

SECTION 7 WATER USE AND HYDROLOGICAL CONDITIONS OF THE WATER BODY THROUGH THE FUTURE

7.2 Hydrological Condition of the Rivers and Lakes

7.2.1 Flow Rate Estimation and Flow Balance

(1) River Flow

1) Specific Discharge Rate

The specific discharges are estimated at respective measuring points as shown in Table 7.2.1.

Table 7.2.1 Specific Flow Rate at Flow Rate Measuring Points

		1985/94		1990/94		Catchment Area Km ²	S.T.W Effluent m ³ /day
		Annual	Dry	Annual	Dry		
Flow Rate (m ³ /day)							
Manyame R.	Harava Dam U/S	102,000	31,000	46,000	17,000	474	0
Manyame R.	Lake Chivero U/S	266,000	89,000	131,000	36,000	1,530	*1
Mukuvisi R.	Lake Chivero U/S	114,000	54,000	104,000	59,000	230	27,700
Marimba R.	Lake Chivero U/S	63,000	21,000	38,000	21,000	215	16,000
Specific Discharge Rate (m ³ /day km ²)							
Manyame R.	Harava Dam U/S	215	65	97	36	474	
Manyame R.	Lake Chivero U/S	174	58	86	24	1,530	
Mukuvisi R.	Lake Chivero U/S	496	235	452	257	230	
Marimba R.	Lake Chivero U/S	293	98	177	98	215	

Note: *1; Effluent from Zengeza STW was included during the study period

2) Influence of STWs Effluent

Table 7.2.2 summarises average flows measured and estimated using specific discharge rate of the Mukuvisi and Marimba rivers. Data on STWs effluent and transmitted treated sewage to irrigated farms between 1990-1994 are also shown in the table. The difference of flow between measured data and estimated figure of Marimba River almost coincides with effluent amount discharged from STW.

Table 7.2.2 Flow Comparison between Measured Data and Estimated Figures

		1985/94		1990/94		Catchment Area Km ²	S.T.W Effluent (m ³ /day)			
		Annual m ³ /day	Dry m ³ /day	Annual m ³ /day	Dry m ³ /day		Annual		Dry	
							To River	To Farm	To River	To Farm
Mikwisi	Observed	114,000	54,000	104,000	59,000	230				
	Estimated	49,500	15,000	22,300	8,300					
	Difference	64,500	39,000	81,700	50,700		27,700	-	28,100	-
Mwinba	Observed	63,000	21,000	38,000	21,000	215				
	Estimated	46,000	14,000	21,000	8,000					
	Difference	17,000	7,000	17,000	13,000		16,000	39,300	15,700	32,300
Specific Discharge Rate		215	65	97	36					

Note: Estimated flow arrived using specific discharge rate in the sub-basin
 Inflow to the rivers derived from STWs is estimated as shown in table 7.2.3 using the following equation.

$$y = x_1 + 0.08 \times x_2$$

y : Flow caused by STW effluent (annual average)

x₁ : STW effluent (discharge to the rivers)

x₂ : STW effluent (transmitted to farmland)

Present flow (m³/day) of the main river and major sub-rivers is presented in Table 7.2.4.

Table 7.2.3 Inflow to the Rivers derived from STWs Effluent

Sub-basin		S.T.W.	Effluent Flow		Reach to River			
			Annual (m ³ /day)	Dry (m ³ /day)	Annual		Dry	
					Ratio	(m ³ /day)	Ratio	(m ³ /day)
Marimba R.	Farm	Crowborough	39,400	32,300	0.08	3,200	0.08	2,600
	River		16,000	15,700	1.00	16,000	1.00	15,700
	Total		55,400	48,000		19,200		18,300
L.Chivero	Farm	Firle	83,900	81,300	0.08	6,700	0.08	6,500
Mukuvisi R.	River		27,700	28,100	1.00	27,700	1.00	28,100
	Total		111,600	109,400				
Gwebi R.	Farm	Marlborough	2,000	2,000	0.08	200	0.08	200
	River				1.00	0	1.00	0
	Total		2,000	2,000		200		200
Ruwa R.	Farm	Donnybrook	5,500	5,500	0.08	400	0.08	400
	River				1.00	0	1.00	0
	Total	5,500	5,500		400		400	
	Farm	Ruwa	2,900	2,900	0.08	200	0.08	200
	River				1.00	0	1.00	0
Total	2,900	2,900		200		200		
Ruwa R. sub-total			8,400	8,400		600		600
Out of Study Area	Farm	Zengeza	18,000	18,000				
Nyatsime R.	River		18,400	15,100	1.00	18,400	1.00	15,100
	Total		36,400	33,100		18,400		15,100
L.Manyame	Farm	Norton	2,700	2,700	0.08	200	0.08	200
	River				1.00	0	1.00	0
	Total		2,700	2,700		200		200
Total	Farm		154,400	144,700		10,900		10,100
	River		62,100	58,900		62,100		58,900
	Total		216,500	203,600		73,000		69,000

Table 7.2.4 Present Daily Flow of the Rivers

Unit: m³/day

River	Natural Flow Rate				S.T.W.		Total Flow Rate				Catchment Area (km ²)
	1985/94		1990/94		Annual	Dry	1985/94		1990/94		
	Annual	Dry	Annual	Dry			Annual	Dry	Annual	Dry	
Manyame Origin	102,000	31,000	46,000	17,000	0	0	102,000	31,000	46,000	17,000	A 474.0
Ruwa R.	42,000	13,000	19,000	7,000	600	600	42,600	13,600	19,600	7,600	B 195.0
Seke D/S							170,000	40,000	41,000	16,000	A 115.0
Nyatsime R.	77,600	33,900	71,600	4,900	18,400	15,100	96,000	49,000	90,000	20,000	B 580.0
Manyame R.	247,600	73,900	112,600	20,900	18,400	15,100	266,000	89,000	131,000	36,000	A 1530.0
Mukuvisi R.	86,300	25,900	76,300	30,900	27,700	28,100	114,000	54,000	104,000	59,000	A 230.0
Marimba R.	43,800	2,700	18,800	2,700	19,200	18,300	63,000	21,000	38,000	21,000	A 215.0
L.Chivero					6,700	6,500					
L.Chivero D/S							45,000	16,000	16,000	11,000	A
Muzururu R.	67,000	20,000	30,000	11,000	0	0	67,000	20,000	30,000	11,000	B 310.0
Gwebi R.	166,000	50,000	75,000	28,000	200	200	166,200	50,200	75,200	28,200	B 770.0
L.Manyame D/S							154,000	211,000	94,000	123,000	A

Note: A-measured flow

B-modified flow (effluent of STWs is added to natural flow)

(2) Direct rainfall into the lake

Direct inflow of rainfall into the lakes is considered without any losses as shown in Table 7.2.5.

Table 7.2.5 Direct Rainfall into the Lake

Lake/Dam	Surface Area (Km ²)	Rain Fall Amount					
		(mm/year)		(x1000m ³ /year)		(m ³ /day)	
		1985/94	1990/94	1985/94	1990/94	1985/94	1990/94
Harava	2.2	817.8	788.6	1,800	1,700	4,900	4,700
Seke	1.1	817.8	788.6	900	900	2,500	2,500
Chivero	26.3	817.8	788.6	21,500	20,700	58,900	56,700
Manyame	81.0	817.8	788.6	66,200	63,900	181,400	175,100

(3) Direct Inflow

The direct inflow into the lake through small rivers/channels is estimated as shown in Table 7.2.6, using specific discharge rate of river basin.

Table 7.2.6 Direct Inflow from Surrounding Area of the Lake

Lake/Dam	Area (Km ²)	Specific Discharge Rate (m ³ /day km ²)		Flow Rate(m ³ /day)		STW Eff. (m ³ /day)
		1985/94	1990/94	1985/94	1990/94	
Harava & Seke	115.0	215	97	25,000	11,000	
Chivero	228.7	215	97	49,000	22,000	6,700
Manyame	509.0	215	97	109,000	49,000	

(4) Evaporation

According to the study on Lake McIlwaine (1982), the evaporation on Lake Chivero is estimated at 1291- 2005 mm(Average 1541 mm). The water amount of evaporation is estimated using surface area of the lake/dam at the average water level and rainfall of 1541 mm/ year as shown in Table 7.2.7. Likewise, the surface area of the lake/dam is estimated using H-V curve shown in sub-section 7.2.3 (0.88 power of lake level).

Table 7.2.7 Evaporation

Lake/Dam	Surface Area (Km ²)	Average Depth (%)	Surface Area at Ave. Depth (Km ²)	Evaporation		
				(mm/y)	(x1000m ³ /y)	(m ³ /day)
Harava	2.2	50.02	1.17	1,541	1,800	5,000
Seke	1.1	42.27	0.51	1,541	800	2,000
Chivero	26.3	85.22	22.84	1,541	35,200	96,000
Manyame	81.0	64.83	55.27	1,541	85,200	233,000

(5) WTWs Water Intake

Table 7.2.8 shows the breakdown of the average intake water amount at the two WTWs from 1994 to 1996 together with the produced water amount at Morton Jaffray WTW.

Table 7.2.8 Average Water Intake Amount at WTWs

Unit: m³/day

Year	Intake Water Amount						Production		
	Prince Edward		Morton Jaffray				Morton Jaffray		
	Seke Dam	%	L.Chivero	%	L.Manyam	%	Total	%	
1994	48,300	11	160,700	37	231,300	53	440,300	303,800	78
1995	17,930	4	452,370	90	30,900	6	501,200	340,100	70
1996	8,000	2	201,300	47	222,300	52	431,600	309,400	73
Average	28,200	7	181,000	42	226,800	52	436,000	306,600	75

The intake amount from the respective lakes/dams is stable except for the experience (draught) in 1995.

Table 7.2.9 shows water intake and production amount at WTWs in the average of last 10 years and 5 years, respectively.

Table 7.2.9 Outline of the Operation at WTWs

Unit: x1000 m³/day

	Intake Ratio	Discharge Ratio	1986-94			1990-94		
			Intake	Produced	Loss	Intake	Produced	Loss
Seke & Harava	5%	25%	20.5	15.4	5.1	22.1	16.6	5.5
L.Chivero	40%	25%	164.3	123.2	41.4	176.5	132.4	44.1
L.Manyame	55%	25%	225.9	169.4	56.5	242.7	182.0	60.7
Total	100%	N.A.	410.7	308.0	103.0	441.3	331.0	110.3

(6) Flow Balance at the Lakes/Dams

The flow balances of respective lakes/dams between the study of "LAKE McILWAINE", and this study are shown in Table 7.2.10. The inflows and outflows in annual average of lakes/dams between the two studies are within an allowable range.

Table 7.2.10 Inflow to and Outflow from Lake Chivero

Unit: x1000m³/day

	Study of Lake McIlwaine				Study	
	A	B		1985-94	1990-94	
			1966			1968
<u>Inflow to the lake</u>						
Rivers	559	Total gauged flow	277	54	443	273
		Estimated flow	68	14	55.7	28.5
Direct Rainfall		Direct Rainfall	57	27	58.9	56.7
Total	559		402	95	557.6	358.2
<u>Outflow from the lake</u>						
Controlled Abstraction	337		68	95	164.3	176.5
Evaporation	93		112	44	96.4	96.4
Spillway Discharge	129		159	115	45	16
Total	559		339	254	319	303

Note:A; "Physical limnology" by P.R.B.Ward

B; "The hydrology of the Lake McIlwaine catchment" by B.R.Ballinger and J.A.Thornton

(7) Flow Balance in the Future

The inflow to the rivers derived from STWs effluent for each scenario are shown in Tables 7.2.11(1) and (2) respectively.

Table 7.2.11(1) Inflow to the Rivers Derived from STWs Effluent (Scenario-1)

Unit: m³/day

S.T.W.	Effluent Flow						Reach to River						Sub-basin	
	Present		2000	2005	2015	Present		2000	2005	2015	2000	2005		2015
	Annual	Dry				Annual	Dry							
Crowborough	Farm	39,400	32,300	36,000	36,000	36,000	3,200	2,600	2,900	2,900	2,900	2,900	2,900	Marimba R.
	River	16,000	15,700	49,500	112,100	142,900	16,000	15,700	49,500	112,100	142,900	112,100	142,900	Marimba R.
	Total	55,400	48,000	85,500	148,100	178,900	19,200	18,300	52,400	115,000	145,800	115,000	145,800	
Firle	Farm	83,900	81,300	36,000	36,000	36,000	6,700	6,500	2,900	2,900	2,900	2,900	2,900	L.Chivero
	River	27,700	28,100	144,200	212,100	273,700	27,700	28,100	144,200	212,100	273,700	212,100	273,700	Mukuvisi R.
	Total	111,600	109,400	180,200	248,100	309,700	34,400	34,600	147,100	215,000	276,600	215,000	276,600	
Marlborough	Farm	2,000	2,000	2,000	2,000	4,800	200	200	200	200	200	200	200	Gwebi R.
	River	2,000	2,000	2,000	2,000	4,800	0	0	0	0	0	0	0	
	Total	4,000	4,000	4,000	4,000	9,600	200	200	200	200	200	200	200	
Donnybrook	Farm	5,500	5,500	7,900	7,900	12,300	400	400	600	600	600	600	600	Ruwa R.
	River	5,500	5,500	7,900	7,900	12,300	0	0	0	0	0	0	0	
	Total	11,000	11,000	15,800	15,800	24,600	400	400	600	600	600	600	600	
Harare South	Farm			13,200	63,600	92,100	0	0	1,100	5,100	7,400	5,100	7,400	Manyame R (Chivero u/s)
	River			13,200	63,600	92,100	0	0	0	0	0	0	0	
	Total			26,400	127,200	184,200	0	0	1,100	5,100	7,400	5,100	7,400	
Harare East	Farm			5,500	6,300	37,700	0	0	400	500	3,000	500	3,000	Ruwa R.
	River			5,500	6,300	37,700	0	0	0	0	0	0	0	
	Total			11,000	12,600	75,400	0	0	400	500	3,000	500	3,000	
Zengeza	Farm	18,000	33,100	20,400	20,400	20,400	1,400	2,600	1,600	1,600	1,600	1,600	1,600	Out of Study Area
	River	18,400	0	17,100	18,300	49,800	18,400	0	17,100	18,300	49,800	18,300	49,800	Nyatsime R.
	Total	36,400	33,100	37,500	38,700	70,200	19,800	2,600	18,700	19,900	51,400	19,900	51,400	
Norton	Farm	2,700	2,700	6,400	12,400	41,300	200	200	500	1,000	3,300	1,000	3,300	L.Manyame
	River	2,700	2,700	6,400	12,400	41,300	0	0	0	0	0	0	0	
	Total	5,400	5,400	12,800	24,800	82,600	200	200	500	1,000	3,300	1,000	3,300	
Ruwa	Farm	2,900	2,900	8,400	13,200	18,400	200	200	700	1,100	1,500	1,100	1,500	Ruwa R.
	River	2,900	2,900	8,400	13,200	18,400	0	0	0	0	0	0	0	
	Total	5,800	5,800	16,800	26,400	36,800	200	200	700	1,100	1,500	1,100	1,500	
Total	Farm	154,400	159,800	135,600	197,800	299,000	12,300	12,700	10,900	15,900	24,000	15,900	24,000	
	River	62,100	43,800	210,800	342,500	466,400	62,100	43,800	210,800	342,500	466,400	342,500	466,400	
	Total	216,500	203,600	346,400	540,300	765,400	74,400	56,500	221,700	358,400	490,400	358,400	490,400	

Note: Present effluent flow referred from Table 9.3.2 and future from Table 12.2.7

Table 7.2.11(2) Inflow to the Rivers Derived from STWs Effluent (Scenario-2)

Unit: m³/day

S.T.W.	Effluent Flow						Reach to River						Sub-basin
	Present		2000	2005	2015	Present		2000	2005	2015	Sub-basin		
	Annual	Dry				Annual	Dry						
Crowborough	Farm	39,400	32,300	36,000	36,000	36,000	3,200	2,600	2,900	2,900	2,900	Marimba R.	
	River	16,000	15,700	48,800	48,800	88,200	16,000	15,700	48,800	56,700	88,200	Marimba R.	
	Total	55,400	48,000	84,800	84,800	124,200	19,200	18,300	51,700	59,600	91,100		
Firle	Farm	83,900	81,300	36,000	36,000	36,000	6,700	6,500	2,900	2,900	2,900	L.Chivero	
	River	27,700	28,100	147,700	147,700	241,900	27,700	28,100	147,700	169,300	241,900	Mukuvisi R.	
	Total	111,600	109,400	183,700	183,700	277,900	34,400	34,600	150,600	172,200	244,800		
Marlborough	Farm	2,000	2,000	2,000	2,000	2,600	200	200	200	200	200	Gwebi R.	
	River						0	0	0	0	0		
	Total	2,000	2,000	2,000	2,000	2,600	200	200	200	200	200		
Donnybrook	Farm	5,500	5,500	7,100	7,100	11,700	400	400	600	700	900	Ruwa R.	
	River						0	0	0	0	0		
	Total	5,500	5,500	7,100	7,100	11,700	400	400	600	700	900		
Harare South	Farm			3,500	47,100	47,400	0	0	300	3,800	3,800	Manyame R	
	River						0	0	0	0	0	(Chivero u/s)	
	Total			3,500	47,100	47,400	0	0	300	3,800	3,800		
Harare East	Farm			5,500	6,300	37,700	0	0	400	500	3,000	Ruwa R.	
	River						0	0	0	0	0		
	Total			5,500	6,300	37,700	0	0	400	500	3,000		
Zengeza	Farm	18,000	33,100	20,400	20,400	20,400	1,400	2,600	1,600	1,600	1,600	Out of Study Area	
	River	18,400	0	25,100	37,700	87,300	18,400	0	25,100	37,700	87,300	Nyatstime R.	
	Total	36,400	33,100	45,500	58,100	107,700	19,800	2,600	26,700	39,300	88,900		
Norton	Farm	2,700	2,700	3,800	7,600	26,500	200	200	300	600	2,100	L.Manyame	
	River						0	0	0	0	0		
	Total	2,700	2,700	3,800	7,600	26,500	200	200	300	600	2,100		
Ruwa	Farm	2,900	2,900	3,200	4,300	5,700	200	200	300	300	500	Ruwa R.	
	River						0	0	0	0	0		
	Total	2,900	2,900	3,200	4,300	5,700	200	200	300	300	500		
Total	Farm	154,400	159,800	117,500	168,100	224,000	12,300	12,700	9,500	13,500	17,900		
	River	62,100	43,800	221,600	263,700	417,400	62,100	43,800	221,600	263,700	417,400		
	Total	216,500	203,600	339,100	431,800	641,400	74,400	56,500	231,100	277,200	435,300		

Note; Present effluent flow referred from Table 9.3.2 and future from Table 12.2.7

SECTION 8 UNIT WASTEWATER QUANTITY AND QUALITY

8.3 Industrial Wastewater

Table 8.3.1 Unit Quantity of Industrial Wastewater

No.	Sampling Number	Company Name	Type of Industry	Number of Employees	Wastewater Quantity (m ³ /day)	Unit Wastewater Quantity (m ³ /day person)
1	1	Chibuku Brew	1 Processed Foodstuffs	250	75.0	0.300
2	2	United Bottlers	1 Processed Foodstuffs	942	1258.1	1.336
3	3	Olivine Ind.	1 Processed Foodstuffs	1,500	759.1	0.506
4	4	National Breweries	1 Processed Foodstuffs	800	738.3	0.923
5	5	Olivine Ind.	1 Processed Foodstuffs	440	216.7	0.492
6	6	Suncrest Chickens	1 Processed Foodstuffs	175	171.8	0.982
7	16	D.M.B.	1 Processed Foodstuffs	600	900.0	1.500
8	17	ZSR	1 Processed Foodstuffs	532	552.6	1.039
9	18	Colcom	1 Processed Foodstuffs	1,100	349.1	0.317
10	19	National Foods	1 Processed Foodstuffs	516	256.5	0.497
11	26	Chibuku Brewer	1 Processed Foodstuffs	350	13.3	0.038
12	27	Aroma Bakeries LTD	1 Processed Foodstuffs	145	18.7	0.129
13	28	Dairiboard	1 Processed Foodstuffs	70	22.0	0.314
14	29	Food & Industrial	1 Processed Foodstuffs	168	22.0	0.131
15	30	NBC	1 Processed Foodstuffs	103	3.3	0.032
16	39	Dandy	1 Processed Foodstuffs	135	12.5	0.093
17	40	Copro	1 Processed Foodstuffs	30	20.0	0.667
18	41	Zim Freeze	1 Processed Foodstuffs	200	64.8	0.324
		Total	18	8,056	5,453.8	0.677
19	36	Hunyani	4 Pulp, Paper & Related Products	650	2,800.0	4.308
		Total	1	650	2,800.0	4.308
20	7	Colgate Palmolive	6 Chemicals	170	51.6	0.304
21	8	Caps	6 Chemicals	400	65.0	0.163
22	9	Dullux	6 Chemicals	120	6.7	0.056
23	20	Lever Bro	6 Chemicals	1,200	512.7	0.427
24	21	Windmill (Pvt) Ltd	6 Chemicals	450	12.0	0.027
25	22	Lion Match	6 Chemicals	155	70.9	0.457
		Total	6	2,495	718.9	0.288
26	42	Mega Pak	7 Plastic Products	40	0.2	0.004
27	44	Pyramid Products	7 Plastic Products	34	6.0	0.176
		Total	2	74	6.2	0.083
28	11	Turnal Products	11 Ceramics, Stone & Clay Products	550	66.7	0.121
29	31	Southern Granite	11 Ceramics, Stone & Clay Products	30	416.7	13.889
		Total	2	580	483.3	0.833
30	32	Star Chains Drives	14 Metal Products	47	13.3	0.284
31	23	BICC Cafca	14 Metal Products	243	25.0	0.103
32	12	Aluminium Ind.	14 Metal Products	457	73.1	0.160
33	13	Industrial Galv	14 Metal Products	39	59.7	1.530
		Total	4	786	171.1	0.218
34	14	W/Vale M. M. Ind.	17 Transportation Equipment	600	200.0	0.333
35	24	Zupco	17 Transportation Equipment	3,226	70.0	0.022
36	25	Chloride Zim	17 Transportation Equipment	320	66.7	0.208
37	34	Zupco	17 Transportation Equipment	400	300.0	0.750
38	35	GDC Hauliers	17 Transportation Equipment	400	33.3	0.083
39	37	Lucas	17 Transportation Equipment	103	20.0	0.194
		Total	6	5,049	690.0	0.137
40	10	Imponente Tanning	9 Leather & Related Products	172	220.0	1.279
41	15	Abercorn Dry Co.	19 Other Industry Products	35	80.0	2.286
42	38	Norton Hospital	19 Other Industry Products	46	16.7	0.362
43	43	NAT.REH.CENTRE	19 Other Industry Products	200	115.2	0.576
44	45	Aurex	19 Other Industry Products	1,000	63.0	0.063
45	33	Guard - Alert	19 Other Industry Products	131	3.3	0.025
		Total	5	1,584	498.2	0.315

Table 8.3.2 Unit Quality of Industrial Wastewater by Industrial Type

No.	Sampling Number	Company Name	Type of Industry ¹⁾	Number of Employees	Wastewater Quantity (m ³ /day)	Wastewater Quality (mg/l)				Wastewater Pollution Load (kg/day)				Unit Pollution Load (g/day person)						
						BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P
1	1	Chibuku Brew	1	250	75.0	6,200	2,565	88	30.00	17.70	465.0	192.4	6.6	2.25	1.33	1,860.0	769.5	26.4	9.00	5.32
2	2	United Bottlers	1	942	1,258.1	190	4,320	784	13.00	2.40	239.0	5,435.1	986.4	16.36	3.02	253.8	1,047.1	17.37	17.37	3.21
3	3	Olivine Ind.	1	1,500	759.1	280	1,080	176	2.30	0.08	212.5	819.8	133.6	1.75	0.06	141.7	546.5	89.1	1.17	0.04
4	4	National Breweries	1	800	738.3	1,360	3,780	308	40.00	16.70	1,004.1	2,790.7	227.4	29.53	12.33	1,255.1	3,488.3	284.2	36.91	15.41
5	5	Olivine Ind.	1	440	216.7	380	270	445	20.00	8.50	82.3	58.5	96.4	4.33	1.84	187.1	133.0	219.1	9.84	4.18
6	6	Suncrest Chickens	1	175	171.8	2,500	2,295	320	48.00	9.80	429.5	394.3	55.0	8.25	1.68	2,454.3	2,253.0	314.2	47.14	9.60
7	16	D.M.B.	1	600	900.0	1,900	2,160	595	12.50	17.70	1,710.0	1,944.0	535.5	11.25	15.93	2,850.0	3,240.0	892.5	18.75	26.55
8	17	ZSR	1	532	552.6	900	1,620	182	29.00	14.70	497.4	895.3	100.6	16.03	8.12	934.9	1,682.8	189.1	30.13	15.26
9	18	Colcom	1	1,100	349.1	1,200	3,240	756	152.00	50.60	419.0	1,131.2	263.9	53.07	17.67	380.9	1,028.3	239.9	48.25	16.06
10	19	National Foods	1	516	256.5	8,800	17,324	2,980	340.00	112.00	2,256.9	4,443.1	764.3	87.20	28.72	4,373.9	8,610.6	1,481.2	168.99	55.66
11	26	Chibuku Brewer	1	350	13.3	1,300	2,835	620	2.45	24.60	17.3	37.8	8.3	0.03	0.33	49.5	108.0	23.6	0.09	0.94
12	27	Aroma Bakeries LTD	1	145	18.7	220	270	131	33.00	5.30	4.1	5.0	2.5	0.62	0.10	28.3	34.8	16.9	4.28	0.69
13	28	Dairibord	1	70	22.0	540	155	35	2.40	4.20	11.9	3.0	0.8	0.05	0.09	169.7	42.4	11.0	0.71	1.29
14	29	Food & Industrial	1	168	22.0	12,800	11,664	3,210	265.00	131.00	281.6	256.6	70.6	5.83	2.88	1,676.2	1,527.4	420.4	34.70	17.14
15	30	NBC	1	103	3.3	240	540	258	60.00	6.20	0.8	1.8	0.9	0.20	0.02	7.8	17.5	8.3	1.94	0.19
16	39	Dandy	1	135	12.5	882	6,400	232	115.00	2.88	11.0	80.0	2.9	1.44	0.04	81.7	592.6	21.5	10.67	0.30
17	40	Copro	1	30	20.0	1,012	8,640	69	6.30	0.69	20.2	172.8	1.4	0.13	0.01	674.7	5,760.0	46.0	4.33	0.33
18	41	Zim Freeze	1	200	64.8	12	1,350	270	21.00	2.40	0.8	87.5	17.5	1.36	0.16	3.9	437.4	87.5	6.80	0.80
		Total	18	8,056	5,453.8	2,262	3,916	637	66.22	23.75	12,336.5	21,357.1	3,472.0	361.15	129.51	965.8	2,002.3	301.0	25.06	9.61
19	36	Hunyani	4	650	2,800.0	2,275	9,720	498	38.00	6.20	6,370.0	27,216.0	1,394.4	106.40	17.36	9,800.0	41,870.8	2,145.2	163.69	26.71
		Total	1	650	2,800.0	2,275	9,720	498	38.00	6.20	6,370.0	27,216.0	1,394.4	106.40	17.36	9,800.0	41,870.8	2,145.2	163.69	26.71

Table 8.3.2 Unit Quality of Industrial Wastewater by Industrial Type (cont'd)

No.	Sampling Number	Company Name	Type of Industry*	Number of Employees	Wastewater Quantity (m ³ /day)	Wastewater Quality (mg/l)				Wastewater Pollution Load (kg/day)				Unit Pollution Load (g/day person)						
						BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P
20	7	Colgate Palmolive	6	170	51.6	320	511	120	36.00	12.60	16.5	26.4	6.2	1.86	0.65	97.2	155.2	36.5	10.94	3.82
21	8	Caps	6	400	65.0	240	227	135	45.00	4.60	15.6	14.8	8.8	2.93	0.30	39.0	36.9	22.0	7.33	0.75
22	9	Dullux	6	120	6.7	440	2,565	270	28.00	5.70	2.9	17.1	1.8	0.19	0.04	24.4	142.6	15.0	1.58	0.33
23	20	Lever Bro	6	1,200	512.7	950	10,800	3,920	23.50	11.30	487.1	5,537.2	2,009.8	12.05	5.79	405.9	4,614.3	1,674.8	10.04	4.83
24	21	Windmill (Pvt) Ltd	6	450	12.0	260	1,176	136	31.00	14.40	3.1	14.1	1.6	0.37	0.17	6.9	31.4	3.6	0.82	0.38
25	22	Lion Match	6	155	70.9	140	135	186	15.50	0.55	9.9	9.6	13.2	1.10	0.04	64.0	61.7	85.0	7.10	0.26
		Total	6	2,495	718.9	392	2,569	795	29.83	8.19	281.6	1,846.8	571.2	21.45	5.89	106.2	840.4	306.2	6.30	1.73
26	42	Mega Pak	7	40	0.2	220	1,620	430	73.00	5.70	0.04	0.28	0.1	0.01	0.001	1.0	7.0	1.8	0.25	0.03
27	44	Pyramid Products	7	34	6.0	260	2,700	22,130	1.00	0.70	1.56	16.20	132.8	0.01	0.004	45.9	476.5	3,905.3	0.29	0.12
		Total	2	74	6.2	240	2,160	11,280	37.00	3.20	1.48	13.33	69.6	0.20	0.020	23.5	241.8	1,953.6	0.27	0.08
28	11	Tural Products	11	550	66.7	120	405	480	12.00	1.50	8.0	27.0	32.0	0.80	0.10	14.5	49.1	58.2	1.45	0.18
29	31	Southern Granite	11	30	416.7	12	6	94	1.90	0.31	5.0	2.5	39.2	0.79	0.13	166.7	83.3	1,305.7	26.33	4.33
		Total	2	580	483.3	66	206	287	6.95	0.91	31.9	99.3	138.7	3.36	0.44	90.6	66.2	682.0	13.89	2.26
30	32	Star Chains Drives	14	47	13.3	150	600	150	25.00	1.20	2.0	8.0	2.0	0.33	0.02	42.6	170.2	42.6	7.02	0.43
31	23	BICC Cafca	14	243	25.0	120	270	154	28.00	4.70	3.0	6.8	3.9	0.70	0.12	12.3	27.8	15.8	2.88	0.49
32	12	Aluminium Ind.	14	457	73.1	220	742	46	15.00	1.10	16.1	54.3	3.4	1.10	0.08	35.2	118.7	7.4	2.41	0.18
33	13	Industrial Galv	14	39	59.7	100	338	200	10.00	1.00	6.0	20.2	11.9	0.60	0.06	153.1	517.2	305.9	15.38	1.54
		Total	4	786	171.1	148	488	138	19.50	2.00	25.2	83.4	23.5	3.34	0.34	60.8	208.5	92.9	6.92	0.66

Table 8.3.2 Unit Quality of Industrial Wastewater by Industrial Type (cont'd)

No.	Sampling Number	Company Name	Type of Industry*1	Number of Employees	Wastewater Quantity (m ³ /day)	Wastewater Quality (mg/l)				Wastewater Pollution Load (kg/day)				Unit Pollution Load (g/day person)						
						BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P
34	14	W/Vale M. M. Ind.	17	600	200.0	270	700	18.00	46.20	46.20	46.0	54.0	140.0	3.60	9.24	76.7	90.0	253.3	6.00	15.40
35	24	Zupco	17	3,226	70.0	1,136	390	13.50	6.30	6.30	21.0	79.5	27.3	0.95	0.44	6.5	24.6	8.5	0.29	0.14
36	25	Chloride Zim	17	320	66.7	100	45	42.00	0.26	0.26	6.7	9.0	3.0	2.80	0.02	20.8	28.1	9.4	8.75	0.06
37	34	Zupco	17	400	300.0	270	158	2.65	10.00	10.00	81.0	270.0	47.4	0.80	3.00	202.5	675.0	118.5	2.00	7.50
38	35	GDC Hauliers	17	400	33.3	160	480	3.65	53.20	53.20	5.3	27.0	16.0	0.12	1.77	13.3	67.5	40.0	0.30	4.43
39	37	Lucas	17	103	20.0	510	402	19.75	9.60	9.60	10.2	151.2	8.0	0.40	0.19	99.0	1,468.0	78.1	3.88	1.84
		Total	6	5,049	690.0	2,621	363	16.59	20.93	20.93	180.6	1,243.3	250.1	11.45	14.44	69.8	392.2	81.3	3.54	4.90
40	10	Imponente Tanning	9	172	220.0	550	1,230	220.00	3.90	3.90	121.0	594.0	270.6	48.40	0.86	703.5	3,453.5	1,573.3	281.40	5.00
41	15	Abercorn Dry Co.	19	35	80.0	240	325	17.00	14.10	14.10	19.2	21.6	26.0	1.36	1.13	548.6	617.1	742.9	38.86	32.29
42	38	Norton Hospital	19	46	16.7	170	49	6.60	0.65	0.65	2.8	45.0	0.8	0.11	0.01	61.5	978.5	17.8	2.39	0.22
43	43	NAT.REH.CENTRE	19	200	115.2	100	30	19.00	1.10	1.10	11.5	31.1	3.5	2.19	0.13	57.6	155.5	17.3	10.95	0.65
44	45	Aurex	19	1,000	63.0	100	398	30.00	13.90	13.90	6.3	110.6	25.1	1.89	0.88	6.3	110.6	25.1	1.89	0.88
45	33	Guard - Alert	19	131	3.3	120	120	31.00	1.00	1.00	0.4	0.8	0.4	0.10	0.00	3.1	6.3	3.1	0.76	0.00
		Total	6	1,584	498.2	213	359	53.93	5.78	5.78	106.3	659.7	178.7	26.87	2.88	230.1	886.9	396.6	56.04	6.51

*1 Number of Industrial Type

- 1 Processed Foodstuffs
- 4 Pulp, Paper & Related Products
- 6 Chemicals
- 7 Plastic Products

- 11 Ceramics, Stone & Clay Products
- 14 Metal Products
- 17 Transportation Equipment
- 19 Other Industry Products

8.4 Unit Pollution Load of Other Pollution Sources

Table 8.4.1.(1) Nitrogen Fertilizers Used by Farms in the Study Area

Fertilizer Dosed at Several Farms in the Study Area

Farm No.	Location	Crops (kg/yr)							Pastures (kg/yr)		Comments
		Area (ha)	CO(NH ₂) ₂	NH ₄ NO ₃	Ca(NO ₃) ₂	NaNO ₃	(NH ₄) ₂ SO ₄	KNO ₃	Area (ha)	NH ₄ NO ₃	
1	Harare	642	Nil	92,000	4,000	4,000	8,000	Nil	78	N/A	Incl. horticulture
2	Harare	1,296	30,000	60,000	3,000	3,000	Nil	Nil	509	N/A	
3	Gwebi	800	Nil	17,000	Nil	Nil	Nil	Nil	700	5,000	
4	Darwendale	65	3,000	40,000	Nil	450	Nil	Nil	N/A	N/A	
5	Darwendale	550	Nil	17,500	Nil	Nil	Nil	Nil	100	-	
6	Norton	50	Nil	35,000	250	5,000	100	Nil	Nil	N/A	Incl. horticulture
7	Ruwa	10	Nil	6,000	15,000	Nil	Nil	6,000	Nil	N/A	Horticulture only

Source: Surveyed by Department of Research and Specialist Services, Ministry of Agriculture in May 1996

Percentage of Nitrogen in Fertilizer

Fertilizer	Molecular Weight	Weight of N	% of N
CO(NH ₂) ₂	60.05556	28.0134	46.6%
NH ₄ NO ₃	80.04336	28.0134	35.0%
Ca(NO ₃) ₂	164.0878	28.0134	17.1%
NaNO ₃	84.99467	14.0067	16.5%
(NH ₄) ₂ SO ₄	132.14052	28.0134	21.2%
KNO ₃	101.1012	14.0067	13.9%

Fertilized Nitrogen

Farm No.	Location	Crops							Pastures	
		CO(NH ₂) ₂	NH ₄ NO ₃	Ca(NO ₃) ₂	NaNO ₃	(NH ₄) ₂ SO ₄	KNO ₃	Total	NH ₄ NO ₃	Total
1	Harare	-	32,193	683	659	1,696	-	35,236	-	-
2	Harare	13,994	20,999	512	494	-	-	35,999	-	-
3	Gwebi	-	5,950	-	-	-	-	5,950	824	824
4	Darwendale	1,399	13,999	-	74	-	-	15,473	-	-
5	Darwendale	-	6,125	-	-	-	-	6,125	-	-
6	Norton	-	12,249	43	824	21	-	13,137	-	-
7	Ruwa	-	2,100	2,561	-	-	831	5,492	-	-

Fertilized Nitrogen Per Hectare

Farm No.	Location	Crops							Pastures	
		CO(NH ₂) ₂	NH ₄ NO ₃	Ca(NO ₃) ₂	NaNO ₃	(NH ₄) ₂ SO ₄	KNO ₃	Total	NH ₄ NO ₃	Total
1	Harare	-	50.2	1.1	1.0	2.6	-	54.9	-	-
2	Harare	10.8	16.2	0.4	0.4	-	-	27.8	-	-
3	Gwebi	-	7.4	-	-	-	-	7.4	1.0	1.0
4	Darwendale	21.5	215.4	-	1.1	-	-	238.0	-	-
5	Darwendale	-	11.1	-	-	-	-	11.1	-	-
6	Norton	-	245.0	0.9	16.5	0.4	-	262.7	-	-
7	Ruwa	-	210.0	256.1	-	-	83.1	549.2	-	-

Total Area (Crops) = 3,413 ha
 Total Fertilized Nitrogen = 117,411 kg/yr
 Average Fertilized Nitrogen per Hectare = 34.40 kg/ha/yr = 3,440 kg/km²/yr

Total Area (Pastures) = 1,367 ha
 Total Fertilized Nitrogen = 824 kg/yr
 Average Fertilized Nitrogen per Hectare = 0.59 kg/ha/yr = 59 kg/km²/yr

Table 8.4.1.(2) Phosphate Fertilizers Used by Farms in the Study Area

Fertilizer Dosed at Several Farms in the Study Area

Farm No.	Location	Crops			Pastures			Comments
		Area (ha)	DSP*	SSP**	Area (ha)	DSP	SSP	
1	Harare	642	Nil	Nil	78	Nil	Nil	Horticulture included
2	Harare	1,296	5,000	5,000	509	-	-	
3	Gwebi	800	5,000	10,000	700	Nil	10,000	
4	Darwendale	65	Nil	20,000	N/A	N/A	N/A	
5	Darwendale	550	14,000	Nil	100	Nil	17,500	
6	Norton	50	Nil	Nil	Nil	Nil	Nil	Horticulture included
7	Ruwa	10	Nil	Nil	Nil	Nil	Nil	Horticulture only

* : Double Super Phosphate

** : Single Super Phosphate

Source: Surveyed by Department of Research and Specialist Services, Ministry of Agriculture in May 1996

Percentage of Phosphorus in Fertilizer

Fertilizer	Molecular Wt. of P ₂ O ₅	Weight of P	% of P in Total
Double Super Phosphate (36% P ₂ O ₅)	141.94452	61.94752	15.7%
Single Super Phosphate (18% P ₂ O ₅)	141.94452	61.94752	7.9%

Fertilized Phosphorus

Farm No.	Location	Crops			Pastures		
		Area (ha)	DSP	SSP	Area (ha)	DSP	SSP
1	Harare	642	-	-	78	-	-
2	Harare	1,296	786	393	509	-	-
3	Gwebi	800	786	786	700	-	786
4	Darwendale	65	-	1,571	-	-	-
5	Darwendale	550	2,200	-	100	-	1,375
6	Norton	50	-	-	-	-	-
7	Ruwa	10	-	-	-	-	-

Fertilized Phosphorus Per Hectare

Farm No.	Location	Crops			Pastures		
		DSP	SSP	Total	DSP	SSP	Total
1	Harare	-	-	-	-	-	-
2	Harare	0.6	0.3	0.9	-	-	-
3	Gwebi	1.0	1.0	2.0	-	1.1	1.1
4	Darwendale	-	24.2	24.2	-	-	-
5	Darwendale	4.0	-	4.0	-	13.7	13.7
6	Norton	-	-	-	-	-	-
7	Ruwa	-	-	-	-	-	-

Total Area (Crops) = 3,413 ha
 Total Fertilized Phosphorus = 6,520 kg/yr
 Average Fertilized Phosphorus per Hectare = 1.9 kg/ha/yr 191 kg/km²/yr

Total Area (Pastures) = 1,387 ha
 Total Fertilized Phosphorus = 2,160 kg/yr
 Average Fertilized Phosphorus per Hectare = 1.6 kg/ha/yr 156 kg/km²/yr

Table 8.4.2 Leachate from Solid Waste Landfill Site

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	20.00	19.80	19.40	18.70	15.90	13.60	13.60	15.60	19.00	21.30	20.80	20.40	18.18
Evaporation Amount by Thornthwaite Method													
Ti/5	4.00	3.96	3.88	3.74	3.18	2.72	2.72	3.12	3.80	4.26	4.16	4.08	
(Ti/5) ^{1.514}	8.157	8.034	7.789	7.368	5.763	4.549	4.549	5.600	7.547	8.973	8.656	8.405	
I = Sum (Ti/5) ^{1.514} =	85.389												
a = (0.675 I ³ - 77.1 I ² + 17,920 I + 492,390) x 10 ⁻⁶ =	1.8807												
E = 16 (10 T / I) ^a (mm/month)													
E	79.298	77.813	74.883	69.88	51.509	38.394	38.394	49.697	72.006	89.268	85.368	82.307	
Adjusting Coefficient for Length of Daytime (S.L.18°)													
Dadj	1.13	1.10	1.02	1.00	0.94	0.95	0.96	0.90	1.03	1.05	1.12	1.10	
Adjusted Evaporation (mm/month) Ea = E x Dadj													
Ea	89.607	85.594	76.381	69.88	48.419	36.475	36.859	44.727	74.166	93.732	95.612	90.538	70.166
Rainfall (mm)													
R	219.3	174	103.8	38.6	0.9	2.7	0.9	1.7	1.7	35.6	65.6	173.2	68.167
Leaching Coefficient for On-going Landfill Site C ₁ = 1 - Ea / R													
C ₁	0.59	0.51	0.26	0	0	0	0	0	0	0	0	0.48	
	0.5914	0.5081	0.2642	-0.81	-52.8	-12.51	-39.95	-25.31	-42.63	-1.633	-0.458	0.4773	
Leaching Coefficient for Completed Landfill Site C ₂ = C ₁ x 0.6													
C ₂	0.35	0.31	0.16	0	0	0	0	0	0	0	0	0.29	
Monthly Average Rainfall (mm/day) Rd = R / days													
Rd	7.07	6.21	3.35	1.29	0.03	0.09	0.03	0.05	0.06	1.15	2.19	5.59	
Average Leachate for C ₁ (m ³ /ha/day) L ₁ = Rd x C ₁ x 10													
L ₁	42	32	9	0	0	0	0	0	0	0	0	27	
Monthly													
(m ³ /month)	1,294	887	270	0	0	0	0	0	0	0	0	831	3,283
Average Leachate for C ₂ (m ³ /ha/day) L ₂ = Rd x C ₂ x 10													
L ₂	25	19	5	0	0	0	0	0	0	0	0	16	Total
Monthly													
(m ³ /month)	768	539	166	0	0	0	0	0	0	0	0	502	1,975



SECTION 9 PRESENT WATER POLLUTION ANALYSIS

9.3 Frame Values and Pollution Load by Sub-basin

Table 9.3.1 Estimated Wastewater Quantity by Sewered/Unsewered Area by Sub-basin (Present)

Sub-basin/District	Discharged Wastewater Quantity (m ³ /day)												
	Sewered Area						Unsewered Area						
	Domestic			Com. & Inst.	Industrial	Total	Domestic			Com. & Inst.	Industrial	Total	
	Low	Medium	High				Low	Medium	High				
1. Manvame River (Upstream) S/B													
Gotomonzi Rural	-	-	-	-	-	-	-	-	-	-	-	-	-
Harare Rural	-	-	-	-	-	-	-	-	-	-	-	-	-
Manvame Rural	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Ruwa River S/B													
Harare City	-	-	5,050	-	-	5,050	-	-	-	-	-	-	-
Ruwa Local Board	40	7	84	7	657	795	5	-	-	2,740	137	-	2,877
Epworth Local Board	-	-	-	-	-	-	-	-	-	368	-	-	368
Gotomonzi Rural	-	-	-	-	-	-	-	-	-	244	-	-	244
Harare Rural	-	-	-	-	-	-	-	-	-	3,351	137	-	3,493
Total	40	7	5,134	7	657	5,845	5	-	-	3,351	137	-	3,493
3. Seke & Harava Dams S/B													
Epworth Local Board	-	-	-	-	-	-	-	-	-	296	15	-	311
Gotomonzi Rural	-	-	-	-	-	-	-	-	-	7	-	-	7
Harare Rural	-	-	-	-	-	-	-	-	-	448	-	-	448
Manvame Rural	-	-	-	-	-	-	-	-	-	58	-	-	58
Total	-	-	-	-	-	-	-	-	-	809	15	-	824
4. Nyatsime River S/B													
Chitungwiza Municipality	-	2,826	19,043	1,360	923	21,869	-	-	-	-	-	-	49
Manvame Rural	-	-	-	-	-	-	-	-	-	611	-	-	611
Marondera Rural	-	-	-	-	-	-	-	-	-	448	-	-	448
Total	-	2,826	19,043	1,360	923	21,869	-	-	-	1,059	-	49	1,108
5. Mukuvisi River S/B													
Harare City	11,908	12,815	30,118	50,107	32,210	137,159	8,548	-	-	-	-	325	8,873
Epworth Local Board	-	-	-	-	-	-	-	-	-	1,074	54	-	1,127
Harare Rural	-	-	-	-	-	-	-	-	-	111	-	-	111
Zvimba Rural	-	-	-	-	-	-	-	-	-	25	-	-	25
Total	11,908	12,815	30,118	50,107	32,210	137,159	8,548	-	-	1,209	54	325	10,137

Table 9.3.1 Estimated Wastewater Quantity by Sewered/Unsewered Area by Sub-basin (Present)

Sub-basin/District	Discharged Wastewater Quantity (m ³ /day)																					
	Sewered Area						Unsewered Area															
	Domestic			Com. & Inst.	Industrial	Total	Low	Domestic		Com. & Inst.	Industrial											
	Low	Medium	High					Medium	High													
6. Manyame River (D-stream) S/B	-	-	5,337	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Chitungwiza Municipality	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	608
Harare Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88
Manyame Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	696
Total	-	-	5,337	-	-	5,337	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	696
7. Mazimba River S/B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harare City	18,074	5,800	25,273	12,527	11,392	73,066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zvimba Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	157
Total	18,074	5,800	25,273	12,527	11,392	73,066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	157
8. Lake Chivero S/B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harare City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chegutu Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83
Manyame Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	121
Zvimba Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	279
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	483
9. Muzuru River S/B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zvimba Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	822
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	822
10. Gwebi River S/B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harare City	3,073	-	-	-	-	3,073	21,421	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21,421
Mazowe Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	745
Zvimba Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,193
Total	3,073	-	-	-	-	3,073	21,421	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23,359
11. Lake Manyame S/B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norton Town	83	60	1,228	89	735	2,195	407	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,451
Chegutu Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	362
Zvimba Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	735
Total	83	60	1,228	89	735	2,195	407	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,955
Grand Total	33,180	21,507	86,134	64,090	45,917	248,545	30,381	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47,731

Note: 1. Estimated population for year 1995 is based on Scenario - 2.
 2. Residential density is based on those shown in 12.2.3, Section 12.2, Chapter 2, Supporting Report
 3. Population in rural districts is categorised to high-density area.

Table 9.3.2 Present and Future Industrial Wastewater Quantity

Local Authority	Sub-Basin	Type No.	Type of Industry	Ratio of Employees (%)	Unit Wastewater (m ³ /day person)	Present		2000 Year		2005 Year		2015 Year			
						Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)		
Harare City	Marimba River Sub-Basin	1	Processed Foodstuffs	41.6	0.677	9,276	6,280	9,276	6,280	9,276	6,280	9,276	6,280		
		4	Pulp, Paper & Related Products	1.3	4.308	290	1,249	290	1,249	290	1,249	290	1,249		
		6	Chemicals	13.4	0.288	2,988	861	2,988	861	2,988	861	2,988	861		
		7	Plastic Products	5.0	0.083	1,115	93	1,115	93	1,115	93	1,115	93		
		11	Ceramics, Stone & Clay Products	8.2	0.833	1,829	1,524	1,829	1,524	1,829	1,524	1,829	1,524		
		14	Metal Products	20.0	0.218	4,460	972	4,460	972	4,460	972	4,460	972		
		17	Transportation Equipment	8.2	0.137	1,829	251	1,829	251	1,829	251	1,829	251		
		19	Other Industry Products	2.3	0.315	513	162	513	162	513	162	513	162		
			Total			100.0		22,300	11,392	22,300	11,392	22,300	11,392	22,300	
		Mukuvisi River Sub-Basin	1	Processed Foodstuffs	41.6	0.677	26,500	17,941	31,157	21,093	31,157	21,093	31,157	21,093	
			4	Pulp, Paper & Related Products	1.3	4.308	828	3,567	974	4,196	974	4,196	1,071	4,614	
			6	Chemicals	13.4	0.288	8,536	2,458	10,037	2,891	10,037	2,891	11,042	3,180	
			7	Plastic Products	5.0	0.083	3,185	264	3,745	311	3,745	311	4,120	342	
			11	Ceramics, Stone & Clay Products	8.2	0.833	5,223	4,351	6,142	5,116	6,142	5,116	6,757	5,629	
			14	Metal Products	20.0	0.218	12,740	2,777	14,980	3,266	14,980	3,266	16,480	3,593	
			17	Transportation Equipment	8.2	0.137	5,223	716	6,142	841	6,142	841	6,757	926	
			19	Other Industry Products	2.3	0.315	1,465	461	1,723	543	1,723	543	1,895	597	
				Total			100.0	63,700	32,535	74,900	38,257	74,900	38,257	82,400	42,087
			Ruwa River Sub-Basin	1	Processed Foodstuffs	41.6	0.677	0	0	0	0	0	0	0	20,883
4	Pulp, Paper & Related Products			1.3	4.308	0	0	0	0	0	0	0	653	2,813	
6	Chemicals			13.4	0.288	0	0	0	0	0	0	0	6,727	1,937	
7	Plastic Products			5.0	0.083	0	0	0	0	0	0	0	2,510	208	
11	Ceramics, Stone & Clay Products			8.2	0.833	0	0	0	0	0	0	0	4,116	3,429	
14	Metal Products			20.0	0.218	0	0	0	0	0	0	0	10,040	2,189	
17	Transportation Equipment			8.2	0.137	0	0	0	0	0	0	0	4,116	564	
19	Other Industry Products			2.3	0.315	0	0	0	0	0	0	0	1,155	364	
	Total					100.0	0	0	0	0	0	0	50,200	25,642	

Table 9.3.2 Present and Future Industrial Wastewater Quantity (cont'd)

Local Authority	Sub-Basin	Type No.	Type of Industry	Ratio of Employees (%)	Unit Wastewater (m ³ /day person)	Present		2000 Year		2005 Year		2015 Year			
						Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)		
Harare City	Manyame River Sub-Basin	1	Processed Foodstuffs	41.6	0.677	0	0	1,248	845	32,198	21,798	32,198	21,798		
		4	Pulp, Paper & Related Products	1.3	4.308	0	0	39	168	1,006	4,334	1,006	4,334		
		6	Chemicals	13.4	0.288	0	0	402	116	10,372	2,987	10,372	2,987		
		7	Plastic Products	5.0	0.083	0	0	150	12	3,870	321	3,870	321		
		11	Ceramics, Stone & Clay Products	8.2	0.833	0	0	246	205	6,347	5,287	6,347	5,287		
		14	Metal Products	20.0	0.218	0	0	600	131	15,480	3,375	15,480	3,375		
		17	Transportation Equipment	8.2	0.137	0	0	246	34	6,347	870	6,347	870		
		19	Other Industry Products	2.3	0.315	0	0	69	22	1,780	561	1,780	561		
			Total			100.0		0	0	3,000	1,533	77,400	39,533	77,400	39,533
			Total			41.6	0.677	35,776	24,221	41,681	28,218	72,631	49,171	96,635	65,422
				4	Pulp, Paper & Related Products	1.3	4.308	1,118	4,816	1,303	5,613	2,270	9,779	3,020	13,010
				6	Chemicals	13.4	0.288	11,524	3,319	13,427	3,868	23,397	6,739	31,129	8,965
				7	Plastic Products	5.0	0.083	4,300	357	5,010	416	8,730	725	11,615	964
				11	Ceramics, Stone & Clay Products	8.2	0.833	7,052	5,875	8,217	6,845	14,318	11,927	19,049	15,869
				14	Metal Products	20.0	0.218	17,200	3,749	20,040	4,369	34,920	7,613	46,460	10,129
				17	Transportation Equipment	8.2	0.137	7,052	967	8,217	1,126	14,318	1,962	19,049	2,611
				19	Other Industry Products	2.3	0.315	1,978	623	2,305	727	4,016	1,266	5,343	1,684
			Total			100.0		86,000	43,927	100,200	51,182	174,600	89,182	232,300	118,654

Table 9.3.2 Present and Future Industrial Wastewater Quantity (cont'd)

Local Authority	Sub-Basin	Type No.	Type of Industry	Ratio of Employees (%)	Unit Wastewater (m ³ /day person)	Present		2000 Year		2005 Year		2015 Year		
						Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	
Chitungwiza Municipality	Nyatsime River Sub-Basin	1	Processed Foodstuffs	42.0	0.677	1,048	709	1,301	881	1,512	1,024	11,592	7,848	
		7	Plastic Products	1.3	0.083	33	3	40	3	47	4	359	30	
		11	Ceramics, Stone & Clay Products	1.5	0.833	38	32	47	39	54	45	414	345	
		14	Metal Products	4.7	0.218	118	26	146	32	169	37	1,297	283	
		17	Transportation Equipment	43.9	0.137	1,098	150	1,361	186	1,580	216	12,116	1,660	
		19	Other Industry Products	6.6	0.315	165	52	205	65	238	75	1,822	574	
			Subtotal	100.0		2,500	972	3,100	1,206	3,600	1,401	27,600	10,740	
		Manyame River Sub-Basin	1	Processed Foodstuffs	42.0	0.677	0	0	0	0	0	0	2,184	1,479
			7	Plastic Products	1.3	0.083	0	0	0	0	0	0	68	6
	11		Ceramics, Stone & Clay Products	1.5	0.833	0	0	0	0	0	0	78	65	
	14		Metal Products	4.7	0.218	0	0	0	0	0	0	244	53	
	17		Transportation Equipment	43.9	0.137	0	0	0	0	0	0	2,283	313	
	19		Other Industry Products	6.6	0.315	0	0	0	0	0	0	343	108	
			Subtotal	100.0		0	0	0	0	0	0	5,200	2,024	
	Total		1	Processed Foodstuffs	42.0	0.677	1,048	709	1,301	881	1,512	1,024	13,776	9,327
			7	Plastic Products	1.3	0.083	33	3	40	3	47	4	427	36
		11	Ceramics, Stone & Clay Products	1.5	0.833	38	32	47	39	54	45	492	410	
		14	Metal Products	4.7	0.218	118	26	146	32	169	37	1,541	336	
		17	Transportation Equipment	43.9	0.137	1,098	150	1,361	186	1,580	216	14,399	1,973	
19		Other Industry Products	6.6	0.315	165	52	205	65	238	75	2,165	682		
		Total	100.0		2,500	972	3,100	1,206	3,600	1,401	32,800	12,764		

Table 9.3.2 Present and Future Industrial Wastewater Quantity (cont'd)

Local Authority	Sub-Basin	Type No.	Type of Industry	Ratio of Employees (%)	Unit Wastewater (m ³ /day person)	Present		2000 Year		2005 Year		2015 Year			
						Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)	Number of Employees	Wastewater Quantity (m ³ /day)		
Norton Town Council	Lake Manyame Sub-Basin	1	Processed Foodstuffs	10.1	0.677	303	205	333	225	495	335	1,555	1,053		
		4	Pulp, Paper & Related Products	26.7	4.308	801	3,451	881	3,795	1,308	5,635	4,112	17,714		
		6	Chemicals	1.2	0.288	36	10	40	12	59	17	185	53		
		11	Ceramics, Stone & Clay Products	2.5	0.833	75	62	83	69	123	102	385	321		
		14	Metal Products	22.4	0.218	672	146	739	161	1,098	239	3,450	752		
		17	Transportation Equipment	7.3	0.157	219	30	241	33	358	49	1,124	154		
		19	Other Industry Products	29.8	0.315	894	282	983	310	1,459	460	4,589	1,446		
			Total	100.0		3,000	4,186	3,300	4,605	4,900	6,837	15,400	21,493		
		Ruwa Local Board	Ruwa River Sub-Basin	1	Processed Foodstuffs	5.3	0.677	122	83	493	334	658	445	859	582
				6	Chemicals	2.6	0.288	60	17	242	70	322	93	421	121
7	Plastic Products			19.1	0.083	439	36	1,776	147	2,368	197	3,094	257		
11	Ceramics, Stone & Clay Products			1.5	0.833	35	29	140	117	186	155	243	202		
14	Metal Products			11.4	0.218	262	57	1,060	231	1,414	308	1,847	403		
19	Other Industry Products			60.1	0.315	1,382	435	5,589	1,761	7,452	2,347	9,736	3,067		
	Total	100.0		2,300	657	9,300	2,660	12,400	3,545	16,200	4,632				

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)					Present					Year 2000							
				BOD		COD		SS	T-N		T-P		Employees		Industrial Wastewater Pollution Load (kg/day)		Employees		Industrial Wastewater Pollution Load (kg/day)		
				BOD	COD	SS	T-N	T-P	Number of	BOD	COD	SS	T-N	T-P	Number of	BOD	COD	SS	T-N	T-P	
Harare City	Marimba River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	9,276	8,958	18,574	2,792	232	89	9,276	8,958	18,574	2,792	232	89	
		4	1.3	9,800	41,871	2,145	163.69	26.71	290	2,842	12,143	622	47	8	290	2,842	12,143	622	47	8	
		6	13.4	106	840	306	6.30	1.73	2,988	317	2,511	915	19	5	2,988	317	2,511	915	19	5	
		7	5.0	23	242	1,954	0.27	0.08	1,115	26	270	2,178	0	0	1,115	26	270	2,178	0	0	
		11	8.2	91	66	682	13.89	2.26	1,829	166	121	1,247	25	4	1,829	166	121	1,247	25	4	
		14	20.0	61	208	93	6.92	0.66	4,460	271	930	414	31	3	4,460	271	930	414	31	3	
		17	8.2	70	392	81	3.54	4.90	1,829	128	717	149	6	9	1,829	128	717	149	6	9	
		19	2.3	230	887	397	56.04	6.51	513	118	455	203	29	3	513	118	455	203	29	3	
				100.0					22,300	12,826	35,721	8,520	389	121	22,300	12,826	35,721	8,520	389	121	
		Mukuvisi River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	26,500	25,592	53,062	7,977	664	255	31,157	30,090	62,387	9,378	781	299
			4	1.3	9,800	41,871	2,145	163.69	26.71	828	8,114	34,669	1,776	136	22	974	9,545	40,782	2,089	159	26
			6	13.4	106	840	306	6.30	1.73	8,536	907	7,173	2,613	54	15	10,037	1,066	8,435	3,073	63	17
			7	5.0	23	242	1,954	0.27	0.08	3,185	75	770	6,272	1	0	3,745	88	905	7,316	1	0
			11	8.2	91	66	682	13.89	2.26	5,223	473	346	3,562	73	12	6,142	556	407	4,189	85	14
			14	20.0	61	208	93	6.92	0.66	12,740	775	2,656	1,184	88	8	14,980	911	3,123	1,392	104	10
			17	8.2	70	392	81	3.54	4.90	5,223	365	2,048	425	18	26	6,142	429	2,409	499	22	30
		19	2.3	230	887	397	56.04	6.51	1,465	337	1,299	581	82	10	1,723	396	1,528	683	97	11	
				100.0					63,700	36,638	102,023	24,340	1,116	348	74,900	43,081	119,976	28,619	1,312	407	

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)					Present Industrial Wastewater Pollution Load (kg/day)					Year 2000 Industrial Wastewater Pollution Load (kg/day)						
				BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P
Harare City	Ruwa River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	0	0	0	0	0	0	0	0	0	0	0	
		4	1.3	9,800	41,871	2,145	163.69	26.71	0	0	0	0	0	0	0	0	0	0	0	
		6	13.4	106	840	306	6.30	1.73	0	0	0	0	0	0	0	0	0	0	0	
		7	5.0	23	242	1,954	0.27	0.08	0	0	0	0	0	0	0	0	0	0	0	
		11	8.2	91	66	682	13.89	2.26	0	0	0	0	0	0	0	0	0	0	0	
		14	20.0	61	208	93	6.92	0.66	0	0	0	0	0	0	0	0	0	0	0	
		17	8.2	70	392	81	3.54	4.90	0	0	0	0	0	0	0	0	0	0	0	
		19	2.3	230	887	397	56.04	6.51	0	0	0	0	0	0	0	0	0	0	0	
		100.0																		
		Manyame River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	0	0	0	0	0	0	0	0	0	0	0
			4	1.3	9,800	41,871	2,145	163.69	26.71	0	0	0	0	0	0	0	0	0	0	0
			6	13.4	106	840	306	6.30	1.73	0	0	0	0	0	0	0	0	0	0	0
			7	5.0	23	242	1,954	0.27	0.08	0	0	0	0	0	0	0	0	0	0	0
			11	8.2	91	66	682	13.89	2.26	0	0	0	0	0	0	0	0	0	0	0
			14	20.0	61	208	93	6.92	0.66	0	0	0	0	0	0	0	0	0	0	0
			17	8.2	70	392	81	3.54	4.90	0	0	0	0	0	0	0	0	0	0	0
			19	2.3	230	887	397	56.04	6.51	0	0	0	0	0	0	0	0	0	0	0
			100.0																	
			Total	1	41.6	966	2,002	301	25.06	9.61	35,776	34,550	71,636	10,769	896	344	41,681	40,253	83,460	12,546
4	1.3			9,800	41,871	2,145	163.69	26.71	1,118	10,956	46,812	2,398	183	30	1,303	12,769	54,558	2,795	212	35
6	13.4			106	840	306	6.30	1.73	11,524	1,224	9,684	3,528	73	20	13,427	1,426	11,284	4,111	85	23
7	5.0			23	242	1,954	0.27	0.08	4,300	101	1,040	8,400	1	0	5,010	118	1,211	9,787	1	0
11	8.2			91	66	682	13.89	2.26	7,052	639	467	4,809	98	16	8,217	744	544	5,604	113	19
14	20.0			61	208	93	6.92	0.66	17,200	1,046	3,586	1,598	119	11	20,040	1,218	4,178	1,862	139	13
17	8.2			70	392	81	3.54	4.90	7,052	493	2,765	574	24	35	8,217	574	3,222	668	29	40
19	2.3			230	887	397	56.04	6.51	1,978	455	1,754	784	111	13	2,505	530	2,044	913	130	14
100.0									86,000	49,464	137,744	32,860	1,505	469	100,200	57,632	160,501	38,286	1,753	544

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)					Present					Year 2000								
				BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P		
																					Industrial Wastewater Pollution Load (kg/day)	Industrial Wastewater Pollution Load (kg/day)
Chitungwiza Municipality	Nyatsime River Sub-Basin	1	42.0	966	2,002	301	25.06	9.61	1,048	1,012	2,098	315	26	10	1,301	1,256	2,605	392	33	13		
		7	1.3	23	242	1,954	0.27	0.08	33	1	8	64	0	0	0	40	1	10	78	0	0	
		11	1.5	91	66	682	13.89	2.26	38	3	3	26	1	1	0	47	4	3	32	1	0	
		14	4.7	61	208	93	6.92	0.66	118	7	25	11	1	0	0	146	9	30	14	1	0	
		17	43.9	70	392	81	3.54	4.90	1,098	77	431	89	4	5	1,361	95	534	111	5	7		
		19	6.6	230	887	397	56.04	6.51	165	38	146	65	9	1	205	47	182	81	11	1		
					100.0				2,500	1,138	2,711	570	41	16	3,100	1,412	3,364	708	51	21		
		Manyame River Sub-Basin	1	42.0	966	2,002	301	25.06	9.61	0	0	0	0	0	0	0	0	0	0	0	0	
			7	1.3	23	242	1,954	0.27	0.08	0	0	0	0	0	0	0	0	0	0	0	0	
			11	1.5	91	66	682	13.89	2.26	0	0	0	0	0	0	0	0	0	0	0	0	
			14	4.7	61	208	93	6.92	0.66	0	0	0	0	0	0	0	0	0	0	0	0	
			17	43.9	70	392	81	3.54	4.90	0	0	0	0	0	0	0	0	0	0	0	0	
			19	6.6	230	887	397	56.04	6.51	0	0	0	0	0	0	0	0	0	0	0	0	
						100.0				0	0	0	0	0	0	0	0	0	0	0	0	
			Total	1	42.0	966	2,002	301	25.06	9.61	1,048	1,012	2,098	315	26	10	1,301	1,256	2,605	392	33	13
				7	1.3	23	242	1,954	0.27	0.08	33	1	8	64	0	0	0	40	1	10	78	0
				11	1.5	91	66	682	13.89	2.26	38	3	3	26	1	1	0	47	4	3	32	1
				14	4.7	61	208	93	6.92	0.66	118	7	25	11	1	0	146	9	30	14	1	
				17	43.9	70	392	81	3.54	4.90	1,098	77	431	89	4	5	1,361	95	534	111	5	
19	6.6			230	887	397	56.04	6.51	165	38	146	65	9	1	205	47	182	81	11			
				100.0				2,500	1,138	2,711	570	41	16	3,100	1,412	3,364	708	51	21			

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)					Present					Year 2000								
				BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P		
																					Industrial Wastewater Pollution Load (kg/day)	Industrial Wastewater Pollution Load (kg/day)
Norton Town Council	Lake Manyara Sub-Basin	1	10.1	966	2,002	301	25.06	9.61	303	293	607	91	8	3	333	322	667	100	8	3		
		4	26.7	9,800	41,871	2,145	163.69	26.71	801	7,850	33,539	1,718	131	21	881	8,634	36,888	1,890	144	24		
		6	1.2	106	840	306	6.30	1.73	36	4	30	11	0	0	40	4	34	12	0	0		
		11	2.5	91	66	682	13.89	2.26	75	7	5	51	1	0	83	8	5	57	1	0		
		14	22.4	61	208	93	6.92	0.66	672	41	140	62	5	0	739	45	154	69	5	0		
		17	7.3	70	392	81	3.54	4.90	219	15	86	18	1	1	241	17	95	20	1	1		
		19	29.8	230	887	397	56.04	6.51	894	206	793	355	50	6	983	226	872	390	55	6		
					100.0				3,000	8,416	35,200	2,306	196	31	3,300	9,256	38,715	2,538	214	34		
		Ruwa Local Board	Ruwa River Sub-Basin	1	5.3	966	2,002	301	25.06	9.61	122	118	244	37	3	1	493	476	987	148	12	5
				6	2.6	106	840	306	6.30	1.73	60	6	50	18	0	0	242	26	203	74	2	0
				7	19.1	23	242	1,954	0.27	0.08	439	10	106	858	0	0	1,776	42	429	3,470	0	0
				11	1.5	91	66	682	13.89	2.26	35	3	2	24	0	0	140	13	9	95	2	0
				14	11.4	61	208	93	6.92	0.66	262	16	55	24	2	0	1,060	64	221	99	7	1
				19	60.1	230	887	397	56.04	6.51	1,382	318	1,226	548	77	9	5,389	1,286	4,957	2,217	313	36
							100.0				2,300	471	1,683	1,509	82	10	9,300	1,907	6,806	6,103	336	42

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)					Year 2005					Year 2015							
				BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P	
																					Industrial Wastewater Pollution Load (kg/day)
Harare City	Marimba River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	9,276	8,958	18,574	2,792	232	89	9,276	8,958	18,574	2,792	232	89	
		4	1.3	9,800	41,871	2,145	163.69	26.71	290	2,842	12,143	622	47	8	290	2,842	12,143	622	47	8	
		6	13.4	106	840	306	6.30	1.73	2,988	317	2,511	915	19	5	2,988	317	2,511	915	19	5	
		7	5.0	23	242	1,954	0.27	0.08	1,115	26	270	2,178	0	0	1,115	26	270	2,178	0	0	
		11	8.2	91	66	682	13.89	2.26	1,829	166	121	1,247	25	4	1,829	166	121	1,247	25	4	
		14	20.0	61	208	93	6.92	0.66	4,460	271	930	414	31	3	4,460	271	930	414	31	3	
		17	8.2	70	392	81	3.54	4.90	1,829	128	717	149	6	9	1,829	128	717	149	6	9	
		19	2.3	230	887	397	56.04	6.51	513	118	455	203	29	3	513	118	455	203	29	3	
					100.0					22,300	12,826	35,721	8,520	389	121	22,300	12,826	35,721	8,520	389	121
		Mukwisi River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	31,157	30,090	62,387	9,378	781	299	34,278	33,104	68,636	10,318	859	329
			4	1.3	9,800	41,871	2,145	163.69	26.71	974	9,545	40,782	2,089	159	26	1,071	10,496	44,844	2,298	175	29
			6	13.4	106	840	306	6.30	1.73	10,037	1,066	8,435	3,073	63	17	11,042	1,173	9,279	3,381	70	19
			7	5.0	23	242	1,954	0.27	0.08	3,745	88	905	7,316	1	0	4,120	97	996	8,049	1	0
			11	8.2	91	66	682	13.89	2.26	6,142	556	407	4,189	85	14	6,757	612	447	4,608	94	15
			14	20.0	61	208	93	6.92	0.66	14,980	911	3,123	1,392	104	10	16,480	1,002	3,436	1,531	114	11
			17	8.2	70	392	81	3.54	4.90	6,142	429	2,409	499	22	30	6,757	472	2,650	549	24	33
		19	2.3	230	887	397	56.04	6.51	1,723	396	1,528	683	97	11	1,895	436	1,681	752	106	12	
					100.0					74,900	43,081	119,976	28,619	1,312	407	82,400	47,392	131,969	31,486	1,443	448

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)				Year 2005 Industrial Wastewater Pollution Load (kg/day)				Year 2015 Industrial Wastewater Pollution Load (kg/day)										
				BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P	Employees	BOD	COD	SS	T-N	T-P		
Harare City	Ruwa River Sub-Basin	1	41.6	966	2,002	301	25.06	9.61	0	0	0	0	0	20,883	20,168	41,815	6,286	523	201			
		4	1.3	9,800	41,871	2,145	163.69	26.71	0	0	0	0	0	653	6,399	27,342	1,401	107	17			
		6	13.4	106	840	306	6.30	1.73	0	0	0	0	0	6,727	715	5,653	2,059	42	12			
		7	5.0	23	242	1,954	0.27	0.08	0	0	0	0	0	2,510	59	607	4,903	1	0			
		11	8.2	91	66	682	13.89	2.26	0	0	0	0	0	4,116	373	272	2,807	57	9			
		14	20.0	61	208	93	6.92	0.66	0	0	0	0	0	10,040	610	2,093	933	70	7			
		17	8.2	70	392	81	3.54	4.90	0	0	0	0	0	4,116	287	1,614	335	15	20			
		19	2.3	230	887	397	56.04	6.51	0	0	0	0	0	1,155	266	1,024	458	65	8			
		100.0																				
		Manyame River Sub-Basin		1	41.6	966	2,002	301	25.06	9.61	32,198	31,095	64,471	9,692	807	309	32,198	31,095	64,471	9,692	807	309
				4	1.3	9,800	41,871	2,145	163.69	26.71	1,006	9,859	42,122	2,158	165	27	1,006	9,859	42,122	2,158	165	27
				6	13.4	106	840	306	6.30	1.73	10,372	1,102	8,716	3,175	65	18	10,372	1,102	8,716	3,175	65	18
				7	5.0	23	242	1,954	0.27	0.08	3,870	91	936	7,560	1	0	3,870	91	936	7,560	1	0
				11	8.2	91	66	682	13.89	2.26	6,347	575	420	4,328	88	14	6,347	575	420	4,328	88	14
				14	20.0	61	208	93	6.92	0.66	15,480	941	3,227	1,438	107	10	15,480	941	3,227	1,438	107	10
				17	8.2	70	392	81	3.54	4.90	6,347	443	2,489	516	22	31	6,347	443	2,489	516	22	31
				19	2.3	230	887	397	56.04	6.51	1,780	410	1,579	706	100	12	1,780	410	1,579	706	100	12
				100.0							77,400	44,516	123,960	29,573	1,355	421	77,400	44,516	123,960	29,573	1,355	421
				Total		1	41.6	966	2,002	301	25.06	9.61	72,631	70,143	145,432	21,862	1,820	697	96,635	93,325	193,496	29,088
4	1.3					9,800	41,871	2,145	163.69	26.71	2,270	22,246	95,047	4,869	371	61	3,020	29,596	126,451	6,479	494	81
6	13.4					106	840	306	6.30	1.73	23,397	2,485	19,662	7,163	147	40	31,129	3,307	26,159	9,530	196	54
7	5.0					23	242	1,954	0.27	0.08	8,730	205	2,111	17,054	2	0	11,615	273	2,809	22,690	3	0
11	8.2					91	66	682	13.89	2.26	14,318	1,297	948	9,764	198	32	19,049	1,726	1,260	12,990	264	42
14	20.0					61	208	93	6.92	0.66	34,920	2,123	7,280	3,244	242	23	46,460	2,824	9,686	4,316	322	31
17	8.2					70	392	81	3.54	4.90	14,318	1,000	5,615	1,164	50	70	19,049	1,330	7,470	1,549	67	93
19	2.3					230	887	397	56.04	6.51	4,016	924	3,562	1,592	226	26	5,345	1,230	4,739	2,119	300	35
100.0											174,600	100,423	279,657	66,712	3,056	949	232,300	133,611	372,070	88,761	4,067	1,264

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)						Year 2005						Year 2015										
				BOD		COD		SS		T-N		T-P		Employees		BOD		COD		SS		T-N		T-P		
				g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	g/day	kg/day	
Chitungwiza Municipality	Nyatsime River Sub-Basin	1	42.0	966	2,002	301	25.06	9.61	1,512	1,460	3,028	455	38	15	11,592	11,195	23,211	3,489	290	111	0	0	0	0		
		7	1.3	23	242	1,954	0.27	0.08	47	1	11	92	0	0	0	359	8	87	701	0	0	0	0	0		
		11	1.5	91	66	682	13.89	2.26	54	5	4	37	1	1	0	414	38	27	282	6	1	0	0	0		
		14	4.7	61	208	93	6.92	0.66	169	10	35	16	1	0	1,297	79	270	121	9	1	0	0	0	0		
		17	43.9	70	392	81	3.54	4.90	1,580	110	620	128	6	8	12,116	846	4,752	985	43	59	0	0	0	0	0	
		19	6.6	230	887	397	56.04	6.51	238	55	211	94	13	2	1,822	419	1,616	723	102	12	0	0	0	0	0	
			100.0						3,600	1,641	3,909	822	59	25	27,600	12,585	29,963	6,301	450	184	0	0	0	0	0	
		Manyame River Sub-Basin	1	42.0	966	2,002	301	25.06	9.61	0	0	0	0	0	0	0	2,184	2,109	4,373	657	55	21	0	0	0	
			7	1.3	23	242	1,954	0.27	0.08	0	0	0	0	0	0	0	68	2	16	133	0	0	0	0	0	
			11	1.5	91	66	682	13.89	2.26	0	0	0	0	0	0	78	7	5	53	1	0	0	0	0	0	
			14	4.7	61	208	93	6.92	0.66	0	0	0	0	0	0	244	15	51	23	2	0	0	0	0	0	
			17	43.9	70	392	81	3.54	4.90	0	0	0	0	0	0	2,283	159	895	186	8	11	0	0	0	0	
			19	6.6	230	887	397	56.04	6.51	0	0	0	0	0	0	343	79	304	136	19	2	0	0	0	0	
			100.0						0	0	0	0	0	0	5,200	2,371	5,644	1,188	85	34	0	0	0	0	0	
		Total	1	42.0	966	2,002	301	25.06	9.61	1,512	1,460	3,028	455	38	15	13,776	13,304	27,584	4,146	345	132	0	0	0	0	0
			7	1.3	23	242	1,954	0.27	0.08	47	1	11	92	0	0	0	427	10	103	834	0	0	0	0	0	
			11	1.5	91	66	682	13.89	2.26	54	5	4	37	1	1	0	492	45	32	335	7	1	0	0	0	
			14	4.7	61	208	93	6.92	0.66	169	10	35	16	1	0	1,541	94	321	144	11	1	0	0	0	0	
			17	43.9	70	392	81	3.54	4.90	1,580	110	620	128	6	8	14,399	1,005	5,647	1,171	51	70	0	0	0	0	0
19	6.6		230	887	397	56.04	6.51	238	55	211	94	13	2	2,165	498	1,920	859	121	14	0	0	0	0	0		
	100.0						3,600	1,641	3,909	822	59	25	32,800	14,956	35,607	7,489	535	218	0	0	0	0	0	0		

Table 9.3.3 Present and Future Industrial Wastewater Pollution Load (cont'd)

Local Authority	Sub-Basin	No. of Industrial Type	Ratio of Employees (%)	Unit Wastewater Quality (g/day/person)				Year 2005						Year 2015								
				BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P	Number of Employees	BOD	COD	SS	T-N	T-P		
																					Industrial Wastewater Pollution Load (kg/day)	Industrial Wastewater Pollution Load (kg/day)
Norton Town Council	Lake Manyame Sub-Basin	1	10.1	966	2,002	301	25.06	9.61	495	478	991	149	12	5	1,555	1,502	3,114	468	39	15		
		4	26.7	9,800	41,871	2,145	163.69	26.71	1,308	12,818	54,767	2,806	214	35	4,112	40,298	172,173	8,821	673	110		
		6	1.2	106	840	306	6.30	1.73	59	6	50	18	0	0	185	20	155	57	1	0		
		11	2.5	91	66	682	13.89	2.26	123	11	8	84	2	0	385	35	25	263	5	1		
		14	22.4	61	208	93	6.92	0.66	1,098	67	229	102	8	1	3,450	210	719	321	24	2		
		17	7.3	70	392	81	3.54	4.90	358	25	140	29	1	2	1,124	78	441	91	4	6		
		19	29.8	230	887	397	56.04	6.51	1,459	356	1,294	579	82	9	4,589	1,056	4,070	1,820	257	30		
					100.0				4,900	13,741	57,479	3,767	319	52	15,400	43,199	180,697	11,841	1,003	164		
		Ruwa Local Board	Ruwa River Sub-Basin	1	5.3	966	2,002	301	25.06	9.61	658	635	1,318	198	16	6	859	830	1,720	259	22	8
				6	2.6	106	840	306	6.30	1.73	322	34	271	99	2	1	421	45	354	129	3	1
				7	19.1	23	242	1,954	0.27	0.08	2,368	56	572	4,626	1	0	3,094	73	748	6,044	1	0
				11	1.5	91	66	682	13.89	2.26	186	17	12	127	3	0	243	22	16	166	3	1
				14	11.4	61	208	93	6.92	0.66	1,414	86	295	131	10	1	1,847	112	385	172	13	1
				19	60.1	230	887	397	56.04	6.51	7,452	1,715	6,609	2,955	418	48	9,756	2,240	8,635	3,861	546	63
							100.0				12,400	2,543	9,077	8,136	450	56	16,200	3,322	11,858	10,631	588	74

Table 9.3.4 Pollution Load of Cattle (Present)

(unit: kg/head/day, kg/day)

Sub-basin	No. of head	BOD			COD			T-N			T-P		
		Generated	Concent'd	Cnc'd (dry)	Generated	Concent'd	Concent'd	Generated	Concent'd	Concent'd	Generated	Concent'd	Concent'd
Manyame R. (U/S)	12,140	7,769	622	50	15,539	1,243	4,589	367	0.03024	0.056	680	54	
Ruwa River	5,955	3,811	305	24	7,623	610	2,251	180		333	27		
Seke & Harava D.	5,051	3,233	259	21	6,465	517	1,909	153		283	23		
Nyatsime River	20,530	13,139	1,051	84	26,278	2,102	7,760	621		1,150	92		
Mukwisi River	1,674	1,072	86	7	2,143	171	633	51		94	8		
Manyame R. (D/S)	3,994	2,556	204	16	5,112	409	1,510	121		224	18		
Manimba River	1,565	1,002	80	6	2,004	160	592	47		88	7		
Lake Chivero	6,507	4,165	333	27	8,330	666	2,460	197		364	29		
Muzuru River	22,406	14,340	1,147	92	28,679	2,294	8,469	678		1,255	100		
Gwebi River	44,720	28,621	2,290	183	57,242	4,579	16,904	1,352		2,504	200		
Lake Manyame	10,265	6,570	526	42	13,139	1,051	3,880	310		575	46		
Study Area Total	134,808	86,277	6,902	552	172,554	13,804	50,957	4,077		7,549	604		

Note: Concentration ratio = 8%

Table 9.3.5 Pollution Load of Sheep/Goats (Present)

(unit: kg/head/day, kg/day)

Sub-basin	No. of head	BOD			COD			T-N			T-P		
		Generated	Concent'd	Cnc'd (dry)	Generated	Concent'd	Concent'd	Generated	Concent'd	Concent'd	Generated	Concent'd	Concent'd
Manyame R. (U/S)	3,106	199	0.00512	0.0004096	398	0.01024	32	0.038	0.00304	9	0.006	19	0.00048
Ruwa River	1,036	66	5	0	133	11	39	3	6	0	0	0	0
Seke & Harava D.	709	45	4	0	91	7	27	2	4	0	0	0	0
Nyatsime River	5,057	324	26	2	647	52	192	15	30	2	2	30	2
Mukuvisi River	268	17	1	0	34	3	10	1	2	0	0	2	0
Manyame R. (D/S)	472	30	2	0	60	5	18	1	3	0	0	3	0
Marimba River	250	16	1	0	32	3	10	1	2	0	0	2	0
Lake Chivero	829	53	4	0	106	8	32	3	5	0	0	5	0
Muzuru River	1,876	120	10	1	240	19	71	6	11	1	1	11	1
Gwebi River	2,961	189	15	1	379	30	113	9	18	1	1	18	1
Lake Manyame	624	40	3	0	80	6	24	2	4	0	0	4	0
Study Area Total	17,188	1,100	88	7	2,200	176	653	52	103	8	8	103	8

Note: Concentration ratio = 8%

Table 9.3.6 Pollution Load of Pigs (Present)

(unit: kg/head/day, kg/day)

Sub-basin	No. of head	BOD			COD			T-N			T-P		
		Generated	Concent'd	Cnc'd (drv)	Generated	Concent'd	Generated	Concent'd	Generated	Concent'd	Generated	Concent'd	
		0.200	0.016	0.00128	0.400	0.032	0.040	0.0032	0.025	0.002			
Manyame R. (U/S)	1,280	256	20	2	512	41	51	4	32	3			
Ruva River	915	183	15	1	366	29	37	3	23	2			
Seke & Harava D.	265	53	4	0	106	8	11	1	7	1			
Nyatsime River	928	186	15	1	371	30	37	3	23	2			
Mukuvisi River	191	38	3	0	76	6	8	1	5	0			
Manyame R. (D/S)	189	38	3	0	76	6	8	1	5	0			
Marimba River	179	36	3	0	72	6	7	1	4	0			
Lake Chivero	591	118	9	1	236	19	24	2	15	1			
Muzuru River	4,678	936	75	6	1,871	150	187	15	117	9			
Gwebi River	10,346	2,069	166	13	4,139	331	414	33	259	21			
Lake Manyame	1,313	263	21	2	525	42	53	4	33	3			
Study Area Total	20,876	4,175	334	27	8,350	668	835	67	522	42			

Note: Concentration ratio = 8%

Table 9.3.7 Pollution Load of Horses (Present)

(unit: kg/head/day, kg/day)

Sub-basin	No. of head	BOD			COD		T-N		T-P	
		Generated	Concent'd	Cnc'd (dry)	Generated	Concent'd	Generated	Concent'd	Generated	Concent'd
Manyame R. (U/S)	91	20	2	0	40	3	16	1	4	0
Ruwa River	237	52	4	0	104	8	40	3	9	1
Seke & Harava D.	94	21	2	0	41	3	16	1	4	0
Nyatsime River	31	7	1	0	14	1	5	0	1	0
Mukuvisi River	92	20	2	0	40	3	16	1	4	0
Manyame R. (D/S)	67	15	1	0	30	2	11	1	3	0
Marimba River	86	19	2	0	38	3	15	1	3	0
Lake Chivero	277	61	5	0	122	10	47	4	11	1
Muzuru River	472	104	8	1	208	17	80	6	19	2
Gwebi River	594	151	10	1	261	21	101	8	24	2
Lake Manyame	149	33	3	0	65	5	25	2	6	0
Study Area Total	2,190	482	39	3	964	77	372	30	88	7

Note: Concentration ratio = 8%

Table 9.3.8 Correlation between BOD and COD of River Water

Sampling Point	COD	BOD
R1	28.40	1.10
R2	11.40	0.60
R3	11.40	1.00
R4	22.70	2.10
R5	34.10	3.80
R6	17.00	2.00
R7	54.00	8.70
R8	24.10	0.50
R9	22.70	1.60

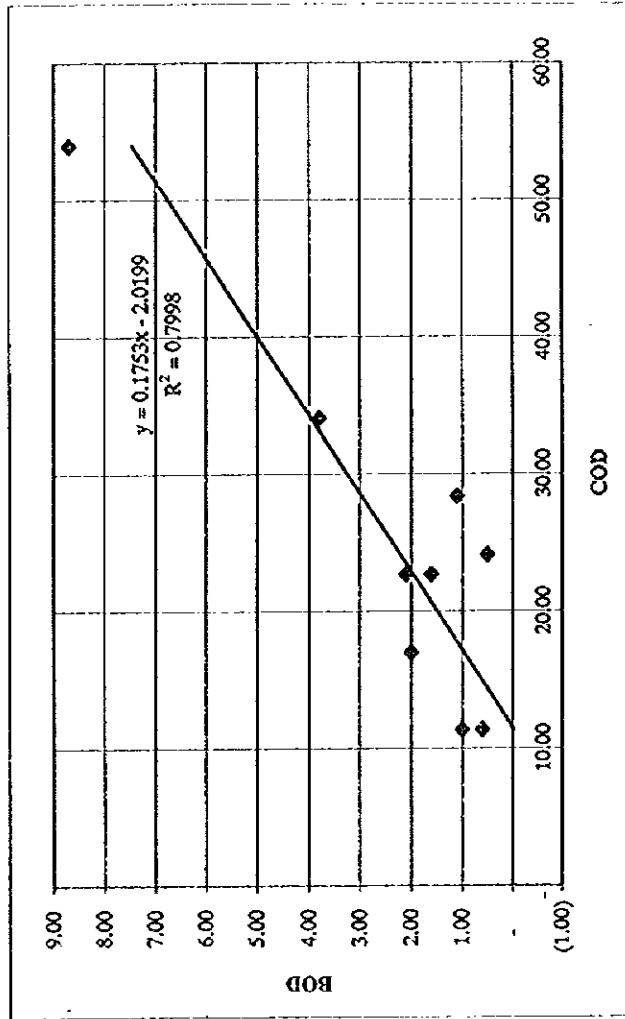


Table 9.3.9 Correlation between T-P and P-P of Raw & Treated Sewage

	P-P	T-P
Crowborough Raw	4.30	5.00
Crow. TF Effluent	2.40	5.70
Crow. BNR Effluent	0.80	1.48
Firle Raw	1.10	4.80
Firle TF Effluent	3.90	5.30
Firle BNR Effluent	0.00	0.01
Donnybrook Raw	1.80	1.88
Donny. Effluent	7.50	9.40
Zengeza Raw	10.00	17.40
Zengeza Effluent	10.00	16.60
Norton Raw	2.70	4.60
Norton Effluent	4.50	7.60
Ruwa Raw	1.92	2.52
Ruwa Effluent	1.20	2.16

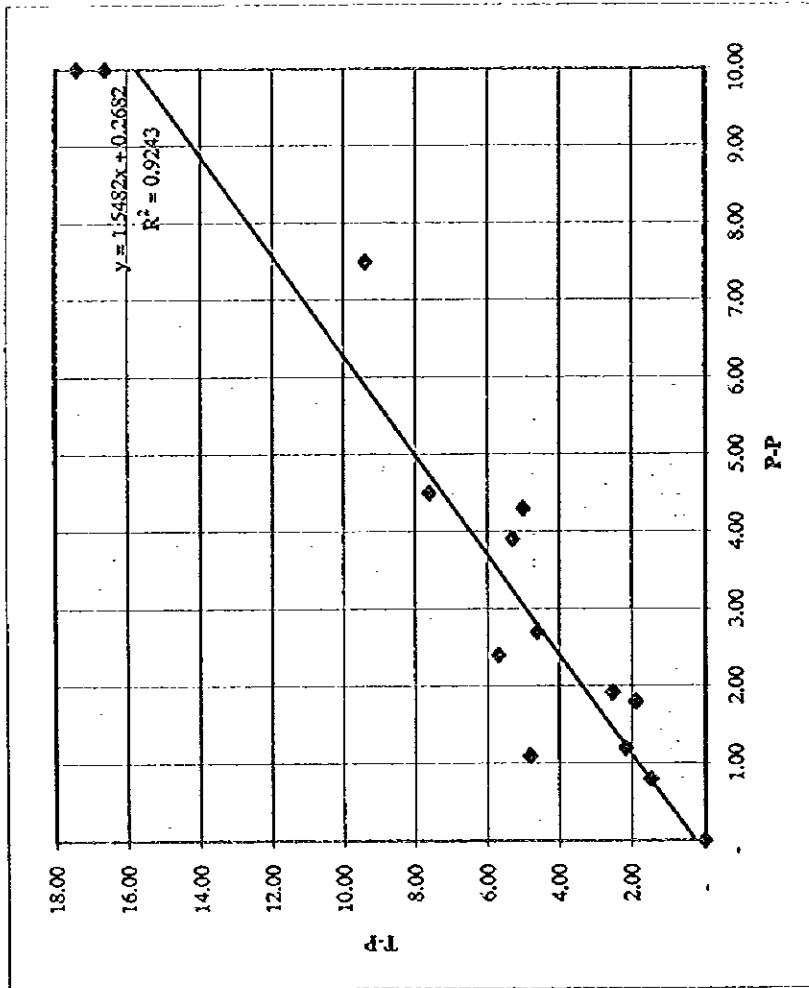
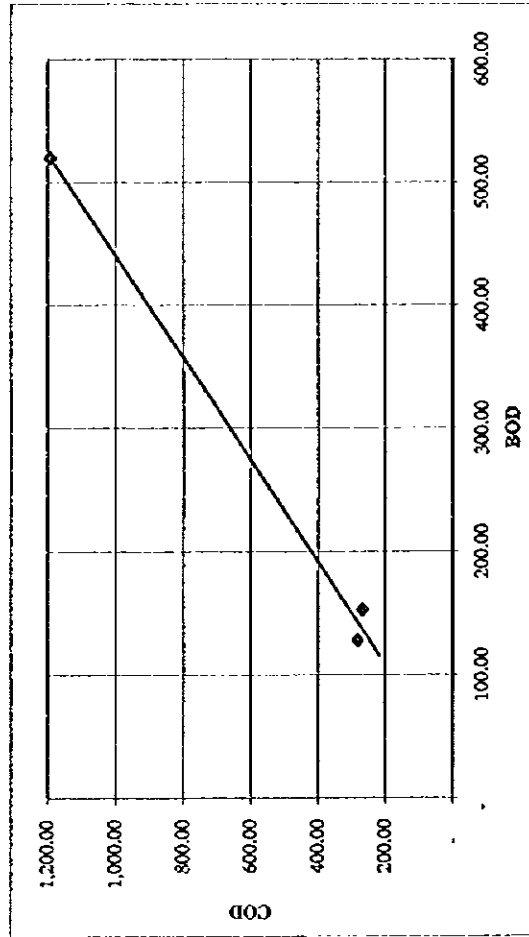


Table 9.3.10 Correlation between BOD and COD of STW (Trickling Filter Effluent)

STW	BOD	COD	C/B
Crowborough (TF)	128.00	282.00	2.20
Firle (TF)	153.00	268.00	1.75
Norton (TF)	520.00	1,192.00	2.29
Average			2.08





9.4 Establishment of Pollution Load Run-off Model with Water Quality Checking Points

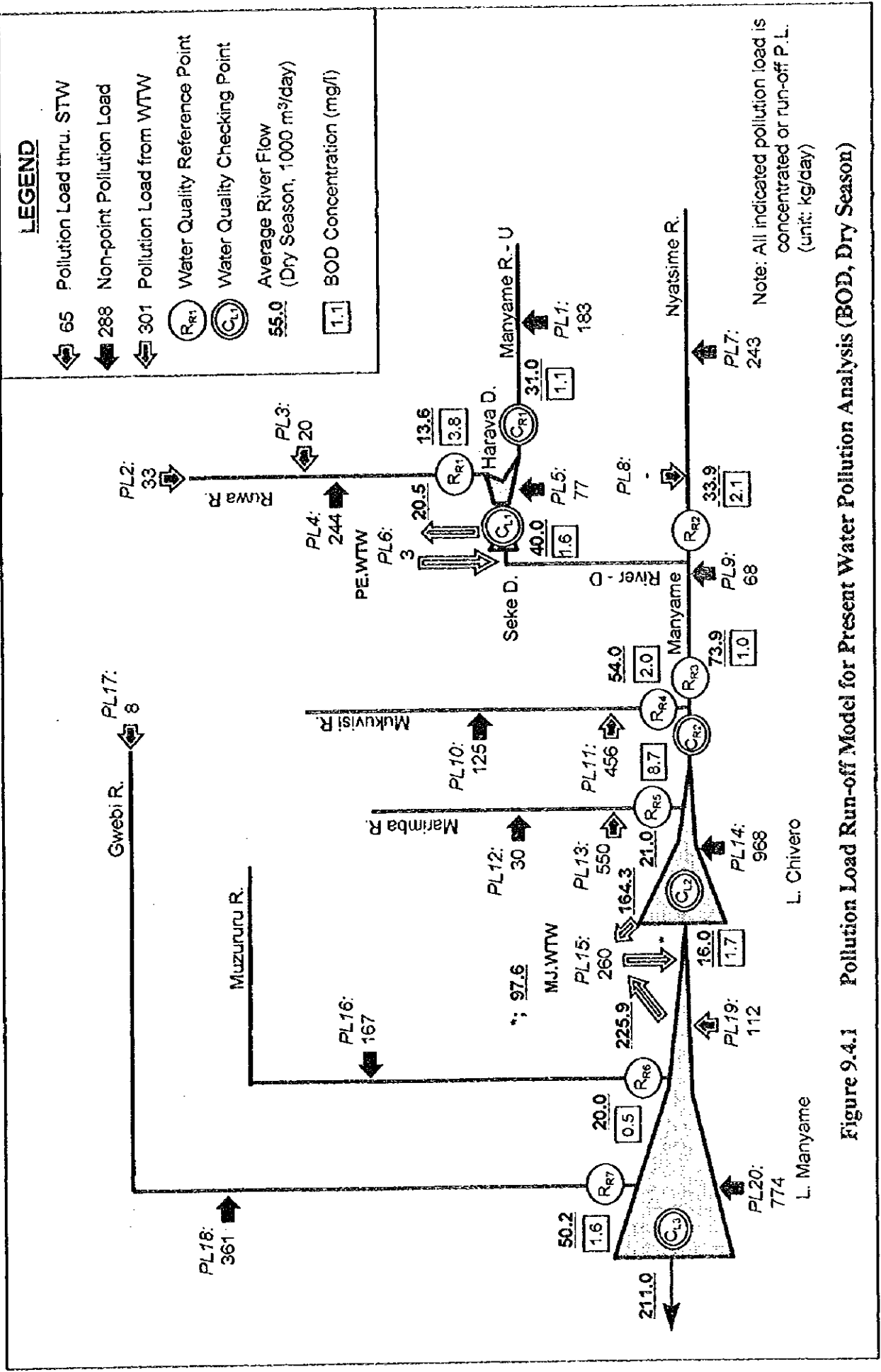


Figure 9.4.1 Pollution Load Run-off Model for Present Water Pollution Analysis (BOD, Dry Season)

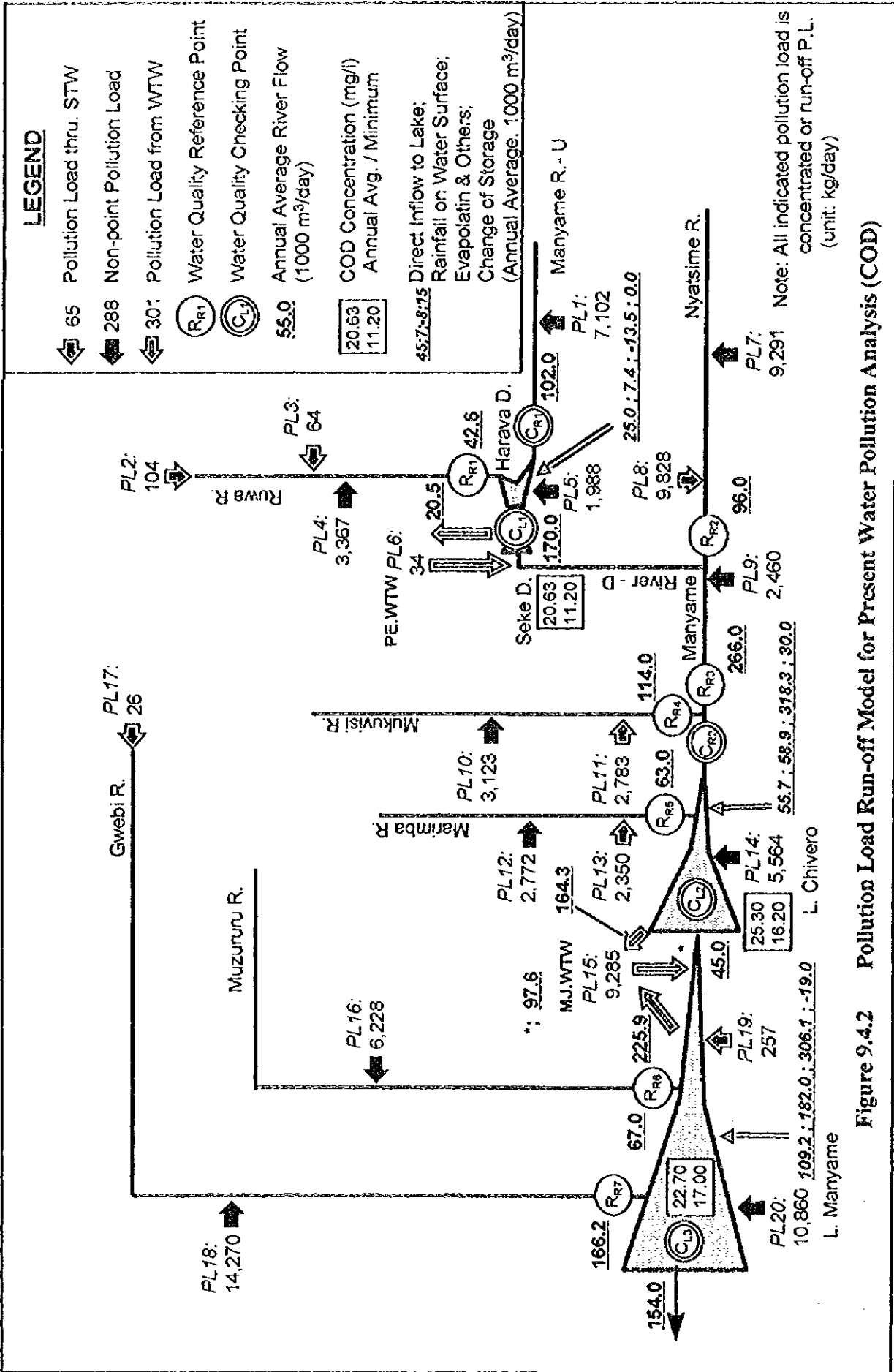


Figure 9.4.2 Pollution Load Run-off Model for Present Water Pollution Analysis (COD)

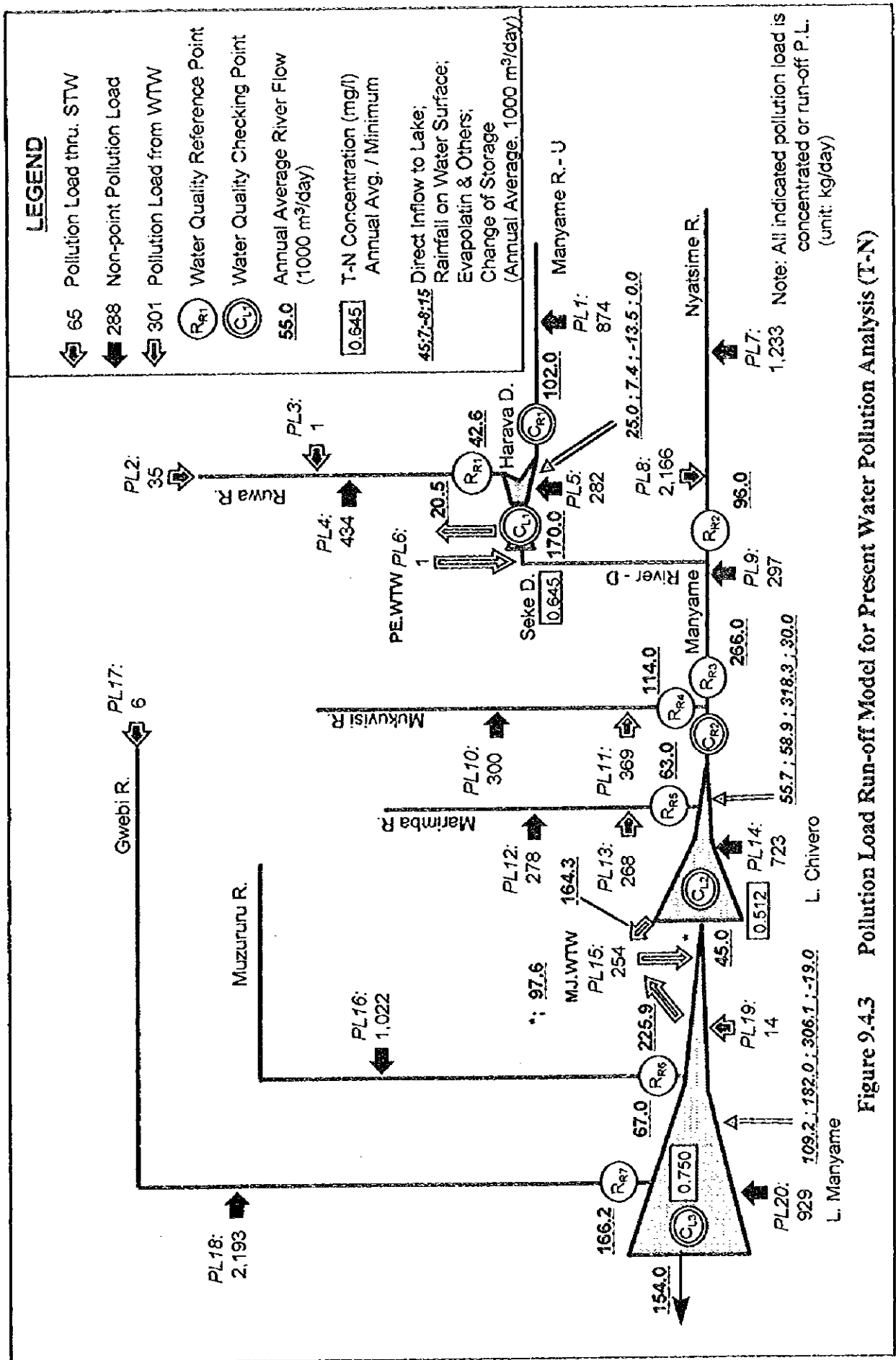


Figure 9.4.3 Pollution Load Run-off Model for Present Water Pollution Analysis (T-N)

