe	liter/hour	26	22-30	-	-
3	Bulldozer	liter/hour	18	16-20	-	-

Cost Estimation for "01 Works at Bridge Km293"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				1,083,960	
2		Construction works					
2-1		Gabion	cu.m	70,000	36	2,520,000	
2-2		Filter Cloth	sq.m	9,500	49	465,500	
2-3		Concrete (Grade 20)	cu.m	350,000	3	1,085,000	
2-4		Lean Concrete	cu.m	350,000	1	262,500	
2-5		Backfillng with compaction	cu.m	10,000	310	3,100,000	
2-6		Precas Pipe Culvert (D=0.9m, L=1.0m)	nos.	320,000	5	1,600,000	
		Sub Total of 2.				9,033,000	
3		Micellaneous (20% of 2.)				1,806,600	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				1,083,960	
		Total			TZS	13,007,520	
					(USD	7,400	) 1USD=TZS 1,750
					(JPY	873,200	) 1USD=JPY 118.0

Cost Estimation for "04 Works between KM337.2-337.7 (Option 2: Revetment with Spur Dikes)"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				52,034,400	
2		Construction works					
2-1		Gabion	cu.m	70,000	3,410	238,700,000	
2-2		Filter Cloth	sq.m	9,500	3,410	32,395,000	
2-3		Concrete (Grade 20)	cu.m	350,000	55	19,250,000	
2-4		Lean Concrete	cu.m	350,000	83	28,875,000	
2-5		Backfillng with compaction	cu.m	10,000	6,600	66,000,000	
2-6		Concrete Pile (0.15x0.15x1.50)	unit	44,000	1,100	48,400,000	
		Sub Total of 2.				433,620,000	
3		Micellaneous (20% of 2.)				86,724,000	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				52,034,400	
		Total			TZS	624,412,800	
					(USD	356,800	) 1USD=TZS 1,750
					(JPY	42,102,400	) 1USD=JPY 118.0

Cost Estimation for "05 Works between KM349.4B - KM349.9B"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				84,440,400	
2		Construction works					
2-1		Gabion	cu.m	70,000	100	7,000,000	
2-2		Filter Cloth	sq.m	9,500	200	1,900,000	
2-3		Concrete (Grade 20)	cu.m	350,000		0	
2-4		Lean Concrete	cu.m	350,000	25	8,750,000	
2-5		Backfillng with compaction	cu.m	10,000	2,000	20,000,000	
2-6		Channel Excavation	cu.m	7,500	67,000	502,500,000	
2-7		Embankment	cu.m	10,000	16,352	163,520,000	Include Tansport Cost
		Sub Total of 2.				703,670,000	
3		Micellaneous (20% of 2.)				140,734,000	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				84,440,400	
		Total				TZS 1,013,284,800	
						(USD 579,000)	) 1USD=TZS 1,750
						(JPY 68,322,000)	) 1USD=JPY 118.0

Cost Estimation for "06 Works between KM350.0-351.0 (Kidibo River Confluence)"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				22,657,200	
2		Construction works					
2-1		Gabion	cu.m	70,000	800	56,000,000	
2-2		Filter Cloth	sq.m	9,500	600	5,700,000	
2-3		Concrete (Grade 20)	cu.m	350,000	20	7,000,000	
2-4		Lean Concrete	cu.m	350,000	10	3,500,000	
2-5		Channel Excavation	cu.m	7,500	3,900	29,250,000	
2-6		Disposal of Soil (D<1km)	cu.m	2,400	3,900	9,360,000	
2-7		Steel Sheet Piling	l.m.	260,000	300	78,000,000	
		Sub Total of 2.				188,810,000	
3		Micellaneous (20% of 2.)				37,762,000	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				22,657,200	
		Total				TZS 271,886,400	
					(USD	155,400	) 1USD=TZS 1,750
					(JPY	18,337,200	) 1USD=JPY 118.0

Cost Estimation for "07 Works in Km366 (Mzase River)"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				81,000,000	
2		Construction works					
2-1		Channel Excavation in Mzase River	cu.m	7,500	80,000	600,000,000	
2-2		Channel Excavation at Confluence	cu.m	7,500	10,000	75,000,000	
2-3		Disposal of Soil (D<1km)	cu.m	2,400	90,000	216,000,000	
		Sub Total of 2.				675,000,000	
3		Micellaneous (20% of 2.)				135,000,000	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				81,000,000	
		Total			TZS	972,000,000	
					(USD	555,400	) 1USD=TZS 1,750
					(JPY	65,537,200	) 1USD=JPY 118.0

Cost Estimation for "08 Works for removal of sediment depositions in existing culverts"

No	Work Item No.	Item	Unit	Unit Price (TzS)	Quantity	Amount (TzS)	Remarks
1		Mobilization/Preparatory Works (10% of 2. and 3.)				5,203,440	
2		Construction works					
2-1		Removal of sediment depositions in existing culverts	cu.m	7,500	4,380	32,850,000	
2-2		Disposal of Soil (D<1km)	cu.m	2,400	4,380	10,512,000	
		Sub Total of 2.				43,362,000	
3		Micellaneous (20% of 2.)				8,672,400	
4		Demobilization/Cleaning up site (10% of 2. and 3.)				5,203,440	
		Total			TZS	62,441,280	
					(USD	35,700	) 1USD=TZS 1,750
					(JPY	4,212,600	) 1USD=JPY 118.0

Quantity for Removal of Sediment in Existing Culvert

No.	Section	Location	Type of Culvert	Major Dimensions (m)	Quantity of Removal Sediment (m ³)
		(km)			
1	1. From Kilosa (282.7km) to St. Munisagara (298.3km)	287.15	Pipe Culvert	Hc0.0, Bc0.0, L6.0 (2)	30.88
2		287.25	Box Culvert	Hc0.9, Bc7.0, L5.0 (1)	236.50
3		287.3	Pipe Culvert	Hc0.1, Bc0.9, L5.0 (1)	32.56
4		290.4	Box Culvert	Hc1.3, Bc3.0 (1)	78.40
5		291.7	Box Culvert	Hc0.0 (1)	35.87
6		295.1	Box Culvert	Hc0.9, Bc3.9, L3.6 (2)	251.68
7		295.9	Box Culvert	Hc0.9, Bc3.9, L3.6 (2)	18.05
8		297.1	Box Culvert	Hc0.8, Bc1.9, L3.6 (1)	102.66
9		297.6	Box Culvert	Hc1.2, Bc0.9, L3.6 (1)	48.99
10		299.3	Pipe culvert	D1.1, L3.9 (4)	84.00
11		299.7	Pipe culvert	D1.2, L10.6 (3)	108.65
12	2. From St. Munisagara (298.3km) to Kidete (325.5km)	300.1	Pipe Culvert	Hc0.2, Bc0.9, L5.0 (1)	28.46
13		308.3	Box Culvert	Hc0.0, Bc3.6, (1)	252.80
14		309.9	Box Culvert	Hc0.4, Bc2.0, (1)	140.80
15	3. From Kidete (325.5km) to Godegode (349.1km)	325.7	Pipe Culvert	Hc0.36, Bc0.9, L6.0 (2)	23.91
16		325.75	Pipe Culvert	Hc0.45, Bc0.9, L7.0 (2)	13.97
17		333.1	Box Culvert	Hc0.4, Bc2.0, (1)	140.80
18		334.7	Box Culvert	Hc0.9, Bc1.8, (1)	91.52
19		334.8	Box Culvert	Hc0.5, Bc2.0, (1)	132.00
20		335	Box Culvert	Hc0.5, Bc2.0, (1)	132.00
21		336.1	Box Culvert	Hc0.85, Bc2.0, (1)	101.20
22		347.5	Box Culvert	Hc0.5, Bc2.9, L4.0 (1)	20.40
23		347.5	Box Culvert	Hc0.5, Bc2.0, L4.0 (1)	262.24
24		348	Box Culvert	Hc0.8, Bc2.0, L4.0 (2)	161.84
25	4. From Godegode (349.1km) to Gulwe (365.9km)	354.3	Box Culvert	Hc0.55, Bc2.0 (1)	127.60
26		355.6	Box Culvert	Hc0.95, Bc3.0 (1)	117.60
27		356.1	Box Culvert	Hc0.8, Bc3.0 (1)	134.40
28		360.6	Box culvert	Hc0.6, Bc5.0, L3.6 (1)	216.41
29		361.1	Box culvert	Hc0.6, Bc2.0, L3.7 (1)	126.73
30		361.9	Box culvert	Hc0.3, Bc5.0, L3.6 (1)	263.86
31		362.1	Box culvert	2 steps	259.93
32		362.5	Pipe culvert	D0.8, L8.6 (2)	48.17
33		362.9	Box culvert	2 steps	120.60
34		363.3	Box culvert	Hc0.2, Bc2.0, L5.0 (2)	109.38
35		363.7	Box culvert	Hc1.6, Bc?, L5.0 (1)	36.00
36		364.2	Box culvert	Hc0.3, Bc2.5, L5.0 (2)	281.25
TOTAL					4,372.1
					4,380.0

APPENDIX K

RESULT OF FREQUENCY ANALYSIS

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

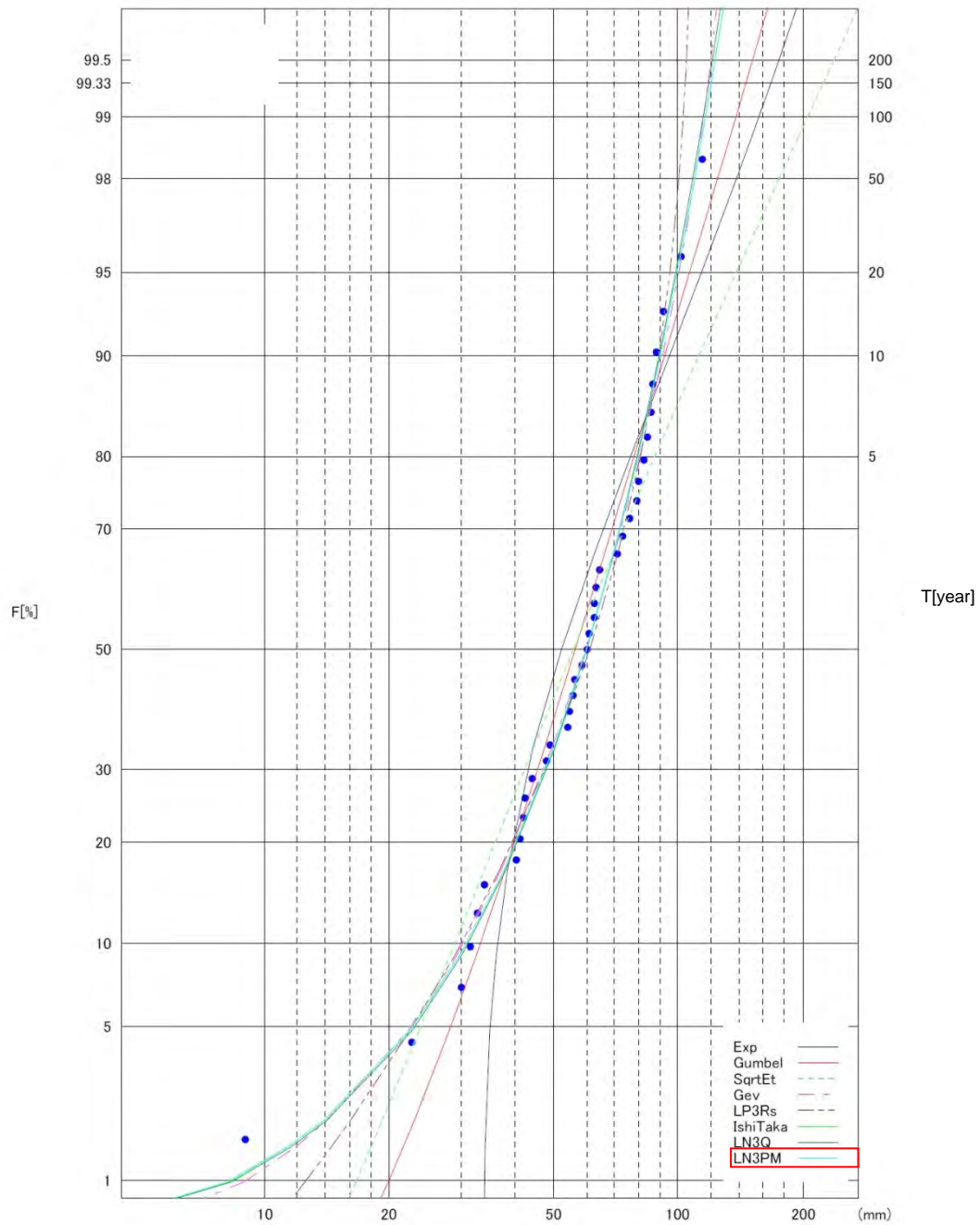
Station ID	9535005	9535006	9536000	9536002	9536004	9536005	9536011	9536017	9635001	9635012	9635014	9636000	9636002	9636004	9636006	9636008	9636013	9636018	9636020
No. of Sample	6	5	37	14	34	6	6	38	76	24	24	32	5	6	28	44	34	30	50
Type	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	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 in	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)

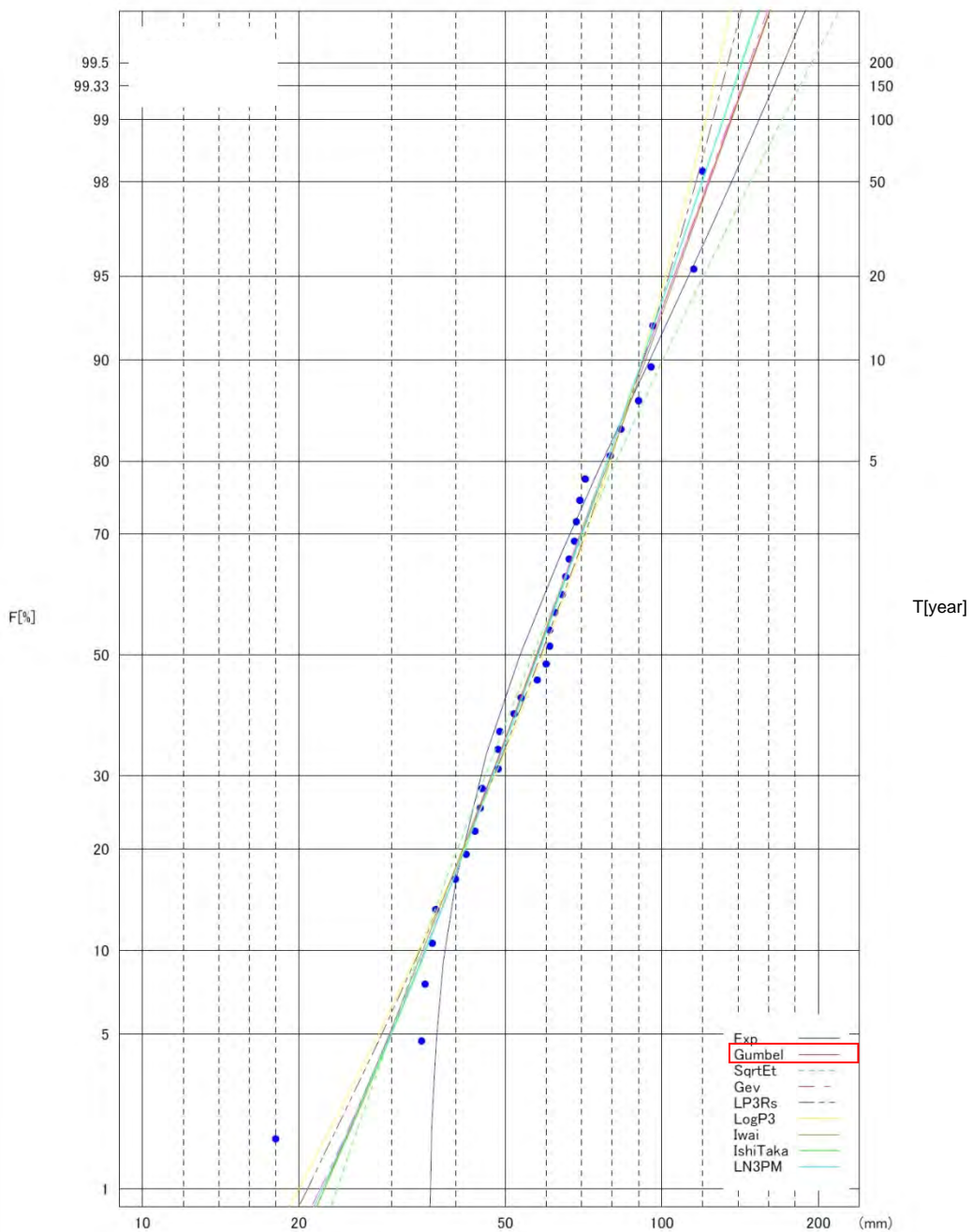
Station ID	9636026	9636027	9636029	9636030	9636031	9636032	9636033	9636034	9636037	9636038	9736007	Azimio	Chihanga	Ibwaga	Kikombo	Mayamaya	1GD2	1GD2
No. of Sample	13	12	15	6	5	5	5	6	4	6	23	6	5	4	6	6	76	20
Type	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	Rainfall	CA Rainfall	Discharge
Method	-	-	Gev	-	-	-	-	-	-	-	LN2LM	-	-	-	-	-	Iwai	Iwai
SLSC(99%)	-	-	0.036	-	-	-	-	-	-	-	0.034	-	-	-	-	-	0.018	0.038
Probability Hydrological Value in Return Period	2	-	59.1	-	-	-	-	-	-	-	73.4	-	-	-	-	-	27.5	55
	3	-	65.5	-	-	-	-	-	-	-	82.9	-	-	-	-	-	31.1	74
	5	-	70.8	-	-	-	-	-	-	-	93.1	-	-	-	-	-	34.9	98
	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 Estimate in Return Period	2	-	59.1	-	-	-	-	-	-	-	73.3	-	-	-	-	-	27.4	54
3	-	65.6	-	-	-	-	-	-	-	82.8	-	-	-	-	-	31.0	74	
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 Estimate Error in Return Period	2	-	4.6	-	-	-	-	-	-	-	4.2	-	-	-	-	-	1.1	11
3	-	4.2	-	-	-	-	-	-	-	4.8	-	-	-	-	-	1.2	14	
5	-	3.6	-	-	-	-	-	-	-	5.7	-	-	-	-	-	1.4	16	
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



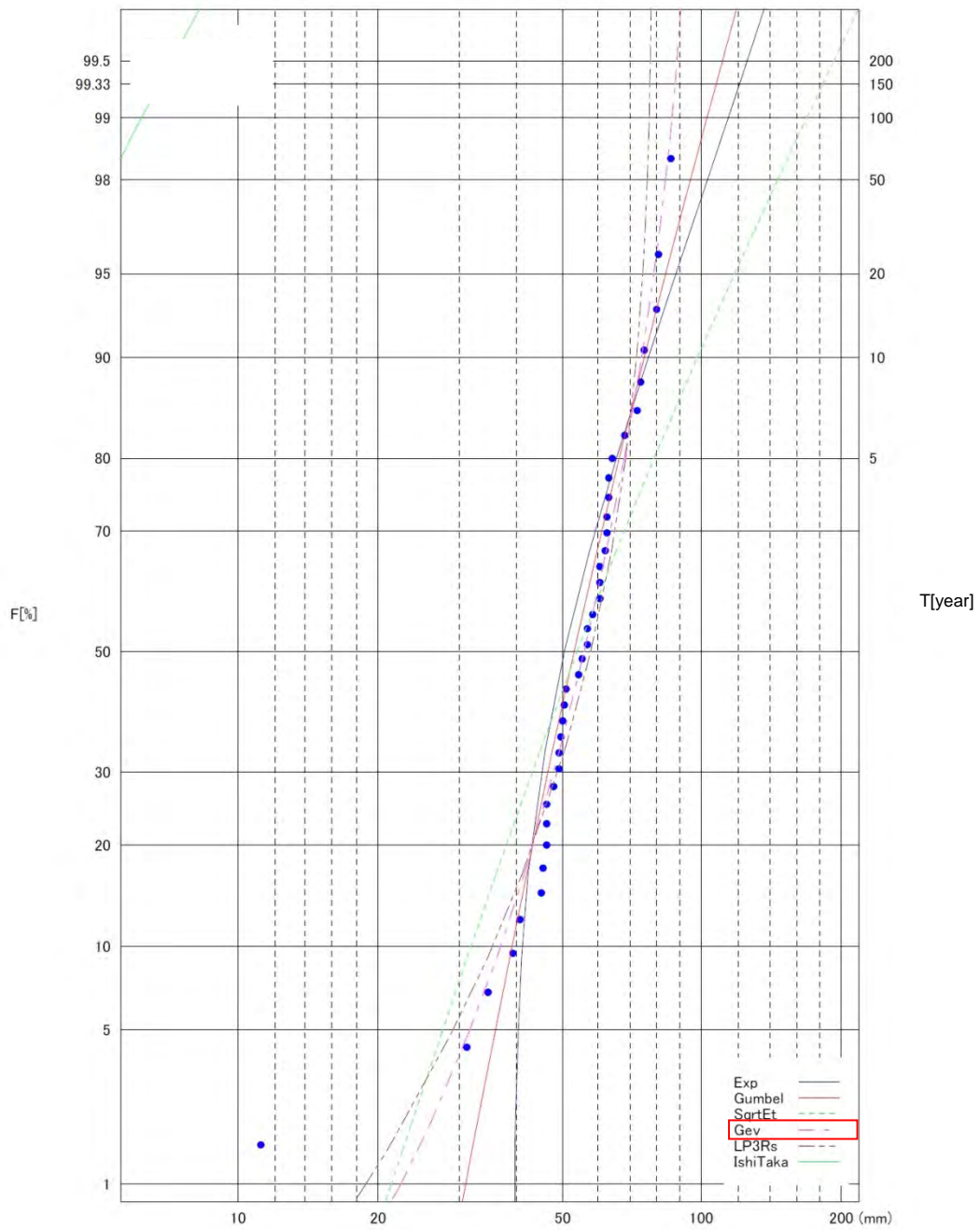
Source: JICA Study Team

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



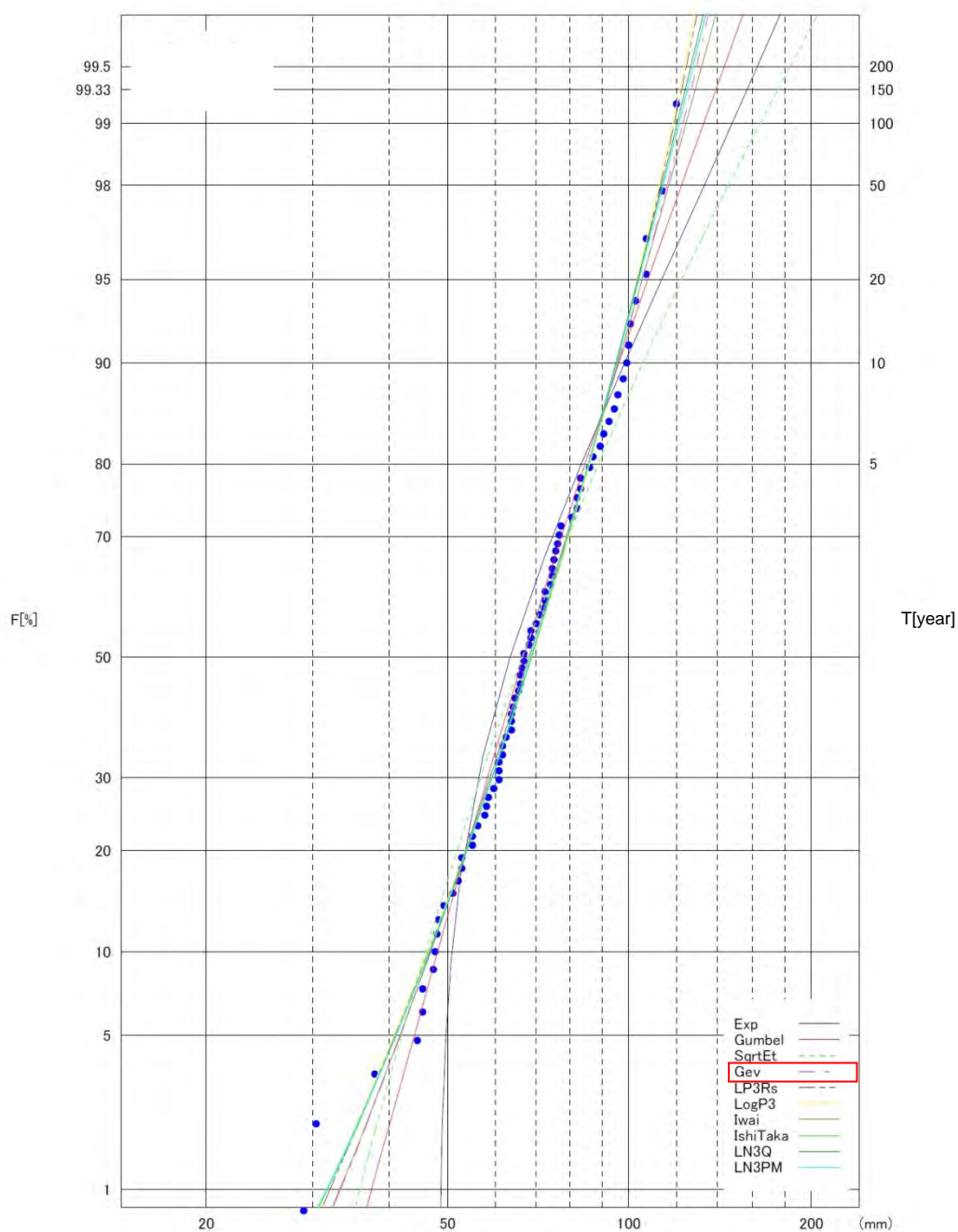
Source: JICA Study Team

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



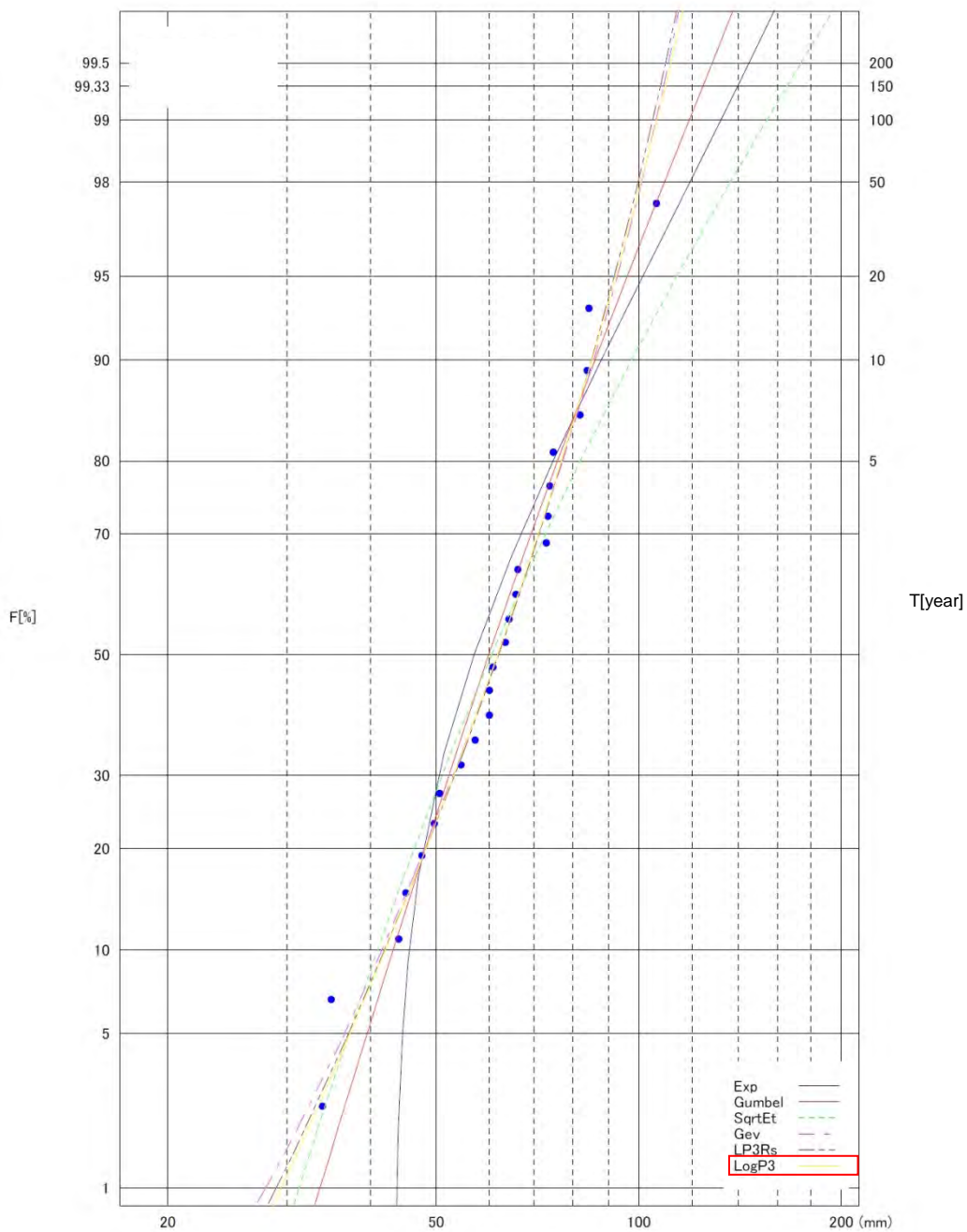
Source: JICA Study Team

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



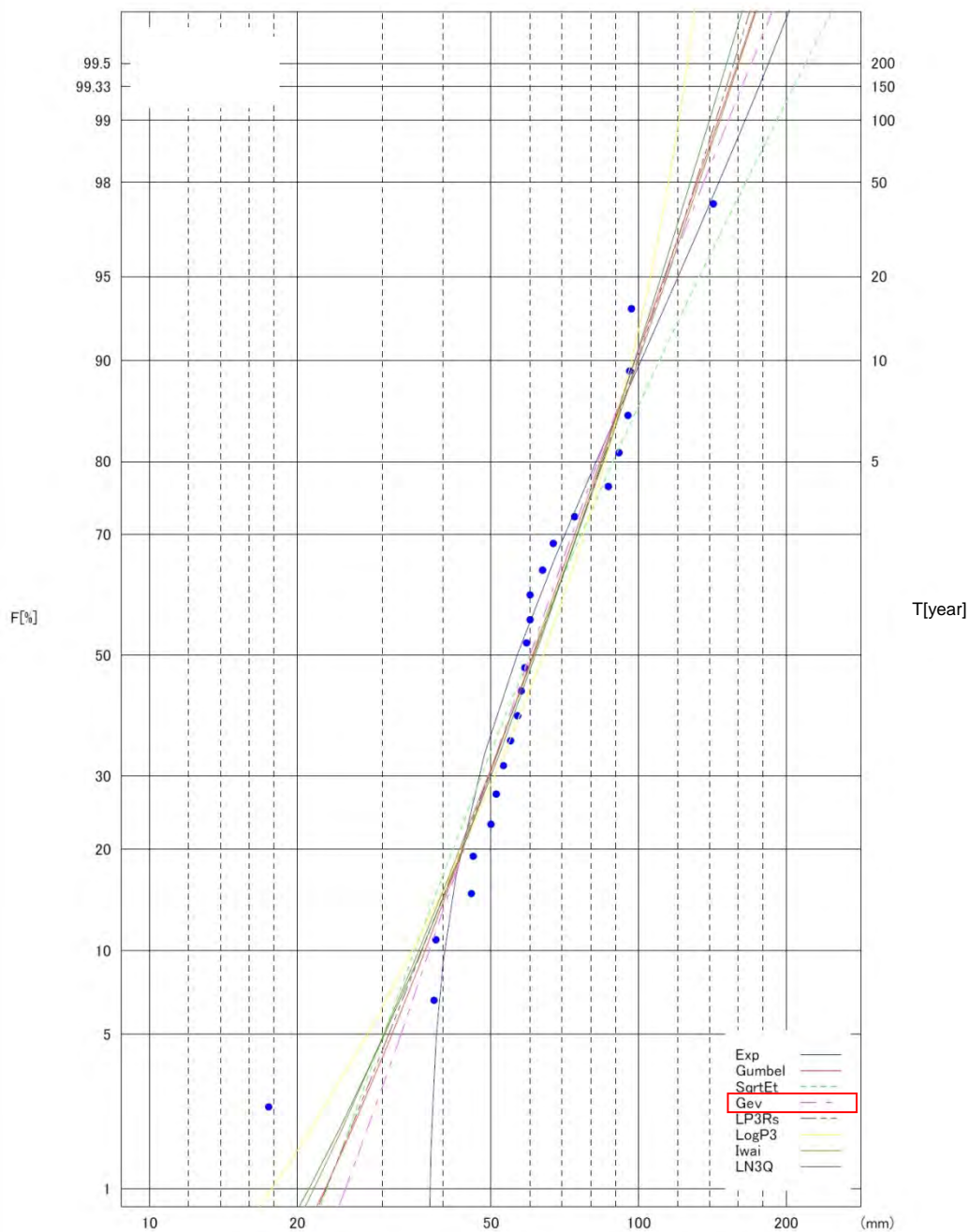
Source: JICA Study Team

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



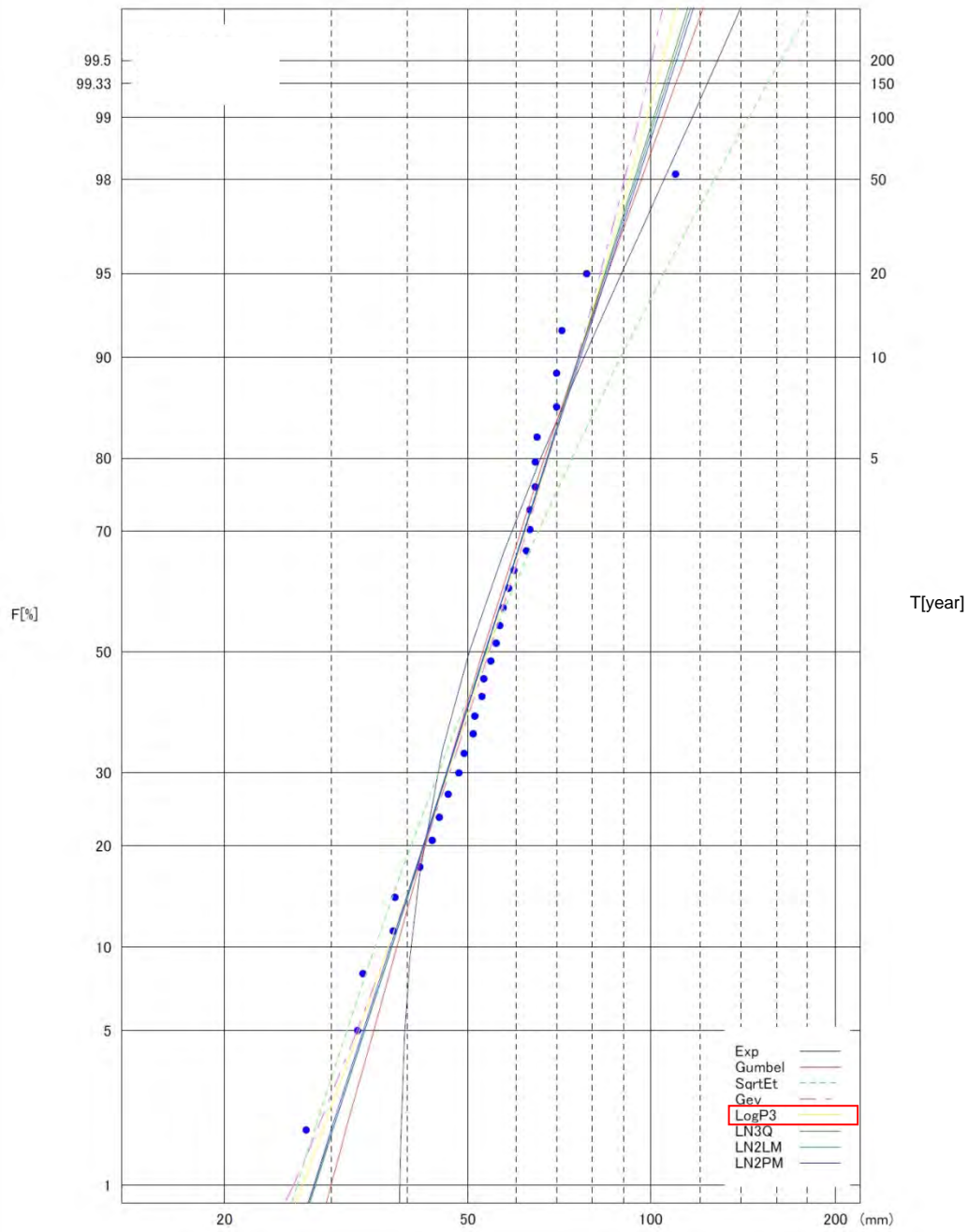
Source: JICA Study Team

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



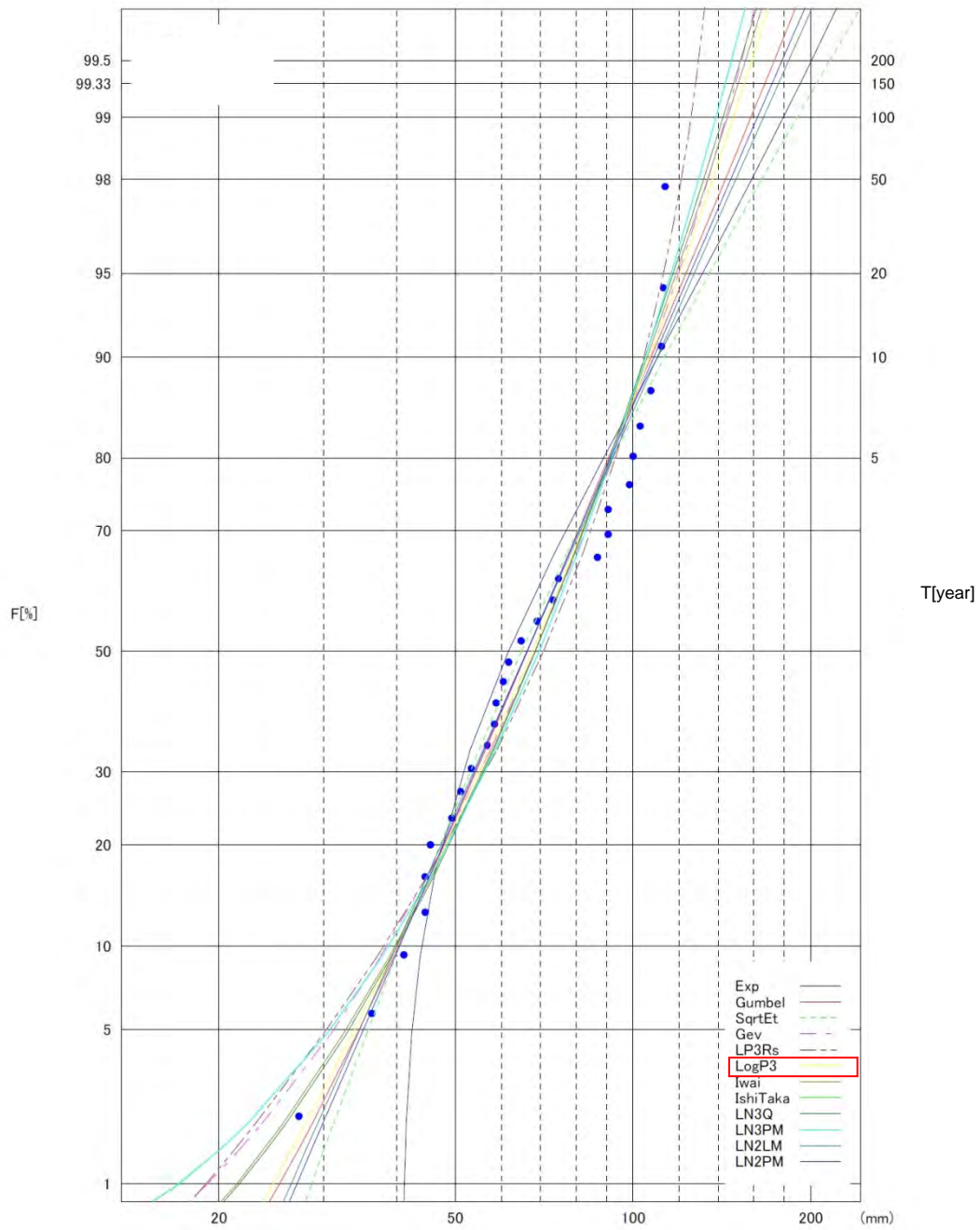
Source: JICA Study Team

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



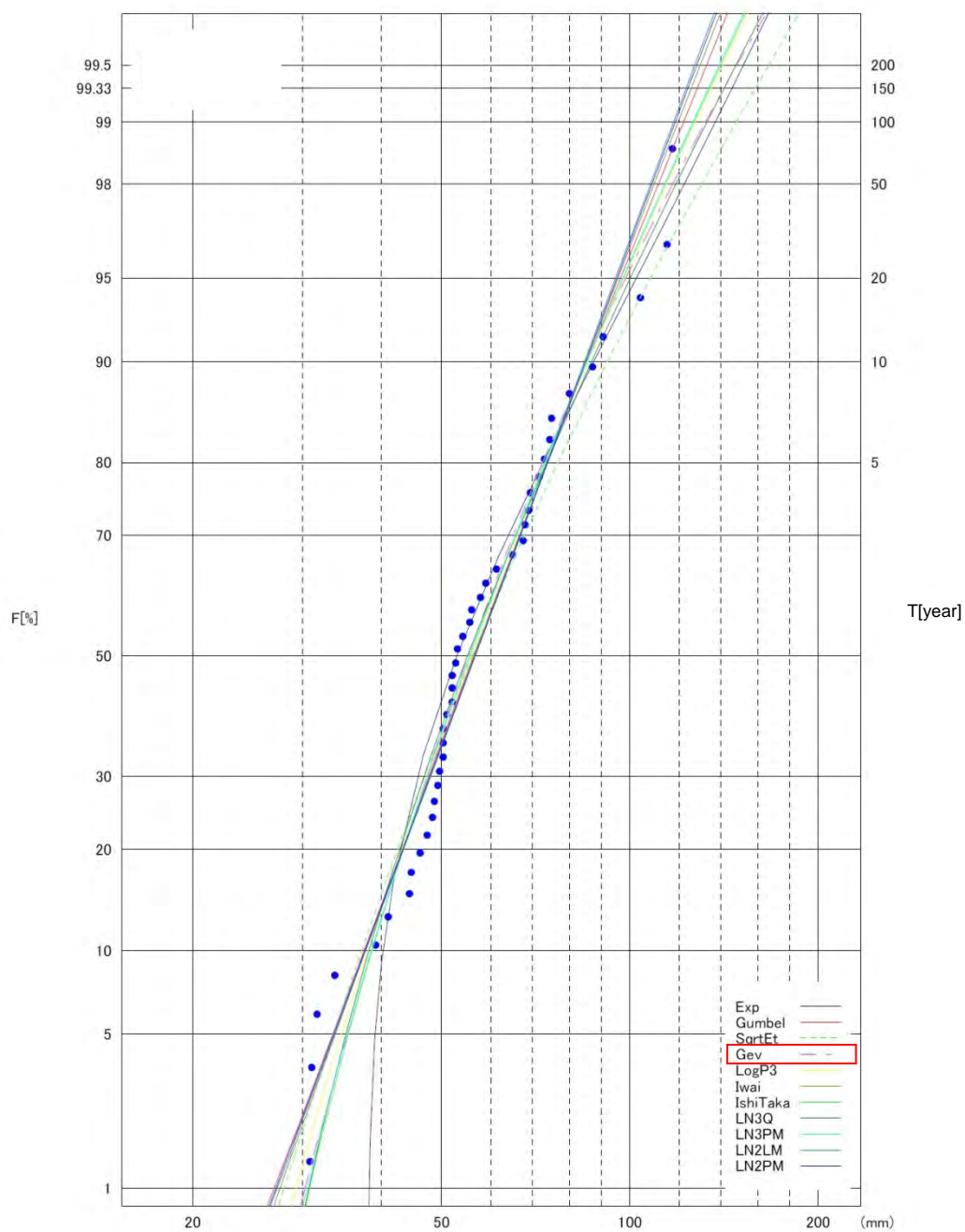
Source: JICA Study Team

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



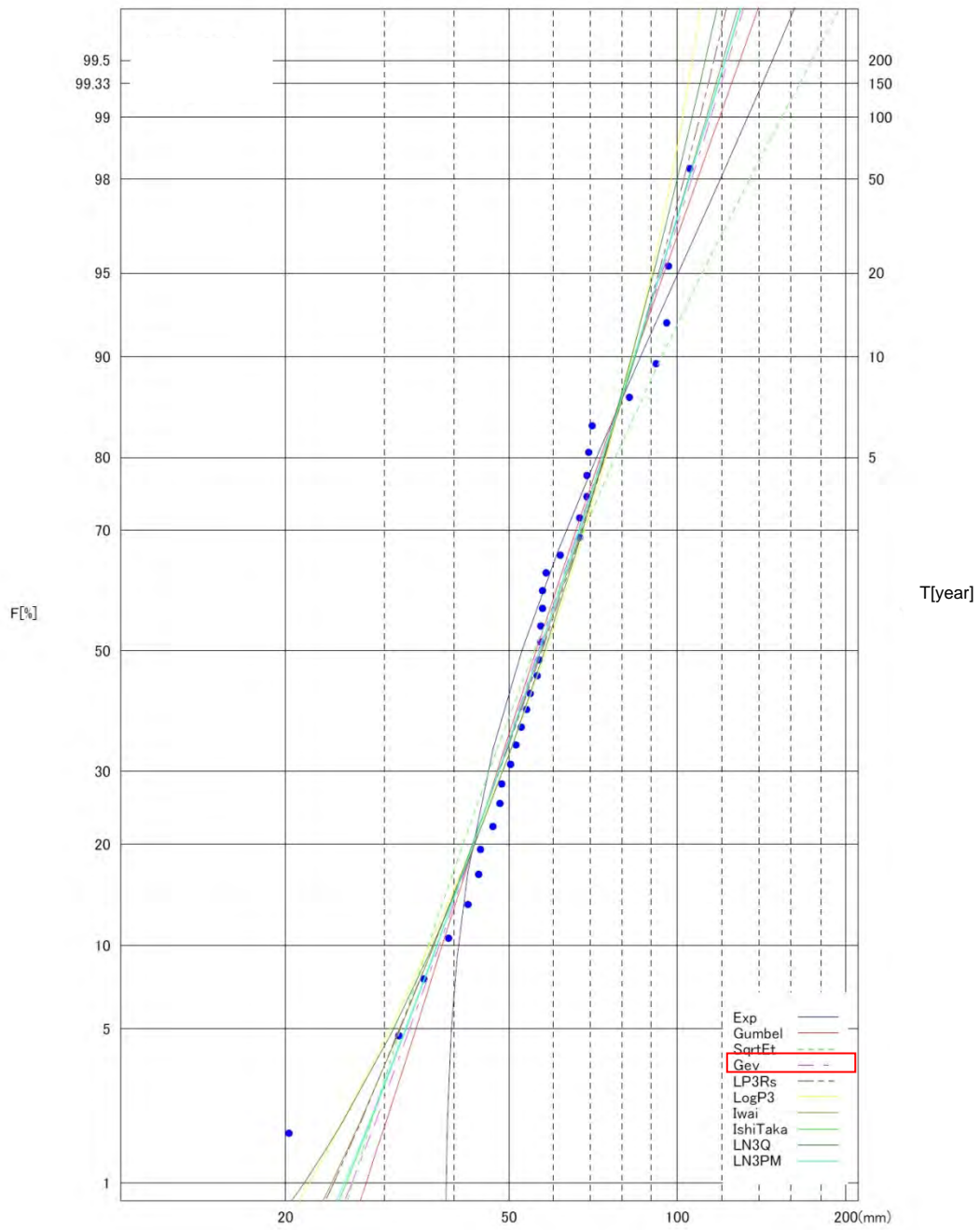
Source: JICA Study Team

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



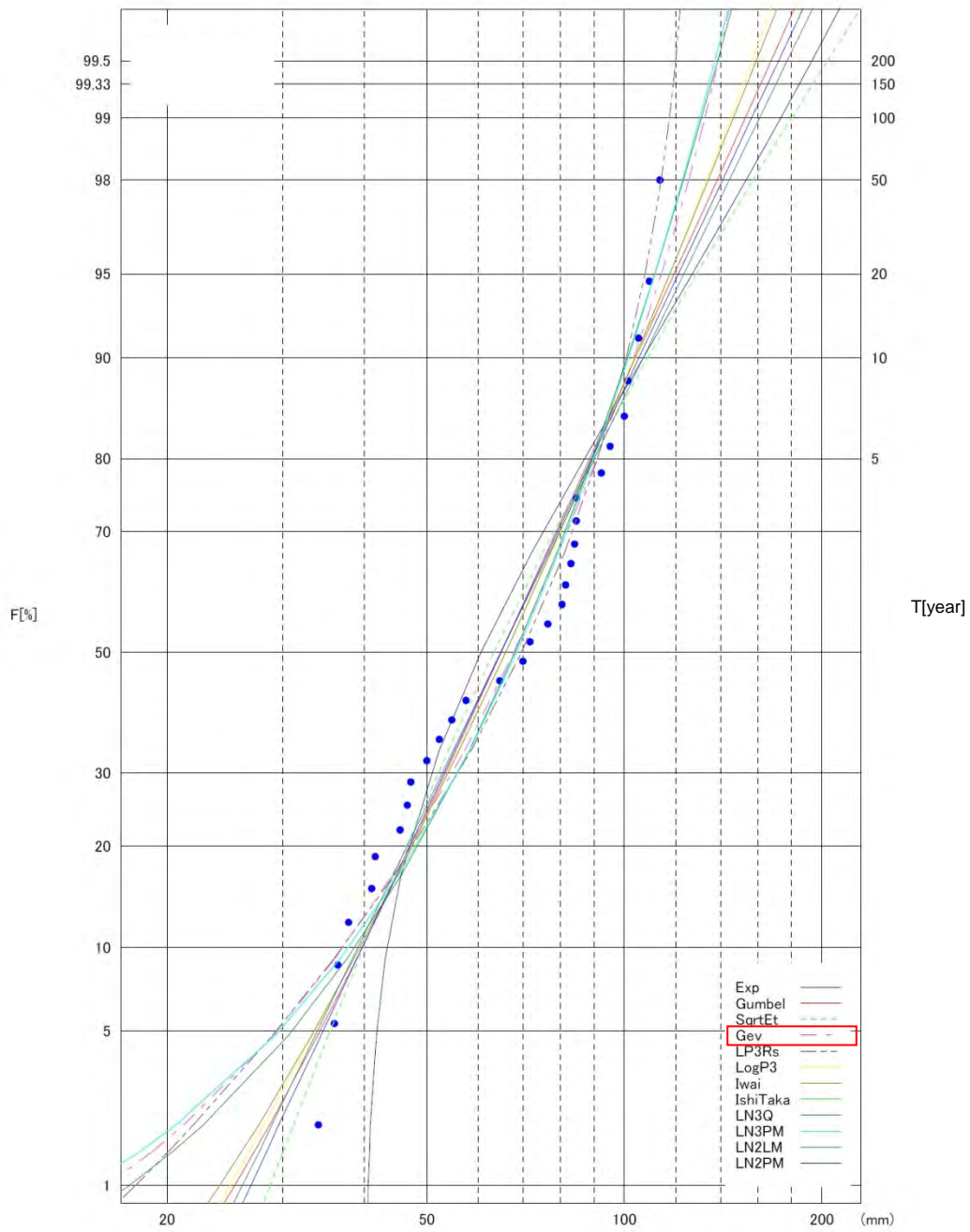
Source: JICA Study Team

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



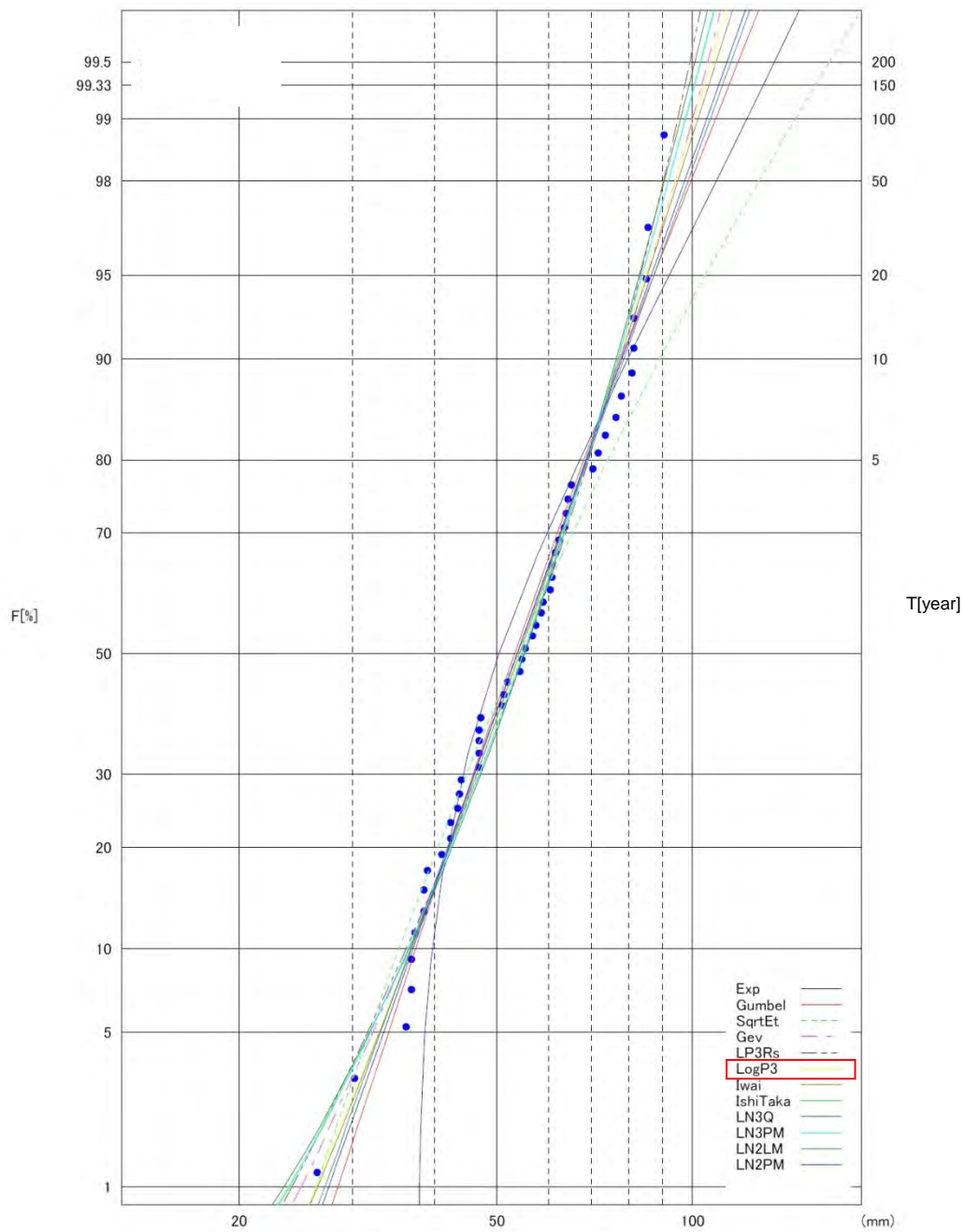
Source: JICA Study Team

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



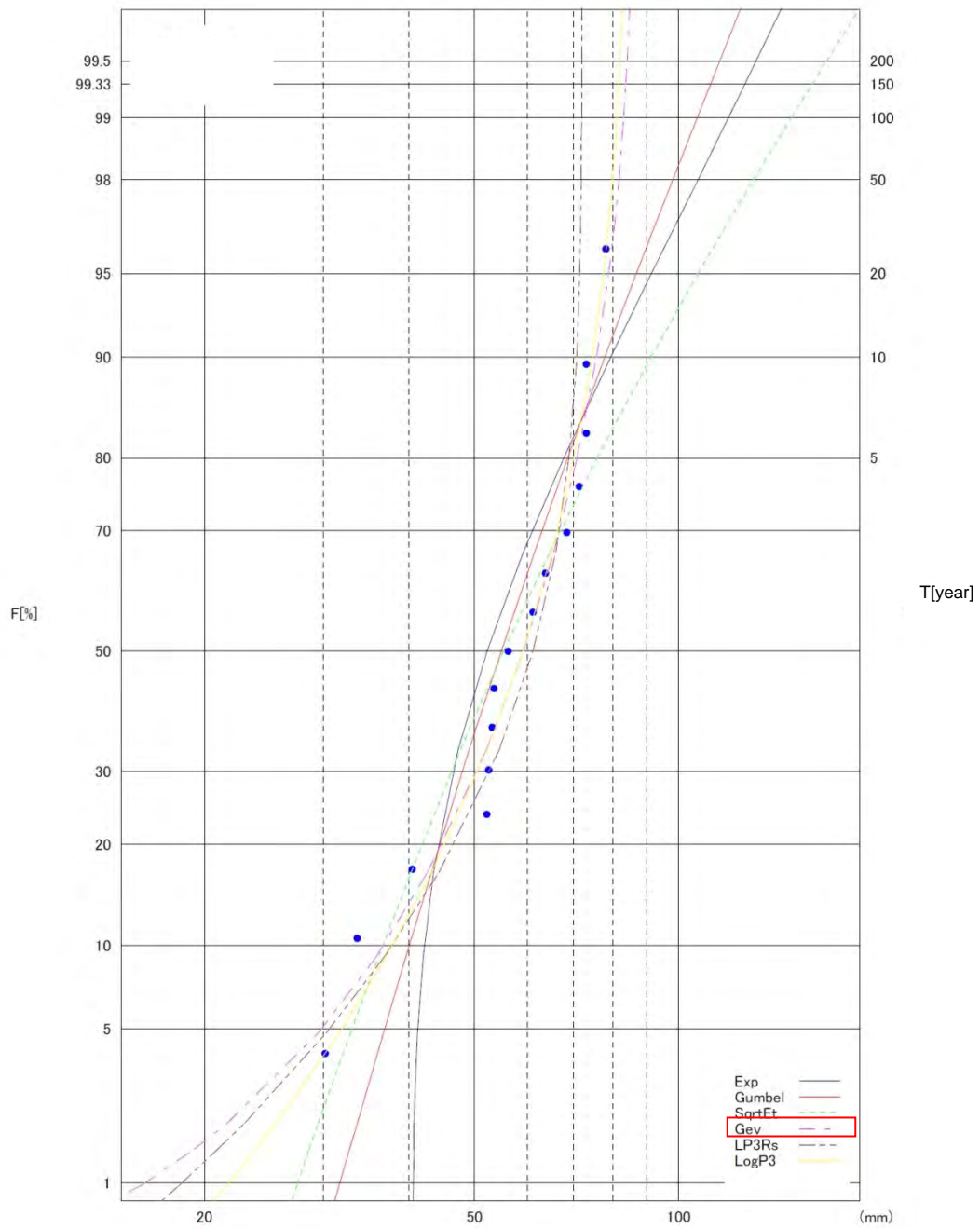
Source: JICA Study Team

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



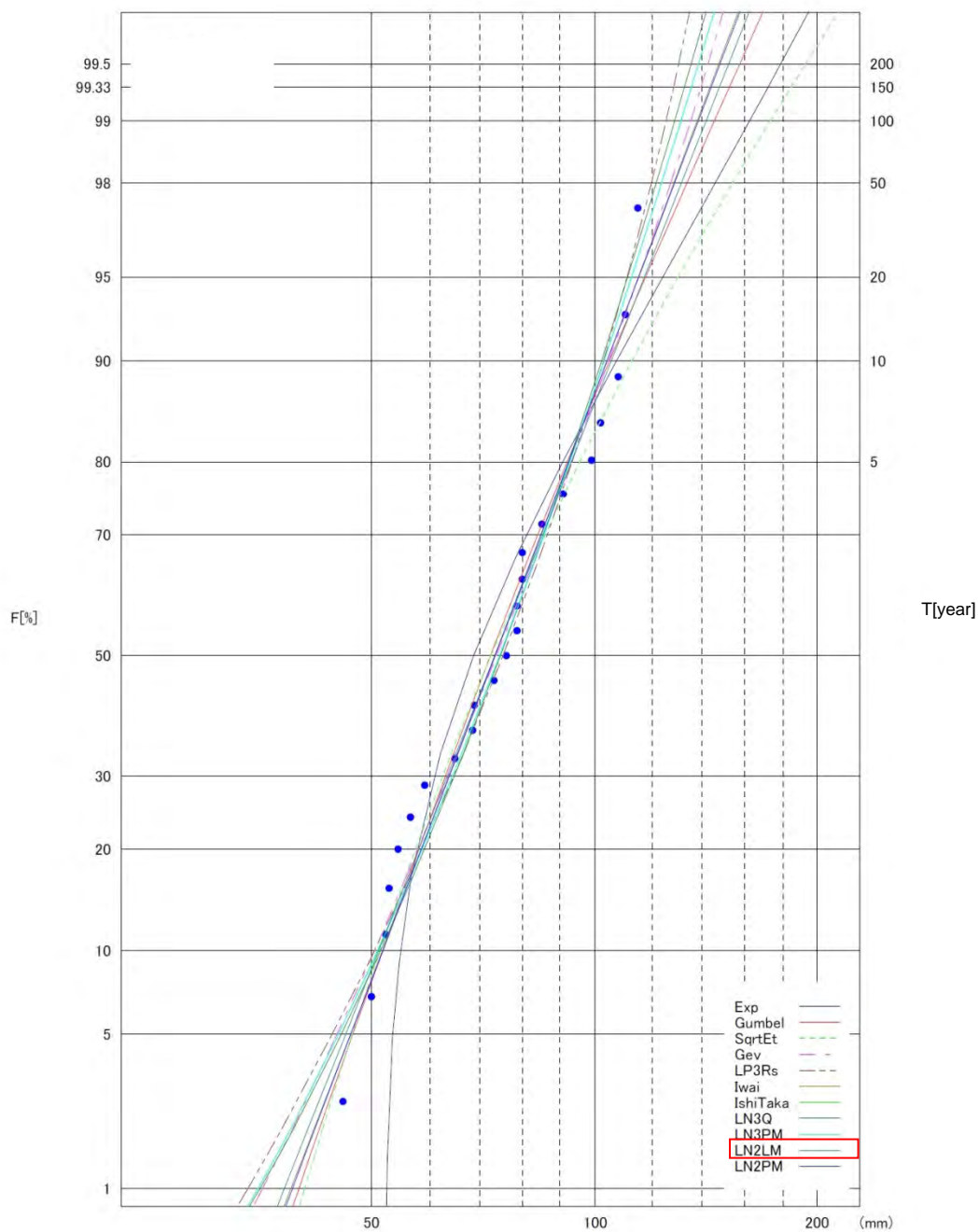
Source: JICA Study Team

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



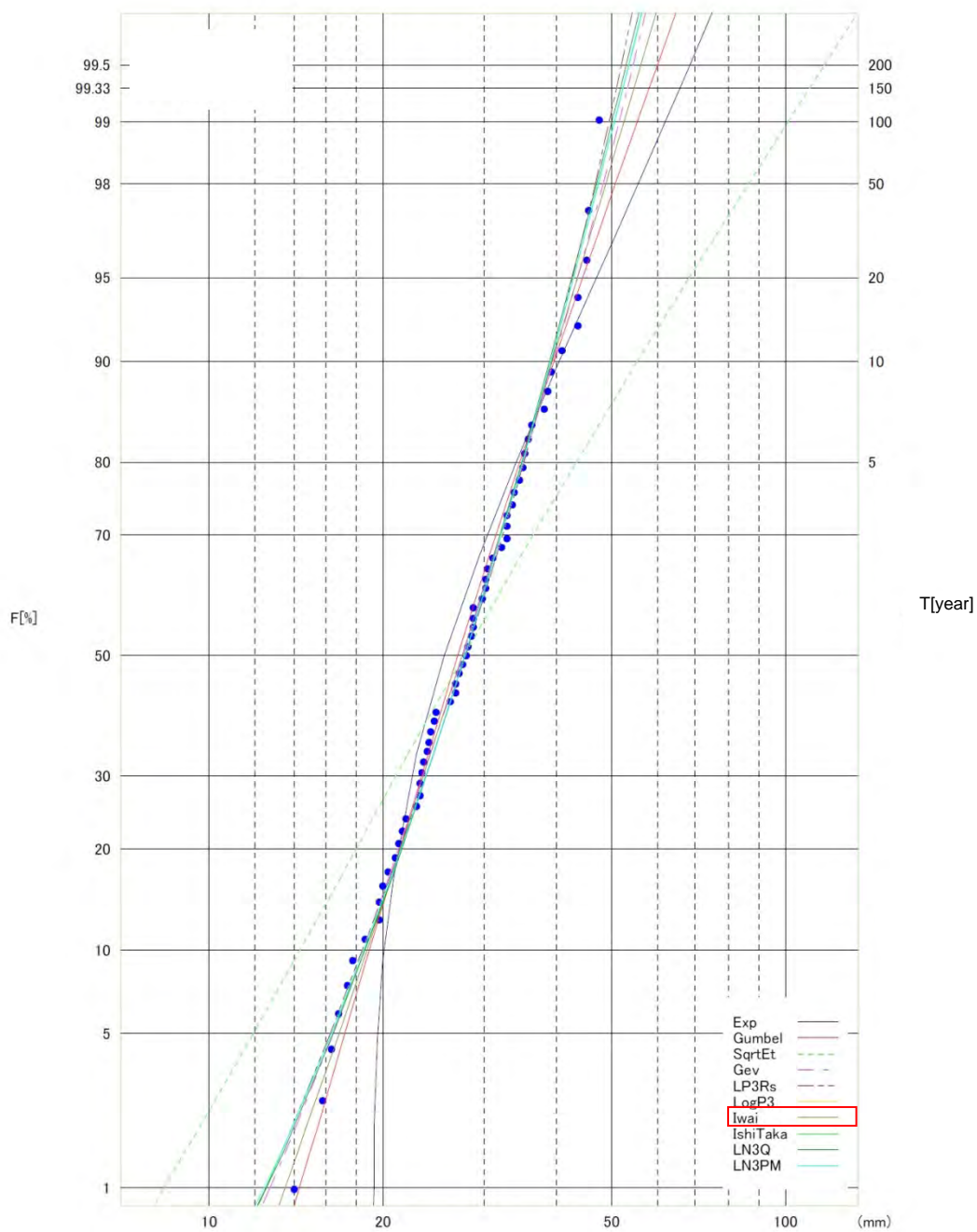
Source: JICA Study Team

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



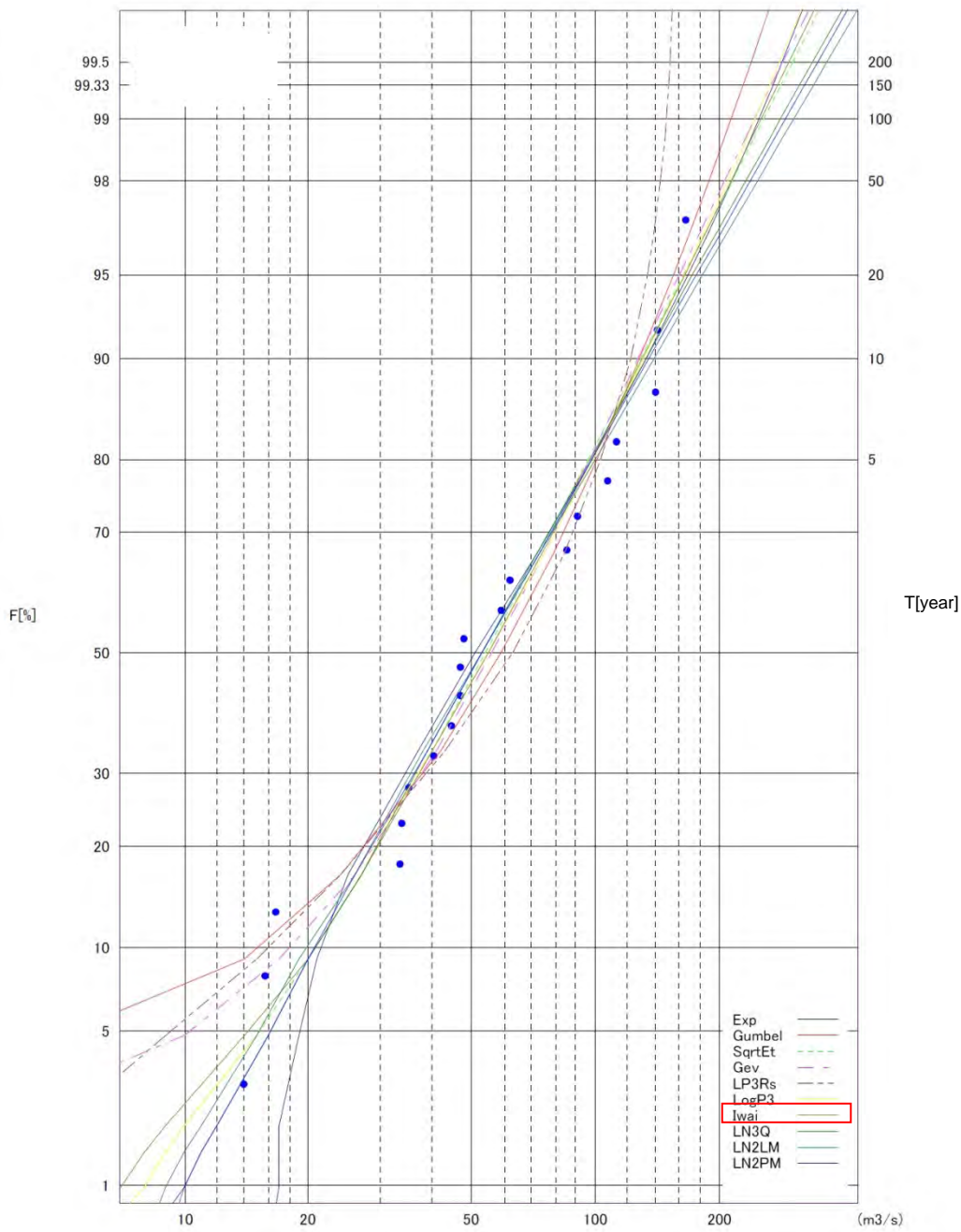
Source: JICA Study Team

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

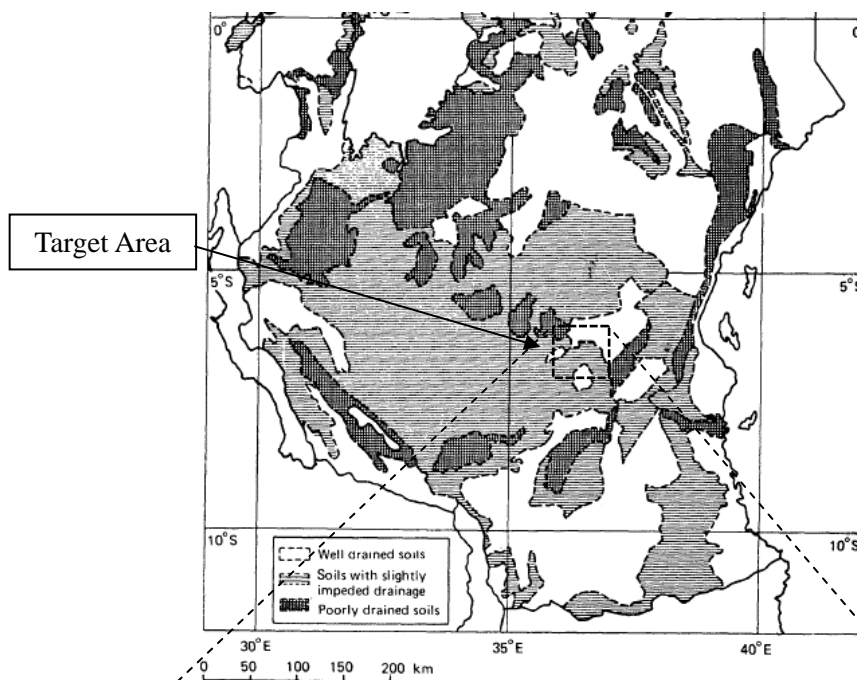
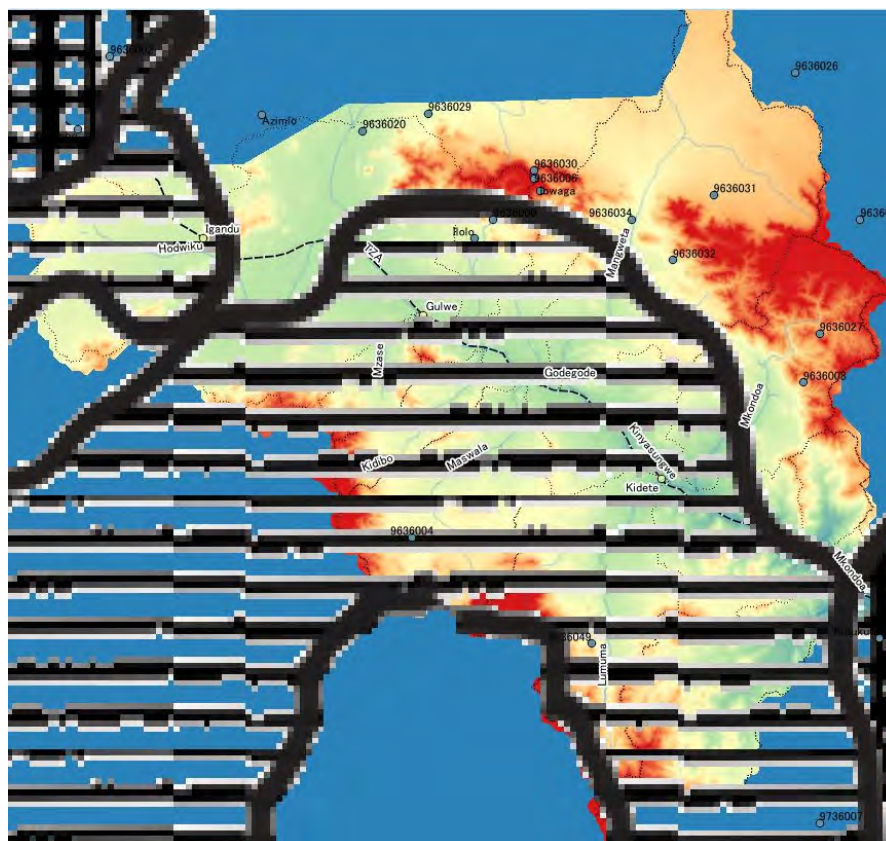


Fig. 15 SOIL ZONES



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

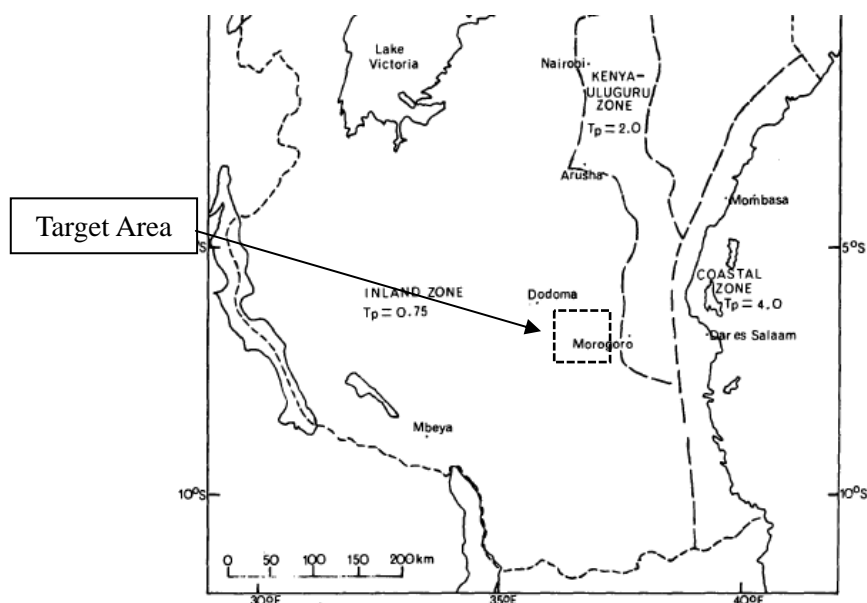


Fig. 16 RAINFALL TIME (Tp) ZONES

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(T_p)for East African 10 year storms

TABLE 8

Rainfall time (T_p) for East African 10 year storms

Zone	Index "n"	Rainfall time (T_p) (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

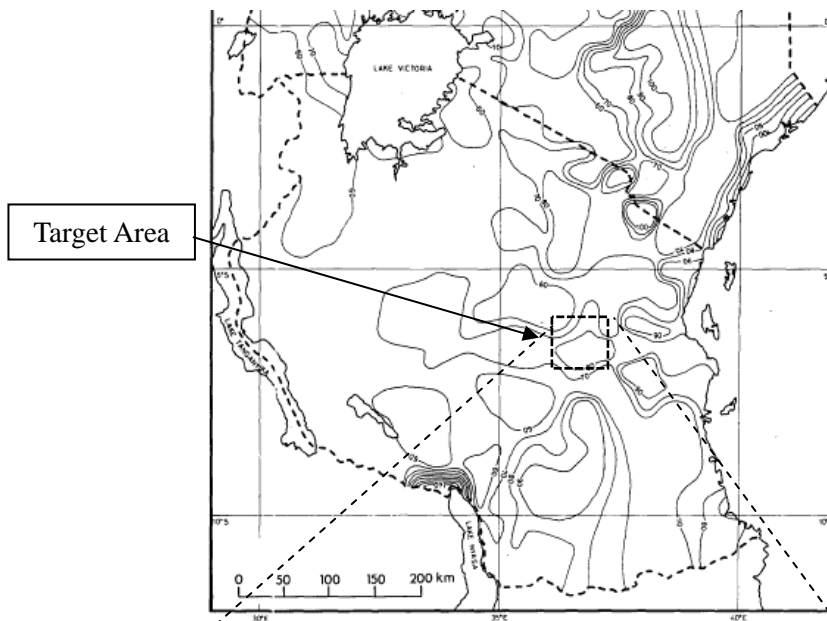
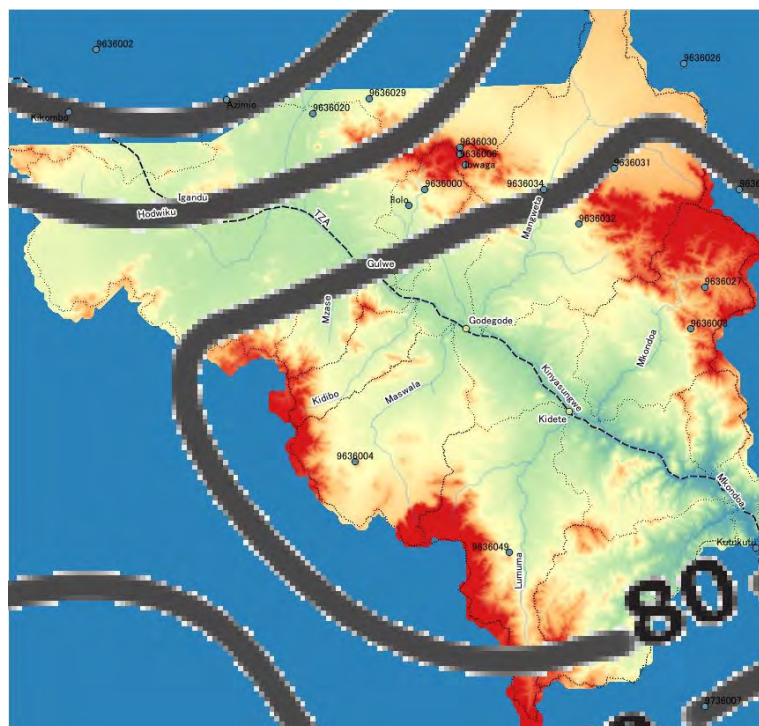


Fig .1 2 YEAR 24 HOUR STORM RAINFALL



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

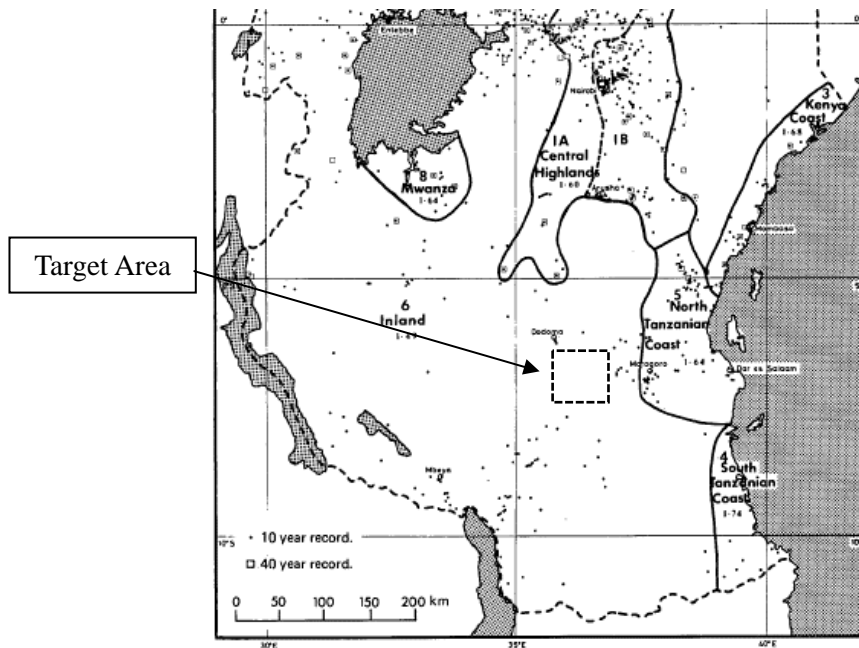


Fig. 4 10YEAR RATIO

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

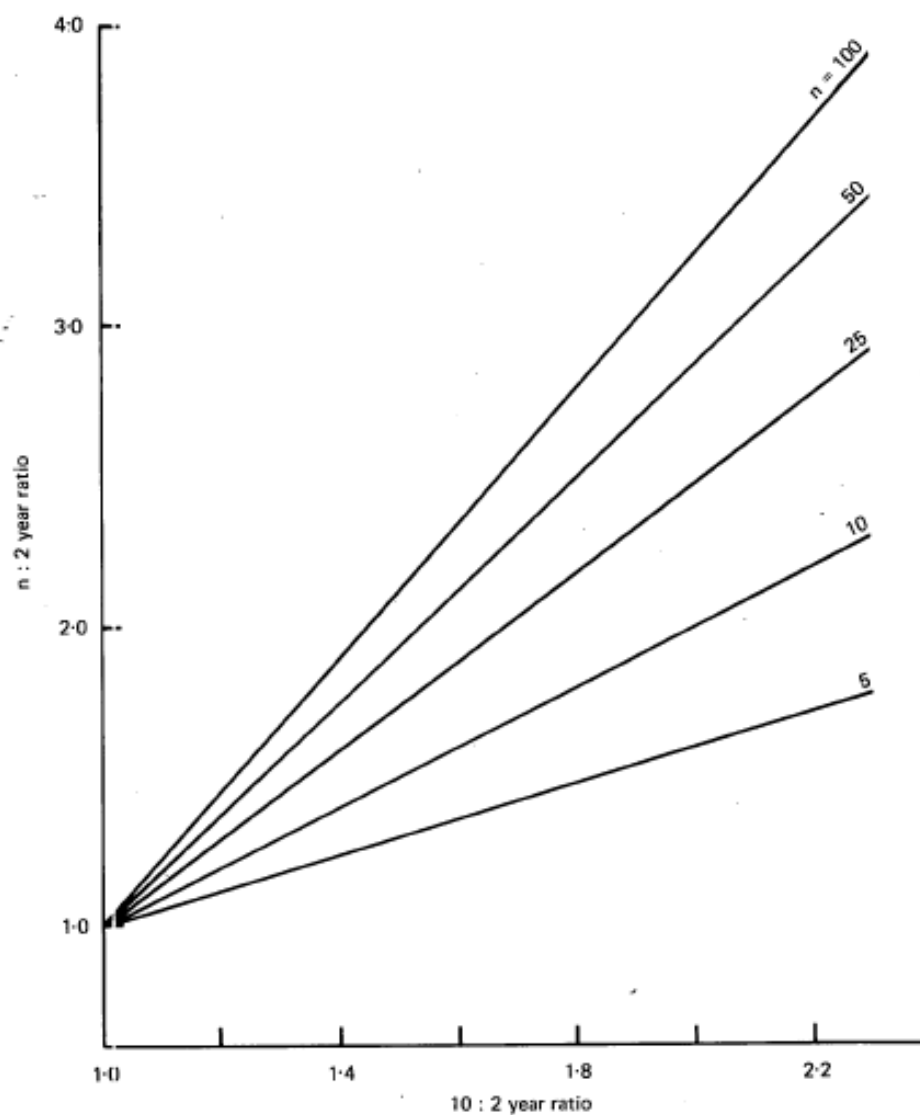


Fig. 5 FLOOD FACTORS

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

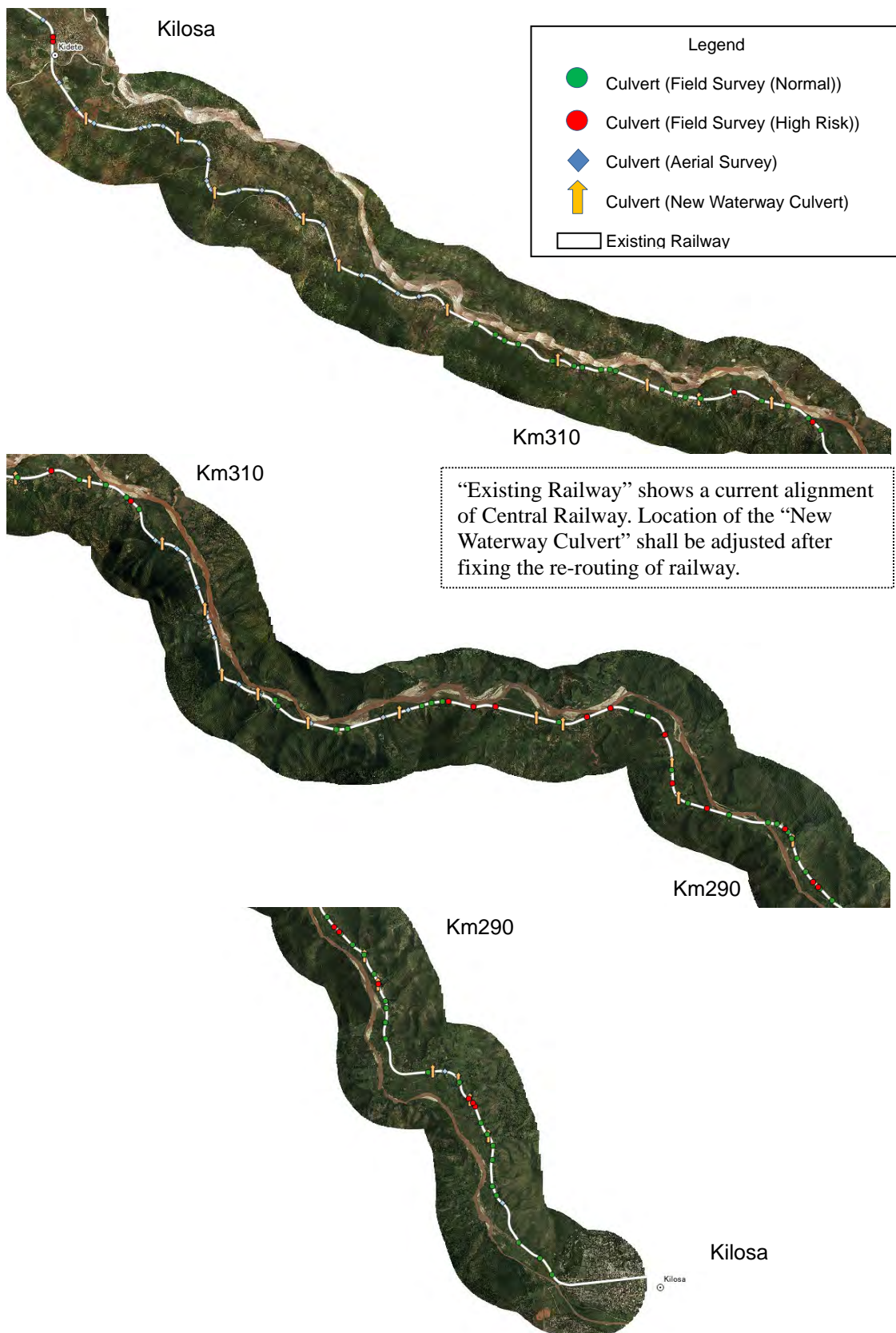
The List of Culverts and Bridge of Concerned Area (6/6)

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	
						○
						○
						○

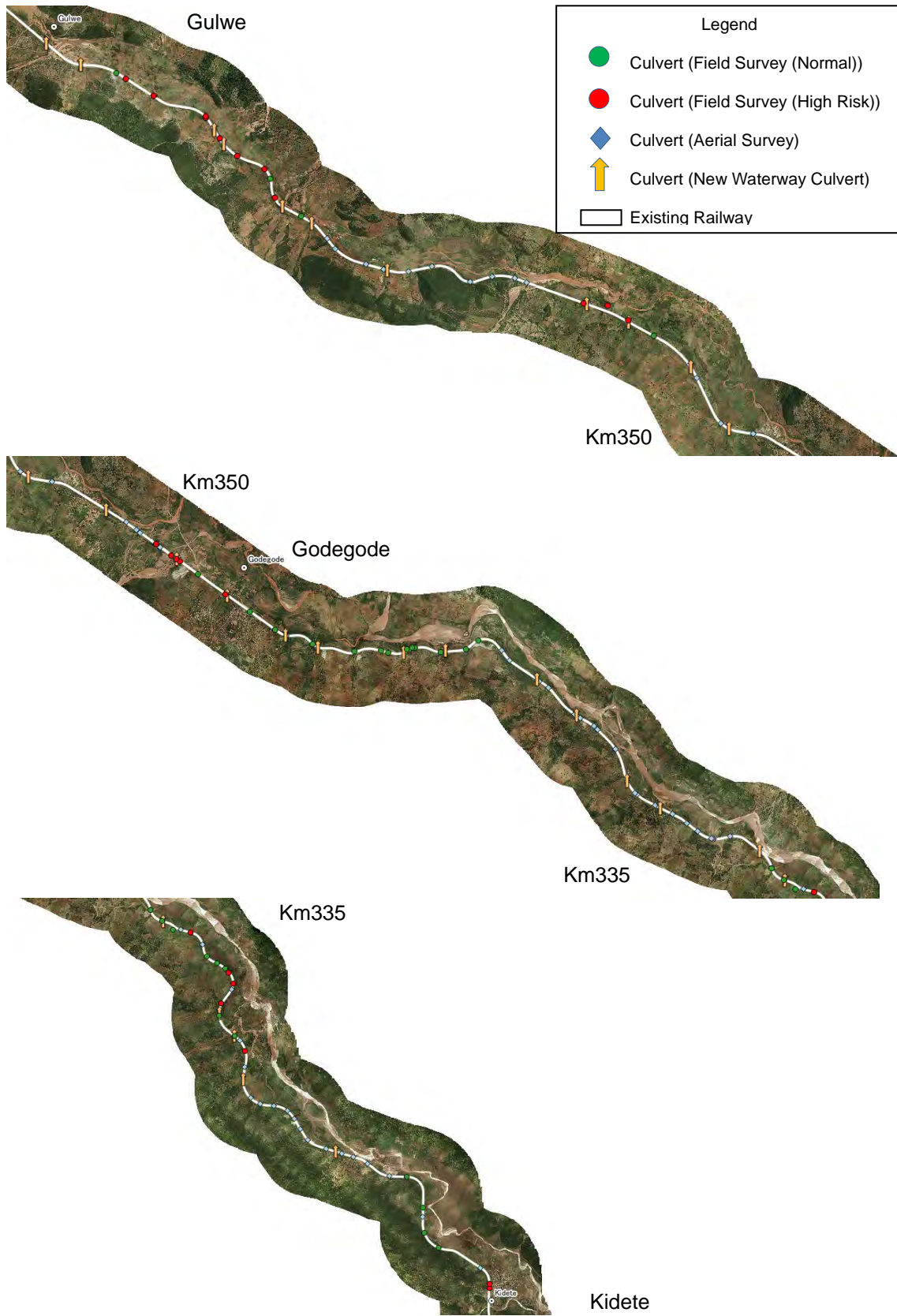
Reference: W/C: Waterway Culvert, BCL: Box Culvert, PCL: Pipe Culvert, BR: Bridge
Station Km is Kilometerage of existing railway

APPENDIX N

THE LOCATION OF CULVERTS



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).

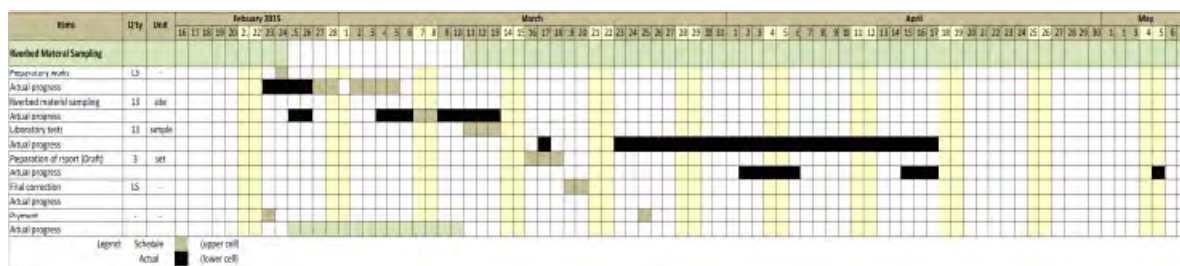


Figure O.1: Actual Schedule

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.

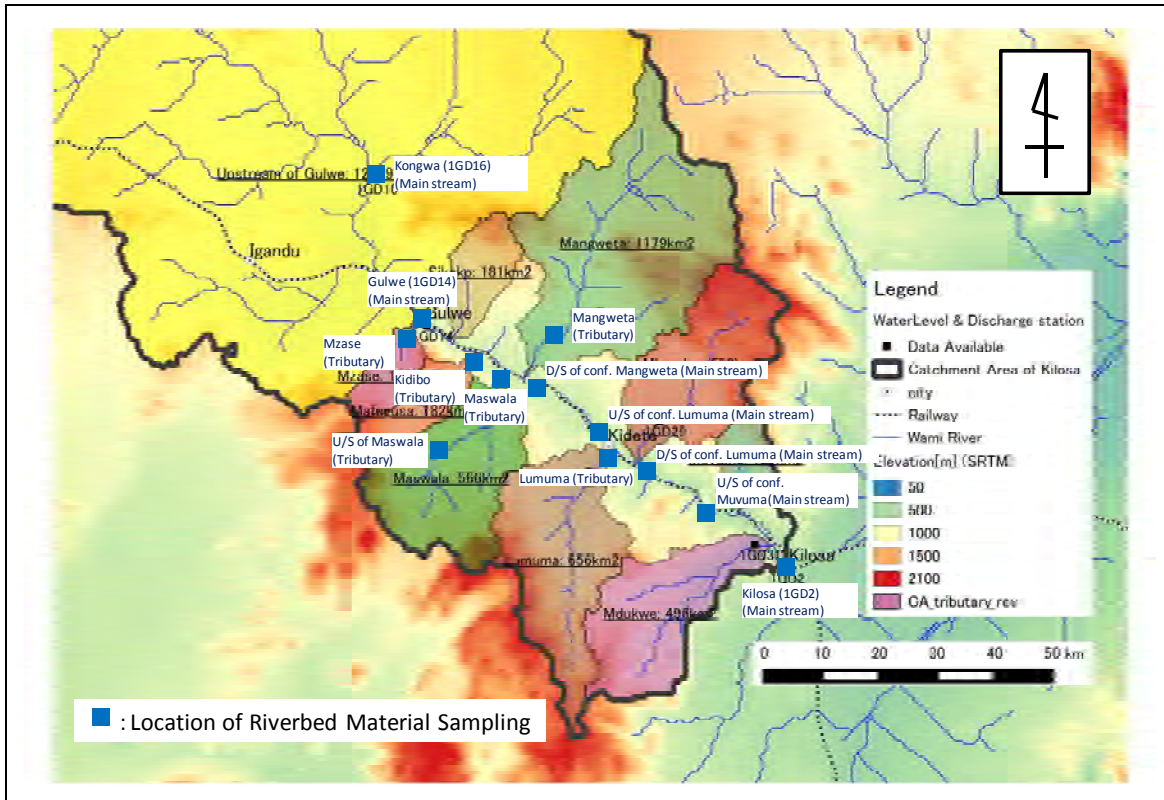


Figure O.2: Location of Riverbed Material Sampling

Table O.2: Site Location

	Site	Latitude (S)	Longitude (E)	Ana No	Remarks
1	Kongwa (IGD16) (Main stream)	6°13'02.25"	36°19'37.41"	1083	LB
				1084	Middle of river
2	Gulwe (IGD14) (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 (IGD2) (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.

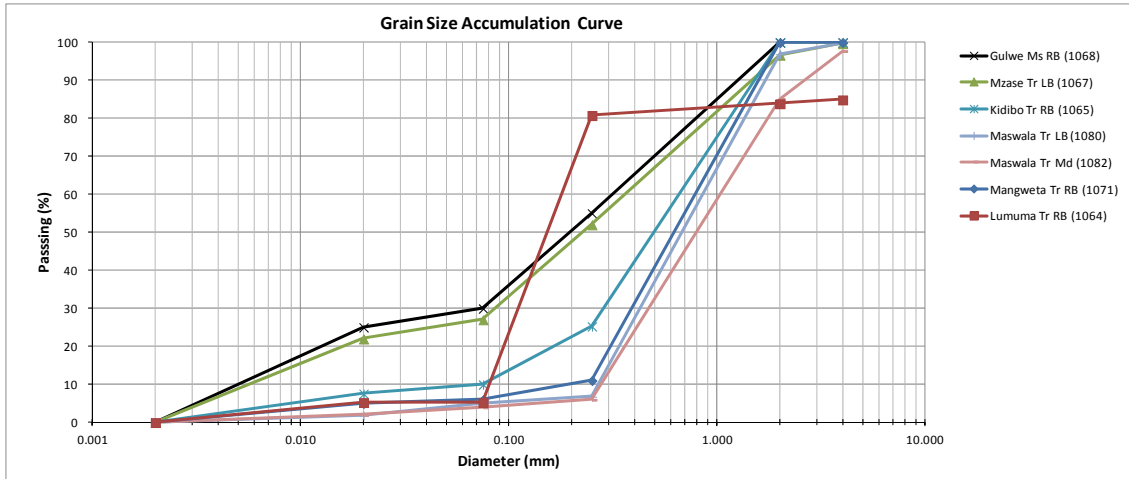


Figure O.16: Grain Size Accumulation Curve

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%.

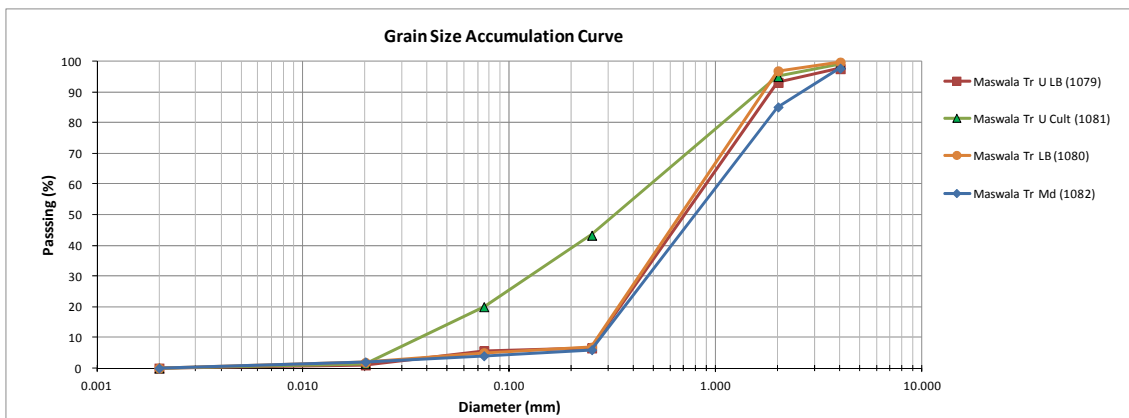


Figure O.17: Grain Size Accumulation Curve

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 ratio of very fine sand and medium sand accounts for a high ratio compared with the riverbed. The ratio accounts for about 30%.

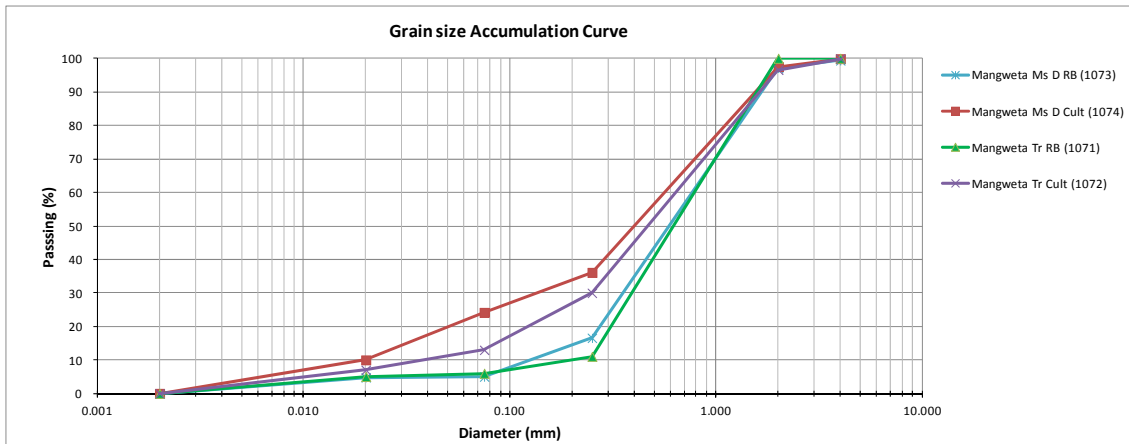


Figure O.18: Grain Size Accumulation Curve

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 ratio 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 fine sand and medium sand.

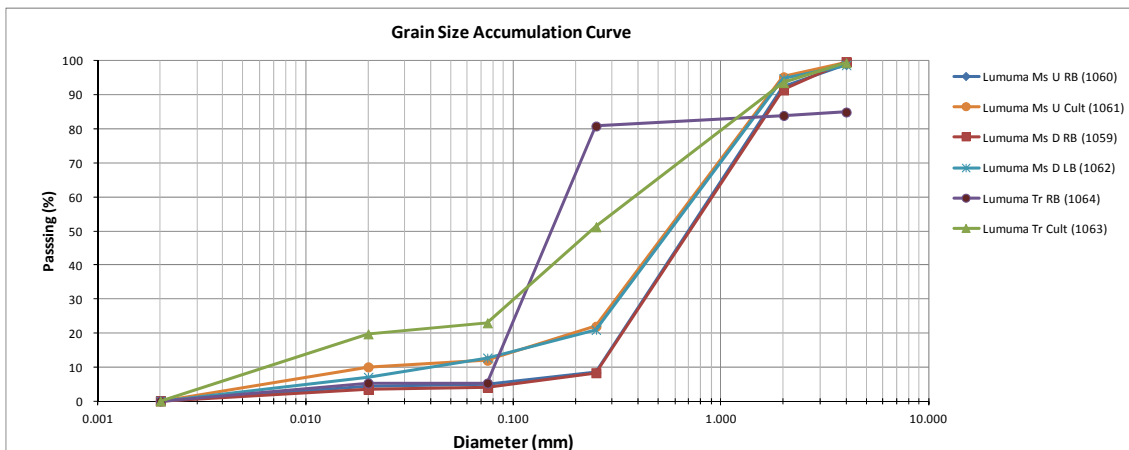


Figure O.19: Grain Size Accumulation Curve

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%.

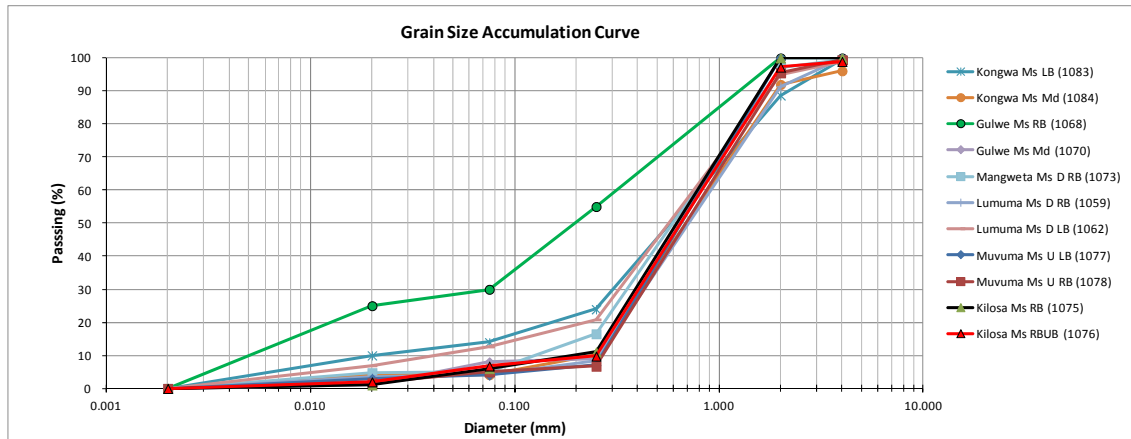


Figure O.20: Grain Size Accumulation Curve

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 fine 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.

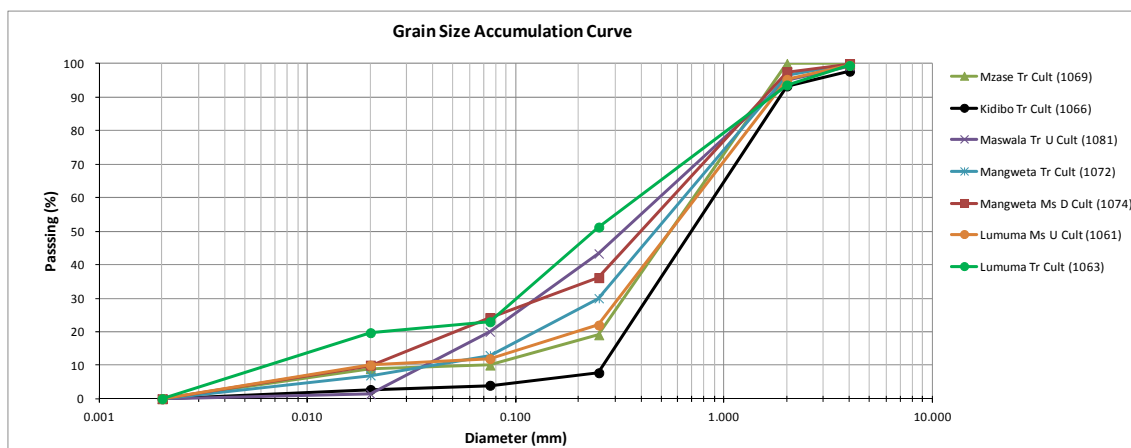


Figure O.21: Grain Size Accumulation Curve

(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

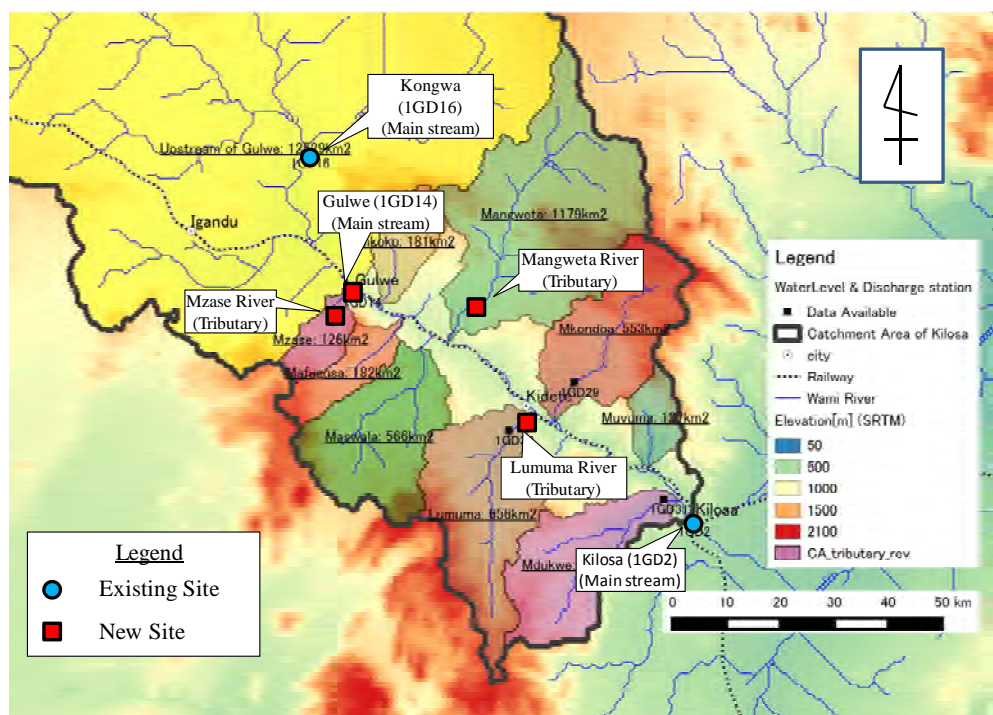
The work was conducted at six gauging stations as shown in the table below. The location for the Work is shown on the location map of the proposed gauging stations in Table P.1. The location is subject to change in the course of the Work depending on site conditions (See Figure P.2). Table P.1 shows 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 Mangweta/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).

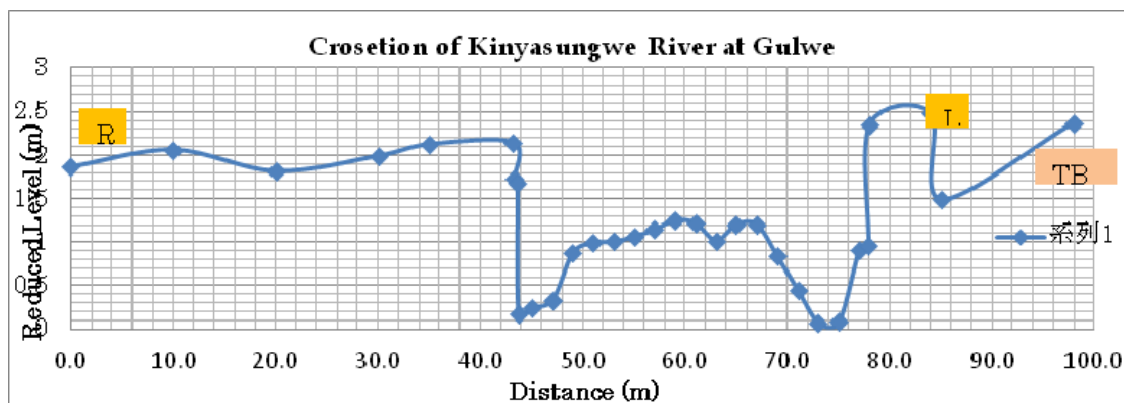


Figure P.2: Cross Section of the Kinyasungwe River at Gulwe



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 March 2015).

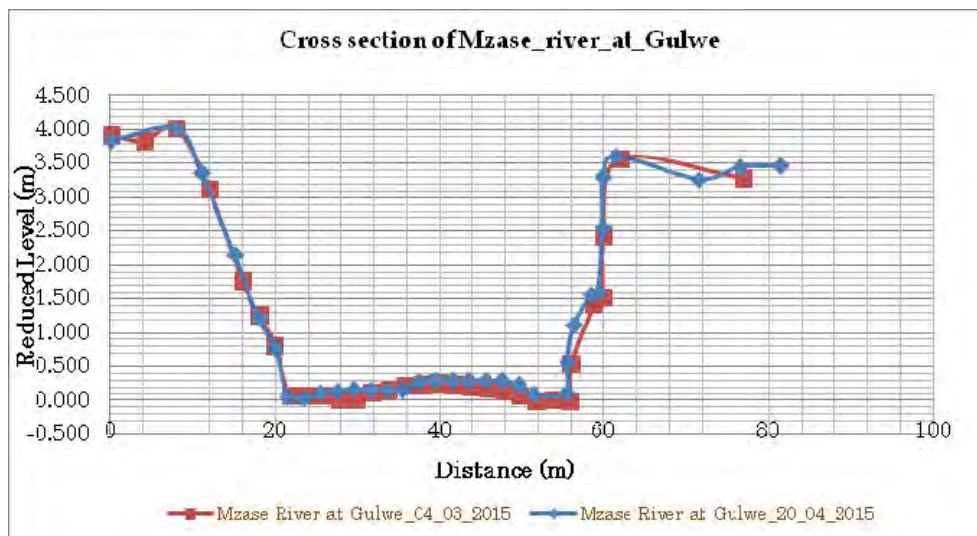


Figure P.4: Cross Section of the Mzase River at Gulwe



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).

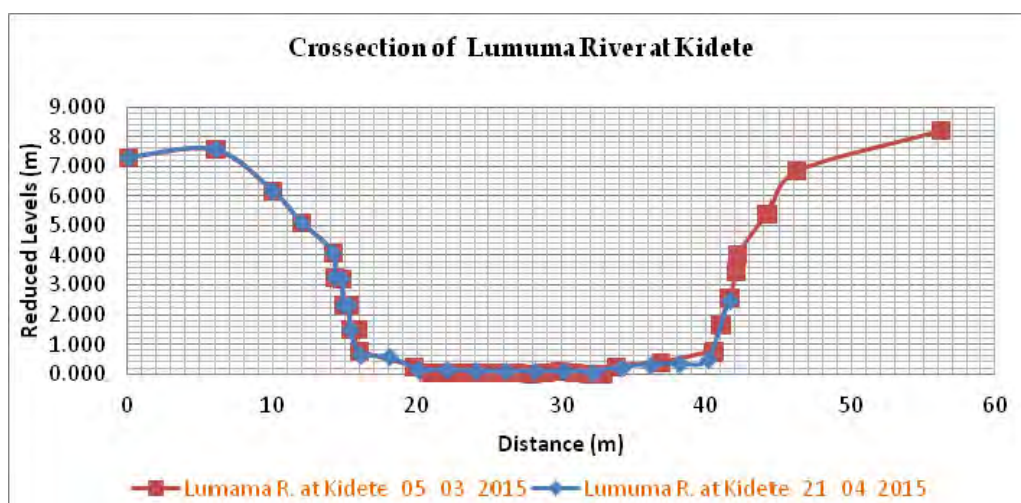


Figure P.6: Cross Section of the Lumuma River at Kidete



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).

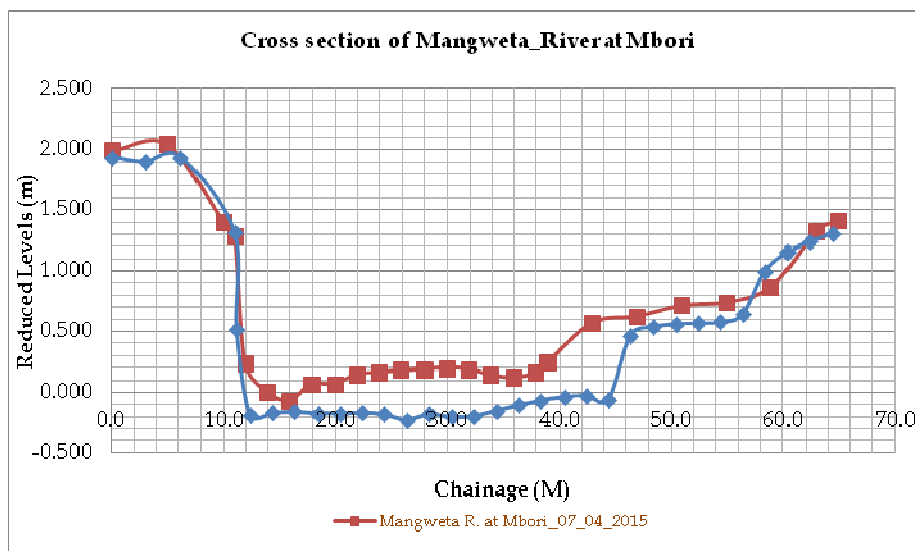


Figure P.8: Cross Section of the Mangweta River at Mbori



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 sites are the existing sites.

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

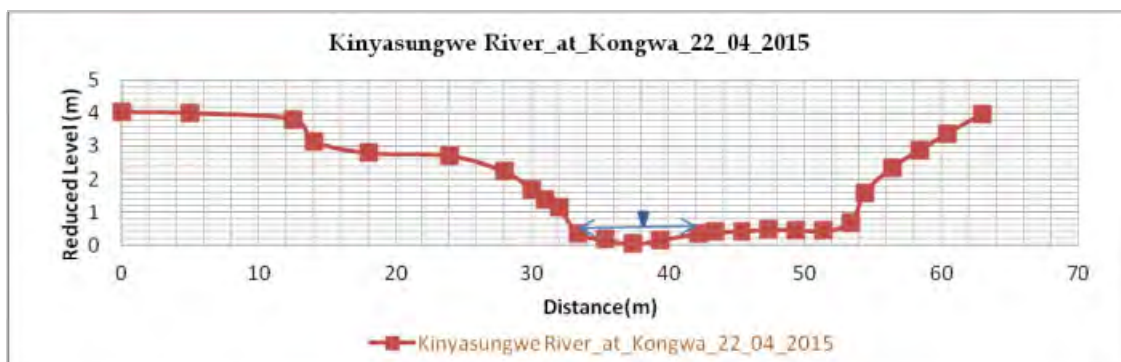


Figure P.10: Cross Section of the Kinyasungwe River at Kongwa



Figure P.11: Existing Gauges at Kongwa

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

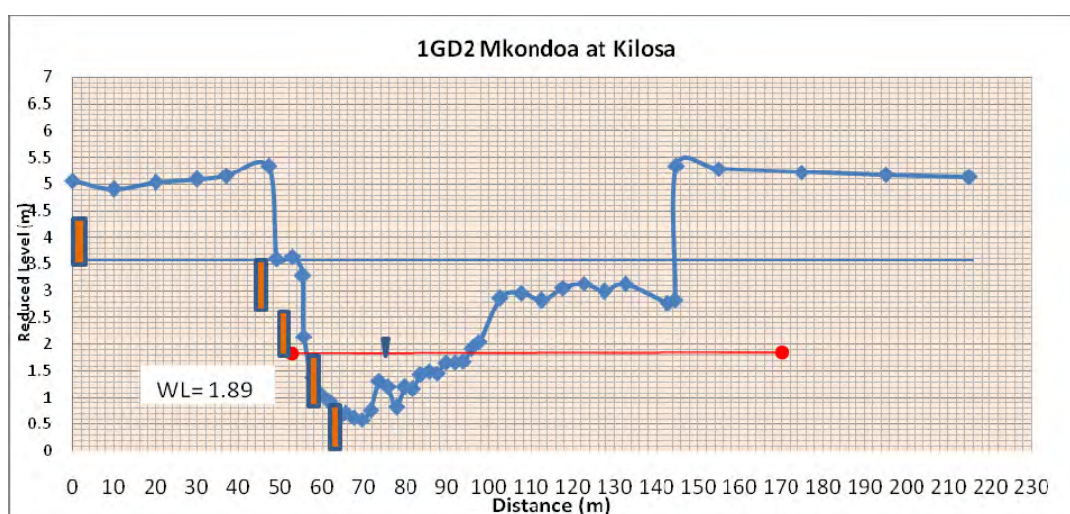


Figure P.12: Cross Section of the Mkondowa River at Kilosa



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:

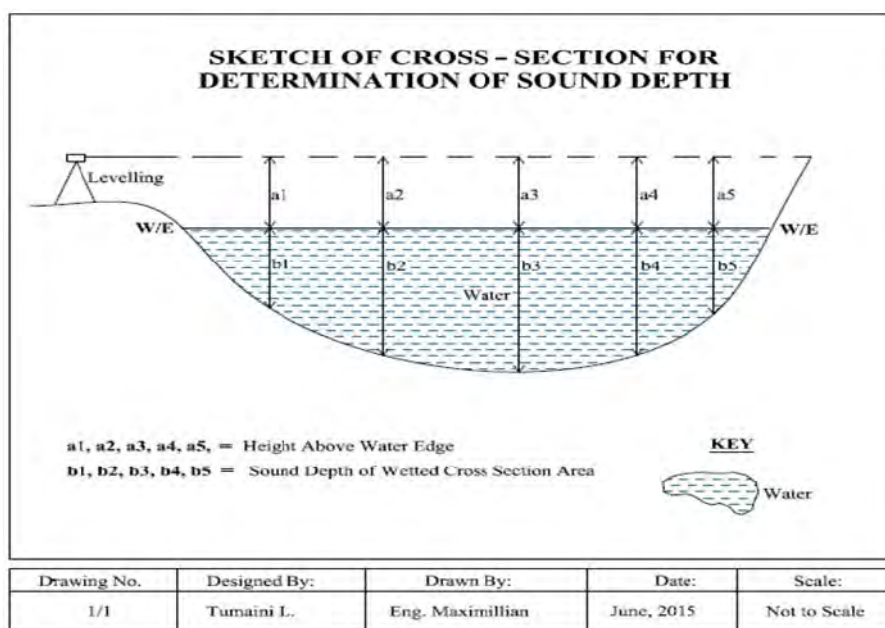


Figure P.14: Sketch of Cross-Section for Determination of the Sound Depth in the Wetted Area

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 Pygmy 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 (Iloilo met station and Kongwa met station) the data shows for the period from January to mid-May 2015 the total rainfall recorded at Iloilo 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.

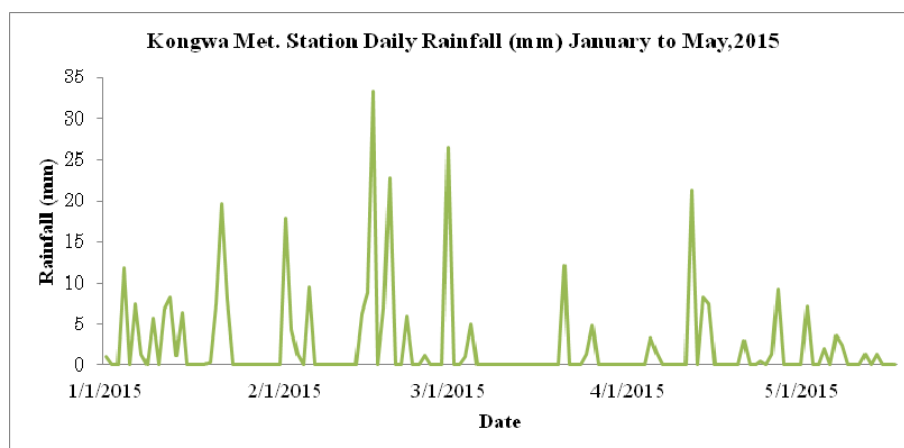


Figure P.15: Kongwa Met. Station Daily Rainfall

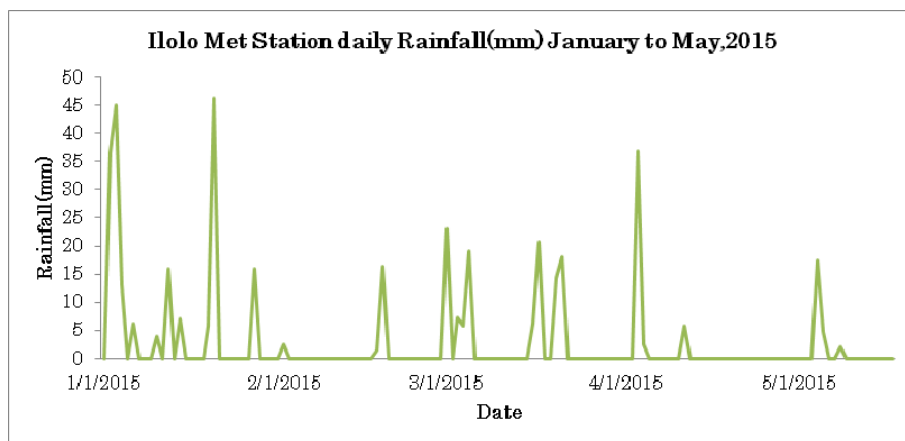


Figure P.16: Iloilo Met. Station Daily Rainfall

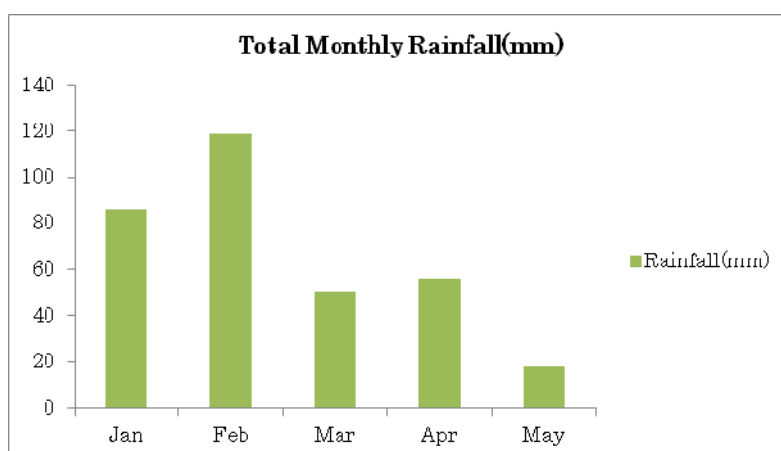


Figure P.17: Rainfall Distribution at Kongwa St. (January to May 2015)

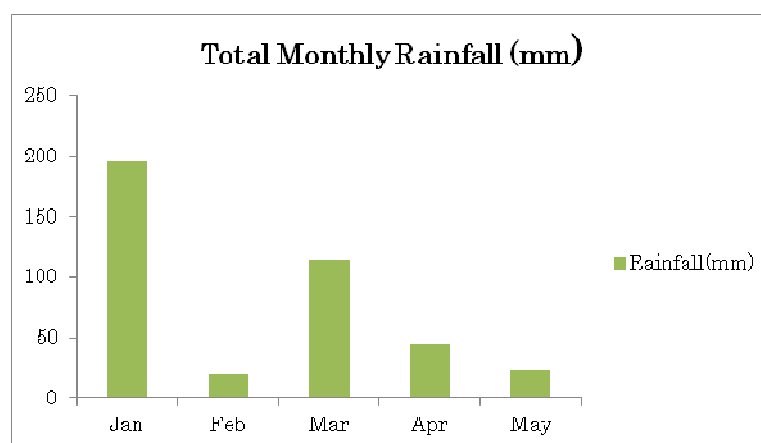


Figure P.18: Rainfall Distribution at Iloilo-Mpwapwa St. (January to May 2015)

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
Iloilo-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.

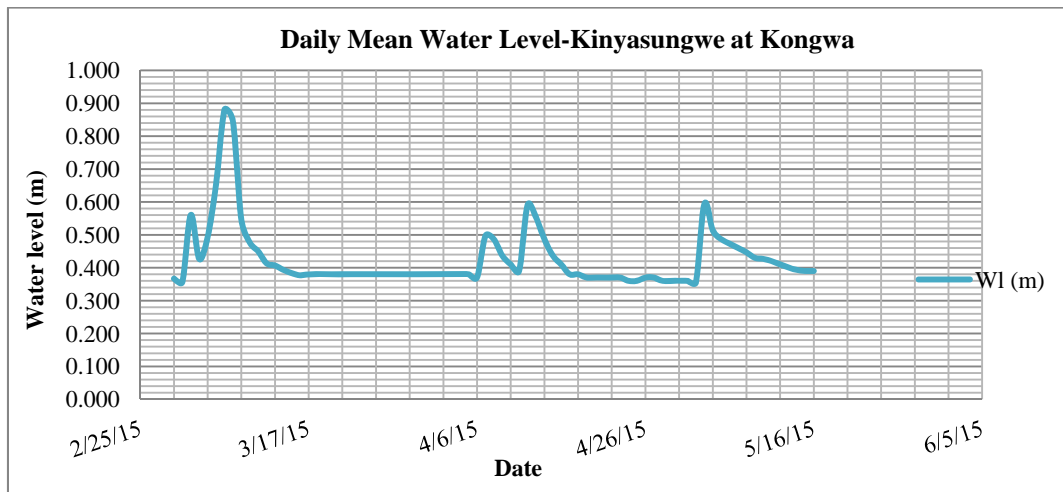


Figure P.19: Water Level at Kongwa

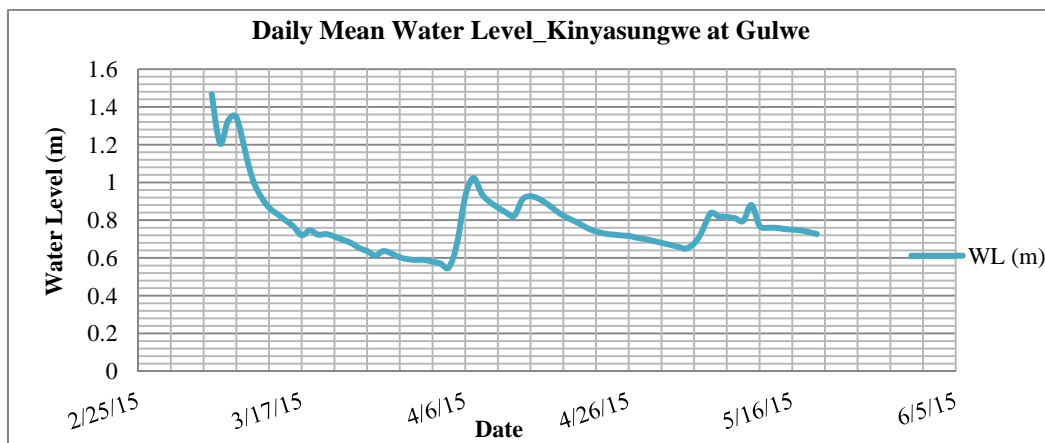


Figure P.20: Water Level at Gulwe

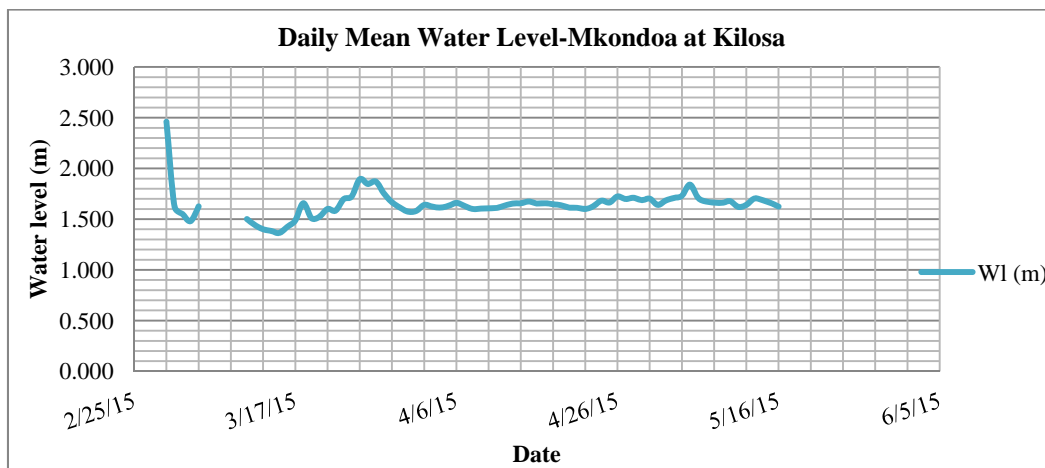


Figure P.21: Water Level at Kilosa

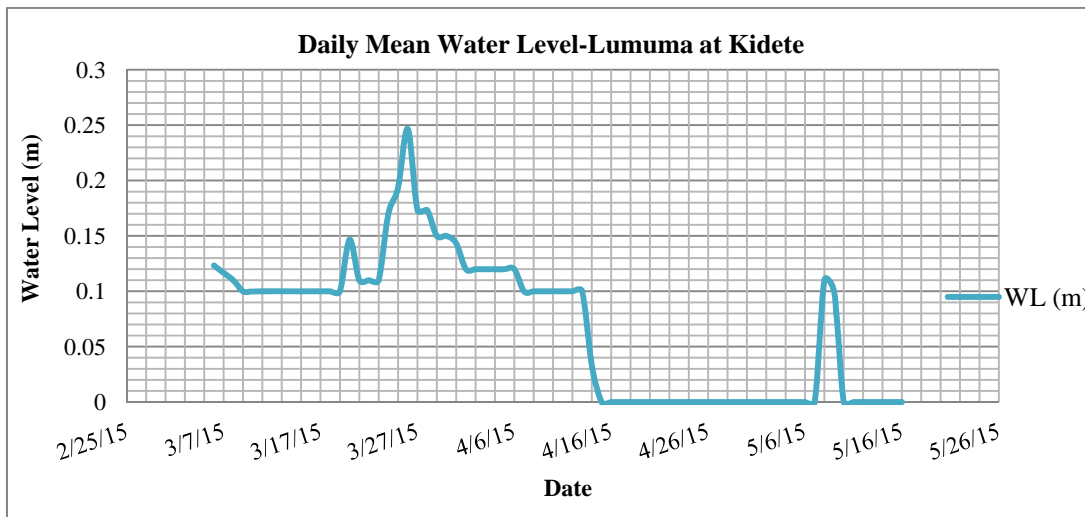


Figure P.22: Water Level at Kidete

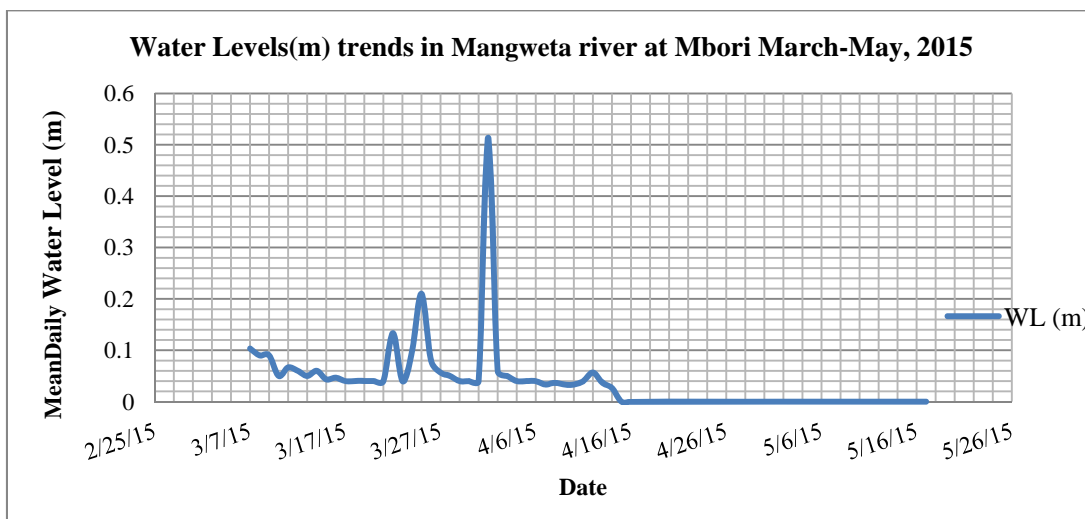


Figure P.23: Water Level at Mbori in the Mangweta River

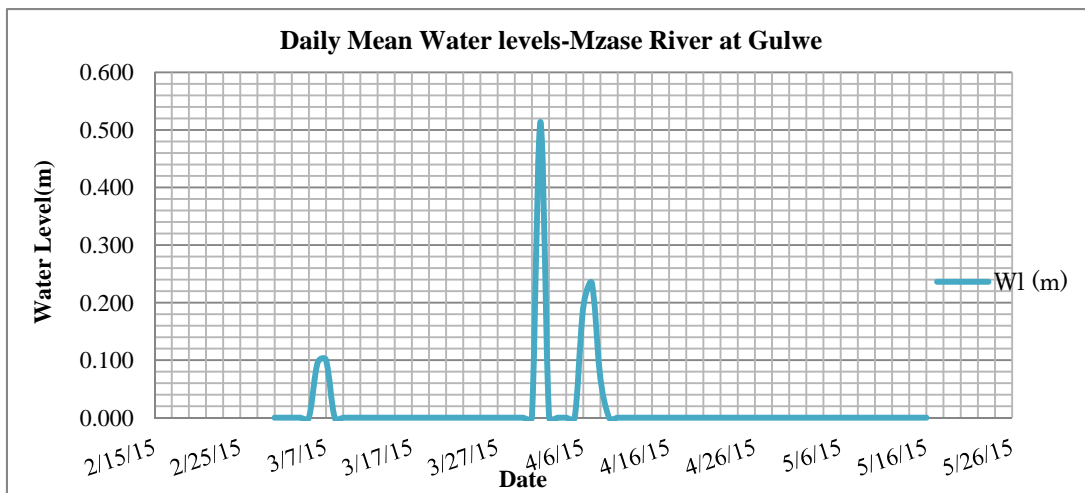


Figure P.24: Water Level at Gulwe in the Mzase River

(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 0.45 μ m 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;

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

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/cm³.

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

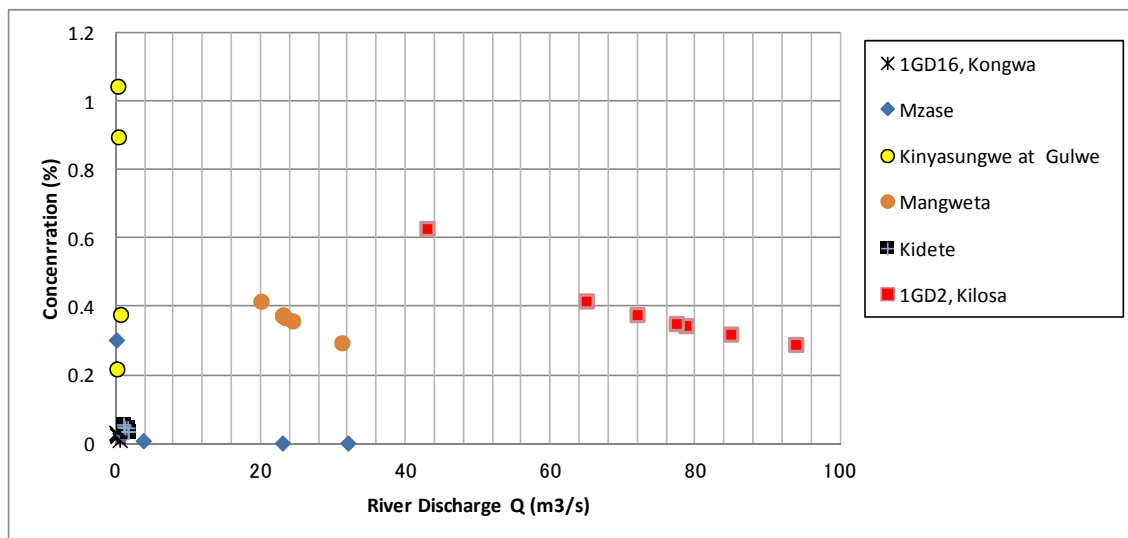
No:	Descriptions of Stations	Sample Taken (Low Flow)	Sample Taken (High Flow)
1	Kinyasungwe/Gulwe	4	15
2	Lumuma/Kidete	1	21
3	Mangweta/Mbori	3	18
4	Kinyasungwe/Kongwa	3	18
5	Mkondoa/Kilosa	3	21
6	Mzase/Gulwe	0	18
Sub-Total Samples No.		14	111
Grand Total No.		125 (More than 29 samples collected) in low 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 (%)
IGD16, 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
IGD2, 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/cm³)

2.65

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

SOKOINE UNIVERSITY OF AGRICULTURE
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 sp	wfip + sed	wt sed	TSS g/ml	TSS g/L
LAB NOS	DATE		ml	g	g	g		
S/72/2015		MIDDLE	500	0.129	0.442	0.313	0.00063	0.626
73	11-03-15	MIDDLE	500	0.133	0.158	0.025	0.00005	0.050
74	11-03-15		500	0.127	0.346	0.219	0.00044	0.438
75	13-03-15	RIGHT	500	0.126	0.699	0.573	0.00115	1.146
76	11-03-15		500	0.128	0.172	0.044	0.00009	0.088
77			500	0.131	0.177	0.046	0.00009	0.092
78			500	0.13	0.674	0.544	0.00109	1.088
79		LB	500	0.128	2.607	2.479	0.00496	4.958
80		RIGHT	500	0.126	2.021	1.895	0.00379	3.790
81		LEFT	500	0.13	0.229	0.099	0.00020	0.198
82		LEFT	500	0.128	0.511	0.383	0.00077	0.766
83		LEFT	500	0.128	0.187	0.059	0.00012	0.118
84		MIDDLE	500	0.133	0.142	0.009	0.00002	0.018
85		MIDDLE	500	0.135	0.160	0.025	0.00005	0.050


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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

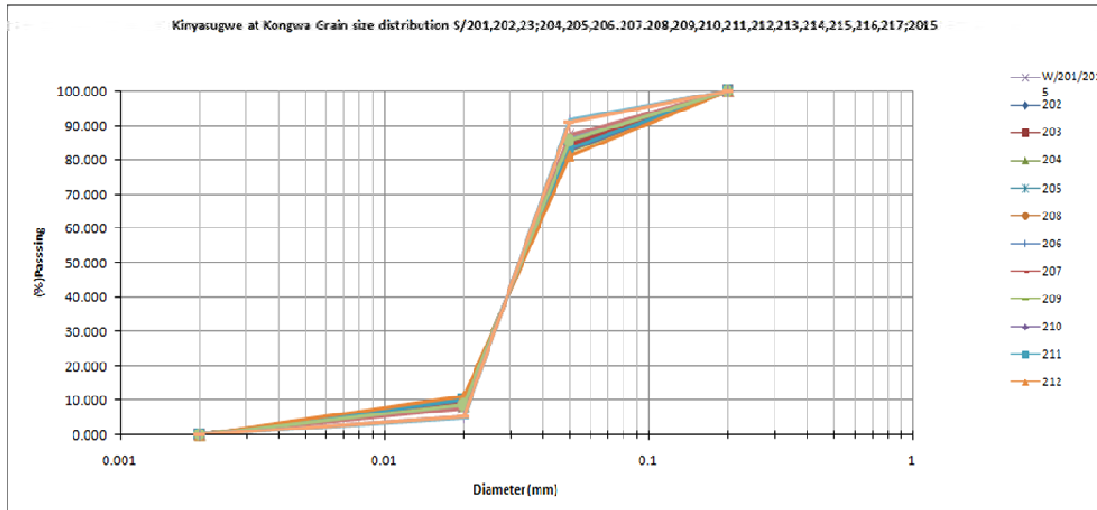


Figure P.31: Grain Size Distribution Analysis Graphs (Kinyasungwe/Kongwa)

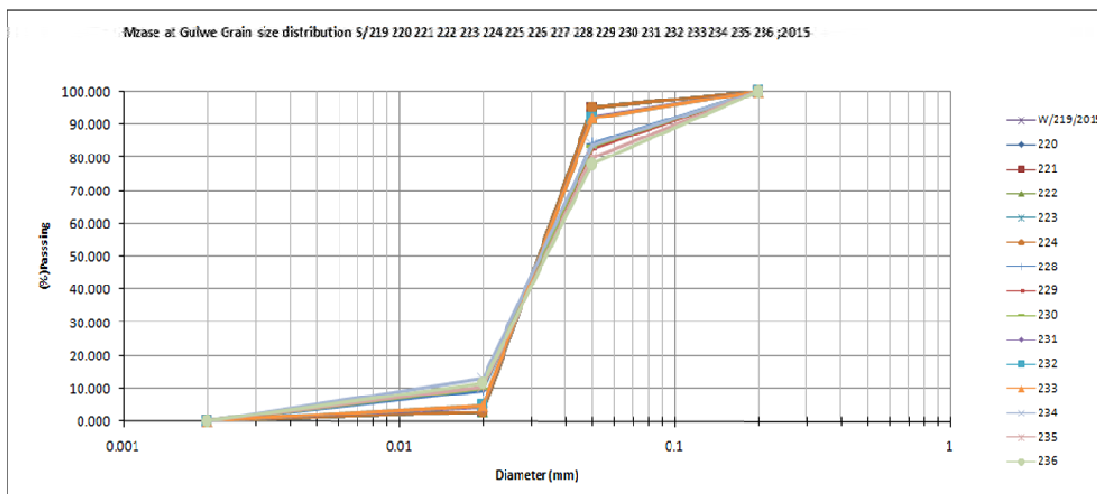


Figure P.32: Grain Size Distribution Analysis Graphs (Mzase/Gulwe)

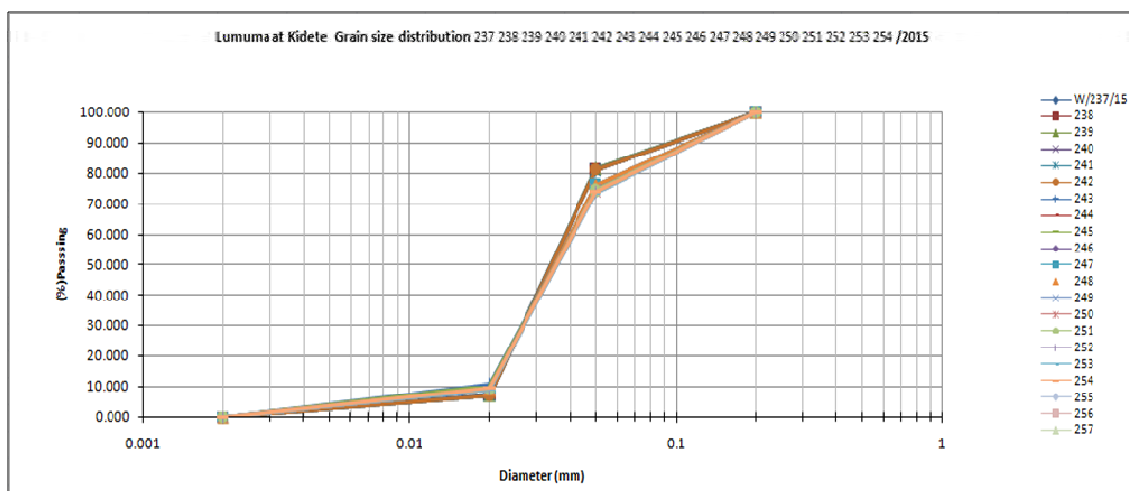


Figure P.33: Grain Size Distribution Analysis Graphs (Lumuma/Kidete)

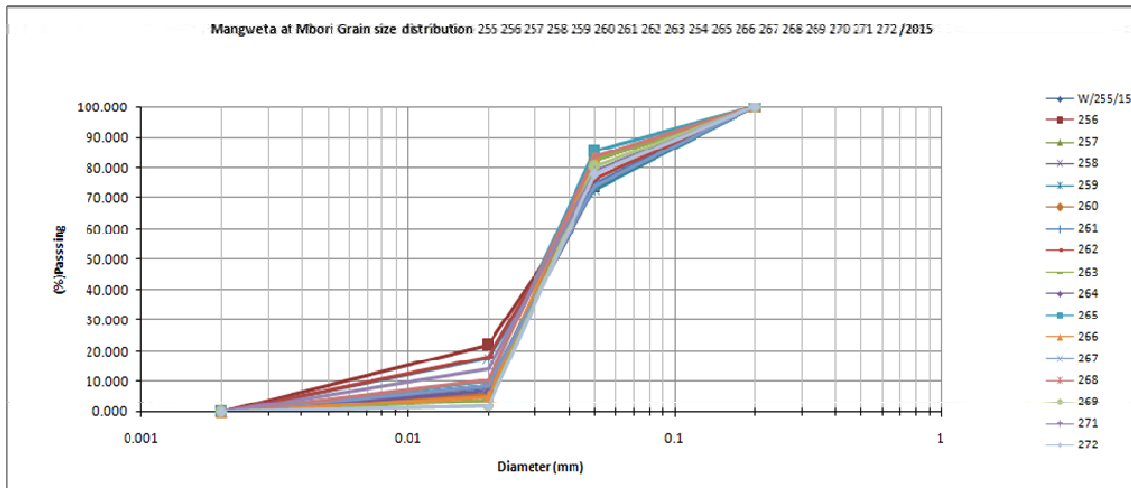


Figure P.34: Grain Size Distribution Analysis Graphs (Mangweta/Mbori)

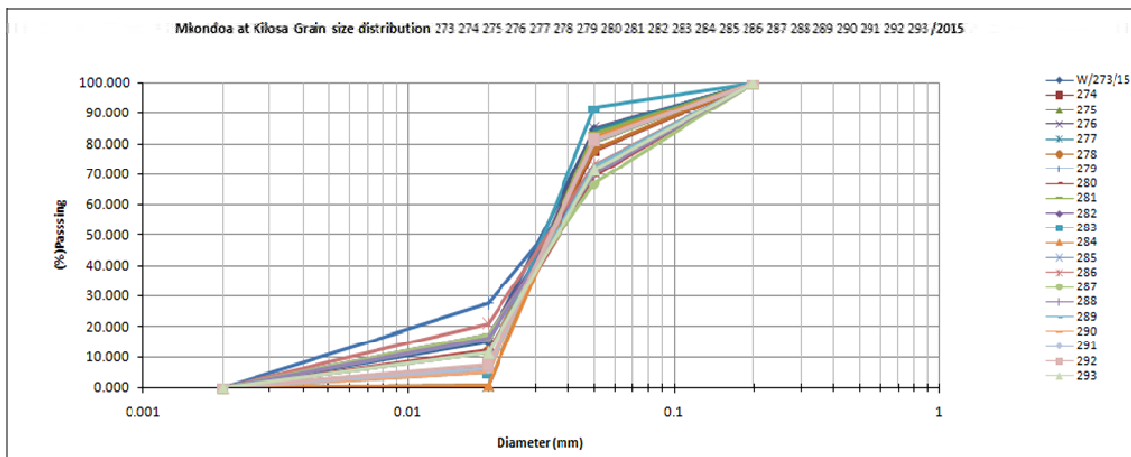


Figure P.35: Grain Size Distribution Analysis Graphs (Mkondoa/Kilosa)

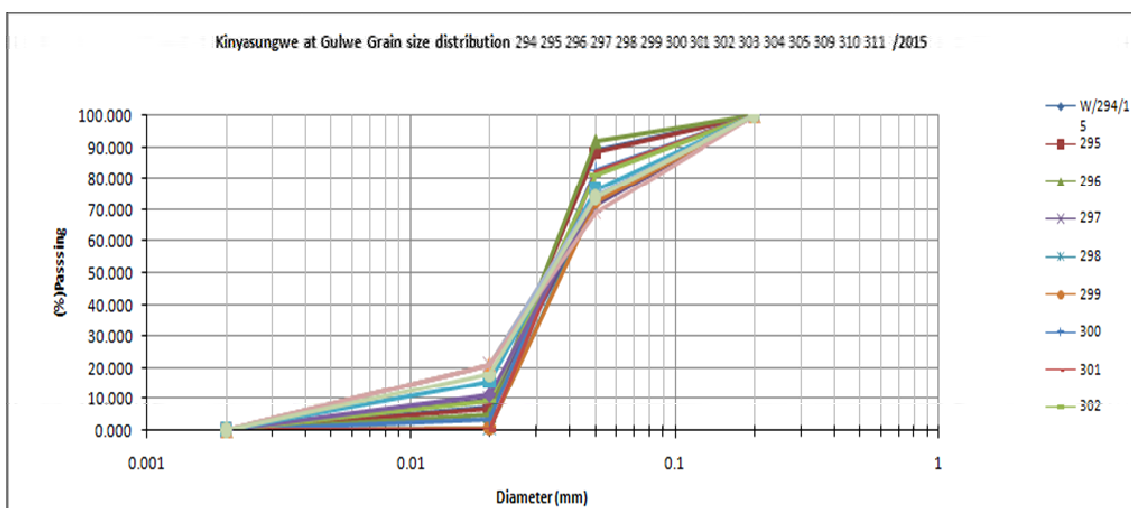


Figure P.36: Grain Size Distribution Analysis Graphs (Kinyasungwe/Gulwe)

Appendix 1: Discharge Floats Sheet at Mangweta

DISCHARGE CALCULATION FORM

(USING FLOAT METHOD)

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)	
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	Discharge (m ³ /s)
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)	
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	Discharge (m ³ /s)
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)	
		Rdg. No.	Time, s	Float velocity (m/s)	Mean float velocity (m/s)	Coef.	Mean velocity (m/s)	Upstream section	Downstream section	Average	Discharge (m ³ /s)
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:	13 April 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:			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 (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	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 April 2015				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 April 2015				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
 Station Number ;local PRPPELLOR NO I-171646
 date of measurements 11/4/2015
 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
 BODY N0 C2170020 Gauge height 0.85
 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			area of sect	discharge in section	discharge accum	
									multiplier		mean vel. in vert				mean vel. in section
0.0	0.00							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

date of measurements
n=<1.78 V=0.0678*n+0.016,
V=0.0537*n+0.061

12/4/2015

BODY NO C2170020

Gauge height 0.79

Station
Number :local PRPELOR NO I-171646

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

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			area of sect	discharge in section	discharge accum	
									multiplier		mean vel. in vert				mean vel. in section
0.0	0.00							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

$n < 1.78 \quad V = 0.0678 * n + 0.016,$

$1.78 \leq n < 7.65$

$V = 0.0571 * n + 0.0357, 7.65 \leq n < 17.551$

$V = 0.0537 * n + 0.061$

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			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				
												0.097	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

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

Number ;local

PRPPELLOR NO I-171646

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 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)

- coated 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:

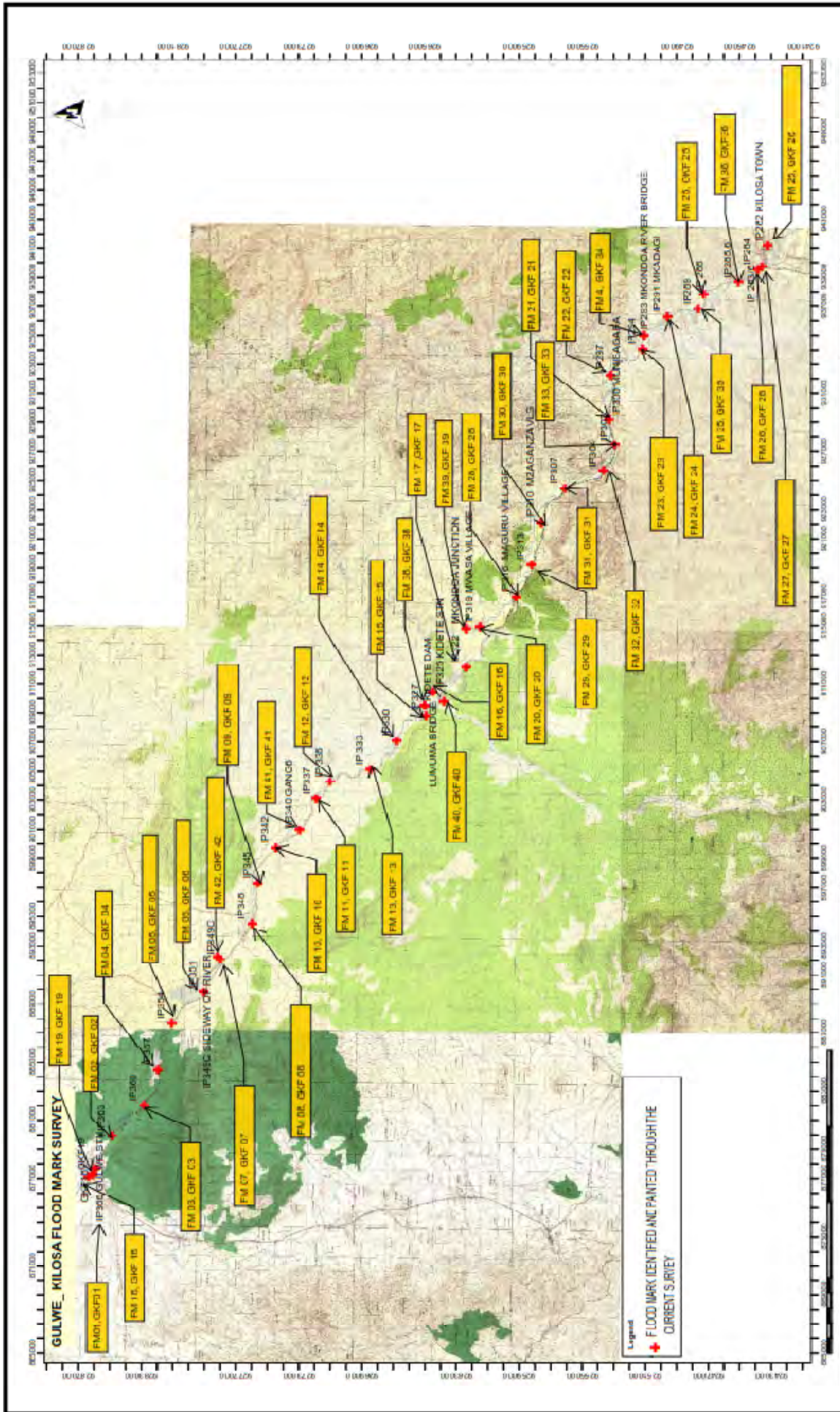
- Remarkably good cooperation from the local people who were willing to be interviewed and provided important information on the flood events, when they occurred and showed us the location of maximum flooding.
- Good cooperation from RAHCO people in terms of assistance on transportations by trolleys 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



<p>PROJECT TITLE: PREPARATORY SURVEY ON FLOOD PROTECTION MEASURES FOR CENTRAL RAILWAY LINE IN THE UNITED REPUBLIC OF TANZANIA</p>	<p>CLIENT : Nippon Koe Co.Ltd</p>	<p>SCALE: 1:25,000</p>	<p>PLAN DRAWING</p>
		<p>Drawn by: Bawazir A. M.</p> <p>Checked by: Hemed I A</p> <p>Date: March, 2013</p>	