

Appendix F Plots of Piezometer Data

- F1 Recent (October 2024) Piezometer plot of Reduced Level vs time**
- F2 Piezometer data record sheets**
- F3 Monitoring Location Plan**

Instrument ID.	PZ40								
Site	Redvale Landfill, Daing Flat, Auckland								
Borehole Number	BH W135								
Installed Depth (m)	15.0								
Reference Level RL(m)	79.70								
Installed RL (m)	64.70								
Serial No.	2320520/S14056								
Cable (m)	30								
Tag	PZ40 S14056								
Range (kPa)	350								
A (MPa)	-2.292E-07								
B (MPa)	-0.1066								
Site Zero C (MPa)	954.3268								
K (MPa)	-0.1530								
Site Initial TemperatureTo	15.9								
Factory C (MPa)	954.5017								
Factory Zero TemperatureT*	20.0								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings	23/10/2024 10:27	OLAR/PACO	2892.9	8368.9	16.5	4.70	46.06	69.40	
Manual Readings	5/11/2024 9:50	PACO	2898.7	8402.5	16.5	4.32	42.35	69.02	
Manual Readings	19/11/2024 9:28	PACO	2900.0	8410.0	16.5	4.23	41.52	68.94	
Manual Readings	3/12/2024 9:53	PACO	2902.3	8423.3	16.5	4.08	40.04	68.79	
Manual Readings	17/12/2024 10:46	OLAR	2902.8	8426.2	16.5	4.05	39.72	68.75	
Manual Readings	7/01/2025 9:53	PACO	2906.1	8445.4	16.5	3.83	37.61	68.54	
Manual Readings	21/01/2025 10:47	OLAR	2907.6	8454.1	16.5	3.74	36.64	68.44	
Manual Readings	5/02/2025 11:30	PACO	2905.3	8440.8	16.5	3.89	38.12	68.59	
Manual Readings	18/02/2025 11:08	PACO	2906.3	8446.6	16.5	3.82	37.48	68.52	
Manual Readings	7/03/2025 9:22	PACO	2905.9	8444.3	16.5	3.85	37.73	68.55	
Manual Readings	18/03/2025 10:13	PACO	2906.8	8449.5	16.5	3.789	37.16	68.49	
Manual Readings	1/04/2025 9:30	PACO	2906.4	8447.2	16.4	3.817	37.43	68.52	
Manual Readings	14/04/2025 14:52	PACO	2905.4	8441.3	16.4	3.882	38.07	68.59	
Manual Readings	28/04/2025 9:48	PACO	2905.4	8441.3	16.4	3.882	38.07	68.59	
Manual Readings	15/05/2025 9:36	PACO	2905.0	8439.0	16.4	3.908	38.33	68.61	
Manual Readings	27/05/2025 9:28	PACO	2906.2	8446.0	16.4	3.830	37.56	68.53	
Manual Readings	10/06/2025 13:47	PACO	2906.4	8447.2	16.4	3.817	37.43	68.52	
Manual Readings	27/06/2025 9:13	PACO	2907.1	8451.2	16.4	3.771	36.98	68.47	
Manual Readings	8/07/2025 9:52	PACO	2905.8	8443.7	16.4	3.856	37.81	68.56	
Manual Readings	22/07/2025 9:21	PACO	2906.5	8447.7	16.4	3.810	37.36	68.51	
Manual Readings	5/08/2025 9:25	PACO	2906.6	8448.3	16.4	3.803	37.30	68.51	
Manual Readings	20/08/2025 9:32	PACO	2908.7	8460.5	16.4	3.666	35.95	68.37	
Manual Readings	2/09/2025 10:40	PACO	2907.7	8454.7	16.4	3.731	36.59	68.43	
Manual Readings	14/10/2025 15:22	PACO	2910.2	8469.3	16.4	3.568	34.99	68.27	
Manual Readings	27/11/2025 10:48	PACO	2908.8	8461.1	16.4	3.659	35.89	68.36	
Manual Readings	5/01/2026 13:23	PACO	2909.4	8464.6	16.4	3.620	35.50	68.32	

Instrument ID.	PZ41 (Shallow)								
Site	Redvale Landfill, Dairy Flat, Auckland								
Borehole Number	BH V136								
Installed Depth (m)	8.0								
Reference Level RL(m)	78.45								
Installed RL (m)	70.45								
Serial No.	2269597/S12525								
Cable (m)	15								
Tag	PZ41 S12525								
Range (kPa)	350								
A (MPa)	-1.350E-07								
B (MPa)	-0.1213								
Site Zero C (MPa)	1083.7887								
K (MPa)	-0.1360								
Site Initial TemperatureTo	15.4								
Factory C (MPa)	1084.7922								
Factory Zero TemperatureT*	21.0								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings	23/10/2024 10:30	OLAR/PACO	2926.3	8563.2	16.6	3.57	35.01	74.02	
Manual Readings	5/11/2024 10:00	PACO	2931.8	8595.5	16.3	3.17	31.06	73.62	
Manual Readings	19/11/2024 9:32	PACO	2934.4	8610.7	16.2	2.98	29.19	73.43	
Manual Readings	3/12/2024 9:46	PACO	2935.9	8619.5	16.2	2.87	28.10	73.32	
Manual Readings	17/12/2024 10:50	OLAR	2938.2	8633.0	16.1	2.70	26.45	73.15	
Manual Readings	7/01/2025 9:57	PACO	2939.9	8643.0	16.1	2.57	25.21	73.02	
Manual Readings	21/01/2025 10:43	OLAR	2942.3	8657.1	16.0	2.39	23.48	72.85	
Manual Readings	5/02/2025 11:35	PACO	2942.1	8656.0	16.0	2.41	23.63	72.86	
Manual Readings	18/02/2025 11:12	PACO	2944.3	8668.9	16.0	2.25	22.02	72.70	
Manual Readings	7/03/2025 9:26	PACO	2944.1	8667.7	16.0	2.26	22.17	72.71	
Manual Readings	18/03/2025 10:16	PACO	2945.1	8673.6	16.1	2.185	21.43	72.64	
Manual Readings	1/04/2025 9:34	PACO	2944.2	8668.3	16.1	2.252	22.08	72.71	
Manual Readings	14/04/2025 14:56	PACO	2943.6	8664.8	16.1	2.296	22.52	72.75	
Manual Readings	28/04/2025 9:54	PACO	2942.9	8660.7	16.2	2.347	23.02	72.80	
Manual Readings	15/05/2025 9:42	PACO	2941.9	8654.8	16.2	2.421	23.74	72.88	
Manual Readings	27/05/2025 9:32	PACO	2943.0	8661.2	16.3	2.338	22.93	72.79	
Manual Readings	10/06/2025 13:54	PACO	2942.9	8660.7	16.3	2.346	23.00	72.80	
Manual Readings	27/06/2025 9:16	PACO	2942.8	8660.1	16.3	2.353	23.08	72.81	
Manual Readings	8/07/2025 9:55	PACO	2941.1	8650.1	16.4	2.478	24.30	72.93	
Manual Readings	22/07/2025 9:26	PACO	2941.3	8651.2	16.4	2.463	24.15	72.92	
Manual Readings	5/08/2025 9:29	PACO	2941.5	8652.4	16.4	2.448	24.01	72.90	
Manual Readings	20/08/2025 9:36	PACO	2944.1	8667.7	16.4	2.255	22.12	72.71	
Manual Readings	2/09/2025 10:52	PACO	2943.8	8666.0	16.4	2.277	22.33	72.73	
Manual Readings	14/10/2025 15:27	PACO	2946.2	8680.1	16.3	2.101	20.60	72.55	
Manual Readings	27/11/2025 10:54	PACO	2947.2	8686.0	16.2	2.028	19.88	72.48	
Manual Readings	5/01/2026 13:28	PACO	2947.0	8684.8	16.1	2.044	20.04	72.50	

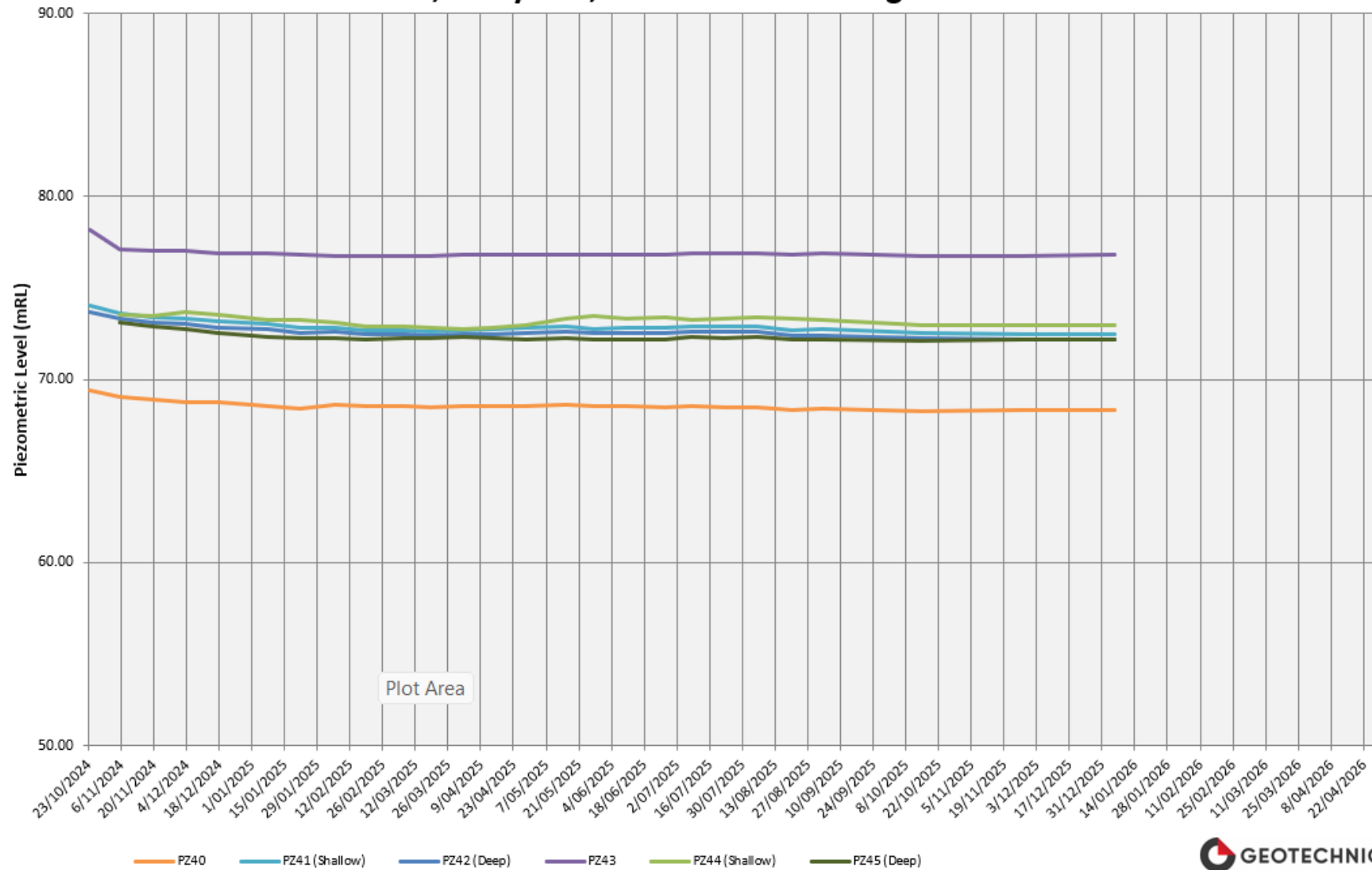
Instrument ID.	PZ42 (Deep)								
Site	Redvale Landfill, Dairg Flat, Auckland								
Borehole Number	BH W136								
Installed Depth (m)	15.0								
Reference Level RL(m)	78.45								
Installed RL (m)	63.45								
Serial No.	2320523?S14059								
Cable (m)	30								
Tag	PZ42 S14059								
Range (kPa)	350								
A (MPa)	-8.558E-08								
B (MPa)	-0.0998								
Site Zero C (MPa)	869.8246								
K (MPa)	-0.1302								
Site Initial TemperatureTo	15.3								
Factory C (MPa)	869.6733								
Factory Zero TemperatureT*	24.3								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings	23/10/2024 10:31	OLAR/PACO	2767.8	7660.7	16.3	10.21	100.13	73.66	
Manual Readings	5/11/2024 9:58	PACO	2773.8	7694.0	16.2	9.87	96.78	73.32	
Manual Readings	19/11/2024 9:34	PACO	2777.0	7711.7	16.2	9.69	94.99	73.14	
Manual Readings	3/12/2024 9:48	PACO	2778.8	7721.7	16.2	9.58	93.98	73.04	
Manual Readings	17/12/2024 10:50	OLAR	2781.8	7738.4	16.2	9.41	92.29	72.86	
Manual Readings	7/01/2025 9:59	PACO	2783.9	7750.1	16.2	9.29	91.11	72.74	
Manual Readings	21/01/2025 10:44	OLAR	2786.9	7766.8	16.2	9.12	89.42	72.57	
Manual Readings	5/02/2025 11:37	PACO	2786.5	7764.6	16.2	9.14	89.64	72.59	
Manual Readings	18/02/2025 11:14	PACO	2789.2	7779.6	16.2	8.99	88.12	72.44	
Manual Readings	7/03/2025 9:28	PACO	2789.0	7778.5	16.2	9.00	88.23	72.45	
Manual Readings	18/03/2025 10:18	PACO	2790.2	7785.2	16.2	8.928	87.56	72.38	
Manual Readings	1/04/2025 9:36	PACO	2789.0	7778.5	16.2	8.997	88.23	72.45	
Manual Readings	14/04/2025 14:57	PACO	2788.3	7774.6	16.2	9.037	88.63	72.49	
Manual Readings	28/04/2025 9:53	PACO	2787.4	7769.6	16.2	9.089	89.14	72.54	
Manual Readings	15/05/2025 9:40	PACO	2786.0	7761.8	16.2	9.170	89.92	72.62	
Manual Readings	27/05/2025 9:34	PACO	2787.6	7770.7	16.2	9.078	89.02	72.53	
Manual Readings	10/06/2025 13:52	PACO	2787.6	7770.7	16.2	9.078	89.02	72.53	
Manual Readings	27/06/2025 9:18	PACO	2787.7	7771.3	16.2	9.072	88.97	72.53	
Manual Readings	8/07/2025 9:57	PACO	2785.6	7759.6	16.2	9.193	90.15	72.65	
Manual Readings	22/07/2025 9:28	PACO	2786.0	7761.8	16.2	9.170	89.92	72.62	
Manual Readings	5/08/2025 9:30	PACO	2786.2	7762.9	16.2	9.158	89.81	72.61	
Manual Readings	20/08/2025 9:38	PACO	2789.8	7783.0	16.2	8.951	87.78	72.41	
Manual Readings	2/09/2025 10:53	PACO	2789.3	7780.2	16.2	8.980	88.06	72.43	
Manual Readings	14/10/2025 15:28	PACO	2792.6	7798.6	16.2	8.790	86.20	72.24	
Manual Readings	27/11/2025 10:55	PACO	2793.9	7805.9	16.2	8.715	85.47	72.17	
Manual Readings	5/01/2026 13:30	PACO	2793.5	7803.6	16.2	8.738	85.69	72.19	

Instrument ID.	PZ43								
Site	Redvale Landfill, Daing Flat, Auckland								
Borehole Number	BH V137								
Installed Depth (m)	15.1								
Reference Level RL(m)	88.85								
Installed RL (m)	73.75								
Serial No.	2320521/S14057								
Cable (m)	30								
Tag	PZ43 S14057								
Range (kPa)	350								
A (MPa)	-5.822E-07								
B (MPa)	-0.1254								
Site Zero C (MPa)	1121.5244								
K (MPa)	-0.0962								
Site Initial TemperatureTo	19.1								
Factory C (MPa)	1120.2808								
Factory Zero TemperatureT*	22.7								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings	23/10/2024 10:34	OLAR/PACO	2877.4	8279.4	17.2	4.44	43.56	78.19	
Manual Readings	5/11/2024 9:40	PACO	2890.6	8355.6	17.0	3.39	33.29	77.14	
Manual Readings	19/11/2024 9:38	PACO	2891.9	8363.1	17.0	3.29	32.28	77.04	
Manual Readings	3/12/2024 9:41	PACO	2892.3	8365.4	17.0	3.26	31.96	77.01	
Manual Readings	17/12/2024 10:53	OLAR	2893.5	8372.3	17.0	3.16	31.02	76.91	
Manual Readings	7/01/2025 10:02	PACO	2893.6	8372.9	17.0	3.16	30.95	76.90	
Manual Readings	21/01/2025 10:41	OLAR	2894.9	8380.4	17.0	3.05	29.93	76.80	
Manual Readings	5/02/2025 11:40	PACO	2895.1	8381.6	17.0	3.04	29.77	76.78	
Manual Readings	18/02/2025 11:18	PACO	2895.4	8383.3	17.0	3.01	29.54	76.76	
Manual Readings	7/03/2025 9:32	PACO	2895.2	8382.2	17.0	3.03	29.69	76.78	
Manual Readings	18/03/2025 10:22	PACO	2895.6	8384.5	17.0	3.0	29.38	76.74	
Manual Readings	1/04/2025 9:40	PACO	2894.9	8380.4	17.0	3.1	29.93	76.80	
Manual Readings	14/04/2025 15:00	PACO	2894.5	8378.1	17.0	3.1	30.24	76.83	
Manual Readings	28/04/2025 9:58	PACO	2894.6	8378.7	17.0	3.1	30.16	76.82	
Manual Readings	15/05/2025 9:46	PACO	2894.2	8376.4	17.0	3.1	30.48	76.86	
Manual Readings	27/05/2025 9:36	PACO	2894.9	8380.4	17.0	3.1	29.93	76.80	
Manual Readings	10/06/2025 13:56	PACO	2894.5	8378.1	17.0	3.1	30.24	76.83	
Manual Readings	27/06/2025 9:26	PACO	2895.0	8381.0	16.9	3.0	29.86	76.79	
Manual Readings	8/07/2025 10:00	PACO	2893.6	8372.9	17.0	3.2	30.95	76.90	
Manual Readings	22/07/2025 9:33	PACO	2893.5	8372.3	17.0	3.2	31.02	76.91	
Manual Readings	5/08/2025 9:34	PACO	2893.8	8374.1	17.0	3.1	30.79	76.89	
Manual Readings	20/08/2025 9:42	PACO	2895.0	8381.0	17.0	3.0	29.85	76.79	
Manual Readings	2/09/2025 10:55	PACO	2894.0	8375.2	16.9	3.1	30.64	76.87	
Manual Readings	14/10/2025 15:31	PACO	2895.4	8383.3	17.0	3.0	29.54	76.76	
Manual Readings	27/11/2025 10:50	PACO	2895.2	8382.2	17.0	3.0	29.69	76.78	
Manual Readings	5/01/2026 13:32	PACO	2894.5	8378.1	17.0	3.1	30.24	76.83	

Instrument ID.	PZ44 (Shallow)								
Site	Redvale Landfill, Daing Flat, Auckland								
Borehole Number	BH V138								
Installed Depth (m)	7.1								
Reference Level RL(m)	78.38								
Installed RL (m)	71.33								
Serial No.	2266995/S12292								
Cable (m)	15								
Tag	PZ44 S12292								
Range (kPa)	350								
A (MPa)	2.454E-07								
B (MPa)	-0.1100								
Site Zero C (MPa)	953.0174								
K (MPa)	-0.2323								
Site Initial TemperatureTo Factory C (MPa)	16.5								
Factory Zero TemperatureT*	21.9								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings									
Manual Readings	5/11/2024 9:30	PACO	2937.6	8629.5	16.9	2.24	21.95	73.57	
Manual Readings	19/11/2024 9:15	PACO	2939.0	8637.7	16.8	2.15	21.11	73.48	
Manual Readings	03/12/24 09:30	PACO	2935.8	8618.9	16.7	2.36	23.12	73.69	
Manual Readings	17/12/24 10:38	OLAR	2937.6	8629.5	16.7	2.24	22.00	73.57	
Manual Readings	07/01/25 09:35	PACO	2943.1	8661.8	16.6	1.90	18.60	73.23	
Manual Readings	21/01/25 10:36	OLAR	2943.1	8661.8	16.6	1.90	18.60	73.23	
Manual Readings	05/02/25 11:20	PACO	2944.7	8671.3	16.6	1.80	17.61	73.13	
Manual Readings	18/02/25 10:55	PACO	2948.6	8694.2	16.6	1.55	15.18	72.88	
Manual Readings	07/03/25 09:12	PACO	2947.8	8689.5	16.6	1.598	15.68	72.93	
Manual Readings	18/03/25 10:02	PACO	2949.2	8697.8	16.6	1.509	14.80	72.84	
Manual Readings	01/04/25 09:18	PACO	2950.8	8707.2	16.6	1.408	13.81	72.74	
Manual Readings	14/04/25 14:40	PACO	2949.4	8699.0	16.7	1.494	14.66	72.83	
Manual Readings	28/04/25 09:41	PACO	2947.1	8685.4	16.7	1.641	16.09	72.97	
Manual Readings	15/05/25 09:27	PACO	2941.4	8651.8	16.7	2.003	19.64	73.33	
Manual Readings	27/05/25 09:18	PACO	2939.3	8639.5	16.8	2.133	20.92	73.46	
Manual Readings	10/06/25 13:38	PACO	2940.9	8648.9	16.8	2.032	19.93	73.36	
Manual Readings	27/06/25 09:00	PACO	2940.6	8647.1	16.9	2.049	20.09	73.38	
Manual Readings	08/07/25 09:42	PACO	2942.0	8655.4	16.9	1.960	19.22	73.29	
Manual Readings	22/07/25 09:10	PACO	2941.9	8654.8	16.9	1.966	19.28	73.30	
Manual Readings	05/08/25 09:16	PACO	2940.6	8647.1	16.9	2.049	20.09	73.38	
Manual Readings	20/08/25 09:20	PACO	2941.5	8652.4	16.9	1.991	19.53	73.32	
Manual Readings	02/09/25 10:28	PACO	2942.3	8657.1	16.9	1.941	19.03	73.27	
Manual Readings	14/10/25 14:54	PACO	2946.9	8684.2	16.8	1.651	16.19	72.98	
Manual Readings	27/11/25 10:28	PACO	2947.5	8687.8	16.6	1.618	15.86	72.95	
Manual Readings	05/01/26 13:13	PACO	2947.2	8686.0	16.5	1.639	16.07	72.97	

Instrument ID.	PZ45 (Deep)								
Site	Redvale Landfill, Daing Flat, Auckland								
Borehole Number	BH V138								
Installed Depth (m)	15.1								
Reference Level RL(m)	78.38								
Installed RL (m)	63.33								
Serial No.	2320525/S14061								
Cable (m)	30								
Tag	PZ45 S14061								
Range (kPa)	350								
A (MPa)	-3.816E-07								
B (MPa)	-0.1192								
Site Zero C (MPa)	1048.8672								
K (MPa)	-0.1322								
Site Initial TemperatureTo	16.6								
Factory C (MPa)	1050.0735								
Factory Zero TemperatureT*	22.7								
Convert Factor kPa to mH2O	0.10197								
General Comments	Date / Time	Tech	Hz	Hz2/1000	T	mH2O	kPa	Water Level RL(m)	Comments
Manual Readings									
Manual Readings	5/11/2024 9:27	PACO	2792.7	7799.2	16.7	9.79	95.98	73.12	
Manual Readings	19/11/2024 9:17	PACO	2795.4	7814.3	16.6	9.60	94.11	72.93	
Manual Readings	3/12/2024 9:33	PACO	2797.8	7827.7	16.6	9.42	92.43	72.76	
Manual Readings	17/12/2024 10:39	OLAR	2801.2	7846.7	16.6	9.18	90.04	72.51	
Manual Readings	7/01/2025 9:38	PACO	2803.6	7860.2	16.6	9.01	88.36	72.34	
Manual Readings	21/01/25 10:37	OLAR	2804.5	7865.2	16.6	8.95	87.73	72.28	
Manual Readings	5/02/2025 11:23	PACO	2804.4	7864.7	16.6	8.95	87.80	72.28	
Manual Readings	18/02/2025 10:58	PACO	2805.3	7869.7	16.6	8.89	87.16	72.22	
Manual Readings	7/03/2025 9:14	PACO	2804.6	7865.8	16.6	8.94	87.66	72.27	
Manual Readings	18/03/2025 10:05	PACO	2805.0	7868.0	16.6	8.910	87.38	72.24	
Manual Readings	1/04/2025 9:20	PACO	2804.0	7862.4	16.6	8.981	88.08	72.31	
Manual Readings	14/04/2025 14:42	PACO	2804.7	7866.3	16.5	8.933	87.60	72.26	
Manual Readings	28/04/2025 9:40	PACO	2805.4	7870.3	16.5	8.882	87.11	72.21	
Manual Readings	15/05/2025 9:25	PACO	2804.8	7866.9	16.5	8.925	87.53	72.26	
Manual Readings	27/05/2025 9:20	PACO	2805.5	7870.8	16.5	8.875	87.04	72.21	
Manual Readings	10/06/2025 13:36	PACO	2805.8	7872.5	16.5	8.854	86.83	72.18	
Manual Readings	27/06/2025 9:03	PACO	2805.8	7872.5	16.5	8.854	86.83	72.18	
Manual Readings	8/07/2025 9:44	PACO	2804.1	7863.0	16.5	8.975	88.02	72.31	
Manual Readings	22/07/2025 9:11	PACO	2804.6	7865.8	16.5	8.940	87.67	72.27	
Manual Readings	5/08/2025 9:17	PACO	2804.1	7863.0	16.5	8.975	88.02	72.31	
Manual Readings	20/08/2025 9:22	PACO	2806.2	7874.8	16.5	8.825	86.55	72.16	
Manual Readings	2/09/2025 10:29	PACO	2805.5	7870.8	16.5	8.875	87.04	72.21	
Manual Readings	14/10/2025 14:55	PACO	2807.1	7879.8	16.5	8.761	85.91	72.09	
Manual Readings	27/11/2025 10:30	PACO	2806.2	7874.8	16.5	8.825	86.55	72.16	
Manual Readings	5/01/2026 13:14	PACO	2805.5	7870.8	16.5	8.875	87.04	72.21	

Redvale Landfill, Dairy Flat, Auckland - Vibrating Wire Piezometers



Notes:



01	2024Update		18/04/24
0	2017Update		16/02/17
Issue	Description	approved	Date



Operational and Technical Services
Landfill Access Road,
RD 4, Albany 0794, Auckland
Ph +64 (09) 427 0600
www.wastemanagement.co.nz

Surveyed:	Name	Date
Designed:		
Drawn:	DG	16/02/17
Checked:		
Scale	@A3,1:4300	

Project:

**REDVALE.LANDFILL
MONITORING
LOCATIONS 2024**

Issued for:

Drawing Number:

Figure F3

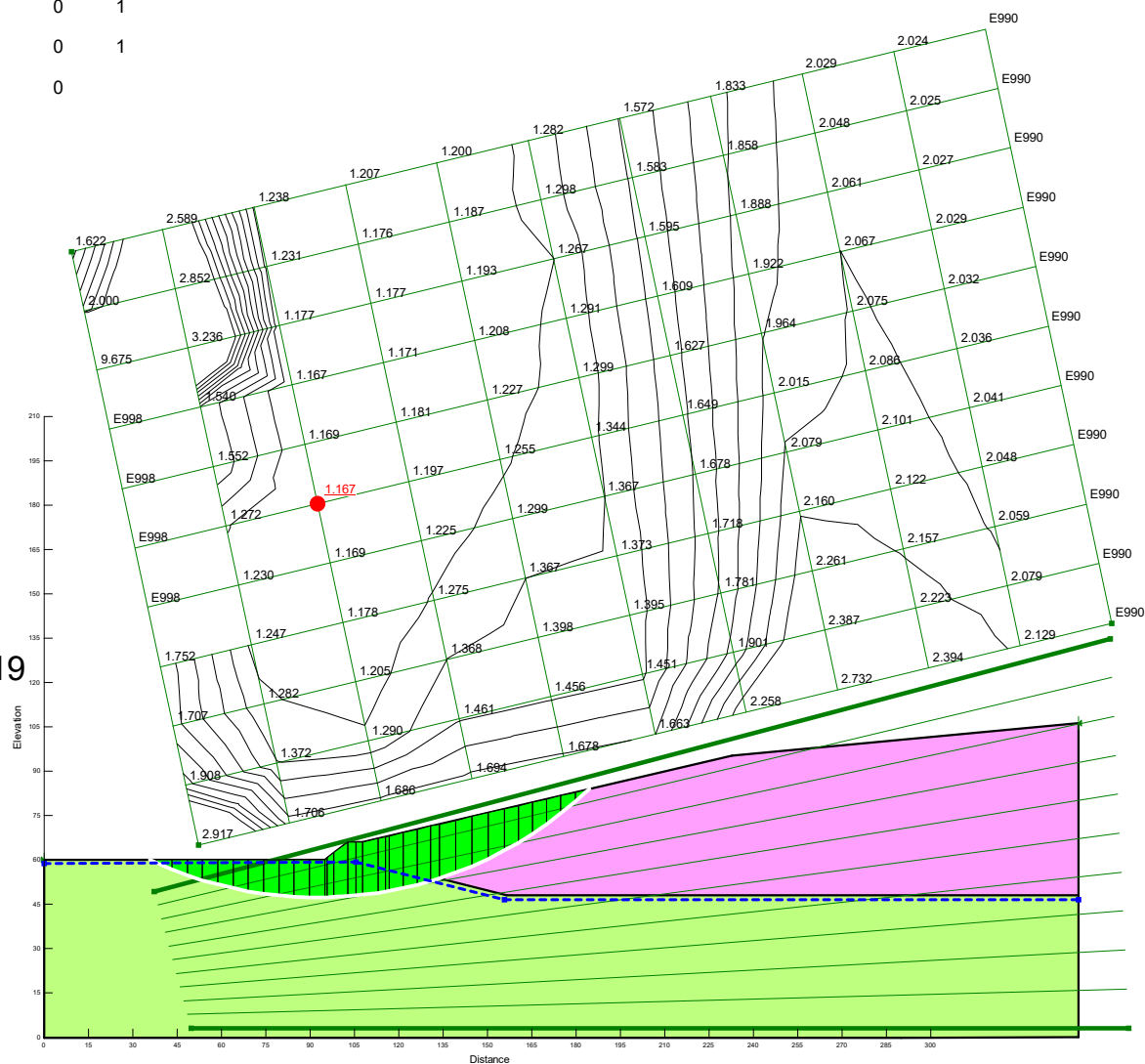


Appendix G Slope Stability Analyses' SLOPE/W Plots

G1	Cross-section N1
G2	Cross-section N2
G3	Cross-section N2a
G4	Cross-section E1
G5	Cross-section E2
G6	Cross-section E3
G7	Cross-section S1
G8	Cross-section MF1
G9	Cross-section MF2
G10	Cross-section MF3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Horz Seismic Coef.: 0.19



Title: Section E1-2025.gsz

Job Number: 1092369.2000

Analysis: 2. E1-Elevated-N7-APS -seismic DBE

Analysed by: Nick Buckton

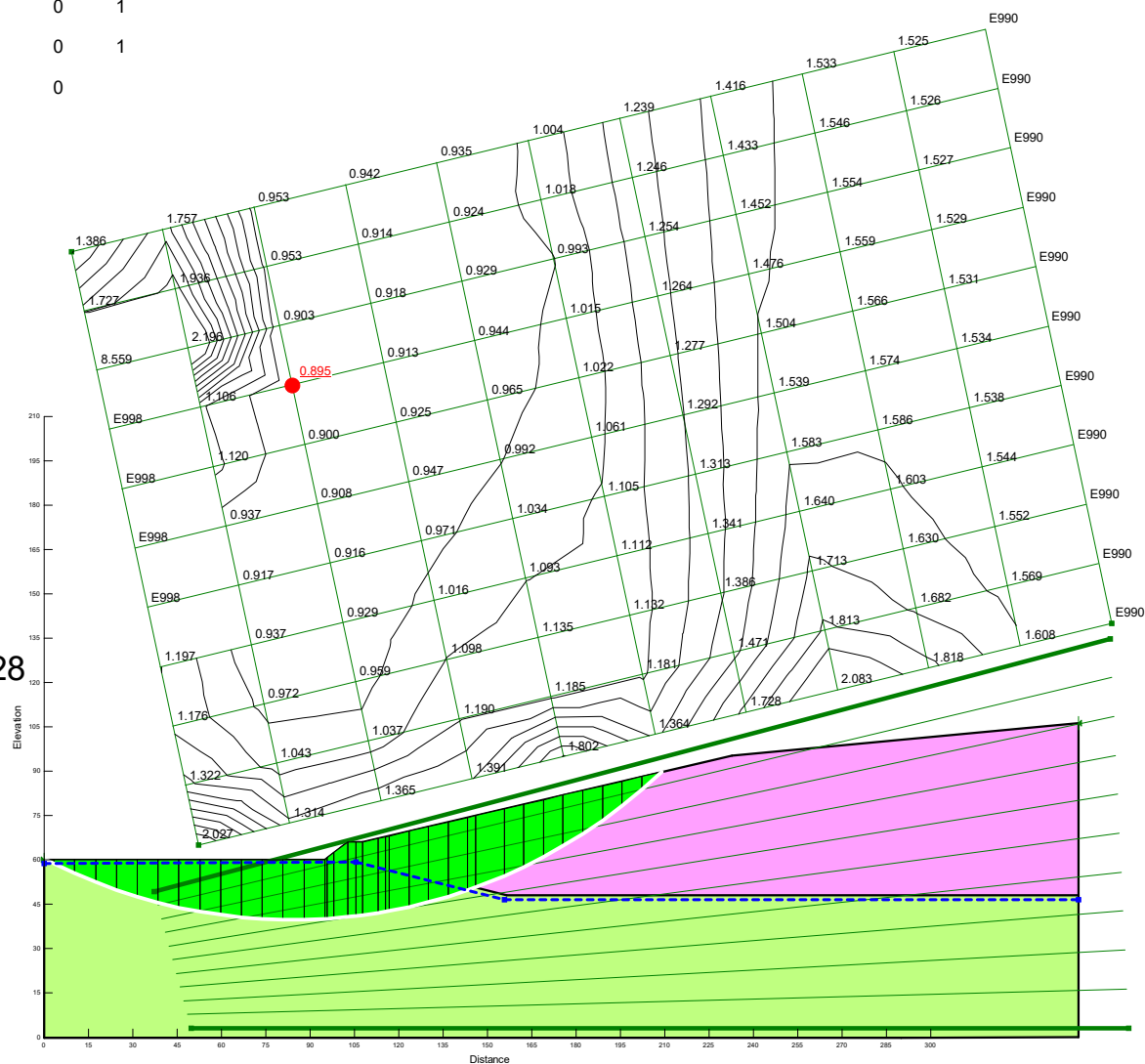
Comments:

Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Horz Seismic Coef.: 0.28



Title: Section E1-2025.gsz

Job Number: 1092369.2000

Analysis: 3. E1-Elevated-N7-APS -seismic MCE

Analysed by: Nick Buckton

Comments:

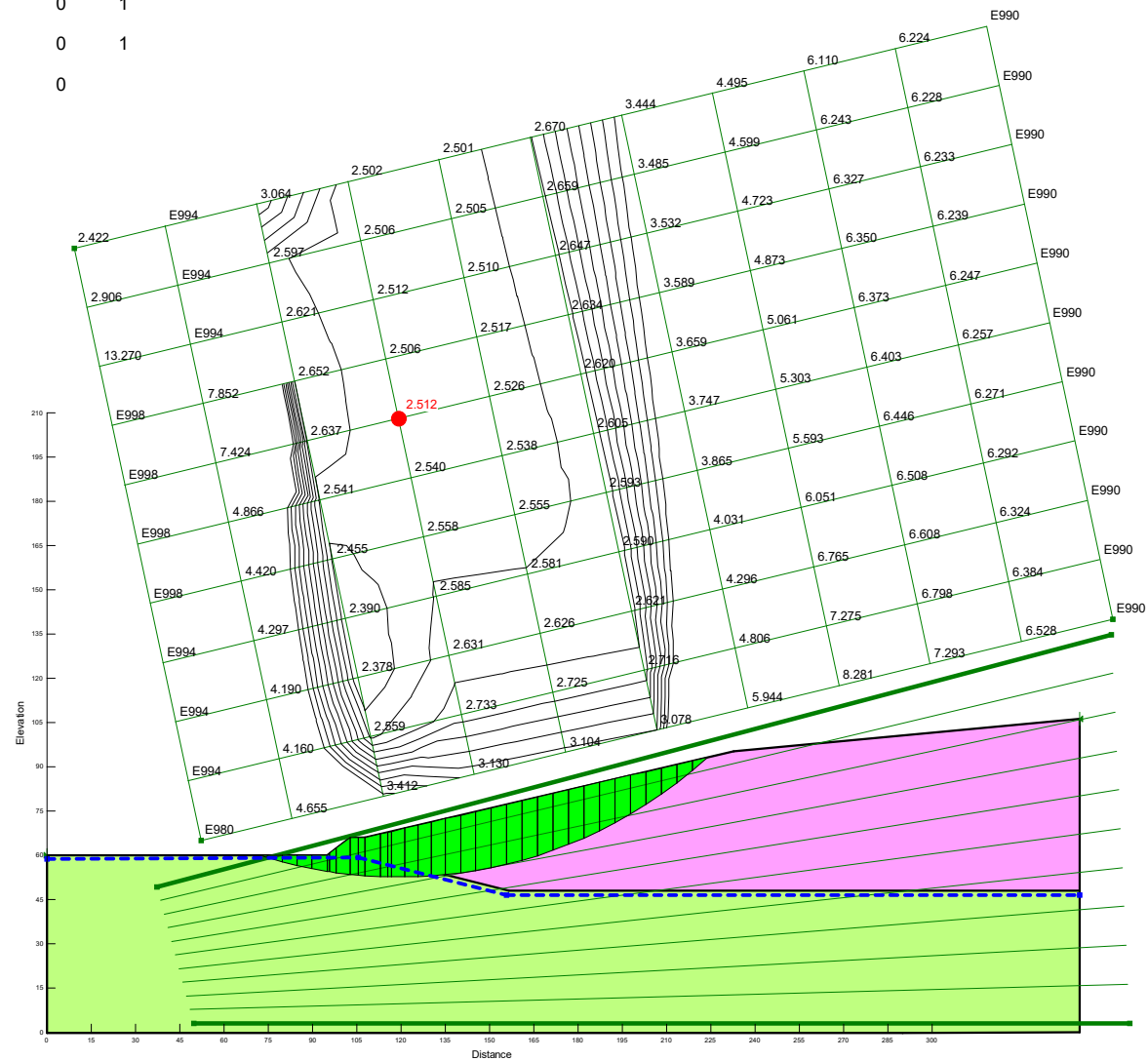
Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

1. Name: E1-Elevated-N7-APS
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section E1-2025.gsz

Job Number: 1092369.2000

Analysis: E1-Elevated-N7-APS

Analysed by: Nick Buckton

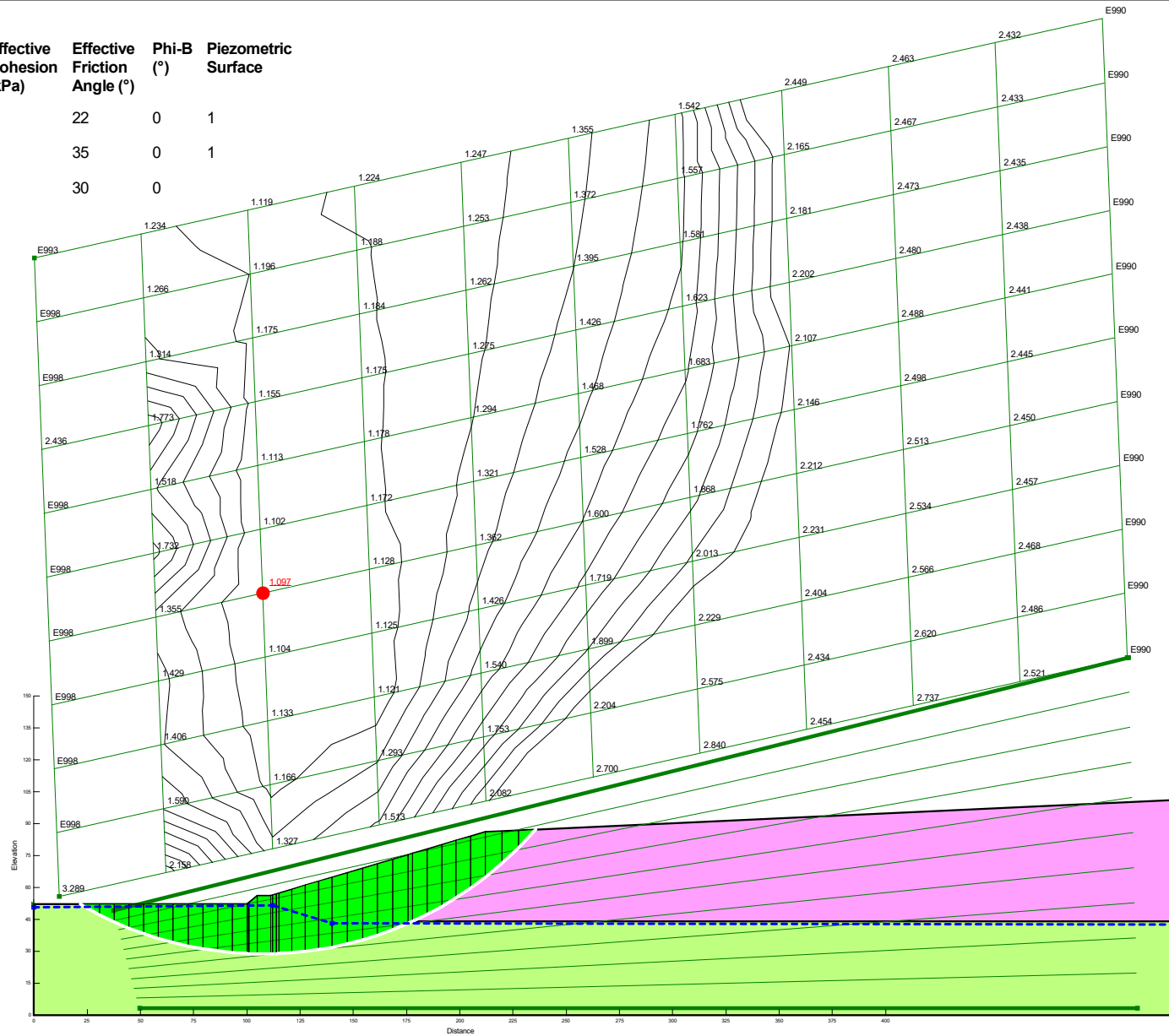
Comments:

Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Horz Seismic Coef.: 0.19



Title: Section E2-2025-check.gsz

Job Number: 1092369.2000

Analysis: 2. E2-Elevated-APS-seismic DBE

Analysed by: Nick Buckton

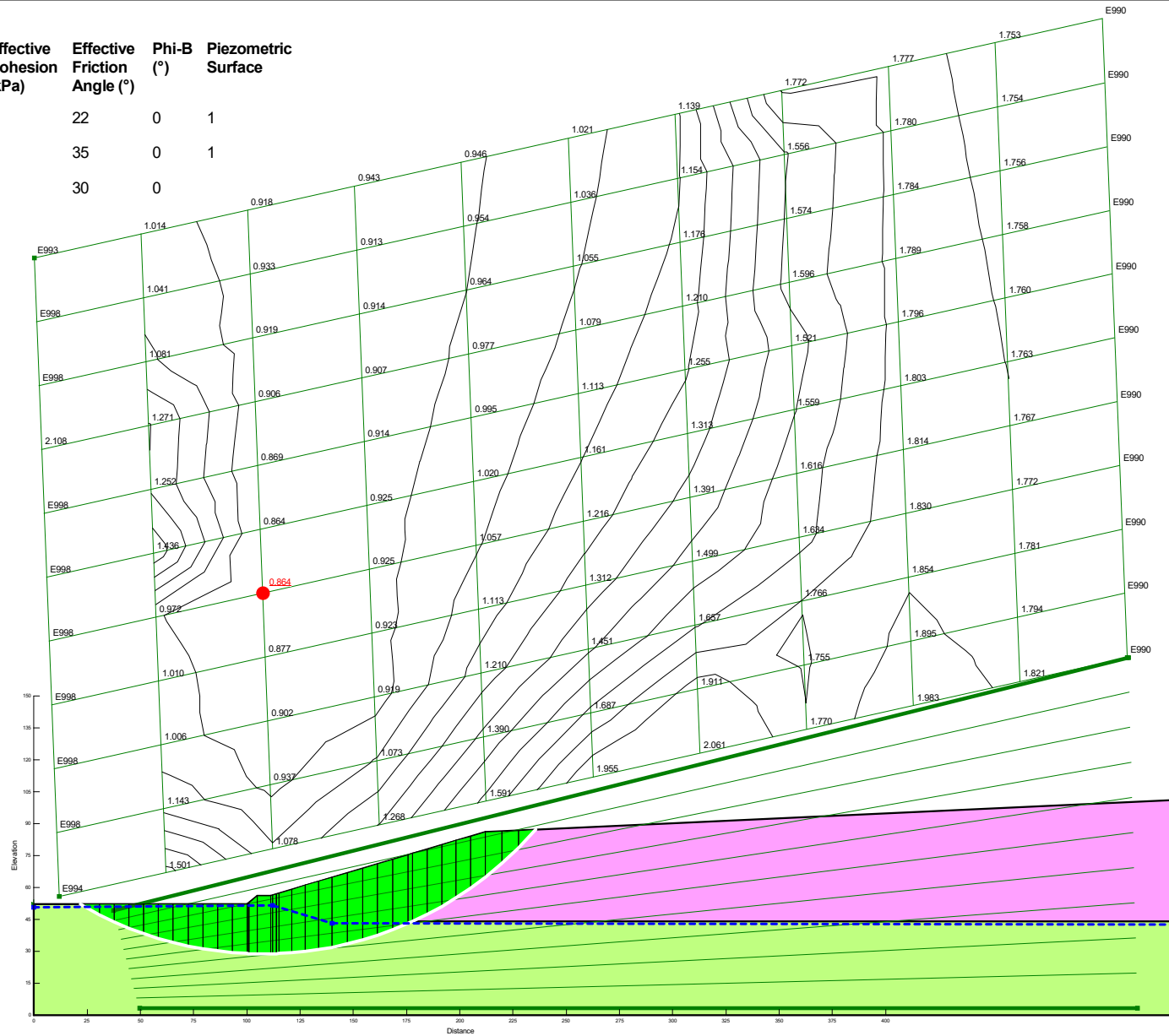
Comments:

Scale: 1:3,000 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Horz Seismic Coef.: 0.28



Title: Section E2-2025-check.gs

Job Number: 1092369.2000

Analysis: 3. E2-Elevated-APS-seismic MCE

Analysed by: Nick Buckton

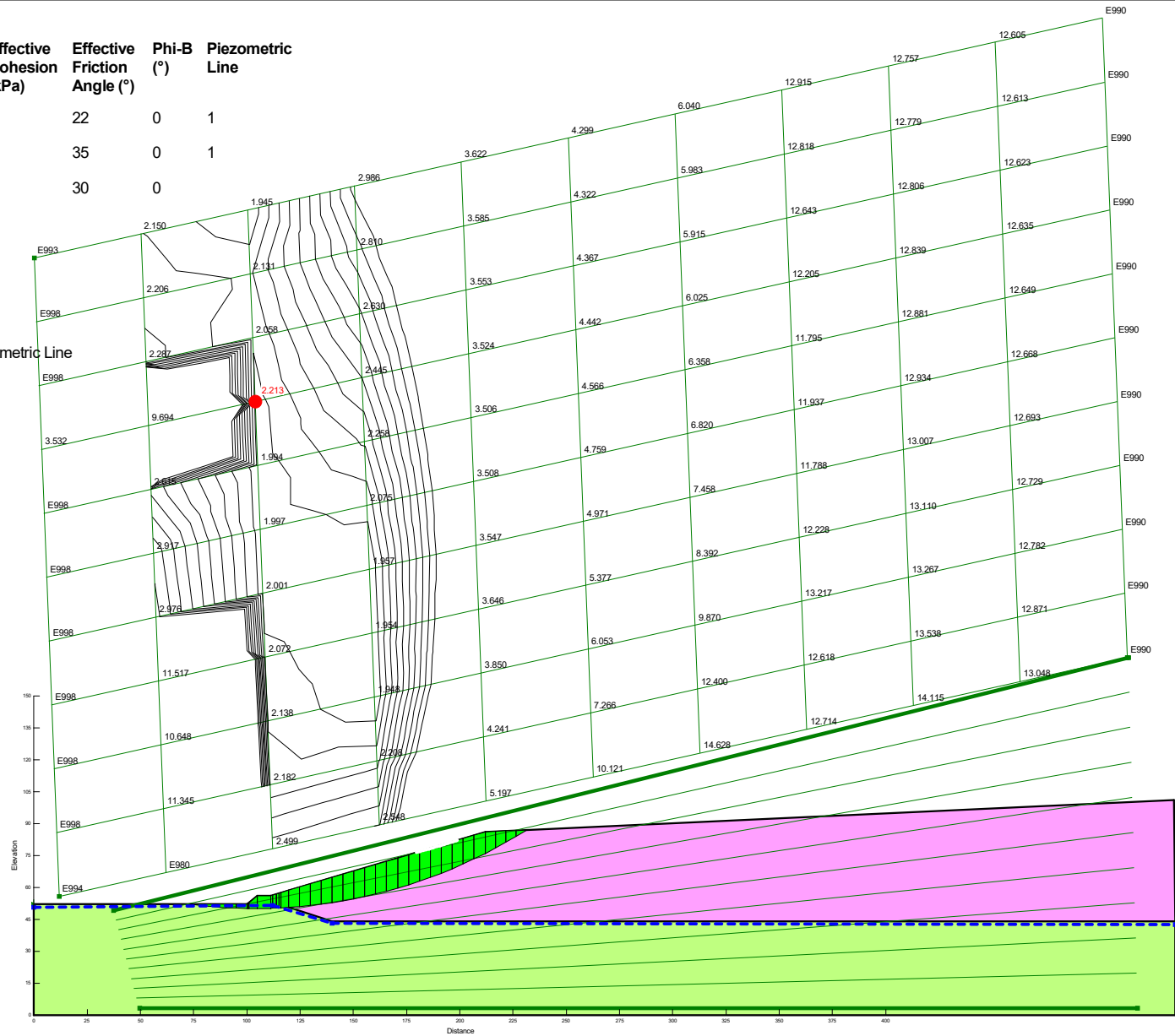
Comments:

Scale: 1:3,000 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

- Analysis Notes:
1. Name: E2-Elevated-APS
 2. Method: Morgenstern-Price
 3. Direction of movement: Right to Left
 4. Slip Surface Option: Grid and Radius
 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
 6. Optimization: No
 7. Tension Crack Option: (none)
 8. F of S Calculation Option: Constant
 9. Horz Seismic Load:

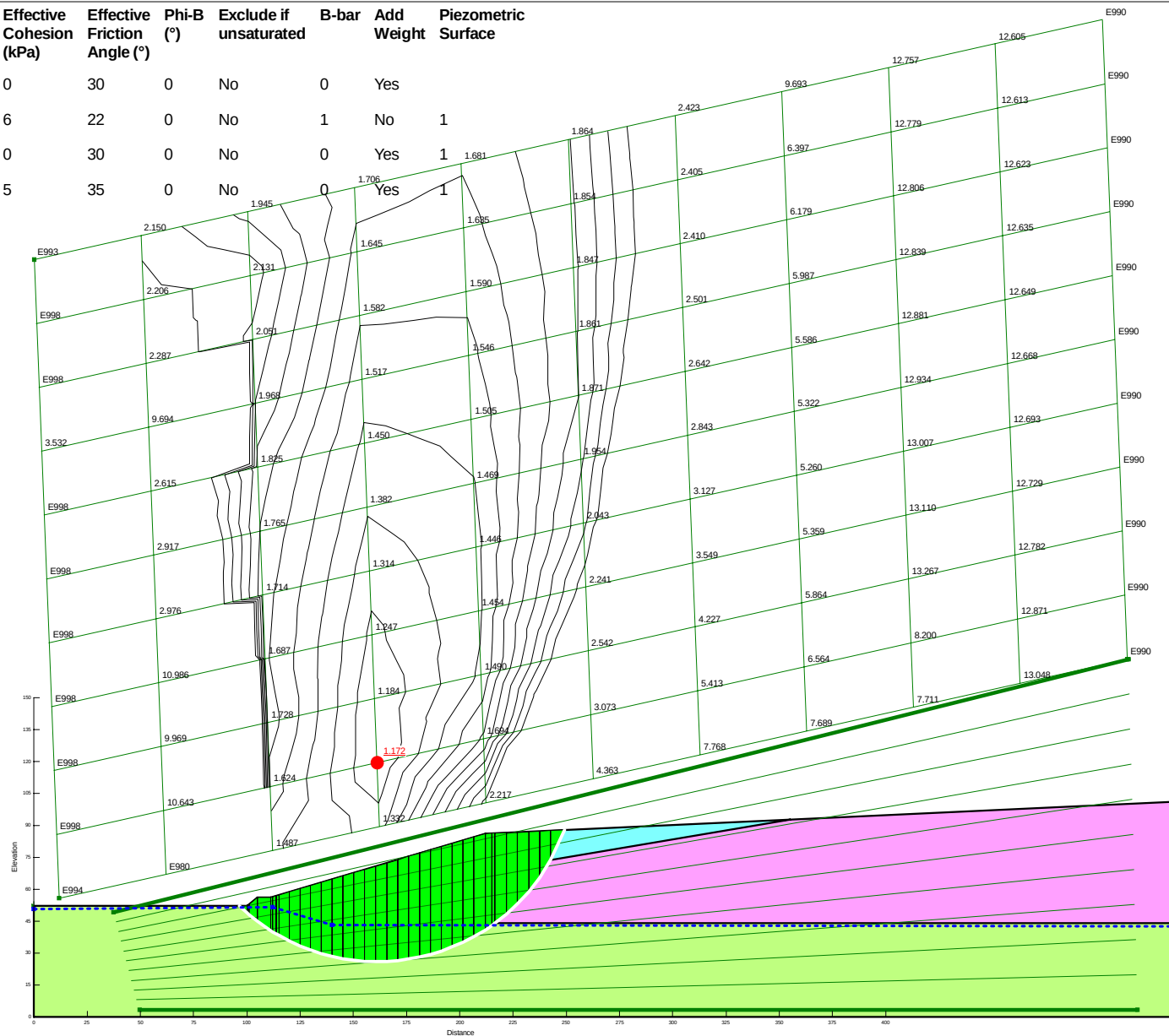


Title: Section E2-2025.gsz		Job Number: 1092369.2000
Analysis: E2-Elevated-APS		Analysed by: Nick Buckton
Comments:	Scale: 1:3,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Exclude if unsaturated	B-bar	Add Weight	Piezometric Surface
	Existing Refuse	Mohr-Coulomb	15	0	30	0	No	0	Yes	
	Mudstone N7	Mohr-Coulomb	20	6	22	0	No	1	No	1
	New Refuse	Mohr-Coulomb	15	0	30	0	No	0	Yes	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	No	0	Yes	1

Analysis Notes:
1. Name: E2 - Elevated - JASL B-Bar
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Search Method: Grid and Radius
5. PWP Conditions from: Piezometric Surfaces with B-bar
6. Optimize Critical Slip Surface: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
8. Horz Seismic Load:

Horz Seismic Coef.:



Title: Section E2-2025-check.gsz

Analysis: E2 - Elevated - JASL B-Bar

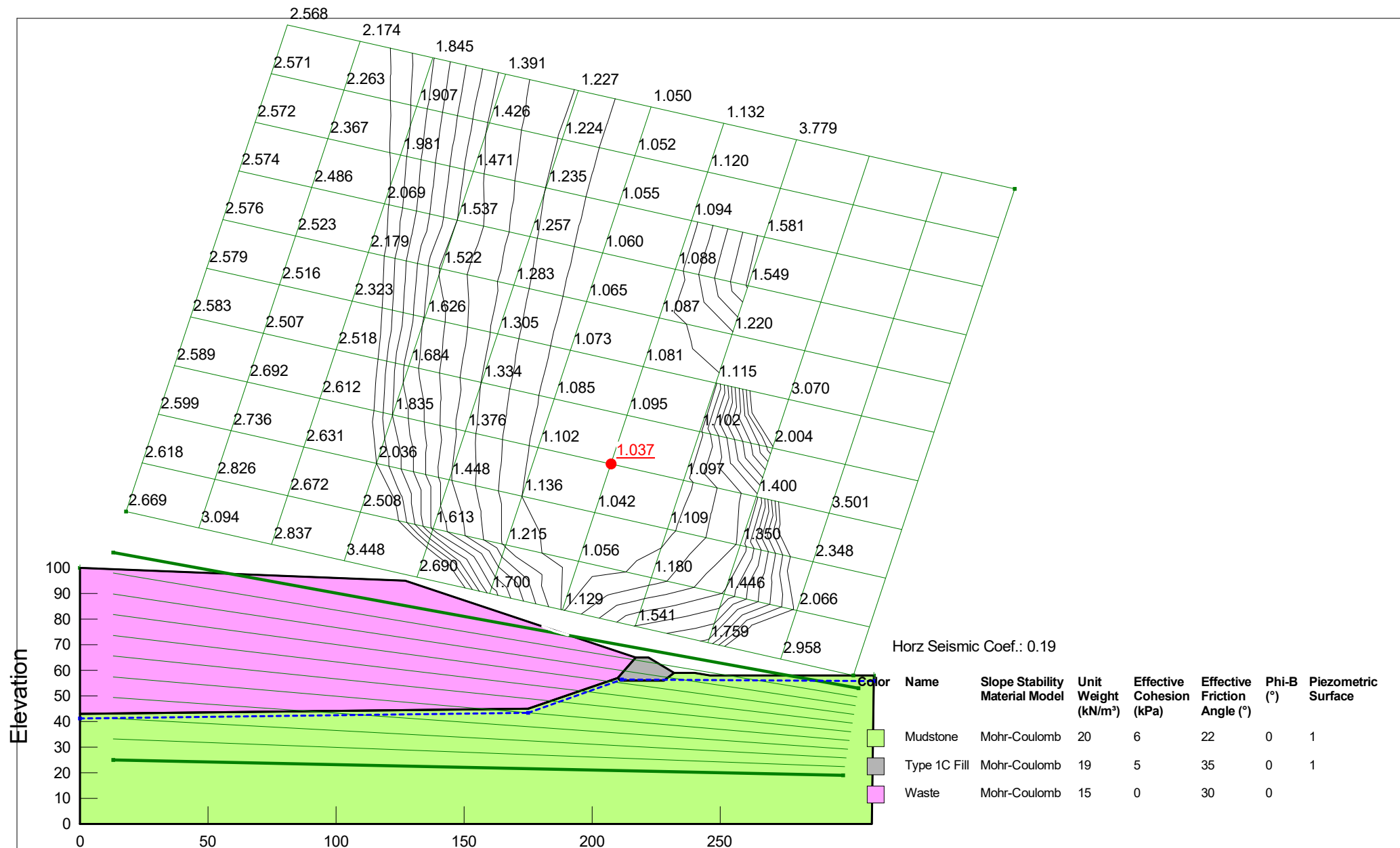
Comments:

Job Number: 1092369.2000

Analysed by: Nick Buckton

Scale: 1:3,000 @ A4

Checked by: Andrew Stiles



Title: Section E3-2025.gsz

Job Number: 1092369.2000

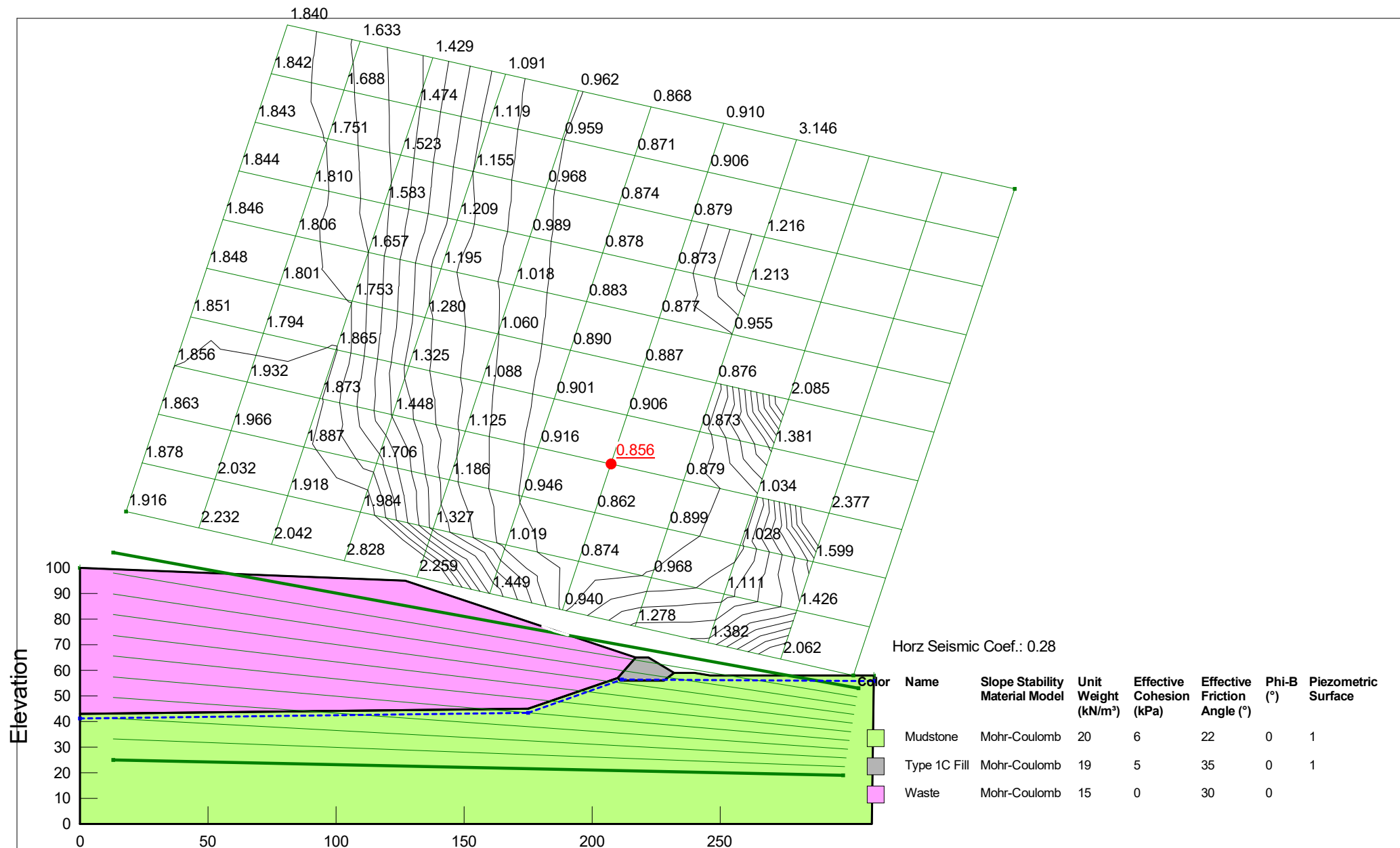
Analysis: 2. E3-Elevated -APS -seismic DBE

Analysed by: Nick Buckton

Comments:

Scale: 1:2,000 @ A4

Checked by: Andrew Stiles



Title: Section E3-2025.gsz

Job Number: 1092369.2000

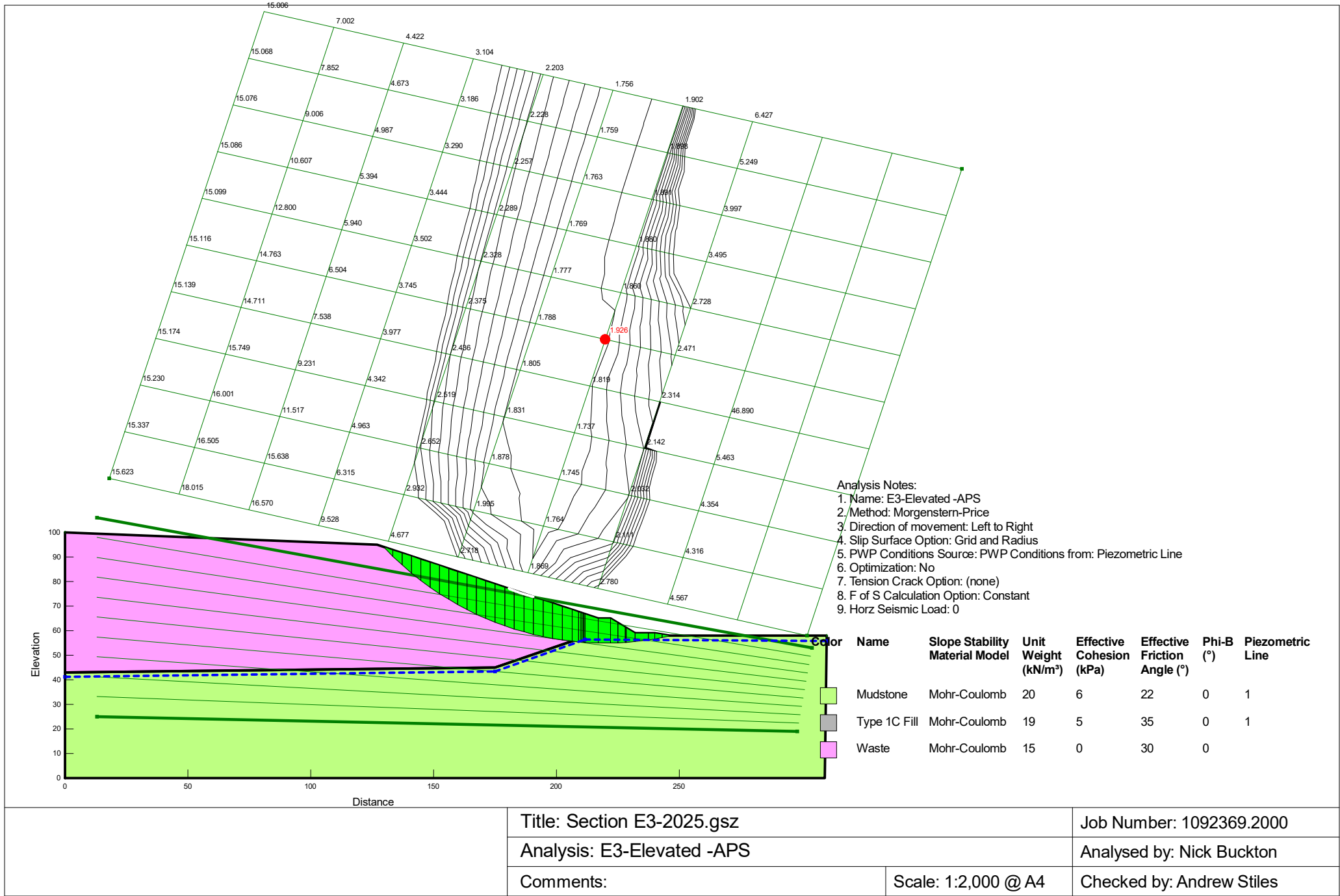
Analysis: 3. E3-Elevated -APS -seismic MCE

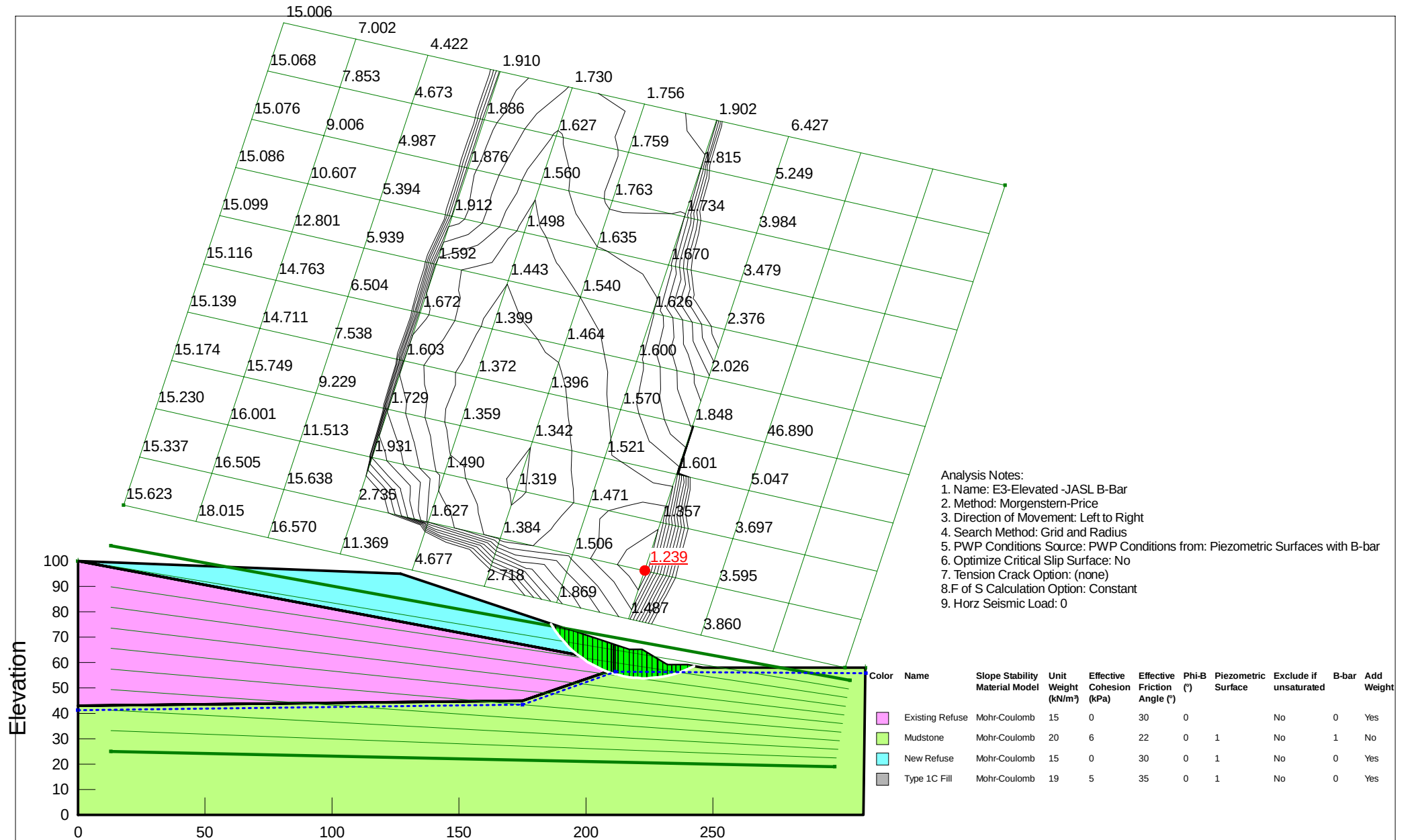
Analysed by: Nick Buckton

Comments:

Scale: 1:2,000 @ A4

Checked by: Andrew Stiles





Title: Section E3-2025.gsz

Job Number: 1092369.2000

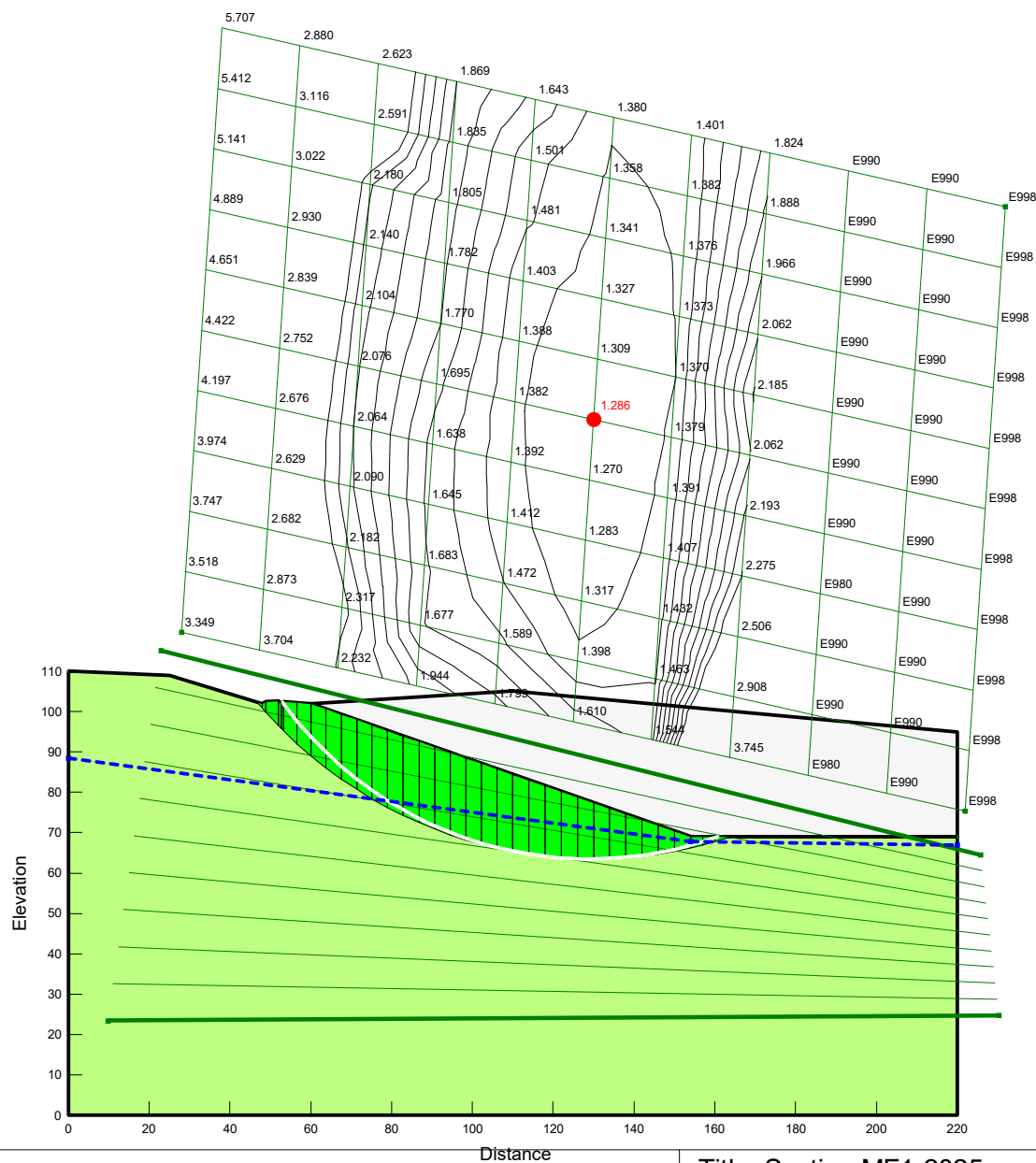
Analysis: E3-Elevated -JASL B-Bar

Analysed by: Nick Buckton

Comments:

Scale: 1:2,000 @ A4

Checked by: Andrew Stiles

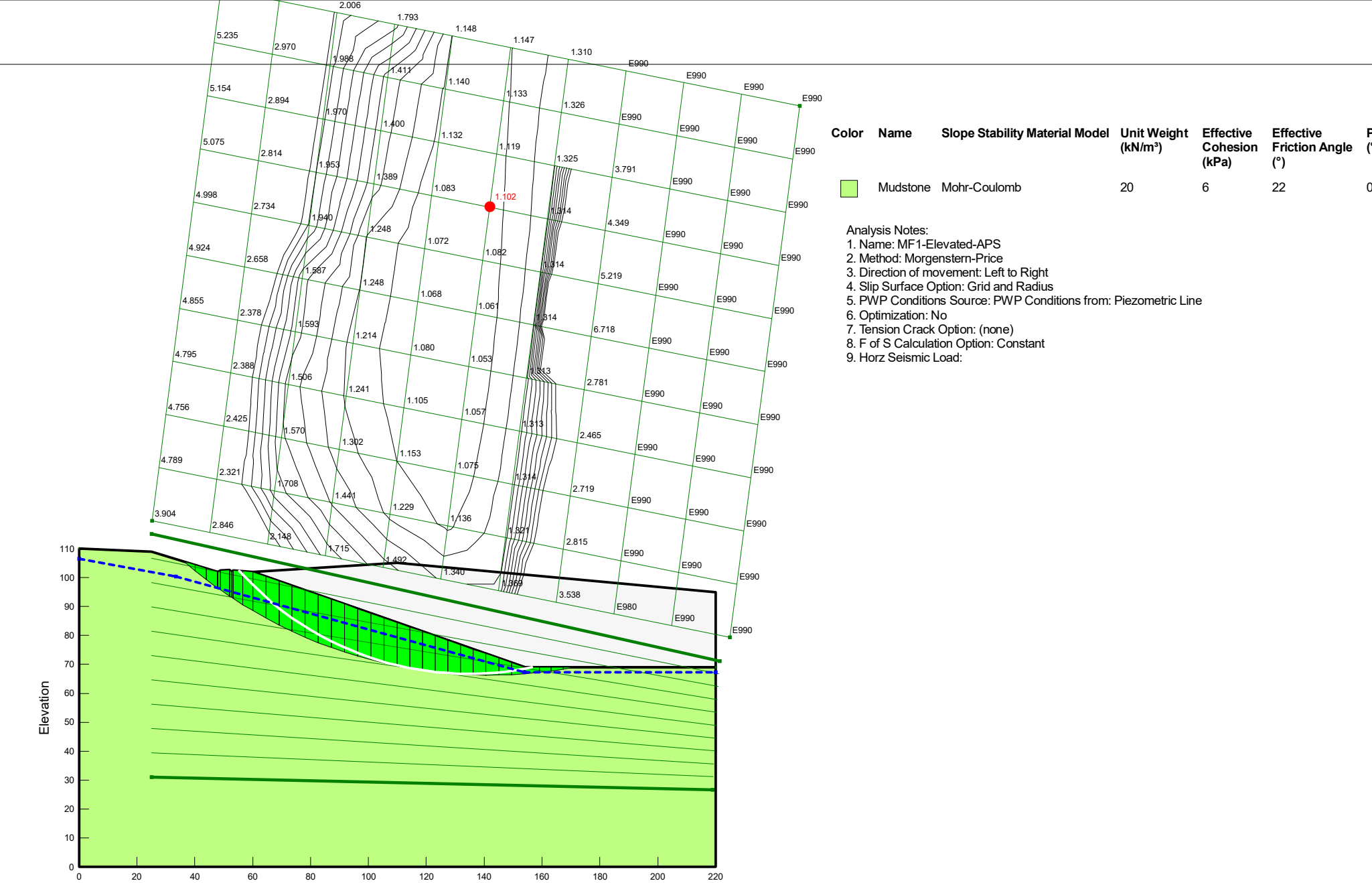


Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piez Line
	Mudstone	Mohr-Coulomb	20	6	22	0	1

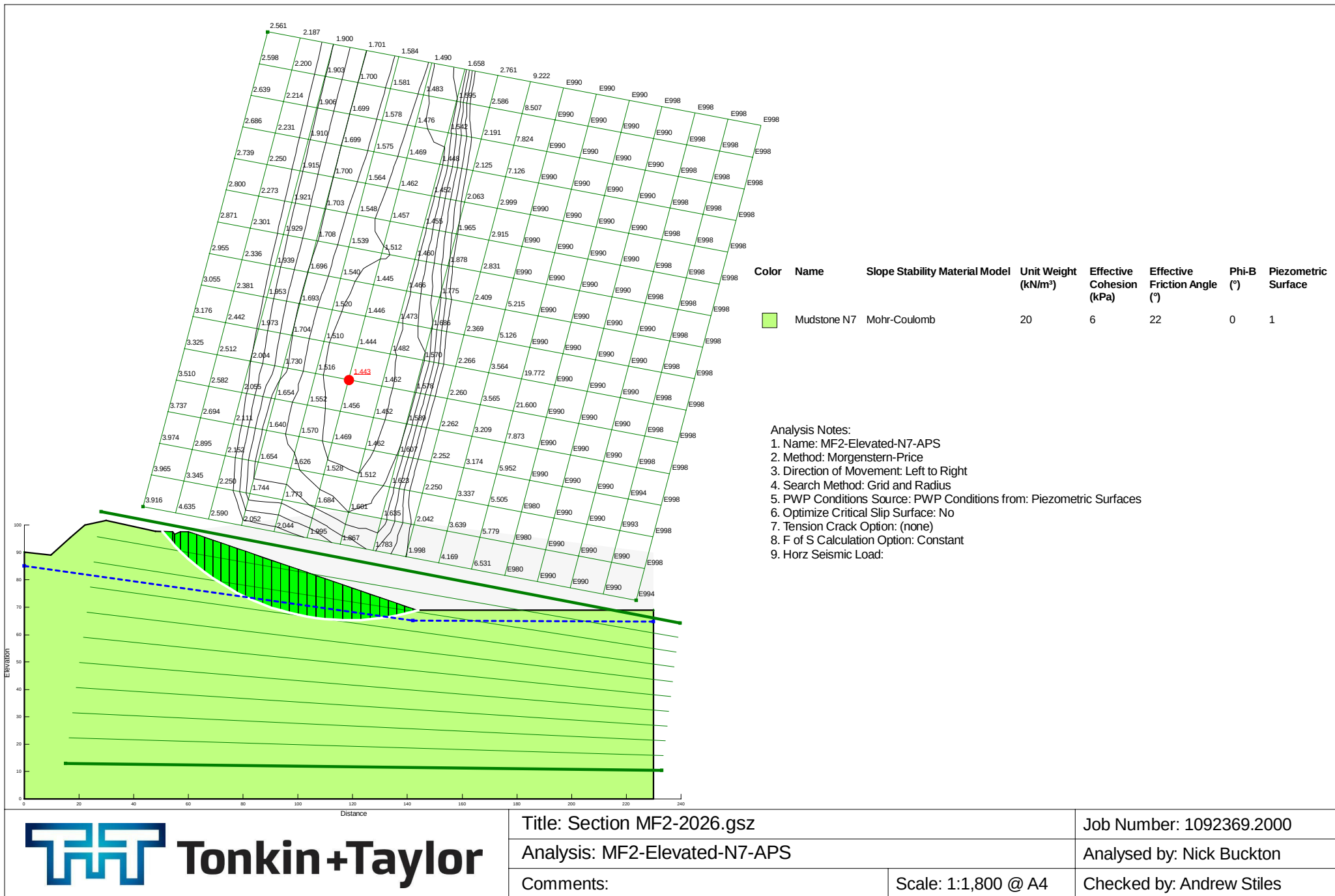
Analysis Notes:

- Analysis Notes:
1. Name: MF1-Baseline -APS
 2. Method: Morgenstern-Price
 3. Direction of movement: Left to Right
 4. Slip Surface Option: Grid and Radius
 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
 6. Optimization: No
 7. Tension Crack Option: (none)
 8. F of S Calculation Option: Constant
 9. Horiz Seismic Load:

Title: Section MF1-2025.gsz		Job Number: 1092369.2000
Analysis: MF1-Baseline -APS		Analysed by: Nick Buckton
Comments:	Scale: 1:1,750 @ A4	Checked by: Andrew Stiles



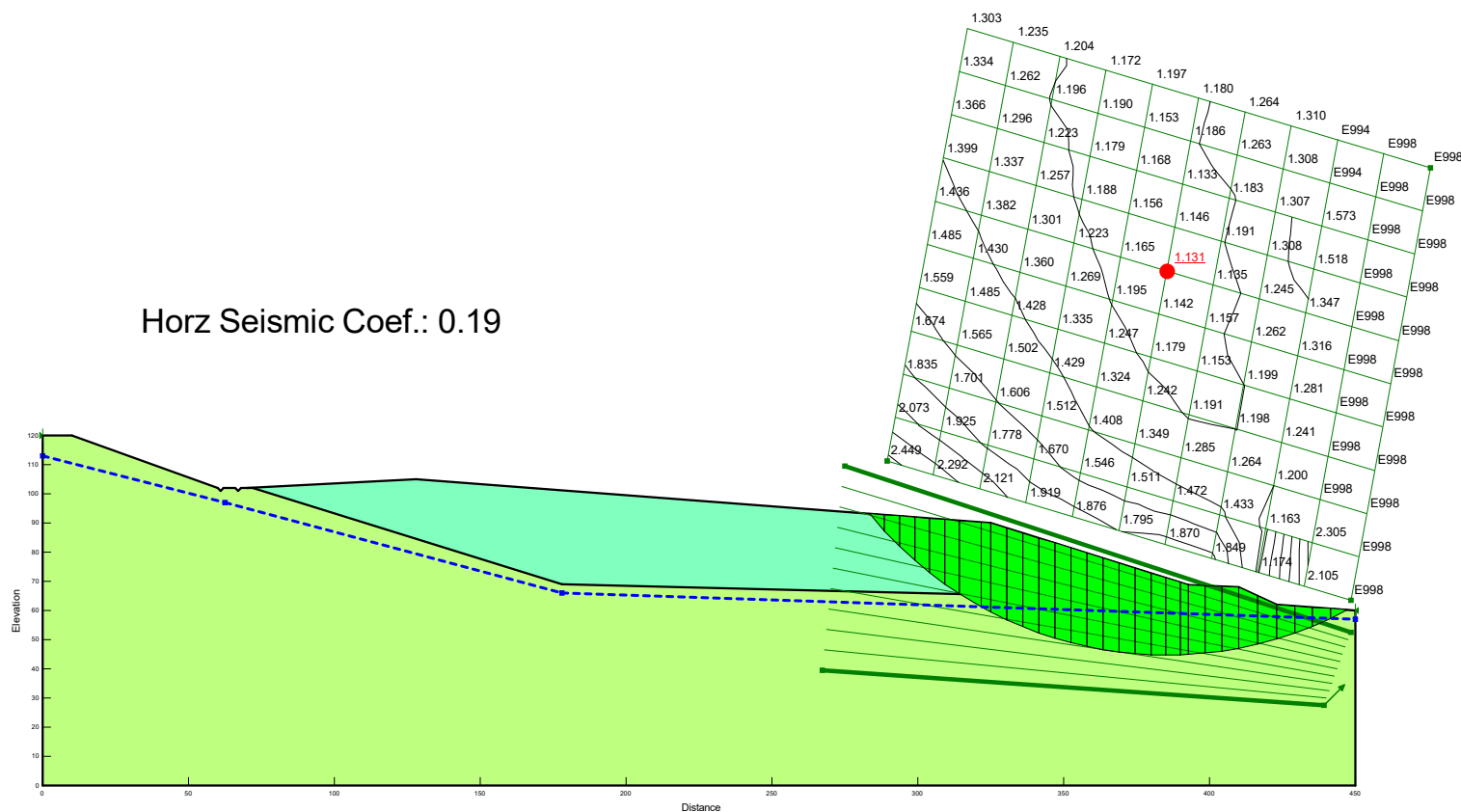
Title: Section MF1-2025.gsz		Job Number: 1092369.2000
Analysis: MF1-Elevated-APS		Analysed by: Nick Buckton
Comments:	Scale: 1:1,750 @ A4	Checked by: Andrew Stiles



 Tonkin+Taylor	Title: Section MF2-2026.gsz		Job Number: 1092369.2000
	Analysis: MF2-Elevated-N7-APS		Analysed by: Nick Buckton
	Comments:	Scale: 1:1,800 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	New Waste	Mohr-Coulomb	12	5	30	0	1

Horz Seismic Coef.: 0.19



Title: Section MF3-2025.gsz

Job Number: 1092369.2000

Analysis: 9. MF3-Waste Elevated-sesmic-APS New Waste DBE

Analysed by: Nick Buckton

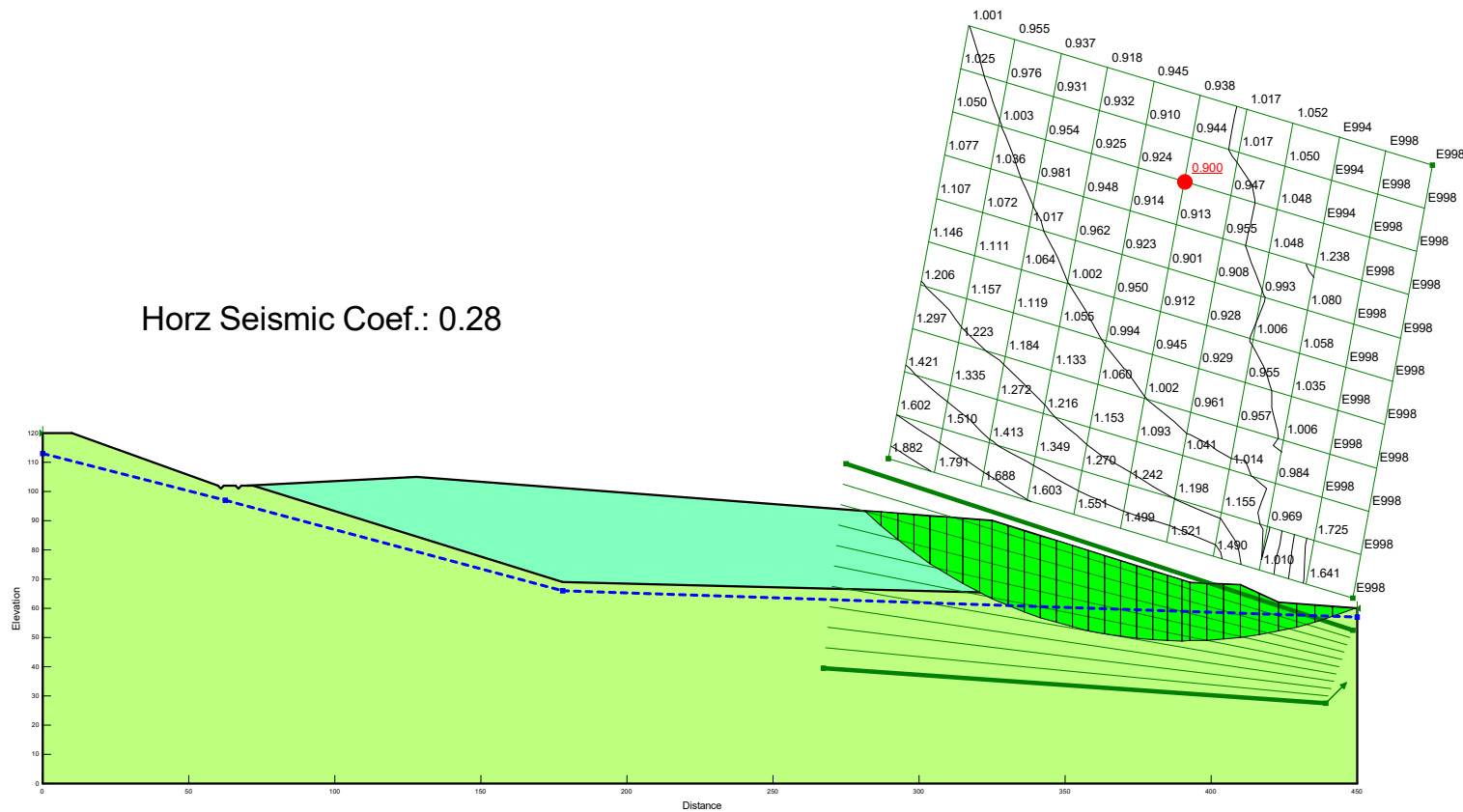
Comments:

Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
	New Waste	Mohr-Coulomb	12	5	30	0	1

Horz Seismic Coef.: 0.28



Title: Section MF3-2025.gsz

Job Number: 1092369.2000

Analysis: 9.1. MF3-Waste Elevated-seismic-APS New Waste MCE

Analysed by: Nick Buckton

Comments:

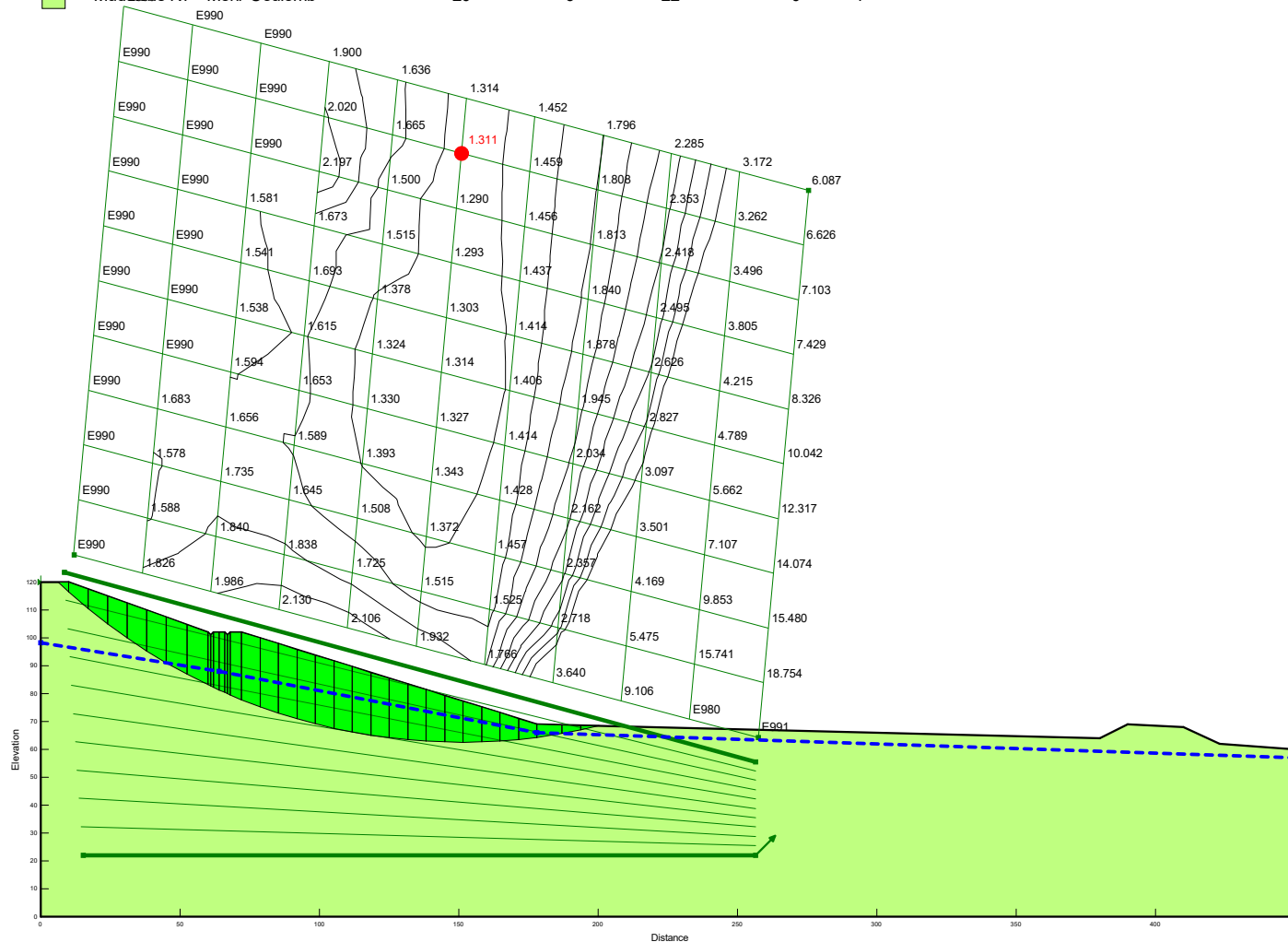
Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1

Analysis Notes:

1. Name: MF3-Basegrade-Design-APS
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Grid and Radius
5. PWP Conditions Source: Piezometric Surfaces
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section MF3-2025.gsz

Job Number: 1092369.2000

Analysis: MF3-Basegrade-Design-APS

Analysed by: Nick Buckton

Comments:

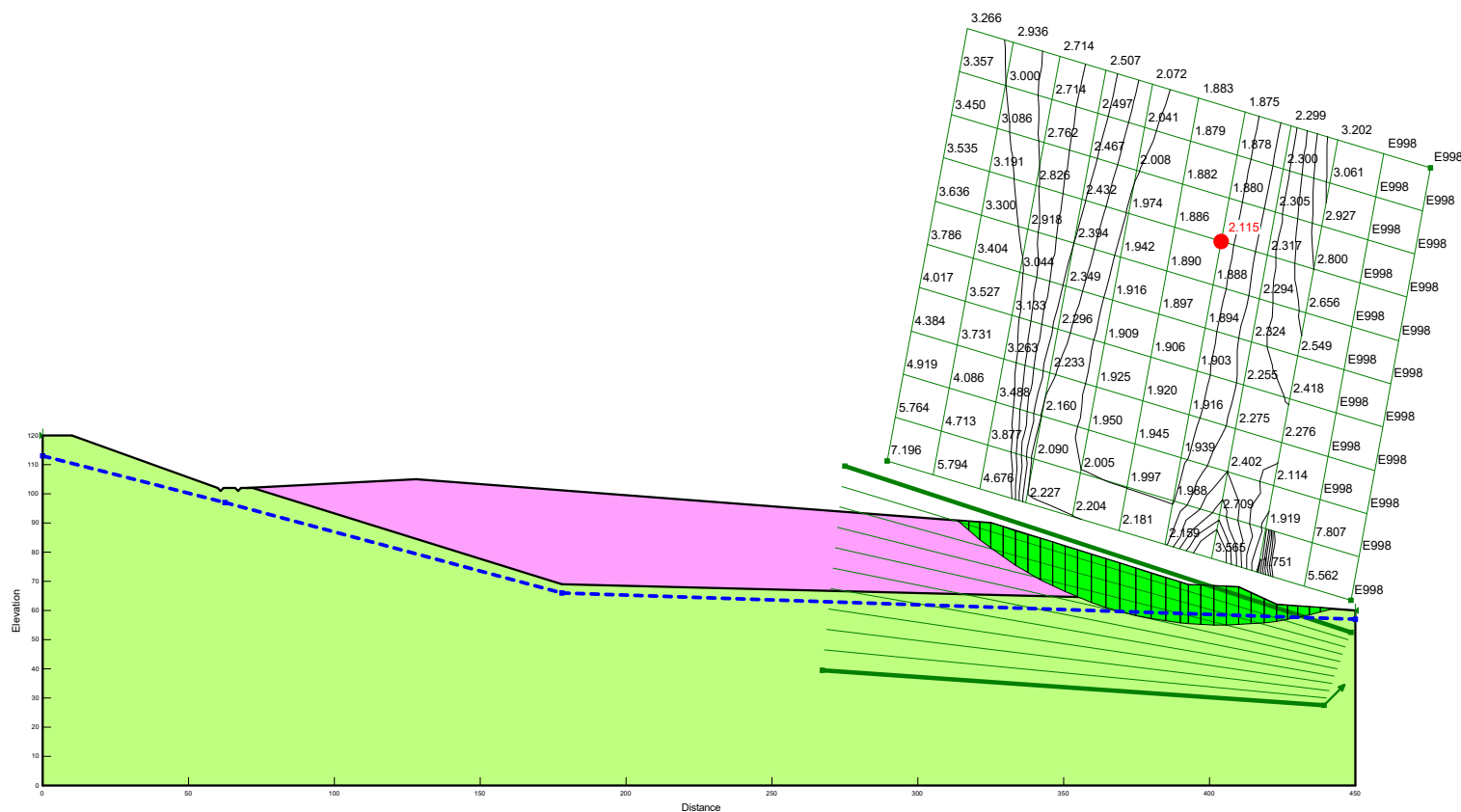
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Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	1

Analysis Notes:

1. Name: MF3-Waste Elevated-APS
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Grid and Radius
5. PWP Conditions Source: Piezometric Surfaces
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section MF3-2025.gsz

Job Number: 1092369.2000

Analysis: MF3-Waste Elevated-APS

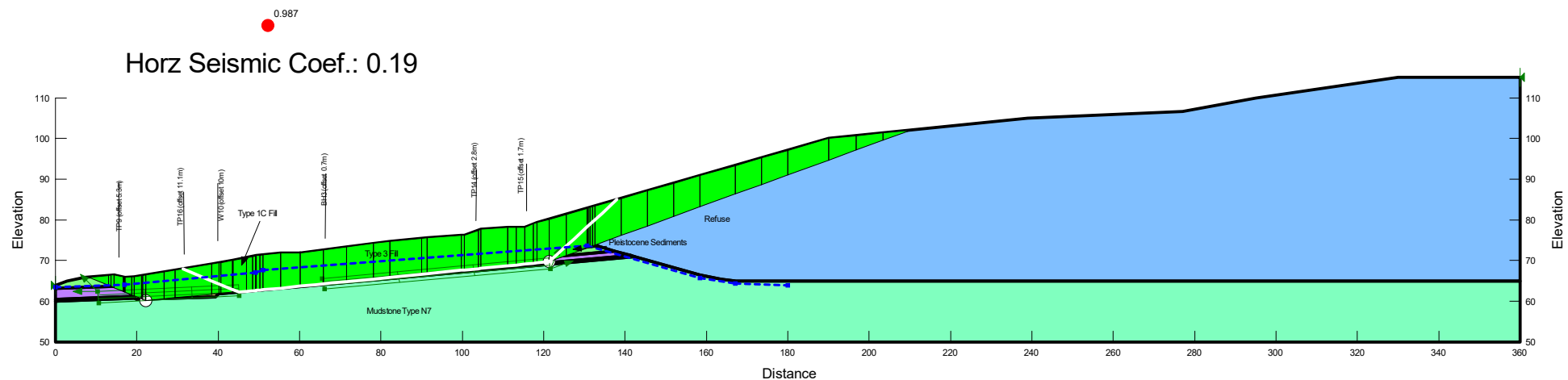
Analysed by: Nick Buckton

Comments:

Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Cohesion R (kPa)	Phi R (°)	Piezometric Surface
	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	0	0	1
	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	0	0	1
	Refuse	Mohr-Coulomb	15	0	30	0	0	0	1
	Sheared Mudstone	Mohr-Coulomb	20	0	14	0	0	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	0	0	1
	Type 3 Fill	Mohr-Coulomb	19	5	30	0	0	0	1
	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	0	0	1



Title: N1-2024-A-F.gsz

Job Number: 1092369.2000

Analysis: Design groundwater final design seismic Trans APS-DBE

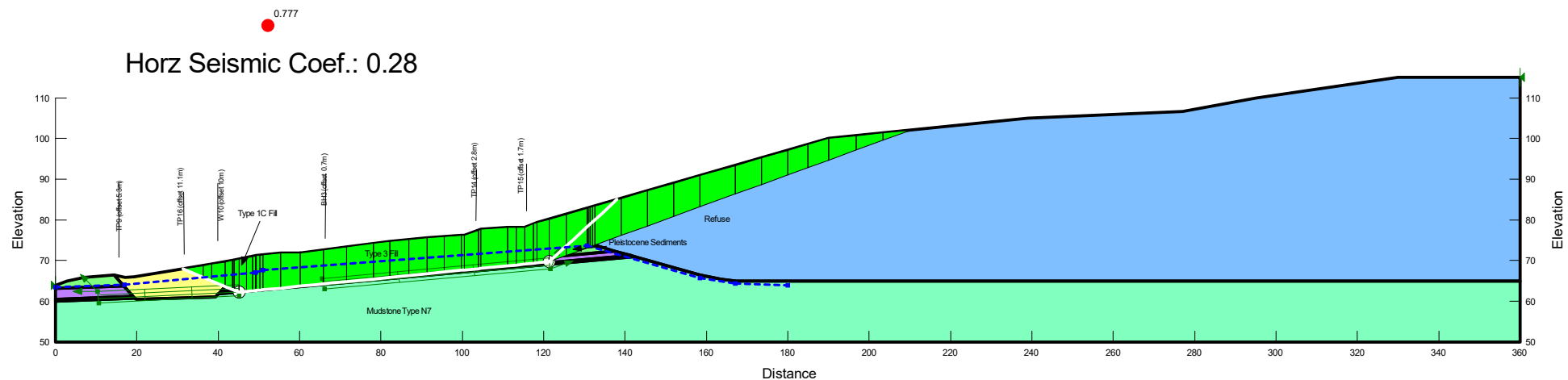
Analysed by: Nick Buckton

Comments:

Scale: 1:1,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Cohesion R (kPa)	Phi R (°)	Piezometric Surface
	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	0	0	1
	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	0	0	1
	Refuse	Mohr-Coulomb	15	0	30	0	0	0	1
	Sheared Mudstone	Mohr-Coulomb	20	0	14	0	0	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	0	0	1
	Type 3 Fill	Mohr-Coulomb	19	5	30	0	0	0	1
	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	0	0	1



Title: N1-2024-A-F.gsz

Job Number: 1092369.2000

Analysis: Design groundwater final design seismic Trans APS-MCE

Analysed by: Nick Buckton

Comments:

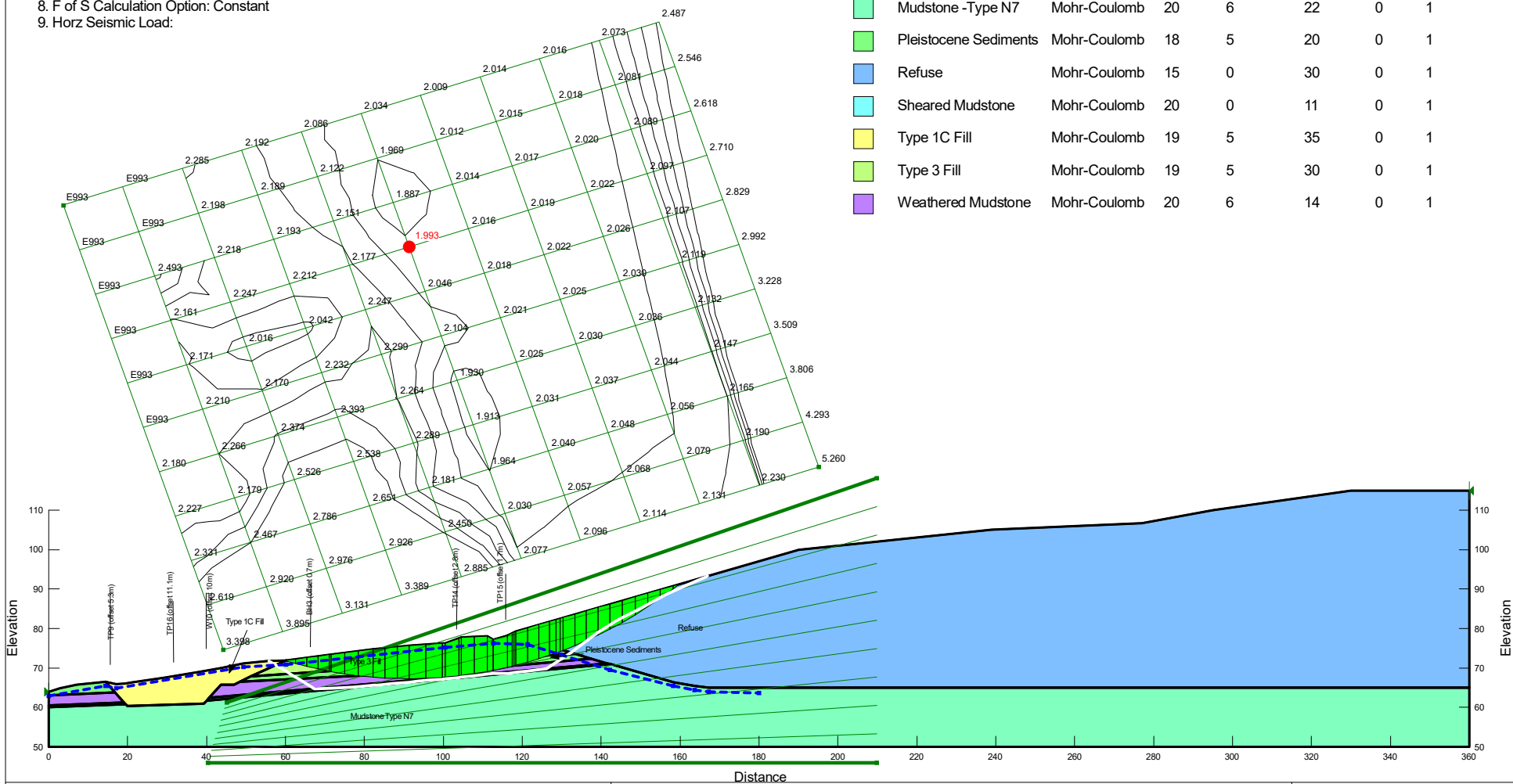
Scale: 1:1,500 @ A4

Checked by: Andrew Stiles

Analysis Notes:

1. Name: High GW (2)
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Grid and Radius
5. PWP Conditions from: Piezometric Surfaces
6. Optimization: Yes
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	1
■	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	1
■	Refuse	Mohr-Coulomb	15	0	30	0	1
■	Sheared Mudstone	Mohr-Coulomb	20	0	11	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Type 3 Fill	Mohr-Coulomb	19	5	30	0	1
■	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	1



Title: N1-2024-A-F.gsz

Job Number: 1092369.2000

Analysis: N1-2024-A

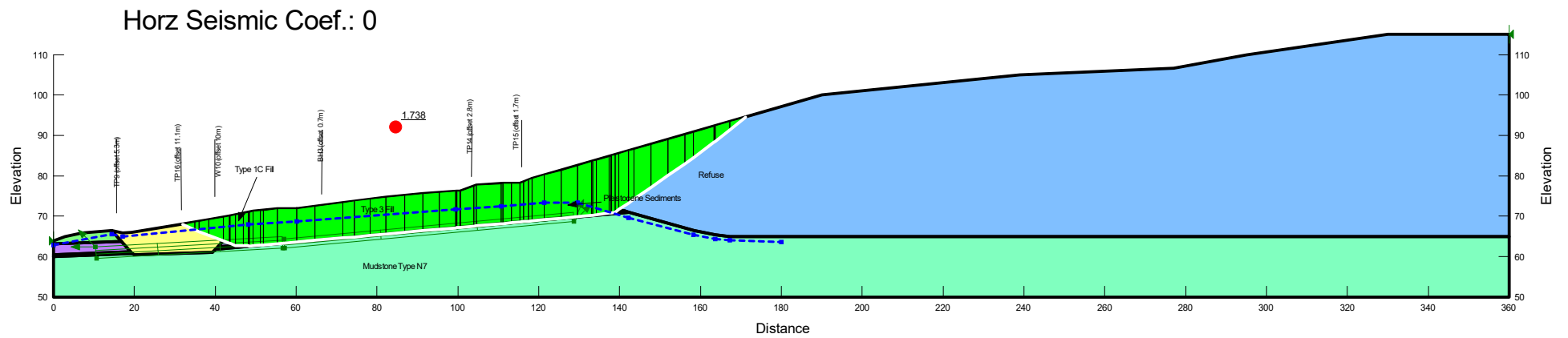
Analysed by: Nick Buckton

Comments:

Scale: 1:1,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	1
■	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	1
■	Refuse	Mohr-Coulomb	15	0	30	0	1
■	Sheared Mudstone	Mohr-Coulomb	20	0	14	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
■	Type 3 Fill	Mohr-Coulomb	19	5	30	0	1
■	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	1

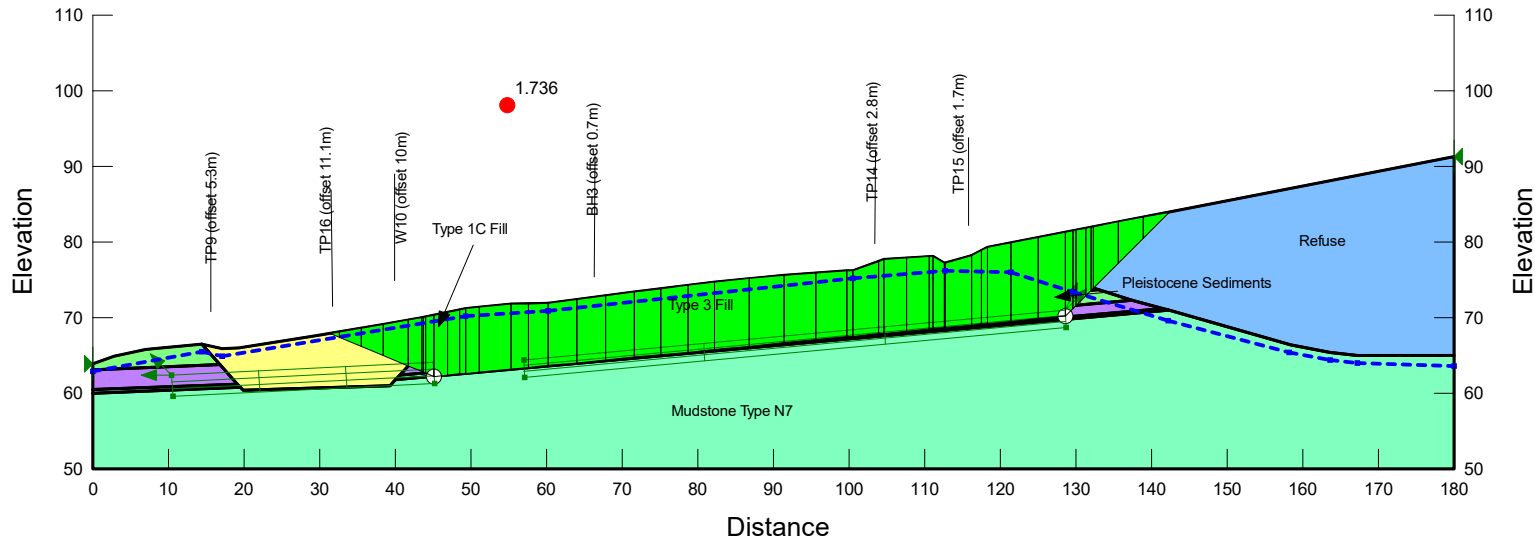


Title: N1-2024-A-F.gsz		Job Number: 1092369.2000
Analysis: N1-2024-B		Analysed by: Nick Buckton
Comments:	Scale: 1:1,500 @ A4	Checked by: Andrew Stiles

Analysis Notes:

1. Name: High groundwaterfinal design
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Block
5. PWP Conditions from: Piezometric Surfaces
6. Optimization: Yes
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	1
	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	1
	Refuse	Mohr-Coulomb	15	0	30	0	1
	Sheared Mudstone	Mohr-Coulomb	20	0	14	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
	Type 3 Fill	Mohr-Coulomb	19	5	30	0	1
	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	1



Title: N1-2024-basic1.gsz

Job Number: 1092369.2000

Analysis: N1-2024-C

Analysed by: Nick Buckton

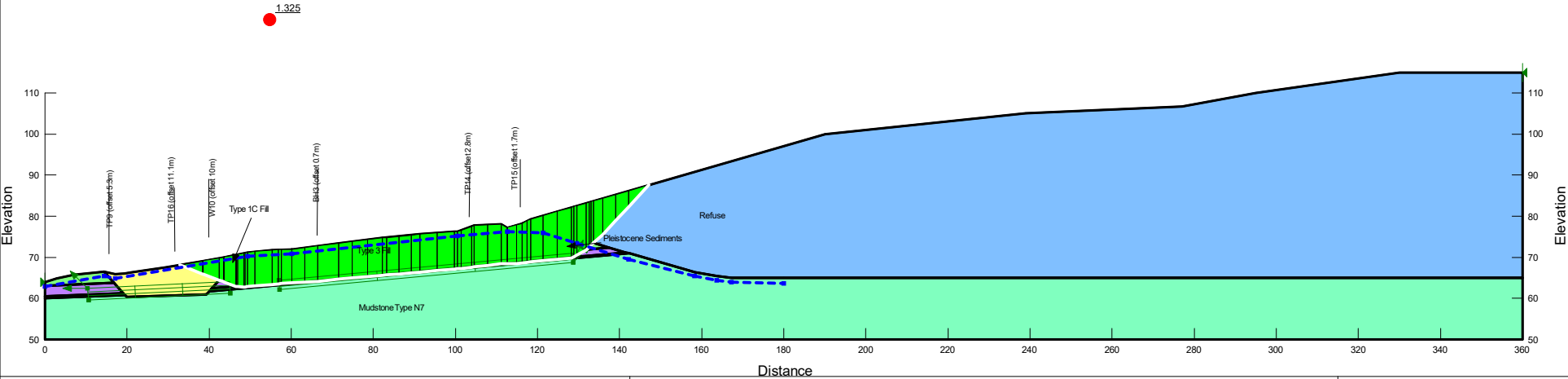
Comments:

Scale: 1:1,000 @ A4

Checked by: Andrew Stiles

- Analysis Notes:
- 1. Name: High GW (2)
 - 2. Method: Morgenstern-Price
 - 3. Direction of movement: Right to Left
 - 4. Slip Surface Option: Block
 - 5. PWP Conditions from: Piezometric Surfaces
 - 6. Optimization: Yes
 - 7. Tension Crack Option: (none)
 - 8. F of S Calculation Option: Constant
 - 9. Horz Seismic Load:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Mudstone -Type N7	Mohr-Coulomb	20	6	22	0	1
	Pleistocene Sediments	Mohr-Coulomb	18	5	20	0	1
	Refuse	Mohr-Coulomb	15	0	30	0	1
	Sheared Mudstone	Mohr-Coulomb	20	0	11	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	1
	Type 3 Fill	Mohr-Coulomb	19	5	30	0	1
	Weathered Mudstone	Mohr-Coulomb	20	6	14	0	1

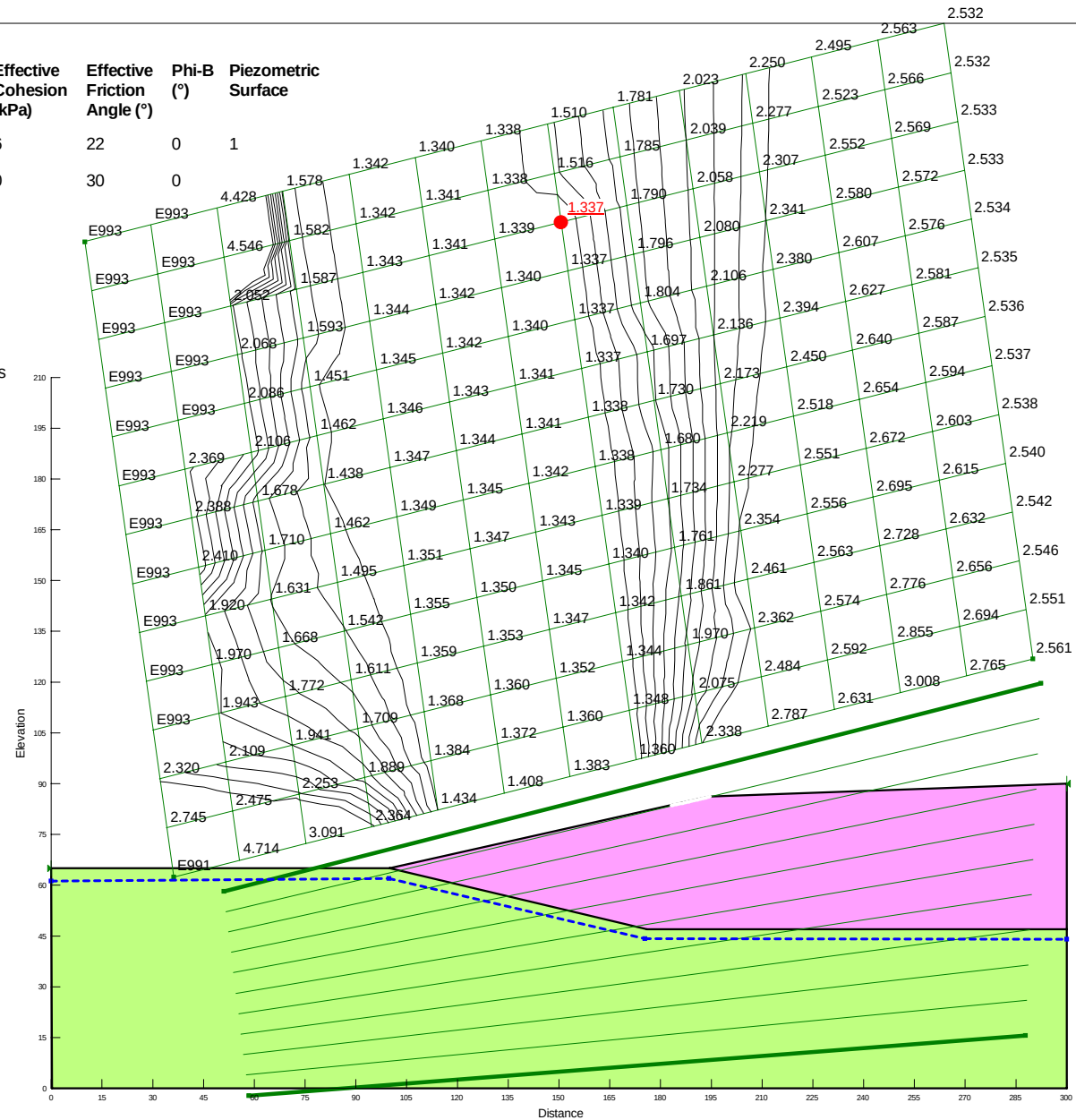


Title: N1-2024-A-F.gsz		Job Number: 1092369.2000
Analysis: N1-2024-D		Analysed by: Nick Buckton
Comments:	Scale: 1:1,500 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

1. Name: 2. N2-C1 design GW-N7 -APS seismic DBE
2. Method: Morgenstern-Price
3. Direction of Movement: Right to Left
4. Search Method: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Surfaces
6. Optimize Critical Slip Surface: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load: 0.19



Title: Section N2-2025.gsz

Job Number: 1092369.2000

Analysis: 2. N2-C1 design GW-N7 -APS seismic DBE

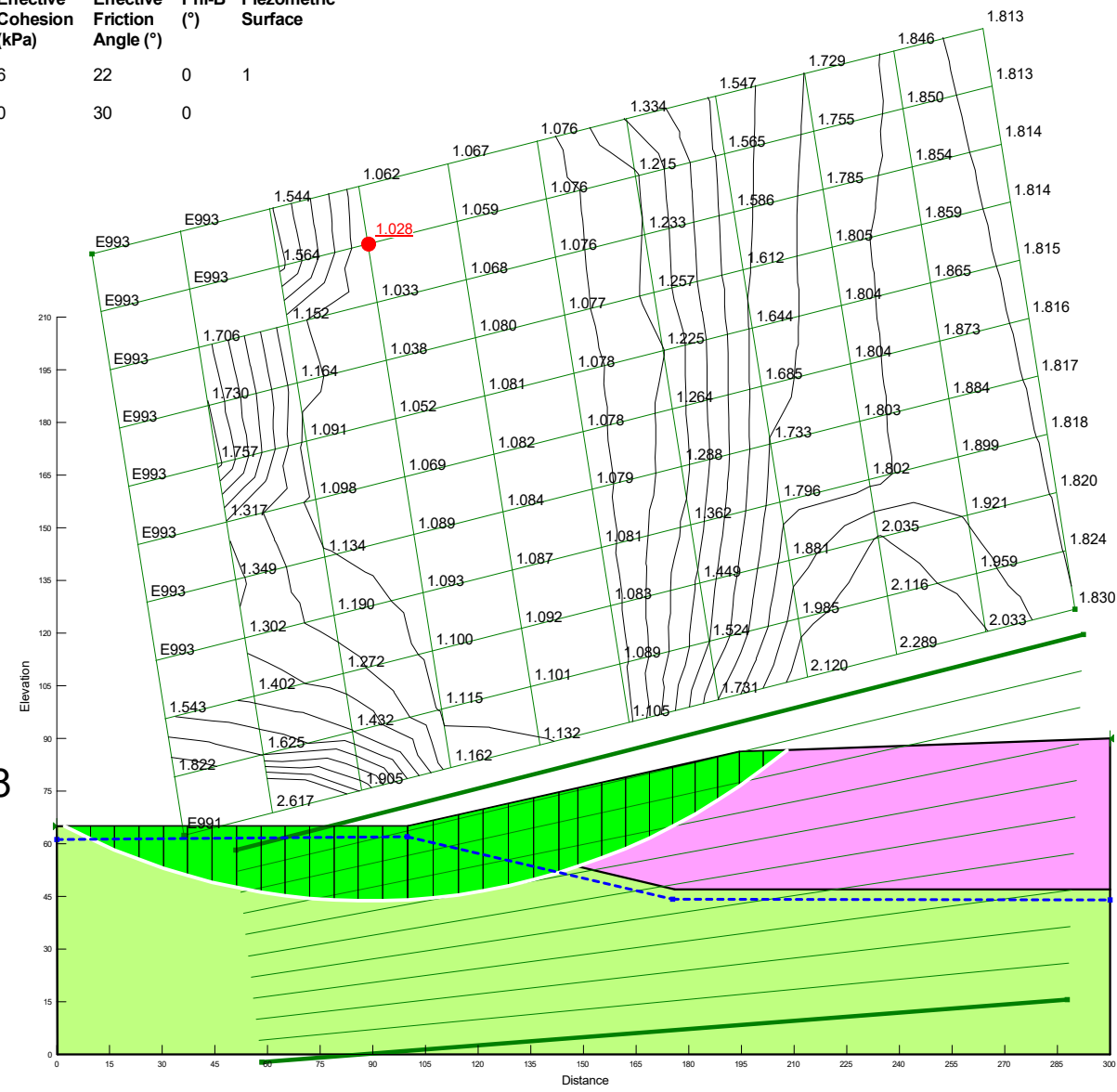
Analysed by: Nick Buckton

Comments:

Scale: 1:2,000 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	



Horz Seismic Coef.: 0.28

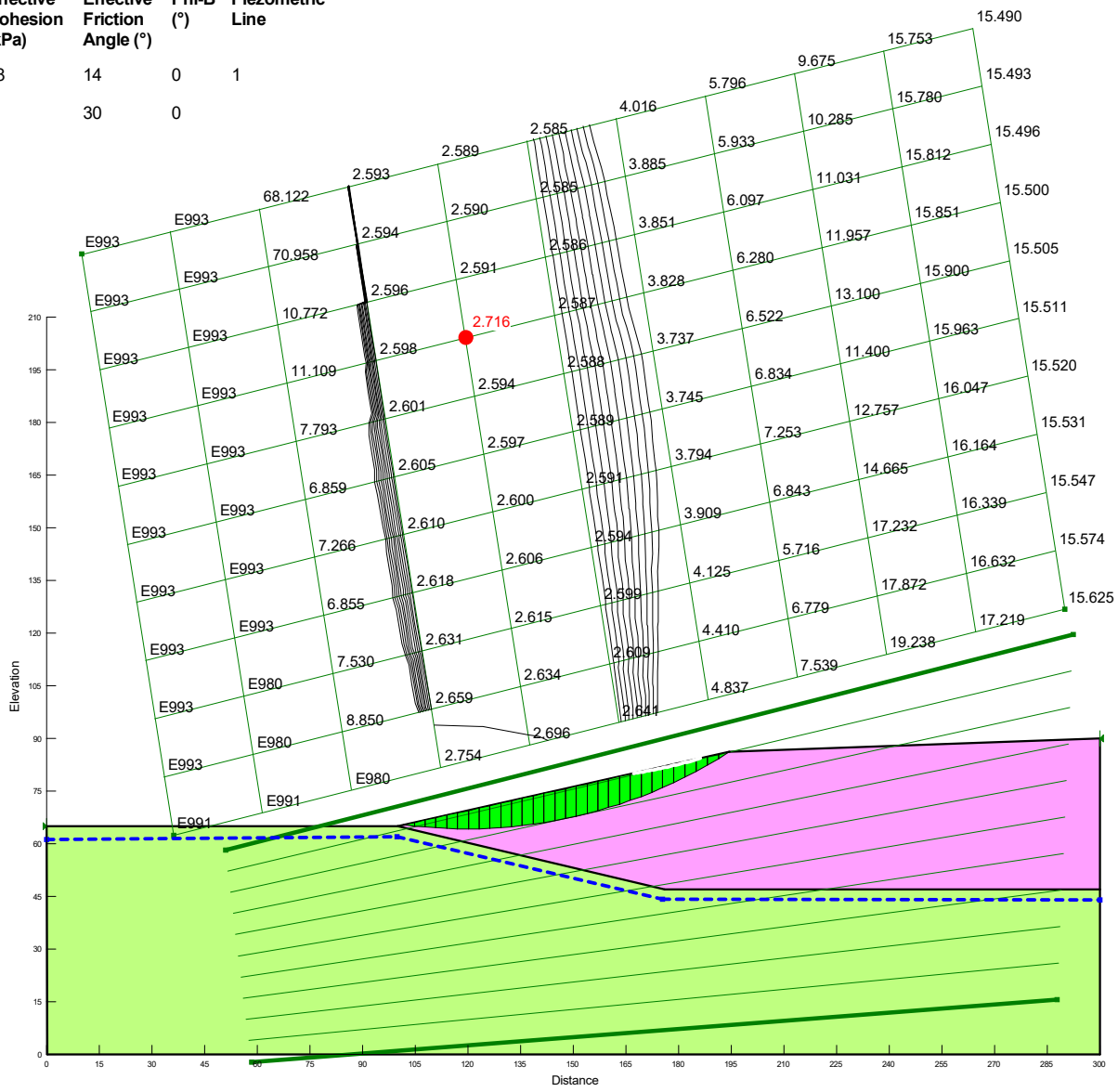


Title: Section N2-2025.gsz		Job Number: 1092369.2000
Analysis: 3. N2-C1 design GW-N7 -APS seismic MCE		Analysed by: Nick Buckton
Comments:	Scale: 1:2,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N5	Mohr-Coulomb	20	28	14	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

- 1. Name: N2-C1 design GW-N5 -APS
- 2. Method: Morgenstern-Price
- 3. Direction of movement: Right to Left
- 4. Slip Surface Option: Grid and Radius
- 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
- 6. Optimization: No
- 7. Tension Crack Option: (none)
- 8. F of S Calculation Option: Constant
- 9. Horz Seismic Load:

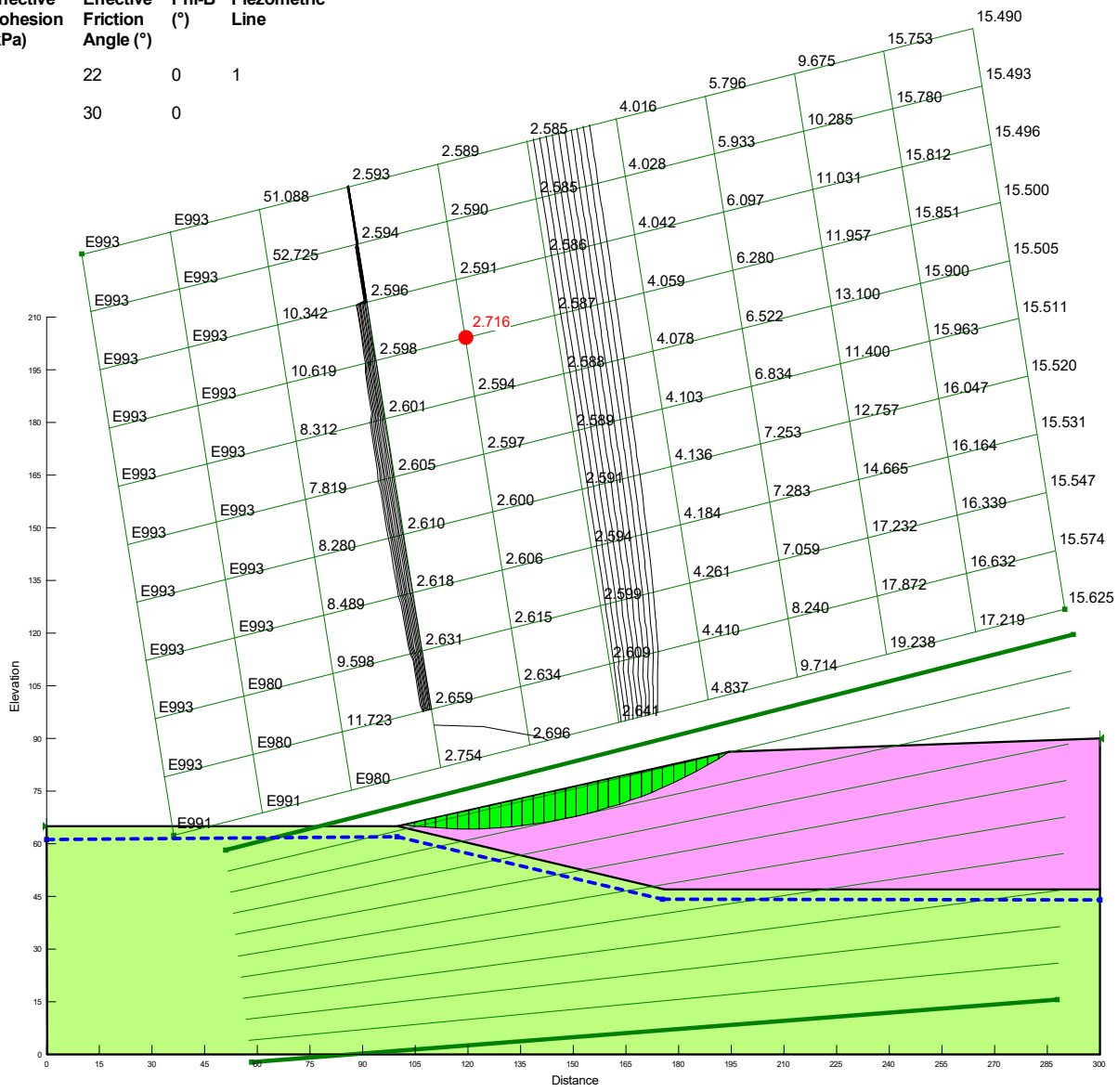


Title: Section N2-2025.gsz		Job Number: 1092369.2000
Analysis: N2-C1 design GW-N5 -APS		Analysed by: Nick Buckton
Comments:	Scale: 1:2,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

- 1. Name: N2-C1 design GW-N7 -APS
- 2. Method: Morgenstern-Price
- 3. Direction of movement: Right to Left
- 4. Slip Surface Option: Grid and Radius
- 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
- 6. Optimization: No
- 7. Tension Crack Option: (none)
- 8. F of S Calculation Option: Constant
- 9. Horz Seismic Load:

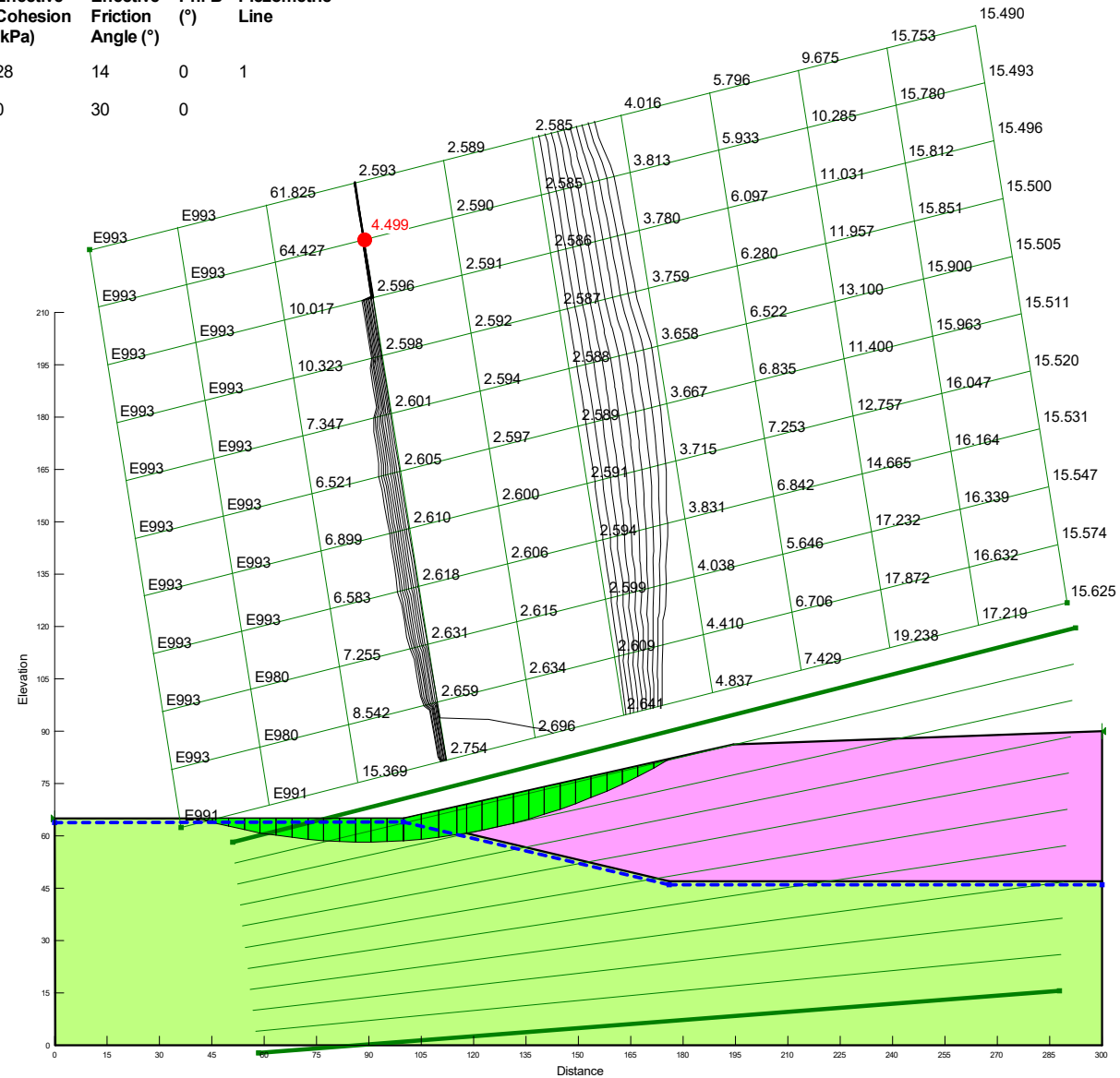


Title: Section N2-2025.gsz		Job Number: 1092369.2000
Analysis: N2-C1 design GW-N7 -APS		Analysed by: Nick Buckton
Comments:	Scale: 1:2,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N5	Mohr-Coulomb	20	28	14	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

1. Name: N2-C1 elevated GW-N5 -APS
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

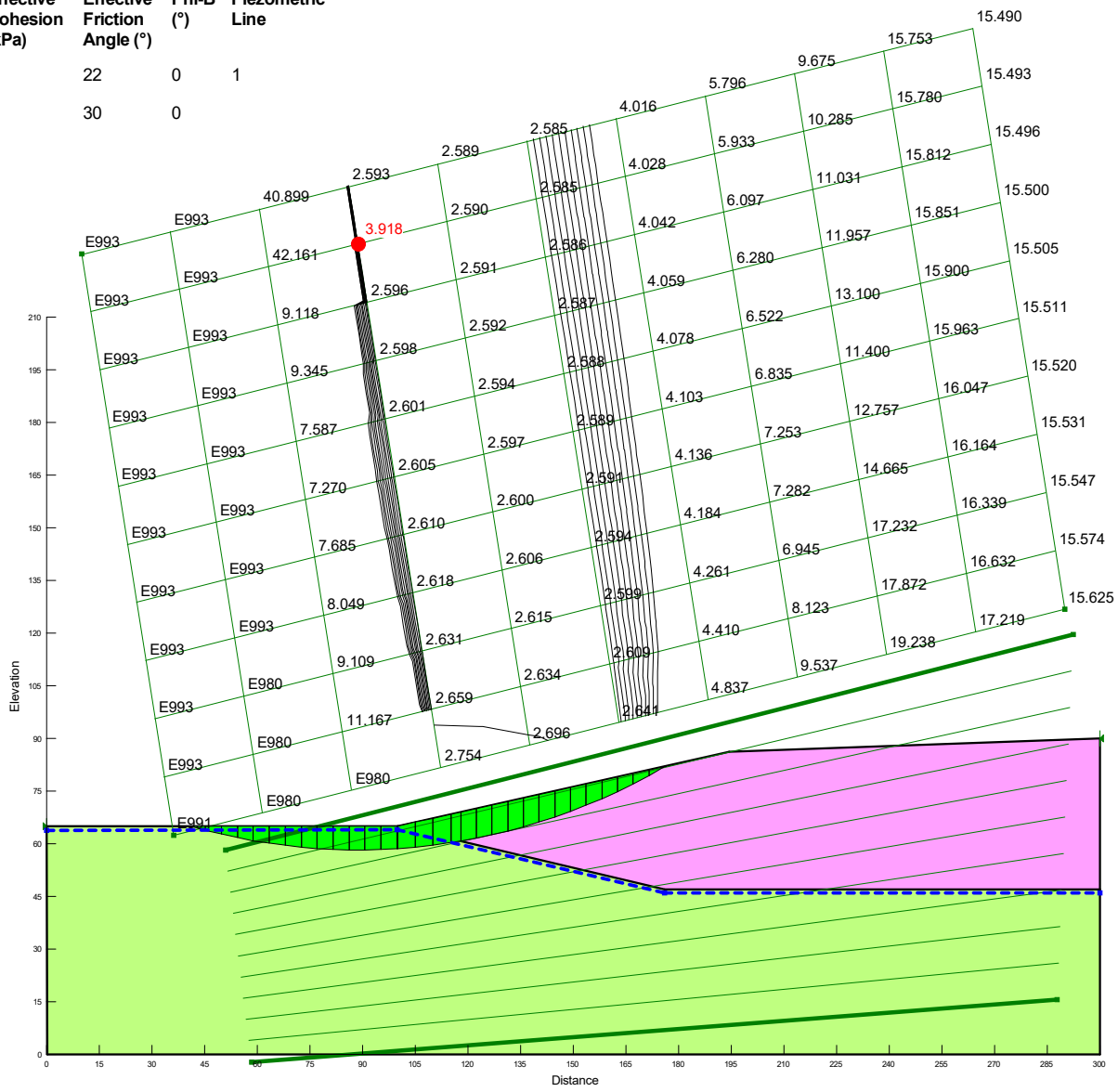


Title: Section N2-2025.gsz		Job Number: 1092369.2000
Analysis: N2-C1 elevated GW-N5 -APS		Analysed by: Nick Buckton
Comments:	Scale: 1:2,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Waste	Mohr-Coulomb	15	0	30	0	

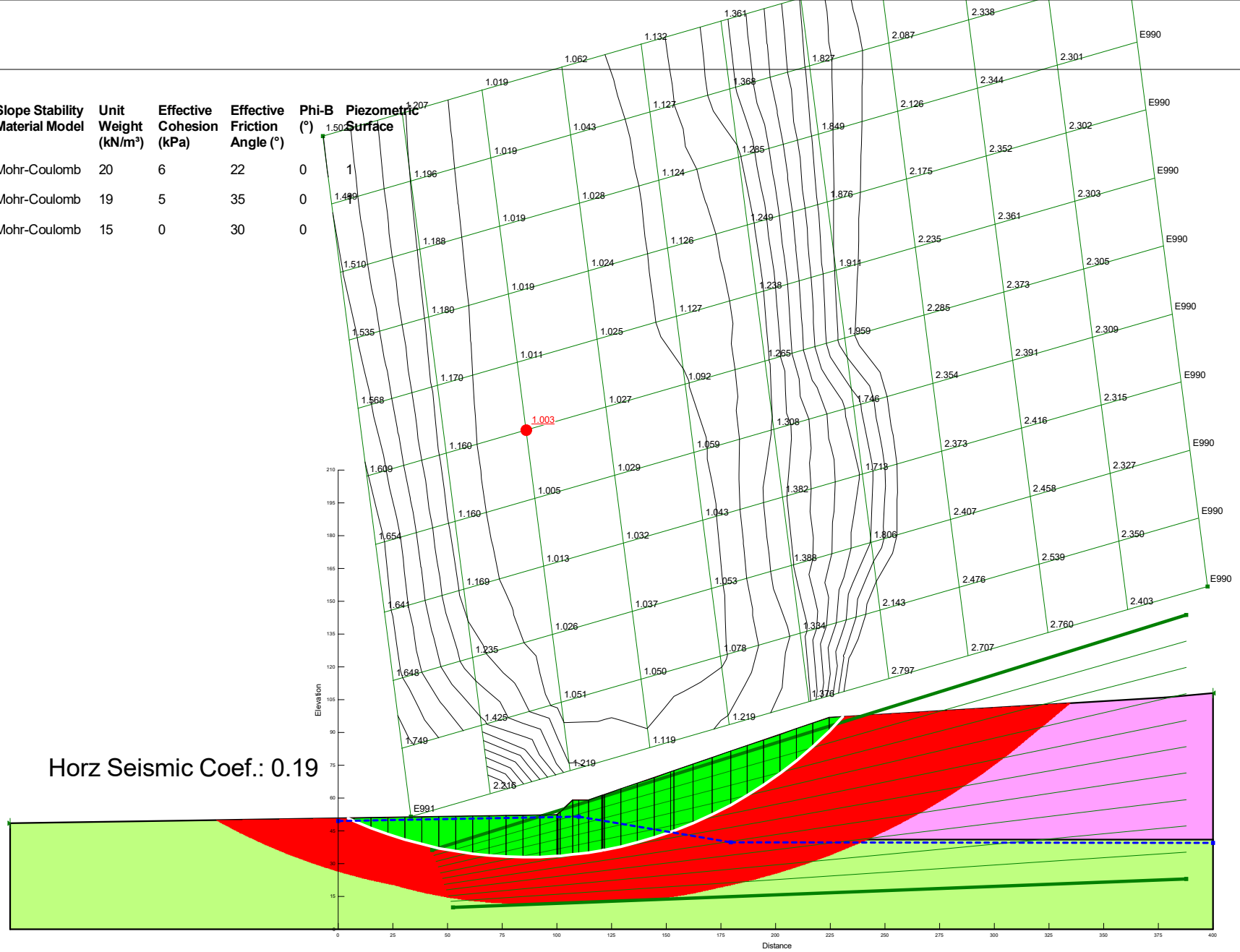
Analysis Notes:

- 1. Name: N2-C1 elevated GW-N5 -APS
- 2. Method: Morgenstern-Price
- 3. Direction of movement: Right to Left
- 4. Slip Surface Option: Grid and Radius
- 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
- 6. Optimization: No
- 7. Tension Crack Option: (none)
- 8. F of S Calculation Option: Constant
- 9. Horz Seismic Load:



Title: Section N2-2025.gsz		Job Number: 1092369.2000
Analysis: N2-C1 elevated GW-N5 -APS		Analysed by: Nick Buckton
Comments:	Scale: 1:2,000 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	
	Waste	Mohr-Coulomb	15	0	30	0	



Title: Section S1-2025.gsz

Job Number: 1092369.2000

Analysis: 2. S1-Elevated-APS -seismic DBE

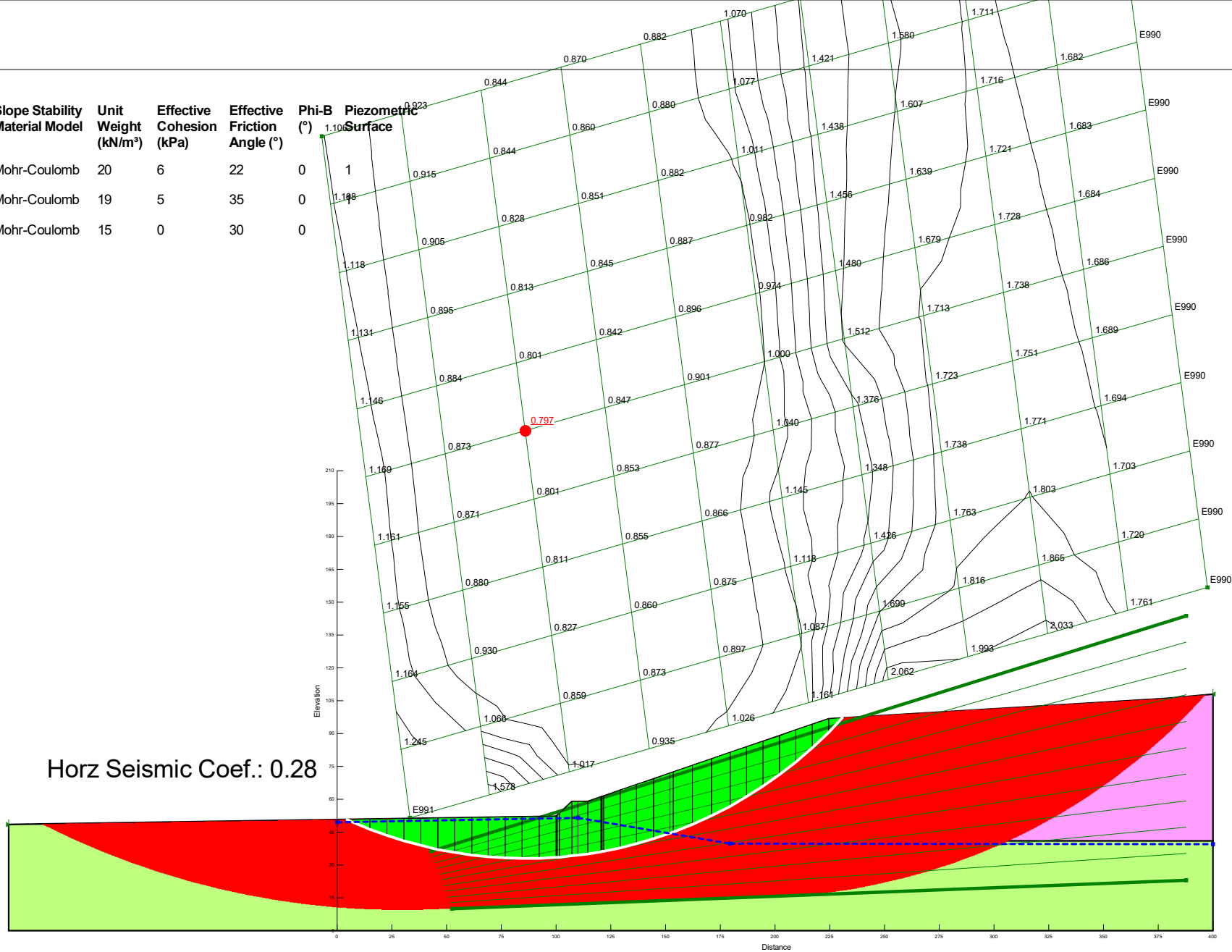
Analysed by: Nick Buckton

Comments:

Scale: 1:2,500 @ A4

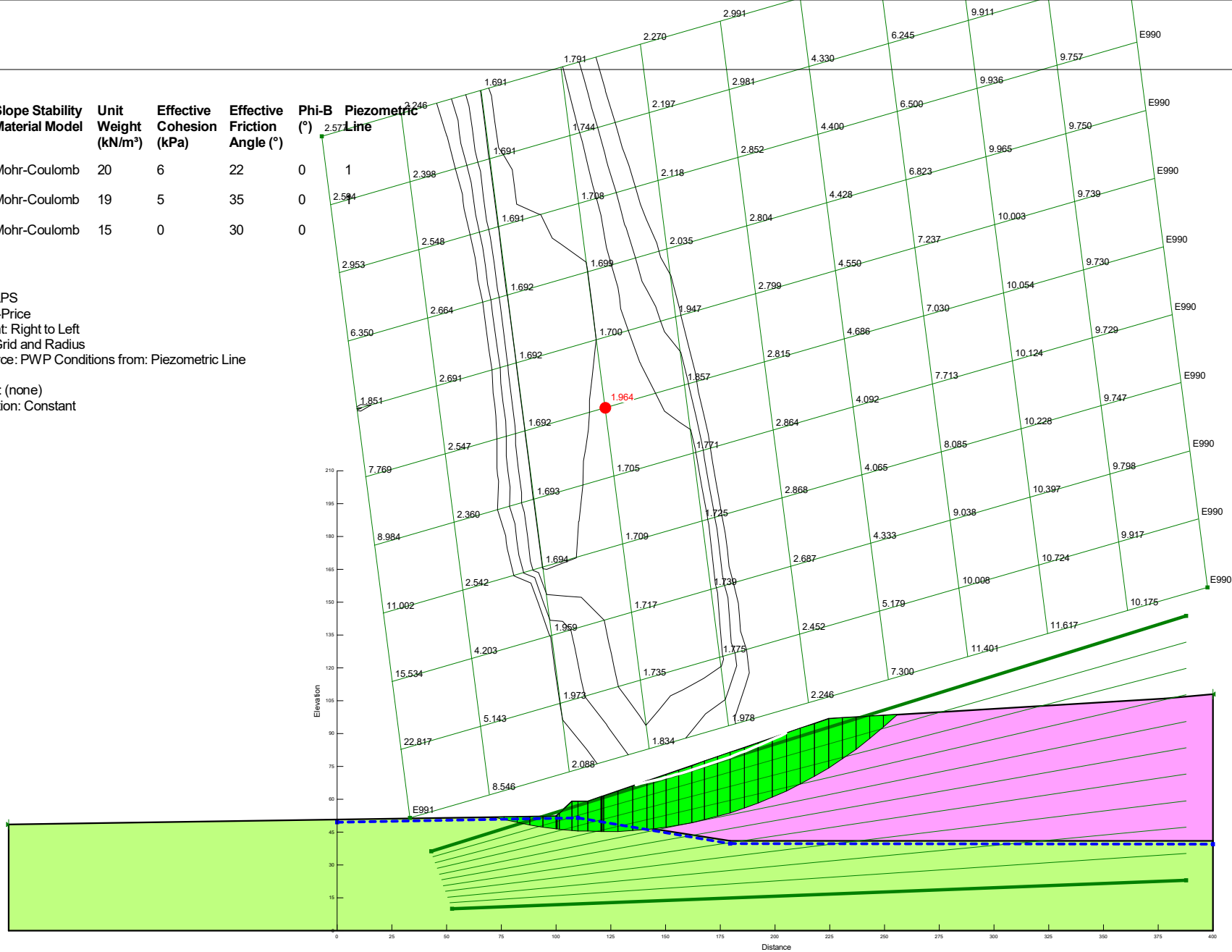
Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B	Piezometric Surface
	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	
	Waste	Mohr-Coulomb	15	0	30	0	



Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
	Type 1C Fill	Mohr-Coulomb	19	5	35	0	
	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:
 1. Name: S1-Elevated-APS
 2. Method: Morgenstern-Price
 3. Direction of movement: Right to Left
 4. Slip Surface Option: Grid and Radius
 5. PWP Conditions Source: PWP Conditions from: Piezometric Line
 6. Optimization: No
 7. Tension Crack Option: (none)
 8. F of S Calculation Option: Constant
 9. Horz Seismic Load:

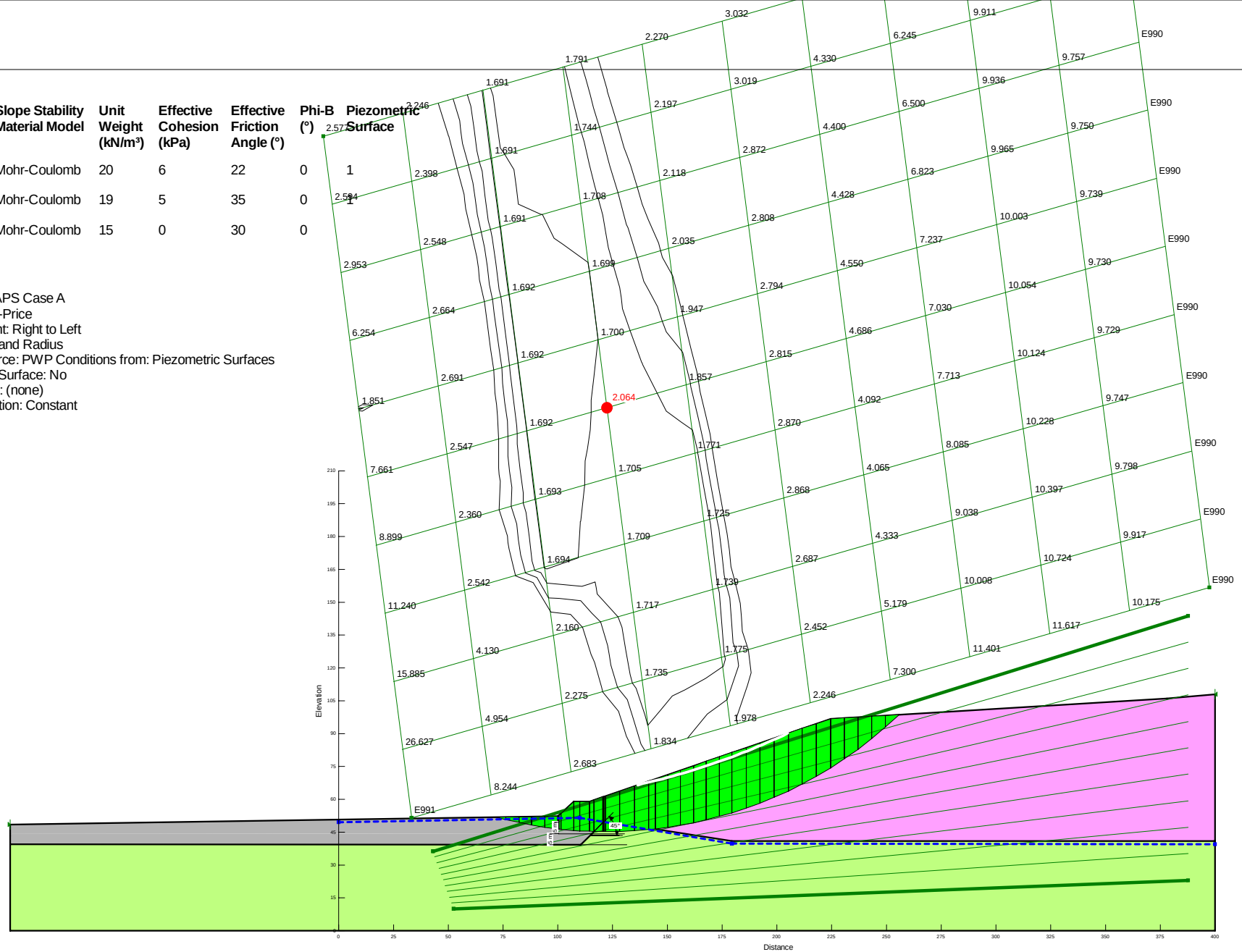


Title: Section S1-2025.gsz		Job Number: 1092369.2000
Analysis: S1-Elevated-APS		Analysed by: Nick Buckton
Comments:	Scale: 1:2,500 @ A4	Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
■	Mudstone N7	Mohr-Coulomb	20	6	22	0	1
■	Type 1C Fill	Mohr-Coulomb	19	5	35	0	2
■	Waste	Mohr-Coulomb	15	0	30	0	

Analysis Notes:

1. Name: S1-Elevated-APS Case A
2. Method: Morgenstern-Price
3. Direction of Movement: Right to Left
4. Search Method: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Surfaces
6. Optimize Critical Slip Surface: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section S1-2025.gsz

Analysis: S1-Elevated-APS Case A

Comments:

Job Number: 1092369.2000

Analysed by: Nick Buckton

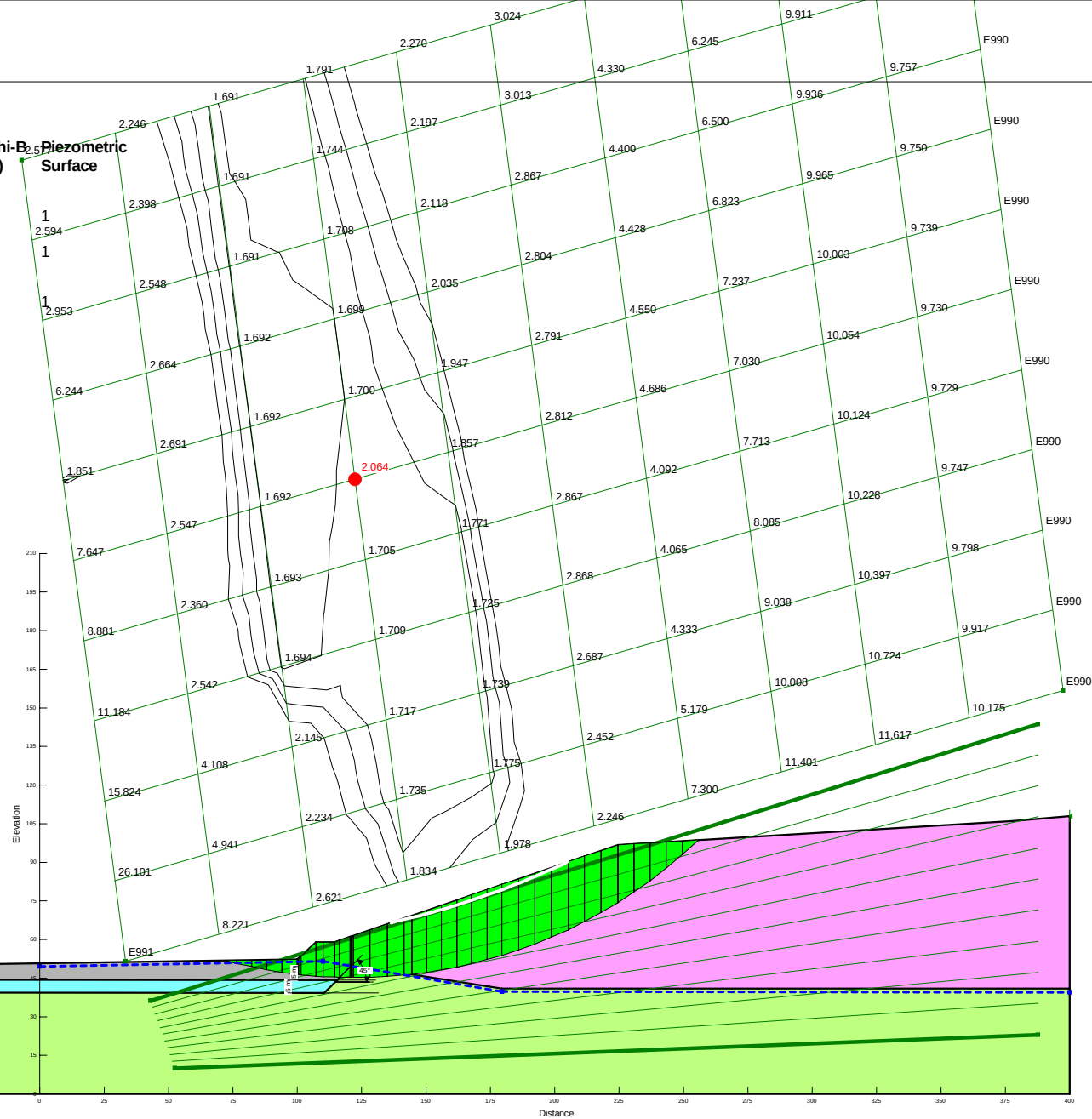
Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B
	Mudstone N7	Mohr-Coulomb	20	6	22	0
	Pleistocene Sediments	Mohr-Coulomb	19	7	32	0
	Type 1C Fill	Mohr-Coulomb	19	5	35	0
	Waste	Mohr-Coulomb	15	0	30	0

Analysis Notes:

1. Name: S1-Elevated-APS Case B
2. Method: Morgenstern-Price
3. Direction of Movement: Right to Left
4. Search Method: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Surfaces
6. Optimize Critical Slip Surface: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section S1-2025.gsz

Job Number: 1092369.2000

Analysis: S1-Elevated-APS Case B

Analysed by: Nick Buckton

Comments:

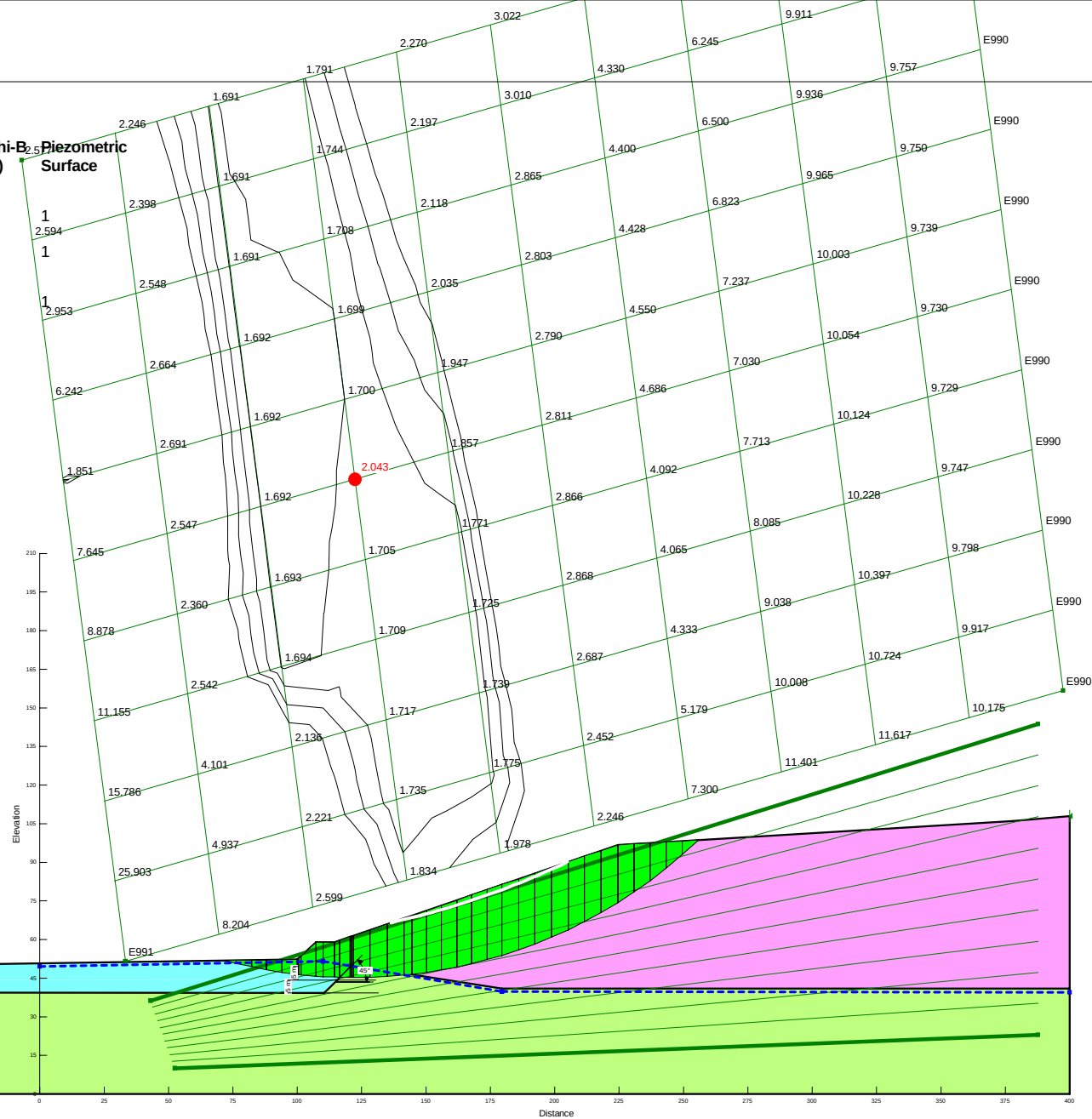
Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B
	Mudstone N7	Mohr-Coulomb	20	6	22	0
	Pleistocene Sediments	Mohr-Coulomb	19	7	32	0
	Type 1C Fill	Mohr-Coulomb	19	5	35	0
	Waste	Mohr-Coulomb	15	0	30	0

Analysis Notes:

1. Name: S1-Elevated-APS Case C
2. Method: Morgenstern-Price
3. Direction of Movement: Right to Left
4. Search Method: Grid and Radius
5. PWP Conditions Source: PWP Conditions from: Piezometric Surfaces
6. Optimize Critical Slip Surface: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:



Title: Section S1-2025.gsz

Analysis: S1-Elevated-APS Case C

Comments:

Job Number: 1092369.2000

Analysed by: Nick Buckton

Scale: 1:2,500 @ A4

Checked by: Andrew Stiles

Appendix H ‘Phase 10 Bund’ as-built plans

REDVALE LANDFILL

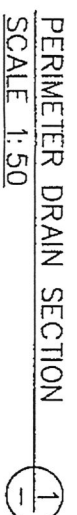
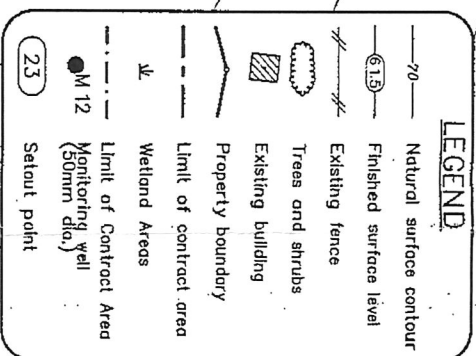
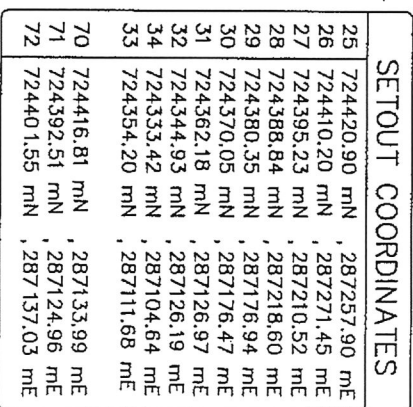
LIMEWORKS ACCESS ROAD, DAIRY FLAT, P.O. BOX 228, SILVERDALE, AUCKLAND, NEW ZEALAND. TELEPHONE 0-9-426 8210, FAX 0-9-426 8284.

PHASE 10 BUND TOE KEY

AS - BUILT

(MASTER)

BUILT - 04/05
5/3/05



NOTES:

1. Grade perimeter access road to follow bund footprint. Max 10% grade.
2. For typical Perimeter access road details refer $\frac{4}{27}$ $\frac{11}{11}$ $\frac{11}{11}$
3. Contract limit where known adjacent to boundary, is boundary
4. For loc key details refer to Drawing 12.14.3-24
5. Piezometers may be ~~required~~ under Stage 3 of the Project 10 bund. Locations to be ~~revised~~ by Tonkin & Taylor.
6. Note: Extent of ~~weak~~ ~~Saite~~ ~~ma~~ ~~ta~~ sandstone/mudstone to be recorded by ~~geotechnical~~ engineer or geologist.

APPROVED

This drawing is not to be used for construction purposes unless signed as approved

D	Additions to toe key		
C	Setout Point 71 Moved		
B	Construction Issue	K/D	25/11/11
A	For Peer Review	K/D	26/10/11
0	First Issue	K/D	26/10/10
	REVISION	CHECKED	
		Initial	Date

DRAWING CHECKED	INITIALS	DATE
	PH	:
APPROVED		

REFERENCE

Waste Management & Recycling



TONKIN & TAYLOR
CONSULTING ENGINEERS

ERS

■ AUCKLAND 19 MORGAN ST NEWMARKET

D WELLINGTON 109 FEATHERSTON ST
 D WHANGAREI 7 HUNT ST

FILE

REDVALE
LANDFILL

PHASE 10 BUND

TOE KEY/ AS-BUILT

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ORIGINAL SCALES

1:500

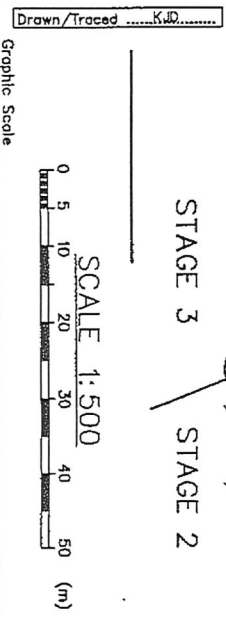
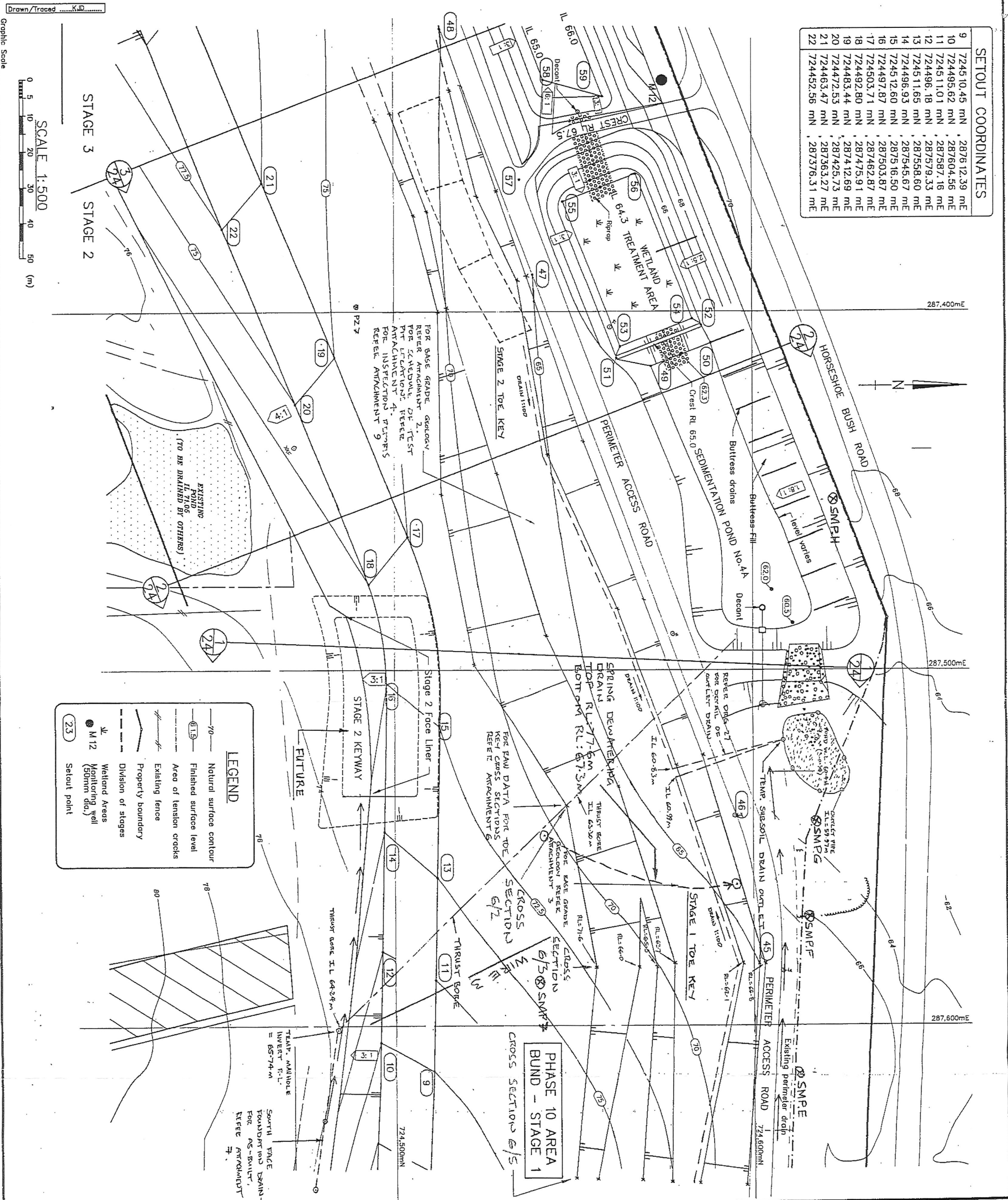


DRAWING No.

12143-10

DATE
OCT 93

SETOUT COORDINATES	
9	724510.45 MN , 287612.39 ME
10	724495.62 MN , 287604.56 ME
11	724511.01 MN , 287587.16 ME
12	724496.18 MN , 287579.33 ME
13	724511.65 MN , 287558.60 ME
14	724496.93 MN , 287545.67 ME
15	724512.60 MN , 287516.50 ME
16	724497.87 MN , 287503.87 ME
17	724503.71 MN , 287462.87 ME
18	724492.80 MN , 287475.91 ME
19	724483.44 MN , 287412.69 ME
20	724472.53 MN , 287425.73 ME
21	724463.47 MN , 287363.27 ME
22	724452.56 MN , 287376.31 ME



LEGEND	
—70—	Natural surface contour
—61.5—	Finished surface level
---	Area of tension cracks
---	Existing fence
---	Property boundary
---	Division of stages
W	Wetland Areas
M 12	Monitoring well (50mm dia.)
23	Setout point

NOTES:

- Grade perimeter access road to follow bund footprint. Max 10% grade.
- For typical perimeter access road details refer 27
- Contract limit where shown adjacent to boundary, is boundary
- For toe key details refer to Drawing 12143-24
- Piezometers may be required under Stage 3 of the bund. Locations to be advised by Tonkin & Taylor.
- Stage 2 toe key to extend to actual limestone pit.
- See Drawing 12143-13 for remainder of setout points.
- For sedimentation pond riprap and decant details refer to Drawing 12143-33.

REVISION

NO	DESCRIPTION	DATE
1	First Issue	K.D. 28/9/93

APPROVED

This drawing is not to be used for construction purposes unless signed as approved

REFERENCE

Waste Management Ltd

Tonkin & Taylor
 CONSULTING ENGINEERS
 19 MORGAN ST NEMARKEET
 DUNEDIN 901 MOUNTAIN ST
 DUNEDIN 901 HUNT ST

REDVALE LANDFILL
PHASE 10 BUND
TOE KEY AS-BUILT

Copyright on this drawing is reserved
 ORIGINAL SCALES
 1:500
 000

DRAWING No. 12143-14
 DATE OCT 1993

NOTES:
1. South face foundation drain to be installed by WMNZ.

B	Construction Issue	KJD	23/11/93
A	For Peer Review	KJD	29/10/93
D	First Issue	KJD	25/10/93
REVISION		CHECKED	
		Initial Date	
Drawing Checked		KJD	23/11/93
APPROVED		23/11/93	
This drawing is not to be used for construction purposes unless signed as approved			
REFERENCE			

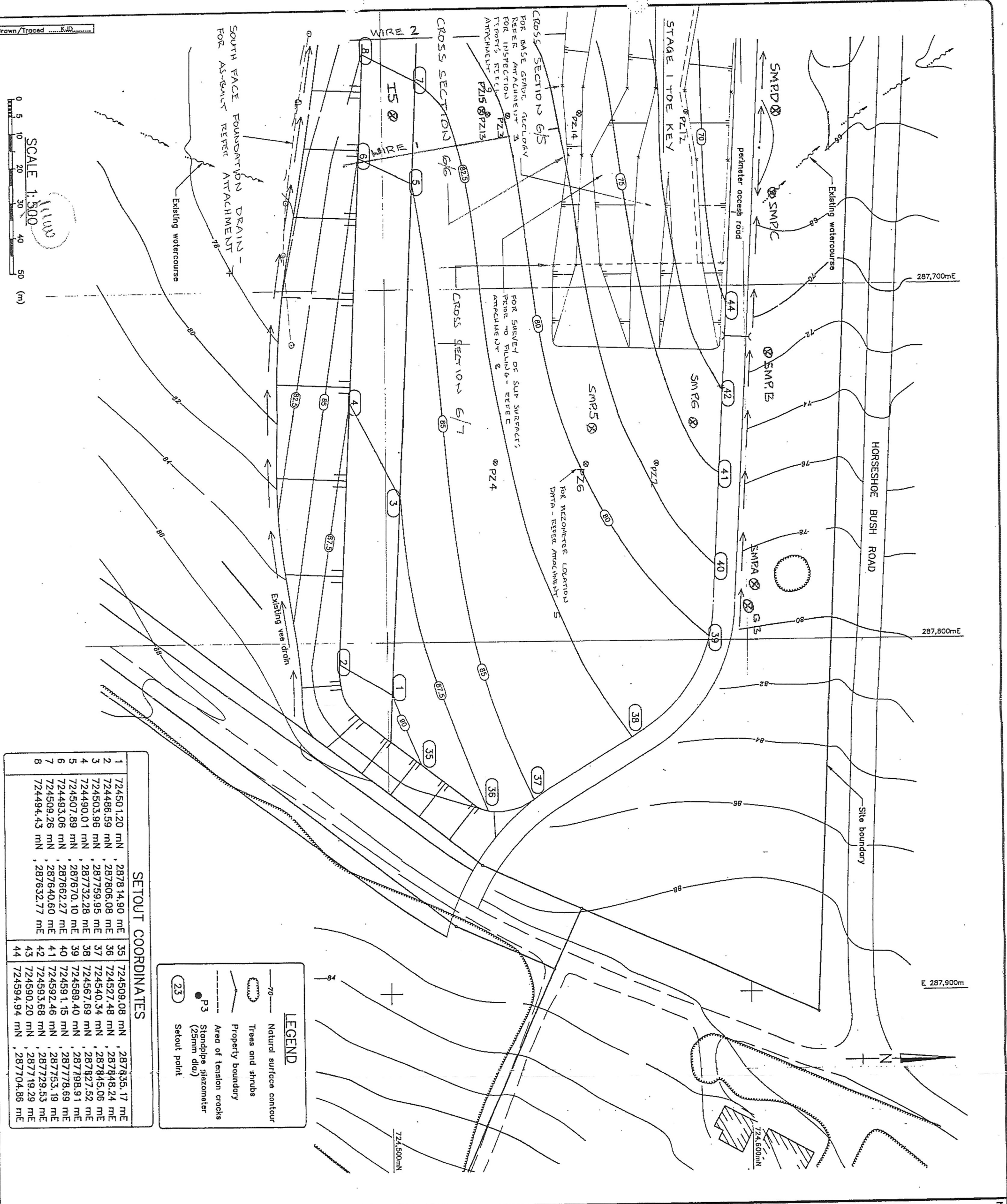
Waste Management Ltd

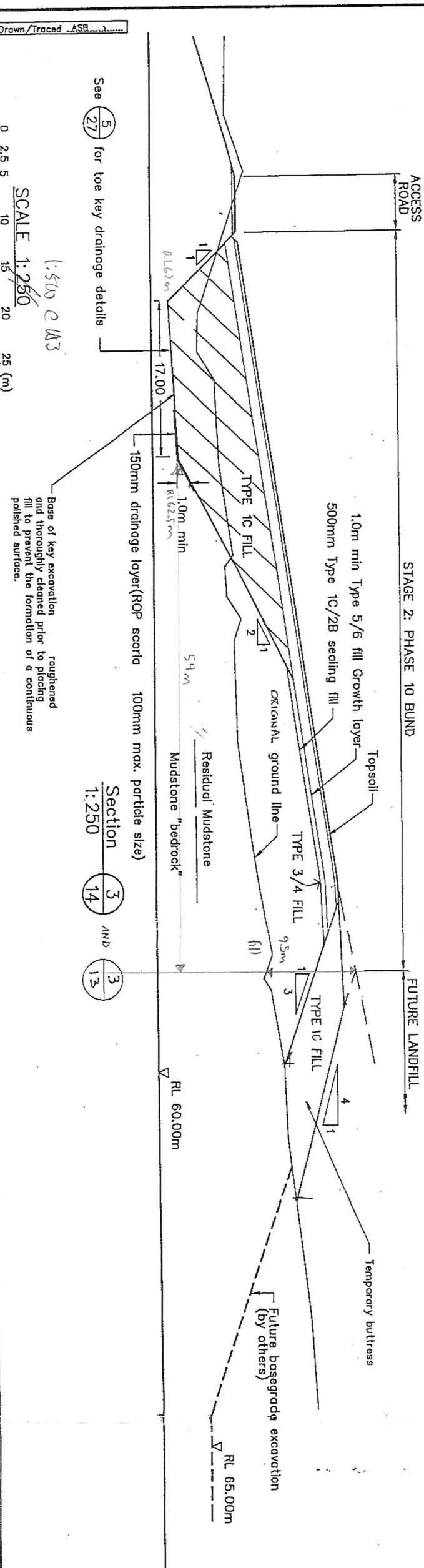
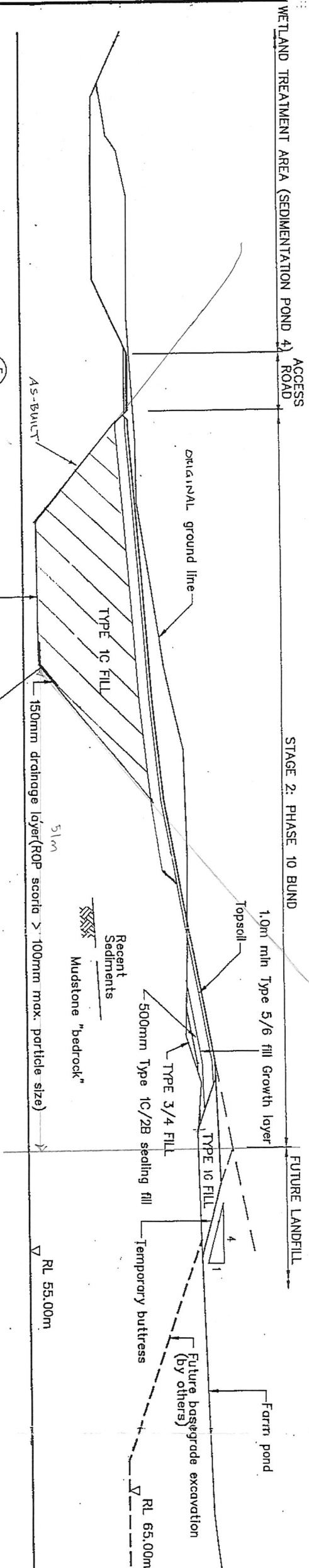
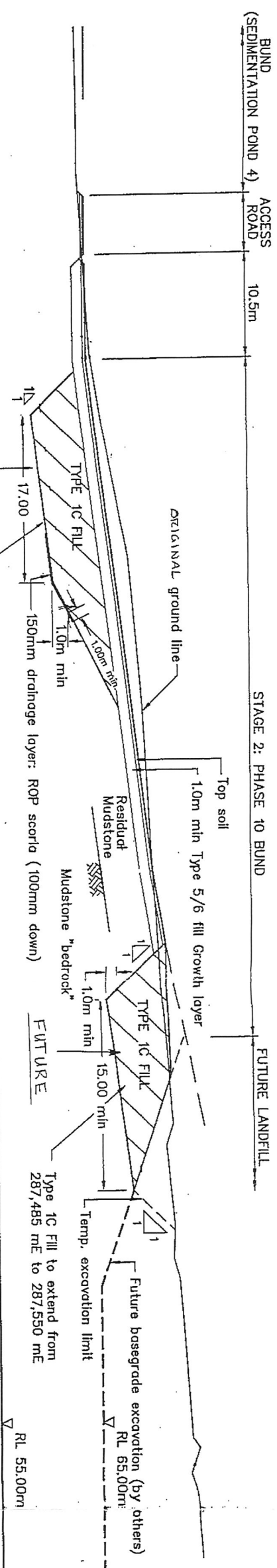
TNT

TONKIN & TAYLOR
CONSULTING ENGINEERS
■ AUCKLAND 19 MORGAN ST NEWMARKET
□ WELLINGTON 101 MOLESWORTH ST
□ HANGARU 7 HUNT ST

TITLE
REDVALE
LANDFILL
PHASE 10 BUND
TOE KEY AS-BUILT

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ORIGINAL SCALES
1:500
DRAWING No. 12 143-15
DATE OCT 1993
Revision 01/02





- NOTES:
1. See drawing 12 143-26 for typical cross sections and notes.
 2. Position of north for key is based on an inferred, myastigone surface on current subsurface information. This position is subject to confirmation after inspection by Tonkin & Toyor.

	B	Construction Issue	K 30	7/10/93
	A	For Peer Review	K.D	10/11/93
	O	First Issue	K.D	26/12/93
	REVISION		CHECKED	
			Initial	Date
Drawing Checked			K 30	31/1/94
APPROVED				
<i>[Signature]</i> 23/1/93				
This drawing is not to be used for construction purposes unless signed as approved				
REFERENCE				



M Waste Management



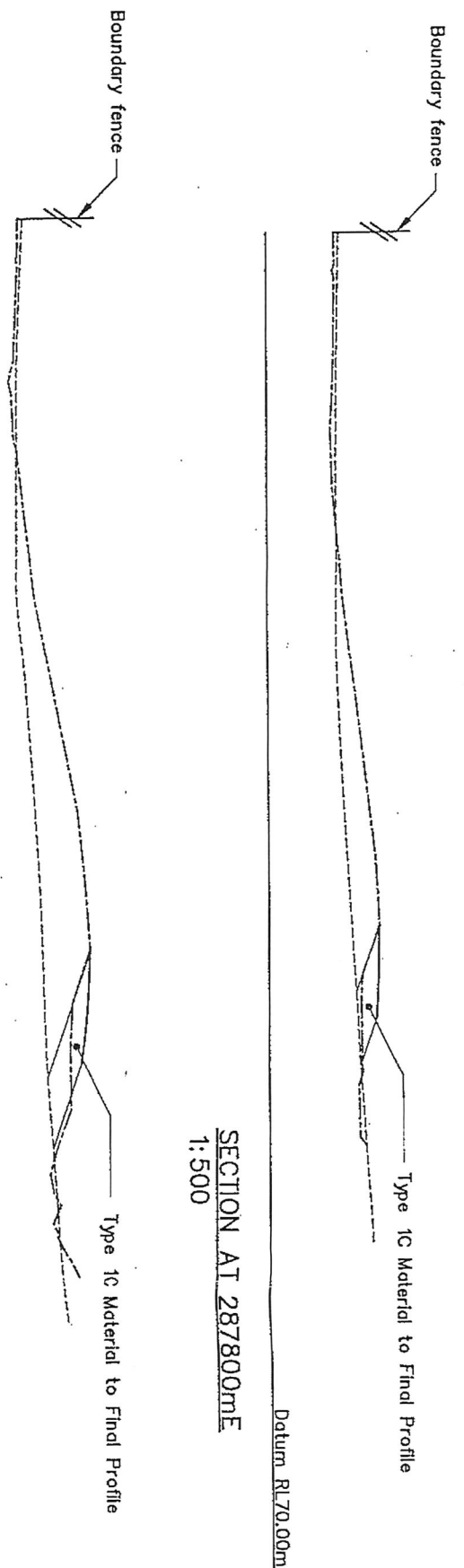
TONKIN & TAYLOR
CONSULTING ENGINEERS

■ AUCKLAND 19 MORGAN ST NEWMARKET
□ WELLINGTON 101 MOLESWORTH ST
□ WHANGAREI 7 HUNT ST

TITLE
 REDVALE
 LANDFILL
 PHASE 2 DEVELOPMENT
 Phase 10 Bund
 THE KEY AS-EMILT

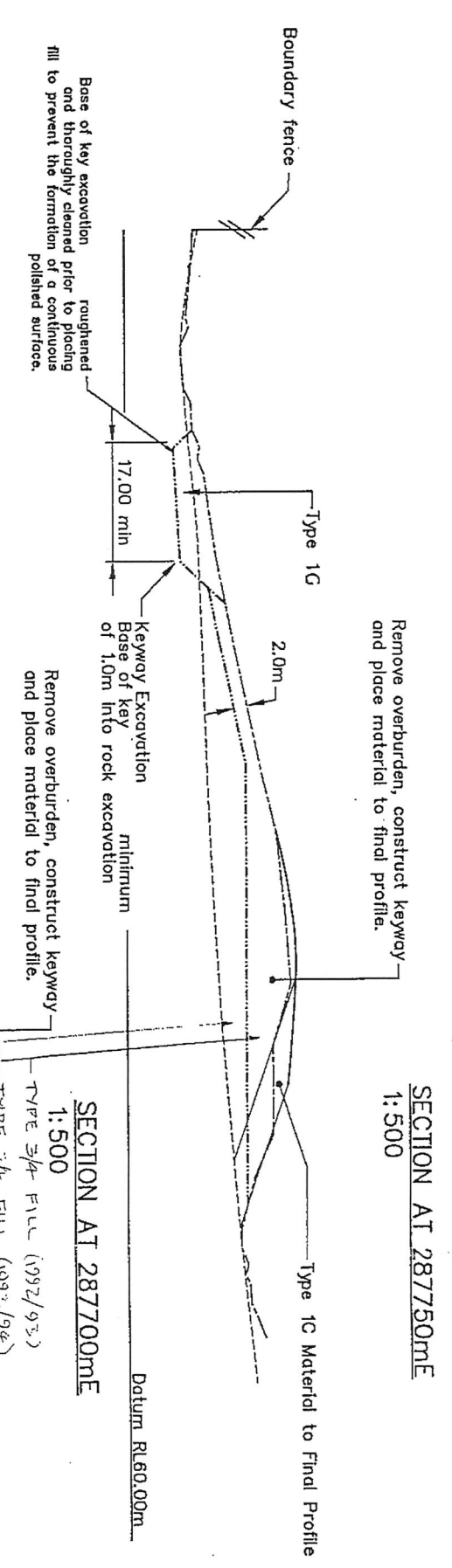
Copyright on this drawing is reserved
ORIGINAL SCALES
1:250

DRAWING No.	DATE
12 143-24	OCT. 1993
Revision	
01 A B C	



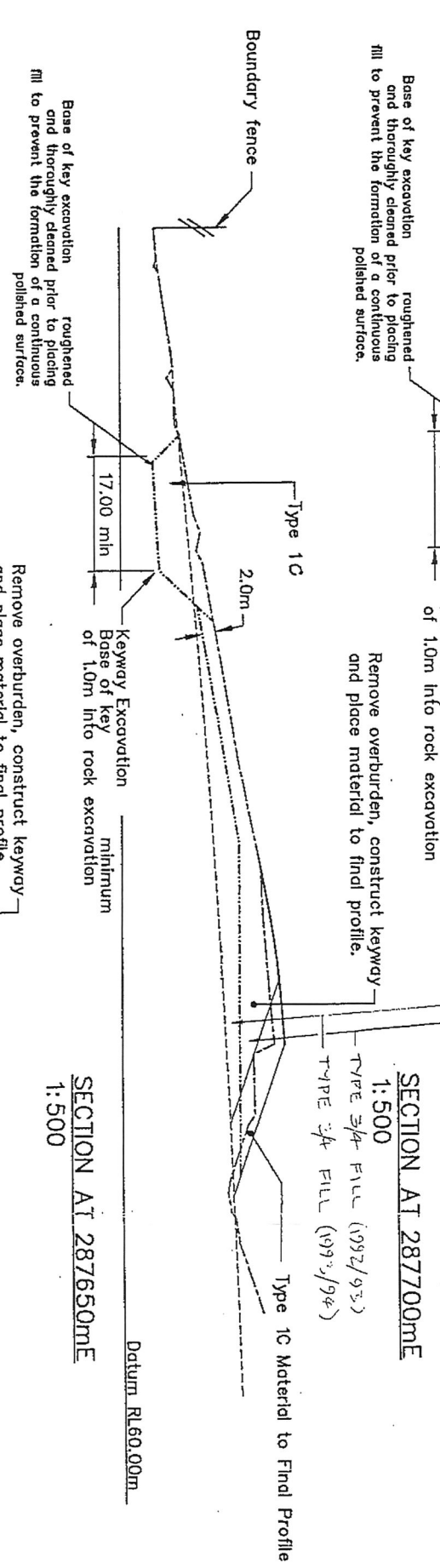
SECTION AT 287800mE
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Datum RL 70.00m



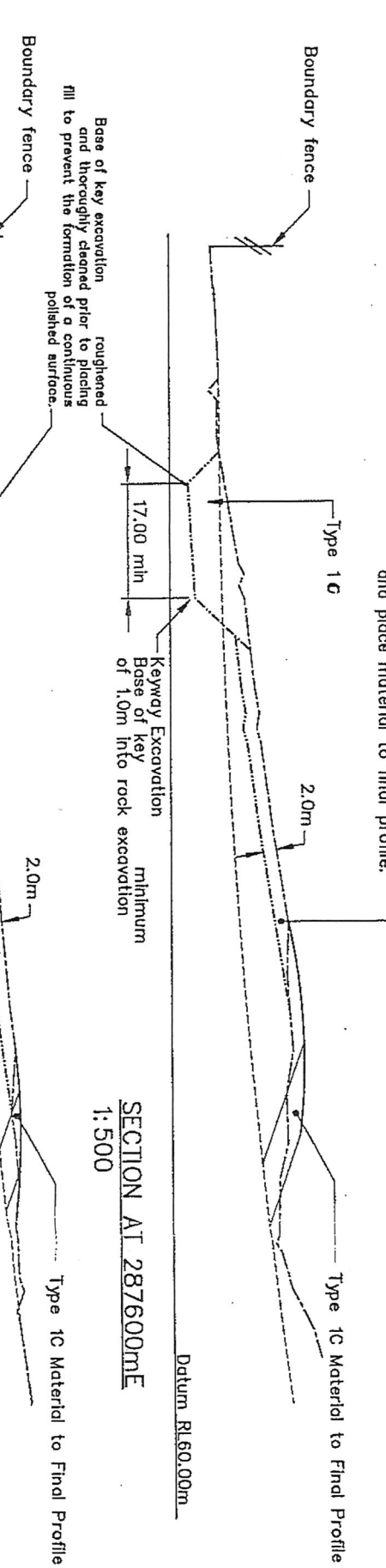
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1:500

Datum RL 65.00m



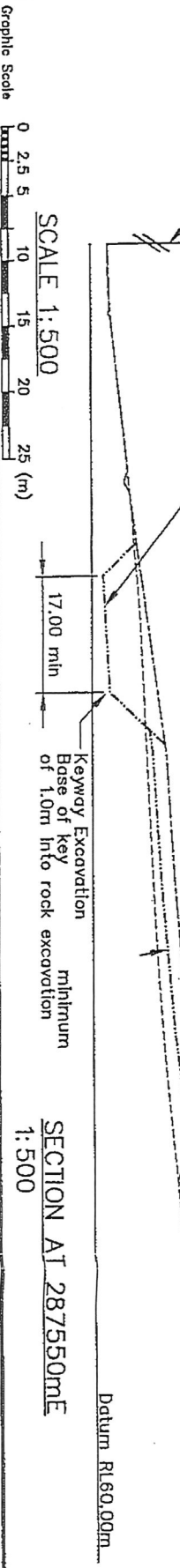
SECTION AT 287700mE
1:500

Datum RL 60.00m



SECTION AT 287650mE
1:500

Datum RL 60.00m



SECTION AT 287550mE
1:500

Datum RL 60.00m

LEGEND

Original Ground (1992)

Profile as at 6/93

Excavated Profile

Final Profile

- NOTES:**
- See drawing 12 143-26 for typical cross sections and notes.
 - Sections show remaining work to complete Type 1C fill zone and reconstruction details for slip dred.
 - See (27) for toe key drainage details.
 - Position of north key is based on an inferred mudstone surface and current subsurface information. This position is subject to confirmation after inspection by Tonkin & Taylor.

REVISION		APPROVED	23/11/93
B	Construction Issue	KJD	23/11/93
A	For Peer Review	KJD	28/9/93
0	First Issue	KJD	28/9/93
CHECKED		Initial Date	23/11/93
Drawing Checked		Initial Date	23/11/93

Waste Management

TONKIN & TAYLOR
CONSULTING ENGINEERS
AUCKLAND 19 MORGAN ST. NEWMARKET
DUNEDIN 101 KILGORE ST.
D WAIKARE 7 HUNT ST.

TITLE

REDVALE LANDFILL

PHASE 2 DEVELOPMENT

Phase 10 Bund

TOE KEY AS-BUILT

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ORIGINAL SCALES

1:500

DRAWING No.

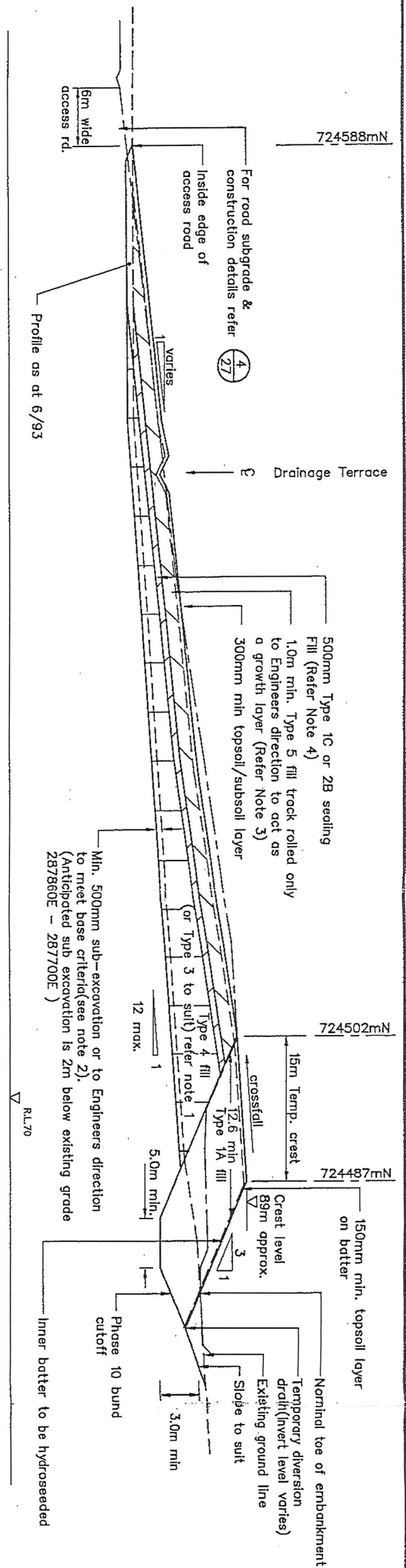
12 143-25

DATE

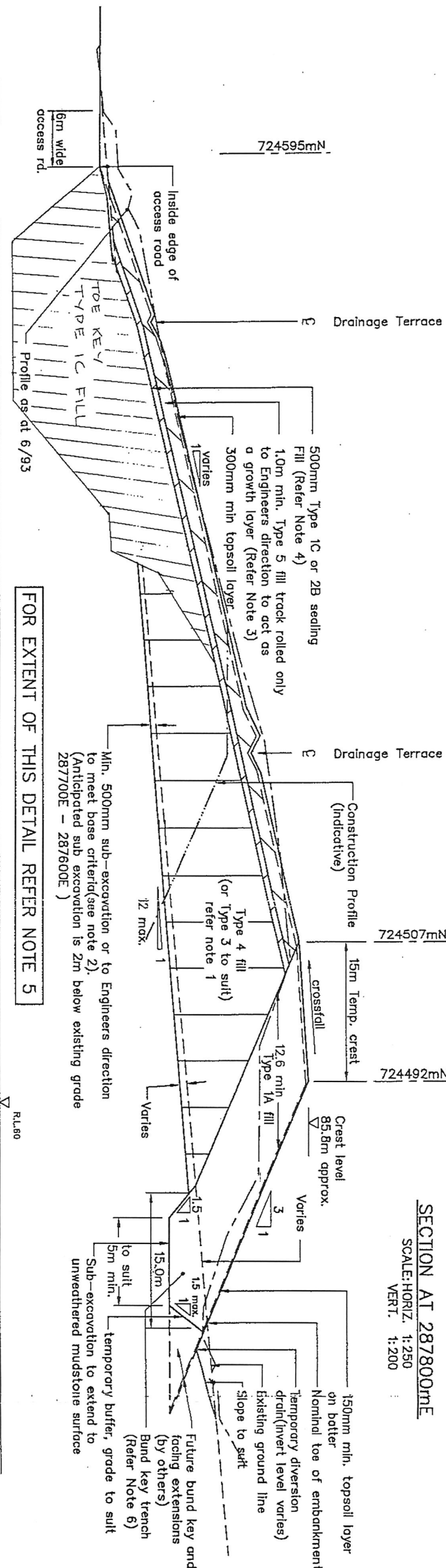
OCT. 1993

Revision

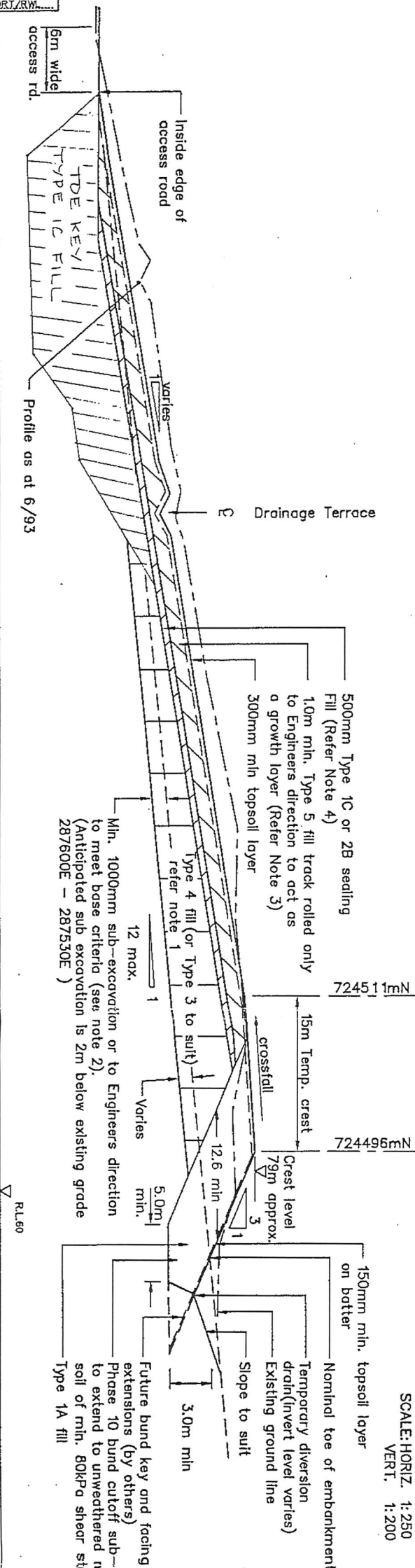
01



SECTION AT 287800ME
SCALE: HORIZ. 1:250
VERT. 1:200



SECTION AT 287700ME
SCALE: HORIZ. 1:250
VERT. 1:200



SECTION AT 287600ME
SCALE: HORIZ. 1:250
VERT. 1:200

- NOTES:**
- Depending on material availability and the relative proportion of Types 3 & 4 materials, Type 3 material shall be mixed with and/or replace Type 4 material in the bund shoulder zone.
 - Basegrade sub-excavation extent to be determined by the Engineer to meet required.
 - Implied by water right conditions, Growth zone of Phase 10/bund will utilise Type 5, unsuitable available from excavation of Phase 2 as directed by the Engineer/Track rolled to form a growth layer beneath the topsoil zone.
 - The Type 1C or 2B seedling fill to the Phase 10 bund shall be of limestone origin (mortar). Mudstone is not acceptable for this layer.
 - Type 1A fill key detail applies from 287600ME to 287800ME. Refer to typical sections shown for 287600ME for 287800ME over 20m length.

B	Construction Issue	K27	23/11/93
A	For Peer Review	K20	24/11/93
0	First Issue	K20	24/11/93
REVISION			
Drawing Checked		Initial Date	
APPROVED		Initial Date	
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CONSULTING ENGINEERS
19 MORRIS ST. NEWMARKET
DUNEDIN 9011 MOLESWORTH ST
DUNEDIN 9011 HUNT ST

TITLE
REDVALE
LANDFILL

PHASE 2 DEVELOPMENT

Phase 10 Bund
TOE KEY AS-BUILT

AS SHOWN

000

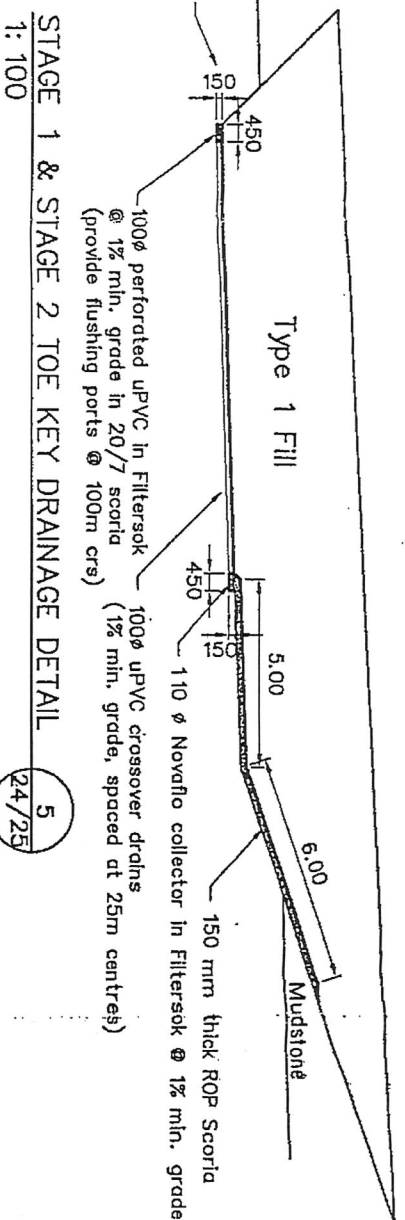
DRAWING No. 12143-26
DATE OCT 93

Revision 1/1

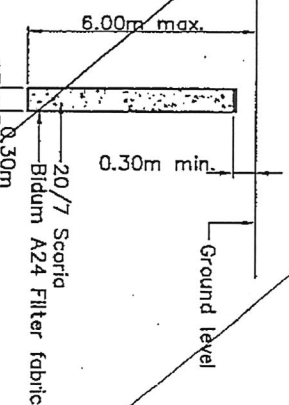
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ORIGINAL SCALES

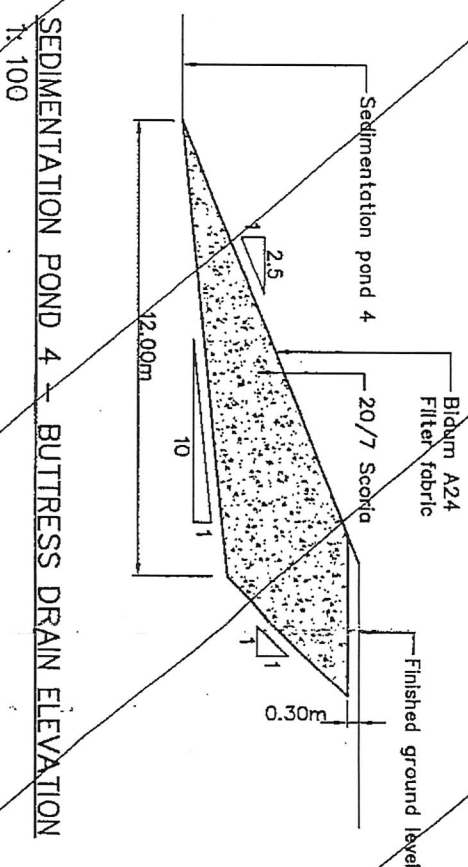
Drawn/Traced DRT/RW



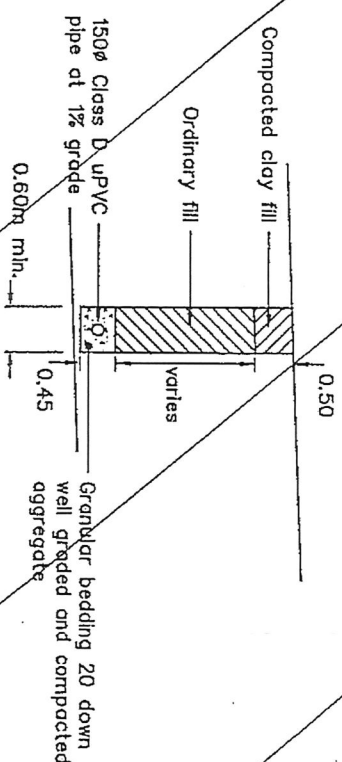
STAGE 1 & STAGE 2 TOE KEY DRAINAGE DETAIL



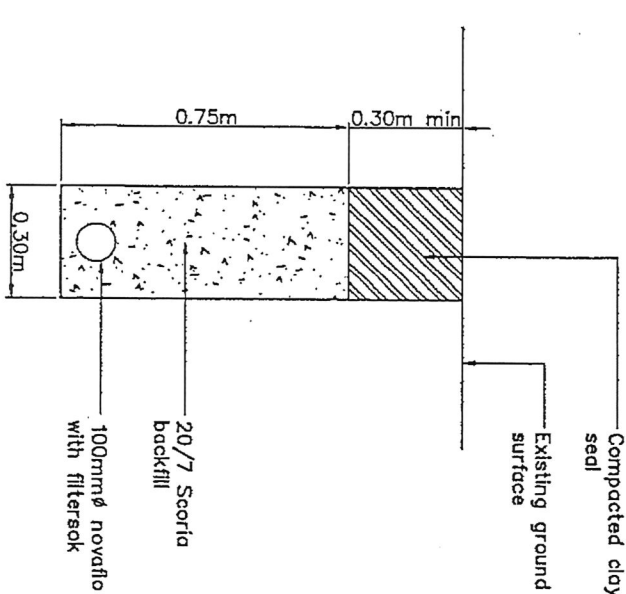
~~SEDIMENTATION POND 4 -- BUTRESS DRAIN SECTION~~
~~1:50~~



~~SEDIMENTATION POND 4 - BUTRESS DRAIN ELEVATION~~



FOUNDATION DRAIN OUTLET SECTION 2
SCALE 1:50 14



OUTLET DRAIN - STAGE 1 KEYWAY PHASE 10 BUND 3
1:10 14

1. Filter fabric on buttress drains to the fully lapped on exposed face.

B	Construction Issue	K70	27-2
A	For Peer Review	K10	27-2
0	First Issue	K10	27-2
	REVISION	CHECK	
		Initial	27-2
Drawing Checked		K70	27-2

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M Waste
Management



TONKIN & TAYLOR
CONSULTING ENGINEERS

■ AUCKLAND 19 MORGAN ST NEWMARKET
□ WELLINGTON 101 MOLESWORTH ST
□ WHANGAREI 7 HUNT ST

TITLE

REDVALE
LANDFILL
PHASE 10 BUND

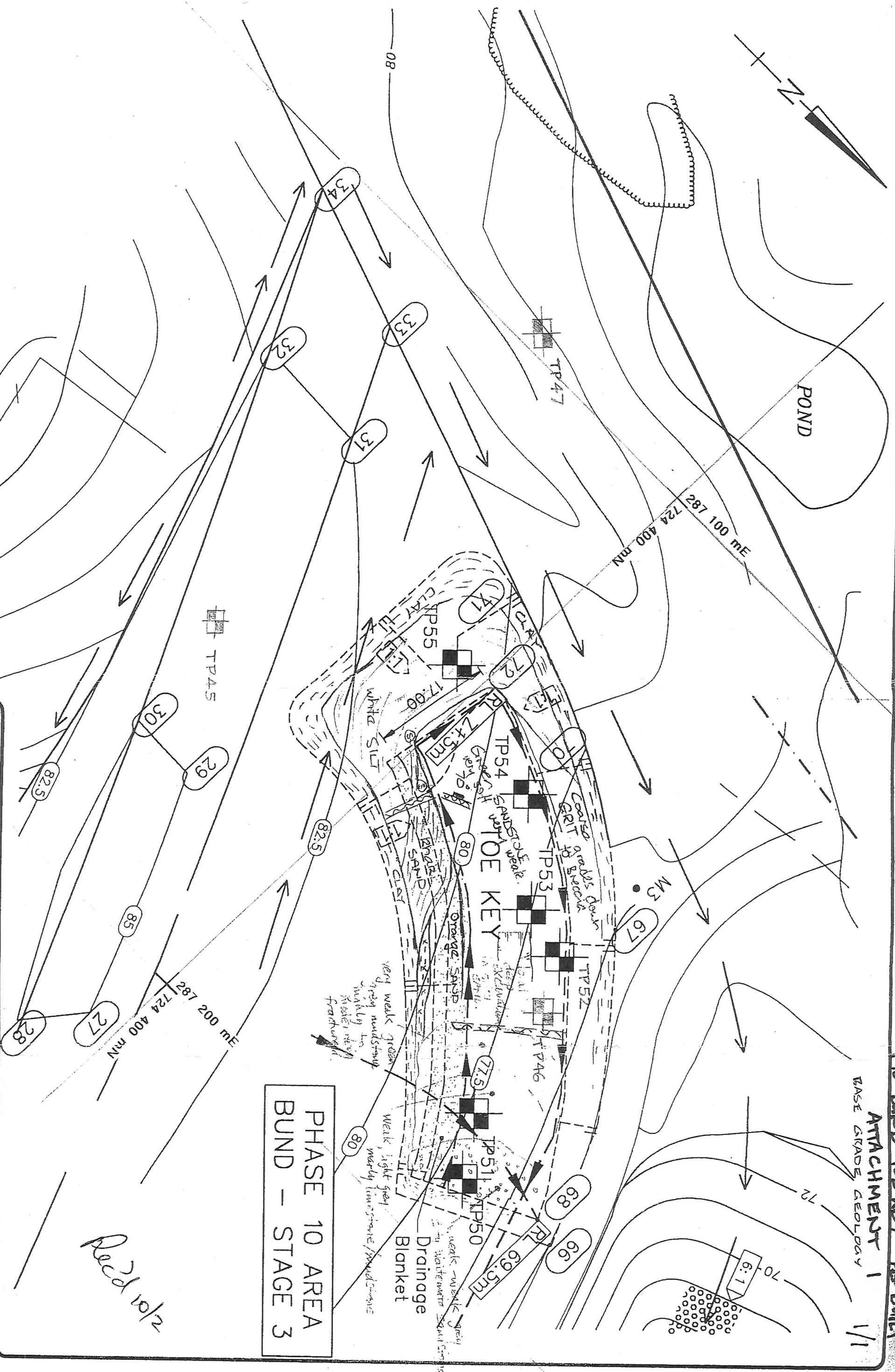
TOE KEY AS-BUILT

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ORIGINAL SCALES

AS SHOWN

12143-27 OCT. 1993

[illegible]



PHASE 10 AREA
BUND - STAGE 3

STAGE 3 KEY GEOLOGY
PHASE 10 BUND
REDVALE LANDFILL

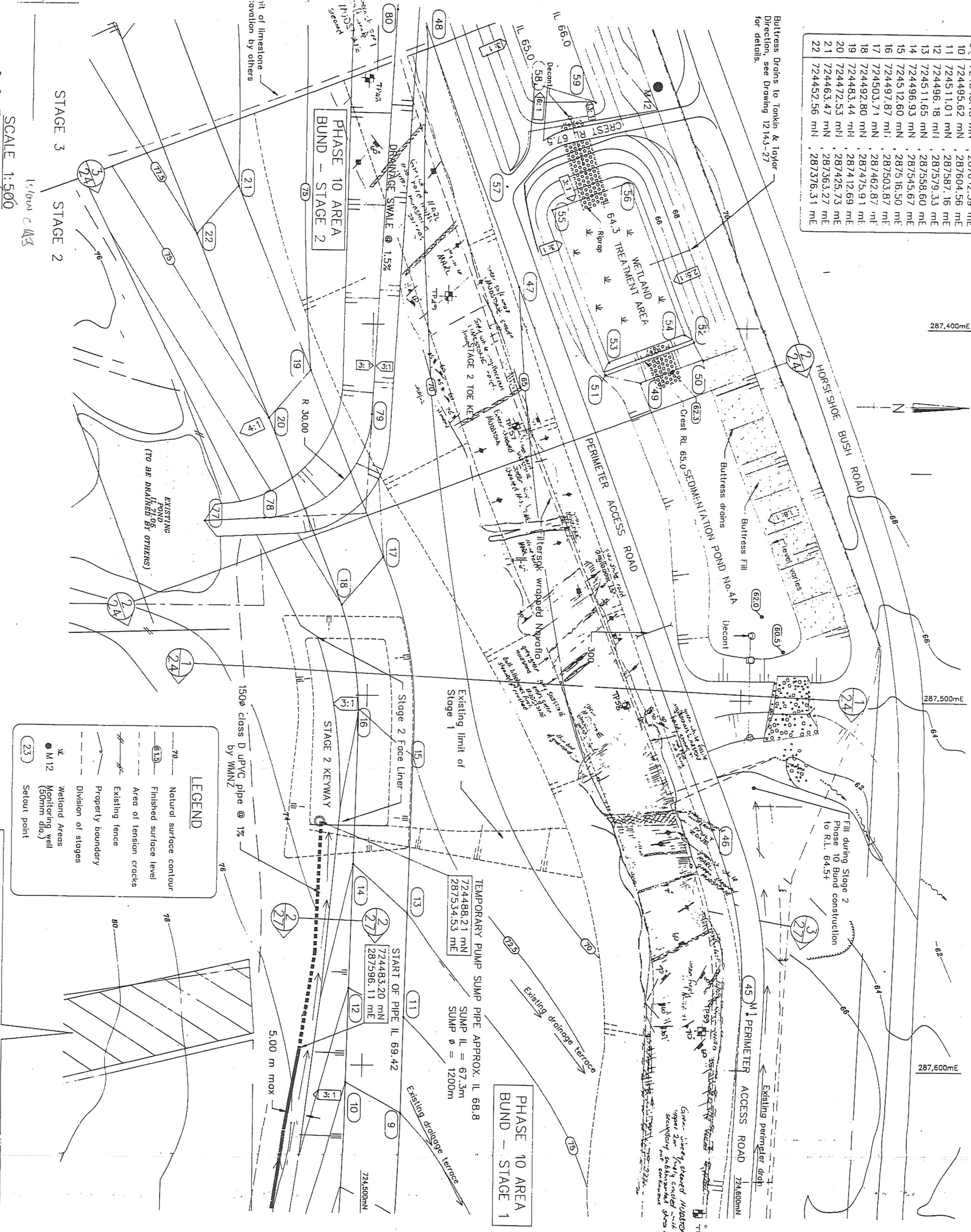


TONKIN & TAYLOR
ENVIRONMENTAL & ENGINEERING
CONSULTANTS

Drawing No.	Rev.
Ref: 12143	
Date	
9-2-94	
Drawn	Checked
SAF	SAF

9	724510.45	mN	287612.39	mE
10	724495.62	mN	287604.56	mE
11	724511.01	mN	287587.16	mE
12	724496.18	mN	287579.33	mE
13	724511.65	mN	287558.60	mE
14	724496.93	mN	287545.67	mE
15	724512.60	mN	287516.50	mE
16	724497.87	mN	287503.87	mE
17	724503.71	mN	287462.87	mE
18	724492.80	mN	287475.91	mE
19	724483.44	mN	287412.69	mE
20	724472.53	mN	287425.73	mE
21	724463.47	mN	287363.27	mE
22	724452.56	mN	287376.31	mE

Buttress Drains to Tonkin & Taylor
Direction, see Drawing 12 143-27
for details.



1. Grade perimeter access road to follow bund footprint. Max 10% grade.
2. For typical perimeter access road details refer to (27)
3. Contract limit where shown adjacent to boundary, is boundary
4. For toe key details refer to Drawing 12 143-24
5. Piezometers may be required under Stage 3 of the Phase 10 bund. Locations to be advised by Tonkin & Taylor.
6. Stage 2 toe key details to actual limestone pit, refer to Drawing 12 143-27
7. See Drawing 12 143-13 for remainder of setout points.
8. For sedimentation pond riprap and decant details refer to Drawing 12 143-33

D	Decants, riprap and toe key position amended	KJD	23/11/93
C	Drainage Swale Defined	KJD	23/11/93
B	Construction Issue	KJD	23/11/93
A	For Peer Review	KJD	23/11/93
0	First Issue	KJD	23/11/93
REVISION	CHECKED	Initial	Date
Drawing Checked			

APPROVED
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Waste Management Ltd
Tonkin & Taylor
CONSULTING ENGINEERS
18 MORGAN ST NEWMARKET
D WELINGTON 101 MOLESWORTH ST
D WANGAREI 7 HUNT ST



TITLE
REDVALE
LANDFILL
PHASE 10 BUND
TOE KEY AS-BUILT
ATTACHMENT 2
BASE GRADE GEOLOGY
(BY B. HEGAN DE TAYLOR)
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1:500

DRAWING No. 12 143-14
DATE OCT 1993
Revision: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

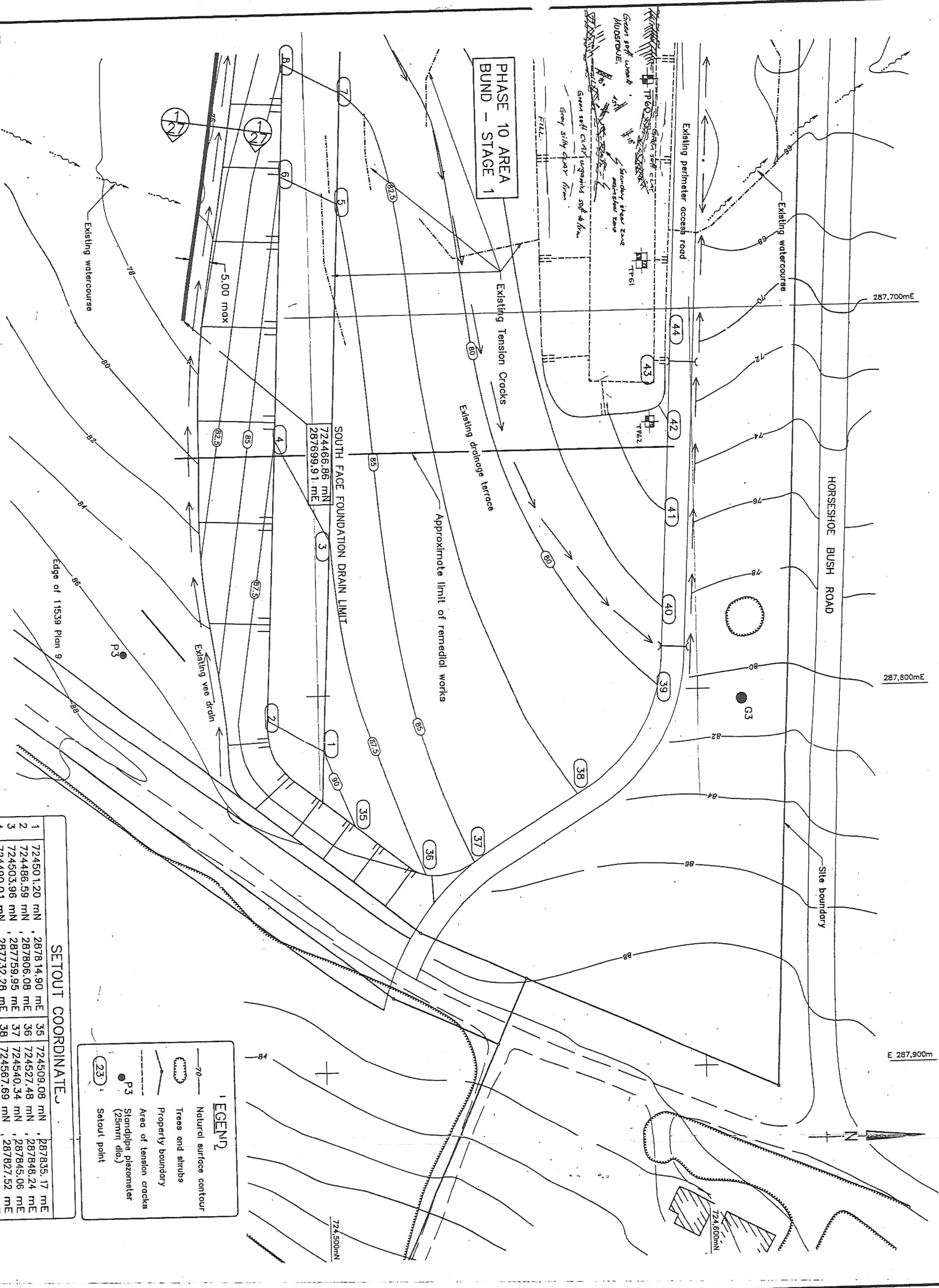
B	Construction Issue	KJD	23/11/93
A	For Peer Review	KJD	28/10/93
O	First Issue	KJD	28/10/93
REVISION		CHECKED	Initial Date
Drawing Checked		KJD	23/11/93
APPROVED		23/11/93	
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TONKIN & TAYLOR
CONSULTING ENGINEERS
19 MORGAN ST NEWMARKET
D WELINGTON 101 MOLESWORTH ST
D HANGAREI 7 HUNT ST

TITLE
REDVALE
LANDFILL
PHASE 10 BUND
TOE KEY AS-BUILT
ATTACHMENT 3
BASE GRADE GEOLOGY
(By B. HEAVY OF T.A.B.T.)
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ORIGINAL SCALES
1:500
DRAWING No.
12 143-15
DATE
OCT 1993



SETOUT COORDINATE

1	724501.20 mN	287814.90 mE	287835.17 mE
2	724486.59 mN	287806.08 mE	287848.24 mE
3	724503.96 mN	287759.95 mE	287845.06 mE
4	724490.01 mN	287732.28 mE	287827.52 mE
5	724507.89 mN	287670.10 mE	287778.69 mE
6	724493.06 mN	287662.27 mE	287753.19 mE
7	724509.26 mN	287640.60 mE	287729.53 mE
8	724494.43 mN	287632.77 mE	287704.86 mE
35	724509.08 mN		
36	724527.48 mN		
37	724540.34 mN		
38	724567.69 mN		
39	724589.40 mN		
40	724591.15 mN		
41	724592.46 mN		
42	724593.68 mN		
43	724590.20 mN		
44	724594.94 mN		

LEGEND

- 70 Natural surface contour
- Trees and shrubs
- Property boundary
- Area of tension cracks
- Standpipe piezometer (25mm dia.)
- Setout point

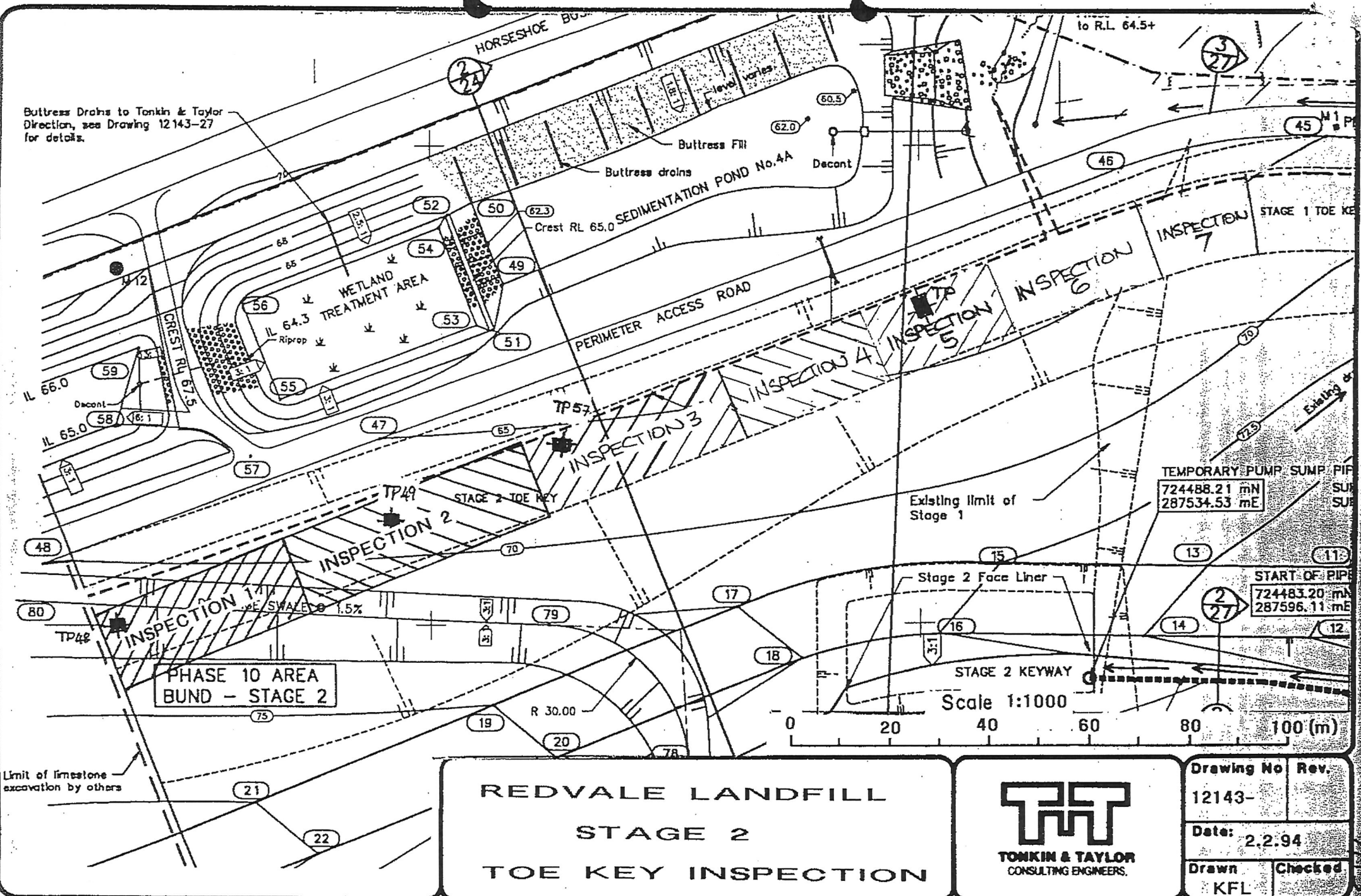
Drawn/Traced KJD

Graphic Scale

0 5 10 20 30 40 50 (m)

SCALE 1:500

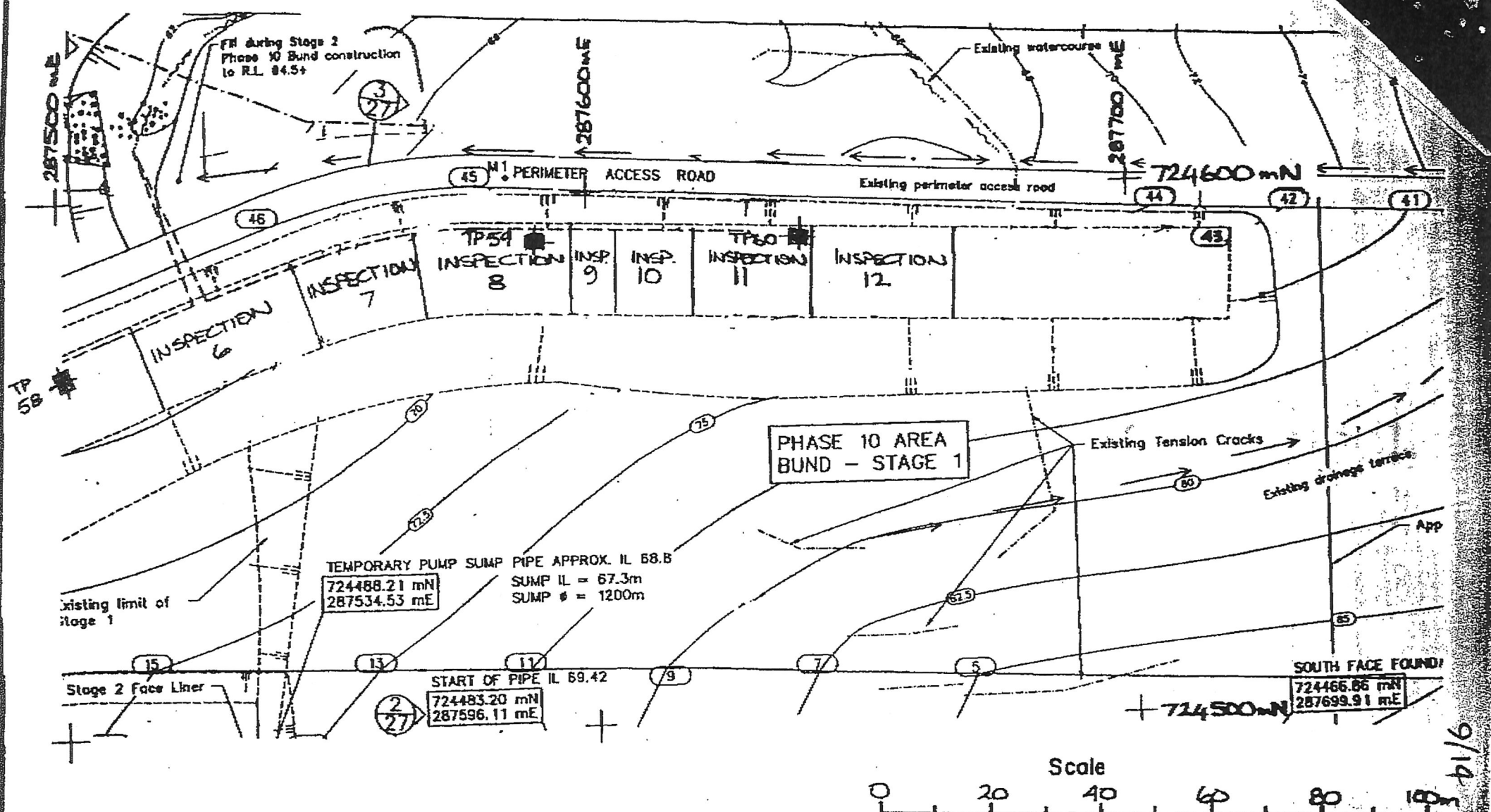
Buttress Drains to Tonkin & Taylor
Direction, see Drawing 12143-27
for details.



REDVALE LANDFILL
STAGE 2
TOE KEY INSPECTION



Drawing No	Rev.
12143-	
Date:	2.2.94
Drawn	Checked
KFL	



REDVALE LANDFILL
 STAGE 1.
 TOE KEY INSPECTION

T&T
 TOMLIN & TAYLOR
 CONSULTING ENGINEERS

Drawing No.	Rev.
12143	
Date:	23/3/94
Drawn	BDH
Checked	

Appendix I Earthworks Section 2 from Technical Specification

2 Earthworks

2.1 Scope

This section of the Specification covers the earthworks for bulk excavation, cartage of materials, temporary roading, construction of part of the perimeter access road, subsoil drainage, compacted soil liner construction, and construction of bulk and structural earth fills for the landfill cells.

Items covered include clearing, topsoil stripping, organic soil removal, removal and stockpiling of materials unsuitable for controlled compacted fills, sub-excavation where required, cut to fill, control of silt and runoff, provision of all necessary temporary pumping, fluming and diversion, rehabilitation and protection of surfaces against erosion, water penetration and softening. The supply and placement of granular materials specified for road surfacing, drainage bedding and erosion protection are contained elsewhere in other sections of the specification.

The works include construction of a low permeability liner using selected Northland Allochthon soils and rock excavated from identified borrow areas or stockpiles at the Redvale Landfill site.

The works require careful sequencing and materials control to ensure minimum uncontrolled mixing of material types and minimum material wastage through poor handling and operating procedures.

2.2 Standard Specifications

Construction work performed under this Section shall comply with the general requirements of the following documents and the specific requirements of this Section:

I Comply with the general requirements of the latest revisions of the following documents:

NZS 4402 : 1986	Methods of Testing Soils for Civil Engineering Purposes
BS 1377 : 1990	Methods of Test for Soils for Civil Engineering Purposes
NZS 3111 : 1986	Methods of Test for Water and Aggregate for Concrete
NZS 4407 : 1991	Methods of sampling and Testing Road Aggregate

2.3 Definitions

2.3.1 Site-won Material Types

2.3.1.1 General

A critical requirement of the Works is the effective scheduling of excavation and fill placement to provide for orderly progression of the Works. There are six main site-won material types that will be encountered below the Redvale Landfill site during excavation works, listed below in general order of occurrence from surface level. The various site-won material types will generally be used for specific Fill Types, as defined in Section 3.3.2 below, or as instructed by the Engineer. Other imported material types may also be used from time to time to supplement the site-won materials, as approved or instructed by the Engineer :

2.3.1.2 Topsoil

Topsoil is confined to the upper 100 to 300 mm of the natural soil profile, with stripping depths to be agreed with the Engineer. Stripped and/or stockpiled topsoil will be used for Type 7 fill material.

2.3.1.3 Organic Unsuitables

This material where encountered will need to be stockpiled to allow it to drain and dry for future use as final cover and landscaping fill, i.e. Type 6 fill material

2.3.1.4 Inorganic Unsuitables

Inorganic unsuitables will need to be stockpiled to allow them to drain and dry for future use as landfill daily and intermediate cover, i.e. Type 5 fill material

2.3.1.5 Pleistocene Sediments and weathered Northland Allochthon

Pleistocene age sediments, predominantly clays and silts, overlie weathered Northland Allochthon materials. Depending on their water content these materials will be stockpiled for possible future use as landfill final cover or for Type 3B, and Type 4 fill materials

2.3.1.6 Northland Allochthon Material

Northland Allochthon materials underlie most of the Redvale Landfill area, with the exception of the south-western boundary, and the unweathered materials will form the bulk of the excavation, cartage and fill placement in the Works. Site characterisation works have identified seven specific material Northland Allochthon sub-types likely to be encountered, as detailed below, and which are generally suitable for Type 1, Type 2, Type 3A and Type 4 fill materials :

- Unit N1 : White to greyish-white, thinly to thickly bedded and weak to moderately strong, Limestone with sandy and muddy (marly) horizons and inter-beds in part. Typically very closely fractured, and generally extensively crushed and sheared with a pervasive fabric, particularly near contacts with other lithologies. (Unsuitable for Type 1A (liner) fill)
- Unit N2 : Light grey to light grey-green silty Mudstone and muddy Siltstone, very weak to weak, and locally moderately strong, with a generally pervasively sheared, but locally more blocky, fabric.
- Unit N3 : Grey brown to dark chocolate brown, often carbonaceous, Mudstone, typically very weak to weak, but locally moderately strong generally with a relatively more blocky fabric with wider generally tight, planar and impersistent spaced fractures. (Unsuitable for Type 1A (liner) fill)
- Unit N4 : White crushed Mudstone, (rarely encountered).
- Unit N5 : Cemented muddy Siltstone, with a characteristic blocky fabric and clay infilled fractures, (rarely encountered). (Unsuitable for Type 1A (liner) fill)
- Unit N6 : Grey to grey-brown, typically weak to locally moderately strong, muddy Siltstone and silty Mudstone. This material is generally less fractured and pervasively sheared than the other units and typically exhibits a relatively blocky fabric with tight, planar and impersistent jointing.
- Unit N7 : Distinctive unit typically comprising grey-green to dark grey-green, fractured and pervasively sheared, very weak to locally weak Mudstone. Fractures are often curvilinear, smooth and polished. The unit generally becomes more intensely sheared and locally softened towards contacts with other lithologies, in particular with the limestone.
- Unit N8 : Calcareous grey to dark grey-green Mudstone often with sandy horizons and a generally blocky fabric.

2.3.1.7 Waitemata Group Sediments

Waitemata Group sandstones and siltstones, together with associated Autoclastic Breccia materials, form the bedrock geology below the south-western boundary of the Redvale Landfill :

- m Waitemata Group : Typically green, grey to dark grey, very weak to weak, interbedded Sandstone and Siltstone. When used for fill these materials are expected to vary between cohesive (for the fine grained units) and cohesionless (for the coarser, predominantly sand sized units). These materials would be generally suitable for landfill final cover or for Type 3B, and Type 4 fill materials, although selected material could also be suitable for Type 1C, Type 1D, Type 2 or Type 3A fill
- n Autoclastic Breccia : Typically very weak angular sand and gravel sized Mudstone and Siltstone fragments (clasts) in a grey-white to red-brown and grey to grey green clayey silt matrix. The rock mass fabric varies but is often pervasively sheared and closely fractured. Depending on the proportion and type of clasts, and water content these materials may be suitable for Type 1C, Type 1D, Type 2, Type 3A and Type 4 fill

2.3.1.8 Imported Fill

Imported material may also be used as fill from time to time, as approved or when instructed by the Engineer. It is expected that any such imported fill would be used for either bulk fill or structural fill, i.e. generally meeting the requirements for Type 1, Type 2, Type 3A and Type 4 fill materials.

Imported fill may not be used for liner fill, i.e. for Type 1A or Type 1B fill, without the prior express agreement of the Engineer.

If it is proposed to use imported fill then the Contractor shall provide representative samples of the material and sufficient laboratory test information so as to demonstrate to the Engineer's satisfaction that the imported fill is of at least similar, or better, quality than equivalent Site-won materials for any proposed Fill Type or use.

2.3.2 Fill Types

2.3.2.1 General

The types of Site-won Materials are defined in Section 3.2.1 and will be used to form differing Fill Types based on their properties and expected behaviour. The Site-won Material types differ but are required to be handled and compacted to form consistent Fill Types of differing properties, in the various different locations shown on the Drawings or as instructed by the Engineer. The compaction standards required to achieve the design properties for each Fill Type are specified in Section 3.1.4.

The specified Fill Types are classified as follows :

2.3.2.2 Type 1 Fill (High Strength Structural Fill)

- a) Type 1A fill is mudstone or suitable siltstone. This fill standard relates to high strength structural zones and liner zones within the landfill area
- b) Type 1B fill is fine grained (all passing 40 mm) marly limestone.
- c) Type 1C fill is mudstone, siltstone or marly limestone, but with slightly less rigorous compaction requirements than Type 1A. This fill type applies to structural key fills.
- d) Type 1D fill is mudstone, siltstone or marly limestone, but with slightly less rigorous compaction requirements than Type 1C. This fill type applies to sub-liner backfill zones.

Type 1 Fill will comprise Northland Allochthon material unless instructed otherwise by the Engineer.

2.3.2.3 Type 2 Fill (Structural Fill)

- a) Type 2A fill is crushed GAP65 limerock (limestone) or (if suitably fine grained) ROP limerock. It shall be free of any organic material or significant mudstone inclusions and shall be of a marly nature suitable for heavy compaction in designated key fills, structural keys and structure base areas.
- b) Type 2B fill is "quarry fill" comprised predominantly of weathered marly limestone. It shall be free of any organic material and shall be suitable for compaction in liner protection zones.

Type 2 Fill will comprise Northland Allochthon (Unit N1) Limestone material unless instructed otherwise by the Engineer.

2.3.2.4 Type 3 Fill (General Structural Fill)

- a) Type 3A fill is mudstone or siltstone suitable for controlled fill to form high strength, low permeability structural fills.
- b) Type 3B fill consists of inorganic clay and clayey silt materials suitable for controlled fill to form high strength, low permeability structural fills. Such materials include Pleistocene Sediments' clays of suitable water content, and weathered Northland Allochthon mudstone and limestone/mudstone mixes of suitable water content.

Waitemata Group sediments or Autoclastic Breccia materials shall only be used as Type 3 fill when approved or instructed by the Engineer.

2.3.2.5 Type 4 Fill (General Fill)

- a) Type 4 fill comprises weaker, softened or wetter materials including :
 - i Pleistocene Sediment clays, silts and silty sands;
 - ii Some Northland Allochthon mudstone materials of high water content or very plastic nature;
 - iii Waitemata Group or Autoclastic Breccia materials unsuited to structural filling.

Type 4 fill material type covers soils considered too wet and/or of a nature unsuited to use as structural fill, but suitable for controlled fill in non-structural zones given suitable handling, placement, blending, drying and compaction.

2.3.2.6 Type 5 Fill – (Inorganic Unsuitables)

As daily cover on the landfill face.

2.3.2.7 Type 6 Fill (Organic Unsuitables)

Type 6 fill is treated as reject fill and comprises organic soils, including peats and organic clays and silts, suitable for excavation and stockpiling for later use by blending or conditioning to form growth medium for use during rehabilitation of the landfill and other areas of the site.

2.3.2.8 Type 7 Fill (Topsoil)

The extent of topsoil will be determined by the Engineer as excavation proceeds, prior to its removal to a stockpile, reject dump or use as daily cover. The stockpile or dump will be at a location on site nominated by the Principal.

2.4 General Requirements for Earthworks

2.4.1 Site Specific Requirements

The physical nature of the Northland Allochthon mudstone and limestone materials which will be encountered in the Contract is such that special care shall be taken by the Contractor at all times to seal surfaces and maintain the works in a fully drained state. Special care shall apply to all fill areas and borrow areas, which shall be evenly graded at all times and immediately prior to rain, or on completion of work each day, shall be graded off using appropriate plant and rubber-tyre sealed to prevent any ponding or ingress of water.

The need for particular care in sealing and diverting water from mudstone slopes and benches is specifically emphasized as is diverting water from flowing into cleared areas. The montmorillonite rich mudstones, which will be exposed during the contract, are sensitive to water softening and the stability of both temporary and permanent slopes could be significantly affected by poor attention to surface water control. The Contractor shall provide contour and/or diversion drainage to all cut and fill areas.

Certain aspects of the work can only be determined following initial excavation or test pitting (e.g. bund founding levels, extent of mudstone in cut and depth of unsuitables in gullies).

The Engineer reserves the right to instruct the Contractor to cease work in any area temporarily in the event that stability or other problems arise in excavating Northland Allochthon mudstone/siltstone materials. The Contractor shall co-operate fully with the Engineer in any reprogramming of the work. Over-excavation

The Contractor shall direct its operations to avoid excavating beyond designated profiles except where specifically instructed. Particular care shall be taken in excavating in areas underlain by, or adjacent to refuse, and immediately adjacent to completed landfill cells and liner. Any over-excavation beyond designated profiles carried out without the direction of the Engineer shall be made good to the direction of the Engineer, with compacted and appropriately placed and structurally keyed fill of a standard designated to cover the original excavated profile (or such other fill of lesser quality, should the Engineer so permit).

2.4.2 Preservation and Maintenance

The Contractor shall preserve and maintain all earthworks, including partly completed earthworks, within their relevant specified standards, and shall make good any earthworks that have deteriorated below their minimum standards for whatever reason. At the discretion of the Engineer, deteriorated materials may be removed to stockpile or disposal.

The Contractor shall carry out the works so as to minimise passage of construction plant over the subgrade or previously filled areas. Areas of subgrade or previous fill that are softened or damaged due to repeated passage of construction plant shall be undercut and re-compacted. The Engineer shall inspect and agree the depth and extent of undercutting.

2.4.3 Tolerances

All cut and fill work shall be carried out to the lines, levels and grades shown on the Drawings or otherwise established by the Engineer. Cut and fill batters shall be of regular shape. Earthworks tolerances shall otherwise be as follows:

Roadway and channel widths	:	-0 to +150 mm
Road levels	:	-0 to +100 mm
Drain inverts	:	-100 to +0 mm

Fill batters	:	-0 to +200 mm
General fill levels	:	-100 to +100 mm
Bulk cell excavation	:	-100 to +100 mm
Liner subgrade level trimming	:	N/A to +50 mm
Liner on batters	:	-100 to +100 mm
Liner on floor	:	- 25 to +50 mm

2.4.4 Use of Materials

Insofar as it is practicable, all excavated material other than Unit N1 limestone (limerock), topsoil or organic material (all of which shall be reserved for future use as specified), shall be used in designated fills or appropriately placed in temporary stockpile so that the quantity of Type 5 (reject) material is minimized.

The Contractor shall control the opening up of cut areas so as not to expose cut areas unnecessarily to wetting by rain and shall rigorously maintain free drainage, with sealing or covering of materials sensitive to rain as necessary.

Where the Contractor meets all requirements for good earthworks practice, but certain material still remains unable to be handled from cut to fill, the Engineer will classify such material as reject fill.

2.5 Clearing

Construction areas subject to excavation or filling shall be cleared of all fences, rubbish, trees (other than those designated to remain), brush, plants or any vegetative growth whatever to ground level prior to stripping. Care must be exercised to prevent clearing of designated bush or trees.

Fence materials, other than single strand wire, able to be recovered during clearing shall be returned to the Principal. Other materials shall be set aside for eventual placing in the landfill.

Clearing shall not extend beyond the designated limits of earthworks.

2.6 Stripping

The term "stripping" refers to the removal from all areas subject to excavation or filling, of all growth medium remaining after clearing, including organic topsoil, roots and the like. Stripping of topsoil shall remove all such materials to expose soil containing an insignificant amount of organic material. Topsoil shall be removed and stockpiled separately.

Material derived from stripping operations shall be stockpiled neatly in locations suiting later reuse for topsoiling of covering on the landfill, and/or as shown on the Drawings, and/or as agreed to by the Principal.

On opening up the first 200 m², the Contractor shall agree with the Engineer the depth of organic soil and a nominal maximum stripping depth.

The plan extent of stripping in excavated areas shall be agreed from time to time with the Engineer prior to commencement of stripping. Except where limited by boundaries, existing works or other limiting features such as large trees, stripping shall extend no more than 2 metres beyond the limits of areas subject to earthworks unless otherwise shown on the Drawings or amended in writing by the Engineer.

2.7 Excavation

2.7.1 General

Excavation includes excavation of bulk fill, removal of unsuitable materials where directed, and preparation of excavations for structural keys and drain bases.

2.7.2 Management

Excavation shall be by digger and truck operation to maximise volumes of suitable material obtained for liner construction. Should large volumes of Fill type material suitable for liner construction be identified in the borrow area, remote from and clearly separate from other Fill type materials, and in a location that could facilitate scraper operation, a temporary change in operation may be approved by the Engineer.

The selection of the various soils will require care and may require multiple handling to maximise the yield for potential Fill types. The Contractor shall separate and maintain separation of the potential Fill types and shall allow to stockpile as necessary to facilitate the use of the borrow.

The Contractor shall work the borrow area in a logical and orderly manner to minimise wastage and to achieve the surface elevations and gradients shown on the consent drawings/management plans for the borrow areas which show the completed borrow surface.

The Contractor shall undertake continuous visual inspections of materials and shall report to the Engineer any visual changes, slope movement or groundwater that affects the borrow source.

The Contractor's excavation and handling methodology shall be such as to ensure that all unsuitables and other non-specified materials are removed at source and not transported to the working platform

2.8 Filling

2.8.1 General

Fill types as defined in Section 3.2.2 will be required to form the following:

- a) Liner Fill : The layer of selected soil compacted with appropriate quality control to form a low permeability liner for the landfill.
- b) Subliner Fill : General fill and structural fill placed and compacted beneath the low permeability liner on the cleared and stripped site to form the required levels and cross-falls.
- c) Bulk Fill : General fill placed to form the required levels and to provide founding for structures, access roads, services and similar
- d) Non-structural Fill : Surplus excavated material placed and compacted as specified in stockpiles or landscaping areas

Where practical, all fill materials shall be selected from the designated borrow areas and, insofar as it is practicable, all excavated material other than topsoil or organic material shall be used in designated fills so that the quantity of reject fill is kept to an absolute minimum. The Engineer may, at his discretion, order the removal of specific areas of material from excavation areas for disposal as reject fill.

The Contractor shall take all precautions and maintain a tidy operation to minimize the presence of any loose, excavated materials which could become wet during rain, as exceptional drying effort will be required for any materials derived from this site which become wet to enable the required compaction criteria to be met.

New fill shall not be spread over surfaces that have deteriorated from a state that complies with the specification, and where necessary, the old surface shall be scarified and conditioned and re-compacted before placing new fill.

Use of permanent grid line stakes within the cell can lead to systematic failure to adequately compact the fill. The Contractor shall allow for removing and replacing all stakes used as level location markers and reworking the soil penetrated by such stakes. Stakes shall not be left in place within an area during filling unless with the direct approval of the Engineer.

2.8.2 Inspections and Approvals

Before cut is commenced or fill is placed in any area, including borrow areas, the Engineer shall be notified so that he can inspect the stripped surface and identify and direct whether further excavation and/or undercutting and backfilling is required or other works such as drainage is necessary.

No cut or fill shall be undertaken in the area until the inspection of the stripped area has been made and the Engineer (after further work has been undertaken by the Contractor as necessary), has approved the commencement of cut and/or fill. In the case of fills and, in particular, mudstone fills, this includes preparation for fill resumptions after rain or periods of time exceeding 2 days.

The Contractor shall allow sufficient time for any subsurface and surface inspections and shall programme his operations and provide drainage, access and survey control so that any further work ordered prior to any filling can be carried out in an orderly manner without delay or damage to the works.

Where there is a delay of more than 24 hours between approval of a stripped area and placement of fill, the Contractor shall obtain a new approval of the surface finish from the Engineer. The Engineer will confirm the strength of the prepared surface at that time. The surface shall be maintained in its approved condition until filled over.

Prior to final trimming of the foundations for all embankments and structural keys, the Contractor shall obtain from the Engineer approval as to the extent and profile of preparatory work. Furthermore, immediately before fill is placed over any foundation, the Contractor shall obtain approval of the surface finish obtained and the strength of the prepared surface. The Engineer may give a general verbal approval of preparatory work as it is approaching finality, but only the written approval given immediately before placement of the fill will have contractual validity, provided that the surface is maintained in its approved condition until satisfactorily filled over.

Any area of ground to be filled which has an irregular surface, or has loose surface material as a result of stripping and sub-excavation work or removal of objects like tree stumps or boulders, such that the loose material or first layer of loose fill may not be able to be compacted adequately, shall be trimmed and re-compacted to achieve the standards set down for the overlying fill before fill operations are commenced.

2.9 Preparation for Filling

2.9.1 General

Except where more specific requirements are stated on the drawings, the final foundation surface in all areas of earthworks subject to earth fill which have been stripped, cleared of reject materials and sub-excavated, or re-prepared following previous work on site (including restarting work after rain), all ready to receive earth fill, shall, apart from benching undertaken during filling, be:

- a) as regular in profile as is practicable
- b) fully drained

- c) free from wheel rutting or desiccation cracking
- d) free from all loose material other than material which can be incorporated in and compacted with the first layer of fill to achieve specified compaction standards
- e) free from all loose material which if left in place would be more permeable than the underlying natural soil and the overlying compacted soil
- f) in the case of mudstone or limestone surfaces, free of any re-worked and/or re-moulded layer resulting from wheels or vehicle tracks, with all such material to be removed by blading and the final surface fully scarified prior to subsequent fill placement
- g) checked for compliance with the specification by the Engineer or his representative before filling commences
- o lightly scarified to ensure a continuous bond with the subsequent lift of fill material.

Additionally, all surfaces covered by drainage or filter material shall be accurately trimmed to preserve the minimum specified granular layer thickness and cleaned to ensure that all loose material which might otherwise become mixed into and contaminate the granular material, is completely removed.

Within the Redvale Landfill footprint there may be areas where excavation has been carried out during earlier phases of the work. Such excavations have been backfilled using a range of materials and in some instances in a non-engineered manner. Where any such areas and backfill material are encountered the Contractor shall bring them to the Engineer's attention. The exposed material shall be treated and Quality Control tested as for subliner fill. Depending on the results of such testing the Engineer may instruct that some or all of the previously placed backfill material be removed and replaced with approved fill.

Prior to placing any fill over the final foundation surface, that prepared surface shall be Quality Control tested in compliance with Tables 3.2 to 3.5. In all cases where the strength criteria in Tables 3.2 or 3.3 are not met, the in-situ material shall be sub-excavated to the Engineer's direction and replaced.

2.9.2 Preparatory excavation for structures not founded on fill

Preparatory excavation for structures not founded on fill, including preparation for foundation concrete, shall unless otherwise permitted by the Engineer be undertaken in two stages as follows :

- a) The first stage shall comprise gross excavation to within about 300 mm of foundation level, generally undertaken using bulk earthmoving equipment.
- b) The second stage, which shall not be undertaken until foundation construction is about to proceed and the Engineer has confirmed that no further sub-excavation and replacement is required. Final excavation shall complete the excavation to expose a trimmed, undisturbed surface free from all loose material on which blinding concrete or drainage layers shall be placed as soon as the Engineer has approved the prepared surface. Final excavation shall be undertaken using appropriate equipment and hand trimming to ensure preservation of the ground below founding level.

2.10 Liner Zone Preparation

2.10.1 General

Landfill side and floor areas will require sub-excavation to 1,050 mm below basegrade level and recompaction or replacement to provide a 900 mm layer of compacted Northland Allochthon mudstone/siltstone liner, formed from Type 1A or Type 1B fill, prior to placing 150 mm of limerock

(protective layer). The approach to be adopted by the Contractor, unless varied by the Engineer, shall be as follows.

- a) In all floor areas where liner is to be placed, the surface shall be excavated to basegrade to the cross-falls and batter slopes shown on the Drawings taking care to avoid deeper excavation and shall be :
 - i as regular in profile as is required to confirm liner thickness during liner placement with a practical minimum of survey control.
 - ii fully drained
 - iii free from wheel rutting or desiccation cracking
 - iv free from all loose material other than material which can be incorporated in and compacted with the first layer of liner fill to achieve specified compaction standards
 - v free from all loose material which if left in place would be more permeable than the underlying soil and the overlying compacted soil
 - vi in the case of mudstone surfaces, free of any re-worked and/or re-moulded layer resulting from wheels or vehicle tracks, with all such material to be removed by blading and the final surface fully scarified prior to subsequent fill placement
 - vii lightly scarified to ensure a continuous bond with the subsequent lift of fill material.
- p Where light scarifying is carried out at the top of the liner subgrade then care shall be taken to ensure that subliner or natural ground material is not mixed into the first layer of the overlying liner. Such mixing will not be permitted.
- q In all side wall areas where liner is to be placed over Northland Allochthon mudstone or siltstone material, the surface shall be excavated below basegrade to sufficient depth to permit construction of the liner layer and limerock protective layer, taking care to avoid excess excavation. Sidewall areas above the Northland Allochthon materials shall be excavated further to form a buttress where specified in the Drawings.
- r Before excavating below basegrade level or filling over any excavated floor and side wall area, the surface shall be cut to an even finish, (a toothed digger bucket is not suitable), and shall not be rolled or otherwise disturbed as it is imperative that the surface soil and rock structure and any defects be clearly visible during inspection.
- s The Engineer shall then inspect the floor and all side wall natural ground surfaces, including any liner Basegrade Inspections required by the Resource Consents. The Contractor shall allow sufficient time for those inspections and for an accurate survey of levels, by both the Engineer and the Contractor, of the foundation subgrade area in order to check that the liner will have the minimum thickness specified.

2.10.2 Floor Liner Zones

The steps for liner preparation of the floor area, which the Contractor shall work in with and fully co-operate in the achievement of, are:

- a) excavate to basegrade level
- b) temporarily cover any areas of over-excavation to protect the subgrade;
- c) excavate to 1050 mm below basegrade level, and remove any subgrade disturbed by construction. If the subgrade is not of Northland Allochthon origin, or other approved material such as Waitemata Group sediments, then the floor shall be undercut and replaced with compacted fill to an extent and Type to be notified by the Engineer. Trim the subgrade to expose undisturbed ground, using a straight blade, within the 2 days prior to a scheduled liner inspection. Notify the Engineer that inspection is required.
- d) establish co-ordinates of the inspection area

- e) survey subgrade floor levels - this is to be done before and after any undercutting as necessary to verify the minimum liner thickness
- f) carry out the liner inspection (I.e. Basegrade Inspections)
- g) determine and record the location of any seepage or particular geologic feature noted by the Engineer (measurements are to be taken by the Principal or surveyors instructed by the Principal)
- h) where liner butts onto previously constructed liner, trim the previously constructed liner to 4H : 1V or flatter
- i) perform further liner preparations as determined by the Engineer, in addition to the above
- j) review any rain-softened and loose material immediately prior to scarifying and filling
- k) scarify the subgrade to a minimum of 75 mm depth, e.g. with 3 passes of a compactor
- l) construct liner fill to 150 mm below basegrade level, or to a higher, temporary over-filled level prior to trimming
- m) trim and then survey the trimmed liner fill to verify the minimum liner thickness
- n) place the protective layer within 2 days after trimming to prevent erosion and drying of the liner
- o) survey as-built basegrade levels (i.e. on top of protective layer).

2.10.3 Side Wall Liner Zones

The steps for liner preparation of the side wall area, which the Contractor shall work in with and fully co-operate in the achievement of, are:

- a) excavate in upper materials, e.g. Pleistocene sediments, to the “initial excavation profile” which will be pre-determined in consultation with the Engineer and the Construction Engineering Advisor.
- b) excavate in lower materials, e.g. Northland Allochthon material, to the “initial excavation profile”, except delay the final excavation where temporary cover is to be left as in c below. Notify the Engineer that inspection is required.
- c) allow for making any pre-specified excavations at specific times due to the possibility of instability or deterioration of the exposed Northland Allochthon materials in the side walls. This possibility may, in some cases, be able to be reduced by leaving a temporary cover of undisturbed ground. The temporary cover may comprise either steep batters with benches in the rock or a uniform thickness of rock cover over the final subgrade level. Final excavation should be delayed until the Contractor will be ready to continue with liner filling immediately after the final excavation and inspection.
- d) excavate to the final profile and remove any subgrade disturbed by construction. If the subgrade is not Northland Allochthon materials, or other approved material such as Waitemata Group sediments, then the sidewall shall be undercut and replaced with compacted fill to an extent to be notified by the Engineer
- e) establish co-ordinates of the inspection area
- f) survey side wall subgrade levels, before and after any undercutting as necessary to verify the minimum liner thickness
- g) carry out the liner inspection; the Engineer may elect to inspect either before or after final excavation depending on the quality of the subgrade exposure for geologic inspection purposes. The Principal will seek adequate guidance from the Engineer on the day of inspection to immediately instruct the Contractor regarding liner preparation requirements

- h) determine and record the location of any seepage or particular geologic feature noted by the Engineer (measurements are to be taken by the Principal or surveyors instructed by the Principal)
- i) where liner butts onto previously constructed liner, trim the previously constructed liner to 4V : 1H or flatter
- j) place and compact the side wall liner fill; 1V : 1H bench into the side wall subgrade at maximum of 0.3 m height intervals, and cut out all loose and disturbed subgrade material and either remove it or mix it with liner fill
- k) trim and then survey the trimmed liner fill to verify the minimum liner thickness
- l) place the protective layer within 2 days after trimming to prevent erosion and drying of the liner

2.11 Fill Placement and Protection

Fill shall be placed in the appropriate zones within the specified tolerances.

The maximum working height differentials and grades between structural and non-structural zones and temporary design slopes for excavation zones, as specified on the Drawings or instructed by the Engineer, shall be strictly observed. In particular, the Contractor shall fully construct all keyway fills before commencing backfilling with stockpile, general fill or ponding uphill of keyways.

2.12 Conditioning and Spreading of Fill

2.12.1 Type 1, Type 2, Type 3 and Type 4 Fill

Prior to compaction, all fill shall be broken up into fragments of less than 150 mm size, laid out in a layer of approximately uniform loose thickness not exceeding 250 mm, and be brought to an appropriate water content by aeration and drying or wetting (as the case may be), and/or by blending and mixing wet and dry materials.

If the fill is too dry, then water shall be added to the uncompacted fill and if necessary mixed in prior to compaction to achieve a uniform water content through each fill lift. If the fill is too wet to permit compaction to the specified air voids and/or strength criteria, the water content shall be adjusted by drying where feasible or mixing with drier material.

Particular attention shall be paid to measured fill water contents, as compared to optimum water contents determined by the relevant material compaction curves.

If neither drying nor mixing is practicable the wet material shall be removed and replaced. In every case the fill shall be mixed and conditioned thoroughly so that immediately prior to compaction, the water content of the fill is reasonably uniform within any one area.

In the case of Type 1, Type 2 and Type 3 fill, a water content variation exceeding 5%, as determined by sampling and testing as set out in this Specification, within an area of 1 square metre will make the fill liable to rejection or further conditioning prior to compaction

Under no circumstances may a compaction machine be used for the spreading of fill requiring water content adjustment. When drying is feasible and can be achieved within the construction programme, it shall be carried out in suitable weather conditions and shall incorporate discing, harrowing or similar at regular intervals to enable efficient aeration of the material to take place. Conditioning could involve the use of temporary stockpiling in addition to the other measures outlined in this Clause.

In the case of embankments, all fill shall be laid out and compacted in a direction approximately parallel to the crest centreline of the embankment wherever the embankment width is less than 30 metres.

Any irregularities in the loose layer thickness after deposition by earthmoving plant shall be levelled out by blade prior to or during the first pass of the compacting equipment, and any oversized fragments shall be removed from the fill or broken by rollers or towed discs.

No fill may be placed until the foundation over which it is to be placed, and which may be previously placed fill, has been inspected and approved by the Engineer. In the event of fill operations ceasing in any area either on account of wet weather or for more than two days for any reason, the Contractor shall obtain the Engineer's approval of the condition of the fill surface before recommencing fill operations.

Fill surfaces which have been rolled smooth by trafficking or are in any other condition which may preclude obtaining a tight bond between successive fill layers or zones, shall be lightly scarified or treated in a similar fashion so that maximum bonding between the layers can be achieved.

No new fill shall be placed over previously placed fill that has not achieved the required standard of compaction, has become contaminated, or has deteriorated from the required fill standards. Previously placed fill that does not comply shall be reinstated or removed at no cost to the Principal. Positive and effective drainage shall be maintained during filling operations to minimize deterioration of material exposed in excavation areas and in the uppermost fill layers. Special care shall be taken to avoid hollows which could pond run off.

In the case of Northland Allochthon mudstone or siltstone, prior to the re-commencement of filling after rain sealed surfaces shall be fully bladed off to a surface which is unaffected by the rain and then scarified, followed by sufficient passes of the compactor to achieve a fill layer surface which meets the compaction standard and is equal to that if work had not ceased. Filling may recommence only after approval of that prepared surface has been given by the Engineer.

Where fill abuts sloping ground with a gradient steeper than 10%, (1V : 10H), the ground being filled against, whether natural ground or previously placed fill, shall be benched into for a sufficient distance so that the vertical depth of the bench is approximately equal to the thickness of the compacted fill layer. The material excavated during the keying operation may be incorporated in the adjacent fill provided that it meets the quality and type requirements for the material being compacted into the key.

2.12.2 Type 5 Fill

Reject fill corresponding to Type 5 Fill shall be placed in nominated dump stockpiles and bladed and track rolled regularly so as to achieve uniform shapes which rapidly shed water and minimize the risk of slumping.

2.13 Fill Adjacent to Structures and Culverts

Fill adjacent to structures shall comply with the requirements of the proposed fill type to be placed against the structure. All filling in the vicinity of and against structures, including culverts, shall be carried out using methods which avoid damage to, and do not cause excessive stresses, in the structures, but without prejudicing the integrity of the completed fill.

Fill within 2 metres horizontal distance of the walls of concrete structures or culvert walls, and to a level 2 m above culverts, shall be compacted using light machine and hand operated equipment. An un-ballasted sheepfoot roller of less than 5 tonnes weight drawn by a tractor whose track ground pressure does not exceed 50 kPa may be used for fill within 2 m of structures, and a vibrating footpath type roller may be used for granular fill in the same zone. Heavy earthmoving equipment