

Result of Soil Investigation Survey



Figure (1.1) Location map of project area

Table 2.1 Summary of Borehole Exploration Work

Borehole No.	Surface Ele.(RL)m	Coordinates		Date Started	Date Completed	Depth of Hole (m)	Soil Drilling (m)	SPT	UD
		Northing	Easting						
WPT-No1	3.418	1875694.682	165709.881	23.10.2015	24.10.2015	40.22	40.22	40	3
WPT-No2	3.198	1875723.414	166086.452	16.10.2015	18.10.2015	40.27	40.27	40	3
WPT-No3	3.532	1875856.382	166181.062	7.10.2015	8.10.2015	41.20	41.20	41	3
WPT-No4	3.435	1875767.562	166212.820	11.10.2015	13.10.2015	44.27	44.27	44	3
WPT-No5	3.170	1875659.866	166233.435	15.10.2015	18.10.2015	59.19	59.19	59	3
WPT-No6	3.581	1875895.206	166293.490	4.10.2015	5.10.2015	40.24	40.24	40	3
WPT-No7	3.237	1875790.710	166363.362	4.10.2015	7.10.2015	58.19	58.19	58	3
WPT-No8	3.061	1875673.242	166365.577	9.10.2015	12.10.2015	49.31	49.31	49	3
WPT-No9	3.404	1875993.982	166400.258	30.9.2015	2.10.2015	40.32	40.32	40	3
WPT-No10	3.107	1875900.996	166513.794	29.9.2015	2.10.2015	56.17	56.17	56	3
Total						469.38	469.38	467	30
Note:	SPT	Standard Penetration Test							
	UD	Undisturbed Sample							
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Tapin Township)							
		Prepared by : TGO			Checked by : HW			Date : 13.11.2015	

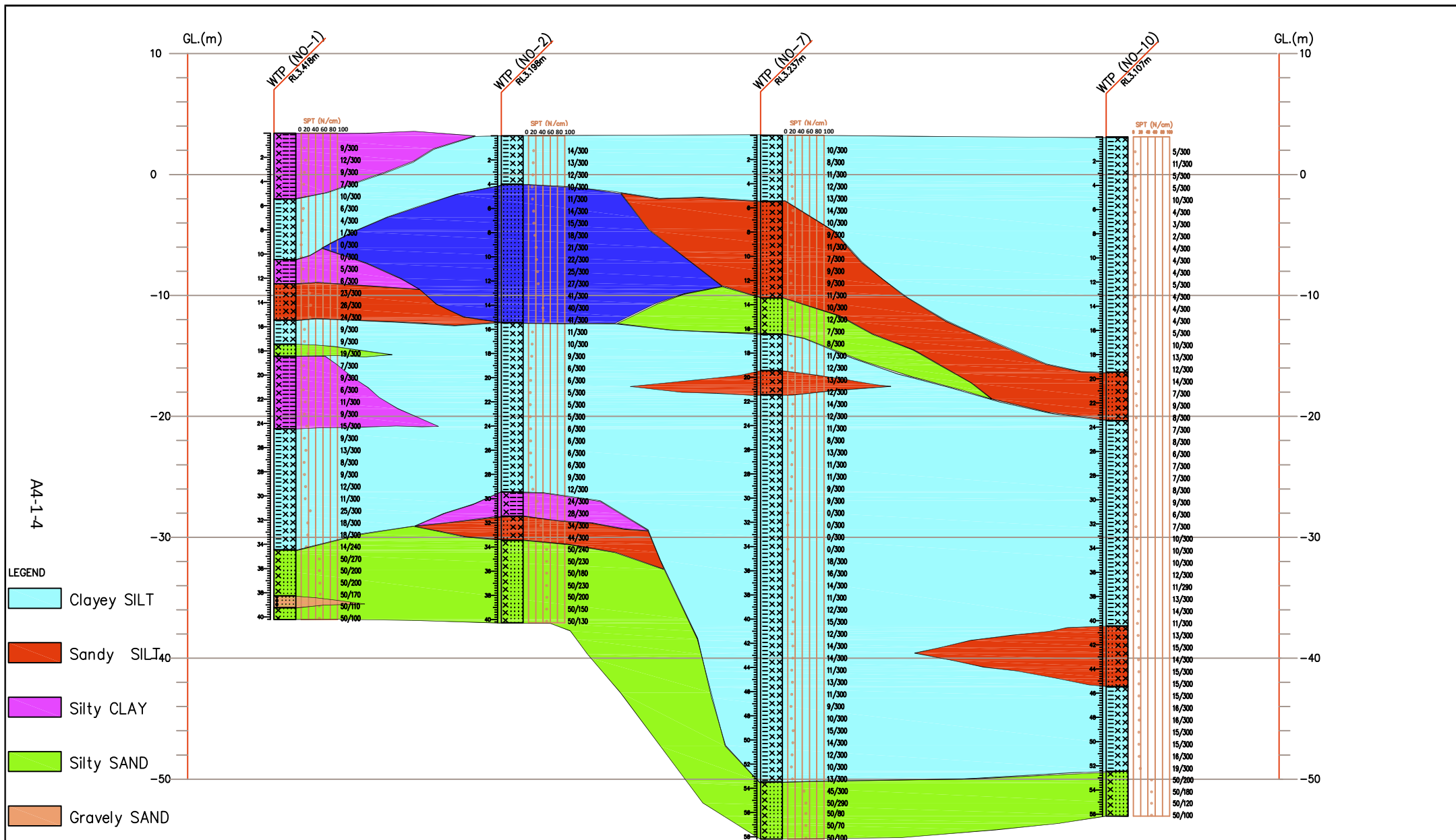


Figure 5.1 Soil Profile Along WTP-1~WTP-2~WTP-7~WTP-10

Remarks 4 WTP-1~WTP-2~WTP-7~WTP10	Section No.	-	Drawing Title: TEC INTERNATIONAL CO.,LTD	Drawn by: NMH	Checked by: HW	Date: 24.11.2015
	Scale	NTS	Project Title: Greater Yangon Water Supply Improvement Project Phase II			

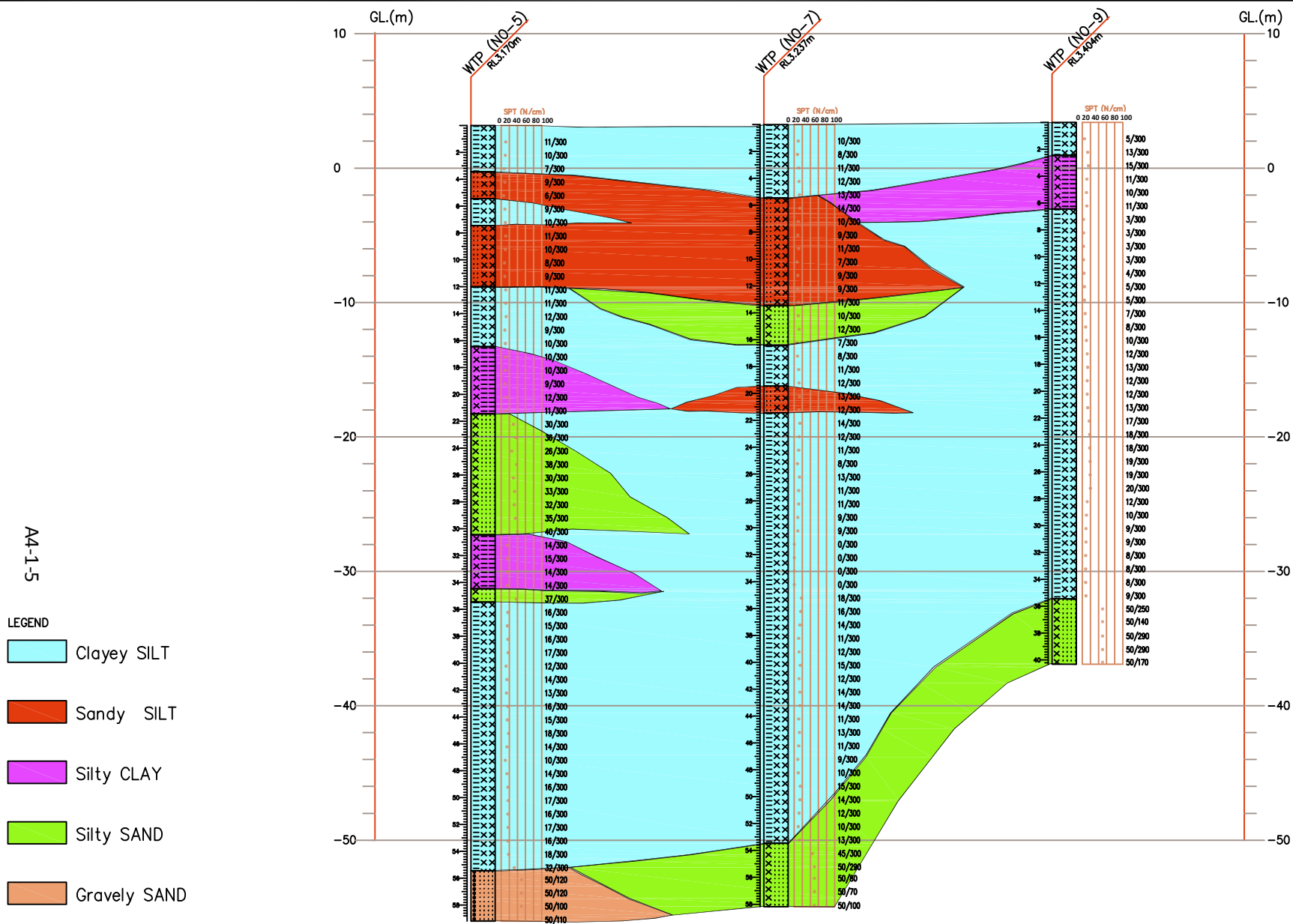


Figure 5.1 Soil Profile Along WTP-5~WTP-7~WTP-9

Remarks

WTP-5~WTP-7~WTP-9

Section No.

-

Drawing Title:

TEC INTERNATIONAL CO.,LTD

Drawn by:

NMH

Checked by:

HW

Date:

24.11.2015

Scale

NTS

Project Title:

Greater Yangon Water Supply
Improvement Project Phase II



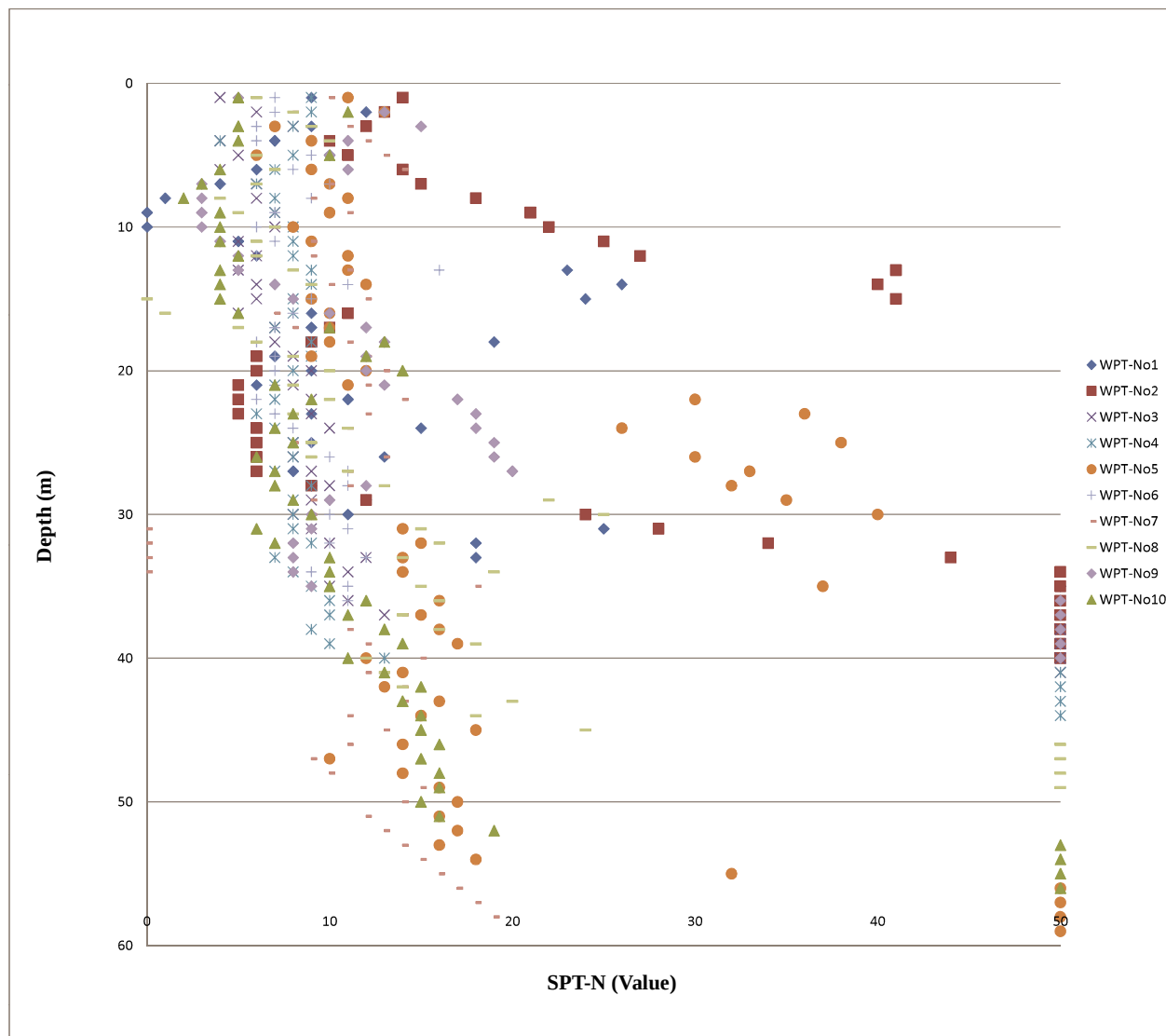


Figure 5.2 Standard Penetration Test N-Value Vs Depth



Project Name : Greater Yangon Water Supply Improvement Project Phase II(Htan Tapin Township)

Prepared by: TGO

Checked by : HW

Date: 30.10.2015

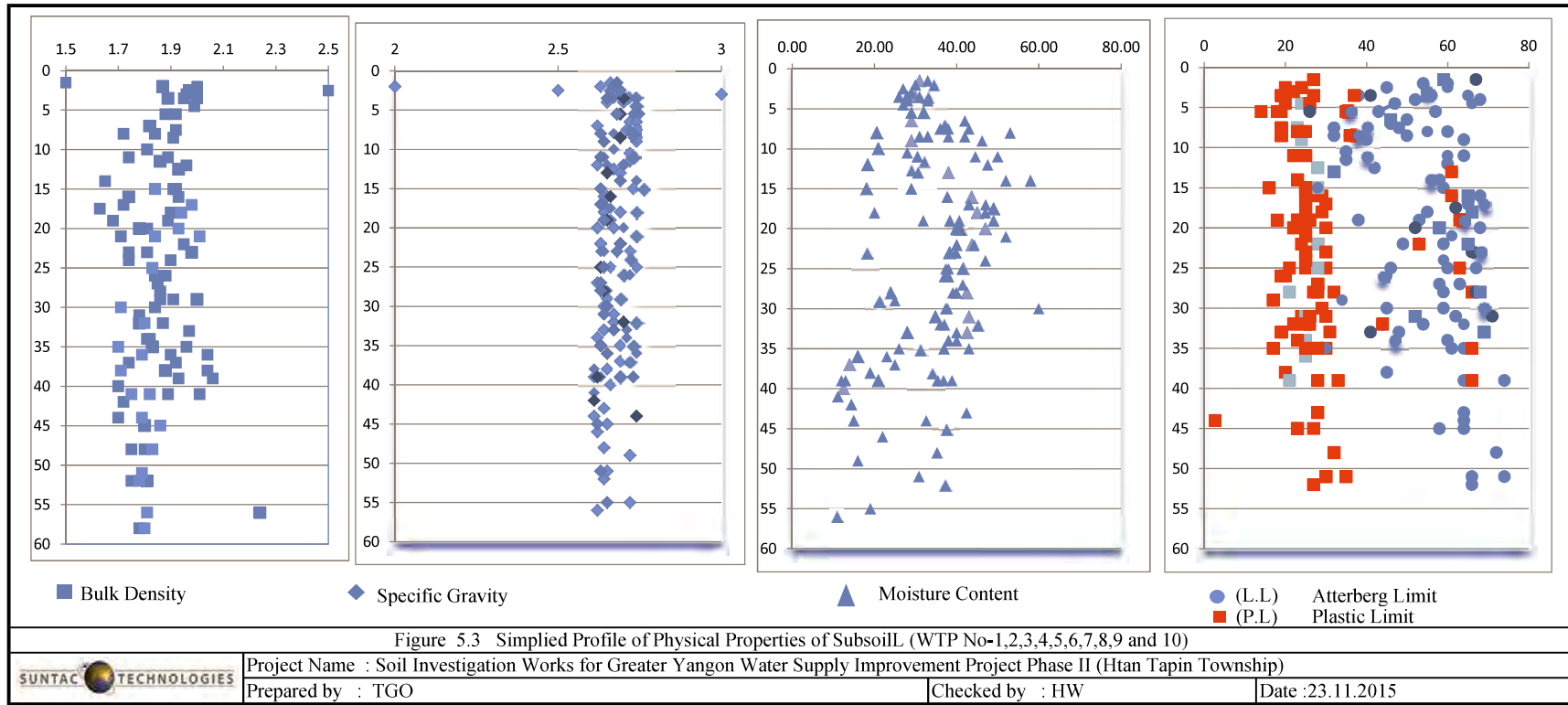


Table 5.1 Summary profile of soil layer

Bore Hole	Ground Elevation	Layer 1		Layer 2		Layer 3		Layer 4		Layer 5	
		Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value
WTP (NO-1)	3.418	3.148 ~ -7.03 -2.03 ~ -9.03	Medium Stiff,Brownish Grey,Silty CLAY (5-12)	-2.03 ~ -12.03 -7.03 ~ -31.03	Medium Stiff to Very Soft,Grey,Clayey SILT(0-6) Medium Stiff to Very Stiff,Grey,Clayey SILT(7-25)	-9.03 ~ -12.03 ~ -12.03	Stiff to Very Stiff,Grey,Sandy SILT(23-26)	-31.03 ~ -34.84 ~ -35.81 ~ -36.8	Very Dense,Grey,Silty SAND (>50)	-34.84 ~ 35.81	Very Dense,Grey,Gravely SAND (>50)
WTP (NO-2)	3.198	3.198 ~ -12.25 ~ -26.25	Medium Stiff to Stiff,,Grey,Clayey SILT(12-14) Medium Stiff ,Grey,Clayey SILT(5-12)	-0.8 ~ -12.25	Medium Dense to Dense,Grey,SAND(10-41)	-26.25 ~ -28.25	Stiff to Verry Stiff,Grey,Silty CLAY(24-28)	-28.25 ~ -30.25	Very to Hard,Greey,Sandy SILT (34-44)	-30.25 ~ -37.07	Very Dense,Grey,Gravely SAND (>50)
WTP (NO-3)	3.532	3.532 ~ -9.92 ~ -33.97	Medium Stiff,Grey to Brown,Clayey SILT (4-8) Medium Stiff Stiff,Grey ,Clayey SILT (5-13)	0.08 ~ -9.92	Medium Stiff,Grey,Sandy SILT (4-7)	-33.97 ~ -37.67	Verry Dense,Grey,Silty SAND (>50)	~	~	~	~
WTP (NO-4)	3.435	3.435 ~ -25.02 -5.57 ~ -12.02 ~ -37	Medium Stiff,Grey to Brown,Clayey SILT (8-9) Medium Stiff,Grey ,Clayey SILT (7-9) Medium Stiff,Grey ,Clayey SILT (7-13)	-0.02 ~ -5.57	Medium Stiff,Grey,Sandy SILT (4-8)	-12.02 ~ -25.2	Medium Stiff,Greey,Silty CLAY (7-9)	-37 ~ -40.02	Very Dense,Grey,Gravely SAND (>50)	-40.02 ~ -40.84	Very Dense,Grey,SAND (>50)
WTP (NO-5)	3.17	3.17 ~ -32.28 -2.28 ~ -4.28 ~ -4.28	Very Stiff,Yellowish Grey,Clayey SILT (7-11) Medium Stiff,Grey,Clayey SILT (6-10) Stiff to Very Stiff,Grey, Clayey SILT 17-32)	-0.28 ~ -4.28 ~ -8.83	Medium Stiff,Grey,Sandy SILT (6-9) Medium Stiff,Grey,Sandy SILT (8-11)	-8.83 ~ -18.29	Medium Stiff,Grey,Silty CLAY (9-12)	-18.28 ~ -32.28	Dense to Medium Dense,Grey,Silty SAND (11-40)	-52.28 ~ -56.02	Very Dense,Grey,Gravely SAND (>50)
		Project Name : SI work for Greater Yangon Water Supply Improvement Project Phase II									
		Prepared By :NMH				Checked By :HW				Date : 24.11.2015	

Table 5.1 Summary profile of soil layer

Bore Hole	Ground Elevation	Layer 1		Layer 2		Layer 3		Layer 4		Layer 5	
		Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value
WTP (NO-6)	3.581	3.581 ~ 1.58	Medium Stiff,Greey to Brown, Silty CLAY	1.58 ~ -8.87 -11.87 ~ -32.82	Medium Stiff,Greey,Clayey SILT (6-10) Medium Stiff to Stiff,Grey, Clayey SILT (6-13)	-8.87 ~ -11.87 ~	Stiff to Medium Stiff,Grey,Sandy SILT (9-16)	-32.82 ~ -34.84 ~	Very Dense,Grey,SAND (>50)	-34.84 ~ -36.66	Very Dense,Grey,Silty SAND (>50)
WTP (NO-7)	3.237	3.237 ~ -13.21	Medium Stiff to Stiff,Grey to Brown,Clayey SILT (6-13) Medium Stiff to Stiff,Grey,Clayey SILT(7-15)	-2.21 ~ -10.21	Medium Stiff,Grey,Sandy SILT (7-14)	-10.21 ~ -13.21 ~ -50.2 ~ -54.94	Medium Dense,Grey,Silty SAND (10-11) Very dense,Grey,Silty SAND (>50)				
WTP (NO-8)	3.061	3.061 ~ -13.39	Medium Stiff to Very Soft,Grey ,Clayey SILT (0-9) Medium Stiff to Stiff,Grey ,Clayey SILT (8-20)	-41.39 ~ -46.25	Very Dense,Grey,Silty SAND (>50)			~		~	
WTP (NO-9)	3.404	3.404 ~ -7.05 -7.05 ~ -32.05	Medium Stiff to Stiff,Grey to Brown,Clayey SILT (5-13) Soft,Grey,Clayey SILT (3) Medium Stiff to Stiff,Grey,Clayey SILT (8-20)	0.95 ~ -3.05	Stiff to Medium Stiff,Grey to Brown,Silty CLAY (11-15)	-32.05 ~ -36.92	Very dense,Grey,Silty SAND (>50)				
WTP (NO-10)	3.107	3.11 ~ -6.34 -6.34 ~ -16.34 -20.34 ~ -37.37	Medium Stiff to Soft,Grey to Brown,Clayey SILT (2-11) Medium Stiff,Grey,Clayey SILT (5-12) Stiff to Medium Stiff,Grey, Clayey SILT (6-14)	-16.34 ~ -20.34 ~ -37.34 ~ -40.34	Medium Stiff to Stiff,Grey, Sandy SILT (7-14) Stiff,Grey,Sandy SILT (13-19)	-49.34 ~ -53.06	Very Dense,Grey,Silty SAND (>50)	-18.28 ~ -32.28	Dense to Medium Dense,Grey,Silty SAND (11-40)	-52.28 ~ -56.02	Very Dense,Grey,Gravely SAND (>50)
											
Project Name : SI work for Greater Yangon Water Supply Improvement Project Phase II											
Prepared By :NMH						Checked By :HW			Date : 24.11.2015		

Table 3.2 Summary of Unconsolidated Undrained Triaxial Compression (UU) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
WTP NO-1	2.5	3	27	1.97	0.72	94.42	68	5
	11.00	11.45	50	1.74	1.29	100	8	4
WTP NO-2	5.50	6.00	32	1.88	0.84	99	69	17
	17.50	18.00	49	1.63	1.38	92	13	4
	33.00	33.45	28	1.97	0.69	100	31	5
WTP NO-3	8.50	9.00	33	1.91	0.83	100	9	4
	14.00	14.45	58	1.65	1.49	100	12	4
	26.00	26.45	38	1.84	0.97	100	13	4
WTP NO-4	3.50	4.00	31	1.90	0.84	97.35	50	11
	5.50	6.00	29	1.90	0.77	96.73	45	12
	8.50	9.00	3	1.90	0.86	97.92	44	18
	32.00	32.45	37	1.86	0.96	100	17	4
WTP NO-5	3.50	4.00	33	1.89	0.84	100	19	5
	12.50	13.00	29	1.93	0.79	94.34	63	4
	38.00	38.45	34	1.88	0.88	100	16	4
WTP NO-6	3.50	4.00	30	1.94	0.79	98.26	35	3
	13.00	13.45	38	1.82	0.97	100	12	4
	20.00	20.45	47	1.72	1.27	99.3	12	4
WTP NO-7	2.00	2.45	30	1.93	0.79	96.57	54	6
	8.50	9.00	38	1.86	1.00	100	28	5
	35.00	35.45	43	1.66	1.25	89.68	14	4
WTP NO-8	7.50	8.00	43	1.81	1.12	99.02	23	4
	8.50	9.00	42	1.80	1.07	100	32	4
WTP NO-9	1.50	2.00	33	1.84	0.82	100	22	5
	33.00	33.45	40	1.79	1.04	98.81	11	3
WTP NO-10	2.50	3.00	23	1.98	0.64	95.31	88	7
	5.50	6.20	35	1.84	0.94	97.51	38	5
	12.00	12.45	52	1.80	1.24	100	8	4
		Project Name : Greater Yangon Watr Supply Improvement Project Phase II(Htan Tapin Township)						
		Prepared by : TGO			Checked by : HW		Date :05.11.2015	

Table 3.3 Summary of Direct Shear (DS) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
WTP NO-1	18	18.45	20	1.9	0.67	81.76	3	36
WTP NO-2	36	36.32	16	2.04	0.54	80.88	21	35
WTP NO-4	44	44.27	15	2.08	0.49	83.25	15	40
WTP NO-5	23	23.45	18	1.98	0.6	79.3	2	32
WTP NO-6	37	37.4	14	2.04	0.52	73.78	10	40
WTP NO-7	55	55.44	19	2.01	0.58	85.09	8	40
WTP NO-8	49	49.31	16	2.07	0.5	82.67	4	39
WTP NO-9	39	39.44	12	2.09	0.45	72.39	15	39
			Project Name : Greater Yangon Watr Supply Improvement Project Phase II(Htan Tapin Township)					
			Prepared By : TGO		Checked By : HW		Date : 05.11.2015	

Table 3.4 Summary of Unconfined Compressive Strength (UCS) Compression Test Results

Borehole No.	Depth (m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Max Stress (kPa)	Strain at Failure (%)	Cohesion (kPa)	Soil Layer No.
	From	To						
WTP NO-1	3.50	4.00	26.00	2.00	152.48	2.53	76	TW-2
	15.00	15.45	29.00	1.92	28.73	7.14	14	SPT-15
	26.00	26.45	37.00	1.88	30.51	12.27	15	SPT-26
WTP NO-2	3.50	4.00	28.00	1.95	78.7	4.21	39	TW-1
	20.00	20.45	40.00	1.81	27.98	10.38	14	SPT-20
WTP NO-3	7.50	8.00	36.00	1.92	47.72	14.51	23	TW-2
	19.00	19.45	49.00	1.68	27.99	12.42	14	SPT-19
	34.00	34.45	38.00	1.81	28.18	9.34	14	SPT-34
WTP NO-4	22.00	22.45	40.00	1.79	33.09	11.31	17	SPT-22
WTP NO-5	11.50	12.00	32.00	1.86	63.86	8.9	32	TW-2
	32.00	32.45	45.00	1.78	32.45	6.5	16	SPT-32
WTP NO-6	9.00	9.45	29.00	1.85	21.54	9.66	11	SPT-9
	31.00	31.45	43.00	1.78	30.91	12.04	15	SPT-31
WTP NO-7	10.50	11.00	28.00	1.91	77.63	3.97	39	TW-3
	25.00	25.45	38.00	1.80	20.05	11.19	10	SPT-25
WTP NO-8	6.50	7.00	42.00	1.82	58.91	5.06	29	TW-1
	18.00	18.45	47.00	1.77	24.5	8.56	12	SPT-18
	30.00	30.45	60.00	1.61	37.44	9.32	19	SPT-30
WTP NO-9	3.50	4.00	26.00	1.94	227.5	10.01	114	TW-2
	14.00	14.45	52.00	1.70	21.55	1.6	11	SPT-14
	22.00	22.45	40.00	1.79	26.59	3.72	13	SPT-22
WTP NO-10	4.50	5.00	30.00	1.93	130.48	9.43	65	TW-2
	23.00	23.45	31.00	1.86	26	4.61	13	SPT-23
	39.00	39.45	39.00	1.83	28.02	6	14	SPT-39
			Project Name : Greater Yangon Watr Supply Improvement Project Phase II(Htan Tapin Township)					
			Prepared By : TGO		Checked By : HW		Date : 05.11.2015	

Table 3.5 Summary of One-dimensional Consolidated Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Initial Void Ratio (e)	Deg. of Saturation (Sr%)	Preconsolidation Pc (kPa)	Compression Index (Cc)
	From	To					
WTP NO-1	2.5	3	27	0.709	98.3	360	0.24
	4.5	5	27	0.782	96.7	570	0.25
	8	8.45	53	1.407	99.5	55	0.4
WTP NO-2	3.5	4	28	0.756	96.9	155	0.17
	5.5	6	32	0.943	97.1	185	0.15
	17.5	18	49	1.469	94.1	105	0.48
WTP NO-3	5.5		32	0.844	98.1	125	0.2
	7.5	8	36	0.885	98.7	150	0.24
	8.5	9	33	0.896	97.4	125	0.23
WTP NO-4	3.5	4	31	0.919	96.8	150	0.26
	5.5	6	29	0.773	99.1	140	0.22
	8.5	9	31	0.868	96.9	220	0.31
WTP NO-5	3.5	4	33	0.883	99.3	115	0.23
	11.5	12	32	0.947	97.8	125	0.24
	12.5	13	29	0.839	98.2	250	0.4
WTP NO-6	1.5	2	31	0.771	96.2	230	0.21
	3.5	4	30	0.681	97.4	315	0.19
	6.5	7	29	0.757	98.4	145	0.2
WTP NO-7	7.5	8	38	0.956	98.8	100	0.23
	8.5	9	38	0.912	98	135	0.17
	10.5	11	28	0.862	9.8	145	0.18
WTP NO-8	6.5	7	42	1.116	96.7	235	0.55
	7.5	8	43	1.217	98.6	190	0.57
	8.5	9	42	1.184	98.7	145	0.4
WTP NO-9	1.5	2	33	1.019	98.8	75	0.33
	3.5	4	26	0.718	98.5	300	0.18
	5.5	6	29	0.731	97.7	400	0.25
WTP NO-10	2.5	3	23	0.662	96.9	145	0.14
	4.5	5	30	0.902	97.8	180	0.24
	5.5	6.2	35	0.985	98.6	125	0.32
			Project Name : Greater Yangon Watr Supply Improvement Project Phase II(Htan Tapin Township)				
			Prepared by : TGO	Checked by : HW	Date : 05.11.2015		

Table 3.6 Summary of Triaxial Permeability Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density(Mg/m3)	Dry Density(Mg/m ³)	Coefficient at 20°C (m/s)
	From	To				
WTP NO-1	2.5	3	27	1.97	1.55	3.3*10 ⁻¹⁰
	3.5	4	26	2	1.59	4.1*10 ⁻¹⁰
	4.5	5	27	1.99	1.57	4.5*10 ⁻¹⁰
WTP NO-2	3.5	4	28	1.95	1.52	5.4*10 ⁻¹⁰
	5.5	6	32	1.88	1.42	2.8*10 ⁻¹⁰
	17.50	18.00	49.00	1.630	1.09	6.3*10 ⁻¹⁰
WTP NO-3	3.00	3.45	29.00	1.960	1.52	4.03*10 ⁻¹⁰
	5.50	6.00	32.00	1.920	1.45	2.3*10 ⁻⁹
	7.50	8.00	36.00	1.920	1.41	6.9*10 ⁻¹⁰
WTP NO-4	3.50	4.00	31.00	1.900	1.45	5.7*10 ⁻⁹
	5.50	6.00	29.00	1.900	1.47	1*10 ⁻⁸
	8.50	9.00	31.00	1.900	1.45	6.6*10 ⁻⁹
WTP NO-5	3.50	4.00	33.00	1.890	1.42	6.0*10 ⁻⁹
	11.50	12.00	32.00	1.860	1.41	8.5*10 ⁻⁹
	12.50	13.00	29.00	1.930	1.50	1.3*10 ⁻⁹
WTP NO-6	1.50	2.00	31.00	1.900	1.46	2.3*10 ⁻¹⁰
	3.50	4.00	30.00	1.940	1.49	9.3*10 ⁻¹¹
	6.50	7.00	29.00	1.950	1.51	1.7*10 ⁻⁹
WTP NO-7	4.00	4.45	33.00	1.890	1.42	1.4*10 ⁻⁹
	7.50	8.00	38.00	1.900	1.38	5*10 ⁻⁹
	8.50	9.00	38.00	1.860	1.35	1.5*10 ⁻⁹
WTP NO-8	6.50	7.00	42.00	1.820	1.28	7.3*10 ⁻¹⁰
	7.50	8.00	43.00	1.810	1.27	9.2*10 ⁻¹⁰
	8.50	9.00	42.00	1.800	1.27	8.6*10 ⁻¹⁰
WTP NO-9	1.50	2.00	33.00	1.840	1.38	9.6*10 ⁻¹¹
	3.50	4.00	26.00	1.940	1.54	6.2*10 ⁻¹⁰
	5.50	6.00	29.00	2.010	1.56	7.3*10 ⁻¹⁰
WTP NO-10	2.50	3.00	23.00	1.980	1.61	2.2*10 ⁻¹⁰
	4.50	5.00	30.00	1.930	1.48	3.2*10 ⁻¹⁰
	5.50	6.20	35.00	1.840	1.36	6.5*10 ⁻¹⁰
13 		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htantapin Township)				
		Prepared By : TGO		Checked By : HW		Date : 05.11.2015

Water Table (m)= 4

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.12)Liquefaction Analysis at WTP-1



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.970	1.970	19.326	19.326	0.988	0.128	9	10.13	0.185	0.241	0.313	1.440	1.872	2.434	x	x	x			
2	1.970	1.970	38.651	38.651	0.976	0.127	12	10.86	0.200	0.260	0.338	1.576	2.049	2.664	x	x	x			
3	1.970	1.970	57.977	58.314	0.964	0.125	9	6.63	0.145	0.189	0.245	1.164	1.513	1.967	x	x	x			
4	2.000	2.000	77.597	77.934	0.952	0.123	7	5.05	0.125	0.163	0.211	1.014	1.319	1.714	x	x	x			
5	1.990	0.990	97.119	87.646	0.940	0.135	10	6.81	0.145	0.189	0.245	1.071	1.392	1.810	x	x	x			
6	1.720	0.720	113.992	94.709	0.928	0.145	6	3.93	0.110	0.143	0.186	0.758	0.985	1.280	x	x	x			
7	1.720	0.720	130.865	101.772	0.916	0.153	4	2.83	0.100	0.130	0.169	0.653	0.849	1.104	x	x	x			
8	1.720	0.720	147.739	108.835	0.904	0.160	1	0.68	0.060	0.078	0.101	0.376	0.489	0.636	x	x	x			
9	1.720	0.720	164.612	115.899	0.892	0.165	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
10	1.720	0.720	181.485	122.962	0.880	0.169	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
11	1.740	0.740	198.554	130.221	0.868	0.172	5	3.29	0.100	0.130	0.169	0.581	0.756	0.982	x	x	x			
12	1.740	0.740	215.624	137.481	0.856	0.175	6	3.84	0.110	0.143	0.186	0.630	0.819	1.065	x	x	x			
13	1.920	0.920	234.459	146.506	0.844	0.176	23	14.25	0.250	0.325	0.423	1.424	1.851	2.406	x	x	x			
14	1.920	0.920	253.294	155.531	0.832	0.176	26	15.64	0.275	0.358	0.465	1.561	2.030	2.638	x	x	x			
15	1.920	0.920	272.129	164.556	0.820	0.176	24	14.03	0.250	0.325	0.423	1.418	1.844	2.397	x	x	x			
16	1.900	0.900	290.768	173.385	0.808	0.176	9	5.13	0.125	0.163	0.211	0.710	0.922	1.199	x	x	x			
17	1.900	0.900	309.407	182.214	0.796	0.176	9	5.00	0.125	0.163	0.211	0.711	0.925	1.202	x	x	x			
18	1.900	0.900	328.046	191.043	0.784	0.175	19	10.31	0.185	0.241	0.313	1.057	1.374	1.786	x	x	x			
19	1.900	0.900	346.685	199.872	0.772	0.174	7	3.71	0.110	0.143	0.186	0.632	0.821	1.068	x	x	x			
20	1.900	0.900	365.324	208.701	0.760	0.173	9	4.67	0.100	0.130	0.169	0.578	0.752	0.977	x	x	x			
if FS $\leq$ 1, Liquefication can occur (YES),						if FS >1, No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.13)Liquefaction Analysis at WTP-2



Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.900	1.900	18.639	18.639	0.988	0.128	14	15.75	0.275	0.358	0.465	2.141	2.783	3.618	x	x	x			
2	1.900	0.900	37.278	27.468	0.976	0.172	13	13.95	0.250	0.325	0.423	1.452	1.887	2.454	x	x	x			
3	1.900	0.900	55.917	36.451	0.964	0.192	12	11.18	0.200	0.260	0.338	1.040	1.352	1.758	x	x	x			
4	1.950	0.950	75.047	45.770	0.952	0.203	10	9.42	0.175	0.228	0.296	0.862	1.121	1.457	x	x	x			
5	1.950	0.950	94.176	55.090	0.940	0.209	11	9.45	0.140	0.182	0.237	0.670	0.871	1.133	x	x	x			
6	1.880	0.880	112.619	63.723	0.928	0.213	14	11.18	0.160	0.208	0.270	0.750	0.976	1.268	√	√	√	√	√	x
7	1.880	0.880	131.062	72.356	0.916	0.216	15	12.56	0.190	0.247	0.321	0.881	1.145	1.489	√	√	√	√	x	x
8	1.840	0.840	149.112	80.596	0.904	0.217	18	14.29	0.200	0.260	0.338	0.920	1.196	1.555	√	√	√	√	x	x
9	1.840	0.840	167.162	88.836	0.892	0.218	21	15.87	0.230	0.299	0.389	1.054	1.370	1.781	√	√	√	x	x	x
10	1.810	0.810	184.919	96.782	0.880	0.219	22	16.77	0.240	0.312	0.406	1.098	1.427	1.856	√	√	√	x	x	x
11	1.960	0.960	204.146	106.200	0.868	0.217	25	18.19	0.260	0.338	0.439	1.199	1.558	2.026	√	√	√	x	x	x
12	1.960	0.960	223.374	115.618	0.856	0.215	27	18.83	0.275	0.358	0.465	1.279	1.663	2.162	√	√	√	x	x	x
13	1.960	0.960	242.601	125.035	0.844	0.213	41	27.50	0.500	0.650	0.845	2.349	3.053	3.969	√	√	√	x	x	x
14	1.960	0.960	261.829	134.453	0.832	0.211	40	25.87	0.500	0.650	0.845	2.374	3.086	4.012	√	√	√	x	x	x
15	1.920	0.920	280.664	143.478	0.820	0.209	41	25.67	0.500	0.650	0.845	2.398	3.117	4.052	√	√	√	x	x	x
16	1.920	0.920	299.499	152.503	0.808	0.206	11	6.68	0.145	0.189	0.245	0.703	0.914	1.188	√	√	√	√	√	x
17	1.630	0.630	315.490	158.684	0.796	0.206	10	5.95	0.135	0.176	0.228	0.656	0.853	1.109	x	x	x			
18	1.630	0.630	331.480	164.864	0.784	0.205	9	5.26	0.125	0.163	0.211	0.610	0.793	1.031	x	x	x			
19	1.630	0.630	347.470	171.044	0.772	0.204	6	3.44	0.100	0.130	0.169	0.490	0.638	0.829	x	x	x			
20	1.630	0.630	363.461	177.224	0.760	0.203	6	3.38	0.000	0.000	0.000	0.000	0.000	0.000	x	x	x			
if FS ≤1, Liquefication can occur (YES),						if FS >1, No Liquefication can cccur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)											Check By: HW		Prepare by : TGO		Date : 23.11.2015					

Water Table (m)= 1

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.14)Liquefaction Analysis at WTP-3



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.870	1.870	18.345	18.345	0.988	0.128	4	4.50	0.125	0.163	0.211	0.973	1.265	1.645	x	x	x			
2	1.870	0.870	36.689	26.879	0.976	0.173	6	6.51	0.145	0.189	0.245	0.837	1.088	1.415	x	x	x			
3	1.960	0.960	55.917	36.461	0.964	0.192	8	7.45	0.145	0.189	0.245	0.754	0.981	1.275	x	x	x			
4	1.920	0.920	74.752	45.486	0.952	0.203	4	3.78	0.110	0.143	0.186	0.541	0.703	0.914	x	x	x			
5	1.920	0.920	93.587	54.512	0.940	0.210	5	4.32	0.110	0.143	0.186	0.524	0.682	0.886	x	x	x			
6	1.920	0.920	112.423	63.537	0.928	0.213	4	3.20	0.100	0.130	0.169	0.468	0.609	0.792	x	x	x			
7	1.920	0.920	131.258	72.562	0.916	0.215	6	5.02	0.125	0.163	0.211	0.580	0.754	0.981	x	x	x			
8	1.920	0.920	150.093	81.587	0.904	0.216	6	4.73	0.125	0.163	0.211	0.578	0.752	0.977	x	x	x			
9	1.910	0.910	168.830	90.514	0.892	0.216	7	5.24	0.125	0.163	0.211	0.578	0.751	0.977	x	x	x			
10	1.910	0.910	187.567	99.441	0.880	0.216	7	5.26	0.125	0.163	0.211	0.579	0.753	0.979	x	x	x			
11	1.890	0.890	206.108	108.172	0.868	0.215	5	3.61	0.110	0.143	0.186	0.512	0.665	0.865	x	x	x			
12	1.890	0.890	224.649	116.903	0.856	0.214	6	4.16	0.110	0.143	0.186	0.514	0.669	0.869	x	x	x			
13	1.890	0.890	243.190	125.634	0.844	0.212	5	3.35	0.100	0.130	0.169	0.471	0.612	0.796	x	x	x			
14	1.650	0.650	259.376	132.011	0.832	0.213	6	3.92	0.110	0.143	0.186	0.518	0.673	0.875	x	x	x			
15	1.650	0.650	275.563	138.387	0.820	0.212	6	3.83	0.110	0.143	0.186	0.518	0.674	0.876	x	x	x			
16	1.650	0.650	291.749	144.764	0.808	0.212	5	3.12	0.100	0.130	0.169	0.472	0.614	0.798	x	x	x			
17	1.720	0.720	308.623	151.827	0.796	0.210	7	4.26	0.110	0.143	0.186	0.523	0.680	0.884	x	x	x			
18	1.720	0.720	325.496	158.890	0.784	0.209	7	4.16	0.110	0.143	0.186	0.527	0.685	0.890	x	x	x			
19	1.680	0.680	341.977	165.561	0.772	0.207	8	4.66	0.125	0.163	0.211	0.603	0.784	1.019	x	x	x			
20	1.680	0.680	358.457	172.232	0.760	0.206	9	5.14	0.100	0.130	0.169	0.486	0.632	0.822	x	x	x			
if FS $\leq$ 1, Liquefication can occur (YES),						if FS >1, No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.15)Liquefaction Analysis at WTP-4



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.890	1.890	18.541	18.541	0.988	0.128	9	10.13	0.185	0.241	0.313	1.440	1.872	2.434	x	x	x			
2	1.890	0.890	37.082	27.272	0.976	0.173	9	9.69	0.185	0.241	0.313	1.072	1.394	1.812	x	x	x			
3	1.890	0.890	55.623	36.155	0.964	0.193	8	7.48	0.145	0.189	0.245	0.752	0.978	1.271	x	x	x			
4	1.900	0.900	74.262	44.984	0.952	0.204	4	3.80	0.110	0.143	0.186	0.538	0.700	0.910	x	x	x			
5	1.900	0.900	92.901	53.813	0.940	0.211	8	6.95	0.145	0.189	0.245	0.687	0.894	1.162	x	x	x			
6	1.900	0.900	111.540	62.642	0.928	0.215	7	5.64	0.135	0.176	0.228	0.628	0.817	1.062	x	x	x			
7	1.900	0.900	130.179	71.471	0.916	0.217	6	5.06	0.125	0.163	0.211	0.576	0.749	0.974	x	x	x			
8	1.900	0.900	148.818	80.300	0.904	0.218	7	5.57	0.135	0.176	0.228	0.620	0.806	1.048	x	x	x			
9	1.900	0.900	167.457	89.129	0.892	0.218	7	5.28	0.125	0.163	0.211	0.574	0.746	0.970	x	x	x			
10	1.890	0.890	185.998	97.860	0.880	0.217	8	6.07	0.135	0.176	0.228	0.621	0.807	1.049	x	x	x			
11	1.890	0.890	204.539	106.591	0.868	0.217	8	5.81	0.135	0.176	0.228	0.623	0.811	1.054	x	x	x			
12	1.890	0.890	223.079	115.322	0.856	0.215	8	5.59	0.135	0.176	0.228	0.627	0.815	1.060	x	x	x			
13	1.890	0.890	241.620	124.052	0.844	0.214	9	6.06	0.135	0.176	0.228	0.632	0.821	1.068	x	x	x			
14	1.890	0.890	260.161	132.783	0.832	0.212	9	5.86	0.135	0.176	0.228	0.637	0.828	1.077	x	x	x			
15	1.890	0.890	278.702	141.514	0.820	0.210	8	5.04	0.125	0.163	0.211	0.595	0.774	1.006	x	x	x			
16	1.880	0.880	297.145	150.147	0.808	0.208	8	4.90	0.125	0.163	0.211	0.601	0.782	1.016	x	x	x			
17	1.880	0.880	315.588	158.780	0.796	0.206	7	4.17	0.110	0.143	0.186	0.535	0.695	0.904	x	x	x			
18	1.880	0.880	334.031	167.413	0.784	0.203	9	5.22	0.125	0.163	0.211	0.615	0.799	1.039	x	x	x			
19	1.790	0.790	351.590	175.163	0.772	0.201	9	5.10	0.125	0.163	0.211	0.621	0.807	1.049	x	x	x			
20	1.790	0.790	369.150	182.912	0.760	0.199	8	4.44	0.090	0.117	0.152	0.451	0.587	0.763	x	x	x			
if FS $\leq$ 1, Liquefication can occur (YES),						if FS >1, No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1.5

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.16)Liquefaction Analysis at WTP-5



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.870	1.870	18.345	18.345	0.988	0.128	11	12.38	0.210	0.273	0.355	1.635	2.126	2.763	x	x	x			
2	1.870	0.870	36.689	26.879	0.976	0.173	13	14.10	0.250	0.325	0.423	1.444	1.877	2.440	x	x	x			
3	1.870	0.870	55.034	35.563	0.964	0.194	7	6.60	0.145	0.189	0.245	0.748	0.972	1.264	x	x	x			
4	1.890	0.890	73.575	44.294	0.952	0.206	9	8.62	0.175	0.228	0.296	0.851	1.107	1.439	x	x	x			
5	1.890	0.890	92.116	53.025	0.940	0.212	6	5.25	0.125	0.163	0.211	0.589	0.765	0.995	x	x	x			
6	1.890	0.890	110.657	61.756	0.928	0.216	9	7.30	0.145	0.189	0.245	0.671	0.872	1.134	x	x	x			
7	1.820	0.820	128.511	69.800	0.916	0.219	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
8	1.820	0.820	146.365	77.844	0.904	0.221	11	8.88	0.175	0.228	0.296	0.792	1.030	1.338	x	x	x			
9	1.820	0.820	164.219	85.888	0.892	0.222	10	7.69	0.155	0.202	0.262	0.699	0.909	1.181	x	x	x			
10	1.820	0.820	182.074	93.932	0.880	0.222	8	6.19	0.135	0.176	0.228	0.609	0.791	1.029	x	x	x			
11	1.860	0.860	200.320	102.369	0.868	0.221	9	6.67	0.145	0.189	0.245	0.657	0.854	1.110	x	x	x			
12	1.860	0.860	218.567	110.806	0.856	0.220	11	7.84	0.155	0.202	0.262	0.706	0.918	1.193	x	x	x			
13	1.930	0.930	237.500	119.929	0.844	0.217	11	7.53	0.155	0.202	0.262	0.713	0.927	1.206	x	x	x			
14	1.930	0.930	256.433	129.052	0.832	0.215	12	7.92	0.155	0.202	0.262	0.721	0.938	1.219	x	x	x			
15	1.930	0.930	275.367	138.175	0.820	0.212	9	5.74	0.135	0.176	0.228	0.635	0.826	1.074	x	x	x			
16	1.740	0.740	292.436	145.435	0.808	0.211	10	6.22	0.135	0.176	0.228	0.639	0.831	1.080	x	x	x			
17	1.740	0.740	309.506	152.694	0.796	0.210	10	6.07	0.135	0.176	0.228	0.644	0.837	1.088	x	x	x			
18	1.740	0.740	326.575	159.954	0.784	0.208	10	5.93	0.135	0.176	0.228	0.649	0.843	1.096	x	x	x			
19	1.740	0.740	343.644	167.213	0.772	0.206	9	5.22	0.125	0.163	0.211	0.606	0.788	1.024	x	x	x			
20	1.780	0.780	361.106	174.865	0.760	0.204	12	6.81	0.120	0.156	0.203	0.588	0.765	0.994	x	x	x			
if FS $\leq$ 1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1.3

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.17)Liquefaction Analysis at WTP-6



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.910	1.910	18.737	18.737	0.988	0.128	7	7.88	0.155	0.202	0.262	1.207	1.569	2.039	x	x	x			
2	1.910	0.910	37.474	27.664	0.976	0.172	7	7.49	0.145	0.189	0.245	0.844	1.097	1.426	x	x	x			
3	1.910	0.910	56.211	36.747	0.964	0.192	6	5.57	0.135	0.176	0.228	0.704	0.915	1.190	x	x	x			
4	1.940	0.940	75.243	45.968	0.952	0.203	6	5.64	0.135	0.176	0.228	0.666	0.866	1.126	x	x	x			
5	1.940	0.940	94.274	55.190	0.940	0.209	9	7.72	0.155	0.202	0.262	0.743	0.965	1.255	x	x	x			
6	1.950	0.950	113.404	64.509	0.928	0.212	8	6.35	0.135	0.176	0.228	0.637	0.828	1.076	x	x	x			
7	1.950	0.950	132.533	73.829	0.916	0.214	10	8.29	0.155	0.202	0.262	0.725	0.943	1.225	x	x	x			
8	1.850	0.850	150.682	82.167	0.904	0.216	9	7.07	0.145	0.189	0.245	0.673	0.875	1.137	x	x	x			
9	1.850	0.850	168.830	90.506	0.892	0.216	7	5.24	0.125	0.163	0.211	0.578	0.751	0.977	x	x	x			
10	1.850	0.850	186.979	98.844	0.880	0.216	6	4.53	0.125	0.163	0.211	0.578	0.751	0.976	x	x	x			
11	1.850	0.850	205.127	107.183	0.868	0.216	7	5.07	0.125	0.163	0.211	0.579	0.752	0.978	x	x	x			
12	1.850	0.850	223.276	115.521	0.856	0.215	6	4.19	0.110	0.143	0.186	0.511	0.665	0.864	x	x	x			
13	1.820	0.820	241.130	123.565	0.844	0.214	16	10.80	0.200	0.260	0.338	0.934	1.214	1.579	x	x	x			
14	1.820	0.820	258.984	131.610	0.832	0.213	11	7.19	0.145	0.189	0.245	0.681	0.886	1.151	x	x	x			
15	1.820	0.820	276.838	139.654	0.820	0.211	9	5.71	0.135	0.176	0.228	0.639	0.831	1.080	x	x	x			
16	1.740	0.740	293.908	146.913	0.808	0.210	8	4.95	0.125	0.163	0.211	0.595	0.773	1.005	x	x	x			
17	1.740	0.740	310.977	154.173	0.796	0.209	7	4.23	0.110	0.143	0.186	0.527	0.685	0.891	x	x	x			
18	1.700	0.700	327.654	161.040	0.784	0.207	6	3.55	0.110	0.143	0.186	0.530	0.690	0.896	x	x	x			
19	1.700	0.700	344.331	167.907	0.772	0.206	7	4.05	0.110	0.143	0.186	0.534	0.695	0.903	x	x	x			
20	1.720	0.720	361.204	174.970	0.760	0.204	7	3.97	0.090	0.117	0.152	0.441	0.574	0.746	x	x	x			
if FS ≤ 1 , Liquefaction can occur (YES),						if FS > 1 , No Liquefaction can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1.5

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.18)Liquefaction Analysis at WTP-7



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.930	1.930	18.933	18.933	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776	x	x	x			
2	1.930	0.930	37.867	28.057	0.976	0.171	5	5.31	0.125	0.163	0.211	0.730	0.949	1.234	x	x	x			
3	1.930	0.930	56.800	37.339	0.964	0.191	5	4.60	0.125	0.163	0.211	0.656	0.852	1.108	x	x	x			
4	1.890	0.890	75.341	46.070	0.952	0.202	6	5.64	0.135	0.176	0.228	0.667	0.867	1.127	x	x	x			
5	1.890	0.890	93.882	54.801	0.940	0.209	11	9.47	0.175	0.228	0.296	0.836	1.087	1.413	x	x	x			
6	1.900	0.900	112.521	63.630	0.928	0.213	17	13.59	0.250	0.325	0.423	1.172	1.523	1.980	x	x	x			
7	1.900	0.900	131.160	72.459	0.916	0.216	20	16.74	0.310	0.403	0.524	1.438	1.870	2.431	x	x	x			
8	1.900	0.900	149.799	81.288	0.904	0.217	22	17.39	0.310	0.403	0.524	1.431	1.861	2.419	x	x	x			
9	1.860	0.860	168.045	89.724	0.892	0.217	25	18.80	0.350	0.455	0.592	1.612	2.095	2.724	x	x	x			
10	1.910	0.910	186.782	98.651	0.880	0.217	27	20.39	0.400	0.520	0.676	1.847	2.401	3.121	x	x	x			
11	1.910	0.910	205.520	107.579	0.868	0.216	28	20.25	0.400	0.520	0.676	1.856	2.412	3.136	x	x	x			
12	1.910	0.910	224.257	116.506	0.856	0.214	30	20.85	0.305	0.397	0.515	1.424	1.851	2.406	x	x	x			
13	1.900	0.900	242.896	125.335	0.844	0.213	31	20.77	0.305	0.397	0.515	1.434	1.865	2.424	√	√	√	x	x	x
14	1.900	0.900	261.535	134.164	0.832	0.211	33	21.37	0.305	0.397	0.515	1.447	1.881	2.445	√	√	√	x	x	x
15	1.900	0.900	280.174	142.993	0.820	0.209	35	21.95	0.325	0.423	0.549	1.556	2.023	2.630	√	√	√	x	x	x
16	1.910	0.910	298.911	151.920	0.808	0.207	37	22.51	0.360	0.468	0.608	1.742	2.264	2.944	√	√	√	x	x	x
17	1.910	0.910	317.648	160.847	0.796	0.204	38	22.47	0.325	0.423	0.549	1.590	2.067	2.688	√	√	√	x	x	x
18	1.910	0.910	336.385	169.774	0.784	0.202	40	23.02	0.500	0.650	0.845	2.476	3.219	4.184	√	√	√	x	x	x
19	1.890	0.890	354.926	178.505	0.772	0.200	40	22.45	0.500	0.650	0.845	2.506	3.257	4.235	x	x	x			
20	1.890	0.890	373.467	187.236	0.760	0.197	42	23.02	0.360	0.468	0.608	1.827	2.375	3.087	x	x	x			
if FS ≤1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1.5

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.19)Liquefaction Analysis at WTP-8



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.810	1.810	17.756	17.756	0.988	0.128	6	6.75	0.145	0.189	0.245	1.129	1.468	1.908	x	x	x			
2	1.810	0.810	35.512	25.702	0.976	0.175	8	8.88	0.175	0.228	0.296	0.998	1.298	1.687	x	x	x			
3	1.810	0.810	53.268	33.787	0.964	0.198	9	8.71	0.175	0.228	0.296	0.886	1.151	1.497	x	x	x			
4	1.960	0.960	72.496	43.204	0.952	0.208	10	9.70	0.185	0.241	0.313	0.891	1.158	1.506	x	x	x			
5	1.960	0.960	91.724	52.622	0.940	0.213	6	5.27	0.125	0.163	0.211	0.587	0.763	0.992	x	x	x			
6	1.960	0.960	110.951	62.040	0.928	0.216	7	5.67	0.135	0.176	0.228	0.626	0.813	1.057	x	x	x			
7	1.820	0.820	128.805	70.084	0.916	0.219	6	5.11	0.125	0.163	0.211	0.571	0.743	0.965	x	x	x			
8	1.810	0.810	146.561	78.030	0.904	0.221	4	3.23	0.100	0.130	0.169	0.453	0.589	0.766	x	x	x			
9	1.810	0.810	164.318	85.976	0.892	0.222	5	3.84	0.110	0.143	0.186	0.496	0.645	0.839	x	x	x			
10	1.720	0.720	181.191	93.039	0.880	0.223	7	5.44	0.125	0.163	0.211	0.561	0.729	0.948	x	x	x			
11	1.720	0.720	198.064	100.102	0.868	0.223	6	4.50	0.110	0.143	0.186	0.493	0.640	0.833	x	x	x			
12	1.720	0.720	214.937	107.166	0.856	0.223	6	4.35	0.110	0.143	0.186	0.493	0.641	0.833	x	x	x			
13	1.720	0.720	231.810	114.229	0.844	0.223	8	5.61	0.135	0.176	0.228	0.606	0.788	1.025	x	x	x			
14	1.720	0.720	248.684	121.292	0.832	0.222	9	6.13	0.135	0.176	0.228	0.609	0.791	1.029	x	x	x			
15	1.770	0.770	266.047	128.846	0.820	0.220	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
16	1.770	0.770	283.411	136.399	0.808	0.218	1	0.64	0.060	0.078	0.101	0.275	0.357	0.465	x	x	x			
17	1.770	0.770	300.775	143.953	0.796	0.216	5	3.13	0.100	0.130	0.169	0.463	0.601	0.782	x	x	x			
18	1.770	0.770	318.138	151.507	0.784	0.214	6	3.66	0.110	0.143	0.186	0.514	0.668	0.869	x	x	x			
19	1.770	0.770	335.502	159.061	0.772	0.212	8	4.76	0.125	0.163	0.211	0.590	0.768	0.998	x	x	x			
20	1.770	0.770	352.866	166.614	0.760	0.209	10	5.81	0.110	0.143	0.186	0.526	0.683	0.888	x	x	x			
if FS ≤ 1 , Liquefication can occur (YES),						if FS > 1 , No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW			Prepare by : TGO			Date : 23.11.2015				

Water Table (m)= 1.5

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.20)Liquefaction Analysis at WTP-9



A4-1-23

Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.840	1.840	18.050	18.050	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776	x	x	x			
2	1.840	0.840	36.101	26.291	0.976	0.174	13	14.26	0.250	0.325	0.423	1.435	1.865	2.425	x	x	x			
3	1.840	0.840	54.151	34.675	0.964	0.196	15	14.33	0.250	0.325	0.423	1.277	1.661	2.159	x	x	x			
4	1.940	0.940	73.183	43.896	0.952	0.206	11	10.58	0.200	0.260	0.338	0.969	1.260	1.638	x	x	x			
5	1.940	0.940	92.214	53.118	0.940	0.212	10	8.75	0.175	0.228	0.296	0.825	1.072	1.394	x	x	x			
6	2.010	1.010	111.932	63.026	0.928	0.214	11	8.83	0.175	0.228	0.296	0.817	1.062	1.380	x	x	x			
7	1.700	0.700	128.609	69.893	0.916	0.219	3	2.56	0.100	0.130	0.169	0.456	0.593	0.771	x	x	x			
8	1.700	0.700	145.286	76.760	0.904	0.222	3	2.44	0.075	0.098	0.127	0.337	0.438	0.570	x	x	x			
9	1.700	0.700	161.963	83.627	0.892	0.225	3	2.34	0.075	0.098	0.127	0.334	0.434	0.564	x	x	x			
10	1.700	0.700	178.640	90.494	0.880	0.226	3	2.37	0.075	0.098	0.127	0.332	0.432	0.561	x	x	x			
11	1.710	0.710	195.415	97.459	0.868	0.226	4	3.04	0.100	0.130	0.169	0.442	0.575	0.747	x	x	x			
12	1.710	0.710	212.190	104.424	0.856	0.226	5	3.67	0.110	0.143	0.186	0.486	0.632	0.822	x	x	x			
13	1.710	0.710	228.965	111.389	0.844	0.226	5	3.55	0.110	0.143	0.186	0.488	0.634	0.824	x	x	x			
14	1.700	0.700	245.642	118.256	0.832	0.225	7	4.83	0.125	0.163	0.211	0.556	0.723	0.940	x	x	x			
15	1.700	0.700	262.319	125.123	0.820	0.223	8	5.36	0.125	0.163	0.211	0.559	0.727	0.945	x	x	x			
16	1.710	0.710	279.095	132.088	0.808	0.222	10	6.53	0.145	0.189	0.245	0.653	0.849	1.104	x	x	x			
17	1.710	0.710	295.870	139.053	0.796	0.220	12	7.63	0.155	0.202	0.262	0.704	0.915	1.190	x	x	x			
18	1.750	0.750	313.037	146.411	0.784	0.218	13	8.06	0.155	0.202	0.262	0.711	0.925	1.202	x	x	x			
19	1.750	0.750	330.205	153.768	0.772	0.216	12	7.26	0.145	0.189	0.245	0.673	0.875	1.137	x	x	x			
20	1.750	0.750	347.372	161.126	0.760	0.213	12	7.09	0.120	0.156	0.203	0.563	0.732	0.952	x	x	x			
if FS ≤ 1 , Liquefication can occur (YES),						if FS > 1 , No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Water Table (m)= 1

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.21)Liquefaction Analysis at WTP-10



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.980	1.980	19.424	19.424	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776	x	x	x			
2	1.980	0.980	38.848	29.038	0.976	0.170	11	11.48	0.200	0.260	0.338	1.178	1.532	1.991	x	x	x			
3	1.980	0.980	58.271	38.819	0.964	0.188	5	4.51	0.125	0.163	0.211	0.664	0.864	1.123	x	x	x			
4	1.890	0.890	76.812	47.550	0.952	0.200	5	4.62	0.125	0.163	0.211	0.625	0.813	1.057	x	x	x			
5	1.930	0.930	95.746	56.673	0.940	0.206	10	8.47	0.155	0.202	0.262	0.751	0.976	1.269	x	x	x			
6	1.840	0.840	113.796	64.914	0.928	0.211	4	3.16	0.100	0.130	0.169	0.473	0.615	0.799	x	x	x			
7	1.830	0.830	131.748	73.056	0.916	0.215	3	2.50	0.100	0.130	0.169	0.466	0.605	0.787	x	x	x			
8	1.830	0.830	149.701	81.198	0.904	0.217	2	1.58	0.075	0.098	0.127	0.346	0.450	0.585	x	x	x			
9	1.830	0.830	167.653	89.340	0.892	0.218	4	3.02	0.100	0.130	0.169	0.460	0.597	0.777	x	x	x			
10	1.830	0.830	185.605	97.483	0.880	0.218	4	3.04	0.100	0.130	0.169	0.459	0.597	0.776	x	x	x			
11	1.830	0.830	203.558	105.625	0.868	0.217	4	2.92	0.100	0.130	0.169	0.460	0.598	0.777	x	x	x			
12	1.800	0.800	221.216	113.473	0.856	0.217	5	3.52	0.110	0.143	0.186	0.507	0.659	0.857	x	x	x			
13	1.800	0.800	238.874	121.321	0.844	0.216	4	2.72	0.100	0.130	0.169	0.463	0.602	0.782	x	x	x			
14	1.800	0.800	256.532	129.169	0.832	0.215	4	2.64	0.100	0.130	0.169	0.466	0.605	0.787	x	x	x			
15	1.790	0.790	274.091	136.919	0.820	0.213	4	2.56	0.100	0.130	0.169	0.469	0.609	0.792	x	x	x			
16	1.790	0.790	291.651	144.669	0.808	0.212	5	3.12	0.100	0.130	0.169	0.472	0.614	0.798	x	x	x			
17	1.790	0.790	309.211	152.419	0.796	0.210	10	6.07	0.135	0.176	0.228	0.643	0.836	1.087	x	x	x			
18	1.790	0.790	326.771	160.169	0.784	0.208	13	7.70	0.155	0.202	0.262	0.745	0.969	1.260	x	x	x			
19	1.820	0.820	344.625	168.213	0.772	0.206	12	6.94	0.145	0.189	0.245	0.705	0.917	1.192	x	x	x			
20	1.820	0.820	362.480	176.257	0.760	0.203	14	7.91	0.130	0.169	0.220	0.640	0.832	1.081	x	x	x			
if FS $\leq$ 1, Liquefication can occur (YES),						if FS >1, No Liquefication can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Htan Ta Pin Township)										Check By: HW		Prepare by : TGO		Date : 23.11.2015						

Greater Yangon Water Supply Improvement Project (Water level)

No	Name	Date	Water Level(m)
1	WTP (No-1)	16.10.2015	1.10
		17.10.2015	1.00
		18.10.2015	1.20
2	WTP (No-2)	16.10.2015	1.10
		17.10.2015	1.00
		18.10.2015	1.20
3	WTP (No-3)	7.10.2015	1.12
		8.10.2015	0.70
4	WTP (No-4)	11.10.2015	1.20
		12.10.2015	0.92
		13.10.2015	0.11
5	WTP (No-5)	15.10.2015	1.50
		16.10.2015	1.00
		17.10.2015	2.00
		18.10.2015	1.50
6	WTP (No-6)	4.10.2015	1.30
		5.10.2015	0.90
7	WTP (No-7)	4.10.2016	1.50
		5.10.2016	1.80
8	WTP (No-8)	9.10.2015	1.50
		10.10.2015	1.50
		11.10.2015	1.00
		12.10.2015	1.00
9	WTP (No-9)	30.9.2015	1.20
		1.10.2015	1.00
		2.10.2015	1.10
10	WTP (No-10)	29.9.2015	1.00
		30.9.2015	1.00
		1.10.2015	1.00
		2.10.2015	2.00



Figuer (1.1) Location site of the project area

Table 2.1 Summary of Borehole Exploration Work

Borehole No.	Surface Ele.(RL)m	Coordinates		Date Started	Date Completed	Depth of Hole (m)	Soil Drilling (m)	SPT	UD
		Northing	Easting						
SR No.1	2.780	1867450.908	158268.744	18.10.2015	20.10.2015	30.25	30.25	29	3
SR No.2	2.515	1867321.876	185298.636	21.10.2015	23.10.2015	30.26	30.26	29	3
SR No.3	3.221	1867396.174	185197.533	16.10.2015	18.10.2015	30.23	30.23	29	3
SR No.4	2.959	1867424.013	185124.796	12.10.2015	14.10.2015	30.27	30.27	29	3
SR No.5	2.860	1867304.146	185112.757	3.10.2015	10.10.2015	32.32	32	32	3
Total						153.33	153.01	148	15
Note:	SPT	Standard Penetration Test							
	UD	Undisturbed Sample							
				Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)					
				Prepared by : TGO			Checked by : HW		Date :13.11.2015

A4-3

LEGEND

- Clayey SILT
- Silty CLAY
- SAND

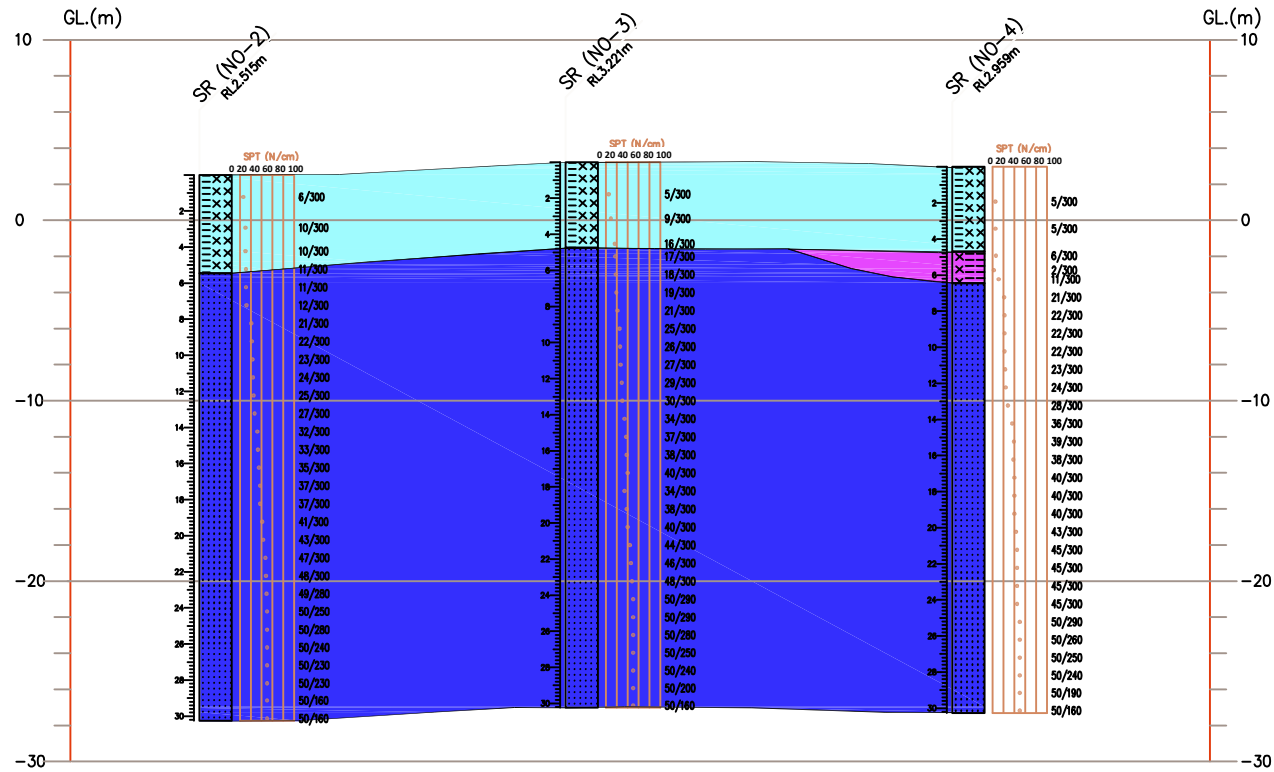
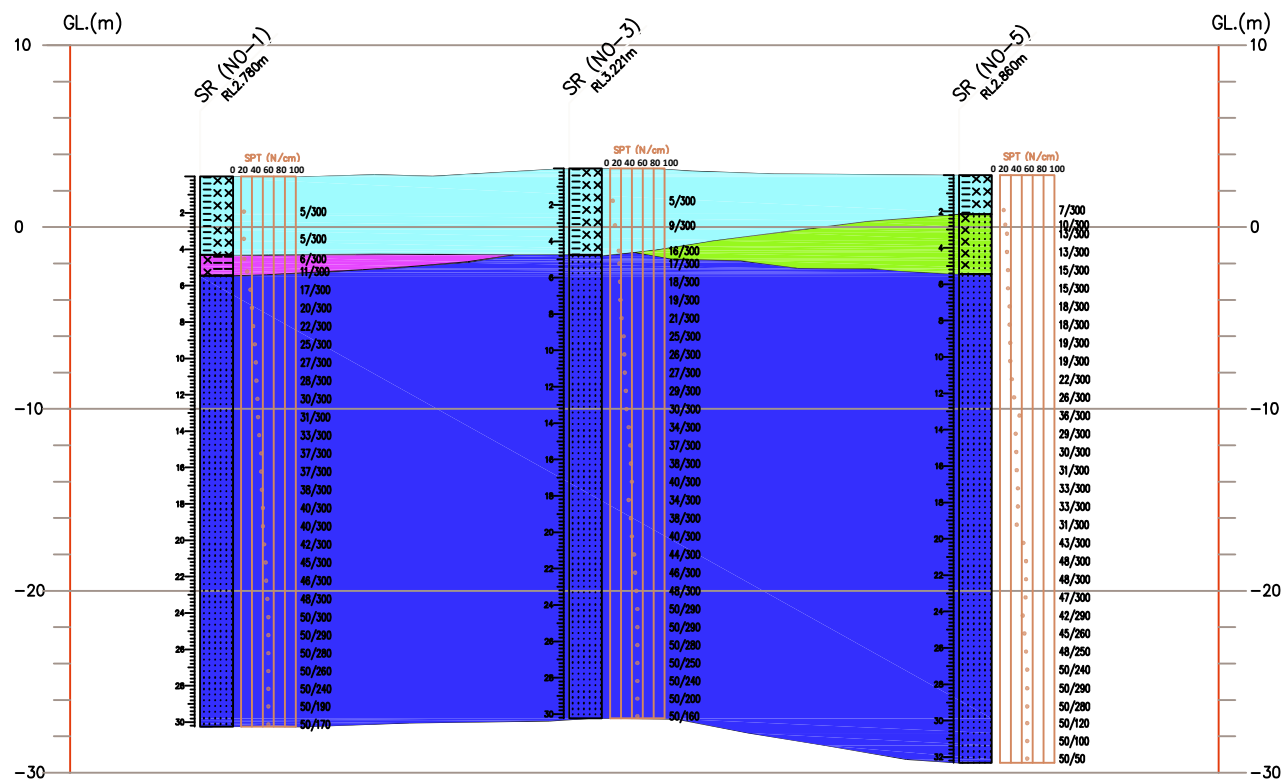


Figure 5.1 Soil Profile Along SR(No-2)~SR(No-3)~SR(No-4)

Remarks:	Section No.	Client:	Drawn by:	Checked by:	Date:
SR(No-2),SR(No-3)&SR(No-4)		TEC INTERNATIONAL CO.,LTD	NMH	HW	13.11.2015
	Scale	Project Title:			
	NTS	Greater Yangon Water Supply Improvement Project Phase II			



LEGEND

- Clayey SILT
- Silty CLAY
- Silty SAND
- SAND

Figure 5.1 Soil Profile Along SR(No-1)~SR(No-3)~SR(No-5)

Remarks:	Section No.		Client:	TEC INTERNATIONAL CO.,LTD	Drawn by:	NMH	Checked by:	HW	Date:	13.11.2015
SR(No-1),SR(No-3)&SR(No-5)	Scale	NTS	Project Title:	Greater Yangon Water Supply Improvement Project Phase II						

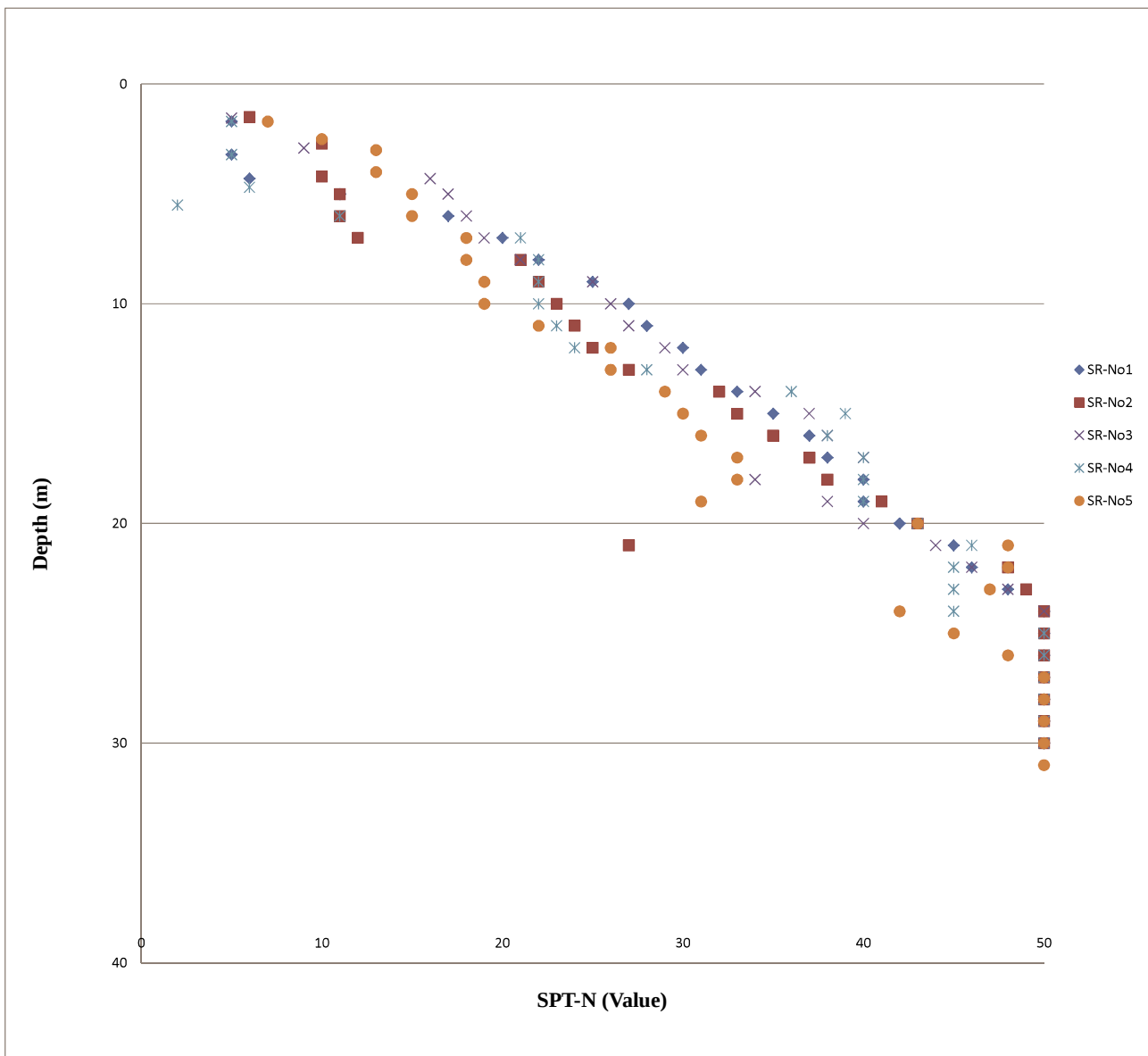


Figure 5.2 Standard Penetration Test N-Value Vs Depth

	Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)		
Prepared by: TGO	Checked by : HW	Date: 27.10.2015	

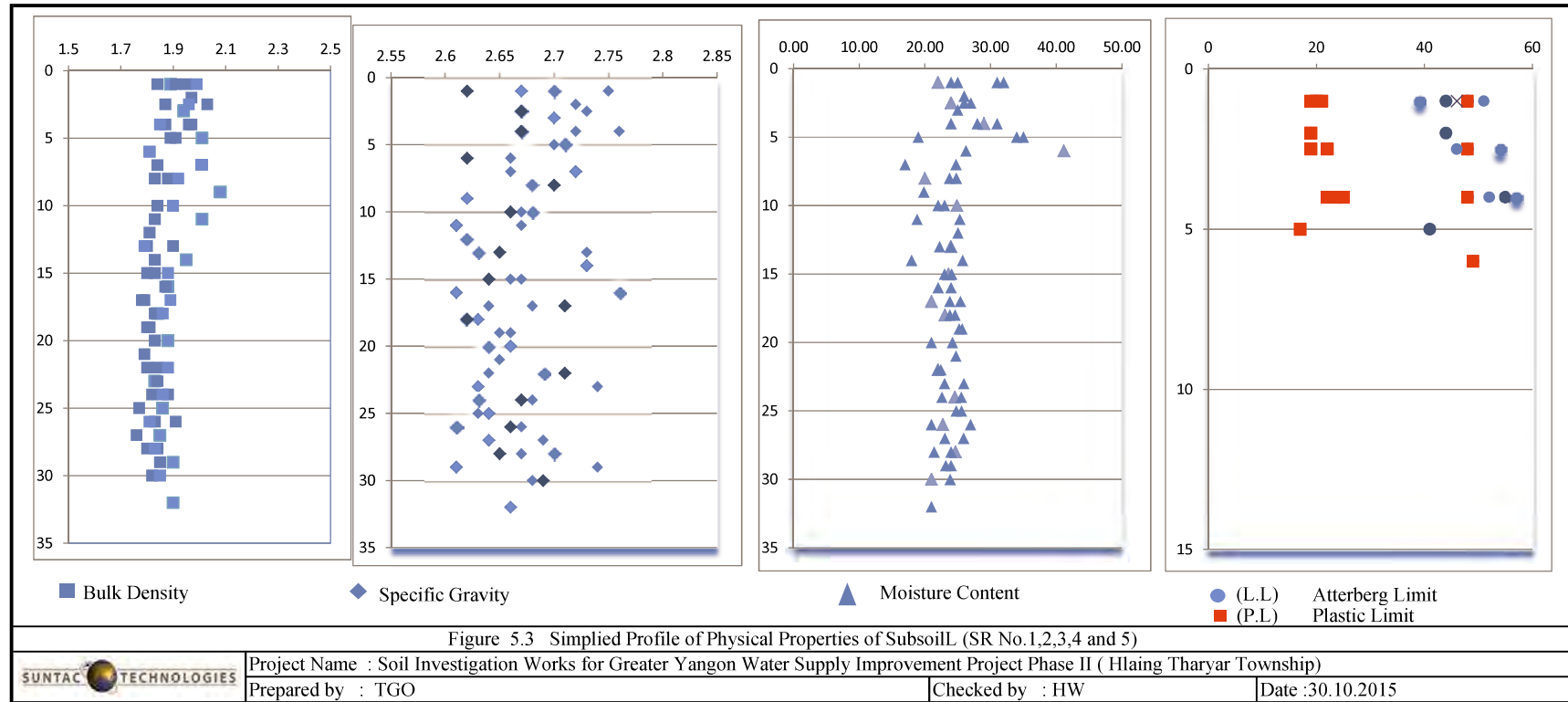


Table 5.1 Summary profile of soil layer

Bore Hole	Ground Elevation	Layer 1		Layer 2		Layer 3	
		Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value
SR (NO-1)	2.780	2.78 ~ -1.52	Medium Stiff,Brown to Grey,Clayey SILT (5)	-1.52 ~ -2.67	Medium Stiff,Brown to Grey,Silty CLAY (6-11)	-2.67 ~ -27.47	Medium Dense to Very Dense,Grey,SAND (17->50)
SR (NO-2)	2.515	2.52 ~ -2.94	Medium Stiff,Brown,Clayey SILT (6-11)	-2.94 ~ -27.75	Medium Dense to Very Dense,Grey,SAND (11->50)		
SR (NO-3)	3.221	3.22 ~ -1.53	Medium Stiff to Stiff,Brown,Clayey SILT (5-16)	-1.53 ~ -27.01	Medium Dense to Very Dense,Grey,SAND (17->50)		
SR (NO-4)	2.959	2.96 ~ -1.74	Medium Stiff,Brown to Grey,Clayey SILT (5)	-1.74 ~ -3.49	Medium Stiff,Grey,Silty CLAY (6-11)	-3.49 ~ -27.31	Medium Dense to Very Dense,Grey,SAND (21->50)
SR (NO-5)	2.860	2.86 ~ 0.71	Medium Stiff,Brown,Clayey SILT (7)	0.71 ~ -2.59	Loose to Medium Dense,Grey,Silty SAND (10-15)	-2.59 ~ -29.46	Medium Dense to Very Dense,Grey,SAND (15->50)
			Project Name : SI work for Greater Yangon Water Supply Improvement Project Phase II				
			Prepared By :NMH		Checked By :HW		Date : 13.11.2015

Table 3.2 Summary of Unconsolidated Undrained Triaxial Compression (UU) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
SR-1	2.50	3.20	26.00	2.03	0.66	100	87.00	8.00
	4.00	4.30	24.00	1.96	0.67	96.44	86.00	5.00
SR-2	1.00	1.50	24.00	1.91	0.70	87.66	49.00	8.00
	5.00	5.45	34.00	1.91	0.87	100	25.00	4.00
SR-3	1.00	1.70	25.00	1.95	0.65	85.41	84.00	9.00
	2.50	3.20	27.00	1.87	0.78	88.47	19.00	4.00
SR-4	2.50	3.20	24.00	1.96	0.69	90.03	91.00	13.00
SR-5	1.00	1.70	32.00	1.89	0.82	99.54	42.00	6.00
		Project Name :Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)						
		Prepared by : TGO			Checked by : HW		Date : 30.10.2015	

Table 3.3 Summary of Direct Shear (DS) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
SR-1	16	16.45	24	1.87	0.75	83.93	18	33
	22	22.45	22	1.84	0.74	78.87	6	39
	28	28.34	24	1.84	0.8	81.62	14	36
SR-2	13	13.45	24	1.8	0.83	76.89	17	35
	23	23.45	23	1.84	0.78	76.37	14	36
	29	29.26	24	1.85	0.78	83.59	6	39
SR-3	10	10.45	23	1.84	0.76	78.73	14	36
	15	15.45	23	1.83	0.78	78.23	15	35
	26	26.41	21	1.83	0.77	74.12	13	37
SR-4	8	8.45	20	1.92	0.67	80.94	18	34
	17	17.45	21	1.89	0.72	98.7	15	36
	22	22.45	22	1.88	0.74	78.22	14	35
	30	30.27	21	1.85	0.73	76.94	13	35
SR-5	5	5.45	19	2.01	0.6	87.43	9	37
	7	7.45	17	2.01	0.57	83.49	16	36
	14	14.45	18	1.95	0.61	79.91	20	33
	20	20.45	21	1.88	0.69	81.66	19	33
	32	32.32	21	1.9	0.69	80.79	13	35
			Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)					
			Prepared By : TGO		Checked By : HW		Date : 30.10.2015	

Table 3.4 Summary of Unconfined Compressive Strength (UCS) Compression Test Results

Borehole No.	Depth (m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Max Stress (kPa)	Strain at Failure (%)	Cohesion (kPa)	Soil Layer No.
	From	To						
SR-1	4.00	4.30	24.00	1.96	231.25	14.93	116	TW-3
SR-2	2.00	2.70	26.00	1.97	72.38	9.48	36	TW-2
SR-3	4.00	4.70	28.00	1.97	208.03	5.34	104	TW-3
SR-4	2.00	2.70	26.00	1.97	72.38	9.48	36	TW-2
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)						
		Prepared By : TGO		Checked By : HW		Date : 30.10.2015		

Table 3.5 Summary of One-dimensional Consolidated Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Initial Void Ratio (e)	Deg. of Saturation (Sr%)	Preconsolidation Pc (kPa)	Compression Index (Cc)
	From	To					
SR-1	1	1.7	31	0.935	95.6	185	0.23
	2.5	3.2	26	0.515	95.5	500	0.16
	5	5.45	35	0.904	99.8	50	0.19
SR-2	1	1.5	24	0.667	96.7	215	0.19
	2	2.7	26	0.917	96.5	120	0.3
	4	4.2	31	0.909	96.1	350	0.31
SR-3	1	1.7	25	0.738	97.9	160	0.17
	2.5	3.2	27	0.846	95.6	205	0.21
	4	4.7	28	0.845	94.9	325	0.28
SR-4	1	1.7	22	0.592	95.7	300	0.19
	2.5	3.2	24	0.718	96.4	200	0.18
	4	4.7	29	0.868	97.9	190	0.26
SR-5	1	1.7	32	0.813	98.3	165	0.26
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaingtharywar Township)					
		Prepared by : TGO		Checked by : HW		Date : 27.10.2015	

Table 3.6 Summary of Triaxial Permeability Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density(Mg/m ³)	Dry Density(Mg/m ³)	Coefficient at 20°C (m/s)
	From	To				
SR-1	1	1.7	31	1.84	1.4	1.8*10 ⁻⁹
	2.5	3.2	26	2.03	1.61	2.2*10 ⁻¹⁰
	4	4.3	24	1.96	1.58	8.7*10 ⁻¹⁰
SR-2	1	1.5	24	1.91	1.54	3.2*10 ⁻¹⁰
	2	2.7	26	1.97	1.56	9.4*10 ⁻¹⁰
	4.00	4.20	31.00	1.870	1.43	6.5*10 ⁻¹⁰
SR-3	1.00	1.70	25.00	1.950	1.56	4.1*10 ⁻¹⁰
	2.50	3.20	27.00	1.870	1.47	2.2*10 ⁻¹⁰
	4.00	4.70	28.00	1.970	1.54	6.6*10 ⁻¹⁰
SR-4	1.00	1.70	22.00	1.990	1.63	9.4*10 ⁻¹⁰
	2.50	3.20	24.00	1.960	1.58	1.7*10 ⁻¹⁰
	4.00	4.70	29.00	1.850	1.43	1.5*10 ⁻¹⁰
SR-5	1.00	1.70	32.00	1.890	1.43	4.2*10 ⁻¹⁰
	3.00	3.45	25.00	1.940	1.55	8.4*10 ⁻¹⁰
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)				
		Prepared By : TGO		Checked By : HW		Date : 30.10.2015

Water Table= 4

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.10)Liquefaction Analysis at SR No.1



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Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Liquefaction Potential for different Mw			Adjustment byfine %for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.840	1.840	18.050	18.050	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776				x	x	x
2	1.840	1.840	36.101	36.101	0.976	0.127	5	4.68	0.125	0.163	0.211	0.985	1.281	1.665				x	x	x
3	2.030	2.030	56.015	56.362	0.964	0.125	5	3.75	0.110	0.143	0.186	0.883	1.148	1.493				x	x	x
4	1.960	1.960	75.243	75.590	0.952	0.123	6	4.40	0.110	0.143	0.186	0.893	1.161	1.509				x	x	x
5	1.890	0.890	93.784	84.321	0.940	0.136	11	7.64	0.155	0.202	0.262	1.140	1.483	1.927				x	x	x
6	1.890	0.890	112.325	93.052	0.928	0.146	17	11.23	0.200	0.260	0.338	1.373	1.785	2.321				x	x	x
7	1.890	0.890	130.865	101.783	0.916	0.153	20	14.12	0.200	0.260	0.338	1.306	1.698	2.208				x	x	x
8	1.880	0.880	149.308	110.415	0.904	0.159	22	14.92	0.220	0.286	0.372	1.384	1.800	2.340	x	x	x	√	√	√
9	1.880	0.880	167.751	119.048	0.892	0.163	25	16.33	0.230	0.299	0.389	1.408	1.830	2.379	x	x	x	√	√	√
10	1.900	0.900	186.390	127.877	0.880	0.167	27	17.91	0.260	0.338	0.439	1.559	2.027	2.635	x	x	x	√	√	√
11	1.900	0.900	205.029	136.706	0.868	0.169	28	17.96	0.260	0.338	0.439	1.536	1.997	2.596	x	x	x	√	√	√
12	1.810	0.810	222.785	144.652	0.856	0.171	30	18.71	0.275	0.358	0.465	1.605	2.086	2.712	x	x	x	√	√	√
13	1.810	0.810	240.541	152.598	0.844	0.173	31	18.82	0.275	0.358	0.465	1.590	2.067	2.687	x	x	x	√	√	√
14	1.830	0.830	258.494	160.741	0.832	0.174	33	19.52	0.290	0.377	0.490	1.667	2.167	2.818	x	x	x	√	√	√
15	1.830	0.830	276.446	168.883	0.820	0.174	35	20.20	0.290	0.377	0.490	1.662	2.161	2.809	x	x	x	√	√	√
16	1.830	0.830	294.398	177.025	0.808	0.175	37	20.86	0.305	0.397	0.515	1.746	2.270	2.951	x	x	x	√	√	√
17	1.830	0.830	312.350	185.168	0.796	0.175	38	20.94	0.305	0.397	0.515	1.747	2.271	2.953	x	x	x	√	√	√
18	1.470	0.470	326.771	189.778	0.784	0.175	40	21.78	0.325	0.423	0.549	1.852	2.408	3.130	x	x	x	√	√	√
19	1.470	0.470	341.192	194.389	0.772	0.176	40	21.52	0.325	0.423	0.549	1.845	2.398	3.118	x	x	x	√	√	√
20	1.470	0.470	355.613	199.000	0.760	0.177	42	22.33	0.325	0.423	0.549	1.841	2.393	3.111	x	x	x	√	√	√
if FS ≤1, Liquefication can occur (YES).						if FS >1, No Liquefication can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)										Check By:		HW	Prepare by :		TGO	Date :		11.11.2015		

Water Table= 4

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.11)Liquefaction Analysis at SR No.2



Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Liquefaction Potential for different Mw			Adjustment byfine %for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.910	1.910	18.737	18.737	0.988	0.128	6	6.75	0.145	0.189	0.245	1.129	1.468	1.908				x	x	x
2	1.970	0.850	38.063	27.076	0.976	0.178	6	6.49	0.135	0.176	0.228	0.757	0.984	1.279				x	x	x
3	1.970	0.840	57.389	35.460	0.964	0.203	10	9.45	0.175	0.228	0.296	0.863	1.122	1.458				x	x	x
4	1.870	1.870	75.733	53.804	0.952	0.174	10	8.69	0.175	0.228	0.296	1.005	1.306	1.698				x	x	x
5	1.910	0.910	94.470	62.731	0.940	0.184	11	8.85	0.175	0.228	0.296	0.951	1.236	1.607				x	x	x
6	1.910	0.910	113.207	71.659	0.928	0.191	11	8.28	0.130	0.169	0.220	0.682	0.887	1.153				x	x	x
7	1.840	0.840	131.258	79.899	0.916	0.196	12	9.57	0.150	0.195	0.254	0.767	0.997	1.296	√	√	x	√	√	√
8	1.840	0.840	149.308	88.139	0.904	0.199	21	15.94	0.230	0.299	0.389	1.155	1.502	1.952	x	x	x	√	√	√
9	1.840	0.840	167.359	96.380	0.892	0.201	22	15.97	0.230	0.299	0.389	1.142	1.485	1.930	x	x	x	√	√	√
10	1.840	0.840	185.409	104.620	0.880	0.203	23	16.86	0.240	0.312	0.406	1.184	1.539	2.001	x	x	x	√	√	√
11	1.830	0.830	203.361	112.762	0.868	0.204	24	16.95	0.240	0.312	0.406	1.179	1.533	1.993	x	x	x	√	√	√
12	1.830	0.830	221.314	120.905	0.856	0.204	25	17.05	0.240	0.312	0.406	1.178	1.532	1.991	x	x	x	√	√	√
13	1.800	0.800	238.972	128.753	0.844	0.204	27	17.85	0.260	0.338	0.439	1.277	1.660	2.158	x	x	x	√	√	√
14	1.800	0.800	256.630	136.601	0.832	0.203	32	20.53	0.305	0.397	0.515	1.501	1.951	2.537	x	x	x	√	√	√
15	1.800	0.800	274.288	144.449	0.820	0.202	33	20.59	0.305	0.397	0.515	1.507	1.959	2.546	x	x	x	√	√	√
16	1.800	0.800	291.946	152.297	0.808	0.201	35	21.27	0.305	0.397	0.515	1.515	1.969	2.560	x	x	x	√	√	√
17	1.780	0.780	309.407	159.949	0.796	0.200	37	21.94	0.325	0.423	0.549	1.624	2.111	2.744	x	x	x	√	√	√
18	1.780	0.780	326.869	167.600	0.784	0.199	38	22.01	0.325	0.423	0.549	1.635	2.126	2.763	x	x	x	√	√	√
19	1.810	0.810	344.625	175.546	0.772	0.197	41	23.21	0.360	0.468	0.608	1.827	2.375	3.088	x	x	x	√	√	√
20	1.810	0.810	362.381	183.493	0.760	0.195	43	23.81	0.400	0.520	0.676	2.050	2.665	3.465	x	x	x	√	√	√
if FS ≤1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)										Check By: HW		Prepare by : TGO		Date : 11.11.2015						

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Water Table=

5

Earth Magnitude (Mw)=

7.5,7.0,6.5

Peak Ground Acceleration(g)=

0.2

Figure (4.12)Liquefaction Analysis at SR No.3



A4-2-15

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Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Liquefaction Potential for different Mw			Adjustment byfine %for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.950	1.950	19.130	19.130	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776				x	x	x
2	1.950	0.850	38.259	27.468	0.976	0.177	5	5.37	0.125	0.163	0.211	0.707	0.920	1.195				x	x	x
3	1.870	0.840	56.604	35.852	0.964	0.198	9	8.45	0.155	0.202	0.262	0.783	1.018	1.324				x	x	x
4	1.970	1.970	75.929	55.178	0.952	0.170	16	13.73	0.250	0.325	0.423	1.468	1.908	2.481				x	x	x
5	1.970	1.970	95.255	74.503	0.940	0.156	17	12.56	0.190	0.247	0.321	1.216	1.581	2.055				x	x	x
6	1.810	0.810	113.011	82.450	0.928	0.165	18	12.64	0.190	0.247	0.321	1.149	1.494	1.942	x	x	x	√	√	√
7	1.810	0.810	130.767	90.396	0.916	0.172	19	14.24	0.200	0.260	0.338	1.161	1.509	1.962	x	x	x	√	√	√
8	1.830	0.830	148.720	98.538	0.904	0.177	21	15.07	0.220	0.286	0.372	1.240	1.612	2.096	x	x	x	√	√	√
9	1.830	0.830	166.672	106.680	0.892	0.181	25	17.25	0.240	0.312	0.406	1.325	1.722	2.239	x	x	x	√	√	√
10	1.840	0.840	184.722	114.921	0.880	0.184	26	18.19	0.260	0.338	0.439	1.414	1.838	2.390	x	x	x	√	√	√
11	1.840	0.840	202.773	123.161	0.868	0.186	27	18.25	0.260	0.338	0.439	1.400	1.819	2.365	x	x	x	√	√	√
12	1.840	0.840	220.823	131.401	0.856	0.187	29	18.97	0.275	0.358	0.465	1.471	1.912	2.485	x	x	x	√	√	√
13	1.900	0.900	239.462	140.230	0.844	0.187	30	19.00	0.275	0.358	0.465	1.468	1.908	2.480	x	x	x	√	√	√
14	1.900	0.900	258.101	149.059	0.832	0.187	34	20.89	0.305	0.397	0.515	1.629	2.117	2.752	x	x	x	√	√	√
15	1.830	0.830	276.053	157.202	0.820	0.187	37	22.13	0.325	0.423	0.549	1.736	2.257	2.934	x	x	x	√	√	√
16	1.830	0.830	294.006	165.344	0.808	0.187	38	22.16	0.325	0.423	0.549	1.740	2.262	2.941	x	x	x	√	√	√
17	1.790	0.790	311.566	173.094	0.796	0.186	40	22.80	0.360	0.468	0.608	1.933	2.513	3.266	x	x	x	√	√	√
18	1.790	0.790	329.126	180.844	0.784	0.185	34	18.96	0.275	0.358	0.465	1.483	1.927	2.506	x	x	x	√	√	√
19	1.800	0.800	346.784	188.692	0.772	0.184	38	20.75	0.305	0.397	0.515	1.654	2.150	2.795	x	x	x	√	√	√
20	1.800	0.800	364.442	196.540	0.760	0.183	40	21.40	0.305	0.397	0.515	1.665	2.164	2.814	x	x	x	√	√	√
if FS ≤1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)										Check By: HW		Prepare by : TGO		Date : 11.11.2015						

Water Table= 4

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.13)Liquefaction Analysis at SR No.4



Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Liquefaction Potential for different Mw			Adjustment byfine %for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.990	1.990	19.522	19.522	0.988	0.128	5	5.63	0.135	0.176	0.228	1.051	1.366	1.776				x	x	x
2	1.990	1.990	39.044	39.044	0.976	0.127	5	4.50	0.125	0.163	0.211	0.985	1.281	1.665				x	x	x
3	0.960	0.960	48.461	48.626	0.964	0.125	5	4.03	0.110	0.143	0.186	0.881	1.145	1.488				x	x	x
4	1.850	1.850	66.610	66.774	0.952	0.123	5	3.90	0.110	0.143	0.186	0.891	1.158	1.506				x	x	x
5	1.850	0.850	84.758	75.113	0.940	0.138	6	4.41	0.110	0.143	0.186	0.798	1.037	1.348				x	x	x
6	1.810	0.810	102.515	83.059	0.928	0.149	11	7.69	0.155	0.202	0.262	1.041	1.353	1.759				x	x	x
7	1.810	0.810	120.271	91.005	0.916	0.157	21	15.68	0.230	0.299	0.389	1.461	1.900	2.470				x	x	x
8	1.920	0.920	139.106	100.030	0.904	0.163	22	15.67	0.230	0.299	0.389	1.407	1.830	2.378	x	x	x	√	√	√
9	1.920	0.920	157.941	109.055	0.892	0.168	22	15.01	0.220	0.286	0.372	1.310	1.703	2.214	x	x	x	√	√	√
10	1.900	0.900	176.580	117.884	0.880	0.171	22	15.20	0.220	0.286	0.372	1.284	1.669	2.170	x	x	x	√	√	√
11	1.900	0.900	195.219	126.713	0.868	0.174	23	15.32	0.220	0.286	0.372	1.265	1.645	2.139	x	x	x	√	√	√
12	1.900	0.900	213.858	135.542	0.856	0.176	24	15.46	0.220	0.286	0.372	1.253	1.629	2.118	x	x	x	√	√	√
13	1.790	0.790	231.418	143.292	0.844	0.177	28	17.54	0.260	0.338	0.439	1.467	1.907	2.480	x	x	x	√	√	√
14	1.790	0.790	248.978	151.042	0.832	0.178	36	21.97	0.325	0.423	0.549	1.823	2.370	3.081	x	x	x	√	√	√
15	1.880	0.880	267.421	159.675	0.820	0.179	39	23.15	0.360	0.468	0.608	2.016	2.621	3.408	x	x	x	√	√	√
16	1.880	0.880	285.863	168.308	0.808	0.178	38	21.97	0.325	0.423	0.549	1.822	2.368	3.079	x	x	x	√	√	√
17	1.890	0.890	304.404	177.038	0.796	0.178	40	22.55	0.360	0.468	0.608	2.023	2.630	3.419	x	x	x	√	√	√
18	1.860	0.860	322.651	185.475	0.784	0.177	40	22.03	0.325	0.423	0.549	1.833	2.383	3.098	x	x	x	√	√	√
19	1.860	0.860	340.898	193.912	0.772	0.176	40	21.54	0.325	0.423	0.549	1.842	2.395	3.113	x	x	x	√	√	√
20	1.860	0.860	359.144	202.348	0.760	0.175	43	22.67	0.360	0.468	0.608	2.053	2.669	3.469	x	x	x	√	√	√
if FS ≤1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)										Check By: HW		Prepare by : TGO		Date : 11.11.2015						

A4-2-16

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Water Table= 3

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.14)Liquefaction Analysis at SR No.5



A4-2-17

33

Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Liquefaction Potential for different Mw			Adjustment byfine %for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.890	1.890	18.541	18.541	0.988	0.128	7	7.88	0.155	0.202	0.262	1.207	1.569	2.039				x	x	x
2	1.890	1.890	37.082	37.082	0.976	0.127	7	6.47	0.110	0.143	0.186	0.867	1.127	1.465				x	x	x
3	1.940	1.940	56.113	56.445	0.964	0.125	13	9.73	0.150	0.195	0.254	1.204	1.565	2.035				x	x	x
4	1.940	0.940	75.145	65.666	0.952	0.142	13	10.23	0.150	0.195	0.254	1.059	1.377	1.790				x	x	x
5	2.010	1.010	94.863	75.574	0.940	0.153	15	11.00	0.160	0.208	0.270	1.043	1.356	1.763				x	x	x
6	2.010	1.010	114.581	85.483	0.928	0.162	15	10.34	0.150	0.195	0.254	0.928	1.206	1.568	√	x	x	√	√	√
7	2.010	1.010	134.299	95.391	0.916	0.168	18	13.13	0.190	0.247	0.321	1.133	1.473	1.915	x	x	x	√	√	√
8	2.010	1.010	154.017	105.299	0.904	0.172	18	12.50	0.180	0.234	0.304	1.047	1.361	1.770	x	x	x	√	√	√
9	2.080	1.080	174.422	115.894	0.892	0.175	19	12.58	0.190	0.247	0.321	1.089	1.415	1.840	x	x	x	√	√	√
10	2.080	1.080	194.827	126.488	0.880	0.176	19	12.67	0.190	0.247	0.321	1.078	1.402	1.822	x	x	x	√	√	√
11	2.010	1.010	214.545	136.396	0.868	0.177	22	14.13	0.200	0.260	0.338	1.127	1.465	1.904	x	x	x	√	√	√
12	2.010	1.010	234.263	146.305	0.856	0.178	26	16.12	0.230	0.299	0.389	1.291	1.678	2.181	x	x	x	√	√	√
13	2.010	1.010	253.981	156.213	0.844	0.178	26	15.60	0.230	0.299	0.389	1.289	1.676	2.179	x	x	x	√	√	√
14	1.950	0.950	273.110	165.532	0.832	0.178	29	16.91	0.240	0.312	0.406	1.345	1.748	2.273	x	x	x	√	√	√
15	1.950	0.950	292.240	174.852	0.820	0.178	30	17.02	0.240	0.312	0.406	1.347	1.751	2.277	x	x	x	√	√	√
16	1.880	0.880	310.683	183.484	0.808	0.178	31	17.16	0.240	0.312	0.406	1.349	1.754	2.280	x	x	x	√	√	√
17	1.880	0.880	329.126	192.117	0.796	0.177	33	17.86	0.260	0.338	0.439	1.467	1.907	2.479	x	x	x	√	√	√
18	1.840	0.840	347.176	200.358	0.784	0.177	33	17.49	0.240	0.312	0.406	1.359	1.767	2.297	x	x	x	√	√	√
19	1.840	0.840	365.226	208.598	0.772	0.176	31	16.10	0.230	0.299	0.389	1.309	1.702	2.212	x	x	x	√	√	√
20	1.880	0.880	383.669	217.231	0.760	0.174	43	21.88	0.325	0.423	0.549	1.862	2.421	3.148	x	x	x	√	√	√
if FS ≤1, Liquefaction can occur (YES),						if FS >1, No Liquefaction can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Hlaing Tharyar Township)										Check By: HW			Prepare by : TGO			Date : 11.11.2015				

Greater Yangon Water Supply Improvement Project (Water level)

No	Name	Date	water Level(m)
1	SR(NO-1)	18.10.2015	4.00
		19.10.2015	4.60
		20.10.2015	5.40
2	SR(NO-2)	21.10.2015	3.70
		22.10.2015	4.10
		23.10.2015	6.70
3	SR(NO-3)	16.10.2015	4.70
		17.10.2015	5.20
		18.10.2015	5.70
4	SR(NO-4)	12.10.2015	4.00
		13.10.2015	4.50
		14.10.2015	6.30
5	SR(NO-5)	3.10.2015	3.00
		6.10.2015	3.50
		8.10.2015	4.50
		9.10.2015	8.00
		10.10.2015	8.70



Figure (1.1) Location Sites of the Project area

Table 2.1 Summary of Borehole Exploration Work

Borehole No.	Surface Ele.(RL)m	Coordinates		Date Started	Date Completed	Depth of Hole (m)	Soil Drilling (m)	SPT	UD
		Northing	Easting						
BH-1 Right	3.988	1864564.401	191263.559	27.10.2015	28.10.2015	40.35	40.35	40	2
BH-2 Left	3.031	1864794.090	191763.221	13.11.2015	17.11.2015	40.26	40.26	40	3
Total						80.61	80.61	80	5
Note:	SPT	Standard Penetration Test							
	UD	Undisturbed Sample							
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)							
		Prepared by : TGO			Checked by : HW			Date : 18.11.2015	

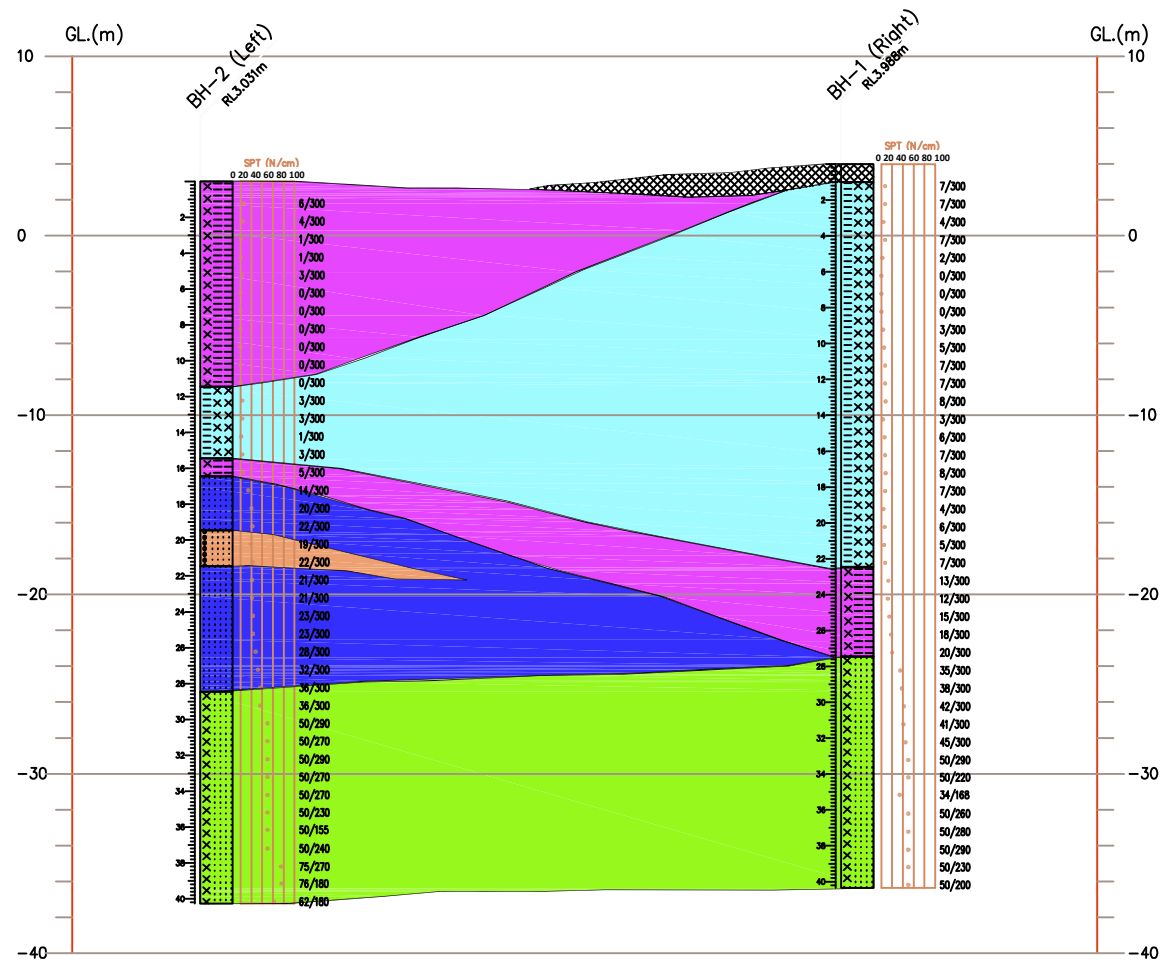


Figure 5.1 Soil Profile Along Bh-1 (Right) ~BH-2(Left)

Remarks:

BH-1(Right),BH-2(Left)

Section No.

0

Drawing Title:

TEC INTERNATIONAL CO.,LTD

Drawn by:

NMH

Checked by:

HW

Date:

27.11.2015

Scale

NTS

Project Title:

Greater Yangon Water Supply Improvement
Project Phase II



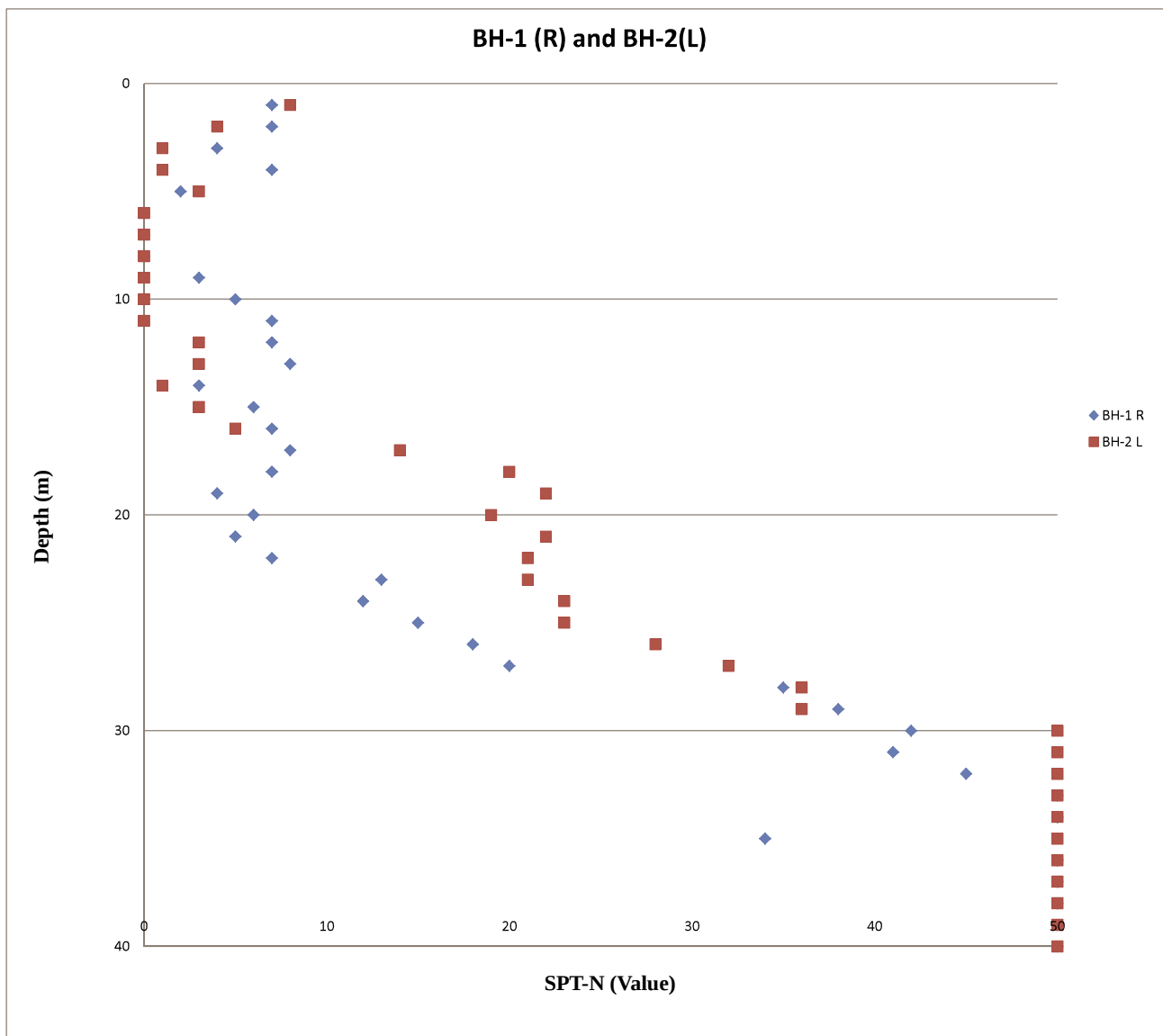


Figure 5.2 Standard Penetration Test N-Value Vs Depth

	Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)		
	Prepared by: TGO	Checked by : HW	Date: 15.10.2015

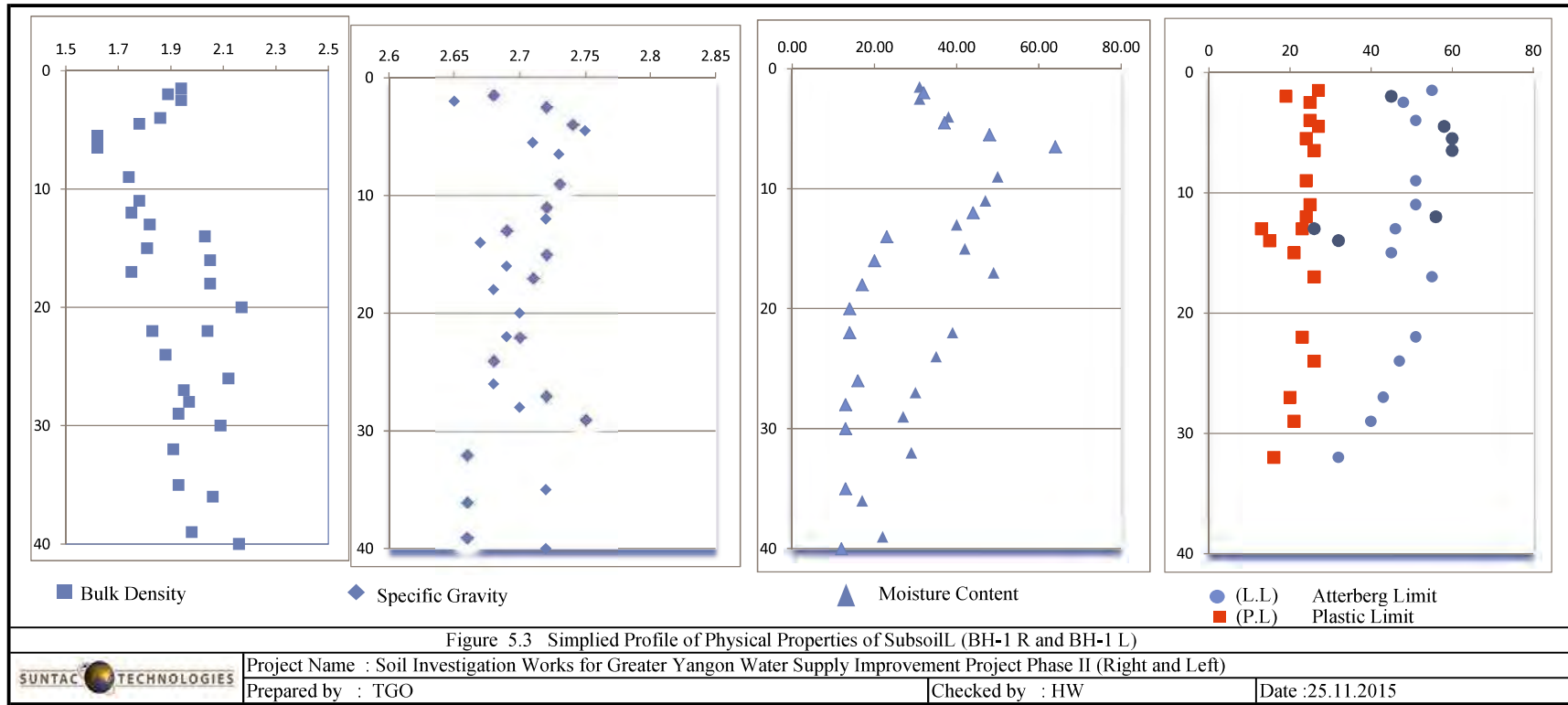


Table 5.1 Summary profile of soil layer

Bore Hole	Ground Elevation	Back fill Soil	Layer 1		Layer 2		Layer 3		Layer 4		Layer 5	
		Thickness From - To	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value	Thickness From - To	Soil Description and N - Value
BH-1 (Right)	3.988	3.99 ~ 2.99	2.99 ~ -5.466	Medium Stiff to Very Soft,Grey, Clayey SILT (0-7)	-18.46 ~ -23.46	Stiff,Reddish Brown,Silty CLAY (12-20)	-23.46 ~ -36.36	Grey to Yellowish Brown,Silty SAND (35->50)	~		~	
			-5.466 ~ -18.46	Medium Stiff ,Grey, Clayey SILT (4-8)								
BH-2 (Left)	3.198		3.0313 ~ -8.42	Medium Stiff to Ver Soft,Grey,Silty CLAY(0-6)	-8.42 ~ -12.42	Soft to Medium Stiff,Grey,Clayey SILT(3-5)	-13.42 ~ -16.42	Medium Dense,Yellowish Brown,SAND (14-22)	-16.42 ~ -18.42	Medium Dense, Yellowish Brown,Gravely SAND(18-22)	25.42 ~ -37.23	Very Dense,Grey,Silty SAND (35 ->50)
			-12.42 ~ -13.42	Medium Stiff,Grey,Silty CLAY (5)			-18.42 ~ -25.42	Medium Dense to Dense, Yellowish Brown,SAND (21-36)				
				Project Name : SI work for Greater Yangon Water Supply Improvement Project Phase II (Right and left)								
				Prepared By :NMH				Checked By :HW			Date : 27.11.2015	

Table 3.2 Summary of Unconsolidated Undrained Triaxial Compression (UU) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
BH-1 (Right)	1.50	2.00	31.00	1.94	0.83	99	46.00	6.00
	2.50	3.00	31.00	1.94	0.77	100.00	62.00	5.00
	17.00	17.45	49.00	1.75	1.21	100.00	4.00	4.00
BH-2 (Left)	2.00	2.45	32.00	1.89	0.83	100.00	9.00	6.00
	16.00	16.45	20.00	2.03	0.56	92.18	16.00	4.00
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)						
		Prepared by : TGO			Checked by : HW		Date : 25.11.2015	

Table 3.3 Summary of Direct Shear (DS) Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Void Ratio (e)	Deg. of Saturation (Sr%)	Shear Strength Parameter	
	From	To					Cohesion C, kPa	Angle of Shearing Resistance ϕ (deg)
BH-1 (Right)	29	29.45	27	1.95	0.87	100	8	32
BH-2 (Left)	22	22.45	14	2.04	0.49	74.75	13	39
			Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)					
			Prepared By : TGO			Checked By : HW		Date 25.11.2015

Table 3.4 Summary of Unconfined Compressive Strength (UCS) Compression Test Results

Borehole No.	Depth (m)		Natural Moisture Content (%)	Bulk Density (Mg/m ³)	Max Stress (kPa)	Strain at Failure (%)	Cohesion (kPa)	Soil Layer No.
	From	To						
BH-1 (Right)	13.00	13.45	40.00	1.82	25.62	9.78	13	SPT-13
	24.00	24.45	35.00	1.88	40.76	11.52	20	SPT-24
BH-2 (Left)	4.50	5.00	37.00	1.78	35.34	6.88	18	TW-1
	12.00	12.45	44.00	1.75	21.71	10.67	11	SPT-12
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)						
		Prepared By : TGO		Checked By : HW		Date : 25.11.2015		

Table 3.5 Summary of One-dimensional Consolidated Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Initial Void Ratio (e)	Deg. of Saturation (Sr%)	Preconsolidation Pc (kPa)	Compression Index (Cc)
	From	To					
BH-1 (Right)	1.5	2	31	0.805	96.6	215	0.22
	2.5	3	31	0.849	98.4	200	0.23
	9	9.45	50	1.333	99.5	65	0.33
BH-2 (Left)	4.5	5	37	1.098	97.4	120	0.37
	5.5	6	48	1.528	97.9	110	0.57
	6.5	7	64	1.605	98.9	55	0.53
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)					
		Prepared by : TGO		Checked by : HW		Date :25.11.2015	

Table 3.6 Summary of Triaxial Permeability Test Results

Borehole No.	Depth(m)		Natural Moisture Content (%)	Bulk Density(Mg/m ³)	Dry Density(Mg/m ³)	Coefficient at 20°C (m/s)
	From	To				
BH-1 (Right)	1.5	2	31	1.94	1.48	5.5*10 ⁻¹⁰
	2.5	3	31	1.94	1.48	2.9*10 ⁻¹⁰
	4	4.45	38	1.86	1.35	1.6*10 ⁻¹⁰
BH-2 (Left)	4.5	5	37	1.78	1.3	3.9*10 ⁻¹⁰
	5.5	6	48	1.62	1.09	3.3*10 ⁻¹⁰
	6.5	7	64	1.62	0.99	4.3*10 ⁻¹⁰
		Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)				
		Prepared By : TGO		Checked By : HW		Date :25.11.2015

Water Table (m)= 1.5

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.8) Liquefaction Analysis at BH-1 R



Depth z(m)	Density, ρ (g/cm ³)	S. Density, ρ' (g/cm ³)	Total Stress, σ (kpa)	Effective Stress, σ' (kpa)	r_d	CSR	N	N1(60)	CRR (for different earthquake magnitude,Mw)			FS (for different earthquake magnitude,Mw)			Adjustment by fine % for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.940	1.940	19.031	19.031	0.988	0.128	7	7.88	0.155	0.202	0.262	1.207	1.569	2.039	x	x	x			
2	1.940	0.940	38.063	28.253	0.976	0.171	7	7.41	0.145	0.189	0.245	0.848	1.103	1.434	x	x	x			
3	1.940	0.940	57.094	37.635	0.964	0.190	4	3.67	0.110	0.143	0.186	0.579	0.752	0.978	x	x	x			
4	1.860	0.860	75.341	46.072	0.952	0.202	7	6.57	0.145	0.189	0.245	0.716	0.931	1.211	x	x	x			
5	1.740	0.740	92.410	53.331	0.940	0.212	2	1.75	0.075	0.098	0.127	0.354	0.460	0.599	x	x	x			
6	1.740	0.740	109.480	60.590	0.928	0.218	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A						
7	1.740	0.740	126.549	67.850	0.916	0.222	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A						
8	1.740	0.740	143.618	75.109	0.904	0.225	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A						
9	1.740	0.740	160.688	82.369	0.892	0.226	3	2.36	0.075	0.098	0.127	0.332	0.431	0.560	x	x	x			
10	1.740	0.740	177.757	89.628	0.880	0.227	5	3.96	0.110	0.143	0.186	0.485	0.630	0.819	x	x	x			
11	1.780	0.780	195.219	97.280	0.868	0.226	7	5.32	0.125	0.163	0.211	0.552	0.718	0.933	x	x	x			
12	1.780	0.780	212.681	104.932	0.856	0.226	7	5.13	0.125	0.163	0.211	0.554	0.720	0.937	x	x	x			
13	1.820	0.820	230.535	112.976	0.844	0.224	8	5.64	0.135	0.176	0.228	0.603	0.784	1.019	x	x	x			
14	1.820	0.820	248.389	121.020	0.832	0.222	3	2.05	0.075	0.098	0.127	0.338	0.439	0.571	x	x	x			
15	1.810	0.810	266.145	128.966	0.820	0.220	6	3.96	0.110	0.143	0.186	0.500	0.650	0.845	x	x	x			
16	1.810	0.810	283.901	136.912	0.808	0.218	7	4.49	0.110	0.143	0.186	0.505	0.657	0.853	x	x	x			
17	1.750	0.750	301.069	144.270	0.796	0.216	8	5.00	0.125	0.163	0.211	0.579	0.752	0.978	x	x	x			
18	1.750	0.750	318.236	151.627	0.784	0.214	7	4.26	0.110	0.143	0.186	0.514	0.669	0.869	x	x	x			
19	1.750	0.750	335.404	158.985	0.772	0.212	4	2.38	0.075	0.098	0.127	0.354	0.461	0.599	x	x	x			
20	1.750	0.750	352.571	166.342	0.760	0.209	6	3.49	0.100	0.130	0.169	0.478	0.621	0.807	x	x	x			
if FS $\leq$ 1, Liquefaction can occur (YES),						if FS > 1, No Liquefaction can occur (No)						$\sqrt{\text{YES}}$, X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)										Check By: HW		Prepare by : TGO		Date : 11.11.2015						

Water Table (m)= 3

Earth Magnitude (Mw)= 7.5,7.0,6.5

Peak Ground Acceleration(g)= 0.2

Figure (4.9)Liquefaction Analysis at BH-2 L



Depth z(m)	Density, ρ (g/cm3)	S. Density,ρ' (g/cm3)	Total Stress,σ (kpa)	Effective Stress,σ' (kpa)	r _d	CSR	N	N1(60)	CRR (for different earthquake mangitude.Mw)			FS (for different earthquake mangitude.Mw)			Adjustment byfine %for different Mw			Liquefaction Potential for different Mw		
									7.5	7	6.5	7.5	7	6.5	7.5	7	6.5	7.5	7	6.5
1	1.890	1.890	18.541	18.541	0.988	0.128	6	6.75	0.145	0.189	0.245	1.129	1.468	1.908	x	x	x			
2	1.890	1.890	37.082	37.082	0.976	0.127	4	3.69	0.110	0.143	0.186	0.867	1.127	1.465	x	x	x			
3	1.890	1.890	55.623	55.946	0.964	0.125	1	0.75	0.060	0.078	0.101	0.482	0.626	0.814	x	x	x			
4	1.890	0.890	74.164	64.677	0.952	0.142	1	0.79	0.060	0.078	0.101	0.423	0.550	0.715	x	x	x			
5	1.780	0.780	91.625	72.329	0.940	0.155	3	2.25	0.075	0.098	0.127	0.484	0.630	0.819	x	x	x			
6	1.620	0.620	107.518	78.411	0.928	0.165	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
7	1.620	0.620	123.410	84.493	0.916	0.174	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
8	1.620	0.620	139.302	90.575	0.904	0.181	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
9	1.750	0.750	156.470	97.933	0.892	0.185	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
10	1.750	0.750	173.637	105.290	0.880	0.189	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
11	1.750	0.750	190.805	112.648	0.868	0.191	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	x	x	x			
12	1.750	0.750	207.972	120.005	0.856	0.193	3	2.05	0.075	0.098	0.127	0.389	0.506	0.657	x	x	x			
13	2.030	1.030	227.886	130.109	0.844	0.192	3	1.97	0.075	0.098	0.127	0.390	0.507	0.660	x	x	x			
14	2.030	1.030	247.801	140.214	0.832	0.191	1	0.63	0.060	0.078	0.101	0.314	0.408	0.530	x	x	x			
15	2.050	1.050	267.911	150.514	0.820	0.190	3	1.83	0.075	0.098	0.127	0.395	0.514	0.668	x	x	x			
16	2.050	1.050	288.022	160.815	0.808	0.188	5	2.96	0.100	0.130	0.169	0.532	0.691	0.898	x	x	x			
17	2.050	1.050	308.132	171.115	0.796	0.186	14	8.03	0.130	0.169	0.220	0.698	0.907	1.179	√	√	√	√	√	x
18	2.050	1.050	328.243	181.416	0.784	0.184	20	11.14	0.160	0.208	0.270	0.868	1.128	1.466	√	√	√	√	x	x
19	2.170	1.170	349.530	192.893	0.772	0.182	22	11.88	0.180	0.234	0.304	0.990	1.287	1.673	√	√	√	√	x	x
20	2.170	1.170	370.818	204.371	0.760	0.179	19	9.97	0.150	0.195	0.254	0.837	1.088	1.414	√	√	√	√	x	x
if FS ≤1, Liquefication can occur (YES),						if FS >1, No Liquefication can occur (No)						√=YES , X= No								
Project Name : Greater Yangon Water Supply Improvement Project Phase II (Right and Left)											Check By: HW		Prepare by : TGO		Date : 25.11.2015					

Greater Yangon Water Supply Improvement Project (Water Level)

No	Name	Date	Water Level(m)
1	Right	27.10.2015	1.80
		28.10.2015	2.50
2	Left	13.11.2015	3.00
		14.11.2015	Full
		15.11.2015	Full
		16.11.2015	2.50
		17.11.2015	3.50

Design Basis**1 Design Condition****1.1 Intake water flow rate**

10%

$$\begin{aligned}
 Q_{Tin} &= 300,000 \text{ m}^3/\text{d} = 12,500 \text{ m}^3/\text{hr} \\
 &= 208.33 \text{ m}^3/\text{min} = 3.472 \text{ m}^3/\text{sec}
 \end{aligned}$$

1.2 Treated water flow rate

5% Loss

$$\begin{aligned}
 Q_{Tin} &= 286,400 \text{ m}^3/\text{d} = 11,933 \text{ m}^3/\text{hr} \\
 &= 198.89 \text{ m}^3/\text{min} = 3.315 \text{ m}^3/\text{sec}
 \end{aligned}$$

1.3 Outlet water flow rate = Transmission water amount

$$\begin{aligned}
 Q_{Tout} &= 272,800 \text{ m}^3/\text{d} = 11,367 \text{ m}^3/\text{hr} \\
 &= 189.44 \text{ m}^3/\text{min} = 3.157 \text{ m}^3/\text{sec}
 \end{aligned}$$

1.4 Water quality

Turbidity (Raw W.)	50~ 1000	NTU	Turbidity Data by YCDC Lab.
Ave.	250	NTU	600NTU x 2 Month, 300 NTU x 4 Month and 100NTU x 6 Month
ave. after Pre-sedimentation pond	50	NTU	by Precipitation test
Turbidity (Treated W.)	< 1	NTU	

2 Specification**2.1 Pre-Sedimentation Pond**

Quantity	1	Pond			
Type	Gravity flow				
W.L	+ 1.30	m			
Dimension	Width	200 m x Length	500 m x Height	5.05 m as Ave.	
Total Volume	505,000	m ³		(including 0.5m sand pocket)	
Retention time	1.7	days (=	42.3 hours)		
Accessories	Slope, Bypass pipe dia.1800mm				

2.2 Lift pump well

Quantity	2	basin			
Dimension	Width	2.2 m x Length	13.6 m x Height	4.0 m	
Dimension	Width	6.0 m x Length	6.0 m x Height	4.0 m	
Total Volume	527	m ³			
Retention time	2.5	min			
Accessories	Gates for lift pumps, Auto-screen, Sand pumps				

2.3 Lift pump

Intake pump	67m ³ /min x H18m x approx. 300kw				
Quantity	5	sets	(3 duty + 2 stand by)		
Type	Horizontal Doble Suction Volute				
Accessories	VFD(Operation), Electrical panel, Electrically crane				

2.4 Receiving well

Quantity	3	basins			
Dimension	Width	4.5 m x Length	4.5 m x Height	6.0 m	
Total Volume	365	m ³			
Retention time	1.8	min			

2.5 Mixing well

Quantity	3	basins			
Type	Flash mixer				
Dimension	Width	4.5 m x Length	4.5 m x Height	5.1 m	
Total Volume	310	m ³			
Retention time	1.5	min			
Accessories	Over flow weir				

Kokkova Water Treatment Plant**60MGD =272,800m3/d****2.6 Flocculation basin**

Quantity	6	basins		
Type	Horizontal and vertical zigzag flow			
Dimension	Width	1.1 m x Length	145.2 m x Height	4.35 m (Ave.)
Total Volume	4,074	m3		
Retention time	20.4	min		
Accessories	Weir			

2.7 Sedimentation basin

Quantity	6	basins		
Type	Horizontal flow + Tube settler			
Total Dimension	Width	24.2 m x Length	31.1 m x Height	4.00 m (Effective)
	(Tube settler: Width	23.9 m x Length	24.4 m x Height	4.00 m
Total Volume	32,059	m3		
Retention time of Total basi	1.5	hr		
Flow speed	0.4	m/min		
Upward flow speed	57	mm/min		
Surface loading	12.5	mm/min		
Accessories	Tube settler, Sludge collector, De-sludging valves with Air-compressor			

2.8 Rpid sand filter

Quantity	8	basins x 3 trains		
Type	Gravity flow rapid sand filter			
Dimension	Width	9.5 m x Length	12.0 m	
Filter layer	single-media filter layer	Sand	Dep.	0.6 m
Filtration rate	120	m/d		
Washing method	Backwashing: 0.40 m/min Self-washing by filtered water Air washing: 0.75 m/min			
Accessories	Underdrain, Rotary blower, Electrical driven valves with Control unit			

2.9 Alum Dosing Facility

Liquid ACH	Packing Style			
Feed Rate	Ave.	25 mg/L		
Consumption	Ave.	7,160 L/day =	7.2 m3/day	

1) Dissolving/Storage Tank

Quantity	6	tanks		
Type	Cylindrical tank			
Effective Volume	50	m3		
Total Volume	300	m3		
Retention time as average	7.0	days as average		
Accessories	Transfer pump			

2) Alum Dosing Pump

Quantity	6	sets (3 duty + 3 stand-by)		
Type	Diaphragm pump			
Capacity	0.8 - 3.4 L/ min x 0.5 Mpa			

2.10 Disinfection Dosing Facility

Liquid Sodium hypochlorite	Packing Style			
Feed Rate of Pre&Interm.	Ave.	3.0 mg/L		
Feed Rate of Post.	Ave.	0.5 mg/L		
Consumption	Ave.	955 L/day =	1.0 m3/day	
Storage Volume	Ave.	1.6 m3/day	Considering concentration reduction	

1) Dissolving/Storage Tank

Quantity	6	tanks		
Type	Cylindrical tank			
Effective Volume	50	m3		
Total Volume	300	m3		
Retention time as average	31.4	days as average		
Accessories	Transfer pump			

Kokkova Water Treatment Plant**60MGD =272,800m3/d**

2) Dosing Pump	Pre& Intermediate chlorination		
Quantity	6	sets	(3 duty + 3 stand-by)
Type	Diaphragm pump		
Capacity	Pre-Chlorine 0.9 - 4.0 L/ min x 0.5 MPa		
	Inter-Chlorine 0.9 - 4.0 L/ min x 0.5 MPa		
	Post-Chlorine 0.9 - 4.0 L/ min x 0.5 MPa		

2.1 Clear Water Reservoir

Quantity	3	basins			
Dimension	Width	25 m	x Length	30 m	x Height 5.5 (Effective)
Total Volume	12,375	m3			
Retention time	1.1	hr			

2.1 Transmission pump station for Zone9

Transmission pump	32 m3/min x H 49.0m x approx. 375 kw				
Quantity	3	sets	(2 duty + 1 stand-by)		
Type	Horizontal Doble Suction Volute				
Accessories	On/Off, Flywheel, Electrical panel, Electrically crane				

2.1 Transmission pump station for Relay Tank

Transmission pump	64 m3/min x H 38.0m x approx. 630 kw				
Quantity	3	sets	(2 duty + 1 stand-by)		
Type	Horizontal Doble Suction Volute				
Accessories	On/Off, Flywheel, Electrical panel, Electrically crane				

3 Wastewater Treatment Facility**3.1 Water quality**

Ave. Turbidity (Intake W.)	250	NTU		
Planned Turbidity	50	NTU	Ave. after 48 hrs	

3.2 Alum Dosing Facility

Liquid PAC	40	Packing Style		
Dissolving Concentration	C=	15 %		
Feed Rate	Ave.	5 ppm		
Dry Sludge Amount		33,975	Dry-kg/day	

3.3 Sludge concentration

Wash water drainage basin	0.5	C: %	5 kg/m3	from Filter
Sludge basin	3.0	C: %	30 kg/m3	from Sedimentation
Sludge thickener	3.0	C: %	30 kg/m3	
Sludge drying bed	6.0	C: %	60 kg/m3	

3.4 Wash water drainage basin

Quantity	3	basins						
Dimension	Width	12 m	x Length	12 m	x Height 3.0 (Effective)			
Total Volume	1,296	m3						
Wash water amount	10,944	m3/day						
Retention time	2.8	hr	> 1 hr of washing cycle					
Accessories	Wastewater Trans. Pump (2 duty + 1 stand-by) x 3							
	Slurry Pump; Capa. 23m3/min x 10m x approx. 55 kw							

3.5 Sludge basin

Quantity	3	basins			
Dimension	Width	12 m	x Length	12 m	x Height 3.0 (Effective)
Total Volume	1,296	m3			
Drainage Amount	789	m3/day			
Retention time	1.6	day	> 1 day		
Accessories	Wastewater Trans. Pump (2 duty + 1 stand-by) x 3				
	Slurry Pump; Capa. 0.2m3/min x 10m x approx. 1.5 kw				

Kokkova Water Treatment Plant**60MGD =272,800m3/d****3.6 Sludge thickener**

Quantity	3	basins		
Dimension	Dia.	12 m x Height	1.5 m (Effective)	
Total Volume	509	m3		
Sludge Amount	395	m3/day		
Retention time	1.3	day		
Accessories	Center driven column : Dia. 12.0 m x 1.5 m x 3			

3.7 Sludge drying bed

Quantity	9	basins		
Dimension	Width	18 m x Length	20 m	
Total Area	3,240	m2		
Accessories	Sand, Gravel, Collecting pipe			

Kokkowa WTP System: Hydraulic Calculation for Transmission Pumps/Pipelines

Starting Point	End Point	Flow (MGD)	Design Flow (m3/D)	Design Flow (m3/min)	Design Flow (m3/sec)	Pipeline Planning													Remarks
						Dia. (mm)	Length (m)	Velocity (m/sec)	C-Value	Hydraulic Gradient (per mille)	Head loss (m)	Start Point LWL (m)	Start Point Pump Head (m)	Pump Around Loss (m)	Start Point D.W.L (m)	End Point D.W.L (m)	End Point HWL (m)	Residual Effective Head(m)	
		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑬	⑭	⑮	⑯=⑬+⑭-⑮	⑰=⑯-⑩	⑱	⑲=⑱-⑩	
In 2025																			
A (Kokkowa WTP)	B (Z9:Zone 9 SR)	60	272,800	189.4	3.20	1600	21,350	1.57	110	1.52	32.39	+3.20	+38.00	+0.50	+40.70	+8.31	+3.00	+5.31	> 5.0m, O.K
C(Z1:Relay P.S.)	D	37	168,300	116.9	1.90	1600	8,250	0.97	110	0.62	5.12	-4.00	+87.00	+0.50	+82.50	+77.38			South Route
Hlaing River Crossing		37	168,300	116.9	1.90	1600	550	0.97	110	0.62	0.34				+77.38	+77.04			
D	F	37	168,300	116.9	1.90	1600	6,150	0.97	110	0.62	3.82				+77.04	+73.22			
F	J	37	168,300	116.9	1.90	1600	2,200	0.97	110	0.62	1.37				+73.22	+71.85			
J	H (Z1:Kokine SR)	37	168,300	116.9	1.90	1400	2,850	1.27	110	1.19	3.39				+71.85	+68.46	+42.60	+25.86	> 5.0m, O.K
In 2030																			
A (Kokkowa WTP)	B (Z9:Zone 9 SR)	60	272,800	189.4	3.20	1600	21,350	1.57	110	1.52	32.39	+3.20	+38.00	+0.50	+40.70	+8.31	+3.00	+5.31	> 5.0m, O.K
C(Z9:Zone 9 SR)	D	60	272,800	189.4	3.20	1600	8,250	1.57	110	1.52	12.52	-4.00	+87.00	+0.50	+82.50	+69.98			South Route
Hlaing River Crossing		60	272,800	189.4	3.20	1600	550	1.57	110	1.52	0.83				+69.98	+69.15			
D	F	60	272,800	189.4	3.20	1600	6,150	1.57	110	1.52	9.33				+69.15	+59.82			
F	J	60	272,800	189.4	3.20	1600	2,200	1.57	110	1.52	3.34				+59.82	+56.48			
J	H (Z1:Kokine SR)	40	181,900	126.3	2.10	1400	2,850	1.37	110	1.37	3.91				+56.48	+52.57	+42.60	+9.97	> 5.0m, O.K
J	K (Z1:Central SR)	20	91,000	63.2	1.10	1000	2,150	1.34	110	1.96	4.22				+56.48	+52.26	+41.94	+10.32	> 5.0m, O.K
C(Z9:Zone 9 SR)	O	22	100,100	69.5	1.20	1800	7,350	0.46	110	0.13	0.98	-4.00	+50.00	+0.50	+45.50	+44.52			North Route
O	D	22	100,100	69.5	1.20	1600	3,650	0.58	110	0.24	0.87				+44.52	+43.65			
D	G	22	100,100	69.5	1.20	1600	3,350	0.58	110	0.24	0.79				+43.65	+42.86			
G	E (Z3:Inya SR)	22	100,100	69.5	1.20	1400	460	0.75	110	0.46	0.21				+42.86	+42.65	+14.00	+28.65	> 5.0m, O.K
In 2035																			
A (Kokkowa WTP)	B (Z9:Zone 9 SR)	60	272,800	189.4	3.20	1600	21,350	1.57	110	1.52	32.39	+3.20	+38.00	+0.50	+40.70	+8.31	+3.00	+5.31	> 5.0m, O.K
A-2 (Kokkowa WTP)	B-2 (Z9:Zone 9 SR)	80	363,700	252.6	4.20	1800	21,350	1.65	110	1.46	31.09	+3.20	+38.00	+0.50	+40.70	+9.61	+3.00	+6.61	> 5.0m, O.K
C(Z9:Zone 9 SR)	D	65	295,500	205.2	3.40	1600	8,800	1.70	110	1.76	15.48	-4.00	+87.00	+0.50	+82.50	+67.02			South Route
D	F	65	295,500	205.2	3.40	1600	6,150	1.70	110	1.76	10.82				+67.02	+56.20			
F	J	65	295,500	205.2	3.40	1600	2,200	1.70	110	1.76	3.87				+56.20	+52.33			
J	H (Z1:Kokine SR)	43	195,500	135.8	2.30	1400	2,850	1.47	110	1.57	4.48				+52.33	+47.85	+42.60	+5.25	> 5.0m, O.K
J	K (Z1:Central SR)	22	100,100	69.5	1.20	1000	2,150	1.48	110	2.34	5.04				+52.33	+47.29	+41.94	+5.35	> 5.0m, O.K
C(Z9:Zone 9 SR)	O	89	404,600	281.0	4.70	1800	7,350	1.84	110	1.77	13.03	-4.00	+50.00	+0.50	+45.50	+32.47			North Route
O	D	50	227,300	157.8	2.60	1600	3,650	1.31	110	1.08	3.95				+32.47	+28.52			
D	G	50	227,300	157.8	2.60	1600	3,350	1.31	110	1.08	3.62				+28.52	+24.90			
G	E (Z3:Inya SR)	50	227,300	157.8	2.60	1600	460	1.31	110	1.08	0.50				+24.90	+24.40	+14.00	+10.40	> 5.0m, O.K
O	P (Z4:Airport SR)	39	177,300	123.1	2.10	1500	3,850	1.16	110	0.94	3.60				+32.47	+28.87	+23.00	+5.87	> 5.0m, O.K
In 2040																			
A (Kokkowa WTP)	B (Z9:Zone 9 SR)	60	272,800	189.4	3.20	1600	21,350	1.57	110	1.52	32.39	+3.20	+38.00	+0.50	+40.70	+8.31	+3.00	+5.31	> 5.0m, O.K
A-2 (Kokkowa WTP)	B-2 (Z9:Zone 9 SR)	80	363,700	252.6	4.20	1800	21,350	1.65	110	1.46	31.09	+3.20	+38.00	+0.50	+40.70	+9.61	+3.00	+6.61	> 5.0m, O.K
C(Z9:Zone 9 SR)	D	110	500,100	347.3	5.80	1600	8,800	2.88	110	4.66	40.98	-4.00	+86.00	+0.50	+81.50	+40.52			South Route
D	G	110	500,100	347.3	5.80	1600	3,350	2.88	110	4.66	15.60				+40.52	+24.92			
G	E (Z3:Inya SR)	110	500,100	347.3	5.80	1600	460	2.88	110	4.66	2.14				+24.92	+22.78	+14.00	+8.78	> 5.0m, O.K
C(Z9:Zone 9 SR)	O	55	250,100	173.7	2.90	1800	7,350	1.14	110	0.73	5.35	-4.00	+50.00	+0.50	+45.50	+40.15			North Route
O	P (Z4:Airport SR)	55	250,100	173.7	2.90	1500	3,850	1.64	110	1.77	6.81				+40.15	+33.34	+23.00	+10.34	> 5.0m, O.K
E (Z3:Inya SR)	I (Z2:Thingangyun SR)	54	245,500	170.5	2.80	1400	9,300	1.85	110	2.39	22.25	+8.00	+36.00	+0.50	+43.50	+21.25	+14.00	+7.25	> 5.0m, O.K
N (Dala SR)	F	71	322,800	224.2	3.70	1600	7,950	1.86	110	2.07	16.47	+5.00	+72.00	+0.50	+76.50	+60.03			
F	J	71	322,800	224.2	3.70	1600	2,200	1.86	110	2.07	4.56				+60.03	+55.47			
J	K (Z1:Central SR)	25	113,700	79.0	1.30	1000	2,150	1.68	110	2.97	6.38				+55.47	+49.09	+41.94	+7.15	> 5.0m, O.K
J	H (Z1:Kokine SR)	46	209,200	145.3	2.40	1400	2,850	1.57	110	1.78	5.07				+55.47	+50.40	+42.60	+7.80	> 5.0m, O.K

Kokkowa WTP System: Hydraulic Calculation for Transmission Pumps/Pipelines (Kokine Repair)

Starting Point	End Point	Flow (MGD)	Design Flow (m3/D)	Design Flow (m3/min)	Design Flow (m3/sec)	Pipeline Planning													Remarks
						Dia. (mm)	Length (m)	Velocity (m/sec)	C-Value	Hydraulic Gradient (per mille)	Head loss (m)	Start Point LWL (m)	Start Point Pump Head (m)	Pump Around Loss (m)	Start Point D.W.L (m)	End Point D.W.L (m)	End Point HWL (m)	Residual Effective Head(m)	
		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑬	⑭	⑮	⑯=⑬+⑭-⑮	⑰=⑯-⑩	⑱	⑲=⑰-⑱	
In 2025																			
C(Z9:Zone 9 SR)	D	41	186,400	129.4	2.20	1600	8,250	1.07	110	0.75	6.19	-4.00	+72.00	+0.50	+67.50	+61.31			Under Kokine Repair: 72m
Hlaing River Crossing		41	186,400	129.4	2.20	1600	550	1.07	110	0.75	0.41				+61.31	+60.90			
D	F	41	186,400	129.4	2.20	1600	6,150	1.07	110	0.75	4.61				+60.90	+56.29			
F	J	41	186,400	129.4	2.20	1600	2,200	1.07	110	0.75	1.65				+56.29	+54.64			
J	H (Z1:Kokine SR)	41	186,400	129.4	2.20	1400	2,850	1.40	110	1.44	4.09				+54.64	+50.55	+42.60	+7.95	> 5.0m, O.K

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Starting Point	End Point	Flow (MGD)	Design Flow (m3/D)	Design Flow (m3/min)	Design Flow (m3/sec)	Pipeline Planning														Remarks	
						Dia. (mm)	Length (m)	Accumulati Length	Velocity (m/sec)	C-Value	Hydrauric Gradient (per mille)	Head loss (m)	Start Point LWL (m)	Start Point Pump Head (m)	Pump Around Loss	Start Point D.W.L (m)	End Point D.W.L (m)	End Point GL/HWL (m)	Residual Effective Head(m)		
						⑤	⑥		⑦	⑧	⑨	⑩	⑬	⑭	⑮	⑯=⑬+⑭-⑮	⑰=⑯-⑩	⑱	⑲=⑱-⑱		
In 2025 (Yegu Pump Station to Central Reservoir), Pump Head 47m (Existing)																					
1 (Yegu Pump Station)	2	22.1	100,500	69.8	1.20	1400	2,120	2,120	0.76	110	0.46	0.97	3.70	+47.00	+2.00	+48.70	+47.73	+12.00	+35.73		
2	3	22.1	100,500	69.8	1.20	1400	320	2,440	0.76	110	0.46	0.15				+47.73	+47.58	+7.00	+40.58		
3	4	22.1	100,500	69.8	1.20	1400	1,680	4,120	0.76	110	0.46	0.77				+47.58	+46.81	+12.00	+34.81		
4	5	22.1	100,500	69.8	1.20	1400	1,240	5,360	0.76	110	0.46	0.57				+46.81	+46.24	+37.50	+8.74		
5	6	22.1	100,500	69.8	1.20	1050	380	5,740	1.34	110	1.86	0.71				+46.24	+45.53	+27.00	+18.53		
6	7	22.1	100,500	69.8	1.20	1050	90	5,830	1.34	110	1.86	0.17				+45.53	+45.36	+25.00	+20.36		
7	8	22.1	100,500	69.8	1.20	1050	420	6,250	1.34	110	1.86	0.78				+45.36	+44.58	+25.00	+19.58		
8	9	22.1	100,500	69.8	1.20	1050	150	6,400	1.34	110	1.86	0.28				+44.58	+44.30	+20.00	+24.30		
9	10	22.1	100,500	69.8	1.20	1050	220	6,620	1.34	110	1.86	0.41				+44.30	+43.89	+17.00	+26.89		
10	11	22.1	100,500	69.8	1.20	1050	580	7,200	1.34	110	1.86	1.08				+43.89	+42.81	+15.00	+27.81		
11	12	22.1	100,500	69.8	1.20	1050	330	7,530	1.34	110	1.86	0.61				+42.81	+42.20	+27.50	+14.70		
12	13	22.1	100,500	69.8	1.20	1050	160	7,690	1.34	110	1.86	0.30				+42.20	+41.90	+32.50	+9.40		
13	14 (Central Reservoir)	22.1	100,500	69.8	1.20	1050	340	8,030	1.34	110	1.86	0.63				+41.90	+41.27	+41.94	-0.67	< 5.0m, N.G	
※Flow (Transmission Flow = 17 MGD, Distribution Flow = 5.1 MGD (30% of transmission flow) , Total Flow =22.1 MGD																					
In 2025 (Yegu Pump Station to Central Reservoir), Pump Head 47m → 53m																					
1 (Yegu Pump Station)	2	22.1	100,500	69.8	1.20	1400	2,120	2,120	0.76	110	0.46	0.97	3.70	+53.00	+2.00	+54.70	+53.73	+12.00	+41.73	Pump Head 47m → 53m	
2	3	22.1	100,500	69.8	1.20	1400	320	2,440	0.76	110	0.46	0.15				+53.73	+53.58	+7.00	+46.58		
3	4	22.1	100,500	69.8	1.20	1400	1,680	4,120	0.76	110	0.46	0.77				+53.58	+52.81	+12.00	+40.81		
4	5	22.1	100,500	69.8	1.20	1400	1,240	5,360	0.76	110	0.46	0.57				+52.81	+52.24	+37.50	+14.74		
5	6	22.1	100,500	69.8	1.20	1050	380	5,740	1.34	110	1.86	0.71				+52.24	+51.53	+27.00	+24.53		
6	7	22.1	100,500	69.8	1.20	1050	90	5,830	1.34	110	1.86	0.17				+51.53	+51.36	+25.00	+26.36		
7	8	22.1	100,500	69.8	1.20	1050	420	6,250	1.34	110	1.86	0.78				+51.36	+50.58	+25.00	+25.58		
8	9	22.1	100,500	69.8	1.20	1050	150	6,400	1.34	110	1.86	0.28				+50.58	+50.30	+20.00	+30.30		
9	10	22.1	100,500	69.8	1.20	1050	220	6,620	1.34	110	1.86	0.41				+50.30	+49.89	+17.00	+32.89		
10	11	22.1	100,500	69.8	1.20	1050	580	7,200	1.34	110	1.86	1.08				+49.89	+48.81	+15.00	+33.81		
11	12	22.1	100,500	69.8	1.20	1050	330	7,530	1.34	110	1.86	0.61				+48.81	+48.20	+27.50	+20.70		
12	13	22.1	100,500	69.8	1.20	1050	160	7,690	1.34	110	1.86	0.30				+48.20	+47.90	+32.50	+15.40		
13	14 (Central Reservoir)	22.1	100,500	69.8	1.20	1050	340	8,030	1.34	110	1.86	0.63				+47.90	+47.27	+41.94	+5.33	> 5.0m, O.K	
※Flow (Transmission Flow = 17 MGD, Distribution Flow = 5.1 MGD (30% of transmission flow) , Total Flow =22.1 MGD																					

