Appendix 5 Flow Calculation of Sewer Network

Appendix 5

Hydraulic Calculation for Design of Sewers (A r e a 1)

P 1

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total											
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
1	3	13.68	13.68	5.20	5.20										0.0039			0.0039	⊙ 150	23.40	1.318	0.0233	94.20	92.528	1.50	
																							82.00	80.331	1.50	
2		0.37	0.37	60	60										0.0001			0.0001	⊙ 150	16.60	1.110	0.0196	83.00	81.327	1.50	
																							82.00	80.331	1.50	
3	9	1.86	15.91	200	7.20										0.0045			0.0045	⊙ 150	30.50	1.505	0.0266	82.00	80.331	1.50	
																							75.90	74.231	1.50	
4	6	3.19	3.19	155	155										0.0009			0.0009	⊙ 150	5.00	0.609	0.0108	82.00	80.331	1.50	
																							82.00	79.556	2.28	
5		3.32	3.32	110	110										0.0009			0.0009	⊙ 150	5.00	0.609	0.0108	82.00	80.331	1.50	
																							82.00	79.781	2.05	
6	8	0.00	6.51	50	205										0.0019			0.0019	⊙ 150	44.40	1.816	0.0321	82.00	79.551	2.28	
																							79.00	77.331	1.50	
7		0.80	0.80	130	130										0.0002			0.0002	⊙ 150	7.60	0.751	0.0133	80.00	78.329	1.50	
																							79.00	77.331	1.50	
8		0.95	8.27	188	393										0.0024			0.0024	⊙ 150	16.40	1.104	0.0195	79.00	77.328	1.50	
																							75.90	74.231	1.50	
9	11	0.35	24.53	67	787										0.0070			0.0070	⊙ 150	44.70	1.822	0.0322	75.90	74.228	1.50	
																							72.90	71.231	1.50	
10		1.59	1.59	205	205										0.0005			0.0005	⊙ 150	24.80	1.357	0.0240	78.00	76.328	1.50	
																							72.90	71.231	1.50	
11	13	1.92	28.04	210	997										0.0080			0.0080	⊙ 200	33.80	1.919	0.0603	72.90	71.175	1.50	
																							65.30	64.075	1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
12		0.85	0.85	90	90										0.0002			0.0002	⊙ 150	67.70	2.242	0.0396	71.90 65.80	70.227 64.131	1.50 1.50	
13	22	2.00	3.089	205	1202										0.0088			0.0088	⊙ 200	24.90	1.647	0.0518	65.80 60.70	64.075 58.975	1.50 1.50	
16	18	2.19	2.19	308	308										0.0006			0.0006	⊙ 150	26.20	1.395	0.0247	81.00 72.90	79.326 71.231	1.51 1.50	
17		0.50	0.50	65	65										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	72.90 72.90	71.231 70.907	1.50 1.82	
18	19	0.54	3.23	85	393										0.0009			0.0009	⊙ 150	32.60	1.556	0.0275	72.90 69.80	70.907 68.131	1.82 1.50	
14		1.41	1.41	173	173										0.0004			0.0004	⊙ 150	8.60	0.799	0.0141	75.90 74.40	74.228 72.731	1.50 1.50	
15		1.04	2.45	165	338										0.0007			0.0007	⊙ 150	27.80	1.437	0.0254	74.40 69.80	72.727 68.131	1.50 1.50	
19	21	0.34	6.02	80	473										0.0017			0.0017	⊙ 150	56.20	2.043	0.0361	69.80 65.30	68.129 63.631	1.50 1.50	
20		0.73	0.73	70	70										0.0002			0.0002	⊙ 150	21.40	1.261	0.0223	65.80 65.30	65.130 63.631	1.50 1.50	
21		0.47	7.22	105	578										0.0021			0.0021	⊙ 150	43.80	1.804	0.0319	65.30 60.70	63.630 59.031	1.50 1.50	
22	43	0.96	3.907	120	1322										0.0111			0.0111	⊙ 200	25.00	1.651	0.0519	60.70 57.70	58.975 55.975	1.50 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
33	35	0.01	0.01	220	220										0.0023			0.0023	⊙ 150	23.10	1.310	0.0231	75.90 70.80	74.227 69.131	1.50 1.50	
34		0.99	0.99	105	105										0.0003	0.0042	0.0042	0.0045	⊙ 150	48.50	1.898	0.0335	75.90 70.80	74.227 69.131	1.50 1.50	
35	36	2.74	11.74	300	520										0.0033		0.0042	0.0075	⊙ 200	18.30	1.412	0.0444	70.80 65.30	69.075 63.575	1.50 1.50	
23		0.50	0.50	45	45										0.0001			0.0001	⊙ 150	22.20	1.284	0.0227	83.00 82.00	81.330 80.331	1.50 1.50	
24	26	0.61	1.11	130	175										0.0003			0.0003	⊙ 150	20.70	1.240	0.0219	82.00 79.30	80.328 77.631	1.50 1.50	
25		0.77	0.77	105	105										0.0002			0.0002	⊙ 150	25.70	1.382	0.0244	82.00 79.30	80.330 77.631	1.50 1.50	
26	29	0.42	2.30	70	245										0.0007			0.0007	⊙ 150	34.20	1.594	0.0282	79.30 76.90	77.628 75.231	1.50 1.50	
27		1.00	1.00	50	50										0.0003			0.0003	⊙ 150	40.00	1.724	0.0305	82.00 80.00	80.331 78.331	1.50 1.50	
28		1.05	2.05	175	225										0.0006			0.0006	⊙ 150	17.70	1.147	0.0203	80.00 76.90	78.330 75.231	1.50 1.50	
29	32	0.42	4.77	85	330										0.0014			0.0014	⊙ 150	47.00	1.868	0.0330	75.90 72.90	75.228 71.231	1.50 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

P 4

1:0.00028453 m³/s-ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
30		1.80	1.80	50	50										0.0005			0.0005	⊙ 150	82.00	2.468	0.0436	80.00 75.90	78.331 74.231	1.50 1.50	
31		1.55	3.35	215	265										0.0010			0.0010	⊙ 150	13.90	1.016	0.0180	75.90 72.90	74.228 71.231	1.50 1.50	
32		1.17	9.29	175	505										0.0026			0.0026	⊙ 150	43.40	1.795	0.0317	72.90 65.30	71.229 63.631	1.50 1.50	
36	38	0.30	21.33	100	620										0.0061		0.0042	0.0103	⊙ 200	4.00	0.660	0.0207	65.30 65.30	63.575 63.175	1.50 1.90	
37		0.76	0.76	88	88										0.0002			0.0002	⊙ 150	34.00	1.589	0.0281	68.30 65.30	66.627 63.631	1.50 1.50	
38	40	0.10	22.19	70	690										0.0063		0.0042	0.0105	⊙ 200	16.40	1.337	0.0420	65.30 63.80	63.175 62.075	1.90 1.50	
39		0.96	0.96	140	140										0.0003			0.0003	⊙ 150	32.10	1.544	0.0273	68.30 63.80	65.629 62.131	1.50 1.50	
40	42	0.19	23.34	75	765										0.0066		0.0042	0.0108	⊙ 200	28.00	1.747	0.0549	63.80 61.70	62.075 59.975	1.50 1.50	
41		1.11	1.11	145	145										0.0003			0.0003	⊙ 150	24.80	1.357	0.0240	65.30 61.70	63.630 60.031	1.50 1.50	
42		0.51	24.96	163	928										0.0071		0.0042	0.0113	⊙ 200	24.50	1.634	0.0513	61.70 57.70	59.975 55.975	1.50 1.50	
43	45	0.64	64.67	110	1432										0.0184		0.0042	0.0226	⊙ 300	14.50	1.647	0.1164	57.70 56.10	55.869 54.269	1.50 1.50	
44		23.94	23.94	130	130										0.0068			0.0068	⊙ 150	35.30	1.619	0.0286	60.70 56.10	59.027 54.431	1.50 1.50	

Hydraulic Calculation for Design of Sewers (A r e a I)

:0.00028453 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
45		0.00	88.61	1000	2432										0.0252		0.0042	0.0294	⊙ 300	4.00	0.865	0.0612	56.10 39.40	54.269 36.969	1.50 2.10	
46	125	0.00	88.61	250	2682										0.0252	0.0083	0.0125	0.0377	⊙ 375	10.00	1.587	0.1753	39.40 36.30	36.387 34.387	2.10 1.50	
47		1.56	1.56	118	118										0.0004			0.0004	⊙ 150	9.30	0.831	0.0147	86.80 85.70	85.130 84.031	1.50 1.50	
48	50	0.34	1.90	57	175										0.0005			0.0005	⊙ 150	10.50	0.883	0.0156	85.70 85.10	84.029 83.431	1.50 1.50	
49		2.33	2.33	50	50										0.0007			0.0007	⊙ 150	12.00	0.944	0.0167	85.70 85.10	84.031 83.431	1.50 1.50	
50	58	1.09	5.32	270	445										0.0015			0.0015	⊙ 150	26.50	1.455	0.0257	85.10 77.40	83.430 75.731	1.50 1.50	
51	53	0.48	0.48	100	100										0.0001			0.0001	⊙ 150	27.90	1.440	0.0254	86.60 83.80	84.925 82.131	1.51 1.50	
52		0.29	0.29	75	75										0.0001			0.0001	⊙ 150	25.30	1.371	0.0242	85.70 83.80	84.030 82.131	1.50 1.50	
53	55	0.26	1.03	58	158										0.0003			0.0003	⊙ 150	22.40	1.290	0.0228	83.80 82.50	82.130 80.831	1.50 1.50	
54		0.55	0.55	115	115										0.0002			0.0002	⊙ 150	22.60	1.296	0.0229	85.10 82.50	83.430 80.831	1.50 1.50	
55	57	0.18	1.76	56	214										0.0005			0.0005	⊙ 150	35.70	1.628	0.0288	82.50 80.50	80.830 78.831	1.50 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewar	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pep/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
56		0.54	0.54	115	115										0.0002			0.0002	⊙ 150	13.10	0.986	0.0174	82.01 80.50	80.339 78.831	1.50 1.50	
57		0.30	2.60	93	307										0.0007			0.0007	⊙ 150	33.30	1.573	0.0278	80.50 77.40	78.829 75.731	1.50 1.50	
58	60	0.15	8.07	40	485										0.0023			0.0023	⊙ 150	12.50	0.964	0.0170	77.40 76.90	75.731 75.231	1.50 1.50	
59		0.38	0.38	80	80										0.0001			0.0001	⊙ 150	45.00	1.828	0.0323	80.50 76.90	78.831 75.231	1.50 1.50	
60	69	0.16	8.61	55	540										0.0024			0.0024	⊙ 150	18.10	1.159	0.0205	76.90 75.90	75.226 74.231	1.51 1.50	
61		0.95	0.95	95	95										0.0003			0.0003	⊙ 150	5.00	0.609	0.0108	86.80 86.60	85.131 84.657	1.50 1.77	
62	64	0.22	1.17	57	152										0.0003			0.0003	⊙ 150	21.50	1.254	0.0223	86.60 85.10	84.655 83.431	1.78 1.50	
63		0.46	0.46	88	88										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	85.10 85.10	83.431 82.991	1.50 1.94	
64	66	0.15	1.78	55	207										0.0005			0.0005	⊙ 150	48.30	1.894	0.0335	85.10 82.00	82.987 80.331	1.94 1.50	
65		0.41	0.41	93	93										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	82.00 82.00	80.331 79.867	1.50 1.96	
66	68	0.14	2.33	56	263										0.0007			0.0007	⊙ 150	34.50	1.601	0.0283	82.00 79.60	79.863 77.931	1.97 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

0.00028453 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
67		0.44	0.44	97	97										0.0001			0.0001	⊙ 150	9.20	0.827	0.0146	80.50 79.60	78.327 77.931	1.50 1.50	
68		0.51	3.28	110	373										0.0009			0.0009	⊙ 150	33.60	1.580	0.0279	79.60 75.90	77.930 74.231	1.50 1.50	
69	71	0.14	12.03	58	598										0.0034			0.0034	⊙ 150	5.00	0.609	0.0108	75.90 75.90	74.231 73.941	1.50 1.79	
70		0.81	0.81	155	155										0.0002			0.0002	⊙ 150	16.70	1.114	0.0197	78.50 75.90	76.827 74.231	1.50 1.50	
71	84	0.31	13.15	95	693										0.0037			0.0037	⊙ 150	5.00	0.609	0.0108	75.90 75.90	73.941 73.467	1.79 2.26	
72		0.00	0.00	60	60										0.0000	0.0021	0.0021	0.0021	⊙ 150	5.00	0.609	0.0108	86.60 86.60	84.931 84.631	1.50 1.80	
73		0.37	0.37	50	110										0.0001		0.0021	0.0022	⊙ 150	35.90	1.633	0.0289	86.60 84.50	84.626 82.831	1.81 1.50	
74	76	0.46	0.83	115	225										0.0002		0.0021	0.0023	⊙ 150	30.40	1.503	0.0266	84.50 81.00	82.829 79.331	1.50 1.50	
75		0.54	0.54	80	80										0.0002			0.0002	⊙ 150	12.50	0.964	0.0170	82.00 81.00	80.331 79.331	1.50 1.50	
76	78	0.09	1.46	35	260										0.0004		0.0021	0.0025	⊙ 150	14.20	1.027	0.0181	81.00 80.50	79.328 78.831	1.50 1.50	
77		0.69	0.69	105	105										0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	80.50 80.50	78.831 78.306	1.50 2.03	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
78	80	0.14	2.29	56	3.16										0.0007		0.0021	0.0028	⊙ 150	26.30	1.398	0.0247	80.50 78.50	78.304 76.831	2.03 1.50	
79		0.88	0.88	1.49	1.49										0.0003			0.0003	⊙ 150	5.00	0.609	0.0108	79.20 78.50	77.531 76.787	1.50 1.54	
80	83	0.21	3.38	65	3.81										0.0010		0.0021	0.0031	⊙ 150	22.40	1.290	0.0228	78.50 77.00	76.787 75.331	1.54 1.50	
81		0.66	0.66	90	90										0.0002			0.0002	⊙ 150	15.50	1.073	0.0190	78.80 77.40	77.128 75.731	1.50 1.50	
82		2.23	2.89	2.00	2.90										0.0008			0.0008	⊙ 150	5.00	0.609	0.0108	77.40 77.00	75.731 74.731	1.50 2.10	
83		0.42	6.69	80	4.61										0.0019		0.0021	0.0040	⊙ 150	6.20	0.679	0.0120	77.00 75.90	74.731 74.231	2.10 1.50	
84	86	2.66	22.50	4.30	11.23										0.0064		0.0021	0.0085	⊙ 200	27.10	1.719	0.0540	75.90 63.50	73.417 61.775	2.25 1.50	
85		0.64	0.64	85	85										0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	63.80 63.50	62.131 61.707	1.50 1.62	
86		0.13	23.27	50	11.73										0.0066		0.0021	0.0087	⊙ 200	50.00	2.334	0.0733	63.50 61.00	61.775 59.275	1.50 1.50	
87	95	0.95	24.22	2.10	13.83										0.0069		0.0021	0.0090	⊙ 200	9.50	1.018	0.0320	61.00 59.00	59.275 57.275	1.50 1.50	
88	90	3.96	3.96	1.35	1.35										0.0011			0.0011	⊙ 150	14.80	1.048	0.0185	70.00 68.00	68.330 66.331	1.50 1.50	

Hydraulic Calculation for Design of Sewers A r e a 1)

:0.00028453 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
89		0.68	0.68	80	80										0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	67.00 66.00	65.331 64.931	1.50 2.90	
90	92	0.86	5.50	120	255										0.0016			0.0016	⊙ 150	32.40	1.551	0.0274	66.00 62.70	64.931 61.031	2.90 1.50	
91		2.91	2.91	210	210										0.0008			0.0008	⊙ 150	19.50	1.203	0.0213	66.80 62.70	65.130 61.031	1.50 1.50	
92	94	0.09	8.50	35	290										0.0024			0.0024	⊙ 150	57.10	2.059	0.0364	62.70 60.70	61.029 59.031	1.50 1.50	
93		0.14	0.14	45	45										0.0001			0.0001	⊙ 150	6.60	0.700	0.0124	61.00 60.70	59.328 59.031	1.50 1.50	
94		0.13	8.77	40	330										0.0025			0.0025	⊙ 150	42.40	1.775	0.0314	60.70 59.00	59.027 57.331	1.50 1.50	
95		0.62	33.61	70	1453										0.0096		0.0021	0.0117	⊙ 200	48.60	2.302	0.0723	59.00 55.60	57.275 53.875	1.50 1.50	
96	98	0.68	34.29	100	1553										0.0098		0.0021	0.0119	⊙ 200	46.00	2.239	0.0703	55.60 51.00	53.875 49.275	1.50 1.50	
97		0.79	0.79	100	100										0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	50.20 51.00	48.531 48.031	1.50 2.80	
98	100	0.20	35.28	40	1593										0.0100		0.0021	0.0121	⊙ 200	5.50	0.774	0.0243	51.00 51.60	47.981 47.761	2.79 3.61	
99		0.31	0.31	40	40										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	51.60 51.60	49.931 49.731	1.50 1.70	
100		0.26	35.85	100	1693										0.0102		0.0021	0.0123	⊙ 200	25.70	1.674	0.0526	51.60 47.00	47.761 45.275	3.61 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer			Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total			Total									
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
101	103	0.32	36.17	75	1768										0.0103		0.0021	0.0124	⊙ 200	13.30	1.204	0.0378	47.00 45.00	45.275 44.275	1.50 1.50	
102		0.24	0.24	60	60										0.0001			0.0001	⊙ 150	50.00	1.927	0.0341	49.00 46.00	47.331 44.331	1.50 1.50	
103	105	0.17	36.58	65	1833										0.0104		0.0021	0.0125	⊙ 200	16.90	1.357	0.0426	46.00 44.90	44.275 43.175	1.50 1.50	
104		0.45	0.45	110	110										0.0001			0.0001	⊙ 150	10.00	0.862	0.0152	46.00 44.90	44.331 43.231	1.50 1.50	
105	124	0.24	37.27	95	1928										0.0106		0.0021	0.0127	⊙ 200	20.00	1.476	0.0464	44.90 43.00	43.175 41.275	1.50 1.50	
115		0.90	0.90	125	125										0.0003			0.0003	⊙ 150	8.00	0.771	0.0136	55.60 54.60	53.931 52.930	1.50 1.50	
116	118	0.37	1.27	90	215										0.0004			0.0004	⊙ 150	44.40	1.816	0.0321	54.60 50.60	52.929 48.931	1.50 1.50	
117		0.28	0.28	50	50										0.0001			0.0001	⊙ 150	20.00	1.219	0.0215	51.60 50.60	49.931 48.931	1.50 1.50	
118	119	1.00	2.55	160	375										0.0007			0.0007	⊙ 150	20.50	1.237	0.0219	50.60 47.30	48.930 45.531	1.50 1.50	
106	108	0.99	0.99	115	115										0.0003			0.0003	⊙ 150	5.00	0.609	0.0108	51.00 50.70	49.331 48.757	1.50 1.77	

Hydraulic Calculation for Design of Sewers (A r e a I)

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
107		0.88	0.88	105	105										0.0003			0.0003	⊙ 150	29.50	1.480	0.0262	63.80 60.70	62.130 59.031	1.50 1.50	
108	112	0.64	2.51	125	240										0.0007			0.0007	⊙ 150	51.40	1.954	0.0345	60.70 54.00	58.757 52.331	1.77 1.50	
109		0.88	0.88	70	70										0.0003			0.0003	⊙ 150	5.00	0.609	0.0108	53.10 54.30	51.431 51.081	1.50 3.05	
110	112	0.00	0.88	50	120										0.0003			0.0003	⊙ 150	5.00	0.609	0.0108	54.30 54.00	51.081 50.831	3.05 3.00	
111		0.88	0.88	115	115										0.0003			0.0003	⊙ 150	5.20	0.621	0.0110	54.60 54.00	52.930 52.331	1.50 1.50	
112	114	0.17	4.44	45	285										0.0013			0.0013	⊙ 150	20.00	1.219	0.0215	54.00 51.60	50.831 49.931	3.00 1.50	
113		0.30	0.30	40	40										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	51.60 51.60	49.931 49.731	1.50 1.70	
114		0.36	5.10	85	370										0.0015			0.0015	⊙ 150	48.20	1.892	0.0334	51.60 47.30	49.731 45.631	1.70 1.50	
119	121	0.00	7.65	15	390										0.0022			0.0022	⊙ 150	5.00	0.609	0.0108	47.30 47.30	45.631 45.556	1.50 1.58	
120		0.46	0.46	60	60										0.0001			0.0001	⊙ 150	39.90	1.721	0.0304	49.70 47.30	48.025 45.631	1.51 1.50	
121	124	0.35	8.46	100	490										0.0024			0.0024	⊙ 150	42.20	1.770	0.0313	47.30 43.00	45.556 41.331	1.58 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 1)

:0.00028453m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewed	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
122		0.33	0.33	90	90										0.0001			0.0001	⊙ 150	29.90	1.490	0.0263	49.70 47.00	48.026 45.331	1.51 1.50	
123		0.32	0.65	100	190										0.0002			0.0002	⊙ 150	40.00	1.724	0.0305	47.00 43.00	45.331 41.331	1.50 1.50	
124		0.01	4.639	165	2093										0.0132		0.0021	0.0153	⊙ 250	40.60	2.441	0.1198	43.00 36.30	41.224 34.524	1.50 1.50	
125	MH 101	0.00	13.500	150	2832										0.0384		0.0146	0.0530	⊙ 450	1.70	0.739	0.1176	36.30 36.30	34.304 34.049	1.50 1.76	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
1-1		0.93	0.93	120	120										0.0003			0.0003	⊙ 150	44.90	1.826	0.0323	43.90 38.50	42.225 36.831	1.51 1.50	
1-2	MH 109	0.00	0.93	60	180										0.0003			0.0003	⊙ 150	57.30	2.063	0.0365	38.50 34.80	36.831 33.394	1.50 1.24	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population	Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person	m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
2	4	2.40	2.40	60	60									0.0009			0.0009	⊙ 150	5.00	0.609	0.0108	60.70 60.70	59.031 58.731	1.50 1.80	
3		5.34	5.34	20	20									0.0020			0.0020	⊙ 150	5.00	0.609	0.0108	60.70 60.70	59.031 58.931	1.50 1.60	
4	6	2.86	10.60	185	245									0.0040			0.0040	⊙ 150	5.00	0.609	0.0108	60.70 59.90	58.731 57.808	1.80 1.92	
5		0.62	0.62	50	50									0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	59.90 59.90	58.231 57.981	1.50 1.75	
6		0.86	12.08	90	335									0.0045			0.0045	⊙ 150	19.70	1.210	0.0214	59.90 57.70	57.808 56.031	1.92 1.50	
7	9	0.23	12.31	48	383									0.0046			0.0046	⊙ 150	31.20	1.522	0.0269	57.70 56.20	56.029 54.531	1.50 1.50	
8		0.26	0.26	60	60									0.0001			0.0001	⊙ 150	8.30	0.735	0.0139	56.70 56.20	56.029 54.531	1.50 1.50	
9	11	0.23	12.80	50	433									0.0048			0.0048	⊙ 150	27.90	1.440	0.0254	56.20 54.80	54.526 53.131	1.51 1.50	
10		0.27	0.27	60	60									0.0001			0.0001	⊙ 150	13.30	0.994	0.0176	55.60 54.80	53.929 53.131	1.50 1.50	
11	13	0.18	13.25	45	478									0.0050			0.0050	⊙ 150	31.10	1.520	0.0269	54.80 53.40	53.130 51.731	1.50 1.50	
12		0.22	0.22	60	60									0.0001			0.0001	⊙ 150	19.90	1.216	0.0215	54.60 53.40	52.925 51.731	1.51 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
13	15	0.16	13.63	42	520										0.0051			0.0051	⊙ 150	30.90	1.515	0.0268	53.40 52.10	51.729 50.431	1.50 1.50	
14		0.25	0.25	60	60										0.0001			0.0001	⊙ 150	10.00	0.862	0.0152	52.70 52.10	51.031 50.431	1.50 1.50	
15	17	0.25	14.13	60	580										0.0053			0.0053	⊙ 150	21.60	1.267	0.0224	52.10 50.80	50.427 49.131	1.50 1.50	
16		0.23	0.23	60	60										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	50.90 50.80	49.231 48.931	1.50 1.70	
17	23	0.10	14.46	43	623										0.0054			0.0054	⊙ 150	25.50	1.376	0.0243	50.80 49.50	48.927 47.831	1.70 1.50	
18		3.60	3.60	290	290										0.0013			0.0013	⊙ 150	15.50	1.073	0.0190	55.10 51.60	54.430 49.931	1.50 1.50	
19	22	0.42	4.02	75	365										0.0015			0.0015	⊙ 150	17.30	1.134	0.0200	51.60 50.30	49.930 48.631	1.50 1.50	
20	22	1.94	1.94	276	276										0.0007			0.0007	⊙ 150	24.20	1.341	0.0237	57.00 50.30	55.827 48.631	1.50 1.50	
21		0.30	0.30	45	45										0.0001			0.0001	⊙ 150	5.00	0.609	0.0108	49.40 50.30	47.731 47.506	1.50 2.63	
22		0.13	6.39	50	415										0.0024			0.0024	⊙ 150	5.00	0.609	0.0108	50.30 49.50	47.506 47.256	2.63 2.03	
23	25	0.59	21.44	148	771										0.0080			0.0080	⊙ 200	13.00	1.190	0.0374	49.50 47.00	47.206 45.275	2.07 1.50	

Hydraulic Calculation for Design of Sewers (A r e a -)

0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
24		1.06	1.06	73	73										0.0004			0.0004	⊙ 150	20.50	1.234	0.0218	48.50 47.00	46.829 45.331	1.50 1.50	
25	40-1	0.48	22.98	72	843										0.0086			0.0086	⊙ 200	43.10	2.167	0.0681	47.00 43.90	45.275 42.175	1.50 1.50	
30		0.59	0.59	150	150										0.0002			0.0002	⊙ 150	30.60	1.508	0.0266	57.70 53.10	56.028 51.431	1.50 1.50	
31		0.63	1.22	170	320										0.0005			0.0005	⊙ 150	27.00	1.416	0.0250	53.10 48.50	51.428 46.831	1.50 1.50	
32	33	0.28	1.50	76	396										0.0006			0.0006	⊙ 150	5.00	0.609	0.0108	48.50 49.00	46.831 46.451	1.50 2.38	
26		0.42	0.42	60	60										0.0002			0.0002	⊙ 150	5.00	0.609	0.0108	57.70 57.70	56.031 55.731	1.50 1.80	
27		0.46	0.88	143	203										0.0003			0.0003	⊙ 150	19.50	1.203	0.0213	57.70 54.60	55.731 52.931	1.80 1.50	
28	33	0.56	1.44	140	343										0.0005			0.0005	⊙ 150	39.30	1.721	0.0304	54.60 49.00	52.926 47.331	1.51 1.50	
29		0.22	0.22	60	60										0.0001			0.0001	⊙ 150	8.30	0.785	0.0139	49.50 49.00	47.829 47.331	1.50 1.50	
33	35	0.14	3.30	45	441										0.0012			0.0012	⊙ 150	18.20	1.163	0.0205	49.00 47.30	46.450 45.631	2.38 1.50	
34		0.24	0.24	60	60										0.0001			0.0001	⊙ 150	21.60	1.267	0.0224	48.60 47.30	46.927 45.631	1.50 1.50	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm				Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population	Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Pe/ha	Person	m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
35	37	0.28	3.82	53	494									0.0014			0.0014	⊙ 150	32.00	1.542	0.0272	47.30 45.60	45.627 43.931	1.50 1.50	
36		0.25	0.25	60	60									0.0001			0.0001	⊙ 150	36.60	1.649	0.0291	47.80 45.60	46.127 43.931	1.50 1.50	
37	40-1	0.21	4.28	50	544									0.0016			0.0016	⊙ 150	33.90	1.587	0.0280	45.60 43.90	43.926 42.231	1.51 1.50	
38		0.69	0.69	116	116									0.0003			0.0003	⊙ 150	39.60	1.715	0.0303	48.50 43.90	46.828 42.231	1.50 1.50	
39		0.35	1.04	85	201									0.0004			0.0004	⊙ 150	5.00	0.609	0.0108	43.90 43.90	42.231 41.807	1.50 1.92	
40-1		1.39	29.69	105	948									0.0111			0.0111	⊙ 200	24.60	1.537	0.0514	43.90 40.90	41.758 39.175	1.92 1.50	
40-2	44	0.00	29.69	45	993									0.0111			0.0111	⊙ 200	3.50	0.618	0.0194	40.90 40.90	39.175 39.018	1.50 1.56	
41	43-1	0.95	0.95	137	137									0.0004			0.0004	⊙ 150	33.50	1.577	0.0279	51.60 47.00	49.927 45.331	1.50 1.50	
42		0.98	0.98	80	80									0.0004			0.0004	⊙ 150	18.70	1.179	0.0208	48.50 47.00	46.829 45.331	1.50 1.50	
43-1		2.21	4.14	170	307									0.0016			0.0016	⊙ 150	35.80	1.631	0.0288	47.00 40.90	45.326 39.231	1.51 1.50	
43-2		0.00	4.14	65	372									0.0016			0.0016	⊙ 150	5.00	0.609	0.0108	40.90 40.90	39.231 38.907	1.50 1.82	
44	MH 113	0.52	34.35	100	1093									0.0129			0.0129	⊙ 200	58.30	2.521	0.0792	40.90 34.30	38.857 33.029	1.82 1.05	

Hydraulic Calculation for Design of Sewers (Area 2)

P 18

0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area: Area	Drainage Area: Total	Length: Length	Length: Total	Concentrated Time	Run-off Storm: Rainfall	Run-off Storm: Run-off Coeffi	Run-off Storm: Arranged Area: Area	Run-off Storm: Arranged Area: Total	Run-off Storm: Rainfall	Wastewater Flow: Pop. Density	Wastewater Flow: Population: Sewer	Wastewater Flow: Population: Total	Wastewater Flow: Design Flow	Other W.W: Sewer	Other W.W: Total	Grand Total Design Flow	Designing of Sewers: Diameter	Designing of Sewers: Slope	Designing of Sewers: Velocity	Designing of Sewers: Flow	Designing of Sewers: Elevation	Designing of Sewers: Invert Level	Designing of Sewers: Earth Cover	Remarks
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
45		1.92	1.92	80	80										0.0007			0.0007	⊙ 150	18.70	1.179	0.0208	48.50 47.00	46.829 45.331	1.50 1.50	
46		3.09	5.01	148	228										0.0019			0.0019	⊙ 150	41.20	1.749	0.0309	47.00 40.90	45.330 39.231	1.50 1.50	
47	MH 115	4.02	9.03	200	428										0.0034			0.0034	⊙ 150	31.70	1.534	0.0271	40.90 33.90	39.231 32.899	1.50 0.83	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area: Area	Drainage Area: Total	Length: Length	Length: Total	Concentrated Time	Run-off Storm: Rainfall	Run-off Storm: Run-off Coeffi.	Run-off Storm: Arranged Area: Area	Run-off Storm: Arranged Area: Total	Run-off Storm: Rainfall	Wastewater Flow: Pop. Density	Wastewater Flow: Population: Sewer	Wastewater Flow: Population: Total	Wastewater Flow: Design Flow	Other W.W: Sewer	Other W.W: Total	Grand Total Design Flow	Designing of Sewers: Diameter	Designing of Sewers: Slope	Designing of Sewers: Velocity	Designing of Sewers: Flow	Designing of Sewers: Elevation	Designing of Sewers: Invert Level	Designing of Sewers: Earth Cover	Remarks
		ha	ha	m	m	min	m³/sec·ha	·	ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
48		1.63	1.63	150	150										0.0006			0.0006	⊙ 150	30.60	1.508	0.0266	42.40 37.80	40.731 36.131	1.50 1.50	
49	MH 123	13.59	15.22	460	610										0.0057			0.0057	⊙ 150	8.50	0.795	0.0140	37.80 33.40	36.131 32.236	1.50 1.00	

Hydraulic Calculation for Design of Sewers (A r e a 2)

0.00037450m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
50	54	1.57	1.57	180	180										0.0006			0.0006	⊙ 150	25.50	1.376	0.0243	51.60 47.00	49.928 45.331	1.50 1.50	
51		2.40	2.40	88	88										0.0009			0.0009	⊙ 150	17.00	1.124	0.0199	48.50 47.00	46.829 45.331	1.50 1.50	
52	54	0.40	2.80	76	164										0.0010			0.0010	⊙ 150	5.00	0.609	0.0108	47.00 47.00	45.331 44.951	1.50 1.88	
53		1.07	1.07	110	110										0.0004			0.0004	⊙ 150	5.00	0.609	0.0108	46.00 47.00	44.331 43.781	1.50 3.05	
54	56	2.69	8.13	210	390										0.0030			0.0030	⊙ 150	28.80	1.463	0.0258	47.00 39.40	43.781 37.731	3.05 1.50	
55		1.75	1.75	128	128										0.0007			0.0007	⊙ 150	23.40	1.318	0.0233	42.40 39.40	40.729 37.731	1.50 1.50	
56	58	1.67	11.55	138	528										0.0043			0.0043	⊙ 150	22.40	1.290	0.0228	39.40 36.30	37.728 34.631	1.50 1.50	
57		2.19	2.19	190	190										0.0008			0.0008	⊙ 150	7.80	0.761	0.0135	37.80 36.30	36.126 34.631	1.51 1.50	
58	MH 133	0.75	14.49	100	628										0.0054			0.0054	⊙ 150	32.90	1.563	0.0276	36.30 32.60	34.631 31.342	1.50 1.09	

Hydraulic Calculation for Design of Sewers (A r e a 2)

0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow			Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi.	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
59		1.31	1.31	110	110										0.0005			0.0005	⊙ 150	5.00	0.609	0.0108	51.60 51.50	49.931 49.381	1.50 2.05	
60		1.31	2.62	155	265										0.0010			0.0010	⊙ 150	16.40	1.104	0.0195	51.60 48.50	49.381 46.831	2.05 1.50	
61	65	1.40	4.02	135	400										0.0015			0.0015	⊙ 150	5.00	0.609	0.0108	48.50 50.10	46.831 46.156	1.50 3.78	
62	64	1.10	1.10	113	113										0.0004			0.0004	⊙ 150	39.80	1.719	0.0304	56.10 51.60	54.430 49.931	1.50 1.50	
63		0.68	0.68	80	80										0.0003			0.0003	⊙ 150	30.00	1.493	0.0264	54.00 51.60	52.331 49.931	1.50 1.50	
64		0.16	1.94	40	153										0.0007			0.0007	⊙ 150	37.50	1.669	0.0295	51.60 50.10	49.931 48.431	1.50 1.50	
65	67	2.94	8.90	250	650										0.0033			0.0033	⊙ 150	27.60	1.432	0.0253	50.10 40.90	46.156 39.231	3.78 1.50	
66		3.73	3.73	318	318										0.0014			0.0014	⊙ 150	41.10	1.747	0.0309	54.00 40.90	51.993 38.249	1.84 2.48	
67	70	1.60	14.23	137	787										0.0053			0.0053	⊙ 150	22.00	1.278	0.0226	40.90 36.90	38.249 35.231	2.48 1.50	
68		4.90	4.90	350	350										0.0018			0.0018	⊙ 150	33.10	1.568	0.0277	54.00 42.40	52.331 40.731	1.50 1.50	
69		3.06	7.96	270	620										0.0030			0.0030	⊙ 150	20.30	1.228	0.0217	42.40 36.90	40.727 35.231	1.50 1.50	
70	MH 136	0.99	23.18	100	887										0.0087			0.0087	⊙ 200	42.20	2.145	0.0674	36.90 32.20	35.175 30.956	1.50 1.02	

Hydraulic Calculation for Design of Sewers (A r e a 2)

:0.00037450 m³/s·ha

No. of Sewers	Downstream Sewers No.	Drainage Area		Length		Concentrated Time	Run-off Storm					Wastewater Flow				Other W.W		Grand Total Design Flow	Designing of Sewers							Remarks
		Area	Total	Length	Total		Rainfall	Run-off Coeffi	Arranged Area		Rainfall	Pop. Density	Population		Design Flow	Sewer	Total		Diameter	Slope	Velocity	Flow	Elevation	Invert Level	Earth Cover	
									Area	Total			Sewer	Total												
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
71		1069	1069	380	380										0.0040			0.0040	⊙ 150	32.10	1.544	0.0273	47.00 34.80	45.331 33.131	1.50 1.50	
72	75	0.00	1069	10	390										0.0040			0.0040	⊙ 150	5.00	0.609	0.0108	34.80 34.80	33.131 33.081	1.50 1.55	
73		1.26	1.26	100	100										0.0005			0.0005	⊙ 150	46.00	1.848	0.0327	40.90 35.30	39.231 34.631	1.50 1.50	
74		2.64	3.90	60	160										0.0015			0.0015	⊙ 150	25.00	1.363	0.0241	35.30 34.80	34.631 33.131	1.50 1.50	
75	MH 138	0.96	15.55	270	660										0.0058			0.0058	⊙ 150	8.40	0.790	0.0140	34.80 32.00	33.081 30.814	1.55 1.02	

Appendix 6 Design Calculation of Kauma Treatment Plant

Appendix 6 Design Calcuration of Kauma Sewege Treatment Plant

1) Design Criteria

① Basic Items

Name : Kauma STP
Location : Area 44, Lilongwe City
Land Area : Approximately 40 ha
Elevation : Present Elevation 1,007～1,030m
Land Use : Crop Field, Uncultivated Land
Type of Sewer : Separate Type
Treatment Method : Sewage Treatment Stabilization Pond Method
(Anaerobic Pond ⇨Facultative Pond⇨Maturation Pond)
Sludge Treatment Pond Drainage⇨Sun Drying⇨Dumping
Effluent Point and Water Level : Effluent Point Lilongwe River
Recorded Highest Flood Water Level Unknown
Design Highest Water Level HHWL+1,007m
Target Year : 2000 (This Project), 2005 (Future Plan)
Lowest Monthly Average Tempreture : 15.2℃ (July)

② Design Sewage Volume

	Future Plan(m^3/day)	This Project(m^3/day)
Dayly Maxmum Q_1	15,600	6,100
Hourly Maxmum Q_2	35,880	14,030

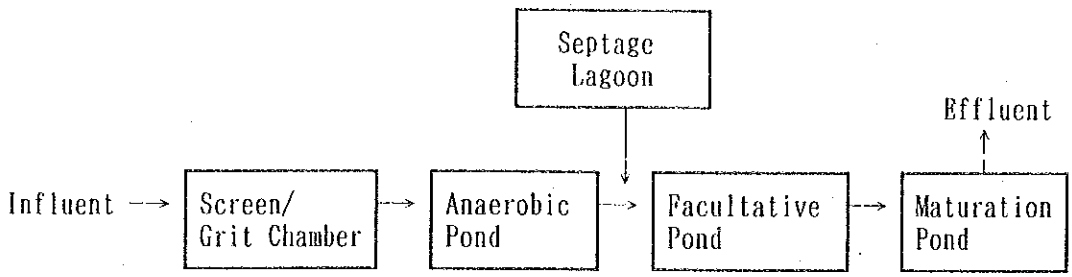
Design Population : Future Plan about 67,000 Persons
This Project about 22,000 Persons

③ Design Water Quality

	Influent	Effluent
BOD_5 (mg/ℓ)	300	20
SS (mg/ℓ)	350	30
Coliform (MPN/100mℓ)	2.0×10^7	1.0×10^3

*Effluent water quality is target water quality

2) Flow Sheet



・Volume of Sludge

Water content ratio of sedimented sludge is assumed at 97 %, and that of dumping sludge is 80 % after sun drying.

$$\text{Volumetric reducing ratio} = \frac{100-97}{100-80} = 0.15$$

3) Design Calcuration

Items		Future Plan	This Project
1. Grit Chamber			
Type		Pallarel Flow Type	ditto
Hourly Maxmum Sewage Volume	Q_2	35,880㎥/d=0.415 ㎥/s	14,030㎥/d=0.162 ㎥/s
Area Load	Lg	1,800㎥／㎡／d	ditto
Required Surface Area	Ag	35,880×1/1,800 =19.93 ㎡	14,030×1/1,800 =7.79㎡
Average Velocity	v	0.3 m/sec	ditto
Effective Depth	h	About 0.6 m	ditto
Required Width	w	0.415×1/0.3 ×1/0.6 =2.31m→ 2.40 m	0.162×1/0.3 ×1/0.6 =0.90m
Required Length	L	19.93×1/2.40 =8.30m	7.79 ×1/1.2 =6.49m
Dimension		1.2m W×8.5m L×2 Units	1.2m W×8.5m L×2 Units (1 unit stand-by)
Sedimentation Volume		0.01㎥ for every 1,000㎥ of sewage $15,600\times\frac{0.01}{1,000}=0.156$ ㎥／d	ditto $6,100\times\frac{0.01}{1,000}=0.061$ ㎥／d

(Check) Area Load	Lg	35,880×1/(1.2×8.5 ×2) =1,759 m³/m²/d...OK	14,030×1/(1.2×8.5 ×1) =1,375 m³/m²/d...OK
Average Velocity	v	0.415 ×1/(0.6×1.2 ×2) =0.29m/s .....OK	0.162 ×1/(0.6×1.2) =0.23m/s .....OK
2. Measuring Device			
Type		Parshall Flume	ditto
Capacity		Hourly Max 35,880=1,495 m³/h →1,800 m³/h	Hourly Max 14,030= 585m³/hr → 1,800m³/hr
No. of unit		1 Unit	1 Unit
3. Anaerobic Pond			
Type		Embanked Rectangular Pond	ditto
BOD Load	Li	15,600×300 ×10⁻³ =4,680 kgBOD₅/d	6,100×300 ×10⁻³ =1,830 kgBOD₅/d
BOD Volumetric Load	v	Temperature Ta =15.2℃ v=160gBOD₅/m³・d	ditto
Required Capacity	V_1	4,680 ×10³ ×1/160 =29,250m³	1,830 ×10³ ×1/160 =11,440m³
Sedimented Sludge Volume	V_2	Dumped once in every 5 year, 67,000person×0.04m³/person/year×5 years =13,400m³	ditto 22,000person×0.04m³/person/year×5 years = 4,400m³
Dryed Volume (Sun drying) 97w%→80w%		$\frac{100-97}{100-80}$ ×13,400=2,010 m³/5 years	$\frac{100-97}{100-80}$ ×4,400 = 660 m³/5years
Required Capacity	V	V_1+V_2 =42,650m³	V_1+V_2 =15,840m³
Depth	Da	4.0m	4.0m
Required Surface Area	Aa	42,650 ×1/4 =10,663m²	15,840 ×1/4 = 3,960m²
Dimension		W (54 ～30)m×L (62 ～38)m ×D 4.0m×5 Units ( )means length at surface /bottom.	W (54 ～30)m×L (62 ～38)m ×D 4.0m×3 Units (1 unit for stand-by)
(Check) Effective Capacity	V_1	4.0 ×1/3 ×(54 ×62+30×38 +√(54 ×62・30×38))×5 −13,400 =29,545m³	4.0 ×1/3 ×(54 ×62+30×38 +√(54 ×62・30×38))×2 −4,400 =12,778m³

BOD Volumetric Load	v	4,680 ÷29,545×10^3 =158g-BOD^5／m^3／d.....OK	1,830 ÷12,778×10^3 =143g-BOD^5／m^3／d.....OK
Effective Retentin Days	Ra	29,545÷15,600 =1.9d .....OK	12,778÷6,100 =2.1d .....OK
Effluent BOD_5 Concentration	Le	300 ×(1-0.5) =150 mg／ℓ	300 ×(1-0.5) =150 mg／ℓ
4. Septage Lagoon			
Type		Embanked Rectangular Pond	ditto
Service Population		About 120,000 persons	About 119,000 persons ×60%(Collection Ratio) =71,400 ps
Sludge Volume		0.001 m^3/person/day	ditto
BOD Concentration	L	5,000 mg／ℓ	ditto
Design Sludge Volume	S	120,000 ×0.001 =120 m^3/day	71,400 ×0.001 =71m^3/day
Required Capacity	Vs	①Retention days (>20days) 120 ×20 =2,400 m^3 ②Volumetric Load (200g BOD/m^3/day) 120 ×5,000 ÷ 200 =3,000 m^3 ①<②..... 3,000m^3	① 71×20 =1,420 m^3 ② 71 ×5,000 ÷ 200 =1,775 m^3 ①<②..... 1,775m^3
Opearation		Alternative Operation	ditto
Dimension/Capacity		W(28.2～10.2)m×L(42.2～24.2)m×D 3.0m×3 Units (1 unit shall always be left non-operational) 3.0 ×1/3 ×(28.2 ×42.2+10.2×24.2+√(28.2 ×42.2×10.2×24.2))×2= 3,958m^3..OK	W(28.2～10.2)m×L(42.2 ～24.2)m×D 3.0m×2 Units (1 unit shall always be left non-operational) 3.0 ×1/3 ×(28.2 ×42.2+10.2×24.2+√(28.2 ×42.2×10.2×24.2)) = 1,979m^3..OK
Effluent BOD Load		120 ×5,000 ×(1-0.5) ×10^{-3} =300 kg-BOD_5/d	71 ×5,000×(1-0.5)×10^{-3} =178 kg-BOD_5/d
Sludge Dumping (Once per month)		Design SS volume SS 50 g/person/day×120,000p =6.0 ton/day Sedimentation rate 50 % 6.0 ton/day × 50 % =3.0 ton/day Water content of dry sludge 80%	Design SS volume SS 50 g/person/day×71,400 =3.6 ton/day Sedimentation rate 50 % 3.6 ton/day × 50 % =1.8 ton/day ditto

		3.0 ton/day $\times \frac{100}{100-80}$ =15.0 ton/day =15.0㎥/day =450 ㎥/month	1.8 ton/day $\times \frac{100}{100-80}$ = 9 ton/day = 9㎥/day =270 ㎥/month
5. Facultative Pond			
Type		Embanked Rectangular Pond	ditto
Influent BOD Load		15,600 ×150 ×10^{-3} ÷300 =2,640 kg-BOD_5/d	6,100×150 ×10^{-3} ÷178 =1,093 kg-BOD_5/d
BOD Area Load		s=60.3×1.0993^{Ta}×1/α Ta:Lowest Monthly Average Temperature (15.2℃) α:Safety Rate(Among 8units 2units are to be drained, 8/6 =1.33) =60.3×1.0993$^{15.2}$×1/1.33 =192 kg-BOD_5/ha/d	s=60.3×1.0993^{Ta}×1/α ditto α:Safety Rate(Among 4units 1 unit is to be drained, 4/3 =1.33) =60.3×1.0993$^{15.2}$×1/1.33 =192 kg-BOD_5/ha/d
Required Surface Area		2,640×1/192 =13.8ha	1,093×1/192 ≒ 5.7ha
Depth	Df	1.5m	1.5m
Dimension		W (105～96)m×L (144～135)m ×D 1.5m×4 Units +2.1ha ×D 1.5m×4 Units	W (105～96)m×L (144～135)m ×D 1.5m×4 Units
(Check)			
Capacity	V1	1.5 ×1/3 ×(105×144 +96×135 +$\sqrt{}$(105×144 ×96×135) ×4 +21,000×1.5 ×4 = 210,157 ㎥	1.5 ×1/3 ×(105×144 +96×135 +$\sqrt{}$(105×144 ×96×135) ×4 = 84,157 ㎥
Surface Area		210,157 ÷1.5 = 14.01 ha > 13.8ha	84,157 ÷1.5 = 5.61 ha ≒ 5.7ha OK

Retention Days	Rf	210,964 ÷15,600 =13.5d	84,157 ÷6,100 =13.8d
Area Load against Influent BOD_5 Load	s	Surface Area 1.05×1.44×4 +2.1 ×4 =14.45 ha 2,640×1/14.45 =183 kg-BOD_5/ha/d.....OK	1.05×1.44×4 = 6.05 ha 1,093×1/6.05 =181 kg-BOD_5/ha/d....OK
Volume of Sludge	V_2	Dumped once in every 5 years 67,000人×0.03㎥/person/year ×5 years =10,050㎥	22,000人×0.03㎥/person/year ×5 years = 3,300㎥
Dumping Sludge Volume		10,050×0.15=1,508㎥/5years	3,300×0.15=495 ㎥/5years
Depth of Sedimented Sludge	Ds	10,050 ×1/ 140,100 =0.072 m	3,300×1/ 56,100 =0.059 m

6. Maturation Pond

Type		Embanked Rectangular Pond	ditto
Retention Days	Rm	3 days/Pond	3 days/Pond
No. of Units	N	3 units/1 series×4 series =12 units	3 units/1 series×2 series = 6 units
Check of Coliform Bacteria Number contained in effluent	NR	$NR = \frac{No}{(K\,Ra+1)(K'Rf+1)(K'Rm+1)^n}$ where: No:Coliform Bacteria Number contained in Influent (2.0×10^7/100 ml) k':Death Constant k' at15.2 = $2.0\times1.07^{(15.2-20)}$ n = 3 (number of units)	

		NR $= \frac{2.0 \times 10^7}{(1.446\times1.9+1)\times(1.446\times13.5+1)\times(1.446\times3+1)^3} \fallingdotseq 1 \times 10^3$...OK	NR $= \frac{2.0 \times 10^7}{(1.446\times2.1+1)\times(1.446\times13.8+1)\times(1.446\times3+1)^3} \fallingdotseq 1 \times 10^3$....OK
Influent volume per series	q	6,100 ×1/2=3,050㎥/day 9,500 ×1/2=4,750㎥/day	6,100×1/2=3,050 ㎥/day
Required Capacity per unit	v	3,050 ×3= 9,150㎥/unit 4,750 ×3=14,250㎥/unit	3,050×3 = 9,150㎥/unit
Depth	Dm	1.5m	1.5m
Dimension		W (72～63)m×L (95～86)m ×D 1.5m×3 units/1 series ×2 series +14,250㎥×3 units/1 series ×2 series	W (72～63)m×L (95～86)m ×D 1.5m×3 units/1 series ×2 series
(Check)			
Capacity		1.5 ×1/3 ×(72 ×95+63×86 +√(72 ×95・63×86))×6 +14,250×6 = 140,540 ㎥	1.5×1/3×(72×95+63×86 +√(72 ×95・63×86))×6 = 55,040㎥
Retention Time		140,540 ÷15,600=9.01 9.01 ÷3 = 3.0 ≧3.0	55,040 ÷6,100 = 9.02 9.02 ÷3 = 3.0 ≧3.0