

TONKIN and TAYLOR GROUP LTD. | Sheet No.  
 Program: WALLAP Version 6.06 Revision A52.B71.R55 | Job No. 30314  
 Licensed from GEOSOLVE | Made by : RECA  
 Data filename/Run ID: Eastern\_RTW\_Chainage35 |  
 Kohimarama Retirement Village | Date:15-10-2019  
 Chainage35\_EasternRTW | Checked :  
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Units: kN,m

**INPUT DATA**

**SOIL PROFILE**

Stratum no.	Elevation of top of stratum	Soil types	
		Left side	Right side
1	37.60	1 Fill	1 Fill
2	37.10	2 Residual ECBF	2 Residual ECBF
3	31.10	3 Weathered ECBF	3 Weathered ECBF
4	21.10	5 ECBF	5 ECBF

**SOIL PROPERTIES**

-- Soil type --	density	Young's Modulus	At rest coeff.	Consol state.	Active limit	Passive limit	Cohesion
No. Description (Datum elev.)	kN/m3	Eh,kN/m2 (dEh/dy)	Ko (dKo/dy)	NC/OC ( Nu )	Ka ( Kac )	Kp ( Kpc )	kN/m2 ( dc/dy )
1 Fill	17.00	10000	0.560	OC	0.337	3.442	3.000d
				(0.350)	(1.360)	( 5.007)	
2 Residual ECBF	18.00	20000	0.530	OC	0.309	3.869	5.000d
				(0.300)	(1.300)	( 5.395)	
3 Weathered ECBF	20.00	50000	0.500	OC	0.259	4.964	10.00d
				(0.300)	(1.185)	( 6.343)	
4 Hardfill	22.00	40000	0.400	OC	0.217	4.599	
				(0.300)	(0.000)	( 0.000)	
5 ECBF	22.00	100000	0.430	OC	0.227	6.084	20.00d
				(0.300)	(1.104)	( 7.261)	

**Additional soil parameters associated with Ka and Kp**

No. Description	--- parameters for Ka ---			--- parameters for Kp ---		
	Soil friction angle	Wall adhesion coeff.	Back-fill	Soil friction angle	Wall adhesion coeff.	Back-fill
1 Fill	26.00	0.670	0.00	26.00	0.500	0.00
2 Residual ECBF	28.00	0.673	0.00	28.00	0.500	0.00
3 Weathered ECBF	32.00	0.670	0.00	32.00	0.500	0.00
4 Hardfill	40.00	0.000	0.00	40.00	0.000	0.00
5 ECBF	35.00	0.665	0.00	35.00	0.500	0.00

**GROUND WATER CONDITIONS**

Density of water = 10.00 kN/m3  
 Initial water table elevation Left side 33.00 Right side 33.00  
 Automatic water pressure balancing at toe of wall : No

Water profile no.	Point no.	Left side			Right side			
		Elev. m	Piezo elev. m	Water press. kN/m2	Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	35.70	35.70	0.0	1	34.00	34.00	0.0
2	1	33.00	33.00	0.0	1	33.00	33.00	0.0

**WALL PROPERTIES**

Type of structure = Fully Embedded Wall  
 Elevation of toe of wall = 31.20  
 Maximum finite element length = 0.30 m  
 Youngs modulus of wall E = 1.2100E+07 kN/m2  
 Moment of inertia of wall I = 1.0472E-03 m4/m run  
 E.I = 12671 kN.m2/m run  
 Yield Moment of wall = Not defined

**HORIZONTAL and MOMENT LOADS/RESTRAINTS**

Load no.	Elevation	Horizontal load	Moment load	Moment restraint	Partial factor
		kN/m run	kN.m/m run	kN.m/m/rad	(Category)
1	35.87	5.800	0	0	N/A

**SURCHARGE LOADS**

Surch-arg	Distance from wall	Length parallel to wall	Width perpendicular to wall	Surcharge kN/m2	Equiv. soil type	Partial factor/Category
1	37.60	0.00(L)	50.00	2.00	0.00	17.00 N/A N/A
2	37.60	2.00(L)	50.00	10.00	17.00 =	N/A N/A

Note: L = Left side, R = Right side  
 A trapezoidal surcharge is defined by two values:  
 N = at edge near to wall, F = at edge far from wall

**CONSTRUCTION STAGES**

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 37.60
2	Apply surcharge no.2 at elevation 37.60
3	Change EI of wall to 12671 kN.m2/m run Yield moment not defined
	Reset wall displacements to zero at this stage
4	Excavate to elevation 34.60 on RIGHT side
5	Fill to elevation 35.10 on RIGHT side with soil type 4
6	Apply water pressure profile no.1
7	Apply water pressure profile no.2
8	Apply load no.1 at elevation 35.87

**FACTORS OF SAFETY and ANALYSIS OPTIONS**

Stability analysis:  
 Method of analysis - Strength Factor method  
 Factor on soil strength for calculating wall depth = 1.00  
 Parameters for undrained strata:  
 Minimum equivalent fluid density = 5.00 kN/m3  
 Maximum depth of water filled tension crack = 0.00 m  
 Bending moment and displacement calculation:  
 Method - Subgrade reaction model using Influence Coefficients  
 Open Tension Crack analysis? - No  
 Non-linear Modulus Parameter (L) = 0 m  
 Boundary conditions:  
 Length of wall (normal to plane of analysis) = 1000.00 m  
 Width of excavation on Left side of wall = 20.00 m  
 Width of excavation on Right side of wall = 20.00 m  
 Distance to rigid boundary on Left side = 20.00 m  
 Distance to rigid boundary on Right side = 20.00 m

**OUTPUT OPTIONS**

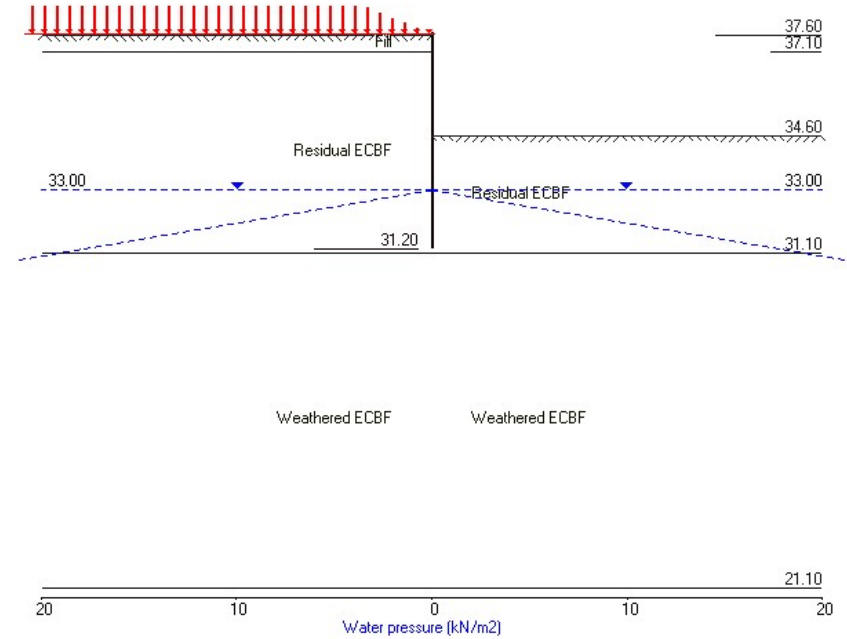
Stage no.	Stage description	Displacement	Active, Bending mom.	Graph. Passive output	Output options pressures
1	Apply surcharge no.1 at elev. 37.60	Yes	Yes	Yes	Yes
2	Apply surcharge no.2 at elev. 37.60	Yes	Yes	Yes	Yes
3	Change EI of wall to 12671kN.m2/m run	Yes	Yes	Yes	Yes
4	Excav. to elev. 34.60 on RIGHT side	Yes	Yes	Yes	Yes
5	Fill to elev. 35.10 on RIGHT side	Yes	Yes	Yes	Yes
6	Apply water pressure profile no.1	Yes	Yes	Yes	Yes
7	Apply water pressure profile no.2	Yes	Yes	Yes	Yes
8	Apply load no.1 at elev. 35.87	Yes	Yes	Yes	Yes
*	Summary output	Yes	-	Yes	Yes

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 Data filename/Run ID: Eastern\_RTW\_Chainage35 |  
 Kohimarama Retirement Village | Date:15-10-2019  
 Chainage35\_EasternRTW | Checked :

Units: kN,m

Stage No.4 Excav. to elev. 34.60 on RIGHT side



(continued)

Units: kN,m  
 Stage No. 4 Excavate to elevation 34.60 on RIGHT side

**STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method**  
 Factor of safety on soil strength

Stage No.	Ground level Act.	Prop Elev.	FoS	Moment of equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetration	Direction of failure
4	37.60	34.60	Cant.	1.496	31.53	33.33	1.27 L to R

**BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**  
 Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall  
 Right side 20.00 from wall

\*\*\* Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	37.60	0.00	0.014	3.12E-03	0.0	0.0	0.0
2	37.35	0.00	0.013	3.12E-03	0.0	0.0	0.0
3	37.10	0.00	0.012	3.12E-03	0.0	0.0	0.0
4	36.85	0.00	0.012	3.12E-03	0.0	0.0	0.0
5	36.60	0.46	0.011	3.12E-03	0.1	0.0	0.0
6	36.30	2.50	0.010	3.12E-03	0.5	0.1	0.0
7	36.09	3.93	0.009	3.11E-03	1.2	0.3	0.0
8	35.87	5.34	0.009	3.10E-03	2.2	0.6	0.0
9	35.70	6.44	0.008	3.09E-03	3.2	1.1	0.0
10	35.40	8.35	0.007	3.04E-03	5.4	2.4	0.0
11	35.10	10.22	0.006	2.95E-03	8.2	4.4	0.0
12	34.85	11.76	0.006	2.83E-03	10.9	6.8	0.0
13	34.60	13.28	0.005	2.66E-03	14.1	9.9	0.0
14	34.30	-13.70	0.005	2.66E-03	14.1	9.9	0.0
15	34.00	-26.05	0.004	2.36E-03	8.1	13.8	0.0
16	33.80	-19.26	0.003	2.01E-03	1.3	15.3	0.0
17	33.60	-14.63	0.003	1.76E-03	-2.1	15.2	0.0
18	33.30	-10.62	0.003	1.52E-03	-4.6	14.5	0.0
19	33.00	-5.65	0.002	1.19E-03	-7.0	12.6	0.0
20	32.70	-1.82	0.002	9.17E-04	-8.2	10.3	0.0
21	32.40	1.10	0.002	6.98E-04	-8.3	7.7	0.0
22	32.10	3.31	0.002	5.39E-04	-7.6	5.3	0.0
23	32.10	5.04	0.001	4.35E-04	-6.4	3.2	0.0
24	31.80	6.46	0.001	3.78E-04	-4.6	1.5	0.0
25	31.50	7.73	0.001	3.55E-04	-2.5	0.4	0.0
26	31.20	8.95	0.001	3.50E-04	0.0	-0.0	0.0

Stage No.4 Excavate to elevation 34.60 on RIGHT side

Node no.	Y coord	Effective stresses				Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit			
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	37.60	0.00	0.00	0.00	15.02	0.00	0.00a	2554
2	37.35	0.00	5.60	0.00	34.28	0.00	0.00a	2554
3	37.10	0.00	11.15	0.00	53.41	0.00	0.00a	2554
4	36.85	0.00	11.15	0.00	70.11	0.00	0.00a	4840
5	36.60	0.00	16.88	0.00	92.28	0.00	0.00a	4840
6	36.30	0.00	22.51	0.46	114.07	0.46	0.46a	4840
7	36.09	0.00	29.13	2.50	139.66	2.50	2.50a	4840
8	35.87	0.00	33.77	3.93	157.63	3.93	3.93a	4840
9	35.70	0.00	38.34	5.34	175.29	5.34	5.34a	4840
10	35.40	0.00	41.89	6.44	189.05	6.44	6.44a	4840
11	35.10	0.00	48.07	8.35	212.94	8.35	8.35a	4840
12	34.85	0.00	54.13	10.22	236.40	10.22	10.22a	4840
13	34.60	0.00	59.11	11.76	255.65	11.76	11.76a	4840
14	34.30	0.00	64.03	13.28	274.67	13.28	13.28a	4840
15	34.00	0.00	69.86	15.08	297.24	15.08	15.08a	4840
16	33.80	0.00	75.63	16.86	319.55	19.92	19.92	4840
17	33.60	0.00	79.44	18.04	334.31	23.69	23.69	4840
18	33.30	0.00	83.23	19.21	348.98	27.22	27.22	4840
19	33.00	0.00	88.89	20.96	370.85	32.09	32.09	4840
20	32.70	3.00	94.50	22.69	392.56	36.50	36.50	4840
21	32.40	6.00	97.08	23.49	402.53	38.95	41.95	4840
22	32.10	9.00	99.62	24.27	412.39	41.13	47.13	4840
23	31.80	12.00	102.14	25.05	422.13	43.10	52.10	4840
24	31.50	15.00	104.64	25.82	431.79	44.95	56.95	4840
25	31.20	18.00	107.11	26.59	441.36	46.73	61.73	4840
26	31.20	18.00	109.57	27.34	450.85	48.49	66.49	4840

Node no.	Y coord	Effective stresses				Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit			
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m3
1	37.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	37.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	37.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	36.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	36.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	36.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	36.09	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	35.87	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	35.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	35.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	35.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	34.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	34.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	34.30	0.00	5.40	0.00	47.87	41.13	41.13	7457
15	34.00	0.00	10.80	0.00	68.76	39.18	39.18	7457
16	33.80	0.00	14.40	0.00	82.69	38.33	38.33	7457
17	33.60	0.00	18.00	0.00	96.62	37.84	37.84	7457
18	33.30	0.00	23.41	0.73	117.53	37.74	37.74	7457
19	33.00	0.00	28.81	2.40	138.44	38.32	38.32	7457
20	32.70	3.00	31.22	3.14	147.75	37.86	40.86	7457
21	32.40	6.00	33.63	3.89	157.08	37.81	43.81	7457

Stage No.4 Excavate to elevation 34.60 on RIGHT side

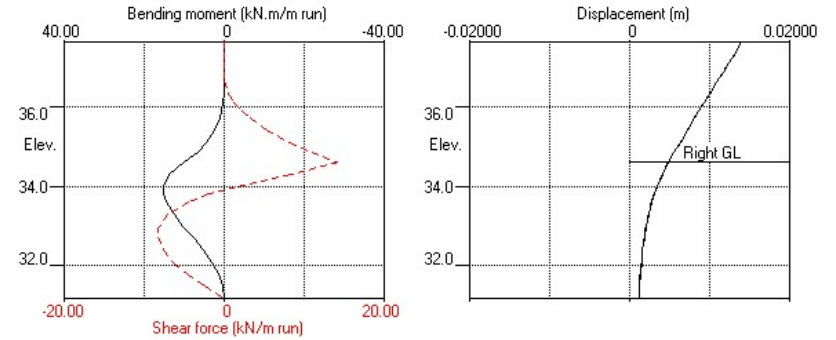
(continued)

Node no.	Y coord	Water press.	Vertic -al	Effective stresses		Earth pressure	Total earth pressure	Coeff. of subgrade reaction
				Active limit	Passive limit			
22	32.10	9.00	36.04	4.63	166.42	38.06	47.06	7457
23	31.80	12.00	38.46	5.38	175.77	38.49	50.49	7457
24	31.50	15.00	40.88	6.13	185.14	39.00	54.00	7457
25	31.20	18.00	43.31	6.88	194.52	39.54	57.54	7457

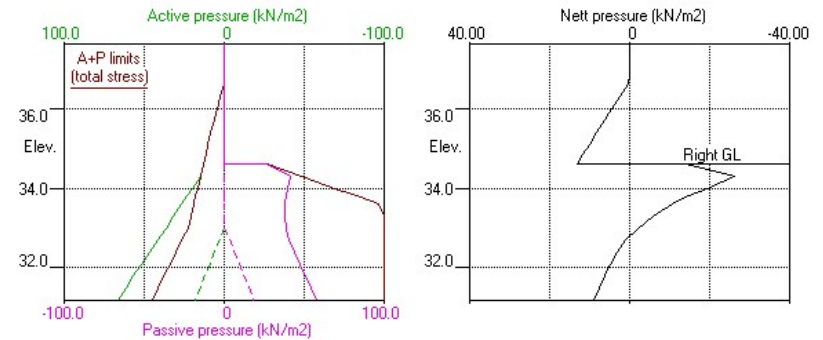
Note: 15.08a Soil pressure at active limit  
 26.98p Soil pressure at passive limit

Units: kN,m

Stage No.4 Excav. to elev. 34.60 on RIGHT side

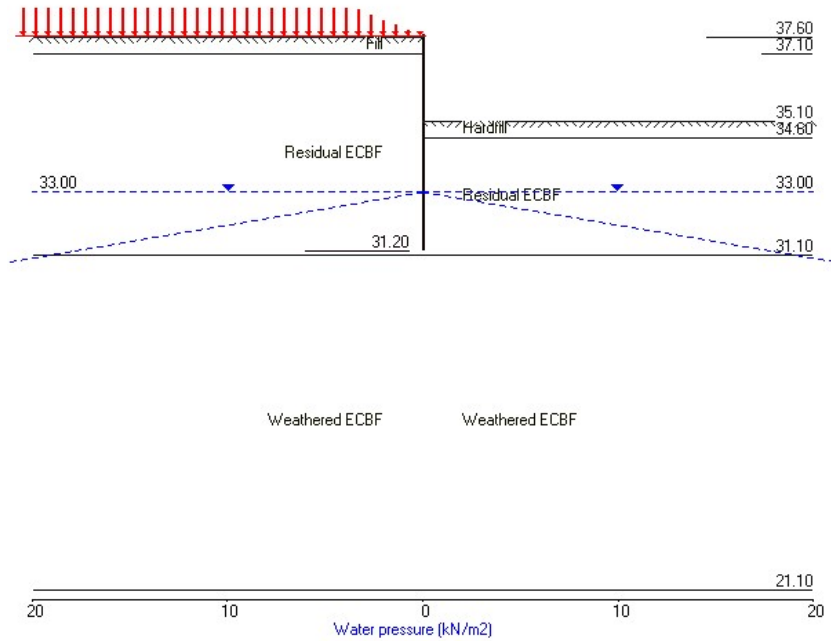


Stage No.4 Excav. to elev. 34.60 on RIGHT side



Units: kN,m

Stage No.5 Fill to elev. 35.10 on RIGHT side



Units: kN,m

Stage No. 5 Fill to elevation 35.10 on RIGHT side with soil type 4

**STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method**  
 Factor of safety on soil strength

Stage No.	Ground level Act. Pass.	Prop Elev.	FoS for toe elev. = 31.20		Toe elev. for FoS = 1.000		Direction of failure
			Factor of Safety	Moment at elev.	Toe elev.	Wall Penetration	
5	37.60 35.10	Cant.	1.872	31.61	34.02	1.08	L to R

**BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**  
 Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall  
 Right side 20.00 from wall

\*\*\* Wall displacements reset to zero at stage 3

Node no.	Y coord	Nett pressure kN/m <sup>2</sup>	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	37.60	0.00	0.014	3.35E-03	0.0	0.0	
2	37.35	0.00	0.013	3.35E-03	0.0	0.0	
3	37.10	0.00	0.013	3.35E-03	0.0	0.0	
4	36.85	0.00	0.012	3.35E-03	0.0	0.0	
5	36.60	0.46	0.011	3.35E-03	0.1	0.0	
6	36.30	2.63	0.010	3.35E-03	0.5	0.1	
7	36.09	4.24	0.009	3.34E-03	1.3	0.3	
8	35.87	5.83	0.008	3.33E-03	2.3	0.7	
9	35.70	7.07	0.008	3.32E-03	3.4	1.1	
10	35.40	9.22	0.007	3.26E-03	5.9	2.5	
11	35.10	11.33	0.006	3.17E-03	9.0	4.7	
12	34.85	11.87	0.005	3.04E-03	11.9	7.3	
13	34.60	12.37	0.004	2.86E-03	14.9	10.7	
		-15.44	0.004	2.86E-03	14.9	10.7	
14	34.30	-27.39	0.004	2.54E-03	8.5	14.7	
15	34.00	-20.24	0.003	2.17E-03	1.3	16.3	
16	33.80	-15.41	0.003	1.90E-03	-2.2	16.2	
17	33.60	-11.20	0.002	1.65E-03	-4.9	15.4	
18	33.30	-5.99	0.002	1.30E-03	-7.5	13.5	
19	33.00	-1.95	0.001	1.00E-03	-8.7	10.9	
20	32.70	1.13	0.001	7.71E-04	-8.8	8.3	
21	32.40	3.49	0.001	6.02E-04	-8.1	5.7	
22	32.10	5.34	0.001	4.91E-04	-6.8	3.4	
23	31.80	6.88	0.001	4.31E-04	-4.9	1.6	
24	31.50	8.26	0.000	4.06E-04	-2.7	0.4	
25	31.20	9.58	0.000	4.00E-04	0.0	-0.0	

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Stage No.5 Fill to elevation 35.10 on RIGHT side with soil type 4

Node no.	Y coord	Effective stresses					Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
1	37.60	0.00	0.00	0.00	15.02	0.00	7015	
2	37.35	0.00	5.60	0.00	34.28	0.00a	7015	
3	37.10	0.00	11.15	0.00	53.41	0.00a	7015	
		0.00	11.15	0.00	70.11	0.00a	13365	
4	36.85	0.00	16.88	0.00	92.28	0.00a	13365	
5	36.60	0.00	22.51	0.46	114.07	0.46a	13365	
6	36.30	0.00	29.13	2.50	139.66	2.63	3554	
7	36.09	0.00	33.77	3.93	157.63	4.24	3554	
8	35.87	0.00	38.34	5.34	175.29	5.83	3554	
9	35.70	0.00	41.89	6.44	189.05	7.07	3554	
10	35.40	0.00	48.07	8.35	212.94	9.22	3554	
11	35.10	0.00	54.13	10.22	236.40	11.33	3554	
12	34.85	0.00	59.11	11.76	255.65	13.06	3554	
13	34.60	0.00	64.03	13.28	274.67	14.76	3554	
14	34.30	0.00	69.86	15.08	297.24	16.77	3554	
15	34.00	0.00	75.63	16.86	319.55	21.79	3554	
16	33.80	0.00	79.44	18.04	334.31	25.67	3554	
17	33.60	0.00	83.23	19.21	348.98	29.29	3554	
18	33.30	0.00	88.89	20.96	370.85	34.28	3554	
19	33.00	0.00	94.50	22.69	392.56	38.79	3554	
20	32.70	3.00	97.08	23.49	402.53	44.33	3554	
21	32.40	6.00	99.62	24.27	412.39	49.57	3554	
22	32.10	9.00	102.14	25.05	422.13	54.61	3554	
23	31.80	12.00	104.64	25.82	431.79	59.52	3554	
24	31.50	15.00	107.11	26.59	441.36	64.36	3554	
25	31.20	18.00	109.57	27.34	450.85	69.17	3554	

Node no.	Y coord	Effective stresses					Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
1	37.60	0.00	0.00	0.00	0.00	0.00	0.0	
2	37.35	0.00	0.00	0.00	0.00	0.00	0.0	
3	37.10	0.00	0.00	0.00	0.00	0.00	0.0	
4	36.85	0.00	0.00	0.00	0.00	0.00	0.0	
5	36.60	0.00	0.00	0.00	0.00	0.00	0.0	
6	36.30	0.00	0.00	0.00	0.00	0.00	0.0	
7	36.09	0.00	0.00	0.00	0.00	0.00	0.0	
8	35.87	0.00	0.00	0.00	0.00	0.00	0.0	
9	35.70	0.00	0.00	0.00	0.00	0.00	0.0	
10	35.40	0.00	0.00	0.00	0.00	0.00	0.0	
11	35.10	0.00	0.00	0.00	0.00	0.00	0.0	
		0.00	0.00	0.00	0.00	0.00	7109	
12	34.85	0.00	5.50	1.20	25.29	1.20a	7109	
13	34.60	0.00	11.00	2.39	50.59	2.39a	7109	
		0.00	11.00	0.00	69.53	30.20	3554	
14	34.30	0.00	16.40	0.00	90.43	44.16	3554	
15	34.00	0.00	21.80	0.24	111.33	42.03	3554	
16	33.80	0.00	25.41	1.35	125.26	41.07	3554	
17	33.60	0.00	29.01	2.46	139.20	40.49	3554	
18	33.30	0.00	34.41	4.13	160.11	40.27	3554	
19	33.00	0.00	39.82	5.80	181.03	40.74	3554	
20	32.70	3.00	42.23	6.55	190.36	43.20	3554	

(continued)

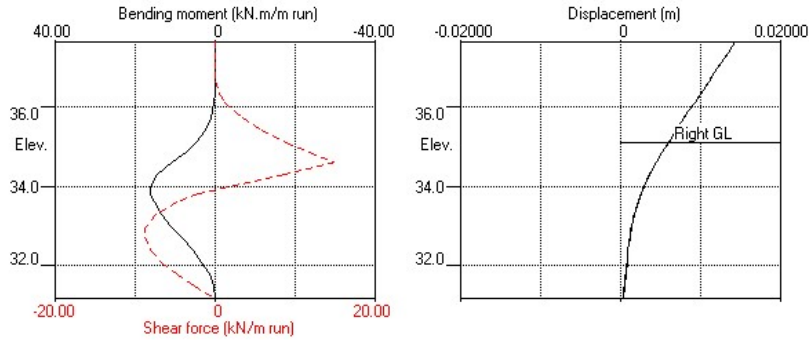
Stage No.5 Fill to elevation 35.10 on RIGHT side with soil type 4

Node no.	Y coord	Effective stresses					Total earth pressure	Coeff. of subgrade reaction
		Water press.	Vertic -al	Active limit	Passive limit	Earth pressure		
21	32.40	6.00	44.65	7.29	199.70	40.09	46.09	3554
22	32.10	9.00	47.06	8.04	209.04	40.27	49.27	3554
23	31.80	12.00	49.48	8.79	218.41	40.64	52.64	3554
24	31.50	15.00	51.91	9.53	227.78	41.10	56.10	3554
25	31.20	18.00	54.33	10.28	237.18	41.59	59.59	3554

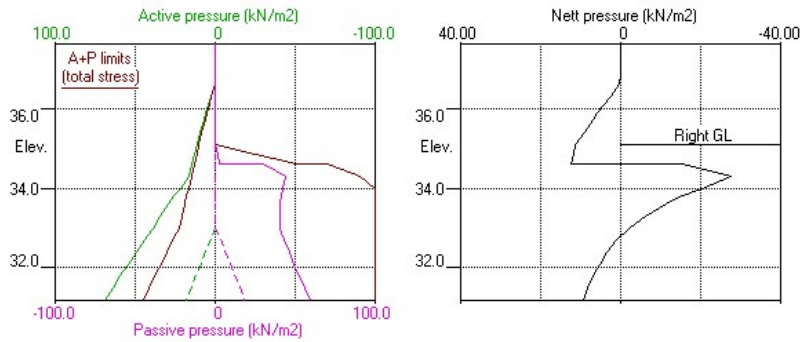
Note: 2.39a Soil pressure at active limit  
 123.45p Soil pressure at passive limit

Units: kN,m

Stage No.5 Fill to elev. 35.10 on RIGHT side



Stage No.5 Fill to elev. 35.10 on RIGHT side



Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method  
 Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 31.20		Toe elev. for FoS = 1.000		Direction of failure
				Factor of Safety	Moment at elev.	Toe elev.	Wall Penetration	
1	37.60	37.60	Cant.	Conditions not suitable for FoS calc.				
2	37.60	37.60	Cant.	Conditions not suitable for FoS calc.				
3	37.60	37.60		No analysis at this stage				
4	37.60	34.60	Cant.	1.496	31.53	33.33	1.27	L to R
5	37.60	35.10	Cant.	1.872	31.61	34.02	1.08	L to R
6	37.60	35.10	Cant.	1.641	31.57	33.82	1.28	L to R
7	37.60	35.10	Cant.	1.872	31.61	34.02	1.08	L to R
8	37.60	35.10	Cant.	1.786	31.63	33.70	1.40	L to R

TONKIN and TAYLOR GROUP LTD. | Sheet No.  
 Program: WALLAP Version 6.06 Revision A52.B71.R55 | Job No. 30314  
 Licensed from GEOSOLVE | Made by : RECA  
 Data filename/Run ID: Eastern\_RTW\_Chainage35 |  
 Kohimarama Retirement Village | Date:15-10-2019  
 Chainage35\_EasternRTW | Checked :

Run ID: Eastern\_RTW\_Chainage35 | Sheet No.  
 Kohimarama Retirement Village | Date:15-10-2019  
 Chainage35\_EasternRTW | Checked :

-----  
**Summary of results (continued)**

**Maximum and minimum displacement at each stage**

Stage no.	Displacement				Stage description
	maximum m	elev.	minimum m	elev.	
1	0.000	35.10	0.000	37.60	Apply surcharge no.1 at elev. 37.60
2	0.001	31.20	0.000	37.60	Apply surcharge no.2 at elev. 37.60
3	Wall displacements reset to zero				Change EI of wall to 12671kN.m2/m run
4	0.014	37.60	0.000	37.60	Excav. to elev. 34.60 on RIGHT side
5	0.014	37.60	0.000	37.60	Fill to elev. 35.10 on RIGHT side
6	0.016	37.60	0.000	37.60	Apply water pressure profile no.1
7	0.016	37.60	0.000	37.60	Apply water pressure profile no.2
8	0.018	37.60	0.000	37.60	Apply load no.1 at elev. 35.87

Units: kN,m

**Summary of results**

**BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall**

**Analysis options**

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq Influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall  
 Right side 20.00 from wall

**Bending moment, shear force and displacement envelopes**

Node no.	Y coord	Displacement		Bending moment		Shear force	
		maximum m	minimum m	maximum kN.m/m	minimum kN.m/m	maximum kN/m	minimum kN/m
1	37.60	0.018	0.000	0.0	0.0	0.0	0.0
2	37.35	0.017	0.000	0.0	-0.0	0.1	-0.1
3	37.10	0.016	0.000	0.0	-0.0	0.1	-0.1
4	36.85	0.015	0.000	0.0	-0.1	0.0	-0.2
5	36.60	0.014	0.000	0.0	-0.1	0.1	-0.3
6	36.30	0.013	0.000	0.1	-0.2	0.6	-0.3
7	36.09	0.012	0.000	0.3	-0.3	1.4	-0.3
8	35.87	0.011	0.000	0.7	-0.3	8.0	-0.3
9	35.70	0.010	0.000	2.1	-0.3	9.0	-0.3
10	35.40	0.009	0.000	5.1	-0.4	11.2	-0.2
11	35.10	0.007	0.000	8.8	-0.4	14.0	-0.2
12	34.85	0.007	0.000	12.7	-0.4	14.8	-0.1
13	34.60	0.006	0.000	16.2	-0.5	15.2	-0.0
14	34.30	0.005	0.000	20.0	-0.5	9.0	0.0
15	34.00	0.005	0.000	21.1	-0.4	1.9	-0.4
16	33.80	0.004	0.000	20.6	-0.4	0.2	-4.2
17	33.60	0.004	0.000	19.4	-0.4	0.1	-7.1
18	33.30	0.003	0.000	16.7	-0.3	0.2	-9.9
19	33.00	0.003	0.000	13.5	-0.3	0.2	-11.0
20	32.70	0.003	0.000	10.1	-0.2	0.2	-11.0
21	32.40	0.003	0.000	6.9	-0.2	0.2	-10.0
22	32.10	0.002	0.000	4.1	-0.1	0.2	-8.3
23	31.80	0.002	0.000	1.9	-0.0	0.1	-6.0
24	31.50	0.002	0.000	0.5	-0.0	0.1	-3.2
25	31.20	0.002	0.000	0.0	-0.0	0.0	0.0

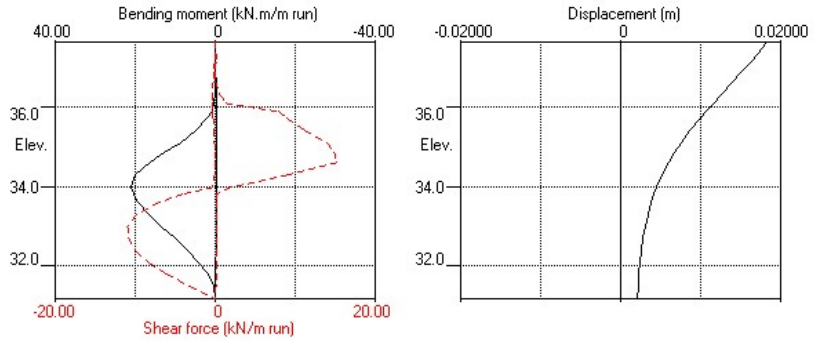
**Maximum and minimum bending moment and shear force at each stage**

Stage no.	Bending moment				Shear force			
	maximum kN.m/m	elev.	minimum kN.m/m	elev.	maximum kN/m	elev.	minimum kN/m	elev.
1	0.0	37.60	-0.4	35.10	0.2	33.80	-0.3	36.60
2	0.0	37.10	-0.5	34.60	0.2	32.70	-0.3	36.09
3	No calculation at this stage							
4	15.3	34.00	-0.0	31.20	14.1	34.60	-8.3	32.70
5	16.3	34.00	-0.0	31.20	14.9	34.60	-8.8	32.70
6	15.9	34.00	-0.0	31.20	13.7	34.60	-8.6	32.70
7	17.5	34.00	-0.0	31.20	15.2	34.60	-9.5	32.70
8	21.1	34.00	-0.0	31.20	14.8	34.85	-11.0	33.00



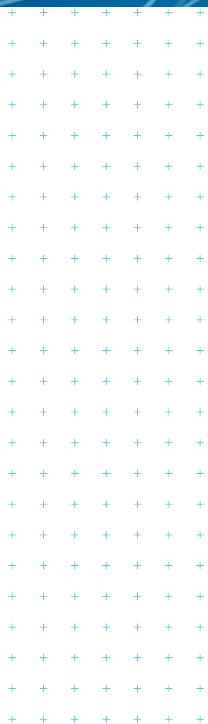
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Units: kN,m

Bending moment, shear force, displacement envelopes



## **Appendix H: Construction monitoring and contingency plan**

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## Document Control

Title: Construction Monitoring and Contingency Plan - Draft					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
8/2019	R0	Draft	GUSI	PT	
10/2019	R1	Draft	RECA	PT	

### Distribution:

Ryman Healthcare Limited

Tonkin & Taylor Ltd (FILE)

1 copies

1 electronic copy

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<b>Appendix A : Proposed Construction Monitoring Plan</b>		



## 1 Introduction

Ryman Healthcare (Ryman) is proposing to build a comprehensive care retirement village at 223 Kohimarama Road and 7 John Rymer Place, Kohimarama.

- A 6 level main building (B01) with communal amenities, serviced care suites, care beds and basement carparking;
- Three 5 level apartment buildings (B02, B04 and B06);
- Two 3 level apartment buildings (B03 and B05);
- A shared basement carpark/podium covering the footprint of buildings B02 to B06 with a bowling green.

A main accessway through from John Rymer Place to Kohimarama Road will be constructed between Building B01 and Buildings B02-B03.

This monitoring and contingency plan (M&CP) presents a summary of the extent and range of monitoring procedures that shall be put in place pre-construction, during construction and post. This plan identifies 'Alert' and 'Alarm' trigger levels, and recommends the courses of action to be taken should they be reached.

This M&CP is based on the assumed works identified in the following reports prepared for the project:

- Geotechnical effects report for 223 Kohimarama Road and 7 John Rymer Place, Kohimarama, Auckland, by T+T referenced 30314 dated October 2019

### 1.1 Site Description

The Site falls from Kohimarama Road towards the southeast, and has a series of undulations in the topography. At the western extent, the ground drops steeply (30 to 35°) into a valley that drains into the Orakei Basin. An old, flat playing field is located in the central area of the Site. The northern boundary is generally level with Selwyn College, except for an existing 60 m long, typically up to 1 m high, timber pole retaining wall. The southern and eastern boundaries are bounded by residential developments. A number of low retained height timber walls are constructed on neighbouring properties that are close to the Site boundaries.

## 2 Definitions

<b>AC</b>	Means the Auckland Council
<b>Commencement of Excavation</b>	Commencement of bulk site excavation <u>excluding</u> all foundation/footing and piling, or excavation beyond 10 m of the perimeter retaining wall.
<b>Completion of Excavation</b>	When all bulk excavation has been completed and all foundation/footing excavations within 10 m of the perimeter retaining wall have been completed
<b>Completion of Construction</b>	Means when the Certificate of completion is issued by AC.
<b>Significant Damage</b>	When damage is considered to affect function, serviceability or structural integrity.
<b>Serviceability Damage</b>	For example when doors and windows start sticking.
<b>Alert Level</b>	Monitored parameter reaches a level close to, or equal to the design value, which is above the level where damage could occur, and requires review of available monitoring information (plus other information) to assess the future trend
<b>Alarm Level</b>	Monitored parameter reaches the design value, and/or level close to which damage could occur, and requires immediate action including the cessation of ground dewatering and other construction activities that may have an effect on ground deformation.
<b>The Team Leader</b>	Team Leader Compliance and Monitoring Central Auckland Council (AC), or nominated AC staff acting on The Team Leader's behalf.
<b>RL</b>	Reduced Level.
<b>Services</b>	Includes for example fibre optic cables, sanitary drainage, gas and water mains, power and telephone, road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture. Plans showing the locations of buried services are included in Appendix A.



## 3 Monitoring

### 3.1 General

Monitoring of the excavation works and surroundings will be undertaken to check that the ground settlements and retaining wall deflections are consistent with the design analyses and that the response of the structures are within design tolerances.

The monitoring requirements for the development has been proposed to support the resource consent.

Instruments shall be installed by the Contractor. Monitoring results shall be submitted to the Project Managers and Geotechnical Representatives in electronic format (excel spreadsheet or similar) within 24 hours of the monitoring being undertaken, at the intervals set out in the M&CP and resource conditions to confirm compliance to the RC conditions.

Table 3.1 is a list of monitoring instrumentation required for the proposed development. Refer to Drawing No. 30314.0001-F10 Rev 1 for their locations.

**Table 3.1: Monitoring summary**

Type	Monitoring ID #	Refer to section
Building condition surveys	N/A	3.2
Retaining wall survey pins	RTW 1 to RTW 26	3.4
Ground settlement survey pins	GS 1 to GS 13	3.5
Building settlement survey pins	BS 1 to BS 11	3.5

Should any of the monitoring pins be damaged and become in-operable, then the Council is to be informed and a new monitoring bore or pin may be required to be drilled at a nearby location as agreed in consultation with the Team Leader and the Geotechnical Representative.

### 3.2 Building Condition Surveys

Surveys of buildings listed below in Table 3.2 are to be undertaken by the Construction Contractor's appointed Chartered Professional Structural Engineer prior to the commencement of excavation and following the Completion of Construction.

Pre-excavation and post-construction surveys are not required if the consent holder can provide reasonable evidence to Auckland Council that the current owner of that building has agreed they do not require such surveys.

The following details shall be included in the survey:

- 1 Any information about the type of foundations;
- 2 Existing levels of external aesthetic damage;
- 3 Existing levels of external serviceability damage, considered to affect the function of the building where visually apparent without intrusive or destructive investigation;
- 4 Susceptibility of structure to further movement;
- 5 Photographic evidence of (2), (3) and (4);
- 6 Review of the proposed alarm/alert trigger levels to confirm they are appropriately set and movement less than trigger levels will not exacerbate damage, and whether the monitoring frequency and locations are adequate; and

### 7 Recommended locations for building monitoring marks.

Within six months of completion of construction, a post-construction survey covering the matters identified in the pre-construction survey should be completed for any precisely surveyed building. The survey report should include a determination of the cause of damage identified (if any) since the pre-construction or previous survey and steps to repair it.

**Table 3.2: Properties / Buildings Requiring Condition Surveys**

Address	Legal Title
203 Kohimarama Road	Lot 2 DP 332284 - Various Buildings along northern boundary of Selwyn College

### 3.3 Visual Inspections

In addition to the building condition surveys, visual inspections of the surrounding ground within 25 m of excavation works, shall be carried out to monitor any deterioration or cracking. A record is to be maintained of the time, date, location, type of construction activity occurring around that time (if applicable) and any observations of each inspection. This shall be carried according to the schedule below:

Commencement of bulk excavations	One inspection shall be undertaken at commencement of bulk excavations.
During construction	One inspection is to be carried out midway between the start and the completion of construction.
At completion of construction	One inspection is to be undertaken upon completion of Construction.
Between six and twelve months after completion of construction	One inspection of all previously surveyed areas.

### 3.4 Retaining Wall Deflection Monitoring

The retaining wall system will be monitored by retaining wall pins.

- RTW 1 to RTW 7 for the boundary wall north of Building B02, B04 and B06.
- RTW 14 to RTW 20 for the basement wall north of Building B02, B04 and B06.
- RTW 8 to RTW 13 for the boundary wall north of Building B01
- RTW 21 to RTW 26 for the basement wall north of Building B01

Location details of the survey monitoring points are shown in Drawing No. 30314.0001-F10 in Appendix A.

#### 3.4.1 Retaining Wall Monitoring Intervals

Measurements shall be accurate to  $\pm 2$  mm for the survey pins. At least two baseline surveys shall be undertaken before commencement of any bulk excavation. A minimum of 24 hours shall apply between reading sets. All survey results should be submitted to the Project Managers and Geotechnical Representatives within three working days of taking the readings to confirm compliance.

Retaining wall survey pins shall be surveyed and recorded at a minimum frequency of weekly intervals from the commencement of excavations until the completion of construction.

Following the completion of construction, surveying and recording shall be carried out at monthly intervals for six months, or until such time following the completion of constructions where stable measurements are demonstrated

### 3.4.2 Retaining Wall Deflection Trigger Levels

Results of this monitoring are to be compared with the design assumptions and baseline readings. Trigger Levels at which actions are required to be undertaken and are summarised in Table 3.3. If the Trigger Levels in Table 3.3 are reached, the actions outlined in Section 6.0 shall be carried out by the Contractor.

**Table 3.3: Trigger level for retaining wall lateral movement**

Monitoring point	Alert trigger level (mm)	Alarm trigger level (mm)
RTW 1-RWT4, RTW6, RW7	45	65
RW5	15	20
RTW8 to RTW10	55	75
RTW11 to RTW13	30	45
RTW15 To RTW17, RTW19-RTW 20	40	60
RTW18	15	20
RTW21 to RTW26	30	40

## 3.5 Settlement Monitoring

Ground and building deformation monitoring marks shall be established on the pavements and buildings surrounding the proposed retention structures. The monitoring points will be surveyed twice prior to commencement of Excavations. A minimum of 24 hours shall apply between reading sets.

Location details of the survey monitoring points are shown in Drawing No. 30314.0001-F10 in Appendix A.

### 3.5.1 Settlement Monitoring Intervals

Measurements shall be accurate to  $\pm 2$  mm. At least two baseline surveys shall be undertaken before commencement of excavation in order to establish a baseline reading. All survey results should be submitted to the Project Managers and Geotechnical Representatives within three working days of taking the readings to confirm compliance.

Retaining wall survey pins shall be surveyed and recorded at a minimum frequency of weekly intervals from the commencement of excavations until the completion of construction.

Following the completion of construction, surveying and recording shall be carried out at monthly intervals for six months, or until such time following the completion of constructions where stable measurements are demonstrated.

### 3.5.2 Settlement Trigger Levels

Results of this monitoring are to be compared with the design assumptions and baseline readings.

Trigger Levels at which actions are required to be undertaken and are summarised in Table 3.3. If the Trigger Levels in Table 3.4 and Table 3.5 are reached, the actions outlined in Section 6.0 shall be carried out by the Contractor.

**Table 3.4: Ground deformation mark trigger levels**

Mark ID	Comment	Settlement Alert Level (mm)	Settlement Alarm Level (mm)	Differential Settlement Alert Level	Differential Settlement Alarm Level
<b>Ground Settlement Pins</b>					
GS 1 to GS 13	Northern boundary	20	30	1:750	1:400

**Table 3.5: Building deformation mark trigger levels**

Mark ID	Comment	Settlement Alert Level (mm)	Settlement Alarm Level (mm)	Differential Settlement Alert Level	Differential Settlement Alarm Level
<b>Building Survey Pins</b>					
BS1, BH3, BH5	Selwyn College (>10 m from boundary)	8	10	1:750	1:1000
BS2 and BS4, BS6 to BS11	Selwyn College (<5 m from boundary)	8	10	1:750	1:1000

## 4 Summary of monitoring frequency requirements

The monitoring frequency requirements detailed in the previous sections are summarised in Table 4.1:

**Table 4.1: Summary of Monitoring Frequency Requirements**

Monitoring System	Monitoring Locations	Prior to excavation commencing	Commencement of excavation	During construction	At completion of construction	After completion of construction
Building Condition Surveys	Northern boundary of Selwyn College and Lot 2 DP318859	<b>Pre excavation survey</b> to be carried out as per details in Section 3.2	N/A	N/A	N/A	<b>A post-construction survey</b> Within six months of completion of construction covering the matters identified in the pre-construction survey
Ground (visual condition survey and inspections)	Surrounding ground	N/A	<b>One inspection</b> to be carried out at commencement of excavation	<b>One inspection</b> is to be carried out midway between the start and the completion of construction.	<b>One inspection</b> is to be undertaken upon completion of Construction.	<b>A post-construction survey</b> of all previously surveyed ground is to be undertaken between six to twelve months after construction
Retaining wall deformation monitoring (monitoring of survey marks by surveyor)	RTW 1 to RTW 26	<b>Two baseline surveys</b> undertaken before commencement of excavation	At <b>weekly intervals</b> from the commencement of excavations	At <b>weekly intervals</b> during construction	N/A	At <b>monthly intervals</b> for six months following completion of construction.
Ground and building deformation settlement monitoring (monitoring of survey marks by surveyor)	GS 1 to GS 13 BS 1 to BS 11	<b>Two baseline surveys</b> undertaken before commencement of excavation	At <b>weekly intervals</b> from the commencement of excavations	At <b>weekly intervals</b> during construction	N/A	At <b>monthly intervals</b> for six months following completion of construction.

Note: Monitoring frequency may be reduced if stable measurements are demonstrated or marks are obscured by construction activity and written approval is granted from the Council.

## 5 Reporting of monitoring records

### 5.1 Reporting intervals and requirements

All monitoring records as detailed in this report shall be compiled and submitted to the Engineer at monthly intervals from the commencement of excavation until three months after the completion of excavation (or at such time following the completion of excavation that stable measurements are demonstrated).

Each report shall include the following:

- 1 Monitoring records presented in a tabulated format as well as on a timeline plot;
- 2 Comparison of monitoring data with trigger levels and the assumed design models;
- 3 Previous results set out with an explanation of any trends;
- 4 A construction progress summary; and
- 5 Any other information relevant to the reporting period (i.e. exceedance of trigger levels and contingency measures being undertaken).

## 6 Alert and alarm trigger level response procedures

### 6.1 Response procedure if the alert trigger levels are exceeded

In the event of any Alert Level being exceeded, the following shall be carried out:

- 1 Notify the Project Manager,
- 2 Notify the Council, in writing within one working day of the trigger level being exceeded, with details of any actions being undertaken.
- 3 Survey all survey monitoring points within 25 m of the affected monitoring mark(s) to confirm the extent of deformation and exceedance of the Alert Trigger.
- 4 Ensure the monitoring data is reviewed, and advice provided, by a SQEP on the need for mitigation measures or other actions necessary to avoid further deformation. Where mitigation measures or other actions are recommended those measures shall be implemented. The review shall include as-built details, geology and comparison against the assumptions made in the design analyses.
- 5 Submit a written report, prepared by the SQEP responsible for overseeing the monitoring, to the Team Leader, Auckland Council within five working days of alert trigger level exceedance. The report shall provide analyses of all monitoring data, including wall deflection and settlement monitoring, relating to the exceedance actions taken to date to address the issue and recommendations for future remedial actions necessary to prevent Alarm Levels be exceeded.
- 6 Measure and record all Monitoring Stations within 25 metres of the location of any Alert Level exceedance every two days until such time that the written report referred to above has been submitted to the team leader and Auckland Council.

If considered necessary;

- 7 Increase monitoring frequency, or
- 8 Develop a detailed contingency plan and submit to the Council.

### 6.2 Response procedure if the alarm trigger levels are exceeded

In the event of any Alert Level being exceeded, the following shall be carried out:

- 1 Immediately halt construction activity, including excavation, or any other works that may result in increased deformation, unless halting the activity is considered by a suitably qualified person to be likely to be more harmful (in terms of effects on the environment) than continuing to carry out the activity.
- 2 Notify the Team Leader, Geotechnical Representative and Auckland Council within 24 hours of the Alarm Level exceedance being detected and provide details of the measurements taken.
- 3 Undertake a condition survey by a SQEP or SQBS of any building or structure located adjacent to any monitoring station where the Alarm Level has been exceeded.
- 4 Take advice from the author of the Alert Level exceedance report (if there is one) or other SQEP on actions required to avoid remedy or mitigate adverse effects on ground, buildings or structures that may occur as a result of the exceedance.
- 5 Not resume construction activities (or any associated activities), subject to any contrary recommendation made in accordance with paragraph 1), above, until mitigation measures have been implemented, to the satisfaction of a SQEP, that will avoid Damage, if this is considered likely.
- 6 Submit a written report, prepared by a SQEP responsible for overseeing the monitoring, for certification by the Team Leaders, Auckland Council on the results of the condition survey(s), the mitigation measures implemented and any remedial works and/or agreements with affected parties within five working days of recommencement of works.

Excavation and/or construction may be resumed once the SQEP provides written notice to the Contractor that the SQEP is satisfied that damage to buildings, structures and services is unlikely with or without any approved additional mitigation measures to be undertaken. And that the Council is satisfied that owners of potentially affected buildings, structures and services have given written approval for dewatering and/or construction to continue.

## 7 Contingency options

If any of the monitoring trigger levels are exceeded the general response will be as detailed in Section 5. Specific actions will be selected depending on the exact nature of the problem. However, as a minimum the consent holder shall:

- 1 Notify the Council and the asset owner within 5 working days of the consent holder becoming aware of the damage.
- 2 Seek permission from the owner of a building, structure or service for a SQEP to prepare a report that: describes the damage; identifies the cause of the damage; identifies methods to remedy and/or mitigate the damage that has been caused; identifies the potential for further damage to occur; and describes actions that will be taken to avoid further damage.
- 3 Provide a copy of the report, prepared under 2) above, to the Council and the asset owner within 1 working days of notification under 1) above.

Additional contingency measures that may be undertaken as part of a ground and building deformation monitoring trigger level exceedance include:

- 4 Discussions on the situation with the property/service owner that may be affected.
- 5 Monitor the rate of settlement (assuming that other steps have been undertaken to address the cause).
- 6 Prop basement or site retaining walls should retaining wall deflection be the cause.
- 7 Check public safety is maintained.

## 8 Notice of completion

The Team Leader shall be advise in writing within 10 working days of when excavation and construction has been completed.

## 9 Applicability

This report has been prepared for the exclusive use of our client Ryman Healthcare Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:

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Gurkunwar Bedi  
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

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Pierre Malan  
Senior Geotechnical Engineer / Project Director

Report reviewed by:

.....

Prisca Tang  
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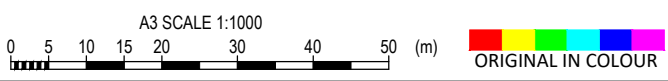
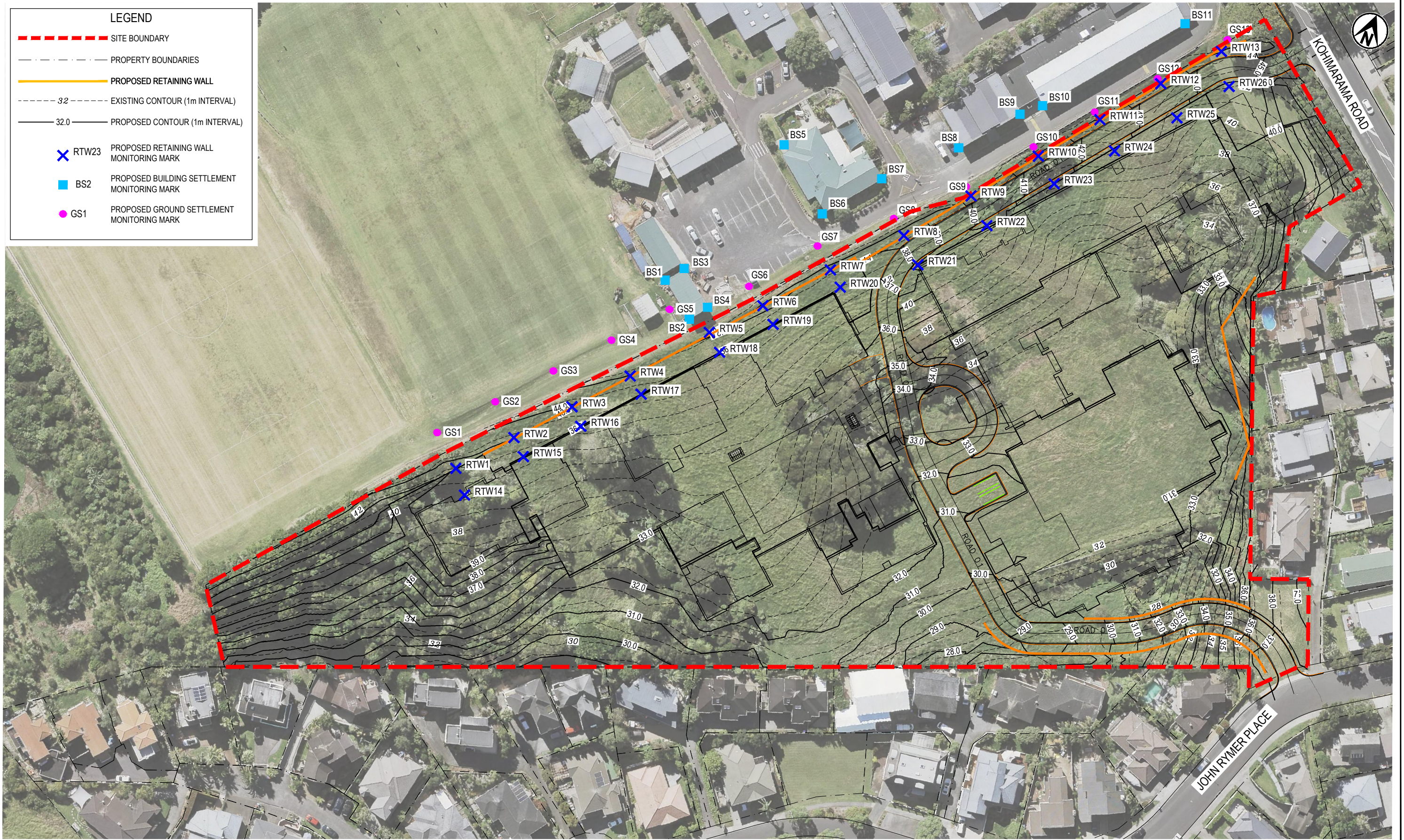
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**Appendix A: Proposed Construction Monitoring  
Plan**

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DRAFT



- NOTES:
1. AERIAL PHOTOGRAPH AND PARCEL BOUNDARIES SOURCED FROM AUCKLAND COUNCIL GEOMAPS SERVICE UNDER CC BY 3.0-NZ LICENCE.
  2. BASEPLAN SUPPLIED BY BECA. REF " 044-RCT\_401\_C0-003.dwg" DATED OCT 17 2019.
  3. EXISTING CONTOUR SUPPLIED BY BECA. REF " 3124460-221-EX Topo.dwg" DATED AUG 08 2019.
  4. PROPOSED CONTOUR SUPPLIED BY BECA. REF "3124460-221-PR Contours.dwg" DATED OCT 17 2019.

PROJECT No. 30314.0001		
DESIGNED	GUSI	Oct.18
DRAWN	JC	Oct.18
CHECKED		
APPROVED		DATE

CLIENT	RYMAN HEALTHCARE LIMITED
PROJECT	RYMAN SITE 3 - GEOTECHNICAL INVESTIGATION
TITLE	223 KOHIMARAMA ROAD AND 7 JOHN RYDER PLACE CONSTRUCTION MONITORING PLAN
SCALE (A3)	1:1000
FIG No.	30314.0001-F10
REV	1

