SUMMARY

LABORATORY TESTS

Client: Oriantal Consultant Co.Ltd in associated with Pacific Consultants international — Job Ref: 2320

Project: Supplimental soil & Geotechnical survey for outer circular highway to city of Colombo — Date: 15.06.2007

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
NS-01-BH-01	10.428	2.45	7.98	Disturb	Clayey sand	SC	15.55					99.04	96	73.74	53.72	47.02	29	28	38	12	26						
		3.45	6.98	Disturb	Clayey sand	SC						99	96	63.85	50.18	48.59	32	29	40	24	16						
NS-01-BH-02	9.134	3.45	5.68	Disturb	Clayey sand	SC	20.05					98	88	58.02	39.42	33.43	26	21	44	20	24						
		4.45	4.68	Disturb	Clayey sand	SC	17.07					100	97	59.66	32.29	25.71	12	9	31	20	11						
NS-01-BH-03	8.834	1.45	7.38	Disturb	Silty sand	S M	38.15					96.00	90	67.52	57.97	54.32	11	6	55	31	24						
		1.6	7.23	Undisturbed	Sandy lean Clay	CL	30.22				2.46	100	97	78.65	63.72	56.25	6.2	2.4	48	26	22						
		2.45	6.38	Disturb	Poorly graded sand with silt	SP-SM	13.42					93.87	80	47.80	13.13	7.38	7	1	NP	NP	NP						
NS-01-BH-04	8.488	1.45	7.04	Disturb			28.56																				
		1.6	6.89	Undisturbed	Sandy lean clay	CL	16.84				2.57	100	96	77.01	62.83	56.2	14	7	31	16	15						
		3.45	5.04	Disturb	Clayey sand	SC	28.56					100	99	68.42	44.17	36.39	8	0	41	24	17						
		5.45	3.04	Disturb																							
		6.45	2.04	Disturb																							
		7.45	1.04	Disturb	Sandy silt	ML	28.59					98	91	72.53	65.17	61.71	10.7	8	37	27	10						
NS-01-BH-05	8.061	1.6	6.46	UD	Sandy lean clay	CL	18.84				2.62	98	90	71.88	63.75	57.6	9	6	31	15	16						
		2.45	5.61	Disturb	Silty sand	SM	18.75					96	88	54.81	40.38	29.24	8	6	NP	NP	NP						
		4.45	3.61	Disturb	Clayeyb sand	SC	15.22					99	92	57.91	33.3	26.63	8	2	26	15	11						
NS-01-BH-06	7.741	2.45	5.29	Disturb	Sandy lean clay	CL	22.71					100	99	72.14	57.55	51.50	14	10	37	21	16						
		3.45	4.29	Disturb	Silty sand	SM	26.57					100	100	81.72	42.48	32.08	16	15	NP	NP	NP						
		4.45	3.29	Disturb	Silty sand	SM	18.81					100	88	48.35	28.08	21.90	4	3	NP	NP	NP						
		7.45	0.29																				9.56				
		7.55	0.19	Core																		2.37					
NS-01-BH-07	7.608	3.45	-3.45	Disturb	Clayey sand	SC	23.34					100	100	81.72	42.48	32.08	16	12.5	50	22	28						
	7.608	4.45	-4.45	Disturb	Clayey sand	SC	16.50					93.21	83	40.23	29.52	26.67	10	7	29	14	15						
NS-01-BH-08	7.010	1.45	5.56	Disturb	Clayey sand	SC	22.38					99	97	74.84	44.41	32.91	10	8	42	19	23						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI			Pc	Cc	Cs	Cc/(1+e)
																			%	%	%						
BH-10 STA-9+106, L-30	22.619	1.45	21.17	Disturbed			19.43	-			-	96.31	82.50	63.67	46.77	39.57	12.00	10.50	-	-	-						
		5.45	17.17	Disturbed	Silty sand with gravel	SM	-	-	-		-	81.83	72.93	50.49	43.38	41.20	-	-	56	38	18						
		6.45	16.17	Disturbed	Sandy elastic silt	MH	-	-	-		-	97.30	94.70	71.17	59.88	57.22	-	-	59	37	22						
		9.45	13.17	Disturbed			28.23	-	-		-								-	-	-						
		12.45	10.17	Disturbed	Silty sand		-	-	-		-	98.10	96.96	68.95	53.86	49.46	-	-	44	28	16						
		14.45	8.17	Disturbed			37.60	-	-		-	-	-	-	-	-	-	-	-	-	-						
BH-12 STA-9+415,R-113	8.443	1.45	6.99	Disturbed	Sandy silt	ML	-	-	-		-	100	99.50	75.24	49.67	45.21	35	32.5	46	29	17						
		2.45	5.99	Disturbed	Silty sand	SM	-	-	-		-	94.95	91.34	53.67	28.64	25.33	-	-	48	36	12						
		3.45	4.99	Disturbed			32.73	-	-		-	-	-	-	-	-	-	-	-	-	-						
		4.45	3.99	Disturbed	Silty sand	SM	-	-	-		-	93.48	90.69	61.68	28.07	19.83	-	-	NP	NP	NP						
		7.45	0.99	Disturbed			28.19	-	-		-	-	-	-	-	-	-	-	-	-	-						
		8.45	-0.01	Disturbed			16.77	-	-		-	-	-	-	-	-	-	-	-	-	-						
BH-13 STA-9+415,R-25	15.343	1.45	13.89	Disturbed	Sandy lean clay	CL				-	2.57	98.64	97	81.19	61.31	56.52	0.50	0.025	52	24	28						
		3.45	11.89	Disturbed	Sandy elastic silt	MH	-	-	-	-	-	98.46	95.17	70.23	58.22	55.75	-	-	54	39	15						
		4.45	10.89	Disturbed			39.36	-	-		-	-	-	-	-	-	-	-	-	-	-						
		7.45	7.89	Disturbed	Sandy lean clay	CL						100.00	99	80.46	62.06	54.77	7	4.5	45	21	24						
		8.45	6.89	Disturbed			28.73	-	-		-	-	-	-	-	-	-	-	-	-	-						
		11.45	3.89	Disturbed			23.92	-	-		-	-	-	-	-	-	-	-	-	-	-						
		12.45	2.89	Disturbed	Sandy elastic silt	MH	-	-	-		-	96.54	90.80	55.75	40.68	36.66	-	-	66	33	33						
		14.45	0.89	Disturbed			14.4				-	-	-	-	-	-	-	-	-	-	-						
BH-14 STA-9+415,L-25	14.359	1.45	12.91	Disturbed	Sandy elastic silt	MH	-	-	-		-	100	99.34	74.95	61.17	58.9	-	-	57	42	15						
		2.45	11.91	Disturbed	Sandy elastic silt	MH	31.22	-	-		-	-	-	-	-	-	-	-	-	-	-						
		7.45	6.91	Disturbed	Sandy elastic silt	MH						99.05	98.02	81.27	62.22	58.28			38	26	12						
		8.45	5.91	Disturbed	Sandy elastic silt	MH	-	-	-		-	100	99.13	71.42	55.97	52.53	-	-	53	36	17						
		9.45	4.91	Disturbed	Silty sand	SM	-	-	-		-	99.3	96.79	69.94	48.13	41.63	-	-	42	29	13						
		12.45	1.91	Disturbed			17.98	-	-		-	-	-	-	-	-	-	-	-	-	-						
		15.45	-1.09	Disturbed			13.34	-	-		-	-	-	-	-	-	-	-	-	-	-						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI			Pc	Cc	Cs	Cc/(1+e)
																			%	%	%						
BH-15 STA-9+520,CL	22.432	2.45	19.98	Disturbed	Sandy elastic silt with grave	MH	37.4	-			-	79.21	77.14	59.27	52.88	51.15	-	-	69	37	32						
		4.45	17.98	Disturbed			44.26	-			-	-	-	-	-	-	-	-	-	-	-						
		7.45	14.98	Disturbed	Sandy elastic silt	MH	-	-			-	99.9	97.92	73.91	60.85	58.01	-	-	54	37	17						
		8.45	13.98	Disturbed			39.71	-			-	-	-	-	-	-	-	-	-	-	-						
		16.45	5.98	Disturbed			34.55	-			-	-	-	-	-	-	-	-	-	-	-						
		19.45	2.98	Disturbed	Silty sand	SM						96.64	83.5	59.31	39.83	34.52	8.50	7.00	NP	NP	NP						
BH-16 STA 9+700,CL	8.536	1.45	7.09	Disturbed	Clayey sand	SC	-	-			-	87.23	82.16	55.28	35.18	30.98	-	-	45	25	20						
		2.45	6.09	Disturbed	Clayey sand	SC						92.67	88.50	58.71	46.71	44.53	8.00	6.50	47	24	23						
		3.45	5.09	Disturbed			40.92	-			-	-	-	-	-	-	-	-	-	-	-						
		6.45	2.09	Disturbed			19.43	-			-	-	-	-	-	-	-	-	-	-	-						
		7.45	1.09	Disturbed	Silty sand	SM	-	-			-	99.82	94.08	53.05	29.59	24.39	-	-	NP	NP	NP						
		8.45	0.09	Disturbed			13.08	-			-	-	-	-	-	-	-	-	-	-	-						
BH-17 STA 9+800,CL	6.521	1.45	5.07	Disturbed	Organic silt	OL	46.81	-				100	100.00	94.62	82.91	76.86	18	13	47	29	100						
		1.5	5.02	Undisturbed	Organic silt	OL	31.67	1.62	36.10	6.3	2.51	100	100.00	97.47	89.69	84.24	45.5	39.9	47	29	18			48	0.361	0.043	0.18
		2.45	4.07	Disturbed			24.53	-			-	-	-	-	-	-	-	-	-	-	-						
		4.45	2.07	Disturbed	Silty sand	SM	-	-			-	100	99.76	54.17	18.35	9.75	-	-	NP	NP	NP						
BH-18 STA 9+900,CL	10.382	1.45	8.93	Disturbed	Clayey sand with gravel	SC						62.92	40.00	23.59	20.23	19.51	10.00	8.00	38	21	17						
		2.45	7.93	Disturbed	Silty sand	SM	-	-			-	85.92	83.17	61.44	46.96	41.79	-	-	52	37	15						
		4.45	5.93	Disturbed			39.05	-			-	-	-	-	-	-	-	-	-	-	-						
		8.45	1.93	Disturbed			34.53	-			-	-	-	-	-	-	-	-	-	-	-						
		9.45	0.93	Disturbed	Silty sand	SM	-	-			-	92.16	81.2	43.07	23.19	17.6	-	-	49	33	16						
		11.45	-1.07	Disturbed			13.72	-			-	-	-	-	-	-	-	-	-	-	-						
BH-19 STA 10+020,CL	21.983	3.45	18.53	Disturbed	Sandy clay	MH						93.64	91.66	79.09	70.2	67.11			57	28	29						
		5.45	16.53	Disturbed			29.98																				
		6.45	15.53	Disturbed	Sandy caly	MH						96.28	94.21	68.9	54.34	50.66			46	24	22						
		12.45	9.53	Disturbed			16.07																				
		13.52	8.46	Core																		2.70	25.08				

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		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-24 STA 10+535,CL	8.391	1.45	6.94	Disturbed			43.22																				
		2.45	5.94	Disturbed	Silty sand	SM	13.2					98.25	90.93	46.47	25.4	20.42			NP	NP	NP						
		3.45	4.94	Disturbed	Silty sand	SM						98.55	92.08	48.41	22.18	16.58			NP	NP	NP						
BH-25 STA 10+800, CL	8.879	2.45	6.43	Disturbed			22.77																				
		3.45	5.43	Disturbed			21.52																				
		4.45	4.43	Disturbed	Silty sand	SM						97.92	92.49	51.36	24.94	18.70			NP	NP	NP						
		5.45	3.43	Disturbed	Silty sand	SM						100	97.47	53.58	23.85	18.88			NP	NP	NP						
BH-26 STA 10+700,CL	9.236	1.45	7.79	Disturbed	Silty sand	SM						98.15	94.2	61.95	35.46	17.75			49	35	14						
		1.9	7.34	Undisturbed	Silt	ML	21.23	2.07	8.00		2.65	100.00	100.00	99.66	95.51	90.42	12.50	5.50	NP	NP	NP			15	0.048	0.007	0.03
		1.9		Undisturbed																				11	0.071	0.016	0.037
		2.45	6.79	Disturbed	Sandy lean clay	OL						98.61	94.64	73.12	56.82	53.54			46	20	26						
		5.45	3.79	Disturbed			18.22																				
		7.45	1.79	Disturbed			17.53																				
BH-27 STA 10+800,CL	11.781	1.45	10.33	Disturbed	Silty gravel with sand	GM						41.61	38.25	31.05	22.66	18.93			49	35	14						
		3.45	8.33	Disturbed	Silty sand	SM						96.55	85.58	61.14	38.67	30.86			NP	NP	NP						
		4.45	7.33	Disturbed			27.32																				
		7.45	4.33	Disturbed			22.6																				
BH-28 STA 10+800 L-35	10.477	1.5	8.98	Undisturbed	Silty sand	SM	37.26		Cannot be done		2.63	98.49	96.73	77.53	53.73	47.43			NP	NP	NP			10	0.359	0.039	0.17
		2.45	8.03	Disturbed			50.72																				
		5.45	5.03	Disturbed			37.26																				
		7.45	3.03	Disturbed	Silty sand with gravel	SM						84.52	78.66	50.74	38.20	33.86			NP	NP	NP						
BH-29 STA 10+950 CL	16.067	1.45	14.62	Disturbed			11.21																				
		2.45	13.62	Disturbed	Clayey sand	SC						86.17	81.72	57.68	35.94	30.73			43	18	25						
		3.45	12.62	Disturbed			19.21																				
		10.45	5.62	Disturbed	Sandy silt	ML						98..51	96.89	87.96	63.78	55.67			42	29	13						
		24.6		Core																		2.72	16.83				
NS-01-BH-30	21.84	4.45	-4.45	Disturb	Silty sand	SM	25.68					100	98.5	65.22	53.05	48.55	22	16	64	38	26						
		8.45	-8.45	Disturb	Silty sand	SM	24.49					100	98	54.86	40.96	36.95	4	1	47	32	15						
		18.45	-18.45	Disturb	Sandy silt	ML	30.72					100	100	82.43	66.96	58.11	11	6	43	29	14						

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		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-32 STA 11+258 CL	31.07	1.45	29.62	Disturbed			17.31																				
		2.45	28.62	Disturbed	Clayey sand with gravel	SC	12.27					72.29	50.2	31.93	26.03	23.83			45	25	20						
		3.45	27.62	Disturbed	Silty sand with gravel	SM						73.51	52.92	36.51	31.27	29.45			64	33	31						
		4.70	26.37	Core	Core																	2.72	31.21				
BH-35 STA 11+400 CL	23.713	2.45	21.26	Disturbed			11.09																				
		3.45	20.26	Disturbed	Clayey sand with gravel	SC						75.2	67.64	46.53	37.86	35.51			65	32	33						
		4.45	19.26	Disturbed			29.19																				
		7.45		Disturbed	Sandy silt	ML						95.33	91.50	79.43	64.01	59.51	28.00	17.45	44	31	13						
		21	2.71	Core																		2.70	12.28				
BH-36 STA-11+650 CL	15.354	1.45	13.90	Disturbed	Silty gravel with sand	GM						51.75	43.48	29.36	23.61	22			50	31	19						
		2.45	12.90	Disturbed			25.72																				
		3.45	11.90	Disturbed	Silty sand with gravel	SM						83.02	78.98	57.34	45.94	43.47			58	33	25						
		4.45	10.90	Disturbed	Silty sand	SM						88.64	87.65	66.5	46.58	41.13			54	36	18						
		7.45	7.90	Disturbed			36.45																				
		8.45	6.90	Disturbed			52.97																				
BH-37 STA11+750,CL	10.121	1.00	9.12	Undisturbed	Sandy organic silt	OL	179.35	1.59	17.10	26.90	2.63	99.23	96.50	91.25	79.63	69.62	6.50	0.25	NP	NP	NP			20	0.625	0.072	20
		1.45	8.67	Disturbed			158.55																				
		2.45	7.67	Disturbed	Silty sand	SM						99.07	95.07	63.28	23.31	13			NP	NP	NP						
		8.45	1.67	Disturbed	Silty sand	SM						99.12	95	65.98	44.74	38.73			NP	NP	NP						
		11.45	-1.33	Disturbed			32.90																				
BH-38 STA 11+850,CL	9.307	1.45	7.86	Disturbed	Clayey sand	SM						98.79	95.52	69.08	53.25	49.1			50	27	23						
		4.45	4.86	Disturbed			30.21																				
		6.45	2.86	Disturbed	Silty sand	SM						100	98.	57.11	47.2	43.36			40	28	12						
		9.45	-0.14	Disturbed	Silty sand	SM						100	99.13	68.12	57.92	53.2			47	34	13						
		10.45	-1.14	Disturbed			24.95																				
		13.45	-4.14	Disturbed			14.19																				

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-39 STA 11+950,CL	10.372	1.45	8.92	Disturbed	Silty gravel with sand	GM						61.47	56.27	42.5	34.3	31.94			65	43	22						
		4.45	5.92	Disturbed	Sandy elastic silt	MH						99.26	93.08	66.88	57.21	53.63			56	37	19						
		5.45	4.92	Disturbed			24.4																				
		7.45	2.92	Disturbed	Silty sand	SM	35.43					99.62	96.21	67.55	27.58	22.55			55	44	11						
		12.45	-2.08	Disturbed			24.95																				
BH-40 STA12+050 L-30	7.535	1.45	6.09	Disturbed			39.53																				
		2.45	5.09	Disturbed	Clayey sand	SC						98.24	93	61.21	46.44	41.33	14.00	8.50	54	25	29						
BH-40 STA 12+050 L-30	7.535	3.45	4.09	Disturbed	Silty sand	SM	15.39					98.73	96.63	63.47	25.86	17.32			NP	NP	NP						
		4.45	3.09	Disturbed			34.86																				
		8.45	-0.91	Disturbed	Silty sannd	SM						98.65	92.76	54.15	27.88	23.07			NP	NP	NP						
BH-41 STA 12+050 CL	9.598	1.45	8.15	Disturbed	Sandy lean clay	CL	26.6					97.32	95.75	77.18	67.91	65.08			44	24	20						
		2.45	7.15	Disturbed	Sandy lean clay	CL						86.53	81.11	63.45	56.79	55.44			39	17	22						
		3.45	6.15	Disturbed	Clayey sand	SC	35.53					93.36	82.32	56.39	41.49	38.58			42	23	19						
		4.45	5.15	Disturbed			20.38																				
BH-42 STA 12+160 CL	15.854	1.45	14.40	Disturbed	Sandy elastic silt	MH						94.23	88.86	63.46	57.3	55.58			69	37	32						
		6.45	9.40	Disturbed	Silty sand	SM						99.64	97.81	65.27	50.82	47.87			59	33	26						
		8.45	7.40	Disturbed			47.3																				
		12.45	3.40	Disturbed			29.68																				
BH-43 STA 12+530 CL	5.618	0.5	5.12	Undisturbed	Clayey sand	SC	29.01	1.02	3.60	3.82	2.53	100.00	98.5	75.21	49.45	38.98	18.5	16	30	19	10						
		1.45	4.17	Disturbed			33.25																				
		3.5	2.12	Undisturbed	Lean clay	CL	85.98	2.07		3.82	2.45	100.00	100.00	97.56	93.45	85.96	25.00	18.00	43	24	19			20	0.656	0.057	0.2
		5.45	0.17	Disturbed	Silty sand	SM	31.4					100.00	97.07	67.39	51.03	44.87			42	34	8						
		9.45	-3.83	Disturbed	Clayey sand	SC						99.13	97.35	69.53	39.97	34.57			30	21	9						
BH-44 STA 12+400 CL	7.708	3.45	4.26	Disturbed	Silty sand	SM	34.67					98.05	91.51	54.79	39.05	35.23			NP	NP	NP						
		5.45	2.26	Disturbed	Silty sand	SM						100.00	97.82	61.93	46.65	44.43			45	31	14						
		7.45	0.26	Disturbed			29.18																				
		10.45	-2.74	Disturbed	Silty sand	SM	27.01					100.00	100.00	73.94	42.77	36.9	5.7	3	52	36	16						
BH-47 STA 12+850 CL	9.779	1.45	8.33	Disturbed	Silty sand with gravel	SM	13.52					78.36	67.21	43.42	32.43	29.19			47	28	19						
		2.45	7.33	Disturbed	Sandy fat clay	CH	24.86					85.27	82.26	68.34	61.69	60.26			80	36	44						
		6.45	3.33	Disturbed			23.42																				
		9.45	0.33	Disturbed	Silty sand	SM						86.75	79.4	54.93	37.82	32.18			54	35	19						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI			Pc	Cc	Cs	Cc/(1+e)
																			%	%	%						
BH-48 STA-12+850,R-28	4.882	1.45	3.43	Disturbed	Clayey sand with gravel	SM	13.93					67.78	62.11	41.54	29.11	26.34			47	26	21						
		2.45	2.43	Disturbed	Sandy fat clay	CH	27.39					99.82	97.53	67.4	54.91	53.2			52	25	27						
		3.45	1.43	Disturbed	Sandy elsatic silt	MH						99.61	99	82.31	60.57	51.88	10	3.8	54	36	18						
		8.45	-3.57	Disturbed			34.95																				
BH-49 STA13+000,CL	3.079	1.5	1.58	Undisturbed	Sandy fat clay	CH	90.63		6.5	12.22	2.37	99.87	99	84.04	63.72	53.45	10.8	3.5	62	29	33						
		1.45	1.63	Disturbed			55.38																				
		2.45	0.63	Disturbed	Sandy lean clay	CL						99.62	98.08	70.86	56.26	52.91			48	27	21						
		11.45	-8.37	Disturbed	Clayey sand	SC						100	99.16	73.28	56.2	49.17			40	21	19						
		14.45	-11.37	Disturbed			18.57																				
BH-50 STA 13+100 CL	2.924	1.5	1.42	Undisturbed	Organic clay with sand	OH	141.18	1.72	58.00	17.42	2.40	100.00	100.00	88.88	80.44	71.59	24.00	21.50	65	33	32			60	0.21	0.053	0.05
		2.45	0.47	Disturbed			20.4																				
		3.45	-0.53	Disturbed			20.4																				
		4.45	-1.53	Disturbed	Silty sand	SM						100	99.28	70.37	35.98	28.8			57	34	23						
BH-51 STA 13+200 CL	2.696	2	0.70	Undisturbed	Sandy organic clay	OH	112.33	1.64	64.10	46.15	2.42	100.00	97.50	83.25	68.55	54.33	18.00	10.00	45	29	16						
		3.45	-0.75	Disturbed	Fat clay with sand	CH						100	99.50	89.13	75.84	71.64	51.3	49	62	28	34						
		4.45	-1.75	Disturbed			27.3																				
		6.45	-3.75	Disturbed	Silty sand	SM						98.13	94.02	49.58	24.3	19.96			NP	NP	NP						
		8.45	-5.75	Disturbed			13.95																				
BH-52 STA 13+300 CL	2.545	3	-0.46	Undisturbed	Elastic silt	MH	73.14	1.47	62.00	14.01	2.22	99.91	99.25	97.99	94.05	87.69	33.00	26.00	71	57	14						
		3.45	-0.91	Disturbed			40.47																				
		4.45	-1.91	Disturbed	Lean clay with sand	CL						100	100	98.68	96.6	96.23	79.3	77	48	21	27						
		5.45	-2.91	Disturbed			65.46																				
		8.45	-5.91	Disturbed	Silty sand	SM						99.79	96.14	33.93	5.27	2.77			NP	NP	NP						
BH-53 STA 13+400 CL	2.379	2	0.38	Undisturbed	Sandy organic silt	OH	52.99	1.66	74.20		2.28	100.00	96.50	87.46	72.95	64.39	2.50	1.50	61	40	21			28	0.228	0.037	0.1
		2	0.38	Undisturbed																				42	0.307	0.029	0.11
		3.45	-1.07		Sandy lean clay	CL						100.00	89.71	66.44	56.21	53.52			44	17	27						
		5.45	-3.07	Disturbed			19.43																				
		7.45	-5.07	Disturbed			14.51																				
		8.45	-6.07	Disturbed	Silty sand with gravel	SM						74.67	60.71	23.95	14.31	13.58			NP	NP	NP						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-54 STA 13+500 CL	2.16	2	0.16	Undisturbed	Clayey sand	SC	168.81	1.76	58.50	21.54	2.04	100.00	94.50	62.60	47.14	42.75	23.00	18.00	54	25	29						
		2.45	-0.29	Disturbed			58.8																				
		7.45	-5.29	Disturbed								76.14	70.92	29.69	14.74	12.57			NP	NP	NP						
		9.45	-7.29	Disturbed			16.57																				
BH-55 STA 13+600 CL	1.224	2	-0.78	Undisturbed	Organic silt	OH	100.54	1.74	26.20	14.62	2.26	99.92	100.00	99.18	95.15	91.45	17.50	15.00	82	50	32						
		2.45	-1.23	Disturbed			30.13																				
BH-55 STA 13+600 CL	1.224	3.45	-2.23	Disturbed	Silty clay	CH					2.65	100.00	97.00	82.62	64.21	54.55	4.50	3.0	82	43	39						
		5.45	-4.23	Disturbed	Silty sand	SM						96.62	91.48	44.91	29.17	25.55			NP	NP	NP						
		6.45	-5.23	Disturbed			16.73																				
		8.45	-7.23	Disturbed	Silty sand	SM						93.98	86.50	47.38	32.79	21.83	11.00	8.50	NP	NP	NP						
BH-56 STA 13+700 CL		2		Undisturbed	Sandy organic clay	CL	33.31	1.68	11.80	5.51	2.51	99.84	99.00	89.98	77.82	69.97	30.00	21.50	46	26	20			160	0.255	0.044	0.11
		2		Undisturbed																				140	0.232	0.037	0.1
		2.45		Disturbed			44.12																				
		3.45		Disturbed	Sandy elastic silt	MH					2.61	99.92	98.5	85.93	70.88	64.78	12.0	7.50	78	37	41						
		5.45		Disturbed			80.33																				
		8.45		Disturbed	Silty sand	SM						99.42	96.7	49.58	16.31	12.29			NP	NP	NP						
BH-57 STA 13+800 CL	1.616	2	-0.38	Undisturbed	Organic silt with sand	OH	80.74			16.80	2.43	100.00	98.75	96.86	90.01	83.59	28.50	18.00	62	46	16						
		3.45	-1.83	Disturbed	Clayey sand	SC					2.66	100.00	95.00	38.73	30.38	27.27	15.00	12.00	43	24	19						
		4.45	-2.83	Disturbed			19.16																				
		6.45	-4.83	Disturbed	Organic clay	OL	85.16																				
		8.45	-6.83	Disturbed	Silty sand	SM						94.77	87.26	37.53	8.76	5.92			NP	NP	NP						
BH-58 STA 13+900 CL	1.69	2	-0.31	Undisturbed	Sandy lean clay	CL	190.98	1.38	9.00	26.50	2.40	100.00	97.00	76.86	59.30	53.27	15.00	10.00	62	23	39						
		2.45	-0.76	Disturbed	Sandy lean clay	CL					2.63	100	99.5	85.93	65.83	58.28	10.0	7.6	50	29	21						
		5.45	-3.76	Disturbed			77.79																				
		7.45	-5.76	Disturbed	Clayey sand	SC					2.12	99.62	90.00	67.32	35.67	26.20	11.00	9.50	21	12	9						
		8.45	-6.76	Disturbed			18.85																				
BH-59 STA 14+000 CL	1.751	2	-0.25	Undisturbed	Elastic silt with sand	CH	34.83	1.65	42.50	4.80	2.54	100.00	97.05	90.93	83.24	78.56	15.50	12.00	58	26	32						
		2.45	-0.70									100.00	96.50	79.00	59.28	49.17	18.00	10.00									
		4.45	-2.70	Disturbed			7.31																				
		5.45	-3.70	Disturbed	Silty sand	SM						99.10	84.50	27.03	17.73	17.25			NP	NP	NP						
		8.45	-6.70	Disturbed	Silty sand	SM						95.39	92.37	67.23	30.09	27.10			NP	NP	NP						
		9.45	-7.70	Disturbed			20.67																				

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-60 STA 14+100 CL	1.786	1.45	0.34	Disturbed			168.78																				
		2.00	-0.21	Undisturbed	Peat (with organic clay)	Pt	129.41		(Cannot extrude	25.97	2.21	100.00	98.00	91.13	75.27	67.41	20.00	15.00	63	44	19						
		2.45	-0.66	Disturbed			219.4																				
		3.45	-1.66	Disturbed	Silty sand	SM					2.66	99.79	93.50	63.51	34.36	23.10	8.00	7.50	NP	NP	NP						
BH-60 STA 14+100 CL	1.786	4.45	-2.66	Disturbed	Sandy lean clay	CL					2.62	99.46	97	79.05	63.02	51.82	7.5	2	32	17	15						
		6.45	-4.66	Disturbed			21.11																				
		7.45	-5.66	Disturbed	Silty sand	SM					2.60	95.68	83.00	48.41	20.12	14.29	6.50	5.50	NP	NP	NP						
BH-61 STA 14+340 CL		1.45		Disturbed	Sandy lean clay	CL						99.62	95	81.30	68.12	62.02	10.00	6.0	75	44	31						
		2.00		Undisturbed	Organic silt with sand	OL	25.14	1.72	5.00	3.86	2.61	98.60	94.50	87.59	81.49	76.59	24.00	15.50	43	30	13						
		3.45		Disturbed	Sandy organic silt	OH	30.14																				
		4.45		Disturbed	Sandy silt	ML						100	99.9	77	55.25	51.35			NP	NP	NP						
		5.45		Disturbed			29.69																				
BH-62 STA 14+410 L-32	1.91	1.45	0.34	Disturbed			48.94																				
		2.45	-0.66	Disturbed	Clayey sand	SC						86.32	79.74	48.82	27.12	22.21			56	29	27						
		4.45	-2.66	Disturbed	Silty sand	SM						99.48	90.00	61.23	43.04	41.50	7.50	6.00	NP	NP	NP						
		5.45	-3.66	Disturbed	Silty sand	SM	24.49					100	98.05	62.35	34.3	28.8			NP	NP	NP						
		6.45	-4.66	Disturbed			13.31																				
BH-63 STA 14+535 CL	14.14	2.45	11.69	Disturbed	Sandy fat clay with gravel	CH						82.27	74.61	58.02	52.09	50.3			68	33	35						
		6.45	7.69	Disturbed			25.77																				
		7.45	6.69	Disturbed			27.68																				
		8.45	5.69	Disturbed	Silty sand	SM						94.75	84.78	59.02	48.51	44.72			55	40	15						
		17.45	-3.31	Disturbed			21.14																				
		19.45	-5.31	Disturbed	Clayey sand	SC						86.78	79.63	51.99	24.86	17.94			23	18	5						
BH-65 STA 14+620 CL	3.214	2	1.21	Undisturbed	Clayey sand	SC	67.6	1.65	12.40		2.59	99.00	94.50	76.88	60.09	49.86	21.50	18.00	57	24	33			90	0.613	0.066	0.17
		2.45	0.76	Disturbed	Silty sand	SM						99.27	95.93	58.49	21.44	15.47			NP	NP	NP						
		3.45	-0.24	Disturbed			26.13																				
		4.45	-1.24	Disturbed	Silty sand	SM						89.94	86.52	58.64	31.82	23.14			NP	NP	NP						
		5.45	-2.24	Disturbed	Clayey sand	SC						96.88	89.96	49.47	21.36	15.76			30	13	17						
		6.45	-3.24	Disturbed			18.90																				
BH-67 STA 14+765 CL	19.739	2.45	17.29	Disturbed	Silty sand with gravel	SM						75.5	67.25	49.56	43.35	41.38			68	39	29						
		8.45	11.29	Disturbed			20.48																				

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-67 STA 14+765 CL	19.739	11.45	8.29	Disturbed	Silty sand	SM						91.15	87.43	52.06	32.85	26.35			47	33	14						
		13.45	6.29	Disturbed			18.30																				
		14.45	5.29	Disturbed	Silty sand	SM						99.41	97.89	55.16	32.51	26.92			41	31	10						
		16.45	3.29	Disturbed			18.45																				
BH-68 STA 14+843 CL	18.747	5.45	13.30	Disturbed	Clayey sand	SC						67	60.74	49.82	39.93	34.88			54	28	26						
		8.45	10.30	Disturbed			1.44																				
		19.45	-0.70	Disturbed	Silty sand	SM						92.43	87.64	64.77	47.91	41.25			49	32	17						
		21.45	-2.70	Disturbed			2.39																				
BH-69 STA 15+130 CL	1.55	2	-0.45	Undisturbed	Organic clay	OH	36.07	1.71	80.80	7.90	2.48	100.00	100.00	98.64	92.41	85.81	2.50	1.50	67	32	35			130	0.136	0.016	0.07
		2.45	-0.90	Disturbed	Sandy organic silt	OL						100.00	100.00	91.42	77.69	68.67	8.00	6.50	47	33	14						
		5.45	-3.90	Disturbed			15.37																				
		8.45	-6.90	Disturbed	Sandy silt	ML						99.14	96.74	72.38	57.59	54.95			46	33	13						
		10.45	-8.90	Disturbed			26.72																				
BH-70 STA 15+233 CL	1.804	1.45	0.35	Disturbed	Peat	Pt						100.00	98.01	89.34	83.94	63.81			66	46	20						
		2	-0.20	Undisturbed	Peat	Pt	41.5	1.59	17.40	12.12	2.39	100.00	100.00	99.26	95.62	92.22	30.00	22.50	Cannot perform test					63	0.206	0.042	0.07
		4.45	-2.65	Disturbed	Organic silt	OL						99.70	98.52	79.52	6.05	59.36			NP	NP	NP						
		5.45	-3.65	Disturbed			32.83																				
		6.45	-4.65	Disturbed			40.06																				
BH-71 STA 15+300 CL	2.051	1.45	0.60	Disturbed	Fat clay with sand	CH						100.00	100.00	97.51	86.85	82.18	14.00	8.50	57	22	35						
		2	0.05	Undisturbed	Sandy fat clay	CH	80.2	1.63	47.00	11.96	2.45	97.95	95.00	75.14	61.07	53.00	12.00	7.50	64	30	34						
		3.45	-1.40	Disturbed			196.42																				
		5.454	-3.40	Disturbed	Elastic silt with sand	MH						99.61	99.36	96.9	81.36	74.50			51	38	13						
		12.45	-10.40	Disturbed			15.94																				
BH-72 STA 15+400 CL	1.124	1.45	-0.33	Disturbed			46.17																				
		2	-0.88	Undisturbed	Elastic silt	MH	93.71	1.5	25.20	14.15	2.45	100.00	100.00	99.60	96.22	93.62	8.00	4.50	78	40	38			230	0.258	0.098	0.09
		3.45	-2.33	Disturbed	Silty sand	SM						98.21	92.5	61.68	44.44	38.53	6	2.5	74	46	28						
		4.45	-3.33	Disturbed			72.99																				
		7.45	-6.33	Disturbed	Silty sand	SM						97.47	88.95	31.05	15.21	15.1			NP	NP	NP						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI			Pc	Cc	Cs	Cc/(1+e)
																			%	%	%						
BH-73 STA 15+500 CL	1.939	1.45	0.49	Disturbed			38.13																				
		2	-0.06	Undisturbed	Lean clay	CL	77.4	1.64	7.10	14.88	2.35	100.00	100.00	99.39	97.54	93.86	6.50	4.50	48	25	23			100	0.121	0.018	0.05
		2.45	-0.51	Disturbed	Elastic silt	MH						100.00	100.00	98.12	95.86	90.52	4.50	2.50	60	40	20						
		3.45	-1.51	Disturbed	Organic silt	OH					2.05	98.13	93.50	99.39	97.54	93.86	6.00	4.50	77	48	29						
		4.45	-2.51	Disturbed			117.88																				
BH-74	13.956	1.45	12.51	Disturbed	Clayey sand	SC	16.59					96.41	82.61	47.47	39.16	36.97			45	25	20						
BH-75	4.028	1.45	2.58	Disturbed	Clayey sand	SC	24.37					70.23	55.01	31.69	22.58	19.44			41	23	18						
BH-76 STA 15+746 CL	2.012	2.45	-0.44	Disturbed	Silty sand	SM	33.34					99.9	99.4	48.53	26.42	23.26			49	32	17						
		3.45	-1.44	Disturbed	Silty sand	SM	24.35					99.71	95.97	39.51	14.07	12.11			NP	NP	NP						
		4.45	-2.44	Disturbed																							
		7.45	-5.44	Disturbed	Sandy silt	ML						99.29	97.57	76.76	66.68	64.86			44	34	10						
		8.45	-6.44	Disturbed			18.64																				
NS-01-BH-77	3.943	1.45	-1.45	Disturb	Sandy lean clay	CL	18.57					100	96	73.26	61.23	56.29	11	8	53	28	25						
		2.45	-2.45	Disturb	Sandy lean clay	CL	23.90					100	91	71.33	64.88	61.9	14	7	43	26	17						
		3.45	-3.45		Silty sand	SM						96.5	90	52.92	40.92	37.76	14	9	47	31	16						
BH-78 STA 15+946 R-30	3.622	1.45	2.17	Disturbed	Silty sand with gravel	SM						79.57	72.23	46.06	36.37	34.02			61	38	23						
		2.45	1.17	Disturbed	Silty sand with gravel	SM	33.34					74.47	68.66	52.23	44.96	42.35			66	40	26						
		3.45	0.17	Disturbed			24.35																				
		4.45	-0.83	Disturbed	Clayey sand with gravel	SC						71.48	66.05	42.77	34.18	32.08			54	25	29						
		5.45	-1.83	Disturbed			23.88																				
		5.8	-2.18	Core	Core																		67.38				
		6.1	-2.48	Core	Core																		51.25				
BH-79 STA 16+000 CL	0.507	2.45	-1.94	Disturbed			83.98																				
		4.45	-3.94	Disturbed	Sandy elastic silt	MH					2.11	100.00	95.5	90.31	74.90	66.72	8.50	6.50	71	50	21						
		5.45	-4.94	Disturbed			132.59																				
		7.45	-6.94	Disturbed	Silty sand	SM						99.71	94.57	29.92	10.95	7.78			NP	NP	NP						
BH-80 STA 16+100 CL	1.447	3.45	-2.00	Disturbed			22.32																				
		4.45	-3.00	Disturbed	Peat	Pt					2.14	100.00	95.50	85.24	81.57	75.67	13.00	6.50	69	46	23						
		6.45	-5.00	Disturbed	Clayey sand	SC					2.55	100.00	98.00	71.57	39.34	30.10	7.5	6.5	28	17	11						
		9.45	-8.00	Disturbed			127.64																				

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type		Natural moisture content	Bulk Density	Compressive Strength (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
BH-81 STA 16+170 CL	5.264	2.45	2.81	Disturbed			32.07																				
		3.45	1.81	Disturbed	Lean clay with sand	CL					2.59	100.00	98.50	93.50	89.14	83.46	7.00	4.50	59	26	33						
		5.00	0.26	Undisturbed	Elastic silt	MH	90.54			15.32	2.34	100.00	100.00	97.77	90.90	85.04	7.00	4.50	70	40	30						
		10.45	-5.19	Disturbed	Silty sand	SM					2.58	96.31	82.00	63.67	46.77	39.57	5.50	2.50	NP	NP	NP						
		15.45	-10.19	Disturbed			41.92																				
		18.9	-13.64	Core	Core																		40.22				
		19.04	-13.78	Core	Core																		21.76				
BH-82 STA 16+240 CL																											
	5.456	2.45	-2.45	Disturbed	Sandy silt	ML					2.06	99.39	96	78.22	62.88	55.59	6.0	4.5	39	28	11						
		3.45	-3.45	Disturbed			34.1																				
		4.45	-4.45	Disturbed	Silty sand with gravel	SM						83.31	64.63	19.83	7.9	5.30			NP	NP	NP						
		12.45	-12.45	Disturbed			17.11																				
		15.45	-15.45	Disturbed			14.76																				
		19.45	-19.45	Disturbed	Silty sand	SM						93.49	58.56	10.07	5.32	5.05			NP	NP	NP						
BH-85 STA 16+415 CL		0.5		Undisturbed	Sandy organic silt	OH	60.71	1.59	12.80	9.72	2.49	99.17	93.5	72.02	60.93	52.71	5.50	4.00	69	59	10			130	0.417	0.029	0.16
		1.45		Disturbed	Sandy lean clay	CL						100	100	99.42	74.82	62.96			24	16	8						
		2.45		Disturbed			12.96																				
		4.45		Disturbed	Elastic silt	MH						100	100	99.64	95.73	94.32			49	32	17						
		9.45		Disturbed	Peat	Pt					2.46	100.00	95.00	82.76	73.21	66.83	9.00	6.00	76	55	21						
		10.45		Disturbed			19.61																				
		15.45		Disturbed			13.26																				
		25.28		Core	Core																		26.11				
BH-86 STA 16+490 CL		1.45		Disturbed	Sandy lean clay	CL						99.76	97.5	82.60	63.38	55.79	5.00	2.50	36	21	15						
		2.45		Disturbed			39.91																				
		3.45		Disturbed	Fat clay	CH					2.56	100.00	100.00	98.63	94.04	90.67	8.00	2.50	84	37	47						
		6.45		Disturbed			113.69																				
		7.00		Undisturbed	Peat	Pt	63.58	1.59	14.60	9.88		98.25	93.00	79.80	69.00	58.46	12.50	8.50	53	35	18						
		12.45		Disturbed	Silty sand	SM	37.64					98.36	96.00	62.31	32.30	29.83	12.50	11.00	NP	NP	NP						
		18.85		Core	Core																	2.74	37.71				
NS-01-BH-87	7.783	1.45	-1.45	Disturb	Poorly graded sand with sil	SP-SM	30.11					98	86	23.21	8.63	7.65	2	0.75	NP	NP	NP						
		3.45	-3.45	Disturb	Silty sand	SM	30.82					85	91	52.92	40.92	37.76	14	8.3	69	33	36						
		6.45	-6.45	Disturb	Clayey sand	SC	14.71					97	88	52.96	38.13	31.76	3	1	37	19	18						

Borehole No	Ground Height (m)	Depth		Type of Sample	Soil Type	Soil type	Natural moisture content	Bulk Density	Compressive Strength Soil (kPa)	Ignition loss	Specific Gravity	Grain Size Analysis							Atterberge's Lmit			Specific Gravity Rock (SSD)	UCT Rock (kPa)	Consolidation results			
		GL(m)	EL(m)									4.75	2	0.425	0.15	0.075	0.006	0.003	LL %	PL %	PI %			Pc	Cc	Cs	Cc/(1+e)
NS-01-BH-88	7.879	1.45	-1.45	Disturb	Fat clay	CH	45.93					100	100	98.29	94.11	88.48	69	67.5	59	30	29						
		2.45	-2.45	Disturb	Fat clay with sand	CH	34.88					100	100	96.94	87.08	78.51	55	50	71	27	44						
		3.45	-3.45	Disturb	Clayey sand	SC	14.37					96	94	62.41	35.08	24.4	3	0.5	27	17	10						
		4.32	-4.32	Core																		2.40	26.08				
		5.2	-5.20	Core																							
NS-01-BH-89	7.661	1.45	-1.45	Disturb	Sandy lean clay	CL	42.15					100	99	87.87	70	58.68	12	8	42	23	19						
		2.45	-2.45	Disturb	Silty sand	SM	18.56					96.41	92	62.84	33.12	26.43	2	0.3	NP	NP	NP						
		6.45	-6.45	Disturb			15.23																				
NS-01-BH-91	23.35	2.45	-2.45	Disturb	Sandy fat clay	CH	23.14					96	89	70.44	62.6	56.56	8	4	72	33	39						
		6.45	-6.45	Disturb	Sandy lean clay	CL	21.78					94	86	66.81	58.46	54.45	13	10	43	22	21						
		9.45	-9.45	Disturb	Silty sand	SM	21.44					92	76	38.47	22.13	19.60	6	4	NP	NP	NP						
		10.65	-10.65	Core																		2.61					
		11	-11.00	Core																							
		11.65	-11.65	Core																			44.36				
A1-BH-01	7.02	2.45	19.98	Disturb	Sandy lean clay	CL	27.36					99.74	97	78.58	62.49	51.86	15	10	31	22	9						
		8.45	13.98	Disturb	Sandy elastic silt	MH	41.47					100	97	71.82	58.54	55.69	12	6	56	43	13						
		9.45	12.98	Disturb	Sandy elastic silt	MH	34.77					98.55	95	67.35	56.76	54.7	13	6	53	38	15						
A1-BH-02	10.93	4.45	-4.45	Disturb	Silty sand	SM	32.89					100	100	78.2	55.22	49.06	12	6	40	27	13						
		9.45	-9.45	Disturb	Silty sand	SM	25.28					97.85	92	59.93	40.92	35.27	3	2	NP	NP	NP						
		14.45	-14.45	Disturb	Silty sand	SM	26.90					96.7	92	66.03	49.78	43.38	4.5	2	NP	NP	NP						
A1-BH-03	7.804	2.45	6.09	Disturb	Clayey sand	SC	12.78					100	98	65.6	36.92	31.71	10	8	30	18	12						
		7.45	1.09	Disturb	Silty sand	SM	15.15					99.51	95	57.94	36.32	29.01	3	2	40	31	9						
		10.45	-1.91	Disturb	Silty sand	SM	16.11					96.93	95	59.68	31.23	24.04	2	0	NP	NP	NP						
A1-BH-04	8.968	1.45	-1.45	Disturb	Sandy lean clay	CL	21.50					96	90	69	58.88	56.22	21	14	28	14	14						
		5.45	-5.45	Disturb	Silty sand	SM	21.18					100	96	58.18	37.27	33.02	13.5	10.5	41	27	14						
	8.968	6.45	-6.45	Disturb	Silty sand	SM	31.43					100	98	65.46	40.17	32.76	4	2	NP	NP	NP						
A1-BH-07 (A)	9.948	1.45	8.50	Disturb	Clayey sand	SC	3.18					99.5	96	63.57	35.84	28.25	2	0	36	19	17						
A1-BH-07 (B)	9.948	1.45	-1.45	Disturb	Silty sand	SM	41.45					99.5	96	62.39	40.11	33.91	11	8	40	27	13						
		2.45	-2.45	Disturb	Silty sand	SM	16.47					98.73	85	40.73	18.03	14.75	2	1	NP	NP	NP						

MATERIAL SURVEY

SUMMARY

MATERIAL SURVEY DETAILS

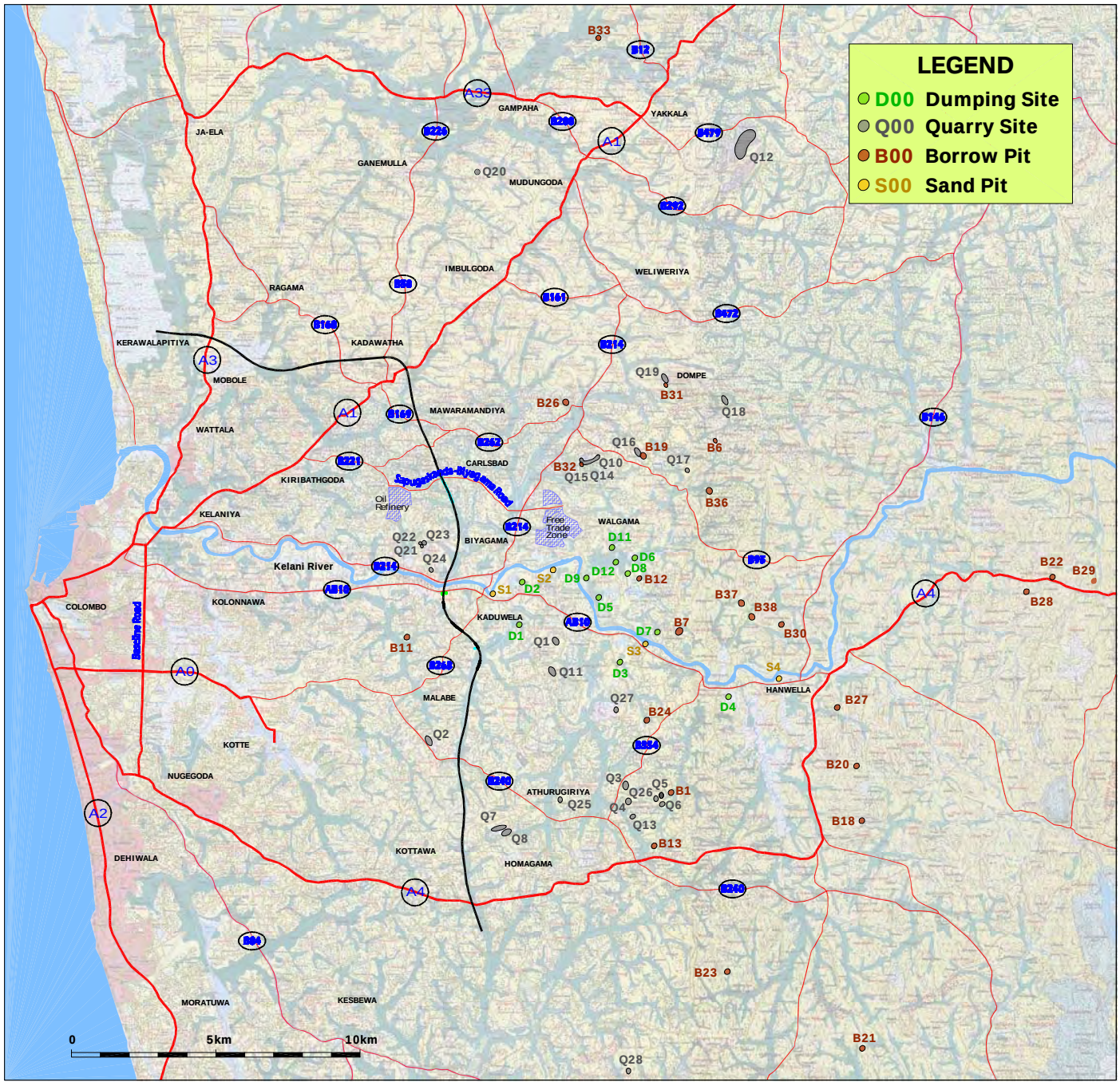
LEGEND
D00 Dumping Site
Q00 Quarry Site
B00 Borrow Pit
S00 Sand Pit
Q31
Q30
B33
B12
A33
GAMPAHA
YAKKALA
JA-ELA
A1
Q12
GANEMULLA
Q20
MUDUNGODA
IMBULGODA
WELIWERIYA
RAGAMA
KERAWALAPITIYA
KADAWATHA
A3
MOBOLE
Q19
DOMPE
B31
B26
Q18
MAWARAMANDIYA
WATTALA
Q16
B19
B6
Q17
Q10
B32
Q15
Q14
CARLSBAD
KIRIBATHGODA
Jayagoda-Biyagama Road
Oil Refinery
B36
KELANIYA
Free Trade Zone
WALGAMA
Q22
Q23
Q21
BIYAGAMA
D11
D6
D8
B12
Q24
Kelani River
S2
D9
D12
S1
D2
B37
B38
B22
B29
B28
COLOMBO
KOLONNAWA
D5
KADUWELA
B7
B30
D7
D1
Q1
S3
B11
Q11
D3
S4
A0
Baseline Road
MALABE
HANWELLA
Q27
D4
B27
B24
Q2
KOTTE
B20
NUGEGODA
Q3
Q5
B1
ATHURUGIRIYA
Q26
Q6
Q25
Q4
A2
Q7
Q13
B18
Q8
B13
DEHIWALA
KOTTAWA
HOMAGAMA
A4
B23
MORATUWA
KESBEWA
0
5km
10km
B21
Q28
B25
Q29

Table 1 Borrow Pits

Site No.	Location	Owenership/ Tel-No.	Distance from C.L /km	Type of site	Type of Material	Area/ m^2	Quantity / m^3	Year of investigation
B1	Lenagala,Panagoda		13.0	Operating Pit	RS	20,000	300,000	
B2	Godella,Kotalawala		1.5	Natural Hill	RS	50,000	None	
B3	Pelahela		11.0	Operating Pit	RS	20,000	None	2001
B4	Namaluwa,Atigala		19.0	Operating Pit	RS	30,000	None	
B5	Kanattagoda		9.5	Operating Pit	RS	40,000	None	
B6	Demalagama		14.0	Operating Pit	RS	400,000	300,000	
B7	Udamapitigama		11.0	*Natural Hill	RS	10,000	600,000	
B8	Udamapitigama	Unknown	11.3	Operating Pit	RS	5,000	None	
B9	Udamapitigama	Mr.Jayasinga	11.5	Operating Pit	RS	10,000	None	
B10	Kalukodayawa	Mr.MAH Alvis/2455620	7.5	**Natural Hill	RS	10,000	100,000	
B11	Karadahena,Weliwita	Government/ (UDA)	3.0	Abondon Pit	RS	75,000	200,000	
B12	Malwana	Mr.Carlo Fernando/2453470	8.5	**Natural Hill	RS	140,000	300,000	2004
B13	Beddegeramulla,Migoda	Mr.Gnanarathna	10.0	Operating Pit	RS	50,000	500,000	
B14	Maeliya,Ja-Ela	Mr.Neel/0776002699	9.0	Operating Pit	RS	160,000	None	
B15	Maeliya,Ja-Ela	.....Do....	9.0	Natural Hill	RS	10,000	None	
B16	Maeliya,Ja-Ela	.....Do....	9.0	Natural Hill	RS	200,000	None	
B17-1	Nawalamulla	Mr.Indika/0714884647	9.0	Operating Pit	RS	65,000	None	
B17-2		.....Do....	9.0	Operating Pit	RS	65,000	None	
B18	Waga-Meepe	.....Do....	18.0	Operating Pit	RS	40,000	300,000	
B19	Dekatana	Mr. M.D.S. Wijerathna	13.0		RS		150,000	
B20	Suduwella	Mr.Gunawardena	30.0		RS		5,000	
B21	Puwakpitiya	Mr. Subasinghe/0716851541	26.0		RS		60,000	
B22	Diddeniya Estate	Mr. Subasinghe/0716851541	16.0		RS		200,000	
B23	Halbarawa	Mr. Indika Koralage/0714884647	27.0		RS		300,000	
B24	Dadigama	Mr. Subasinghe/0716851541	9.0		RS		30,000	2007
B25	Uthuru Uduwa(Near Paduki	Mr. Nihal/0712333888	32.0		RS		200,000	
B26	Delgoda	Mr. Subasinghe/0716851541	9.0		RS		40,000	
B27	Dideniya	Mr.A.D. Abeyawardena/0777343236	16.0	Abondon Pit	RS	52,610	450,000	
B28	Kosgama	Mr.A.D. Abeyawardena/0777343236	23.0	Abondon Pit	RS	14,164	400,000	
B29	Puwakpitiya, Higurala	Mr.A.D. Abeyawardena/0777343236	26.0	Abondon Pit	RS	10,117	50,000	
B30	Samanebeddha	Mr.A.D. Abeyawardena/0777343237	17.0	Abondon Pit	RS	8,094	50,000	
B31	Ahugammana	Mr.Laxman/0777345083	14.0	Operating Pit	RS	50,586	300,000	
B32	Kanduboda	Mr.Mendis/ 0112403473	8.0	Rock Quarry	RS	40,000	150,000	
B33	Pitiyagedara, Bemmulla	Mr.Sunil Munasingha/0334928610	18.0	Operating Pit	RS	30,000	100,000	
B34	Yagoda		13.0	Operating Pit	RS	10,000	None	
B35	Yagoda, North		12.0	Natural Hill	RS	20,000	None	
B36	Dompe	Mr.R.P.Wijepala / 0112409424	14.0	Abondon Pit	RS	12,000	100,000	
B37	Meepawita-1	Mr.Frank Perera/ 0115657604	12.0	Rock Quarry	RS	40,000	100,000	
B38	Meepawita-2	Mr.Ajith/ 0723614813	12.0	Abondon Pit	RS	22,200	200,000	
						Σ	5,485,000 m3	

Northern Section 1	Σ	2,490,000	m3	
Sourthern Section	Σ	2,995,000	m3	

Table 2 Dumping Sites

Site No.	Location	Owenership/ Tel-No.	Distance from C.L /km	Type of site	Area/ (Hectare)	Volume (x1,000 m3)	Year of Investi-gation
D1	Kaduwela	Mr.P.D.Nirmala Sanyakumari, Welay Handiya,Kaduwela /0776723412	3	Abandon Clay Mine	15	-	
D2	Pahala Bomiriya	Mr.Wasantha Lenorole,No.45, Pahala Bomiriya, Kaduwela /0773529084	5	Abandon Clay Mine	5	-	
D3	Ranale	Mr.Udaya Kuruppuarachchi, 337, Jalthara, Ranala /0777276604	6	Abandon Clay Mine	7	-	2007
D4	Atigala	Mr.M Jinadasa,166F, Pahala Hanwella, Hanwella /0114922711	10	Abandon Clay Mine	10	-	Design
D5	Malwana	Mr.Colvin Perera,76/D,Samanbedda Rd, Malwana /0112535915/ 0773242508	7	Abandon Clay Mine	10	200	Review
D6	Kalukodayaya	.....Do....	7	Abandon Clay Mine	5	100	Report
D7	Udamapitigama	.....Do....	11	Abandon Clay Mine	5	100	
D8	Lunukotuwawatta, Malwana	.....Do....	8.5	Abandon Clay Mine	20	400	
D9	Malwana	Mr.Chamli Perera/0112450323/ 723276346	5.5	Abandon Clay Mine	2	40	2007
D10	Yabaraluwa	Mr.A.D. Abeyawardena/0777343236	3.5	Abandon Clay Mine	None	None	
D11	Walgama	Mr.Seelawansha /0112535983	6.5	Abandon Clay Mine	2	40	
D12	Malwana	Mr.Chamli Perera/0112450323/ 723276346	7.5	Abandon Gem Mine	5	100	
				Σ	86	980	m3

Northern Section 1	Σ	980	m3
Sourthern Section	Σ	-	m3

Table 3 Quarry Sites

Site No	Location	Ownership/ Tel.No.	Distance from C.L. (km)	Type of site	Type of material	Area/ (m2)	Quantity/ (m3)	Year of Investi-gation
Q1	Udugoda, Pahala Bomiriya		5.5	O.Q	Massive Diorite	40,000	500,000	
Q2	Arangala		2.5	O.Q	Granitic Gneiss	40,000	700,000	
Q3	Leyland Rd, Panagoda		12.0	O.Q	Dioritic Gneiss	30,000	300,000	
Q4	Leyland Rd, Panagoda		12.5	O.Q	Dioritic Gneiss	20,000	100,000	
Q5	Lenagala Watta, Panagoda		13.5	O.Q	Dioritic Gneiss	2,000		2001
Q6	Lenagala Watta, Panagoda		13.0	O.Q	Dioritic Gneiss	60,000	300,000	
Q7	Walgama		2.5	O.Q	Pegmatite	10,000	50,000	
Q8	Walgama		3.0	O.Q	Fine Gneiss	30,000	300,000	
Q9	Bunwalakanda, Putupagala		15.0	O.Q	Dioritic Gneiss	3,000	-	
Q10	Kanduboda	Jayantha Sandra / 2403807	8.0	O.Q	Granitic Gneiss	10,000	150,000	
Q11	Koratota, Nawagama	Sriwaka Metal Cutter / 0777313160	6.0	O.Q	Dioritic Gneiss	150,000	300,000	2004
Q12	Ambagaspitiya, Attanagala	KNUJ Chandrakumara / 0332279254	17.0	O.Q	Pink Coarse Granite	10,000	300,000	
Q13	Lenagala Watta, Panagoda	Premasiri Wijesundara/ 0714004261, 0602175360	11.0	O.Q	—	—	100,000	
Q14	Kanduboda	Mr.Anura/ 0112403910	8.0	O.Q	Granitic Gneiss	1,000	10,000	
Q15	Kanduboda	Mr.Mendis/ 0112403473	8.0	O.Q	Granitic Gneiss	40,000	1,200,000	
Q16	Pananwala	Ajantha Metal Crusher/ 0714778088	11.0	O.Q	Granitic Gneiss	20,000	700,000	
Q17	Pelhela,Dekatana	Fumihiko Engineering/0714723297	13.0	O.Q	Granitic Gneiss	20,000	100,000	
Q18	Koragahawatta, Karagala	Mr.Daminda Abesignha/ 0777312650	16.0	O.Q	Granitic Gneiss	20,000	400,000	
Q19	Ahugammana	Mr.Laxman/0777345083	13.5	O.Q	Granitic Gneiss	50,586	400,000	2007
Q20	Oruthota South		10.0	O.Q	Pink Coarse Granite	10,000	40,000	
Q21	Mabima	K.A.Dayarathne/ 785455486	2.0	O.Q	Granitic Gneiss	12,000	200,000	
Q22	Mabima	Nawaloka Construction	2.0	O.Q	Granitic Gneiss	20,000	550,000	
Q23	Mabima	Mr.Ranjith Gunasinghe/ 112351235	2.0	O.Q	Granitic Gneiss	12,000	600,000	
Q24	Mabima	Mr.Chandana/Mr.Narada	0.5	O.Q	Granitic Gneiss	12,000	150,000	
Q25	Arangala	W.A.Perera	5.0	O.Q	Granitic Gneiss	32,000	520,000	
Q26	Welipillawa	W.A.Perera	8.5	O.Q	Granitic Gneiss	85,000	2,720,000	
Q27	Dadigamuwa	W.A.Perera	10.0	O.Q	Granitic Gneiss	49,000	1,170,000	
Q28	Talagala	Lanka Quarry	28.0	O.Q	Granitic Gneiss	81,000	1,940,000	
Q29	Paragastota	C&A	40.0	O.Q	Granitic Gneiss	49,000	2,330,000	
Q30	Kotadeniyawa	Senok	50.0	O.Q	Granitic Gneiss	324,000	12,950,000	
Q31	Kithulwalana, Mirigama	Bitumin Lanka	50.0	O.Q	Granitic Gneiss	142,000	6,800,000	
						Σ	35,880,000 m3	

	Northern Section 1	**Σ**	4,800,000 m3
	Sourthern Section	**Σ**	7,060,000 m3

Note : O . Q - Operating Quarry

Note:

The Employer takes no responsibility for the accuracy of the information above tables and makes no representation in relation to the quality and availability of materials at locations, not the quantity of the materials that may be available. The Contractor shall be responsible for sourcing all materials..

SUMMARY

LABORATORY TESTS OF TEST PIT DATA

LABORATORY TESTS - SUMMARY

Client: Oriantal Consultant Co.Ltd in associated with Pacific Consultants international — Job Ref: 2320

Project: Material survey for outer circular highway to city of Colombo — Date: 14.02.2007

Source	Borehole No	Depth	Discription	Soil Type	Natural moisture content	Bulk Density	Dry Density	Specific Gravity	Grain Size Analysis							Atterberge's Lmit		
									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI
																%	%	%
DELGODA 01		0.00-0.45				1.61	1.43		92.27	80.29	61.89	51.83	49.87			67	34	33
	1	1.00-1.45			21.16			2.53								75	50	25
		2.00-2.45	Sandy Silt	ML	21.31				100	96.11	72.88	60.73	57.02			47	41	6
		3.00-3.45			18.97			2.6								51	37	14
		4.00-4.45	Claye Sand	SC	18.59				99.44	93.27	61.37	47.75	43.31			42	21	21
		5.00-5.45			17.64			2.55								51	37	14
		6.00-6.45	Silty Sand	SM	5.49				99.86	95.51	52.36	31.38	24.84			47	31	16
		7.00-7.45			6.88			2.55								40	28	12
		8.00-8.45	Silty Sand	SM	5.95				95.92	89.06	43.75	20.9	14.44			44	29	15
		9.00-9.45			6.24			2.5								42	31	11
		10.00-10.45			6.66													
DIDDENIYA ESTATE 02		0.0-0.45				1.77	1.65											
	2	1.00-1.45			13.55			2.4								58	32	26
		2.00-2.45	Silty Sand	SM	11.58				91.22	70.86	38.03	33.97	32.67			54	31	23
		3.00-3.45			17.72			2.47								48	32	16
		4.00-4.45	Silty Sand with Gravel	SM	18.3				83.63	71.26	47.94	35.37	33.39			49	31	18
		5.00-5.45			18.37			2.35								44	30	14
		6.00-6.45	Claye Sand	SC	16.96				95.96	85.99	52.6	37.91	34.44			56	24	32
		7.00-7.45			14.43			2.59								44	30	14
		8.00-8.45	Silty Sand	SM	4.01				100	97.22	51.98	26.13	21.04			NP	NP	NP
		9.00-9.45			14.1													
		10.00-10.45																

Source	Borehole No	Depth	Discription	Soil Type	Natural moisture content	Bulk Density	Dry Density	Specific Gravity	Grain Size Analysis							Atterberge's Lmit		
									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI
																%	%	%
PATHEGAMA 03	3	0.00-0.45	Silty Sand	SM	11.1	1.81	1.63		89.95	75.65	49.01	39.94	30.17			NP	NP	NP
		1.00-1.45			9.4			2.33										
		2.00-2.45	Claye Sand	SC	13.46				85.19	69.14	29.17	21.83	20.30			49	23	26
		3.00-3.45			10.4			2.5										
		4.00-4.45	Silty Sand	SM	8.65				87.78	77.07	40.43	27.94	25.79			55	35	20
		5.00-5.45			12.62			2.07										
		6.00-6.45	Silty Sand	SM	9.67				95.49	85.98	45.36	30.22	27.52			48	29	19
		7.00-7.45			13.4			2.05										
		8.00-8.45	Silty Sand	SM	10				87.29	81.32	36.87	36.94	17.29			NP	NP	NP
		9.00-9.45			13.19													
		10.00-10.45																
PUWAKPITIYA BORROW PIT 04	4	TOP				1.88	1.7											
		1.00-1.45			8.49			2.59										
		2.00-2.45	Silty Sand	SM	8.31				99.34	96.93	51.26	33.64	29.57			41	28	13
		3.00-3.45			10.36			1.94								38	25	13
		4.00-4.45	Silty Sand	SM	8.69				100	97.16	56.62	38.11	33.75			42	30	12
		5.00-5.45			5.33			2.61										
		6.00-6.45	Silty Sand	SM	7.16				99.58	97.49	39.91	23.41	20.3			36	33	3
		7.00-7.45			6.28			2.5										
		8.00-8.45	Silty Sand	SM	5.01				92.94	86.92	41.84	24.87	20.87			31	26	5
		9.00-9.45			8.96			2.61										
		10.00-10.45																

Source	Borehole No	Depth	Discription	Soil Type	Natural moisture content	Bulk Density	Dry Density	Specific Gravity	Grain Size Analysis							Atterberge's Lmit		
									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI
																%	%	%
HALBARAWA BORROW PIT 05	5	TOP				1.77	1.65											
		1.00-1.45			8.6			2.2								45	28	17
		2.00-2.45	Silty Sand	SM	19.91				90.16	79.53	55.23	36.62	29.29			48	31	17
		3.00-3.45			11			2.54								45	32	13
		4.00-4.45	Silty Sand	SM	23.01				96.25	89.66	66.15	49	43.14			53	38	15
		5.00-5.45			13.48			2.52								43	34	9
		6.00-6.45	Silty Sand	SM	18.17				98.12	87.96	67.23	48.34	41.79			46	33	13
		7.00-7.45			10.08			2.51								48	42	6
		8.00-8.45	Silty Sand with Gravel		16.75				80.87	76.17	56.54	38.3	31.5			37	24	13
		9.00-9.45			12.34			2.5										
		10.00-10.45	Silty Sand	SM	13.04				93.4	84.94	59.82	40.35	33.95			NP	NP	NP
DADIGAMUWA BORROW PIT 06	6	TOP	Silty Sand	SM		1.58	1.47		92.27	80.29	61.89	51.83	49.87			41	33	08
		1.00-1.45						2.45								41	26	15
		2.00-2.45	Silty Sand	SM					97.04	91.89	67.87	52.86	49.48			40	31	9
		3.00-3.45						2.39								38	27	11
		4.00-4.45	Claye Sand	SC					97.54	88.39	56.62	42.14	38.38			42	20	22
		5.00-5.45						2.58										
		6.00-6.45	Silty Sand	SM					90.61	82.04	53.05	36.17	33.28			47	32	15
		7.00-7.45						2.55										
		8.00-8.45	Silty Sand	SM					96.18	88.04	54.97	42.61	40.18			52	40	12
		9.00-9.45						2.52								42	37	5
		10.00-10.45																

Source	Borehole No	Depth	Discription	Soil Type	Natural moisture content	Bulk Density	Dry Density	Specific Gravity	Grain Size Analysis							Atterberge's Lmit		
									4.75	2	0.425	0.15	0.075	0.006	0.003	LL	PL	PI
																%	%	%
07 UDUWA BORROW PIT	7	TOP				1.71	1.45											
		1.00-1.45			8.46			2.52								66	42	24
		2.00-2.45	Sandy Silt	ML	12.54				98.51	95.29	74.02	58.71	53.95			48	32	16
		3.00-3.45			14.68			2.61								60	38	22
		4.00-4.45	Sandy Elastic Silt	MH	12.32				98.63	96.42	77.29	64.63	60.42			64	38	26
		5.00-5.45			13.52			2.33								59	36	23
		6.00-6.45	Sandy Elastic Silt	MH	12.19											67	46	21
		7.00-7.45			14.23			2.31								54	35	19
		8.00-8.45	Sandy Elastic Silt	MH	11.56				99.82	99.13	84.57	68.81	64.50			65	46	19
		9.00-9.45			12.69			2.05								68	43	25
		10.00-10.45	Sandy Elastic Silt	MH	11.06				97.66	95.93	80.34	69.17	66.20			65	41	24

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Prepared by Certified by Approved by

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LABORATORY TESTS - SUMMARY

Client:	Oriantal Consultant Co.Ltd in associated with Pacific Consultants international	Job Ref:	2321
Project:	Material survey for outer circular highway to city of Colombo	Date:	14.03.2007

Source	Borehole No	Depth	Discription	Soil Type	CBR%	PROCTOR COMPACTION	
						Maximum Dry Density	Optimum Moisture content
DELGODA 01		0.00-1.00			12.25	1.71	17.6
	1	1.00-1.50			10.13		
		2.00-2.45	Sandy Silt	ML			
		3.00-3.45					
		4.00-4.45	Claye Sand	SC			
		5.00-5.45					
		6.00-6.45	Silty Sand	SM			
		7.00-7.45					
		8.00-8.45	Silty Sand	SM			
		9.00-9.45					
		10.00-10.45					
DIDDENIYA ESTATE 02		0.0-0.40			13.10	1.82	13.1
	2	1.00-1.50			19.13	1.66	16.6
		2.00-2.45	Silty Sand	SM			
		3.00-3.45					
		4.00-4.45	Silty Sand with Gravel	SM			
		5.00-5.45					
		6.00-6.45	Claye Sand	SC			
		7.00-7.45					
		8.00-8.45	Silty Sand	SM			
		9.00-9.45					
		10.00-10.45					

Source	Borehole No	Depth	Discription	Soil Type	CBR %	PROCTOR COMPACTION	
						Maximum Dry Density	Optimum Moisture content
PATHEGAMA 03	3	0.00-0.50	Silty Sand	SM	21.50	1.92	11.2
		0.50-0.90			32.00	1.97	11.0
		0.90-1.5	Claye Sand	SC	9.08	1.87	14.0
		3.00-3.45					
		4.00-4.45	Silty Sand	SM			
		5.00-5.45					
		6.00-6.45	Silty Sand	SM			
		7.00-7.45					
		8.00-8.45	Silty Sand	SM			
		9.00-9.45					
		10.00-10.45					
BORROW PIT 04 PUWAKPITIYA	4	TOP					
		0.00-0.70			33.25	1.96	12.5
		0.70-1.20	Silty Sand	SM	5.25	1.85	14.4
		1.20-1.50			13.38	1.86	13.2
		4.00-4.45	Silty Sand	SM			
		5.00-5.45					
		6.00-6.45	Silty Sand	SM			
		7.00-7.45					
		8.00-8.45	Silty Sand	SM			
		9.00-9.45					
		10.00-10.45					

Source	Borehole No	Depth	Discription	Soil Type	CBR %	PROCTOR COMPACTION	
						Maximum Dry Density	Optimum Moisture content
HALBARAWA BORROW PIT 05	5	TOP					
	Sample 1	000-1.50			6.13	1.51	24.8
	Sample 2	0.00-1.50	Silty Sand	SM	9.5	1.68	17
	Sample 3	0.00-1.50			10.75	1.74	15.3
		4.00-4.45	Silty Sand	SM			
		5.00-5.45					
		6.00-6.45	Silty Sand	SM			
		7.00-7.45					
		8.00-8.45	Silty Sand with Gravel				
		9.00-9.45					
		10.00-10.45	Silty Sand	SM			
BORROW PIT 06 DADIGAMUWA	6	TOP	Silty Sand	SM			
		0.00-0.70			21.88	1.48	23.4
		0.70-1.20	Silty Sand	SM	8.00	1.84	13.7
		1.20-1.50			19.00	1.63	15.2
		4.00-4.45	Claye Sand	SC			
		5.00-5.45					
		6.00-6.45	Silty Sand	SM			
		7.00-7.45					
		8.00-8.45	Silty Sand	SM			
		9.00-9.45					
		10.00-10.45					

Source	Borehole No	Depth	Discription	Soil Type	CBR %	PROCTOR COMPACTION	
						Maximum Dry Density	Optimum Moisture content
PIT 07 UDUWA BORROW	7	TOP					
		1.00-1.20			9.75	1.77	14.7
		1.20-1.50	Sandy Silt	ML	26.25	1.91	12.3
		0.00-1.50			50.25	2.06	9.8
		4.00-4.45	Sandy Elastic Silt	MH			
		5.00-5.45					
		6.00-6.45	Sandy Elastic Silt	MH			
		7.00-7.45					
		8.00-8.45	Sandy Elastic Silt	MH			
		9.00-9.45					
		10.00-10.45	Sandy Elastic Silt	MH			

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Summary of Laboratory Test Results (Chemical Test for Soil) for Geological Investigation for proposed Outer Circular Highway to city of Colombo

BH No.	Formation & Soil Name / Zone	Sample No.	Type of Sample	Depth		Soil Type	Water Content Wn (%)	Specific Gravity Gs	Chemical Test			
				GL - (m)	EL (m)				pH at 30°C	Cl as % of wt	Alkalinity as % of wt	Ca as % of wt
01				5.00	0.45				5.40	0.0016	0.0005	0.0020
(Pathagama)												
01				7.00	0.45				5.20	0.0024	0.0032	0.0002
(Puwakpitiya)												
01				5.00	0.45				5.50	0.0016	0.0025	0.0004
(Watareka)												
01				4.00	0.45				5.00	0.0096	0.0032	0.0004
02				8.00	0.45				5.10	0.0032	0.0090	0.0008
(Pathagama)												
02				15.00	0.45				7.40	0.0040	N.D.	0.0080
06				6.00	0.45				5.30	0.0048	0.0070	0.0003
07				6.00	0.45				5.60	0.0048	0.0032	0.0007
25				1.00	0.45				6.50	0.0074	0.0028	0.0024
51				3.00	0.45				4.00	-	-	-
54				5.00	0.45				4.40	N.D.	N.D.	N.D.

N.D.-Not detected

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Summary of Laboratory Test Results (Water Quality) for Geological Investigation for proposed O.C.H. to City of Colombo

BH No.	Formation & Soil Name / Zone	Sample No.	Type of Sample	Water Table		Sampling Depth		Water Quality										
								Chemical Test										
				GL - (m)	EL (m)	GL - (m)	EL (m)	pH	Cl mg/l	SO4 mg/l	Na mg/l	Ca mg/l	NH4 mg/l	K mg/l	OH mg/l	CO3 mg/l	HCO3 mg/l	Alkali mg/l
BH-11				8.00	-13.24	8.00	-13.24	6.7	6.00	24.36	20.50	4.80	N.D.	4.50	N.D.	0.0063	0.672	0.680
								(20°C)										
BH-19				9.20	-12.78	9.20	-12.78	6.9	6.00	31.58	18.10	9.62	N.D.	3.50	N.D.	0.0080	0.864	0.900
								(20°C)										
BH-20				5.60	-13.43	5.60	-13.43	6.4	7.00	33.39	18.50	9.62	N.D.	3.50	N.D.	0.0007	0.768	0.769
								(24.8°C)										
BH-31				8.65	-18.38	8.65	-18.38	6.0	5.00	12.63	11.00	6.41	N.D.	2.00	N.D.	0.0004	0.432	0.432
								(19°C)										
BH-32				3.60	-27.47	3.60	-27.47	7.0	6.00	77.60	13.00	24.04	N.D.	1.50	N.D.	0.0045	0.480	0.490
								(22°C)										
BH-34				8.90	-30.09	8.90	-30.09	6.0	6.00	14.44	14.00	6.41	N.D.	1.50	N.D.	0.0003	0.288	0.289
								(25.8°C)										
BH-36				2.70	-12.65	2.70	-12.65	6.4	7.00	9.92	14.00	12.82	N.D.	3.50	N.D.	0.0008	0.864	0.865
								(28°C)										
BH-45				9.50	-8.15	9.50	-8.15	6.8	9.00	46.02	39.00	10.42	N.D.	11.50	N.D.	0.0080	0.864	0.900
								(22°C)										
BH-46				N.E.	-	N.E.	-	7.3	6.00	43.32	37.00	11.22	N.D.	11.50	N.D.	0.0076	0.820	0.829
								(20°C)										
BH-63				8.70	-5.44	8.70	-5.44	7.3	13.00	740.00	80.00	16.03	N.D.	13.00	0.005	0.0026	2.780	2.790
								(25°C)										
BH-64				10.70	-10.39	10.70	-10.39	7.4	14.00	574.00	82.00	17.64	N.D.	13.50	0.005	0.0023	2.400	2.400
								(26°C)										
BH-66				10.70	-8.42	10.70	-8.42	6.2	12.00	37.00	9.50	10.42	N.D.	1.00	N.D.	0.0009	0.960	0.960
								(22.6°C)										
BH-68				9.80	-8.95	9.80	-8.95	6.0	6.00	20.76	14.00	12.82	N.D.	1.00	N.D.	0.0007	0.768	0.769
								(24°C)										

N.D.-Not detected

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LABORATORY TESTS - SUMMARY

Summary of Laboratory Test Results (Chemical Test for Soil) for Material Survey for proposed Outer Circular Highway to city of Colombo

BP No.	Formation & Soil Name / Zone	Sample No.	Type of Sample	Depth		Soil Type	Water Content Wn (%)	Specific Gravity Gs	Chemical Test			
				GL - (m)	EL (m)				pH at 30^{0}C	Cl as % of wt	Alkalinity as % of wt	Ca as % of wt
02 Diddeniya Estate-01				5.00	0.45				5.40	0.0016	0.0005	0.0020
04 Puwakpitiya				7.00	0.45				5.20	0.0024	0.0032	0.0002
05 Halbarawa				5.00	0.45				5.50	0.0016	0.0025	0.0004
01 Delgoda				4.00	0.45				5.00	0.0096	0.0032	0.0004
03 Diddeniya Estate-02				8.00	0.45				5.10	0.0032	0.0090	0.0008
06 Dedigamuwa				6.00	0.45				5.30	0.0048	0.0070	0.0003
07 Uduwa				6.00	0.45				5.60	0.0048	0.0032	0.0007

SUMMARY

LABORATORY TESTS OF QUARRY ROCK DATA

SUMMARY OF TEST RESULTS

Consultant:	Oriantal Consultant CO, LTD in association with	Job ref :	2321
	Pacific Consultants International	Client ref :	-
Project:	Supplemetal material survey for Outer circular High way	Date	15.02.2007
	Nothern Section 01		

Location	Sample no	water absorption	Specific Gravity	LAAV(%)	Effective porosity	Unconfined Compression	Slaking Durability
W.A.Perera ,Athurugiriya	Q1-A	0.67	2.7	44.74	0.62	44.64	99.00
W.A.Perera ,Walipillawa	Q1-B	0.61	2.71	45.84	1.00	65.96	99.20
W.A.Perera ,Dadigamuwa	Q1-C	0.11	2.82	55.28	1.47	34.43	99.2
Lanka Quarry	Q4	0.73	2.71	32.27	0.19	52.89	99.2
C & A	Q5	0.61	2.69	41.92	1.08	26.63	99.40
Senok	Q6	0.52	2.77	31.58	0.34	33.66	99.20
Bitumin Lanka	Q7	0.53	2.85	40.86	1.20	45.04	99.4

Prepared by ..... Checked by ..... Certified by .....

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PART III - JBIC Guidelines for confirmation of Environmental and Social Considerations, April 2002 (or later revision)

Available for viewing on Internet at
www.jbic.go.jp/english/environ/guide/

PART IV

1) **Environmental Impact Assessment (EIA) of Outer Circular Highway to the City of Colombo Project, CEA's Approval letter, February 2001. (and the extended letter, 19 May 2004)**

2) **Supplemental Environmental Impact Assessment (SEIA) of the Proposed Deviation to the Outer Circular Highway to the City of Colombo Project, (From Malambe - Athurugiriya Highway Crossing to Avissawella – Colombo Highway) 31 May 2005, CEA's Letter**

3) **EIA Approval Letter for Outer Circular Highway to the City of Colombo, 15 November 2007**

4) **Interim Standard on Vibration Pollution Control, 4 July 2002, CEA's letter**

1) Environmental Impact Assessment (EIA) of Outer Circular Highway to the City of Colombo Project, CEA's Approval letter, February 2001. (and the extended letter, 19 May 2004)

මගේ යොමුව
உமது தொடர்பு
Your Ref.

අපේ යොමුව
எமது தொடர்பு
Our Ref.

දිනය
திகதி
Date

මධ්‍යම පරිසර අධිකාරිය
மத்திய சுற்றாடல் அதிகார சபை
Central Environmental Authority
08/TRANS/03/99 Vol. II
පරිසර පියස", 104, රොබට් ගුණවර්ධන මාවත, බත්තරමුල්ල. ශ්‍රී ලංකාව.
"பரிசரபியஸ", 104, ரொபர்ட் குணவர்தன மாவத்தை, பத்தரமுல்ல, இலங்கை.
"Parisara Piyasa", 104, Robert Gunawardena Mawatha, Battaramulla, Sri Lanka.

February 2001

Chairman
Road Development Authority
Sethsiripaya
Battaramulla.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PROJECT

This is to inform you that the Central Environmental Authority (CEA), after studying the EIA report of the proposed Outer Circular Highway to the City of Colombo (OCH) dated February 2000 submitted to the Central Environmental Authority (CEA) by the Road Development Authority (RDA) on 20th November 2000, and review of the comments received from the public and your responses to such comments, has decided in terms of regulation 13 of the National Environmental (procedure for approval of projects) Regulations No. 01 of 1993 as amended by the Gazette No 1159/22 dated 2nd November 2000, to grant approval for the construction of the proposed road trace from Kottawa to Kerawalapitiya subject to the following terms and conditions:

1 GENERAL

1.1 This approval is valid for three years from the date of issue of this letter unless upon written application to CEA within thirty days prior to the expiry date, the validity period is extended.

1.2 This environmental clearance is valid for the implementation of the proposed road trace from Kerawalapitiya to Kadawatha, which is a part of the alignment A5 depicted in page No. 19 of the above EIAR submitted by the RDA (Annex 1) subject to the final trace being re-designed to deviate from the Kaduwela – Matabe Road crossing point of OCH at Pittugala Junction towards Kaduwela; by taking the route to pass through the Mahawela paddy field to minimize the social impacts.

Chairman	Director General	Office	HRD. Admin. & Finance Division	Envt. Pollution Control Division	Envt. Mgt. & Assess. Division	Envt. Edu. & Awareness Division	Legal Unit
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வனவள மற்றும் சுற்றாடல் அமைச்சு
Ministry of Forestry & Environment

1.3 As a part of the Southern end section[1] (ie. Galanigama to Bandaragama) is missing from the analysis in the EIAR, this environmental clearance is not valid for that section of the proposed highway.

1.4 RDA should where necessary, obtain fresh approval in terms of Regulation 17 (i) (a) contained in Gazette Extra - Ordinary No 772/22 of 24th June 1993, in respect of any alterations that are intended to be made to the approved traces of the project.

1.5 RDA is bound to ensure that the terms and conditions given in this letter are adhered to, during project implementation. The RDA shall have full control over a third party that may be involved in project implementation, by entering into agreements which contain the conditions stipulated in this letter with such parties. CEA should have access to the contract documents pertaining to environmental aspects, entered into by RDA and any outside contractors.

1.6 RDA shall intimate to CEA, the date of commencement of project activities/construction activities within one month of this letter, inclusive of a phased implementation schedule.

1.7 A copy of this letter of clearance should be kept at the project site, for purposes of perusal.

1.8 It is the duty of the RDA to inform the CEA of any adverse environmental impacts arising during project implementation, which are not anticipated at this stage. In such an event, relevant guidelines and necessary mitigatory measures should be implemented as directed by the CEA. The RDA should ensure that such impacts are properly assessed and addressed even at a later stage of project implementation.

1.9 The RDA should co-ordinate closely with planning agencies such as the Urban Development Authority (UDA), and relevant Provincial and Local Authorities, Divisional Secretariats to resolve any conflicts with existing and future development plans along the trace and at the interchanges in order to regulate the land use adjacent to the highway.

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1 Southern end section is the road trace from Panadura/Pinwatte to Bandaragama

2. HYDROLOGY, DRAINAGE, IRRIGATION AND FLOOD ASPECTS

2.1 The Road Development Authority should carry out a comprehensive hydrological study to determine design flood hydrographs for all the major drainage crossings prior to commencement of any development activity.

2.2 Design discharges of sub-catchments at the crossings of trace should be evaluated in order to determine the impact on flood levels upstream of the highway to be used in the final design of the drainage crossings.

2.3 The bridges and culverts on the OCH must be designed in order to allow floodwaters to pass freely preventing the floodwater backing up. The engineering design of the drainage crossings should ensure that the road embankment causes minimum disruption to the existing drainage pattern and negligible impacts on the upstream flood levels.

2.4 Loss of storage capacity of the lowlands should be assessed in consultation with the relevant authorities such as Sri Lanka Land Reclamation and Development Corporation (SLLRDC) and the Urban Development Authority. Necessary drainage facilities should be provided through the OCH. The RDA along with the UDA and relevant local authorities, should identify the necessary retention areas / wetlands for each catchment that is to be preserved.

2.5 The RDA should study the impacts on irrigation / flood control infrastructure affected due to the construction of OCH, and necessary mitigatory measure should be implemented. The impacts should cover socio-economic aspects in addition to the hydrological / hydraulic aspects.

2.6 Detention areas to be preserved to cater for loss of detention due to OCH should be provided by acquisition of lowland and maintaining them for such purpose, as an integral part of the project.

2.7 To ensure that the above are properly analyzed and designed accordingly, the Terms of Reference for the design Consultant to the RDA shall incorporate the following items to be studied and submitted in a "Drainage Design Report".

i) Hydrological analysis for each catchment
ii) Identification of areas sensitive to flooding
iii) Hydraulic design of bridges and other structures
iv) Computation / estimation of changes in ground water levels in wetland areas and in areas where the downstream drainage paths have been modified.

v) Quantification of any changes in flow regimes into receiving inland water bodies, which could influence water quality in those water bodies.

vi) Changes in drainage patterns in flood protection schemes / drainage schemes encountered by the highway trace.

2.8 The RDA shall submit a copy of the completed "Comprehensive Hydrological Study and the Drainage Design Report" to the CEA, with sufficient time to obtain comments and concurrence of other stakeholders.

2.9 The RDA should initiate the collection of data on groundwater in the project area immediately. The data should be submitted to the CEA in order to serve as baseline data to be used in comparative studies during the construction and operational periods.

2.10 The Project Proponent shall implement the recommendations given in sub section 7.1, 7.2, 7.3 and 7.4 of the EIA report.

3 EXTRACTION, HANDLING, TRANSPORTATION AND STORAGE OF CONSTRUCTION MATERIAL

3 Since large quantities of sand will not be available from rivers, it is recommended that alternative sources of sand such as offshore sand should be used in all construction activities.

3.2 If offshore sand is to be used, a separate EIA should be carried out for mining, storage and transport. A mining license should be obtained from the Geological Survey and Mines Bureau (GS & MB) for offshore sand mining.

3.3 Quarrying of rock for construction activities should be done at carefully selected sites in consultation with the GS & MB.

3.4 Licenses for all borrow pits and quarry sites should be obtained from GS & MB together with the required clearances/permits from the CEA / relevant Local Authority, whenever it is required.

3.5 Necessary approvals shall be obtained from CEA and/or the relevant Local Authorities for the operation of metal crushers prior to commencement of operations.

3.6 The routes for transport, including unusually heavy loads shall be subject to agreements with the appropriate traffic authorities.

3.7 Movement of heavy loads for project purposes shall be done with the concurrence of the relevant authorities and shall be done at non-peak traffic times.

3.8 Transport, loading and unloading of materials shall be carried out in such a way as not to cause a nuisance to the people.

3.9 To prevent dust blowing off from open-topped lorries, it is necessary to ensure that the loads are fully covered, during transportation.

3.10 Exposed areas and the access roads should be dampened at regular intervals during dry periods to prevent emission of dust.

3.11 The measures indicated above from 3.1 to 3.11 as well as any other relevant conditions in this letter, should be included in the contract documents, so that the contractor or sub-contractor is held responsible for carrying them out during construction, and on completion of the work. **The RDA would be held responsible for the breach of any such conditions by any contractor or sub-contractor.**

4 URBAN PLANNING ASPECTS

4.1 The RDA should initiate action immediately to demarcate the proposed Vegetative Barrier / Green Belt (page 162 of EIAR). The landscaping should be carried out in close collaboration with the UDA and other relevant agencies.

4.2 Appropriate tree species should be planted in suitable bare land earmarked for the green belt.

4.3 It is recommended that the RDA should identify an appropriate agency for the management and monitoring of the green belt with a view to maintaining a conducive rural landscape by preventing urban sprawl and ribbon development taking place adjacent to the OCH.

5 TRANSPORTATION ENGINEERING ASPECTS & RELATED IMPACTS

5.1 An accurate and complete assessment of the transport related project impacts should be carried out by the RDA in order to identify suitable mitigatory measures prior to the design stage of the project. Accurate estimates and detail evaluation of

anticipated vehicle emissions, noise levels, travel time savings, extra travel distances, accident costs, effects on public transport and capability of service roads should be provided.

6 Air Pollution & Noise Emission

6.1 The asphalt and concrete plants should be located at carefully selected sites in consultation with the CEA and/or relevant Local Authority.

6.2 Appropriate mitigatory measures should be adopted by asphalt / concrete plants in order to maintain noise levels within the standards stipulated by the CEA in Gazette Extra Ordinary No 924/12 dated 23rd May 1996

6.3 Necessary approvals/permits shall be obtained from the CEA and/or relevant Local Authorities for the asphalt and concrete plants prior to the commencement of operation.

6.4 Mitigatory measures suggested in sub section 7.8 of the EIA report should be implemented.

7 IMPACT ON BIOLOGICAL ENVIRONMENT & AESTHETIC ASPECTS

7.1 A detailed mitigation plan should be developed for the mitigation of adverse impacts on fauna, flora and their habitats. Impacts and mitigatory measures should be studied, dividing the road trace into different segments that cut across different habitats and ecosystems. Mitigatory measures should be specific to the localities.

7.2 The road trace should be re-aligned in order to avoid ecologically sensitive habitats as far as possible.

7.3 The number of rows of trees, height, architecture of tree crowns etc; should be carefully planned.

7.4 As mentioned in the EIA report (page 164) a reservation of at least 100 m on either side of the highway should be maintained in the marshy areas to maintain sufficient amount of habitat areas for marsh vegetation and maintaining ecological values and functions of wetlands.

8 SOCIOLOGICAL IMPACTS

8.1 The final trace should be selected in such a way as to minimize the relocation of people while maximizing potential development opportunities as well as contributing positively to anticipated future development programmes in the region.

8.2 Once the final road alignment is decided, a detailed socio-economic survey should be carried out covering the proposed development area in order to identify the affected families, sub-families and other business enterprises in order to serve as baseline data. The data so collected should be used in the preparation of a socio-infrastructure plan. This data will also help to identify new encroachments in the area.

8.3 A comprehensive resettlement plan / programme and compensation package should be prepared inclusive of relocation sites. The resettlement plan and the compensation package so prepared should be submitted to the CEA for approval.

8.4 Since many larger plots of home gardens provide part of household food and other requirements and income, the compensation should compensate for crops and income obtained from these plots of lands at least for 3 years. This should be in addition to compensation of land.

8.5 Those whose paddy fields are affected should be assisted to find alternative farming sites in the vicinity.

8.6 Home garden plots should be restored in the new settlement sites with the assistance of the Department of Agriculture or a private firm.

8.7 Alternative resettlement sites should be selected in order to provide for the diverse requirements of various groups affected. i.e. industrialists, small businessmen, farmers, the elderly, the disabled, female-headed households, school children, youth etc.

8.8 The payment of compensation should not be delayed and should be paid prior to moving into the alternative land.

8.9 Service roads should be improved on either side of the highway to minimize the adverse impacts for those living along the trace. Underpasses or overhead bridges should be provided to the lands divided by the trace at a reasonable distance.

8.10 Damage to social infrastructure such as schools, cemeteries, and religious places should be avoided as far as possible. In the event this is not possible, suitable sites should be found to relocate them in close proximity to the new settlement sites.

8.11 Recommendations given in sub sections 7.10, 7.11, 7.14 and 7.15 of the EIA report should be implemented.

9 SPOIL DISPOSAL

9.1 If the peat soil in the marshy areas within the road trace requires to be removed, disposal areas must be found to deposit the peat soil. Impact of such deposition would have to be assessed, if the quantity is substantial.

9.2 Details regarding the areas and locations where the removed material is to be disposed of should be marked on a 1: 5000 scale map and forwarded to the CEA for prior approval.

9.3 Recommendations given in the sub section 7.8 of the EIA report should be implemented.

10 AIR QUALITY AND NOISE

10.1 Recommendation given in sub section 7.5 and 7.6 of the EIA report should be implemented.

11 AESTHETIC ASPECTS

11.1 All the structures above the ground should blend with the natural environment as far as possible to enhance the aesthetic quality.

11.2 Recommendation given in sub sections 7.6 and 7.8 of the EIA report should be implemented.

12 ROAD SAFETY ASPECTS

12.1 The RDA should take necessary action to establish animal crossings wherever necessary.

12.2 Recommendations given in the sub section 7.12 of the EIA report should be implemented.

13 ARCHEOLOGICAL, RELIGIOUS AND CULTURALLY IMPORTANT SITES

13.1 Final trace should be designed in such away that it avoids any damage or interference to archeological, religious or culturally important sites.

13.2 Recommendation given in sub sections 7.21 of the EIA report should be implemented.

14 MONITORING PROGRAMME

14.1 The RDA shall forward to the CEA an environmental monitoring plan as specified in Chapter 10 of the EIA report. It should contain the work schedule, parameters to be monitored, with intervals/frequencies and the responsible agencies for monitoring each parameter. This plan should be approved by the monitoring committee.

14.2 Monitoring programme should be implemented to monitor the parameters suggested in chapter 10 of the EIA report as soon as the approval is granted, so as to establish the baseline data.

14.3 All costs incurred by the monitoring committee appointed by CEA to oversee implementation of the mitigatory measures and the monitoring plan, shall be borne by the RDA.

The RDA shall comply with any additional conditions that may be communicated from time to time by the CEA during the execution of the project.

I wish to draw your attention to regulation NO 17 of the National Environmental (procedure for approval of projects) Regulations No. 01 of 1993 which states;

17 (i) The project proponent shall inform the appropriate Project Approving Agency of;

(a) any alteration to a prescribed project approved under regulation 9(i); and 13(ii); and/or,

(b) the abandonment of such approved project.

(ii) The project proponent shall where necessary obtain fresh approval in respect of any such alterations that are intended to be made to such project. The Project

Approving Agency shall in consultation with the Authority, determine the scope and format of the supplemental report required to be submitted for such alterations.

(iii) The Project Proponent shall, where a project is abandoned, restore the project site to a condition as specified by the Project Approving Agency.

Please note that this is only a preliminary approval. The final approval will be granted after the approval of the Board of the CEA is obtained.

Thilak Hewawasam
Chairman
CENTRAL ENVIRONMENTAL AUTHORITY

cc: Secretary, Ministry of Finance
Secretary, Ministry of Highways
Secretary, Ministry of Forestry & Environment
Chairman, Sri Lanka Land Reclamation and Development Corporation
Director General, Irrigation Department
Director, External Resources
Director, Geological Survey and Mines Bureau
District Secretary / Colombo / Kalutara / Gampaha
Chairman, Urban Development Authority –

- *It is recommended that detailed land use zoning plan should be carried out at all interchanges to mitigate land use conflicts and adverse environmental impacts. In this connection the RDA should initiate the following in collaboration with all relevant agencies.*

  (i) Identify the appropriate area of influence associated with each of the proposed interchanges and declare the areas as urban development areas in terms of the relevant sections of the UDA Law.

  (ii) Collaborate with the UDA or other relevant planning agencies in conducting a land use survey and analysis and prepare a detailed land use-zoning plan.

  (iii) *Identify an appropriate institutional set up to approve development applications in conformity with the zoning plan and introduce an effective monitoring mechanism with adequate controls to ensure that there is no violation of the land use zoning plan.*

19 May 2004

..., 104, රොබට් ගුණවර්ධන මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசரபியஸ", 104, ரொபர்ட் குணவர்தன மாவத்தை, பத்தரமுல்ல, இலங்கை.
"Parisara Piyasa", 104, Robert Gunawardena Mawatha, Battaramulla, Sri Lanka.

Road Development Authority
BATTARAMULLA.
21 MAY 2004
Outer Circular Road Project

Chairman
Road Development Authority
Sethsiripaya
Battaramulla.

Attn : Mrs. H Y Fernando / Director (OCH Project)

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO (OCH) PROJECT
ENVIRONMENTAL APPROVAL

This has reference to your letter No. RDA/OCHP/ACC/12(I) dated 19th March 2004 requesting a further extension of the validity of the environmental approval granted under Part IV C of the National Environmental Act by our letters dated 4th May 2001 and 14th June 2001 for the implementation of the above project.

We wish to inform you that the validity period of the above approval is hereby extended until 4th May 2007.

Please note that the terms and conditions of our letter No. 08/TRANS/03/99 Vol III dated 4th May 2001 and 14th June 2001 remain unchanged.

Manel Jayamanna
Director General
CENTRAL ENVIRONMENTAL AUTHORITY.

PD/OCH

CC: Secretary / Ministry of Finance
Secretary / My. of Highways
Secretary / My. of Environment & Natural Resources
Chairman / SLLRDC
Chairman / UDA
Director General / Irrigation Dept.
Director / External Resources / National Planning Dept.
Director / GS&MB
District Secretary / Colombo / Kalutara / Gampaha
Director (Environmental Pollution Control) / CEA
Director / Legal / CEA

Mr. ... To file ... EIA ... 25/5

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சுற்றாடல், இயற்கை வளங்கள் அமைச்சு
MINISTRY OF ENVIRONMENT & NATURAL RESOURCES

2) Supplemental Environmental Impact Assessment (SEIA) of the Proposed Deviation to the Outer Circular Highway to the City of Colombo Project, (From Malambe - Athurugiriya Highway Crossing to Avissawella – Colombo Highway) 31st May 2005, CEA's Letter

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மத்திய சுற்றாடல் அதிகாரசபை
Central Environmental Authority
"පරිසර පියස", 104, ඩෙනසිල් කොබ්බෑකඩුව මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசர பியச", 104, தெனசில் கொப்பேகடுவ மாவத்தை, பத்தரமுல்ல, இலங்கை.
"Parisara Piyasa", 104, Denzil Kobbekaduwa Mawatha, Battaramulla, Sri Lanka.

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உமது தொடர்பு
Your Ref.

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எமது தொடர்பு
Our Ref. 08/EIA/Trans/05/2004

දිනය
திகதி
Date May 31, 2005

Chairman
Road Development Authority
Sethsiripaya
Battaramulla

SUPPLEMENTAL ENVIRONMENTAL IMPACT ASSESSMENT (SEIA) OF THE PROPOSED DEVIATION TO THE OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PROJECT
(From Malambe – Athurugiriya Highway crossing to Avissawella – Colombo Highway)

This is to inform you that the Central Environmental Authority (CEA), after study of the Supplemental Environmental Impact Assessment (SEIA) Report of the Proposed Deviation to the Outer Circular Highway to the City of Colombo Project dated November 2004 and your responses to the clarifications sought by the Technical Evaluation Committee (TEC) appointed by the CEA, has decided in terms of regulation 17 (ii) of the National Environmental (procedure for approval of projects) Regulation No. 01 of 1993, to grant approval for the implementation of the above deviation subject to the following terms and conditions:

A. GENERAL

1. This environmental clearance is valid for the implementation of the proposed deviation to the Outer Circular Highway to the City of Colombo Project (from Malambe – Athurugiriya Highway crossing to Avissawella – Colombo Highway) as specified in the SEIA Report dated November 2004 submitted by the Road Development Authority (RDA).

2. All the terms and conditions already stipulated by CEA letters dated 04th May 2001, 14th June 2001 and 19th May 2004 bearing number 08/Trans/08/99 issued under regulation 13 of the National Environmental (procedure for approval of projects) Regulations No. 01 of 1993 to RDA are valid and shall be adhered to.

3. This Approval is valid for three years from the date of issue of this letter unless upon written application to CEA and payment of the required fee, within thirty days prior to expiry date, the validity period is extended.

Chairman	Director General	Gen. Office	HRD, Admin & Finance Division	Envt. Pollution Control Division	Envt. Mgt. & Assess. Division	Envt. Edu. & Awareness Division	Legal Unit
T Phone 2872361 2872348 Fax 2872347	T Phone 2872359 Fax 2872608	T Phone 2872278 2872263,2873447-51 2872415,2872419 Hot Line 2872602	T Phone 2872361 2872603,2872607 Fax 2872691	T Phone 2872453,2872406 2873452,2872606(Labs) Fax 2872605	T Phone 2872388,2872402 2872346,2872633 Fax 2872296	T Phone 2872274 2872611 Fax 2872694	T Phone 2872694

4. **The final trace of the proposed deviation should be strictly sited within a corridor of 100 m on either side of the centre line specifically described by the coordinates appearing in the RDA letter No. RDA/OCHP/EIA/13 (11) dated 21.05.2005.**

5. RDA should where necessary obtain fresh approval in respect of any further alterations that are intended to be made to the project.

6. RDA is bound to ensure that the terms and conditions given in this letter are adhered to and have full control over a third party that may be involved in project implementation. CEA should have access to the contract documents pertaining to environmental aspects, entered into by RDA and any outside contractors. **The conditions in this letter should be included in the contract documents,** so that the contractor and/or sub contractor is held responsible for carrying them out during construction and on completion of the work. **The RDA would be held responsible for the breach of any such conditions by any contractor or sub contractor.**

B. HYDROLOGY AND DRAINAGE ASPECTS

1. A detailed drainage design should be carried out during the design phase to ensure the proper drainage from the project area. The drainage design should be submitted to CEA for approval prior to commencement of any development activity. RDA shall explore possibilities of constructing an elevated highway for critical sections.

2. The area of marsh/paddy fields remaining after the road construction shall be preserved as a marsh/paddy field capable of serving as a retention area. The marsh area below station 20+000 should be maintained as a strict flood retention area as suggested in Sections 6.1 and 7.1 of the SEIA Report.

3. RDA should develop a workable plan for the entire project area for preservation and maintenance of retention areas in consultation with the Urban Development Authority (UDA) and Sri Lanka Land Reclamation & Development Corporation (SLLRDC) and inform CEA. Until such a plan is finalized, it is recommended to form a committee comprising of members from the RDA, Kaduwela Pradeshiya Sabha, Irrigation Department, UDA, Divisional Secretary, Kaduwela and SLLRDC to evaluate any request for development in a case by case manner.

4. Adequate cross drainage culverts/bridges of required sizes, based on accurate hydrological computations should be provided at proper locations in consultation with the Agrarian Development Department and Irrigation Department.

5. Suitable silt traps should be provided wherever required and maintained regularly in order to prevent siltation of neighboring marsh/paddy lands during construction.

6. The RDA should study the feasibility of reducing the width of the embankment base since the impacts of flooding and spoil disposal from the base are directly proportional to the width of the embankment base. The base width can be reduced by the use of reinforced-earth in constructing the embankment. This would permit the construction of earth fills with vertical sides. RDA shall adopt this method if feasible, at least in the narrower sections of the valley where the passage of drainage may otherwise be obstructed.

7. Dredged material and all other disposable material should not be disposed of into neighboring marsh/paddy lands. Details regarding the areas and locations where the dredged material is to be disposed should be marked in a map and forwarded to CEA for prior approval.

8. All other mitigatory measures suggested in Section 6.1 of the SEIA Report should be adopted.

C. GEOLOGY AND GEOTECHNICAL ASPECTS

1. Details should be provided regarding sources and amounts of sand and fill material required for the project prior to extraction.

2. Licenses for all borrow pits and quarry sites should be obtained from the Geological Survey & Mines Bureau (GSMB) together with the required clearance/ permits from the CEA / relevant Local Authority, whenever it is required.

3. Necessary approval shall be obtained from the CEA and the relevant Local Authority for the operation of the metal crushers prior to commencement of operations.

D. WATER QUALITY

1. In view of the need to incorporate baseline data on groundwater in the project area and surface water of the Maha Ela, RDA shall initiate collecting such information now and submit them to CEA.

2. A continuous monitoring program should be established in order to monitor the surface & groundwater quality during construction period. The parameters to be monitored should include pH, E. Conductivity, DO, BOD_3, COD, Chloride, Nitrate, Oil & Grease, Phosphate, Lead, Zinc, Total Coliform and E-coli.

E. AIR QUALITY

1. RDA should initiate the collection of data on ambient air quality in the project area. The data should be submitted to CEA including site locations in order to serve as baseline data to be used in comparative studies during the construction and operational periods.

2. Appropriate mitigatory measures should be suggested in order to reduce air pollution during construction and operation phases.

F. NOISE AND VIBRATION

1. Baseline conditions of existing noise levels should be established before commencement of the constructions.

2. Appropriate mitigatory measures should be adopted in order to maintain noise levels within the standards stipulated by the CEA in Gazette Extra Ordinary No. 924/12 dated 23rd May 1996 during construction and operational periods.

3. Appropriate mitigatory measures should be adopted in order to maintain the vibration levels generated by operations of machineries, construction activities, vehicle movements and blasting activities, within the interim standards stipulated by the CEA (Annex I).

G. BIOLOGICAL, ECOLOGICAL AND AGRICULTURAL ASPECTS

1. Clearing of vegetation should be minimized as much as possible. Adequate openings shall be kept for animal crossings at suitable places as suggested in Section 6.2.1 of the SEIA report.

2. A comprehensive greenery plan should be prepared for **right of way of the road** and adjacent areas.

3. Paddy fields along the right of way of the deviation should be acquired by the RDA prior to commencement of the project and required approvals should be obtained from the Agrarian Development Department for filling of the paddy lands.

H. SOCIOLOGICAL ASPECTS

1. A detailed socio economic survey should be carried out covering the proposed development area in order to identify the exact number of affected families and business enterprises. The data should be used in the preparation of a socio infrastructure plan. This data will also help to identify new encroachments in the area.

2. A detailed resettlement plan and compensation package should be prepared inclusive of relocation sites. The resettlement plan and the compensation package so prepared should be submitted to the CEA for approval.

3. All compensation should be paid on the basis of the principals contained in the National Involuntary Resettlement Policy.

4. All the sub roads in the area should not be disturbed at all by the project as suggested in Section 6.3 of the SEIA Report.

5. All other mitigatory measures suggested in Section 6.3 of the SEIA Report shall be implemented.

The RDA shall comply with any additional conditions that may be communicated from time to time by the CEA during the execution of the project.

Tilak Ranaviraja
Chairman
CENTRAL ENVIRONMENTAL AUTHORITY

CC: Secretary / Ministry of Highways
Secretary / Ministry of Environment & Natural Resources
Director General / External Resources Department
Director General / Irrigation Department
Director / Geological Survey and Mines Bureau
Chairman / Urban Development Authority
Chairman / Sri Lanka Land Reclamation and Development Corporation
Divisional Secretary / Kaduwela
Chairman / Pradeshiya Sabha / Kaduwela

21eia\e\auk\final approval let of OCH SEIA

3) EIA Approval Letter for Outer Circular Highway to the City of Colombo, 15 November 2007

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மத்திய சுற்றாடல் அதிகாரசபை
Central Environmental Authority
"පරිසර පියස", 104, ඩෙන්සිල් කොබ්බෑකඩුව මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசர பியச", 104, டென்சில் கொப்பேகடுவ மாவத்தை, பத்தரமுல்ல, ஸ்ரீ லங்கா
"Parisara Piyasa", 104, Denzil Kobbekaduwa Mawatha, Battaramulla, Sri Lanka.

08/TRANS/03/99 Vol IV

15th November 2007

Chairman
Road Development Authority
Sethsiripaya
Battaramulla.

Dear Sir,

OUTER CIRCULAR HIGHWAY TO THE CITY OF COLOMBO PROJECT

This is to inform you that the Central Environmental Authority (CEA) after study of the Environmental Impact Assessment report of the Outer Circular Highway (OCH) Project dated February 2000, the Supplemental Environmental Impact Assessment reports dated November 2004, July 2006 and August 2007 of the proposed deviations at Kaduwela, Biyagama and Kadawatha respectively, subsequent report submitted by Road Development Authority dated September 2007 to the Central Environmental Authority indicating that no significant changes have taken place along the proposed corridor and review of the comments made by the Technical Evaluation Committee members at the meeting held on 2nd Nov. 2007, has decided, in terms of regulation 13 of the National Environmental Regulations No. 1 of 1993, to grant approval for the above project subject to the following conditions.

1 GENERAL

1.1 This environmental clearance is valid for the implementation of the proposed road trace from Kerawalapitiya to Kottawa as depicted in the report dated September 2007 submitted by the Road Development Authority (RDA). *(Annex 1)*

1.2 This approval is valid for three years from the date of issue of this letter unless upon written application to CEA within thirty days prior to the expiry date, the validity period is extended.

Chairman	Director General	Gen. Office	HRD. Admin & Finance Division	Envt. Pollution Control Division	Envt. Mgt. & Assess. Division	Envt. Edu. & Awareness Division	Legal Unit
T. Phone : 2872361 2872348 Fax : 2872347	T. Phone : 2872359 Fax : 2872608	T. Phone : 2872278 2872263,2873447-51 2872415,2872419 Hot Line : 2888999	T. Phone : 2865296 2872603,2872607 Fax : 2872601 2872301	T. Phone : 2873453,2872409 2873452,2872606(Lab), 2867268(Lab) Fax : 2872605,2867262	T. Phone : 2872388,2872402 2872346,2876643 Fax : 2872296	T. Phone : 2872297 2876641,2867266, 2867264 Fax : 2872609	T. Phone : 2872604 2867267

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சுற்றாடல் அமைச்சு
MINISTRY OF ENVIRONMENT

1.3 RDA should where necessary, obtain fresh approval in respect of any alterations that are intended to be made to the approved trace of the project.

1.4 **The final trace of the proposed highway should be strictly sited within a corridor of 100 m on either side of the centre line. RDA should submit the coordinates of the centreline of the approved trace prior to implementation of any construction activities of the project**

1.5 RDA is bound to ensure that the terms and conditions given in this letter are adhered to, during project implementation. The RDA shall have full control over a third party that may be involved in project implementation, by entering into agreements which contain the conditions stipulated in this letter with such parties. CEA should have access to the contract documents pertaining to environmental aspects, entered into by RDA and any outside contractors.

1.6 RDA shall intimate to CEA, the date of commencement of project activities/construction activities within one month of this letter, inclusive of a phased implementation schedule.

1.7 A copy of this letter of clearance should be kept at the project site, for purposes of perusal.

1.8 It is the duty of the RDA to inform the CEA of any adverse environmental impacts arising during project implementation, which are not anticipated at this stage. In such an event, relevant guidelines and necessary mitigatory measures should be implemented as directed by the CEA. The RDA should ensure that such impacts are properly assessed and addressed even at a later stage of project implementation.

1.9 The RDA should co-ordinate closely with planning agencies such as the Urban Development Authority (UDA), and relevant Provincial and Local Authorities, Divisional Secretariats to resolve any conflicts with existing and future development plans along the trace and at the interchanges in order to regulate the land use adjacent to the highway.

2. HYDROLOGY, DRAINAGE, IRRIGATION AND FLOOD ASPECTS

2.1 Since the proposed highway trace passes through sensitive low lying areas adequate provision for drainage should be provided to ensure safe drainage at all locations of the project area. Recommendations given in the Hydrology and Drainage Design report dated December 2004 and Hydrological Study Review reports of Sri Lanka Land Reclamation & Development Corporation (SLLRDC) dated November 2006 and October 2007 should be adhered to.

2.2 The OCH trace and parts of the interchange ramps shall be constructed on via ducts over the critical areas as suggested to further ensure safe drainage.

2.3 The sensitive flood retention areas as identified in Hydrology and Drainage Design Report dated December 2004 and Hydrological Study Review Report of SLLRDC dated November 2006 should be preserved and maintained as permanent flood retention area by the RDA.

2.4 RDA should develop a workable plan for the entire project area for preservation and maintenance of retention areas and inform CEA. RDA should ensure that unauthorised construction do not take place within these areas.

2.5 Adequate cross drainage culverts/ bridges of required sizes, based on accurate hydrological computations should be provided at proper locations in consultation with the SLLRDC, Agrarian Development Department & Irrigation Department.

2.6 All drainage canals should be connected to the existing natural streams in a suitable manner to ensure drainage flow.

2.7 The existing natural streams to which the drainage is directed should be improved to cater to the design discharges.

2.8 Natural drainage paths should not be disturbed except in the stretches where the OCH and by pass roads are build up. Necessary measures should be taken to connect natural drainage paths either to build up drains or natural stream network to ensure smooth flow pattern.

2.9 Approval should be obtained from Agrarian Development Department and Irrigation Department prior to construction /rehabilitation of existing irrigation and flood protection structures.

2.10 Suitable silt traps should be provided wherever required and maintained regularly in order to prevent siltation of neighbouring marsh/paddy lands during construction.

2.11 Dredged material and all other disposable material should not be disposed of into marshes. Details regarding the areas and locations where the dredged material is to be disposed of should be marked on a map and forwarded to CEA for prior approval.

2.12 The area of marsh /paddy fields remaining after the road construction shall be preserved as a marsh/paddy fields capable of serving as a flood retention area.

2.13 A continuous monitoring of water levels and water quality should be done in order to establish the baseline situation at least for one year prior to commencement of construction work. The data should be submitted to CEA including locations.

3 EXTRACTION, HANDLING, TRANSPORTATION AND STORAGE OF CONSTRUCTION MATERIAL

3.1 Details should be provided regarding sources and amounts of sand and fill material required for the project prior to extraction.

3.2 Quarrying of rock for construction activities should be done at carefully selected sites in consultation with the Geological Survey & Mines Bureau (GS&MB).

3.3 Licenses for all borrow pits and quarry sites should be obtained from GS & MB together with the required clearances/permits from the CEA / relevant Local Authority, whenever required.

3.4 Necessary approvals shall be obtained from CEA and/or the relevant Local Authorities for the operation of metal crushers prior to commencement of operations.

3.5 The routes for transport, including unusually heavy loads shall be subject to agreements with the appropriate traffic authorities.

3.6 Movement of heavy loads for project purposes shall be done with the concurrence of the relevant authorities and shall be done at non-peak traffic times.

3.7 Transport, loading and unloading of materials shall be carried out in such a way as not to cause a nuisance to people.

3.8 To prevent dust blowing off from open-topped lorries, it is necessary to ensure that the loads are fully covered, during transportation.

3.9 Exposed areas and the access roads should be dampened at regular intervals during dry periods to prevent emission of dust.

3.10 The measures indicated above from 3.1 to 3.10 as well as any other relevant conditions in this letter, should be included in the contract documents, so that the contractor or sub-contractor is held responsible

for carrying them out during construction, and on completion of the work. **The RDA would be held responsible for the breach of any such conditions by any contractor or sub-contractor.**

4 URBAN PLANNING ASPECTS

4.1 The RDA should initiate action immediately to demarcate the proposed vegetative barrier / green belt. The landscaping should be carried out in close collaboration with the UDA and other relevant agencies.

4.2 Appropriate tree species should be planted in suitable bare land earmarked for the green belt.

4.3 It is recommended that the RDA should identify an appropriate agency for the management and monitoring of the green belt with a view to maintaining a conducive rural landscape by preventing urban sprawl and ribbon development taking place adjacent to the OCH.

4.4 Detailed land use zoning plans should be developed for all interchangers to mitigate land use conflicts and adverse environmental impacts in consultation with the Urban Development Authority (UDA).

5 TRANSPORTATION ENGINEERING ASPECTS & RELATED IMPACTS

5.1 An accurate and complete assessment of the transport related project impacts should be carried out by the RDA in order to identify suitable mitigatory measures prior to the design stage of the project. Accurate estimates and detail evaluation of anticipated vehicle emissions, noise levels and capability of service roads should be provided.

6 AIR POLLUTION, NOISE EMISSION & VIBRATION

6.1 RDA should initiate the collection of data on ambient air quality in the project area. The data should be submitted to CEA including site locations in order to serve as baseline data to be used in comparative studies during construction and operational periods.

6.2 The asphalt and concrete plants should be located at carefully selected sites in consultation with the CEA and/or relevant Local Authority.

6.3 Necessary approvals/permits shall be obtained from the CEA and/or relevant Local Authorities for the asphalt and concrete batching plants prior to the commencement of operation.

6.4 Appropriate mitigatory measures should be adopted in order to maintain noise levels within the standards stipulated by the CEA in Gazette Extra Ordinary No. 924/12 dated 23rd May 1996 during construction and operational period.

6.5 Vibration levels generated by operations of machineries, construction activities, vehicle movements and blasting activities should be maintained within the interim standards stipulated by the CEA. *(Annex 2)*

6.6 Appropriate mitigatory measures should be implemented in order to comply with air emission standards of the CEA during operational period of the project.

7 BIOLOGICAL, ECOLOGICAL & AGRICULTURAL ASPECTS

7.1 A detailed mitigation plan should be developed for the mitigation of adverse impacts on fauna, flora and their habitats. Mitigatory measures should be specific to the localities.

7.2 Adequate mitigatory measures should be taken to prevent inundation and silitation of ecologically sensitive low lands during construction.

7.3 **Required approvals should be obtained prior to filling of paddy fields according to the Agrarian Development Act.**

8 SOCIOLOGICAL IMPACTS

8.1 A detailed socio economic survey should be carried out covering the proposed development area in order to identify the exact number of affected families and business enterprises. The data should be used in the preparation of a socio infrastructure plan. This data will also help to identify new encroachments in the area.

8.2 A detailed resettlement plan and compensation package should be prepared inclusive of relocation sites. The resettlement plan and the compensation package so prepared should be submitted to the Ministry of Lands for approval.

8.3 RDA should initiate a consultative dialogue with the persons to be affected by the project with immediate effect. They should be kept informed well in advance, regarding the project components and also the compensation packages as well as the proposed date of commencement of project activities.

8.4 Acquisition of land should be expedited in order to minimize the uncertainty of people.

8.5 All compensation should be paid on the basis of the principals contained in the National Involuntary Resettlement Policy.

9 MONITORING PROGRAMME

9.1 An environmental management plan incorporating the mitigatory measures proposed precisely and the monitoring programme to monitor the implementation of mitigatory measures should be submitted to CEA prior to implementation. This plan should be approved by a monitoring committee appointed by the CEA.

9.2 Monitoring programme should be implemented as soon as the approval is granted, so as to establish the baseline data.

9.3 All costs incurred by the monitoring committee appointed by the CEA to oversee implementation of mitigatory measures shall be borne by the RDA.

The RDA shall comply with any additional conditions that may be communicated from time to time by the CEA during the execution of the project.

Please note that the CEA letters dated 31st May 2005 and 14th February 2006 granting environmental approval for the proposed deviations at Kaduwela and Biyagama respectively are hereby cancelled and replaced by this letter.

Yours faithfully,
CENTRAL ENVIRONMENTAL AUTHORITY

Udaya P Gammanpila
Chairman

CC : Secretary, Ministry of Highways
Secretary, Ministry of Environment & Natural Resources
Chairman, Sri Lanka Land Reclamation and Development Corporation
Director General, Irrigation Department
Director General , External Resources Department
Director, Geological Survey and Mines Bureau
Commissioner General / Agrarian Development Department
Director General / Urban Development Authority
District Secretary / Colombo / Gampaha

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Annex 2

8. PROPOSED VIBRATION STANDARDS FOR SRI LANKA

8.1 Building classification

Before introducing the vibration standards for the operation of machinery, blasting activities, construction activities & vehicle movements, it is necessary to classify the building structure as the vibration affects in accordance with the nature of the nearby structure. Buildings that have been built-up in Sri Lanka could be categorized into the following categories in accordance with the ISO 4866:1990(E) standards. Please note that the following categorization of buildings has been adopted in introducing the vibration standards for all cases. However it is noteworthy to mention here that even though the classification of buildings given by the International Standards are almost the same, the same categories have been divided into sub categories to suit the Sri Lankan situation.

TABLE 8.1.1

Categorization of structures according to the type of building (from ISO 4866 : 1990 E)

Category of the structure of the building		Description
Resistance to vibration	Type 1	Multistorey buildings of reinforced concrete or structural steel, with infilling panels of block work, brick work or precast units not designed to resist earthquakes.
	Type 2	Two-storey domestic houses & buildings constructed of reinforced block work, precast units, and with reinforced floor & roof construction, or wholly of reinforced concrete or similar, not designed to resist earthquakes.
	Type 3	Single and two-storey houses & buildings made of lighter construction, using lightweight materials such as bricks, cement blocks etc., not designed to resist earthquakes.
	Type 4	Structures that, because of their sensitivity to vibration, do not correspond to those listed above 1,2,&3, & declared as archeologically preserved structures by the Department of Archeology.

8.3 Interim Standards on vibration for Blasting Activities.

Category of the structure as given in 8.1.1	Type of Vibration	Type of Blasting	Ground Vibration In PPV (mm/sec.)	Air blast over Pressure | dB (L) |
Type 1	Impulsive	Single bore hole	8.0	105
		Multi bore hole with delay detonators	10.0	115
Type 2	Impulsive	Single bore hole	6.0	105
		Multi bore hole with delay detonators	7.0	115
Type 3	Impulsive	Single bore hole	4.0	105
		Multi bore hole with delay detonators	5.0	115
Type 4	Impulsive	Single bore hole	0.5	95
		Multi bore hole with delay detonators	0.75	100

Note :

1. Please see Chapter 09 for the method of measurement.
2. The values given above are in such a way that minor damage is unlikely to occur at the nearby house/building.

8.4 Standard for the inconvenience of the occupants in buildings

The frequency response of vibration of the human body is complex as explained in chapter 6. However, approximate response curves (basic curve) for Z axis are given in BS 6472 : 1992. These are given in terms of base curves which may be close to the threshold of perception for majority of people.

The interim standards for ABOP at metal quarries have been reviewed by the technical committee appointed in the following manner.

Category of the structure	*Type of Vibration*	*Type of blasting*	*Measurement mode*	*Interim Standard as amended with effect from 6th September, 2007.*
*Type 3**	*Impulsive*	*Single Bore Hole*	$dBL_{(linear\ peak)}$	*115*
		Multi Bore Hole with delay detonators	$dBL_{(linear\ peak)}$	*120*

* Type 3 - Single and two story houses and buildings made of lighter constructions, susing lightweight materials such as bricks, cement blocks etc. and not designed to resist earth quacks

8.4.3 Interim standards on vibration for the inconvenience of the occupants in buildings

Place	Time	Multiplying factors		
		Continuous vibration (day time and night time)*	Impulsive vibration (max. of three occurrence per day	Intermitted vibration
		mm/sec	mm/sec	mm/sec
Critical working areas	Day & Night	0.141	0.141	0.141
Residential	Day Night	0.705 0.282	5.640 1.410	2.820 0.705
Office	Day & Night	0.846	11.280	4.230
Workshop	Day & Night	1.41	14.1	7.05

Note : * " day time" from 0600h to 1800h
" night time" from 1800h to 0600h

All values are frequency weighted in vertical axis

9.5 The Signal Processor

Once the transducer has delivered an electrical signal that truly represents the vibratory signal, it can be manipulated at the signal processing stage. The signal processor is simply a computer that has been specifically adapted to accept continuous electrical signals and to output the results in a preprogrammed way. The vibratory signal is often given in terms of a digital output, a continuous trace of time against magnitude, or a trace of magnitude against frequency.

9.6 The Output

The output from the processor is one or more of the following:

1. A moving coil meter
2. A liquid crystal display
3. Hard copy, (paper) print out
4. A cathode ray tube (CRT)
5. A RS232 or IEEE digital output to a computer
6. An ac output to a tape recorder or spectrum analyzer

9.7 Quantity to be measured

9.7.1 To determine damage criteria

Peak particle velocity has been found to be the best single descriptor for correcting with case history data on the occurrence of vibration induced damage. The preferred method of measuring pp is to record simultaneously unfiltered time histories of the three orthogonal components of particle velocity which allows any desired value to be extracted at a later stage.

The resultant particle velocity is obtained by vector summation of the three orthogonal components considered with time. The peak time resultant particle velocity is the maximum value of the vector sum obtained during a given time internal and should also be derived for reference.

Note 1 The use of the maximum vector sum which takes the maximum of each component regardless of the time when it occurs is discouraged because it may include a large unknown safety factor.

Note 2 Where measurements are being made for the purposes of a detailed engineering analysis, the peak tracc resultant particle velocity should be used.

To determine inconvenience for the occupants

It is suggested that there are summation effects to vibration at different frequencies. Therefore, the evaluation of building vibration with respect to annoyance and comfort, overall weighted values of the vibrations are preferred.

10.1 Building surveys

The first step is to carry out a comprehensive, objective and independent structural damage survey. Building surveys should be carried out to identify existing cracks and minor damage to nearby buildings before the work is carried out. The report should, ideally include a description of the house, a description of the rooms, a sketch of the floor plans, a description of the foundation and basement and a description of the plot.

The results of the survey should then be explained to the complainants in terms with which they are familiar. The results can be compared to 'on the spot' measurements made from everyday sources of vibration such as a door closing or foot steps close to the transducer. For example a door slam or a foot stamp could cause middle floor vibrations in excess of 11 mm/s.
The survey should be carried out by a person who is perceived to be an 'expert' in the subject and independent from the people responsible for generating the vibration.

10.2 Community Education

An education programme should be set up for the affected community. During individual community meetings the following basic facts should be convinced to the people.

(i) human beings are far more sensitive to vibration and noise than buildings are.

(ii) slamming doors and foot stamping may vibrate buildings more than the proposed vibration.

(iii) cracks are caused by a variety of naturally occurring phenomenon such as temperature changes.

(iv) homes contain numerous cracks (of which owners are often unaware) that increase in number and size each year.

(v) most cracks are cosmetic and are not structurally harmful

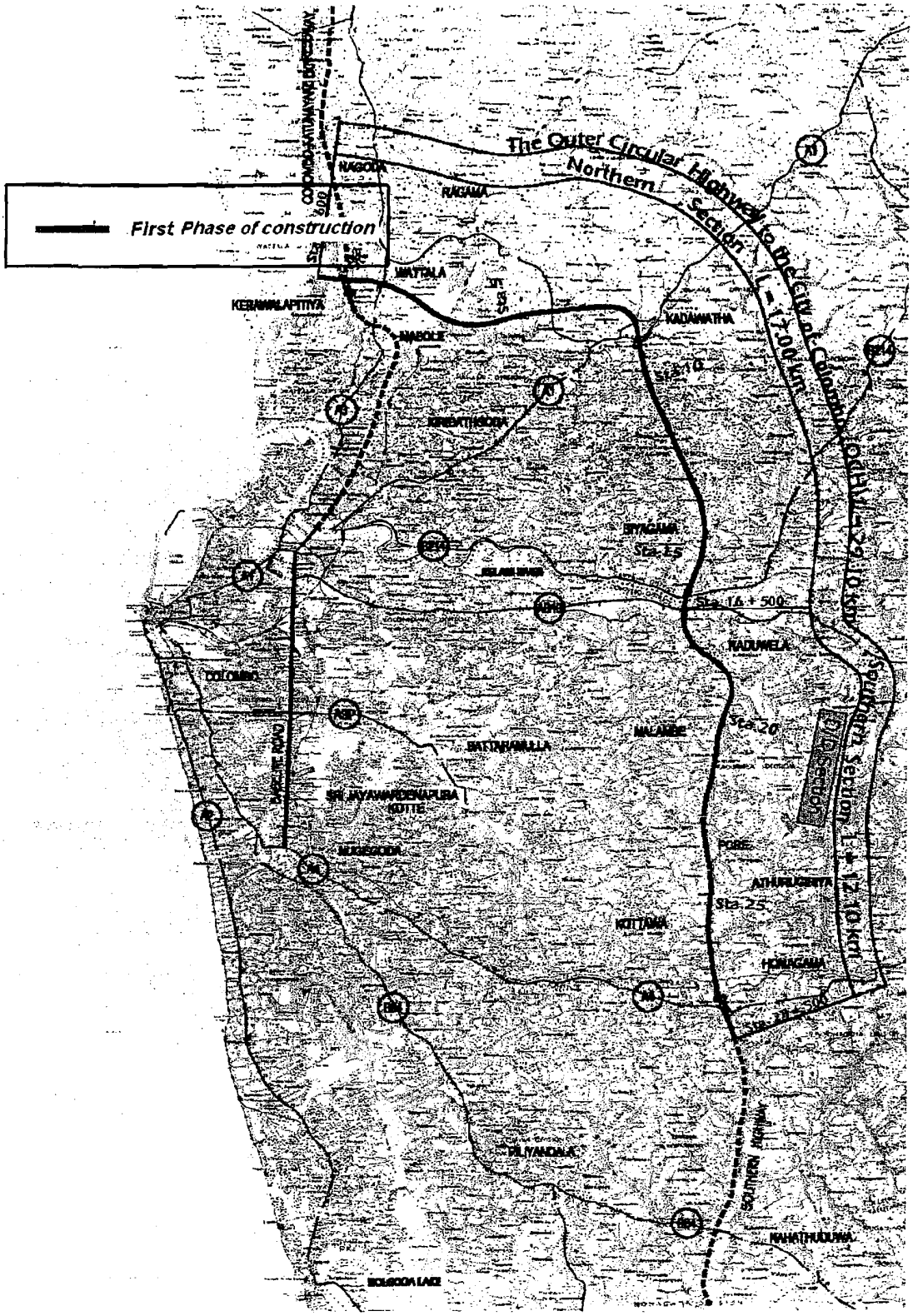
(vi) an independent engineer will be monitoring vibration magnitudes and they will have the power to stop the work if level approach accepted guidelines.

This information is most easily transmitted through a well published community meetings and should be followed by several residential crack surveys

10.3 Monitoring cracks during vibration

It is advisable to monitor the size of any cracks that have been recognized as having the potential for expansion. This can be done with the use of 'Demec' gauges or venire calipers which require the adhesion of small studs or screws on either side of the cracks. The distance between the studs can then be accurately measured with the gauge. Alternatively 'Avongard' tell-tales can be fitted across the cracks which enable direct reading in vertical and horizontal directions with an accuracy of 1.0mm

PRESENT LOCATION MAP OF OCH



4) Interim Standard on Vibration Pollution Control, 4 July 2002,CEA's letter

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மத்திய சுற்றாடல் அதிகார சபை
Central Environmental Authority
"පරිසර පියස", 104, රොබට් ගුණවර්ධන මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசரபியஸ", 104, ரொபர்ட் குணவர்தன மாவத்தை, பத்தரமுல்ல, இலங்கை.
"Parisara Piyasa", 104, Robert Gunawardena Mawatha, Battaramulla, Sri Lanka.

Your Ref.

Our Ref. 07/05/67/2K2-CoV

Date July 04, 2002

Senior Librarian
CEA

Dear Sir, Madam,

INTERIM STANDARDS ON VIBRATION POLLUTION CONTROL

As you are aware that a short – term consultancy was offered to Mr. A.S.Pannila, Snr. Research Officer, ITI under Environment Action 1 Project (EA1P) in order to propose the interim standards on vibration pollution control.
Interim standards proposed by Mr. Pannila were finalized at the half-day workshop held on March 15, 2002 at ITI with the stakeholders.
This is to inform you that this Authority has accepted the proposed standards as interim standards with effect from August 01, 2002. Please note that all the vibration monitoring activities should comply with the proposed vibration measurement techniques and the monitoring results should be compared with the proposed interim standards on vibration pollution control.
Herewith I am sending a copy of the interim standards on;

- Vibration for the operation of Machinery, Construction Activities and Vehicle Movement Traffic.
- Vibration for Blasting Activities and
- Vibration for the Inconvenience of the Occupants in Buildings

together with a copy of the vibration measurement techniques to be followed.
Please do not hesitate to contact if you need any further clarifications in this regard.
Thank you very much for your continued support & efforts for the effective implementation of the interim standards on vibration pollution control.
Thanking you,
Your faithfully,

Lionel Jayasinghe
Director general
CENTRAL ENVIRONMENTAL AUTHORITY

LNSTD/CK

Chairman	Director General	Office	HRD, Admin. & Finance Division	Envt. Pollution Control Division	Envt. Mgt. & Assess. Division	Envt. Edu. & Awareness Division	Legal Unit
...872347 ...one:872361 872348	Fax - 872608 T.Phone:872359	T.Phone:872273	Fax - 872601 T.Phone - 872602, 872301 872607,872605	Fax - 872605 T.Phone - 872415, 872606 872283	Fax - 872296 T.Phone:872388,872419 872402,872346,872300	T.Phone - 872297 872409	T.Phone:872624

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Ministry of Environment & Natural Resources

8. PROPOSED VIBRATION STANDARDS FOR SRI LANKA

8.1 Building classification

Before introducing the vibration standards for the operation of machinery, blasting activities, construction activities & vehicle movements, it is necessary to classify the building structure as the vibration affects in accordance with the nature of the nearby structure. Buildings that have been built-up in Sri Lanka could be categorized into the following categories in accordance with the ISO 4866:1990(E) standards. Please note that the following categorization of buildings has been adopted in introducing the vibration standards for all cases. However it is noteworthy to mention here that even though the classification of buildings given by the International Standards are almost the same, the same categories have been divided into sub categories to suit the Sri Lankan situation.

TABLE 8.1.1

Categorization of structures according to the type of building (from ISO 4866 : 1990 E)

Category of the structure of the building		Description
Resistance to vibration decreasing ↓	Type 1	Multi storey buildings of reinforced concrete or structural steel, with in filling panels of block work, brick work or precast units not designed to resist earthquakes.
	Type 2	Two-storey domestic houses & buildings constructed of reinforced block work, precast units, and with reinforced floor & roof construction, or wholly of reinforced concrete or similar, not designed to resist earthquakes.
	Type 3	Single and two-storey houses & buildings made of lighter construction, using lightweight materials such as bricks, cement blocks etc., not designed to resist earthquakes.
	Type 4	Structures that, because of their sensitivity to vibration, do not correspond to those listed above 1,2,&3, & declared as archeologically preserved structures by the Department of Archeology.

8.2 Interim Standards on Vibration for the Operation of Machinery, Construction Activities and Vehicle Movements Traffic

Category of the structure as given in 8.1.1	Type of Vibration	Frequency of Vibration (Hz)	Vibration In PPV (mm/Sec.)
Type 1	Continuous	0 – 10	5.0
		10 – 50	7.5
		Over 50	15.0
	Intermittent	0 –10	10.0
		10 – 50	15.0
		Over 50	30.0
Type 2	Continuous	0 – 10	2.0
		10 – 50	4.0
		Over 50	8.0
	Intermittent	0 – 10	4.0
		10 – 50	8.0
		Over 50	16.0
Type 3	Continuous	0 – 10	1.0
		10 – 50	2.0
		Over 50	4.0
	Intermittent	0 – 10	2.0
		10 – 50	4.0
		Over 50	8.0
Type 4	Continuous	0 – 10	0.25
		10 – 50	0.5
		Over 50	1.0
	Intermittent	0 – 10	0.5
		10 – 50	1.0
		Over 50	2.0

Note :

1. Please see Chapter 09 for the method of measurement.
2. The values given above are in such a way that minor damage is unlikely to occur at the nearby house/building.

8.3 Interim Standards on vibration for Blasting Activities.

Category of the structure as given in 8.1.1	Type of Vibration	Type of Blasting	Ground Vibration In PPV (mm/sec.)	Air blast over Pressure | dB (L) |
Type 1	Impulsive	Single bore hole	8.0	105
		Multi bore hole with delay detonators	10.0	115
Type 2	Impulsive	Single bore hole	6.0	105
		Multi bore hole with delay detonators	7.0	115
Type 3	Impulsive	Single bore hole	4.0	105
		Multi bore hole with delay detonators	5.0	115
Type 4	Impulsive	Single bore hole	0.5	95
		Multi bore hole with delay detonators	0.75	100

Note :

1. Please see Chapter 09 for the method of measurement.
2. The values given above are in such a way that minor damage is unlikely to occur at the nearby house/building.

8.4 Standard for the inconvenience of the occupants in buildings

The frequency response of vibration of the human body is complex as explained in chapter 6. However, approximate response curves (basic curve) for Z axis are given in BS 6472 : 1992. These are given in terms of base curves which may be close to the threshold of perception for majority of people.

TABLE 8.4.1

Base curve in relation to preparing of interim vibration standards for the inconvenience of the occupants in building taken from the BS 6472 : 1992 standard.

Frequency Hz	PPV (mm/sec)
1	2.25
1.25	1.61
1.6	1.11
2.0	0.296
2.5	0.569
3.15	0.402
4.00	0.281
5.00	0.225
6.30	0.179
8.00	
10.00	
12.50	
16.00	
20.00	0.141
25.00	
31.00	
40.00	
50.00	
63.00	
80.00	

TABLE 8.4.2

Multiplying factors used to specify magnitudes of building vibration with respect to human response using the base curve in 8.4.1.

Place	Time	Multiplying factors		
		Continuous vibration (day time and night time)*	Impulsive vibration (max. of three occurrence per day	Intermittent vibration
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day	1	1	1
	Night	1	1	1
Residential	Day	6	40	20
	Night	2	10	5
Office	Day	6	80	30
	Night	6	80	30
Workshop	Day	8	100	50
	Night	8	100	50

Note : * "day time" from 0600h to 1800h
"night time" from 1800h to 0600h

8.4.3 Interim standards on vibration for the inconvenience of the occupants in buildings

Place	Time	Multiplying factors		
		Continuous vibration (day time and night time)*	Impulsive vibration (max. of three occurrence per day	Intermitted vibration
		mm/sec	mm/sec	mm/sec
Critical working areas	Day & Night	0.141	0.141	0.141
Residential	Day Night	0.705 0.282	5.640 1.410	2.820 0.705
Office	Day & Night	0.846	11.280	4.230
Workshop	Day & Night	1.41	14.1	7.05

Note : * " day time" from 0600h to 1800h
" night time" from 1800h to 0600h

All values are frequency weighted in vertical axis

9. VIBRATION MEASUREMENT TECHNIQUES

9.1 Instrumentation

There are a wide range of instruments that are suitable for the measurements of ground vibration, vibration in buildings and vibration of building elements. However they all should consist of at least:

1. A transducer
2. A signal Processor
3. A display or indicator

9.2 The Transducer

Transducers are devices which change one form of energy into another. For example, a microphone changes sound energy into electrical energy, which can then be amplified through a loudspeaker system. In the case of vibration, the vibratory energy is changed into electrical energy and, after processing, can be displayed to give an indication of the magnitude and/or the frequency of the vibration..

Two types of transducer which are commonly used for building vibration applications are the accelerometer and the velocity transducer (geophone)

9.3 The Accelerometer

The electrical signal from the accelerometer is directly proportional to the vibratory acceleration and is often used for whole body vibration and building damage assessments.

Accelerometers are often small in size which is an advantage for the measurement of building elements (walls, windows, etc.) However, if they are used for ground borne or building superstructure vibration applications the small size is a disadvantage and they usually have to be fixed to a mounting block or a heavy block to increase the stability. The natural frequency of accelerometers is very high (often 10-30 kHz) and does not affect the measurements in the building vibration frequency range (1Hz to 500Hz

9.4 The Velocity Transducer

For the measurement of ground borne vibration or the vibration in floors of buildings a velocity transducer is often used. These are normally built into large and heavy housings as this increases the stability. They normally do not require to be mechanically fixed to the ground (unless the acceleration of the vibration is expected to exceed about 5 m/s^2)

The electrical output from a velocity transducer is generated by a coil moving through a magnetic field. The relative velocity between the coil and the magnetic field produces a directly proportional electrical voltage. The natural frequency of velocity transducers is dependent on the size of the transducer but it is typically between 3 Hz and 8Hz.

9.5 The Signal Processor

Once the transducer has delivered an electrical signal that truly represents the vibratory signal, it can be manipulated at the signal processing stage. The signal processor is simply a computer that has been specifically adapted to accept continuous electrical signals and to output the results in a preprogrammed way. The vibratory signal is often given in terms of a digital output, a continuous trace of time against magnitude, or a trace of magnitude against frequency.

9.6 The Output

The output from the processor is one or more of the following.

1. A moving coil meter
2. A liquid crystal display
3. Hard copy, (paper) print out
4. A cathode ray tube (CRT)
5. A RS232 or IEEE digital output to a computer
6. An ac output to a tape recorder or spectrum analyzer

9.7 Quantity to be measured

9.7.1 To determine damage criteria

Peak particle velocity has been found to be the best single descriptor for correcting with case history data on the occurrence of vibration induced damage. The preferred method of measuring ppv is to record simultaneously unfiltered time histories of the three orthogonal components of particle velocity which allows any desired value to be extracted at a later stage.

The resultant particle velocity is obtained by vector summation of the three orthogonal components considered with time. The peak time resultant particle velocity is the maximum value of the true vector sum obtained during a given time internal and should also be derived for reference.

Note 1 The use of the maximum vector sum which takes the maximum of each component regardless of the time when it occurs is discouraged because it may include a large unknown safety factor.

Note 2 Where measurements are being made for the purposes of a detailed engineering analysis, the peak trace resultant particle velocity should be used.

To determine inconvenience for the occupants

It is suggested that there are summation effects to vibration at different frequencies. Therefore, the evaluation of building vibration with respect to annoyance and comfort, overall weighted values of the vibrations are preferred.

However if the overall weighting could not be performed due to lack of instruments 1/3 octave band analysis could be used with calculated total summation of each ⅓ octave band

9.8 Measurement locations

All the measurements to determine the damage criteria of a building should be made out of the foundation level and in the case of multi -storey building at the highest flow level.

When measuring vibration at the foundation, the transducers should be placed on the lowest storey of the building close to an outer wall. For buildings with no basement, the point of measurements should (not be more than 0.5m above ground level. The measuring points should be located on the side of the building facing the source of vibration.

In the case of complaint it is often useful to taken measurements when the complainant states that the vibration are strongest.

In many cases the magnitude of vertical vibration is higher than the horizontal vibration. The highest magnitude of vertical vibration is usually found in the center of the beams of the largest span in the floor.

9.9 Monitoring the transducer

It is better to fix three uniaxial transducers to three faces of a metal cube of sufficient weight for stable measurements. Use of brackets should be avoided as much as possible.

In special circumstances it is acceptable to glue the transducer or attach it using magnetic attachment.

9.10 Calibration and Traceability

The equipment should have a valid calibration certificate from National or International Standard Laboratory for the required traceability. Since there is no national standard laboratory accredited for the calibration of vibration monitoring equipment, the user of such equipment should have to consult an international standard laboratory accredited for this purpose.

The equipment should have the field calibration facility in order to calibrate the equipment at the site before taking measurements

10. COMMUNITY RELATION PROGRAMME FOR ENVIRONMENT VIBRATION

Where the vibration is generated by relatively short term construction (or similar) work, good community relations with the local residents are of paramount importance for not to delay the work. The reason why the work is being carried out should be explained to the community by the contractor. If the work has some benefit to them, most of the nearby residents are more likely to tolerate it without complaints. Complaints are obviously more likely if residents do not want the construction work carried out (there is nothing in it for them) Community relations programs should, ideally, be set up before any work is started (unfortunately, they rarely are).

10.1 Building surveys

The first step is to carry out a comprehensive, objective and independent structural damage survey. Building surveys should be carried out to identify existing cracks and minor damage to nearby buildings before the work is carried out. The report should, ideally include a description of the house, a description of the rooms, a sketch of the floor plans, a description of the foundation and basement and a description of the plot.

The results of the survey should then be explained to the complainants in terms with which they are familiar. The results can be compared to 'on the spot' measurements made from everyday sources of vibration such as a door closing or foot steps close to the transducer. For example a door slam or a foot stamp could cause middle floor vibrations in excess of 11 mm/s.
The survey should be carried out by a person who is perceived to be an 'expert' in the subject and independent from the people responsible for generating the vibration.

10.2 Community Education

An education programme should be set up for the affected community. During individual community meetings the following basic facts should be convinced to the people.

(i) human beings are far more sensitive to vibration and noise than buildings are
(ii) slamming doors and foot stamping may vibrate buildings more than the proposed vibration.
(iii) cracks are caused by a variety of naturally occurring phenomenon such as temperature changes
(iv) homes contain numerous cracks (of which owners are often unaware) that increase in number and size each year.
(v) most cracks are cosmetic and are not structurally harmful
(vi) an independent engineer will be monitoring vibration magnitudes and they will have the power to stop the work if level approach accepted guidelines.

This information is most easily transmitted through a well published community meetings and should be followed by several residential crack surveys

10.3 Monitoring cracks during vibration

It is advisable to monitor the size of any cracks that have been recognized as having the potential for expansion. This can be done with the use of 'Demec' gauges or venire calipers which require the adhesion of small studs or screws on either side of the cracks. The distance between the studs can then be accurately measured with the gauge. Alternatively 'Avongard' tell-tales can be fitted across the cracks which enable direct reading in vertical and horizontal directions with an accuracy of 1.0mm.

10.4 Causes of cracks in buildings

When people fear building damage due to vibration, one of their first reactions is often to go 'crack hunting' to "prove" their case. In most cases they will find cracks and plenty of them! But are they due to the vibration or could they been unnoticed for many years and caused by other factors?

10.5 The Pre-vibration survey

The best way to answer this question is to avoid it by carrying out a crack survey of any property that could be subjected to damage BEFORE the vibration starts and to monitor the vibration magnitudes from the start. However, this is rarely carried out and the vibration consultant is often only called in when a problem has already arisen.

10.6 The post-vibration survey

After the vibration has commenced it is much more difficult to assure the complainants that the magnitudes of vibration have not, (and could not have been) the cause of cracks (this is, indeed the case). Any further vibration can be measured in the presence of the complainant to confirm that the vibration magnitudes are similar to those experienced at the start of the project. Even when this has been achieved, logical explanation for the cracks can hardly be given.

10.7 Other causes of cracks.

Most buildings will develop cracks at some stage, usually soon after construction, sometimes later. Soon after extensions are built cracks are often found in the main structure where the extension is supported. Much of the early cracking is superficial and goes unnoticed until a close inspection is carried out (e.g. after the building has been subjected to a low magnitude of vibration). Diagnosis of the specific causes of cracks is often difficult. There is often more than one cause producing the defect. Inspections may have to be repeated at long intervals to establish the duration of the movements responsible for the cracks.

PART V - CLIMATE DATA

HOMAGAMA
LAT: 6.83N LON: 80.02E ELEV: 11.0M
Precip, daily
Millimeters
YEAR: 2002

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	48.6	.0	.0	.0	42.0	32.5	22.8	.0	3.4	.0	.0	.0
2	.0	.0	.0	.0	1.1	.0	1.3	.0	.0	2.4	3.0	.0
3	.0	15.0	.0	.0	.0	.0	11.8	.0	.0	26.6	9.0	4.5
4	6.8	60.0	.0	9.1	.0	12.3	2.0	.0	.0	.0	4.0	24.3
5	24.2	.0	.0	.0	48.1	1.6	.0	.0	6.6	34.4	21.5	34.7
6	25.0	.0	.0	.0	18.8	.0	.0	.0	.0	35.2	.0	39.2
7	.0	.0	12.3	3.4	8.4	58.1	3.4	.0	.0	.0	22.8	10.1
8	.0	.0	.0	3.6	.0	8.9	.0	.0	6.8	7.5	9.0	21.2
9	.0	.0	.0	.9	3.0	11.0	.0	.0	.0	18.6	10.0	42.5
10	.0	.0	.0	.0	10.1	.0	.0	.0	.0	27.4	10.0	3.5
11	.0	5.2	.0	48.6	20.0	3.7	.0	.0	.0	9.5	11.2	.0
12	.0	.0	.0	.0	24.2	5.0	.0	.0	.0	3.9	.0	78.6
13	.0	.0	.0	30.0	15.2	13.5	.0	.0	.0	8.7	2.1	5.8
14	.0	.0	4.8	60.0	15.0	.0	.0	.0	.0	62.1	.0	.0
15	.0	.0	.0	.0	4.9	.0	.0	37.4	.0	17.0	10.0	18.8
16	.0	.0	.0	7.2	10.1	.0	.0	.0	18.0	54.6	.0	9.9
17	.0	.0	43.5	29.4	20.0	.0	.0	.0	3.2	4.8	28.8	1.0
18	.0	.0	.0	55.3	24.3	.0	1.2	21.2	1.9	71.6	12.6	.0
19	.0	.0	.0	59.0	15.6	.0	.0	.0	.0	95.9	20.0	16.4
20	.0	1.6	.0	20.4	26.8	.0	.0	.0	8.4	104.1	21.2	.0
21	.0	.0	.0	40.0	17.6	.0	6.2	.0	10.0	14.2	23.0	.0
22	.0	.0	.0	9.5	4.6	.0	.0	.0	.0	22.5	.0	.0
23	3.2	.0	.0	2.8	5.6	.0	.0	.0	.0	12.0	.0	.0
24	48.2	.0	.0	22.0	8.4	.0	.0	.0	5.5	20.9	17.8	.0
25	.0	.0	.0	.0	12.0	.0	.0	.0	.0	15.1	.5	.0
26	.0	.0	.0	.0	8.0	.0	.0	.0	.0	10.0	9.5	.0
27	.0	1.5	.0	.0	11.2	.0	.0	.0	.0	13.8	.0	.0
28	.0	.0	.0	26.2	.0	.0	.0	.0	.0	5.9	.0	.0
29	.0		.0	.0	4.8	.0	.0	.0	15.6	.0	.0	.0
30	.0		30.0	5.2	11.6	.0	.0	.0	8.5	5.4	.0	.0
31	14.0		30.6		29.4		.0	.0		31.3		.0

Values not available are denoted as -9.9M
Issued by the Department of Meteorology, Colombo

HOMAGAMA
LAT: 6.83N LON: 80.02E ELEV: 11.0M
Precip, daily
Millimeters
YEAR: 2003

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	.0	.0	.0	.0	.0	19.0	18.6	.0	39.8	.7	50.0	.0
2	.0	.0	.0	10.8	66.7	.0	4.8	.0	7.3	5.8	35.0	27.5
3	.0	.0	.0	.0	9.4	3.8	11.2	1.8	5.8	11.1	22.5	37.1
4	.0	.0	.0	.0	10.1	10.7	31.1	3.9	2.0	8.0	24.5	3.8
5	8.7	.0	.0	.0	5.9	10.0	33.0	1.6	13.2	11.4	48.4	30.0
6	7.4	7.4	34.5	.0	65.2	16.6	.0	.0	22.4	.0	.0	26.5
7	.0	51.5	.0	.0	.0	20.1	.0	2.5	17.6	35.0	13.6	.0
8	35.8	.0	.0	.0	12.8	.0	.0	.0	10.0	38.4	20.0	.0
9	.6	.0	35.0	4.6	30.0	4.5	4.1	.0	9.6	.0	39.1	.0
10	.0	.0	.0	19.2	21.0	3.0	19.4	1.5	.0	16.9	.9	.0
11	.0	.0	.0	10.0	30.0	3.5	13.6	18.0	.0	10.1	.0	.0
12	.0	21.7	34.6	12.0	11.2	12.2	2.8	23.8	.0	56.8	33.7	.0
13	.0	.0	4.4	17.0	13.5	51.4	9.2	28.2	.0	.0	11.8	.0
14	.0	.0	22.6	24.0	16.8	3.8	21.1	27.6	2.1	.0	14.6	.0
15	.0	.0	25.0	28.8	17.7	.0	55.6	6.8	8.9	3.6	10.0	.0
16	19.2	48.0	32.4	30.0	3.4	11.7	.0	.0	4.7	6.3	.0	.0
17	19.7	.0	35.0	.0	9.9	9.2	1.1	10.1	3.6	14.6	.0	.0
18	25.5	.0	36.5	.0	6.7	26.2	.0	.0	.8	10.0	32.0	.0
19	52.1	.0	19.0	.0	.0	14.3	.0	.0	2.6	29.8	56.2	.0
20	.0	.0	27.7	22.0	.0	34.9	.0	.0	4.2	22.1	8.6	.0
21	.0	.0	11.0	.0	.0	29.0	2.1	6.1	.0	.0	12.4	.0
22	.0	.0	.0	5.5	.0	3.1	.0	22.2	.0	.0	20.2	.0
23	18.9	.0	.0	.0	.0	2.8	.0	7.9	.0	.0	.0	.0
24	.0	.0	38.8	7.4	.0	3.9	.0	.0	4.2	.0	.0	.0
25	.0	.0	.0	4.3	.0	.0	.0	.0	.0	.0	3.8	12.6
26	.0	.0	24.9	.0	.0	.0	.0	1.1	3.8	23.4	8.0	.0
27	.0	.0	.0	4.5	.0	.0	.0	.0	.4	.0	.0	.0
28	.0	.0	.0	25.3	.0	.0	2.8	.0	9.7	5.1	.0	18.2
29	.0		.0	20.0	.0	11.5	.0	.0	25.4	.0	28.8	.0
30	.0		.0	.0	.0	16.5	.0	.0	81.0	39.8	20.0	.0
31	.0		.0		.0		142.6	6.0		42.0		.0

Values not available are denoted as -9.9M
Issued by the Department of Meteorology, Colombo

HOMAGAMA
LAT: 6.83N LON: 80.02E ELEV: 11.0M
Precip, daily
Millimeters
YEAR: 2004

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	.0	.0	.0	131.0	.0	8.0	3.2	.0	.0	6.4	192.4	38.5
2	.0	.0	.0	.0	29.3	8.0	3.0	.0	.0	12.8	15.6	6.4
3	.0	.0	.0	14.6	17.0	8.6	5.9	.0	.0	19.6	13.5	6.6
4	.0	.0	.0	.0	25.0	.0	.0	.0	.0	1.4	.0	19.0
5	.0	.0	.0	10.0	30.0	.0	3.5	19.0	.0	.0	10.0	.0
6	.0	.0	2.5	.0	.0	.0	9.8	14.8	33.3	4.2	13.7	.0
7	.0	.0	.0	.0	8.1	7.6	67.0	.0	18.0	7.8	.0	.0
8	.0	38.6	.0	.0	2.3	21.8	75.5	3.0	.0	18.2	56.9	1.5
9	.0	.0	21.6	.0	7.7	6.6	10.0	.0	9.5	4.0	47.8	57.8
10	.0	.0	.0	.0	.0	22.4	.0	.0	.0	11.6	33.2	5.9
11	.0	.0	.0	.0	.0	25.0	6.5	2.4	10.0	67.0	64.1	8.2
12	.0	.0	4.8	20.0	2.6	24.3	.0	13.8	.0	.0	30.3	11.8
13	.0	.0	.0	21.4	13.7	29.3	.0	.0	1.7	.9	43.4	.0
14	.0	.0	.0	18.0	18.3	.0	.0	12.1	1.0	9.2	31.6	32.1
15	.0	.0	13.7	.0	10.0	10.3	7.5	28.0	13.5	20.8	5.7	.0
16	.0	.0	.0	.0	11.1	.0	20.1	14.4	1.6	12.0	.0	19.6
17	.0	.0	.0	.0	.0	.0	35.6	15.6	36.1	11.5	.0	.0
18	.0	.0	7.6	.0	6.4	.0	29.9	.0	32.3	13.6	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	40.0	15.0	.0	.0
20	.0	.0	.0	.0	29.0	16.5	.0	.0	36.4	13.0	.0	.0
21	.0	.0	.0	.0	4.1	.0	.0	.0	56.8	23.6	93.5	.0
22	.0	20.0	.0	.0	4.1	.0	5.0	.0	1.5	15.8	5.4	.0
23	.0	.0	.0	.0	4.2	.0	.0	.0	.0	14.1	9.2	.0
24	26.1	.0	.0	.0	6.4	.0	.0	.0	72.4	36.2	25.7	.0
25	30.0	.0	.0	11.6	7.0	.0	.0	.0	45.8	.0	10.0	.0
26	27.2	.0	.0	11.4	12.9	.0	.0	.0	44.0	14.6	8.8	.0
27	.0	.0	.0	.0	25.8	10.5	.0	.0	.0	49.8	11.1	24.8
28	.0	.0	.0	.0	2.6	4.6	.0	.0	2.8	.0	.0	5.7
29	.0	.0	.0	42.5	8.3	47.6	1.1	2.0	.0	20.0	.0	.0
30	.0		20.0	.0	10.2	.0	.0	.0	.0	29.0	.0	.0
31	.0		.0		5.5		.0	.0		50.0		.0

Values not available are denoted as -9.9M
Issued by the Department of Meteorology, Colombo

HOMAGAMA
LAT: 6.83N LON: 80.02E ELEV: 11.0M
Precip, daily
Millimeters
YEAR: 2005

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	.0	24.3	.0	15.5	.0	17.5	.0	1.8	24.7	.0	58.0	19.2
2	.0	35.4	.0	15.0	.0	2.2	.0	.0	30.2	.0	3.5	20.0
3	.0	.0	.0	11.5	24.0	10.0	13.8	.0	47.0	.0	16.4	12.4
4	3.0	.0	.0	25.3	5.6	10.0	31.0	.0	5.1	.0	30.0	11.8
5	.0	.0	.0	6.8	6.8	30.8	5.9	.0	.0	.0	27.2	2.0
6	.0	.0	2.8	.0	15.0	12.8	.0	.0	1.2	7.5	81.6	6.0
7	.0	.0	.0	.0	15.0	4.8	6.2	.0	.0	30.0	.9	.0
8	.0	.0	.0	.0	15.0	90.0	.0	.0	18.2	40.0	.0	.0
9	.0	.0	12.9	.0	43.4	34.8	.0	.0	.0	52.0	.0	.0
10	.0	.0	.0	.0	.0	.0	31.5	.0	20.0	16.0	.0	.0
11	.0	.0	.0	.0	3.9	.0	.0	1.0	23.2	90.4	20.0	.0
12	.0	.0	.0	6.2	.0	3.2	.0	.0	.0	54.6	20.0	49.8
13	.0	.0	.0	10.0	.0	3.1	8.3	.0	9.5	18.2	23.0	48.0
14	.0	.0	.0	24.5	.0	5.6	28.6	3.6	5.5	.0	7.0	.0
15	.0	.0	.0	18.7	.0	9.5	.0	.0	.0	.0	7.0	22.8
16	.0	.0	.0	16.8	.0	2.8	.0	.0	.0	.0	.0	20.0
17	1.5	.0	.0	11.4	11.5	9.2	.0	.0	.0	2.1	.0	20.0
18	.0	.0	.0	33.2	11.0	10.8	.0	.0	.0	171.0	.0	33.0
19	34.2	.0	27.1	.0	17.0	43.0	.0	.0	2.6	10.5	.0	1.0
20	.0	.0	30.0	18.2	19.8	32.0	.0	.0	6.4	8.0	3.8	.0
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	31.2	229.0	25.8
22	11.1	.0	.0	.0	9.9	.0	.0	.0	.0	69.4	50.3	.0
23	10.8	13.4	.0	.0	6.1	.0	.0	.0	.0	40.5	15.0	.0
24	16.3	.0	.0	3.5	12.2	12.0	8.5	.0	.0	11.0	22.6	.0
25	.0	.0	.0	.0	2.5	11.8	8.4	.0	.0	17.5	50.0	.0
26	.0	.0	.0	.0	.0	14.5	2.3	.0	.0	11.4	50.0	.0
27	.0	.0	.0	7.8	17.8	8.8	5.6	.0	.0	5.8	56.0	.0
28	17.7	.0	.0	.0	24.7	.0	7.5	.0	.0	3.1	56.0	.0
29	.0		.0	.0	101.0	.0	.0	43.7	4.1	2.3	.0	.0
30	60.0		60.4	.0	2.6	.0	.0	38.1	.0	.0	.0	.0
31	.0		28.2		5.3		22.0	4.2		20.0		.0

Values not available are denoted as -9.9M
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HOMAGAMA
LAT: 6.83N LON: 80.02E ELEV: 11.0M
Precip, daily
Millimeters
YEAR: 2006

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	.0	.0	.0	14.5	.0	.0	15.4	.0	.0	.0	12.8	.0
2	2.0	.0	5.8	20.0	.0	.0	54.2	.0	12.1	.0	4.5	.0
3	6.2	.0	20.0	.0	23.4	.0	18.6	.0	10.0	.0	16.8	.0
4	21.0	.0	12.4	.0	2.5	2.6	15.1	.0	.0	33.2	66.3	15.4
5	44.2	21.0	39.8	.0	.0	.0	9.9	.0	8.1	12.0	39.1	3.1
6	15.0	.0	.0	.0	.0	.0	.0	.0	11.2	20.4	4.9	.0
7	17.2	.0	.0	.0	.0	.0	.0	.0	13.4	22.0	.0	8.4
8	14.5	10.0	24.2	.0	.0	.0	.0	.0	14.6	.0	1.8	.0
9	38.2	.0	5.5	.0	.0	5.7	.0	4.5	21.8	.0	.0	.0
10	.0	.0	.0	.0	.0	4.1	.0	55.1	11.3	1.3	39.8	6.2
11	5.0	.0	.0	7.9	8.1	10.9	.0	20.1	15.6	14.6	43.3	8.1
12	17.6	.0	.0	.0	.0	.0	3.2	30.5	10.2	58.0	49.1	28.3
13	18.4	.0	.0	.0	.0	.0	.0	40.7	7.6	7.3	13.2	.0
14	11.0	.0	.0	.0	13.5	11.2	.0	14.4	13.7	10.0	33.6	6.6
15	.0	.0	6.2	.0	.0	6.8	.0	63.4	.0	9.7	23.3	10.3
16	8.0	.0	.0	24.2	.0	10.5	.0	40.7	.0	13.8	31.6	.0
17	.0	.0	.0	27.6	.0	2.4	.0	.0	.0	53.6	39.3	.0
18	.0	16.7	.0	45.8	22.8	11.5	.0	32.0	4.8	68.2	64.1	.0
19	.0	.0	.0	4.5	19.6	5.2	.0	51.0	11.2	57.7	47.8	23.2
20	.0	.0	29.6	.0	11.1	54.4	.0	30.0	22.1	67.1	6.4	.0
21	.0	.0	.0	.0	8.8	27.3	.0	28.0	.0	88.3	2.2	.0
22	.0	.0	.0	.0	8.6	63.2	.0	22.0	12.3	51.2	.0	.0
23	.0	24.0	.0	.0	10.5	.0	.0	.0	5.9	14.0	32.5	.0
24	.0	45.0	.0	.0	1.4	.0	.0	.0	.0	60.3	18.4	.0
25	.0	.7	.0	.0	11.5	.0	.0	5.8	4.8	74.8	23.5	.0
26	.0	.0	12.2	.0	24.5	.0	.0	11.2	7.2	52.2	17.3	.0
27	.0	.0	.0	.0	14.2	.0	7.2	1.5	.0	79.2	1.7	.0
28	.0	.0	.0	.0	36.4	14.3	.0	.0	.0	49.4	.0	.0
29	.0		.0	.0	26.1	.0	.0	.0	.0	.0	.0	.0
30	.0		.0	.0	54.1	.0	.0	10.1	.0	6.4	.0	.0
31	.0		.0		6.0		.0	.0		.0		.0

Values not available are denoted as -9.9M
Issued by the Department of Meteorology, Colombo


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