Appendix C – Groundwater and soil parameters

Appendix C Table 1: Groundwater levels reported in GIR and adopted for settlement analyses

Shaft ID	Borehole ID	Geological unit	Groundwater levels reported in GIR	Groundwater levels adopted for settlement analysis. Inference of summer low groundwater levels.
SH01	BH_127851	Res ECBF, ECBF	None	48.9 m RL In the absence of monitoring data, groundwater level taken from open hole dip the morning after drilling (Ref: BH_127851, NZGD).
SH02	BH06	Res ECBF	0.56 m bGL 43.15 m RL	43.0 m RL Based on more recent data from the Beyond Monitoring dashboard. Groundwater level taken from the standpipe in BH06, as the VWPs are in weathered to unweathered rock and do not represent groundwater in the upper materials.
	BH07	W ECBF	4.13 m bGL 38.07 m RL	
	BH07	ECBF	4.28 m bGL 37.92 m RL	
SH03	BH10	Alluvium	0.8 m bGL 25.44 m RL	25.4 m RL Based on more recent data from the Beyond Monitoring dashboard. VWP1 in BH11 indicates artesian conditions and was not considered appropriate to assess settlement within alluvium. Therefore, a conservative value was taken from the BH10 standpipe.
	BH11	Alluvium	-2.5 m bGL 29.42 m RL	
	BH11	ECBF	1.62 m bGL 25.3 m RL	
	BH11	ECBF	0.82 m bGL 26.1 m RL	
SH04	BH14	Alluvium	4.7 m bGL 17.08 m RL	17.5 m RL Adopted groundwater level based on dip measurement from the closer borehole (BH14) standpipe.
	BH15	Alluvium	3.09 m bGL 19.65 m RL	
	BH15	ECBF	-0.46m bGL 23.2 m RL	
SH05	BH17	Alluvium, Res ECBF, ECBF	0.04 m bGL 18.96 m RL	17.0 m RL The measured groundwater level in BH17 was deemed an unrealistic summer low; therefore, an assumed value of 2.0 m bGL was adopted.
	BH18	Res ECBF	1.71 m bGL 18.6 m RL	
	BH18	ECBF	3.01 m bGL 17.3 m RL	
	BH19	ECBF	1.28 m bGL 16.53 m RL	

Shaft ID	Borehole ID	Geological unit	Groundwater levels reported in GIR	Groundwater levels adopted for settlement analysis. Inference of summer low groundwater levels.
SH06	BH21	Res ECBF/ECBF	3.5 m bGL 12.88 m RL	12.6 m RL VWPs in BH22 are installed in ECBF rock and do not reflect upper material conditions. Therefore, a morning dip from BH21 was adopted.
	BH22	ECBF	1.6 m bGL 16.7 m RL	
	BH22	ECBF	-10.51 m bGL 28.81 m RL	
SH07	BH24	ECBF	2.13 m bGL 10.64 m RL	10.6 m RL Based on more recent data from the Beyond Monitoring dashboard. VWPs in BH24 are installed in ECBF rock and are not representative of shallow conditions. Groundwater depths are generally around 2.0 m bGL.
	BH24	Res ECBF	1.53 m bGL 11.24 m RL	
	BH25	Res ECBF	1.92 m bGL 11.6 m RL	
SH07a	BH28	n/a	3.38 m bGL 8.84 m RL	9.8 m RL No formal monitoring data available. Morning dip readings from BH28 used as basis.
SH08	BH32	ECBF	4.6 m bGL 6.47 m RL	9.9 m RL VWPs in BH32 are located within deep ECBF rock and do not reflect shallow groundwater. An assumed depth of 2.0 m bGL was adopted.
	BH32	ECBF	-4.81 m bGL 15.88 m RL	
SH09	BH35	Res ECBF	-3.02 m bGL 61.94 m RL	56.2 m RL Due to different readings between VWP1 in BH35 and the BH36 standpipe, a groundwater depth of 3.0 m bGL was adopted.
	BH35	ECBF	9.77 m bGL 49.15 m RL	
	BH36	Res ECBF/ EBCF	14.3 m bGL 45.16 m RL	
SH10	BH38	Res ECBF / ECBF	3.60 m bGL 50.27 m RL	48.3 m RL Groundwater depth adopted from dip measurement within the BH38 standpipe.
	BH38	ECBF	10.09 m bGL 43.78 m RL	
SH11	BH39	ECBF	2.5 m bGL 48.65 m RL	48.9 m RL Groundwater depth adopted from dip measurement within the BH39 standpipe.
	BH39	ECBF	-4.63 m bGL 55.78 m RL	
SH12	BH45	Res ECBF	5.35 m bGL 47.22 m RL	45.3 m RL Variable groundwater levels observed in upper materials; therefore, a conservative depth of 5.0 m bGL was selected. VWP2 is located in ECBF rock.
	BH45	ECBF	0.62 m bGL 51.95 m RL	
	BH46	Res ECBF	7.85 m bGL 44.82 m RL	

Shaft ID	Borehole ID	Geological unit	Groundwater levels reported in GIR	Groundwater levels adopted for settlement analysis. Inference of summer low groundwater levels.
SH12a	BH43	Fill/Alluvium	1.66 m bGL 40.92 m RL	42.3 m RL VWP in BH44 is in ECBF rock and not representative of shallow groundwater. A drilling dip from BH43 was used; an assumed value of 2.0 m bGL was adopted.
	BH44	ECBF	-1.25 m bGL 46.43 m RL	
SH13	BH48	ECBF	4.46 m bGL 30.03 m RL	32.0 m RL Both VWPs are located in ECBF rock and are unrepresentative of shallow conditions. An assumed value of 2.0 m bGL was adopted.
	BH48	ECBF	12.29 m bGL 22.2 m RL	
SH14	BH49	Res ECBF	5.5 m bGL 21.37 m RL	27.2 m RL Both VWPs are within ECBF rock and do not represent the upper unit. An assumed value of 2.0 m bGL was adopted.
	BH49	ECBF	11.42 m bGL 15.45 m RL	
	BH49	ECBF	-0.20 m bGL 27.07 m RL	
SH15	BH51	Alluvium	1.32 m bGL 21.2 m RL	22.1 m RL Groundwater level measured from BH51 standpipe screened across alluvium. Therefore, 1.3 m bGL was adopted.

Appendix C Table 2: Hydraulic conductivity reported in GIR

Geotechnical Unit	K_h (m/s)	K_v (m/s)
Fill - Undifferentiated	4.0E-10	4.0E-10
Basalt	1.0E-04	1.0E-04
Tauranga Group – Alluvium Undifferentiated	4.0E-09	4.0E-10
ECBF Residual Soil	6.0E-10	6.0E-11
ECBF Weathered	2.0E-08	2.0E-09
ECBF Unweathered/Slightly Weathered Rock	2.0E-07	2.0E-08

Appendix C Table 3: Soil compressibility reported in GIR

Geotechnical Unit	Mv (1/MPa)	E (MPa)	Source
Tauranga Group – Alluvium Undifferentiated	0.27	4	GIR

Appendix C Table 4: Soil compressibility adopted for settlement effects assessment

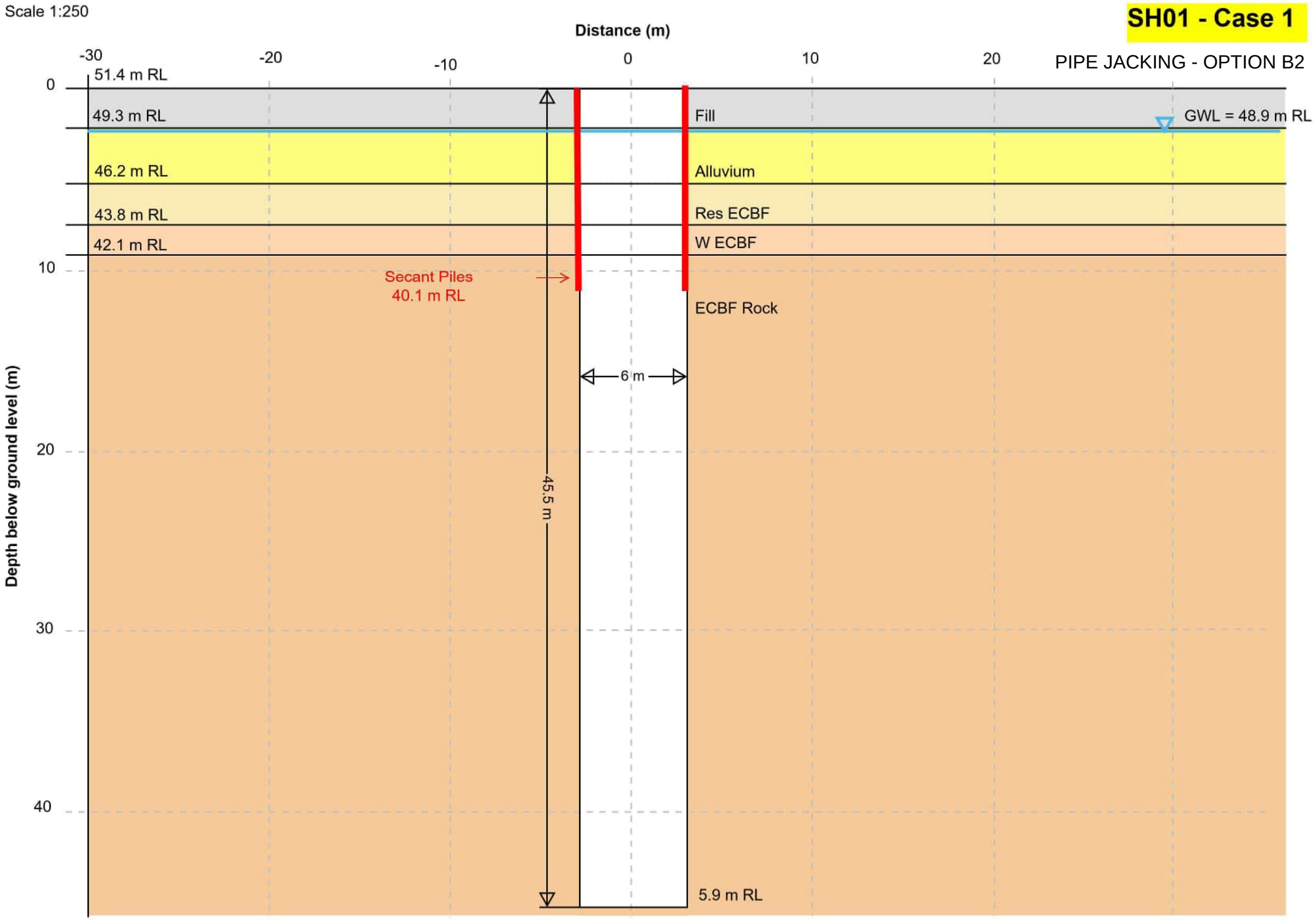
Geotechnical Unit	Mv (1/MPa)	E (MPa)	Source/ method
Fill - Undifferentiated	0.20	5	E50 Ratio
Basalt	Incompressible	Incompressible	None
Tauranga Group – Alluvium Undifferentiated	0.27	4	GIR
ECBF Residual Soil	0.05	20	E50 Ratio
ECBF Weathered	0.02	50	E50 Ratio
ECBF Unweathered/Slightly Weathered Rock	Incompressible	Incompressible	None

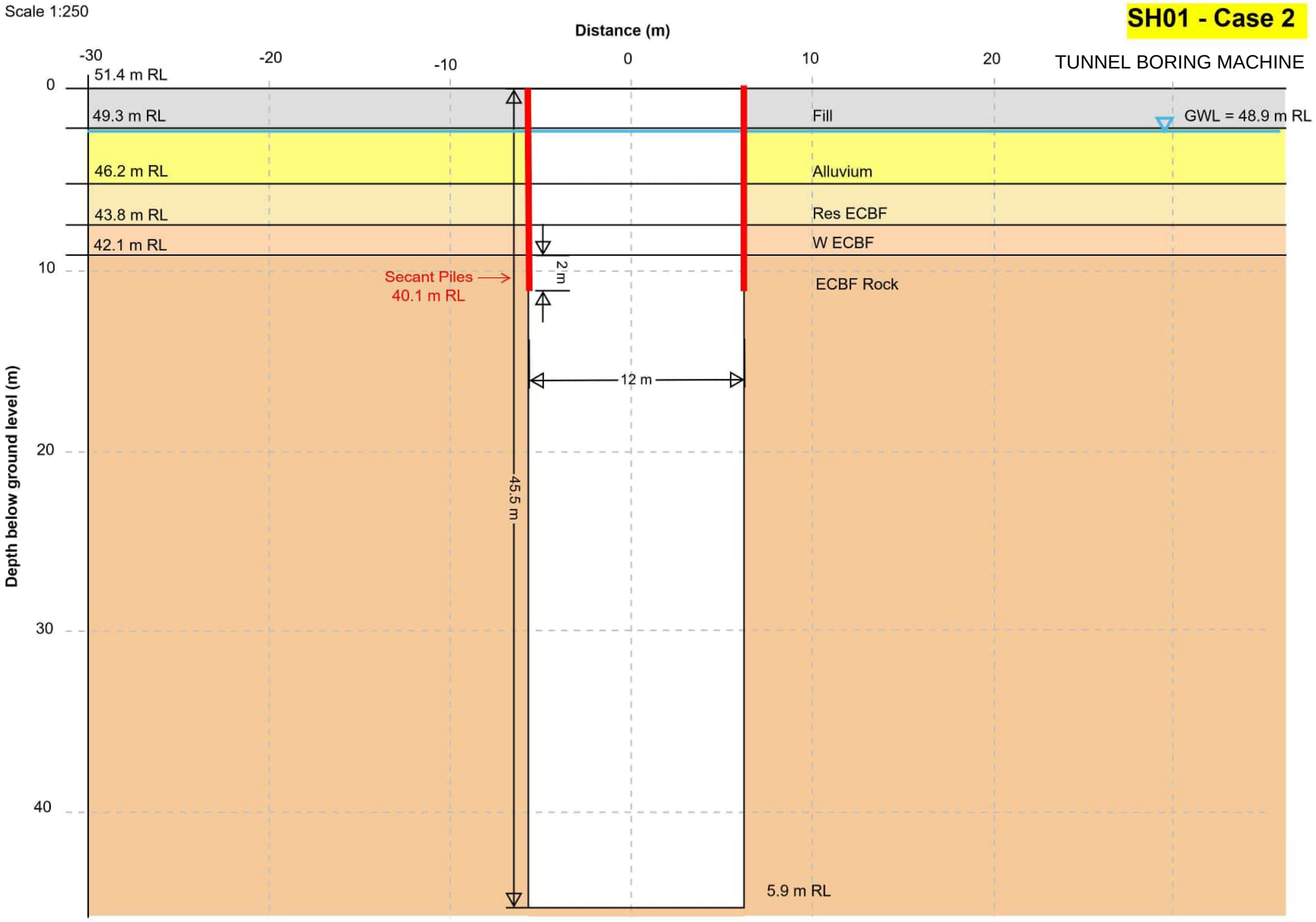
Appendix C Table 5: Hydraulic conductivity adopted for settlement effects assessment

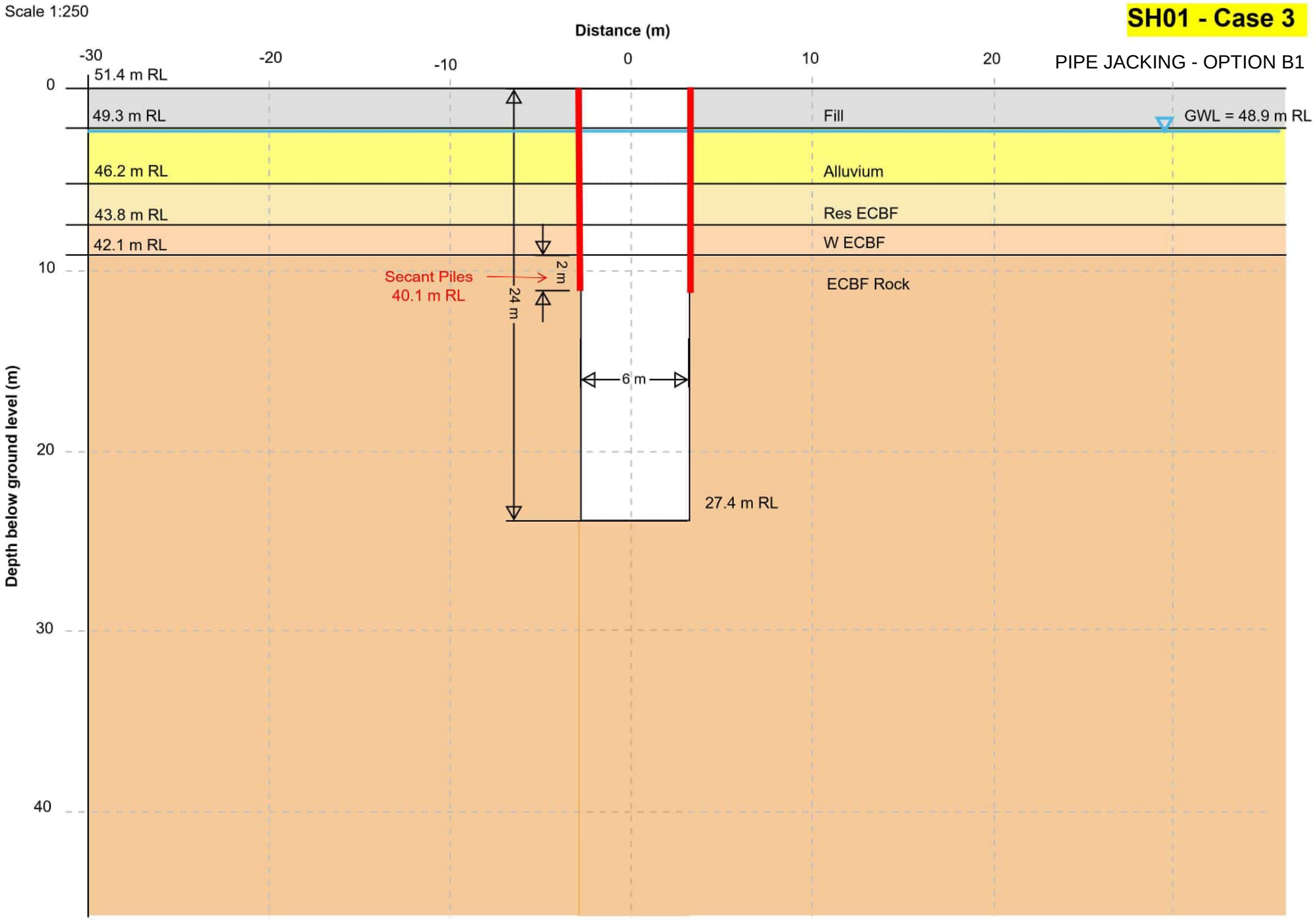
Shaft location	Geological Unit	K_h (m/s)	K_v (m/s)
SH07a	Basalt	1E-04	1E-05
All shafts excluding SH07a	Various (excluding basalt)	1E-07*	1E-08*

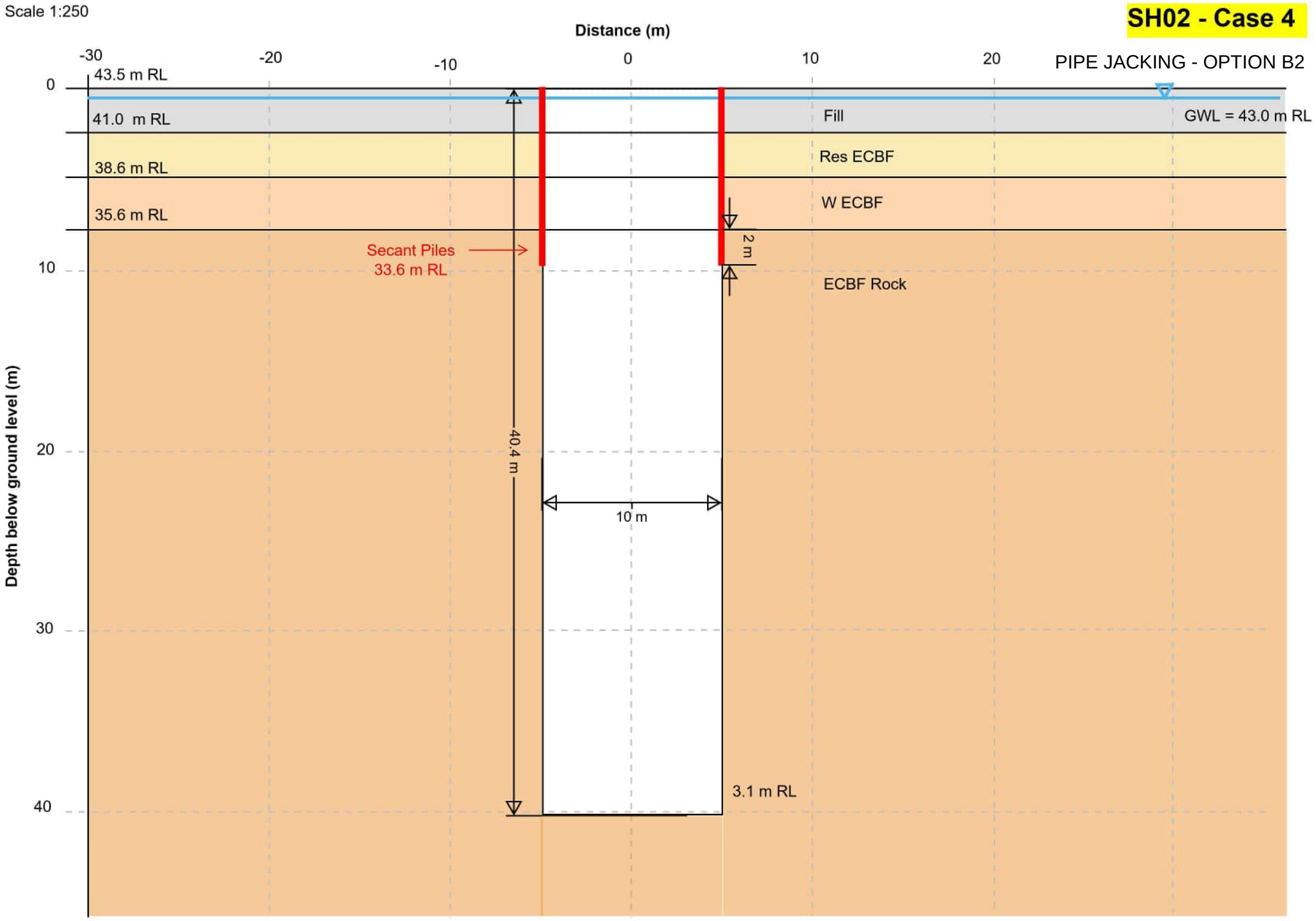
*A geometric mean Kh of 1×10^{-9} m/s was calculated from all geological units presented in the Geotechnical Interpretive Report (excluding basalt). For moderate conservative modelling assessment purposes, Kh was adopted as 1×10^{-7} m/s — two orders of magnitude higher (more permeable) than the calculated geometric mean — to represent a bulk hydrogeological system. The Kv value was set at 1×10^{-8} m/s, i.e. one order of magnitude lower than the adopted Kh.

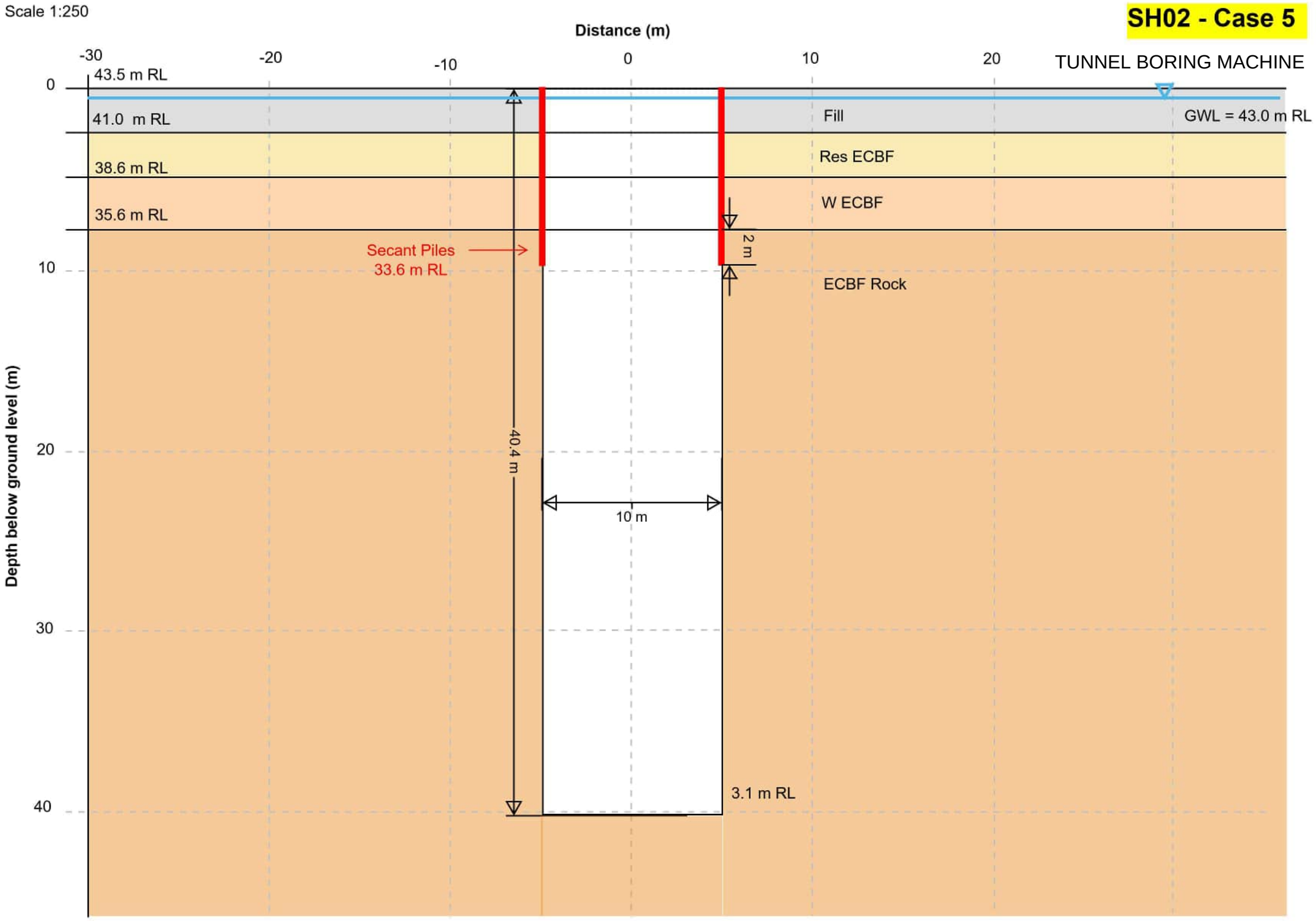
Appendix D – Shaft ground models

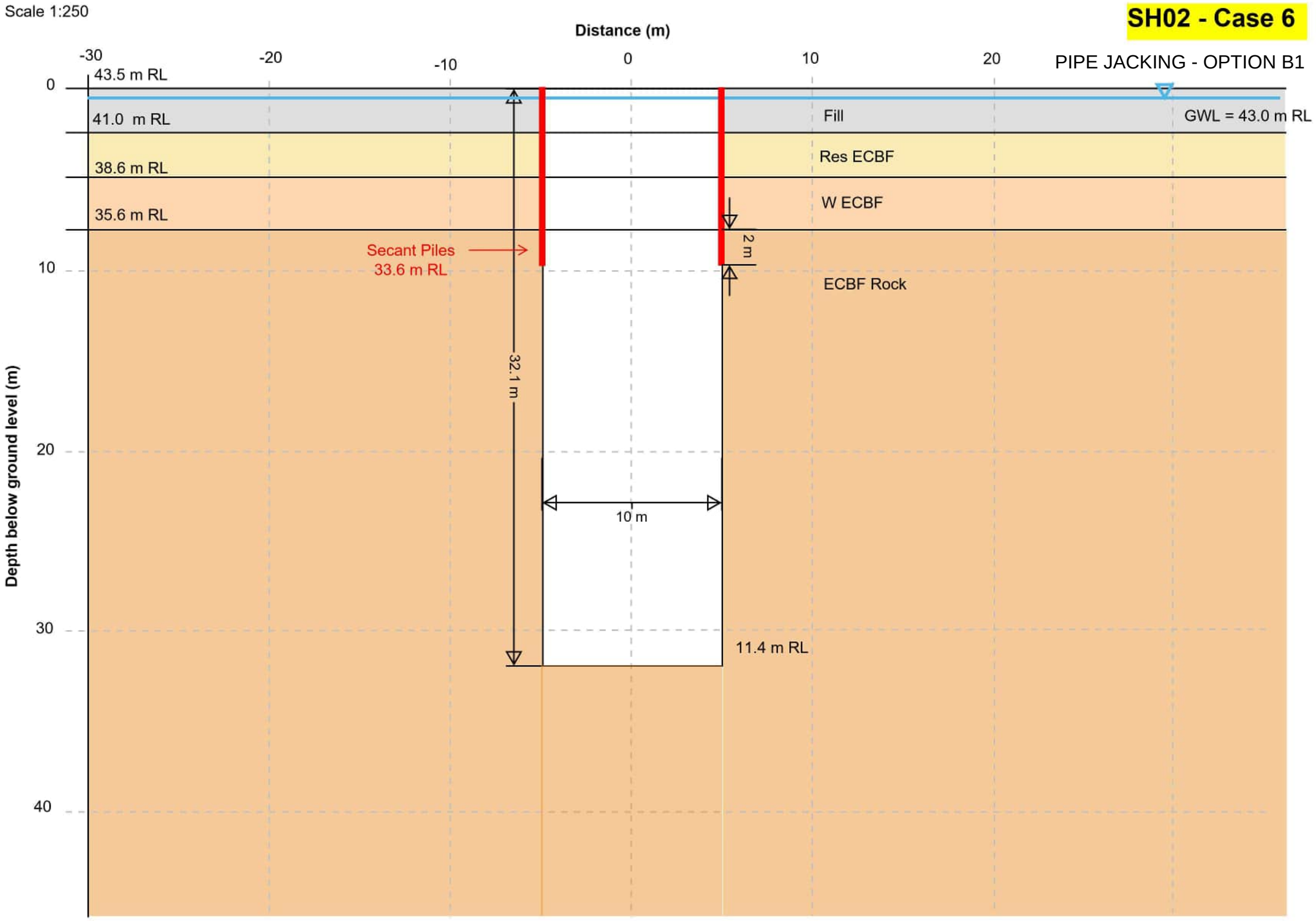

Scale 1:250
SH01 - Case 1
PIPE JACKING - OPTION B2
Distance (m)
-30
-20
-10
0
10
20
51.4 m RL
49.3 m RL
46.2 m RL
43.8 m RL
42.1 m RL
Fill
Alluvium
Res ECBF
W ECBF
ECBF Rock
GWL = 48.9 m RL
Secant Piles
40.1 m RL
6 m
45.5 m
5.9 m RL
Depth below ground level (m)
0
10
20
30
40

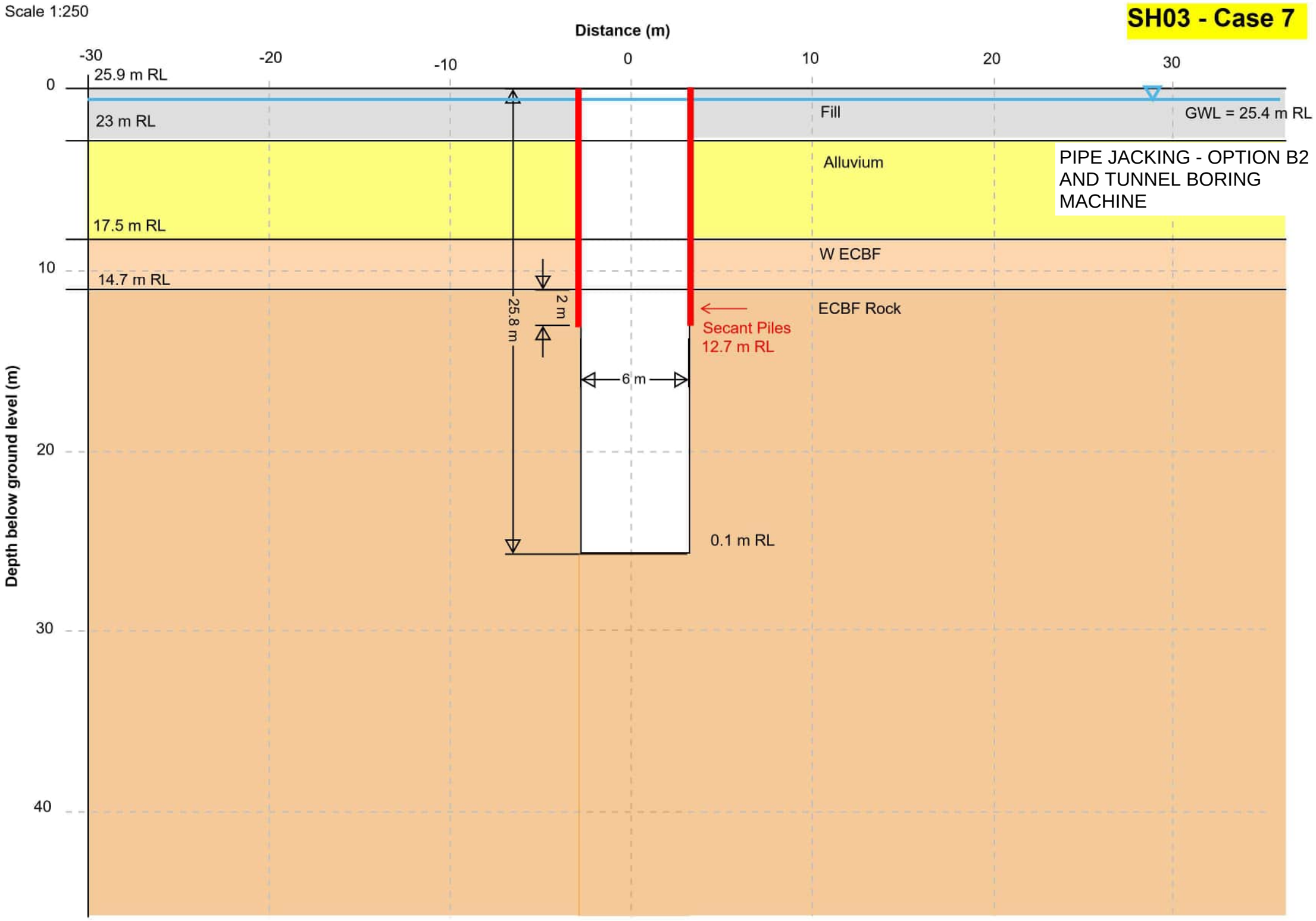

Scale 1:250
SH01 - Case 2
TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
51.4 m RL
49.3 m RL
46.2 m RL
43.8 m RL
42.1 m RL
Fill
Alluvium
Res ECBF
W ECBF
ECBF Rock
GWL = 48.9 m RL
Secant Piles
40.1 m RL
2 m
12 m
45.5 m
5.9 m RL

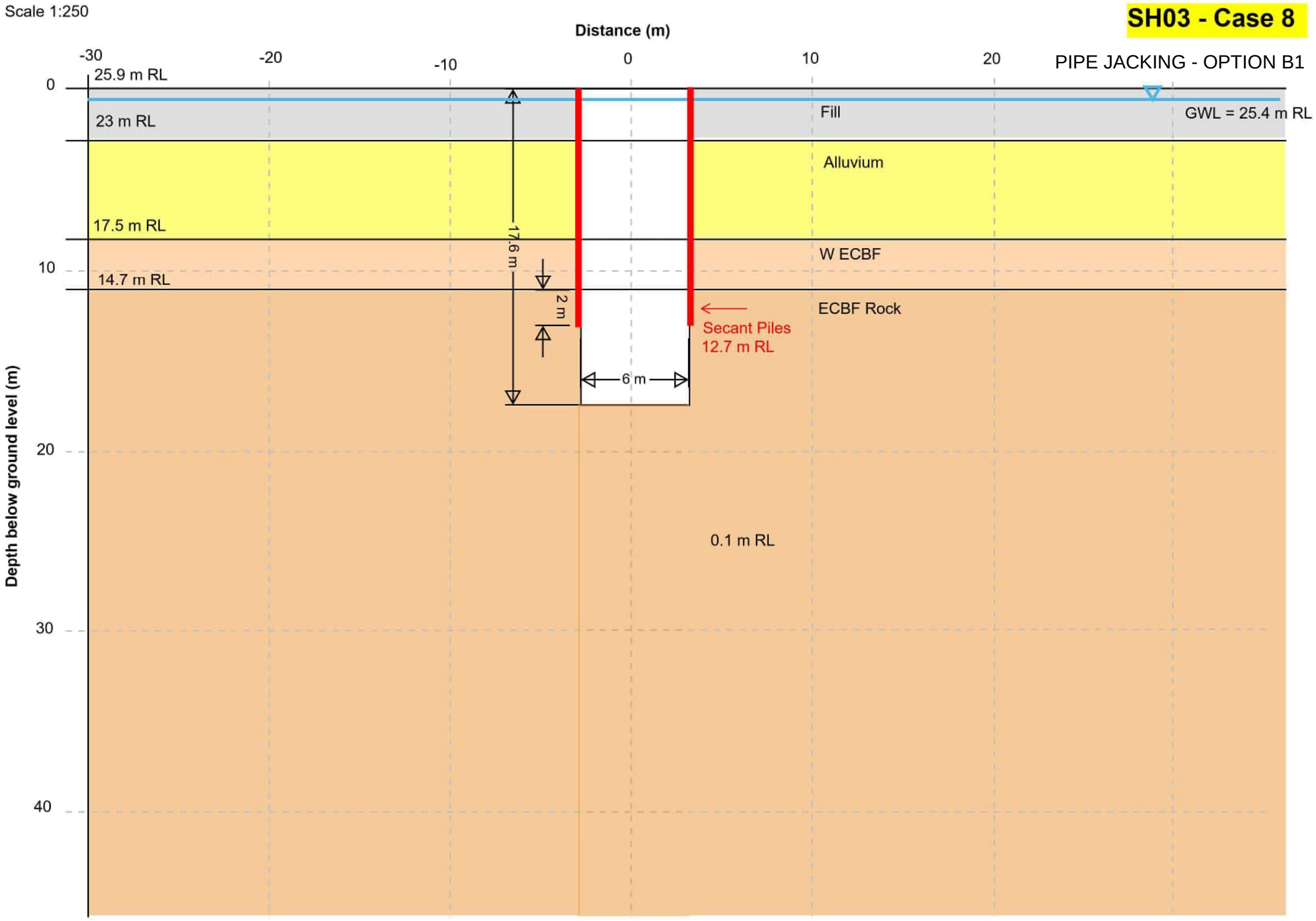

Scale 1:250
SH01 - Case 3
PIPE JACKING - OPTION B1
Distance (m)
-30
-20
-10
0
10
20
51.4 m RL
49.3 m RL
46.2 m RL
43.8 m RL
42.1 m RL
Fill
Alluvium
Res ECBF
W ECBF
ECBF Rock
GWL = 48.9 m RL
Secant Piles
40.1 m RL
2 m
24 m
6 m
27.4 m RL
Depth below ground level (m)
0
10
20
30
40

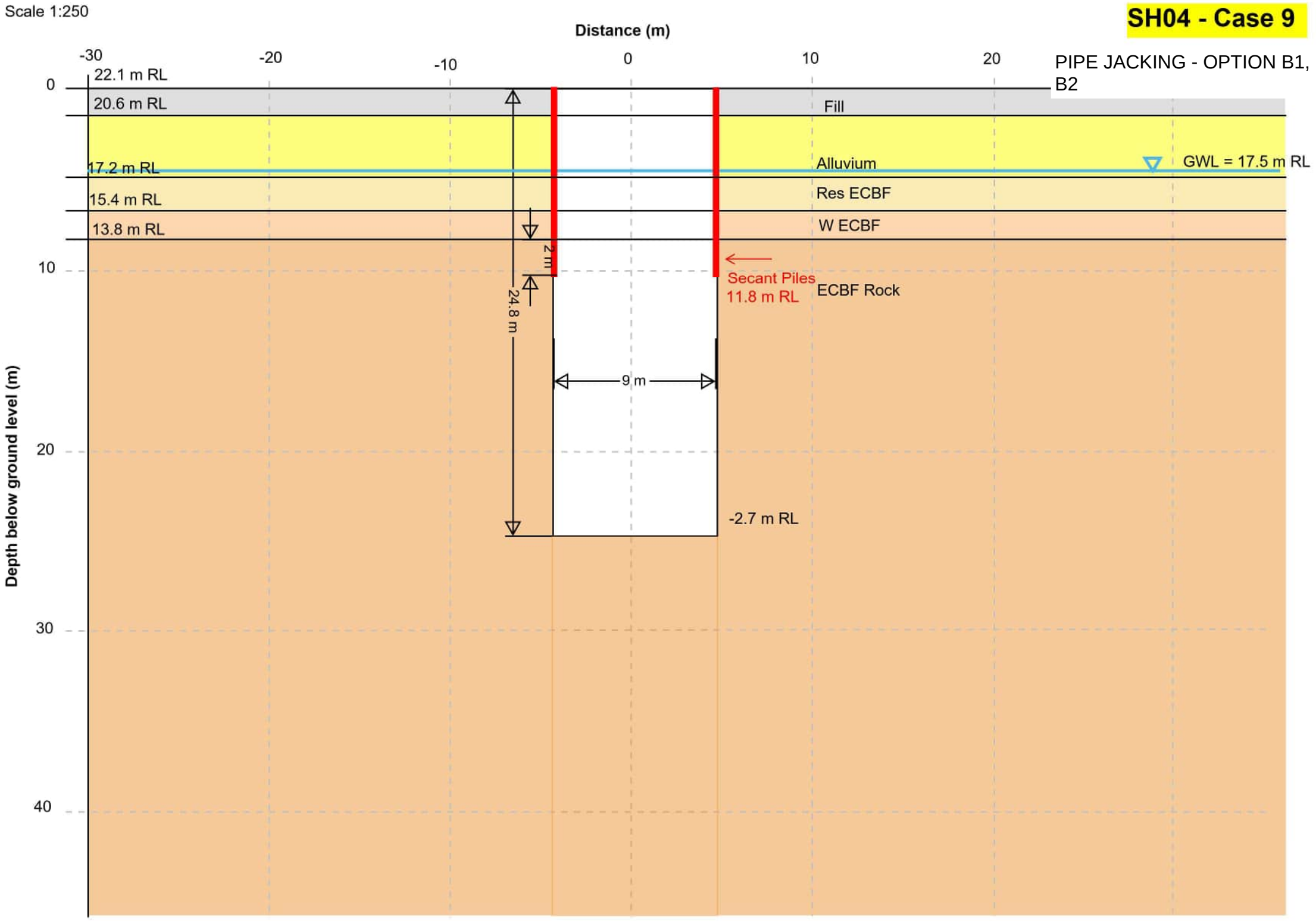

Scale 1:250
SH02 - Case 4
PIPE JACKING - OPTION B2
Distance (m)
-30
-20
-10
0
10
20
43.5 m RL
41.0 m RL
38.6 m RL
35.6 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 43.0 m RL
Secant Piles
33.6 m RL
2 m
40.4 m
10 m
3.1 m RL
Depth below ground level (m)
0
10
20
30
40

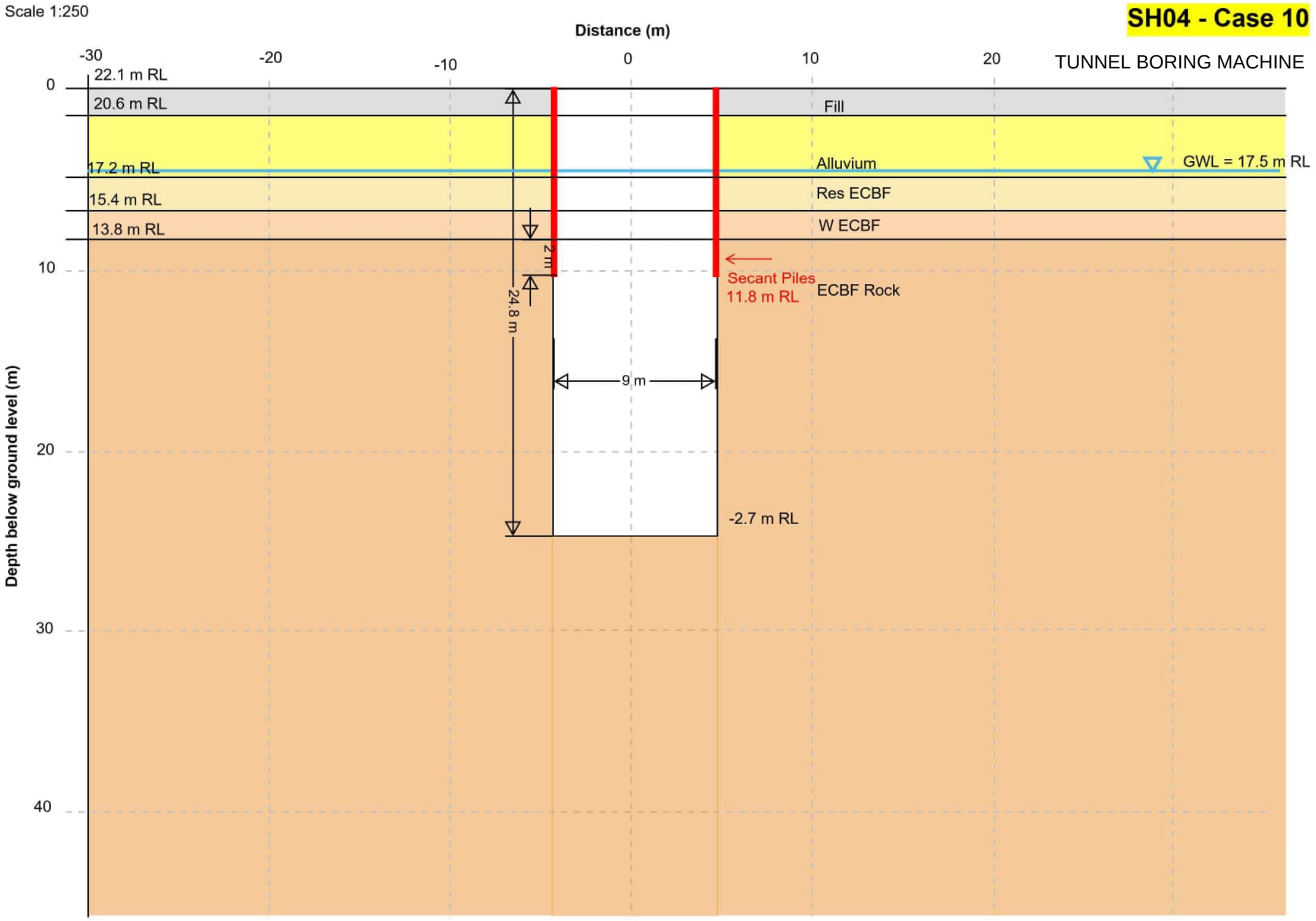

Scale 1:250
SH02 - Case 5
TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
43.5 m RL
41.0 m RL
38.6 m RL
35.6 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 43.0 m RL
Secant Piles
33.6 m RL
2 m
40.4 m
10 m
3.1 m RL
Depth below ground level (m)
0
10
20
30
40

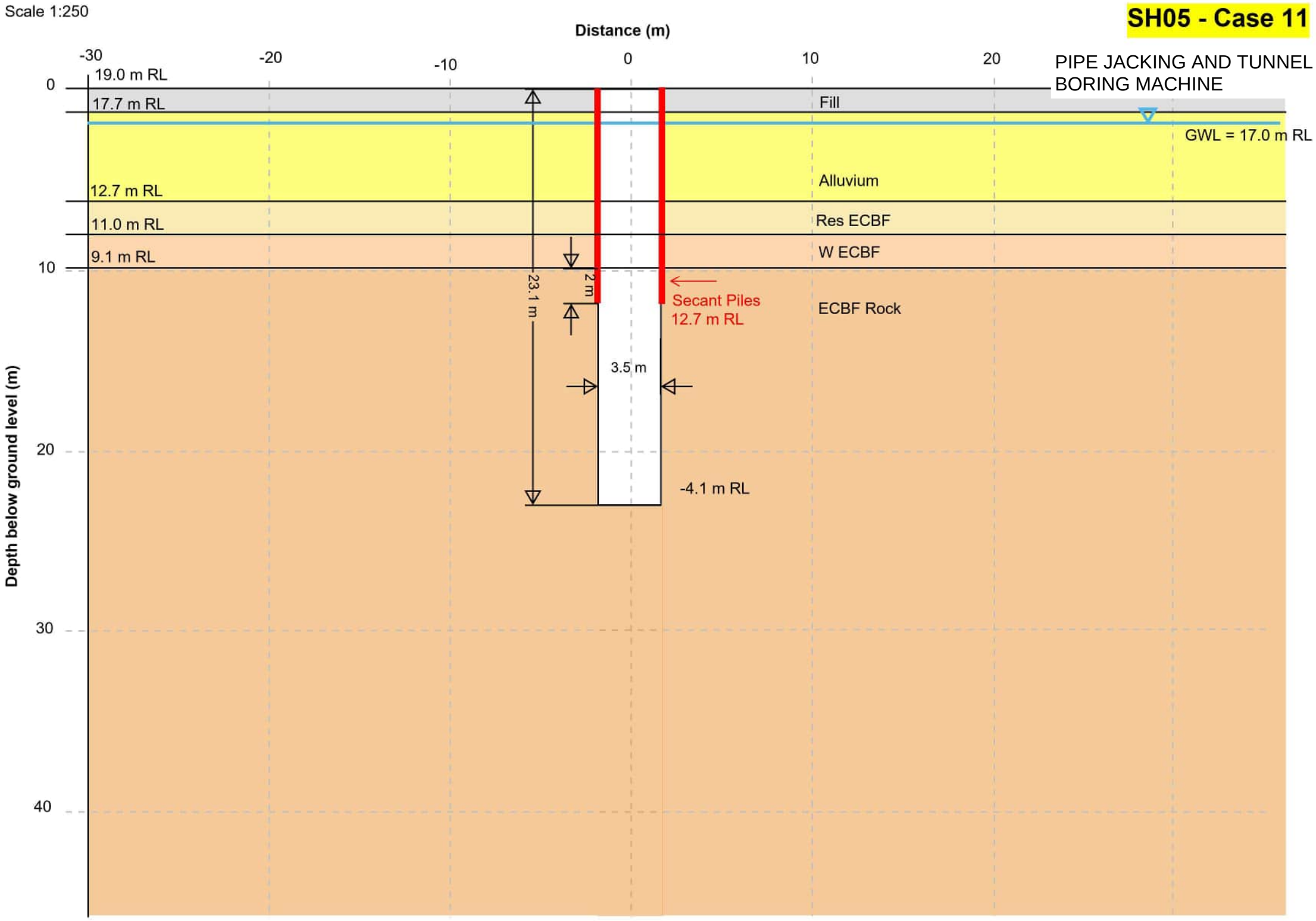

Scale 1:250
SH02 - Case 6
PIPE JACKING - OPTION B1
Distance (m)
-30
-20
-10
0
10
20
43.5 m RL
41.0 m RL
38.6 m RL
35.6 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 43.0 m RL
Secant Piles
33.6 m RL
2 m
32.1 m
10 m
11.4 m RL
Depth below ground level (m)
0
10
20
30
40

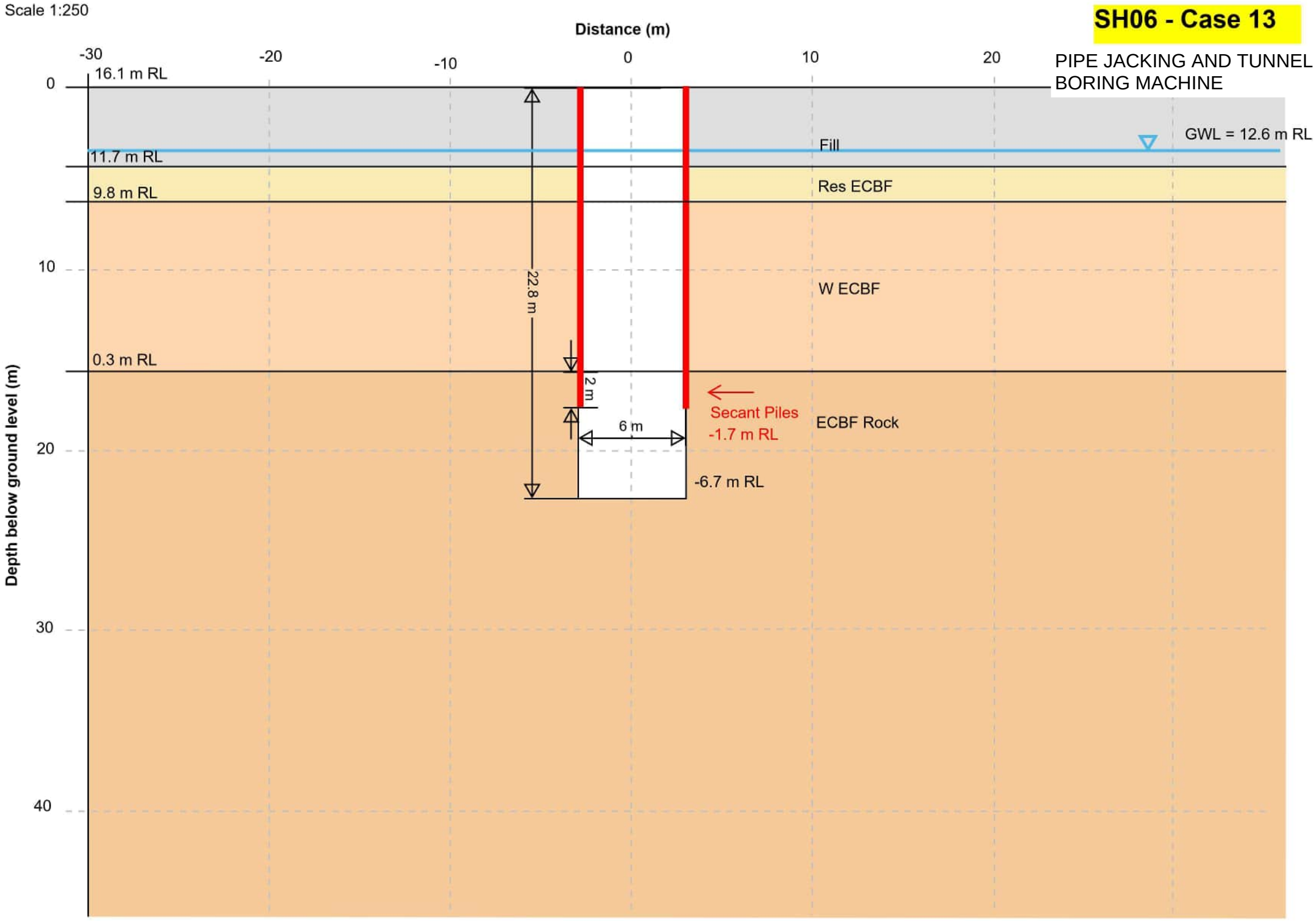

Scale 1:250
SH03 - Case 7
Distance (m)
-30
-20
-10
0
10
20
30
25.9 m RL
23 m RL
17.5 m RL
14.7 m RL
0.1 m RL
Fill
GWL = 25.4 m RL
Alluvium
W ECBF
ECBF Rock
PIPE JACKING - OPTION B2 AND TUNNEL BORING MACHINE
Secant Piles
12.7 m RL
2 m
25.8 m
6 m
Depth below ground level (m)
0
10
20
30
40

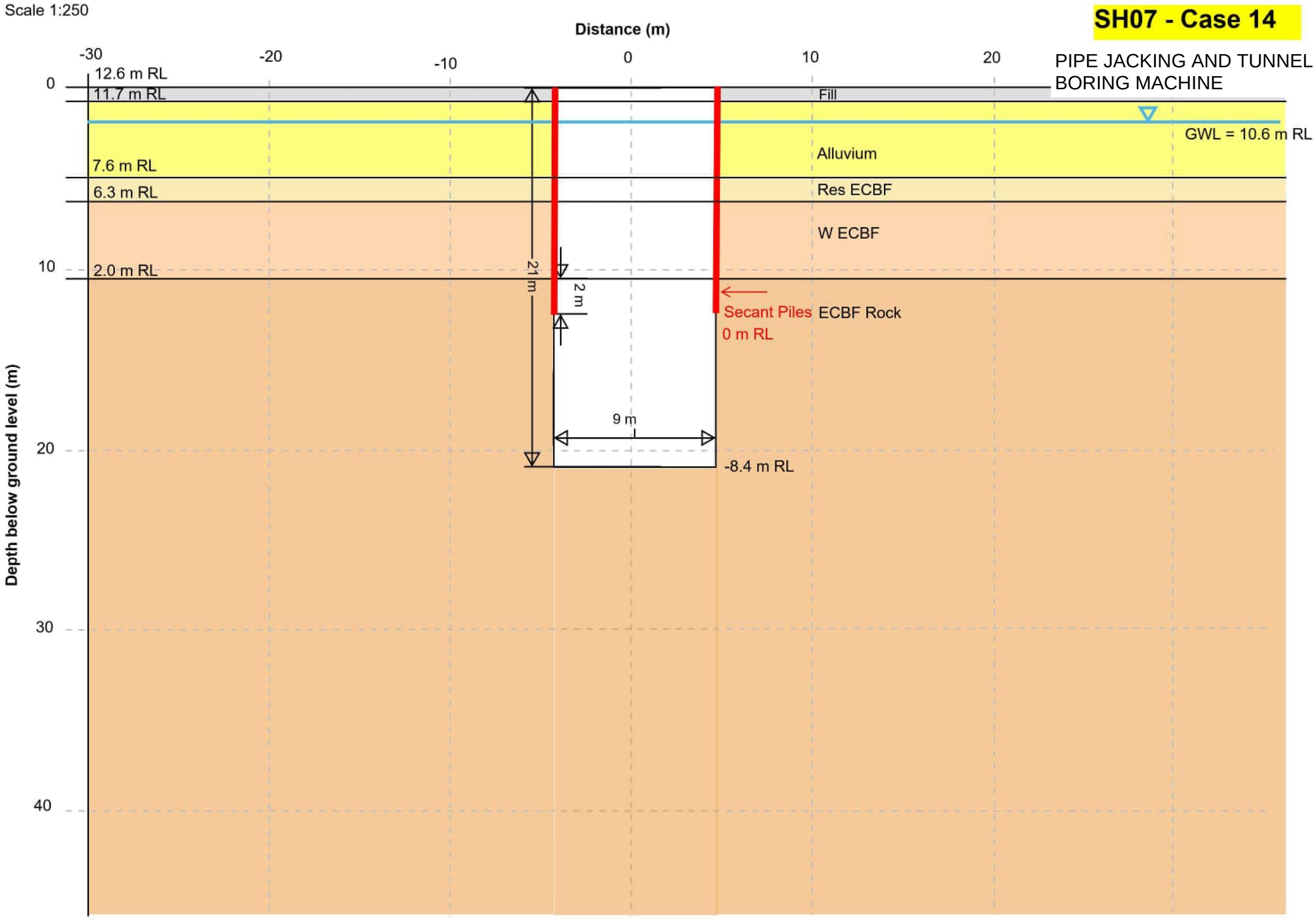

Scale 1:250
SH03 - Case 8
PIPE JACKING - OPTION B1
Distance (m)
-30
-20
-10
0
10
20
25.9 m RL
23 m RL
17.5 m RL
14.7 m RL
0.1 m RL
Fill
Alluvium
W ECBF
ECBF Rock
GWL = 25.4 m RL
Secant Piles
12.7 m RL
17.6 m
2 m
6 m
Depth below ground level (m)
0
10
20
30
40


Scale 1:250
SH04 - Case 9
PIPE JACKING - OPTION B1, B2
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
22.1 m RL
20.6 m RL
17.2 m RL
15.4 m RL
13.8 m RL
Fill
Alluvium
Res ECBF
W ECBF
GWL = 17.5 m RL
2 m
24.8 m
9 m
Secant Piles
11.8 m RL
ECBF Rock
-2.7 m RL


Scale 1:250
SH04 - Case 10
TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
22.1 m RL
20.6 m RL
17.2 m RL
15.4 m RL
13.8 m RL
Fill
Alluvium
Res ECBF
W ECBF
ECBF Rock
GWL = 17.5 m RL
2 m
24.8 m
9 m
Secant Piles
11.8 m RL
-2.7 m RL


Scale 1:250
SH05 - Case 11
Distance (m)
-30
-20
-10
0
10
20
PIPE JACKING AND TUNNEL BORING MACHINE
19.0 m RL
17.7 m RL
Fill
GWL = 17.0 m RL
12.7 m RL
Alluvium
11.0 m RL
Res ECBF
9.1 m RL
W ECBF
ECBF Rock
2 m
23.1 m
Secant Piles
12.7 m RL
3.5 m
-4.1 m RL
Depth below ground level (m)
0
10
20
30
40


Scale 1:250
SH06 - Case 13
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
16.1 m RL
11.7 m RL
9.8 m RL
0.3 m RL
GWL = 12.6 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
22.8 m
2 m
6 m
Secant Piles
-1.7 m RL
-6.7 m RL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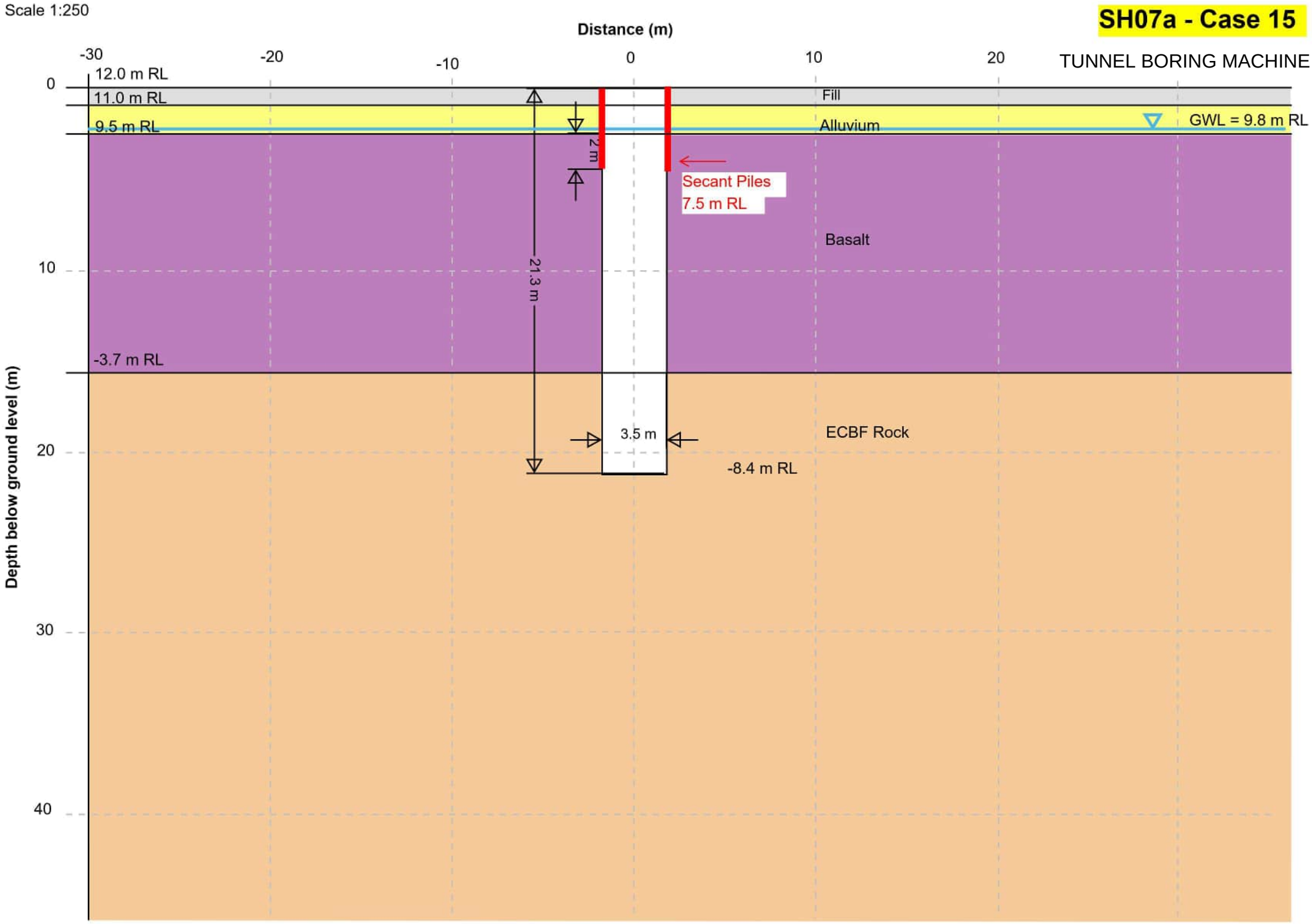
SH07 - Case 14
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
12.6 m RL
11.7 m RL
Fill
GWL = 10.6 m RL
Alluvium
7.6 m RL
6.3 m RL
Res ECBF
W ECBF
2.0 m RL
21 m
2 m
Secant Piles
0 m RL
ECBF Rock
9 m
-8.4 m RL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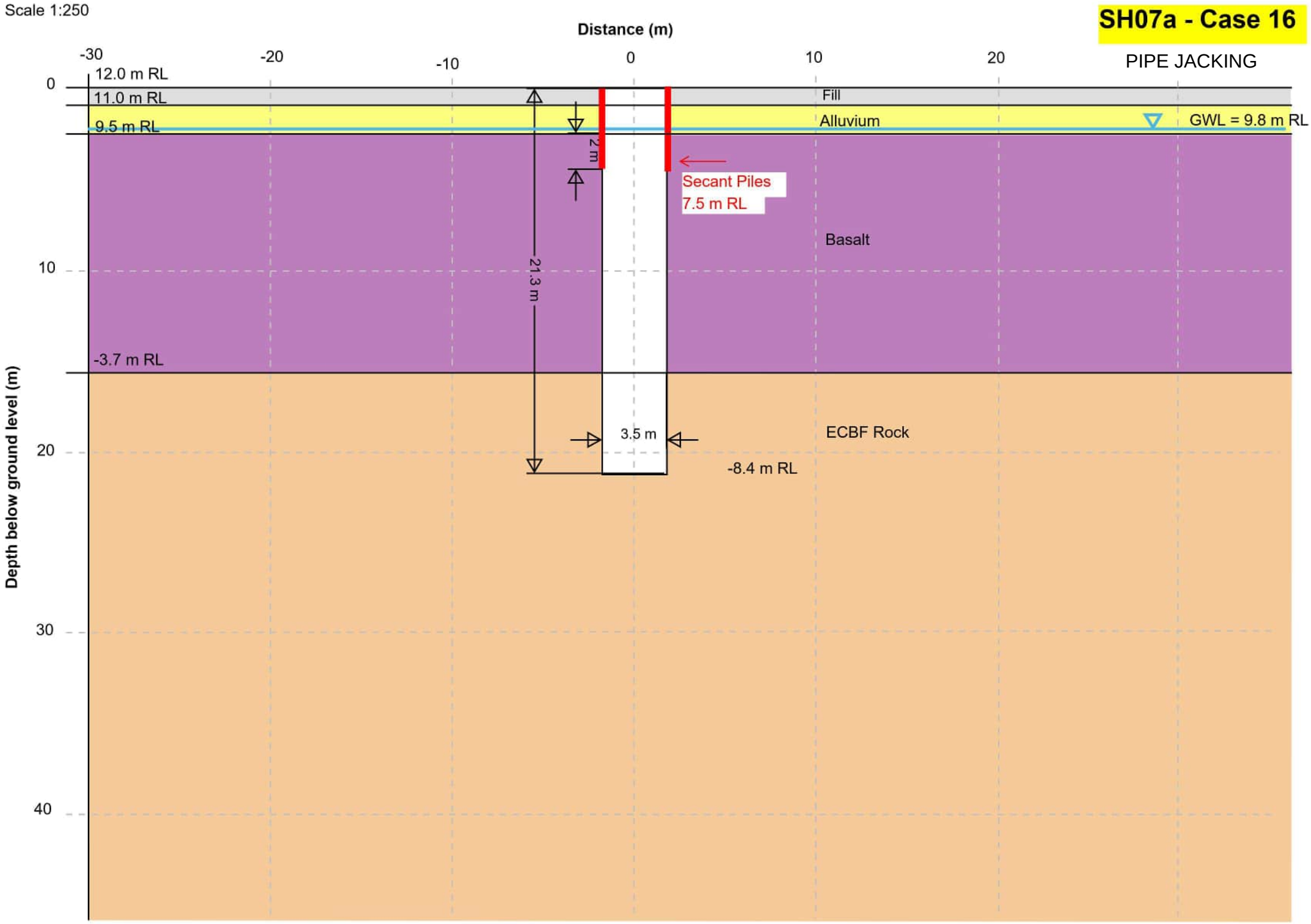
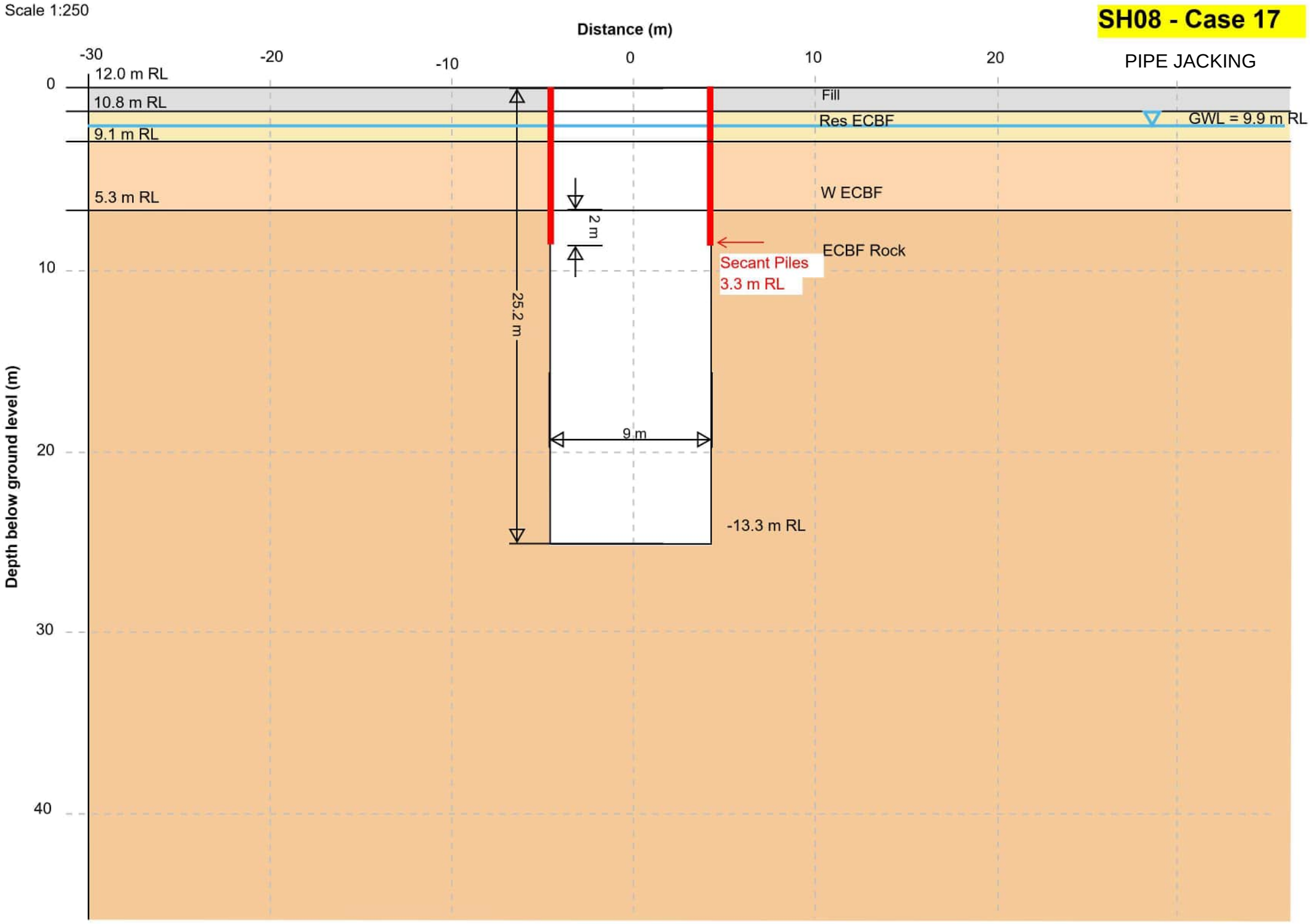
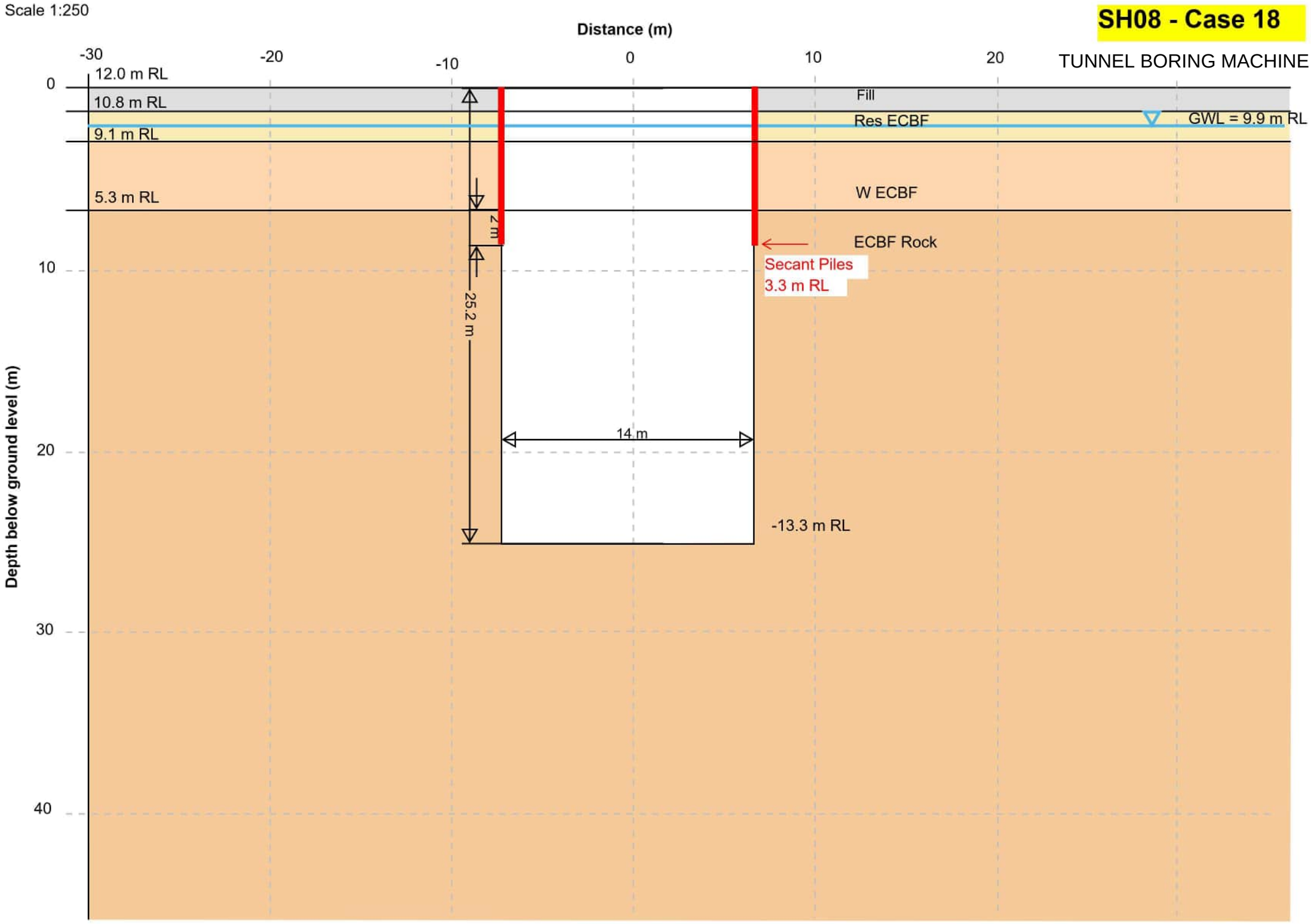
SH07a - Case 15
TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
12.0 m RL
11.0 m RL
9.5 m RL
Fill
Alluvium
GWL = 9.8 m RL
2 m
Secant Piles
7.5 m RL
Basalt
21.3 m
-3.7 m RL
3.5 m
ECBF Rock
-8.4 m RL
Depth below ground level (m)
0
10
20
30
40


Scale 1:250
SH07a - Case 16
PIPE JACKING
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
12.0 m RL
11.0 m RL
9.5 m RL
Fill
Alluvium
GWL = 9.8 m RL
2 m
Secant Piles
7.5 m RL
Basalt
21.3 m
-3.7 m RL
3.5 m
ECBF Rock
-8.4 m RL


Scale 1:250
SH08 - Case 17
PIPE JACKING
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
12.0 m RL
10.8 m RL
9.1 m RL
5.3 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 9.9 m RL
2 m
25.2 m
9 m
Secant Piles
3.3 m RL
-13.3 m RL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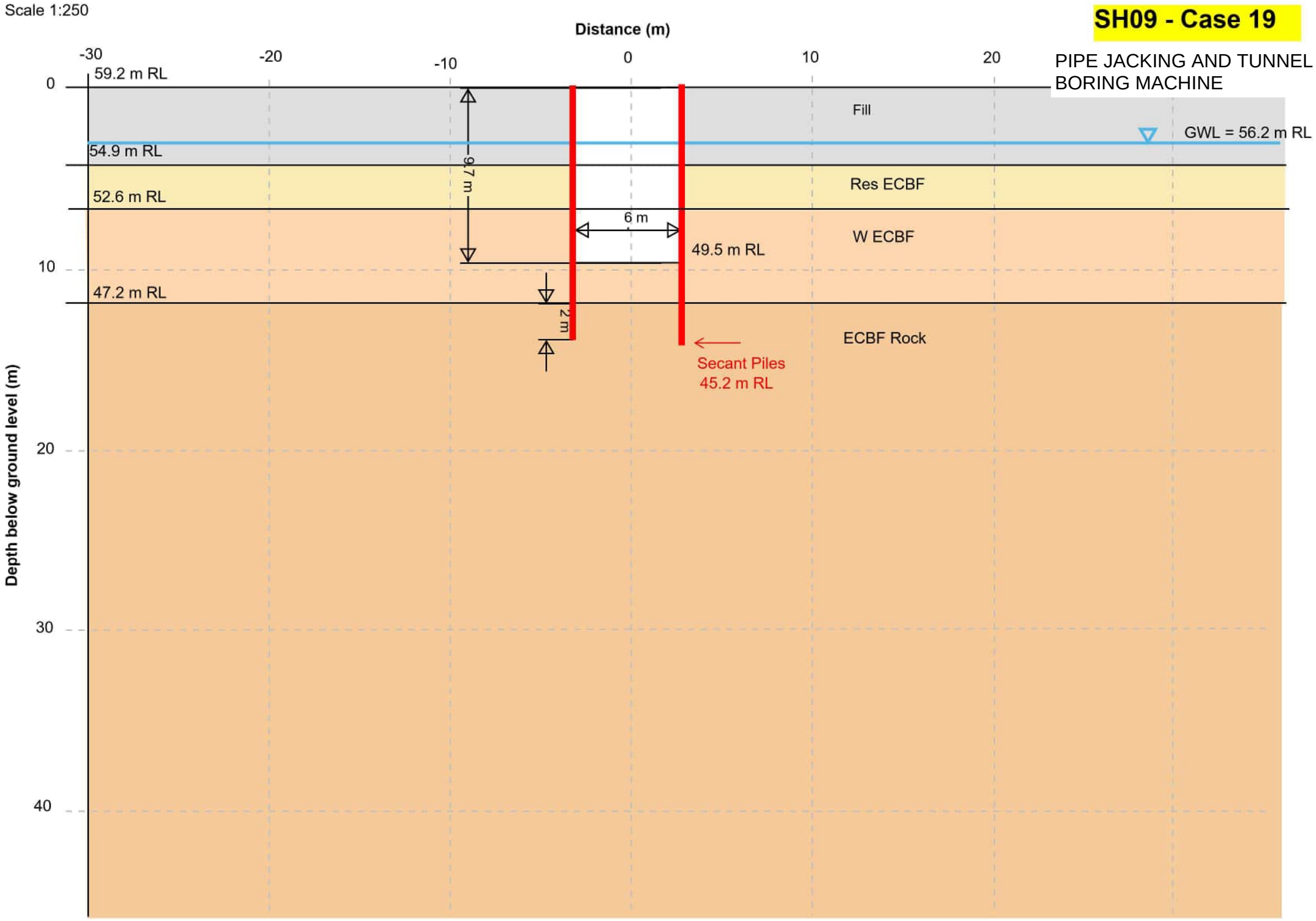
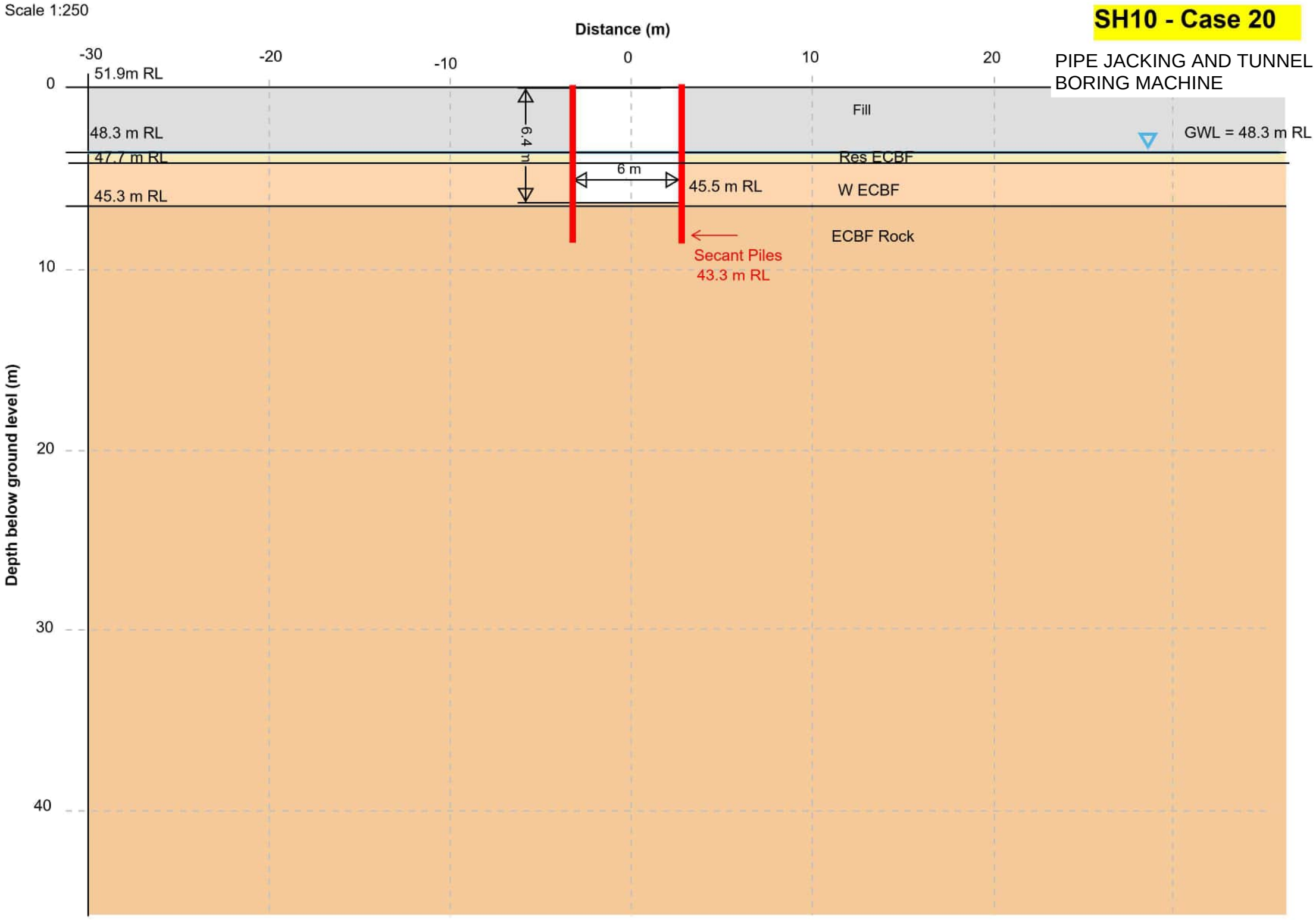
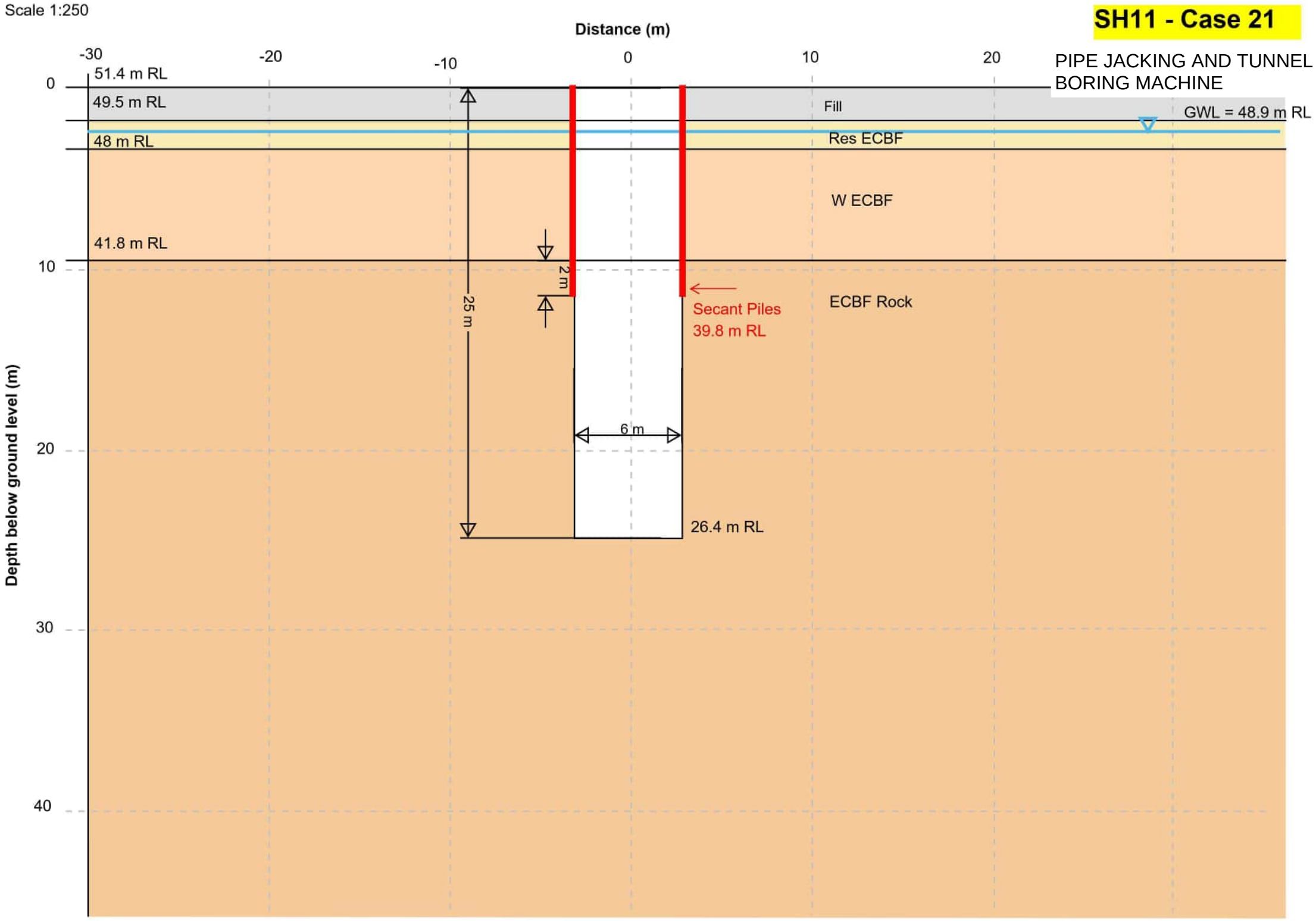
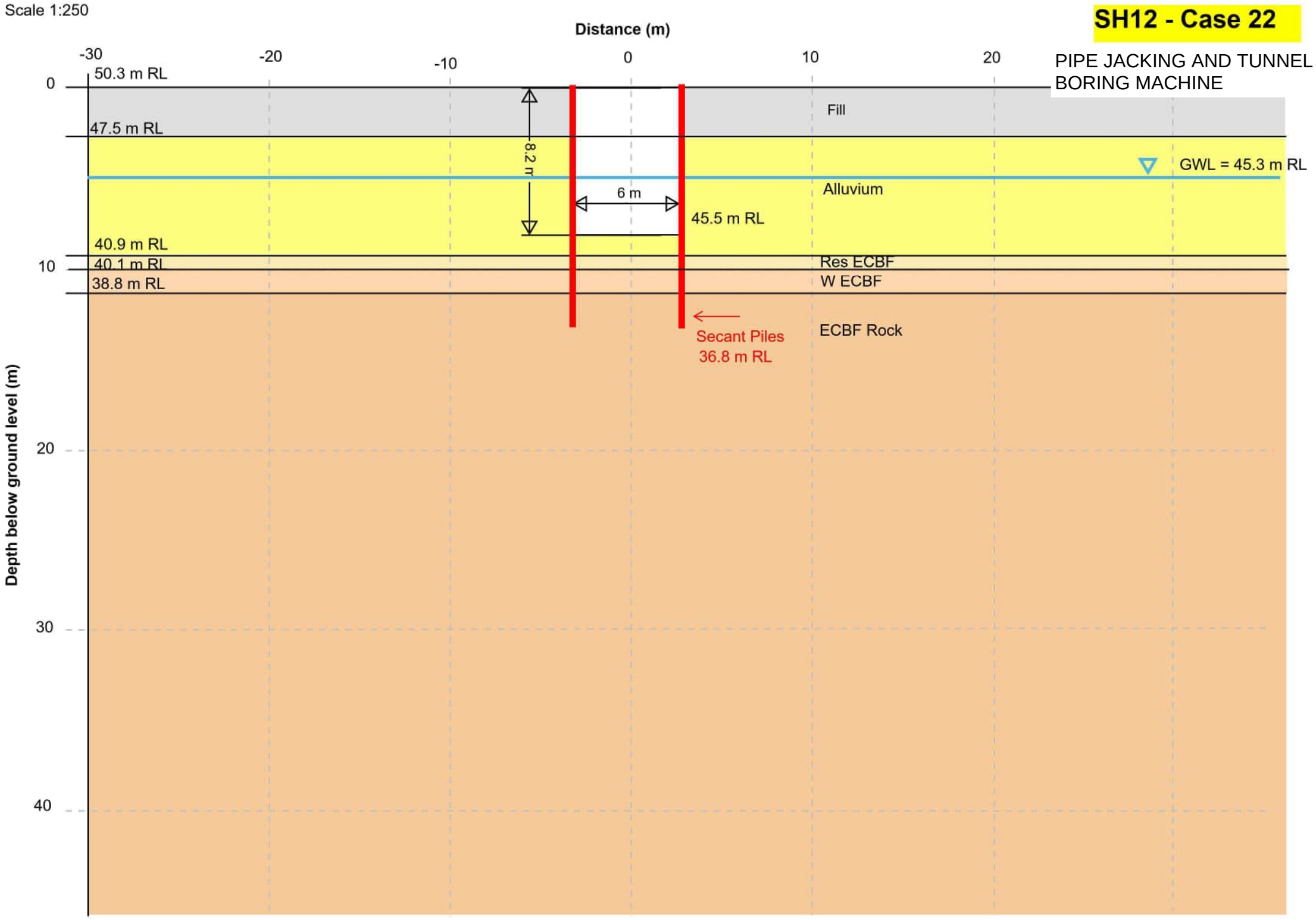
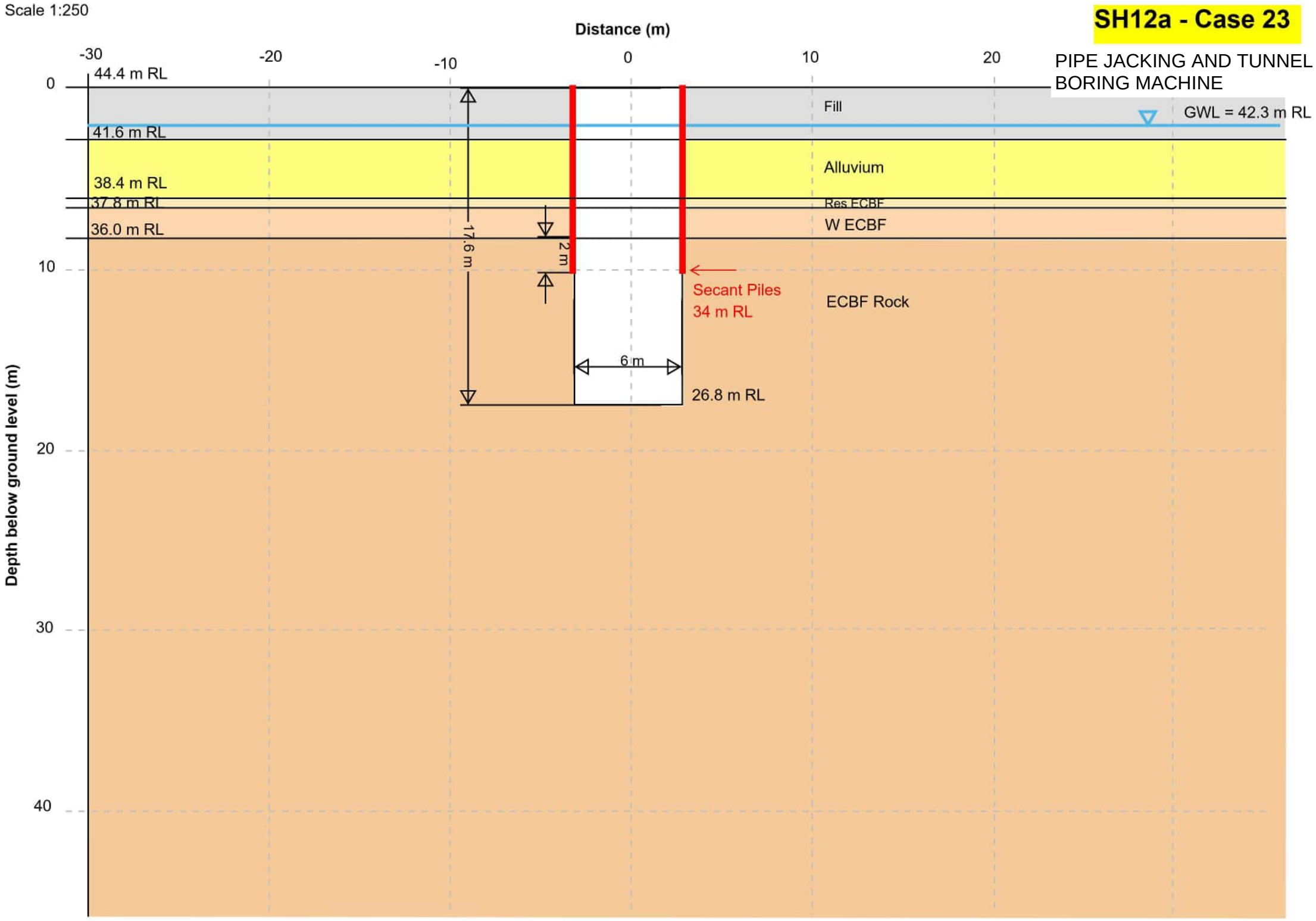
SH08 - Case 18
TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
12.0 m RL
10.8 m RL
9.1 m RL
5.3 m RL
Fill
Res ECBF
GWL = 9.9 m RL
W ECBF
ECBF Rock
Secant Piles
3.3 m RL
2 m
25.2 m
14 m
-13.3 m RL

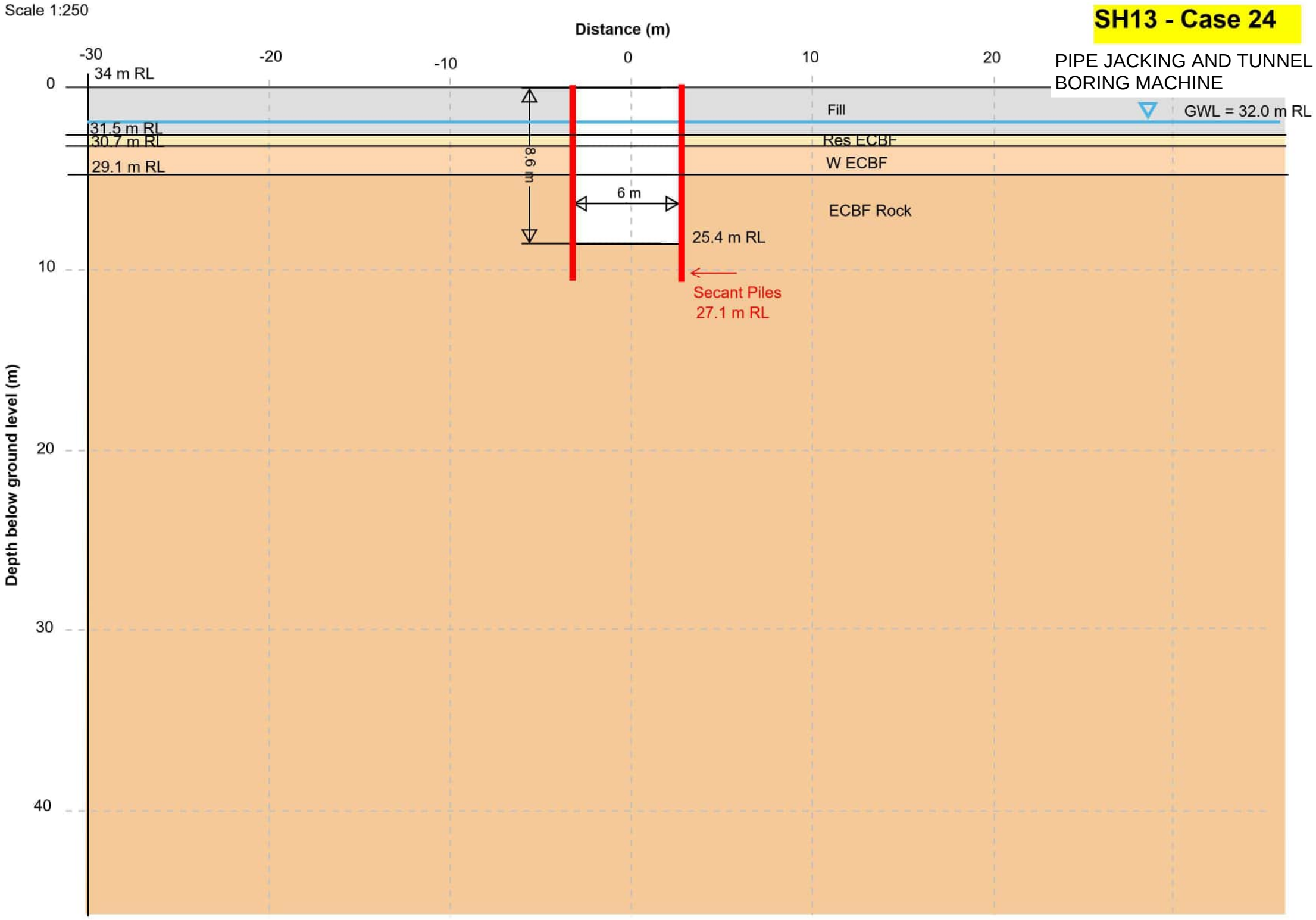

Scale 1:250
SH09 - Case 19
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
59.2 m RL
54.9 m RL
52.6 m RL
47.2 m RL
49.5 m RL
45.2 m RL
GWL = 56.2 m RL
9.7 m
6 m
2 m
Fill
Res ECBF
W ECBF
ECBF Rock
Secant Piles
Depth below ground level (m)
0
10
20
30
40

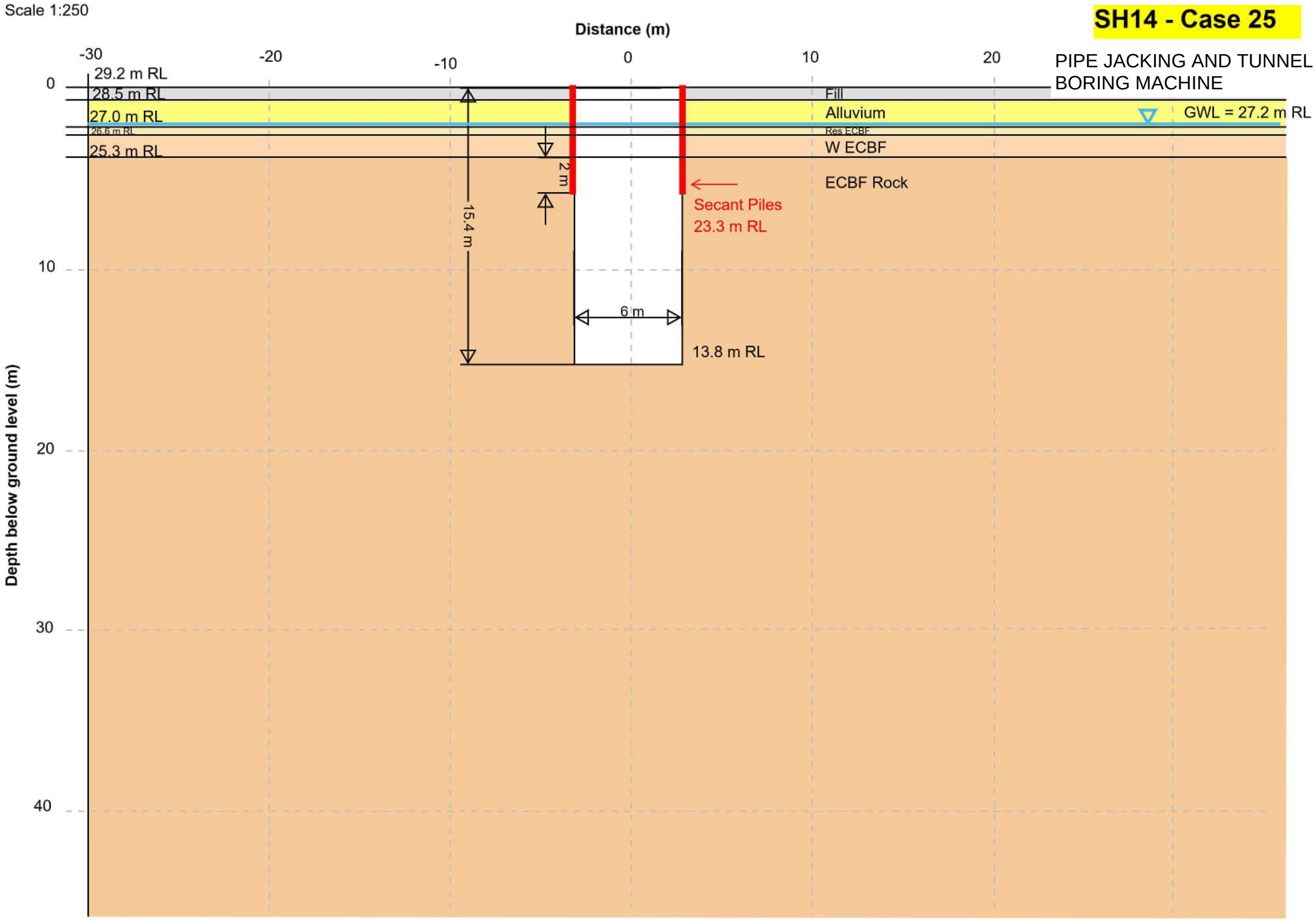

Scale 1:250
SH10 - Case 20
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
51.9m RL
48.3 m RL
47.7 m RL
45.3 m RL
6.4 m
6 m
45.5 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 48.3 m RL
Secant Piles
43.3 m RL
Depth below ground level (m)
0
10
20
30
40

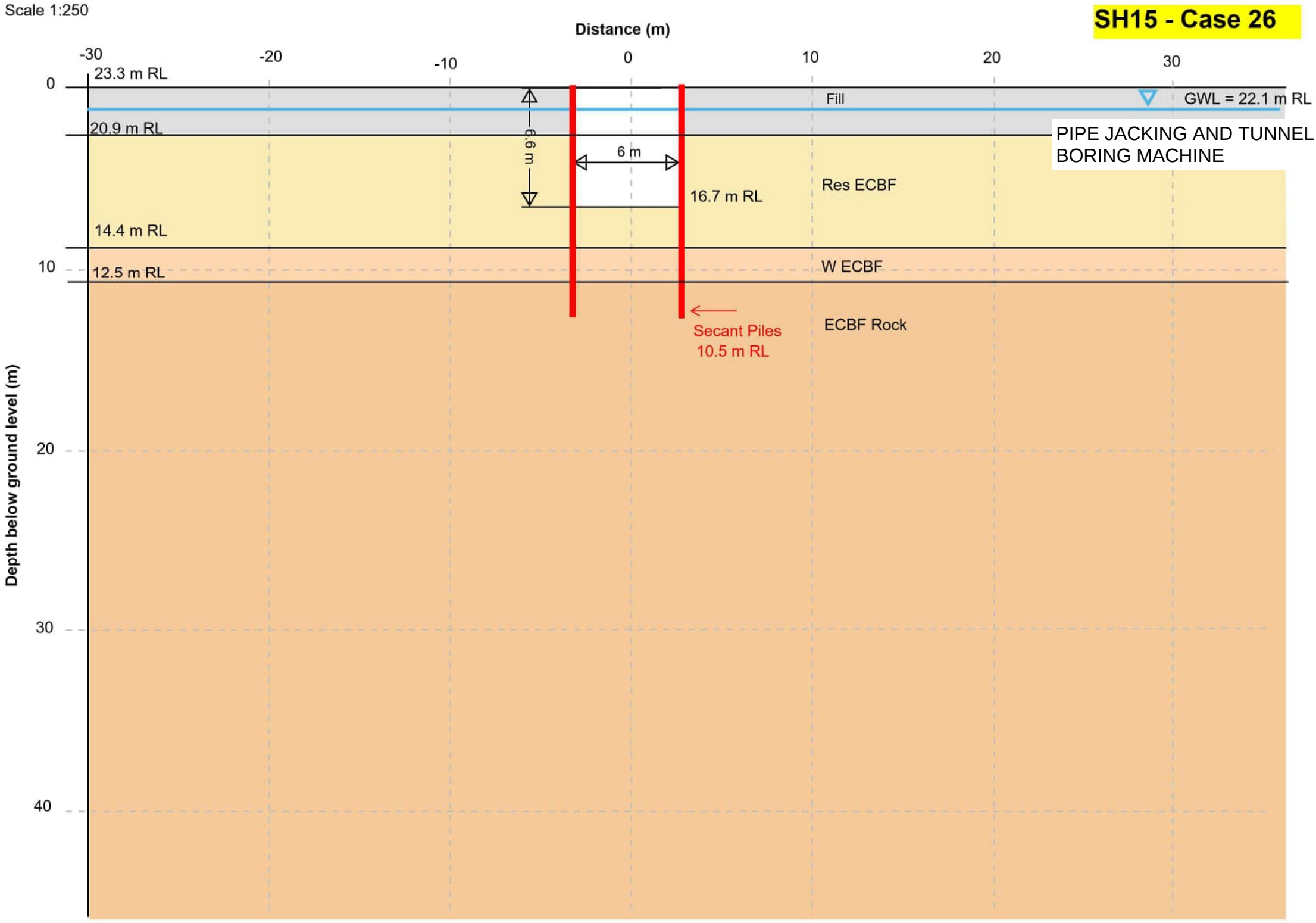

Scale 1:250
SH11 - Case 21
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
51.4 m RL
49.5 m RL
48 m RL
41.8 m RL
Fill
Res ECBF
W ECBF
ECBF Rock
GWL = 48.9 m RL
2 m
25 m
6 m
Secant Piles
39.8 m RL
26.4 m RL


Scale 1:250
SH12 - Case 22
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
50.3 m RL
47.5 m RL
40.9 m RL
40.1 m RL
38.8 m RL
8.2 m
6 m
45.5 m RL
Fill
Alluvium
GWL = 45.3 m RL
Res ECBF
W ECBF
ECBF Rock
Secant Piles
36.8 m RL
Depth below ground level (m)
0
10
20
30
40


Scale 1:250
SH12a - Case 23
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
44.4 m RL
41.6 m RL
38.4 m RL
37.8 m RL
36.0 m RL
Fill
GWL = 42.3 m RL
Alluvium
Res ECBF
W ECBF
ECBF Rock
17.6 m
2 m
6 m
Secant Piles
34 m RL
26.8 m RL


Scale 1:250
SH13 - Case 24
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
34 m RL
31.5 m RL
30.7 m RL
29.1 m RL
Fill
GWL = 32.0 m RL
Res ECBF
W ECBF
ECBF Rock
8.6 m
6 m
25.4 m RL
Secant Piles
27.1 m RL
Depth below ground level (m)
0
10
20
30
40


Scale 1:250
SH14 - Case 25
PIPE JACKING AND TUNNEL BORING MACHINE
Distance (m)
-30
-20
-10
0
10
20
Depth below ground level (m)
0
10
20
30
40
29.2 m RL
28.5 m RL
27.0 m RL
26.6 m RL
25.3 m RL
Fill
Alluvium
Res ECBF
W ECBF
ECBF Rock
GWL = 27.2 m RL
2 m
15.4 m
6 m
Secant Piles
23.3 m RL
13.8 m RL


Scale 1:250
SH15 - Case 26
Distance (m)
-30
-20
-10
0
10
20
30
0
10
20
30
40
Depth below ground level (m)
23.3 m RL
20.9 m RL
14.4 m RL
12.5 m RL
6.6 m
6 m
16.7 m RL
Fill
GWL = 22.1 m RL
Res ECBF
W ECBF
ECBF Rock
Secant Piles
10.5 m RL
PIPE JACKING AND TUNNEL
BORING MACHINE

Appendix E– Shafts groundwater settlement analysis

E1 Introduction

This technical memorandum should be read in conjunction with report titled:

Tonkin & Taylor Ltd. (August 2025). Groundwater and Settlement Assessment of Effects – Motions Catchment Improvement Project. Prepared for Watercare Services Limited. Job No: 30552.5024

E2 Method

E2.1 Groundwater analysis method

Groundwater analysis was undertaken using the Analytical Element Method (AEM), implemented via the three-dimensional groundwater flow modelling software Analytical Aquifer Simulator (AnAqSim). The model was applied to estimate groundwater drawdown associated with excavation dewatering during the construction phase.

Groundwater lowering was simulated by assigning a head-specified boundary condition at the base of each excavation. Model results are presented for a single timestep at 365 days after the initiation of dewatering, representing a pseudo steady-state condition.

A leaky barrier boundary condition was applied to the model to represent the retention system. The leaky barrier is implemented in AnAqSim software as a line with zero actual width using line doublet functions. The Leaky Barrier boundary was offset 0.1 m from the proposed excavation edge and embedded 2 m into the ECBF unit.

AnAqSim describes the leaky barrier boundary condition based on conductance (C = K*/b*), where K* is the hydraulic conductivity of the retention system and b* is the thickness of the retention. The adopted b* value used for the model was set to 0.9 m to represent the thickness of secant piles, where K* was set to 1E-10 m/s, resulting in conductance of 1E-5 day^{-1} (rounded).

For selected shafts (SH01, SH03, SH05), the leaky barrier boundary condition was extended from the base of the secant piles to the base of the excavation with an applied conductance value 1E-2 day-1. This was implemented to be representative of a lower-permeability surface barrier such as shotcrete with an approximate thickness (b*) of 0.05 m, resulting in an assumed hydraulic conductivity (K*) of 5E-04 m/day (5.8E-09 m/s).

The hydrogeological model adopted for all shafts excluding Shaft 07a is presented in Appendix E Table 1.

The hydrogeological model adopted for Shaft 07a is presented in Appendix E Table 1.

Appendix E Table 1: Hydrogeological model adopted for all shafts excluding Shaft 07a

Layer	Elevation top	Elevation bottom	Aquifer type	Initial water level	K horizontal	K vertical	Leaky barrier assigned
1	Refer to the 'Excavation Details' tables for each shaft location in Section E3 below.	ECBF rock level extended by 2 m for retention embed depth	Unconfined	Refer Appendix C Table 1	Refer Appendix C Table 7-5	Refer Appendix C Table 7-5	Yes Set to be negligible leakage at: 1E-5 day^{-1}
2	Same as Bottom elevation for Layer 1	-20 m RL fixed across all models	Unconfined / confined	Same as Layer 1 (hydrostatic)	Same as Layer 1 (homogeneous)	Same as Layer 1 (homogeneous)	No

Appendix E Table 2: Hydrogeological model adopted for shaft Shaft 07a

Layer	Elevation top	Elevation bottom	Aquifer type	Initial water level	K horizontal	K vertical	Leaky barrier assigned
1	12.0 m RL	7.5 m RL	Unconfined	9.8 m RL	1E-4 m/s	1E-5 m/s	Yes Set to be negligible leakage at: 1E-5 day-1
2	7.5 m RL	-3.7 m RL	Unconfined / confined	9.8 m RL	1E-4 m/s	1E-5 m/s	No
3	-3.7 m RL	-20 m RL	Unconfined / confined	9.8 m RL	1E-7 m/s	1E-8 m/s	No

Appendix E Table 3: Groundwater analysis method assumptions

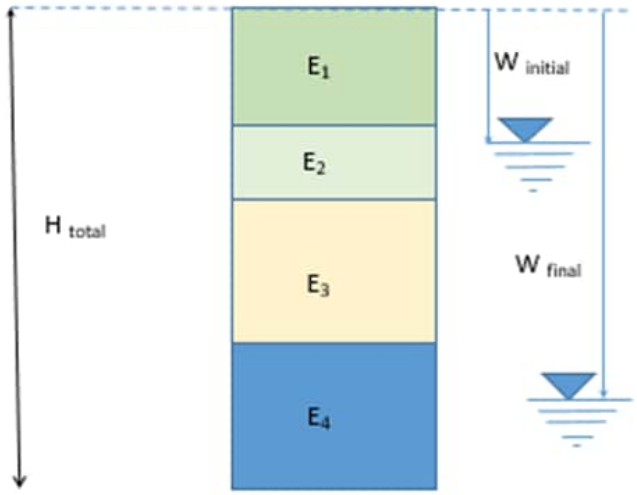
Assumption	Implication and comment
Infiltration recharge does not occur	This assumption provides a more conservative drawdown assessment, i.e. the predicted drawdown extent is larger than if recharge is included.
Model assumed a single-layer representation of the "bulk hydraulic system" assuming an averaged hydraulic conductivity and specific across the excavated soil profile.	Analysis does not account for potential variation in the geological units that have similar hydrogeological features.
Flat horizontal water table, no flow direction or gradient	Analysis does not account for expected variation in groundwater levels across the site. Considered appropriate for short-term construction scenarios when infiltration recharge is not included in the model.
External boundary conditions adopted were 'Head Specified External Line Boundaries', located 1 km radius from the excavation centre.	Site-specific boundary conditions at the site were not incorporated into the model. Checks were completed for each model run to ensure that the drawdown zone of influence did not reach the head-specified external boundary conditions, therefore considered appropriate.

Assumption	Implication and comment
Model assumes that groundwater levels will be instantaneously lowered from the static water level to the base of excavation.	This simplification does not represent a specific type of dewatering system to be selected by the Contractor (e.g. dewatering wells, sumps, combination).
Hydrostatic groundwater conditions	This assumption simplifies the groundwater system by excluding the presence of perched water tables or transient flow conditions. It provides a more conservative estimate of drawdown, as it assumes that all groundwater is hydraulically connected and will respond uniformly to dewatering.

E2.2 Drawdown-induced settlement method

Drawdown-induced settlement calculated based on the following approach:

- Static water level ($W_{initial}$) adopted from the initial water level.
- Final groundwater level (W_{final}) obtained from the drawdown analysis results.
- 1D settlement assessment using an incremental layer-wise summation method:
  - Divided the geological profile (H_{total}) into incremental units for calculation, in this case 0.1 m thick.
  - Assigned constrained modulus to each unit.
  - Calculated the change in pore water pressure at the centre of each incremental layer caused by the groundwater drawdown (refer Equation 1).
  - Estimated the settlement of each incremental unit layer and sum the incremental settlement (refer Equation 2).



Example soil column and initial/final water level for calculating drawdown-induced settlement using the layer-wise summation method.

Equation 1: Change in pore water pressure:

$$\Delta P = \gamma_w(Water_{initial} - Water_{final})$$

$$\Delta P = change\ in\ pore\ water\ pressure\ (kPa)$$

$$\gamma_w = unit\ weight\ of\ water\ (kPa)$$

$$Water_{initial} = Piezomteric\ head\ before\ dewatering\ (m)$$

$$Water_{final} = Piezomteric\ head\ after\ dewatering\ (m)$$

Equation 2: Layer wise summation method:

$$S = \sum_{i=1}^{n} \left(\varphi \frac{\Delta P_i}{E_i} H_i \right)$$

$$S = Total\ settlement\ caused\ by\ dewatering$$

$$Pi = Change\ in\ pore\ water\ pressure$$

$$\varphi = \text{empirical coefficient, defined as 1 in this calculation}$$

$$i = Profile\ divided\ into\ 0.1\ m\ thick\ slices$$

E3. Results

E3.1 Shaft 01

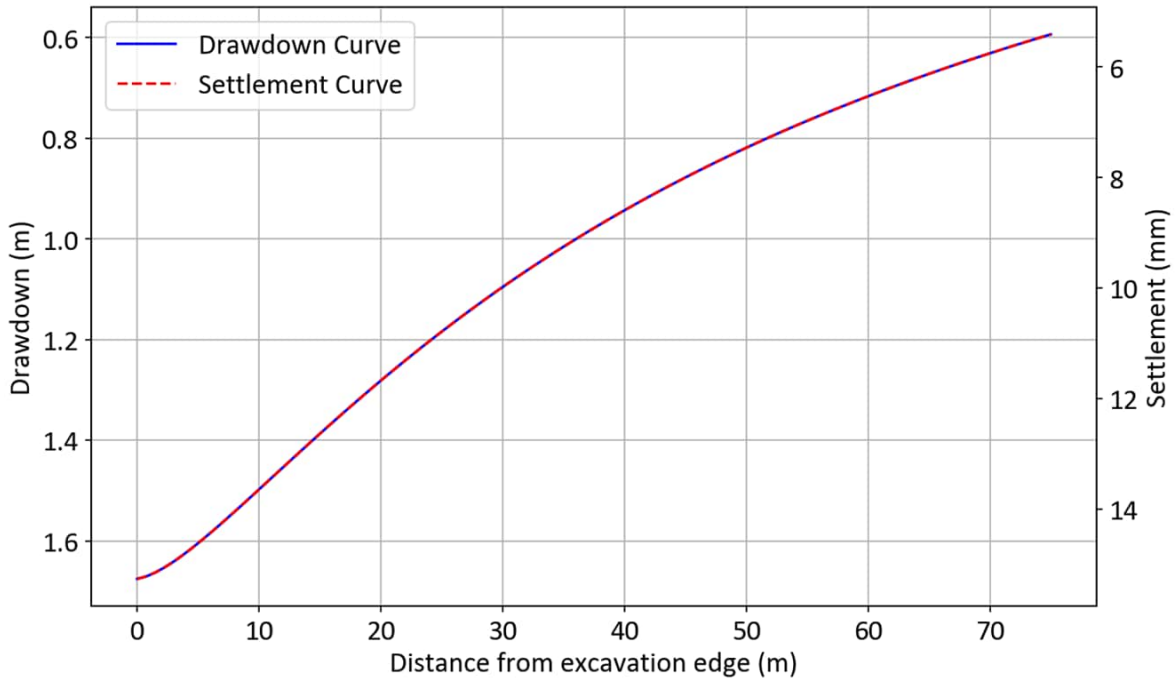
E3.1.1 Case 1

Appendix E Table 4: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
51.4 m RL	5.9 m RL	45.5 m bGL	28.2 m²

Appendix E Table 5: Soil compressibility

m RL bottom	Constrained modulus
49.3 m RL	5 MPa
46.2 m RL	4 MPa
43.8 m RL	20 MPa
42.1 m RL	50 MPa



Appendix Figure E.1: Calculated drawdown and drawdown-induced settlement.

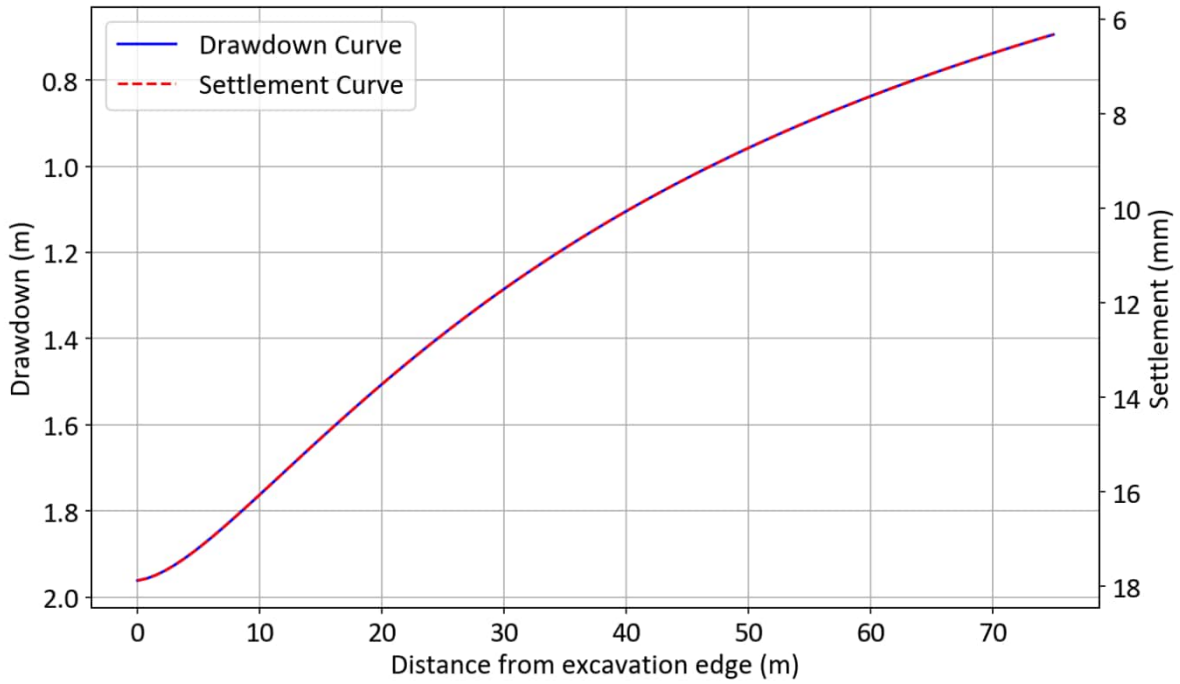
E3.1.2 Case 2

Appendix E Table 6: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
51.4 m RL	5.9 m RL	45.5 m bGL	113.0 m²

Appendix E Table 7: Soil compressibility

m RL bottom	Constrained modulus
49.3 m RL	5 MPa
46.2 m RL	4 MPa
43.8 m RL	20 MPa
42.1 m RL	50 MPa



Appendix Figure E.2: Calculated drawdown and drawdown-induced settlement.

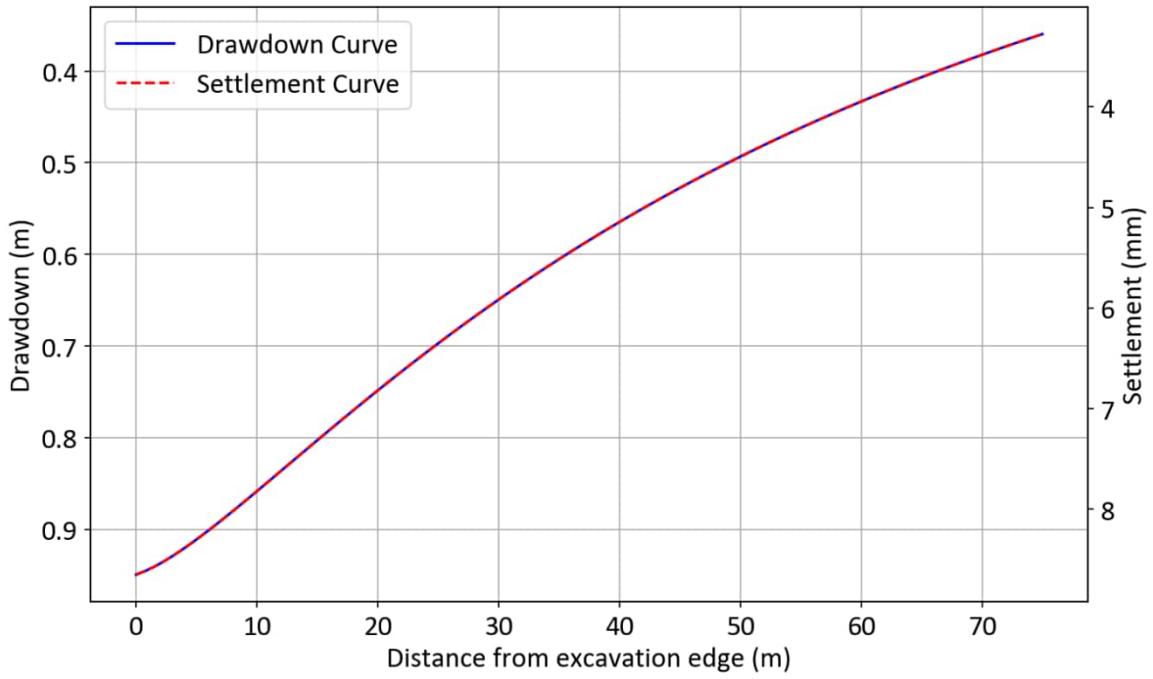
E3.1.3 Case 3

Appendix E Table 8: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
51.4 m RL	27.4 m RL	24.0 m bGL	28.2 m²

Appendix E Table 9: Soil compressibility

m RL bottom	Constrained modulus
49.3 m RL	5 MPa
46.2 m RL	4 MPa
43.8 m RL	20 MPa
42.1 m RL	50 MPa



Appendix Figure E.3: Calculated drawdown and drawdown-induced settlement.

E3.2 Shaft 02

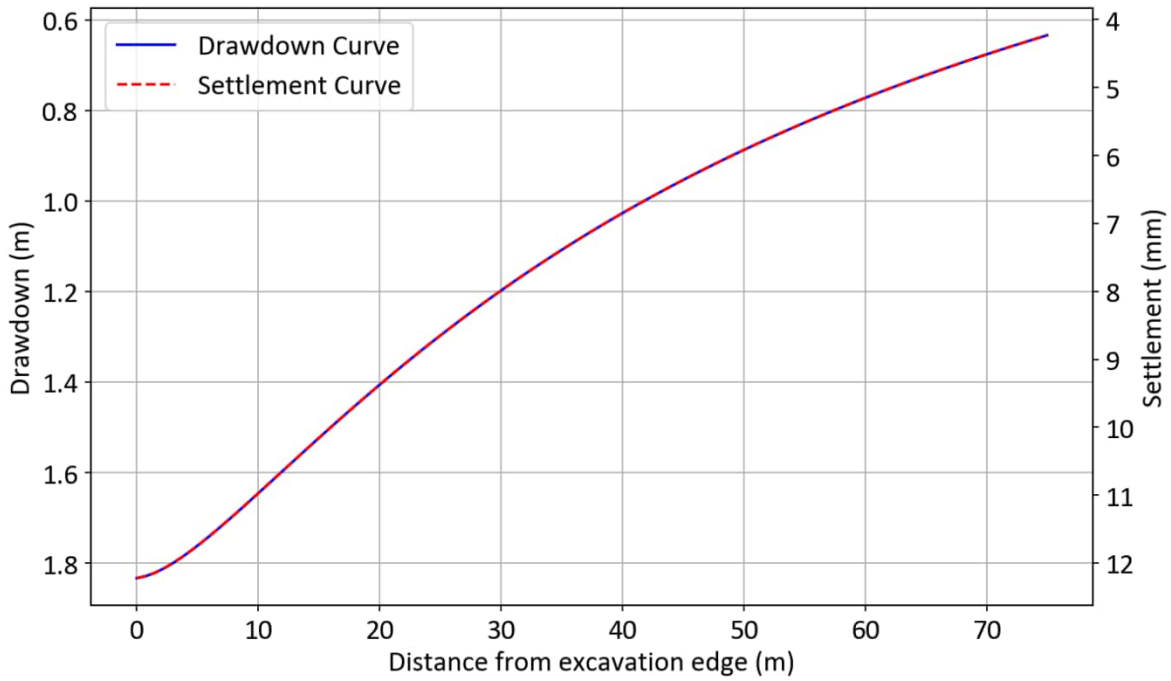
E3.2.1 Case 4

Appendix E Table 10: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
43.5 m RL	3.1 m RL	40.4 m bGL	78.5 m²

Appendix E Table 11: Soil compressibility

m RL bottom	Constrained modulus
41.0 m RL	5 MPa
38.6 m RL	20 MPa
35.6 m RL	50 MPa



Appendix Figure E.4: Calculated drawdown and drawdown-induced settlement

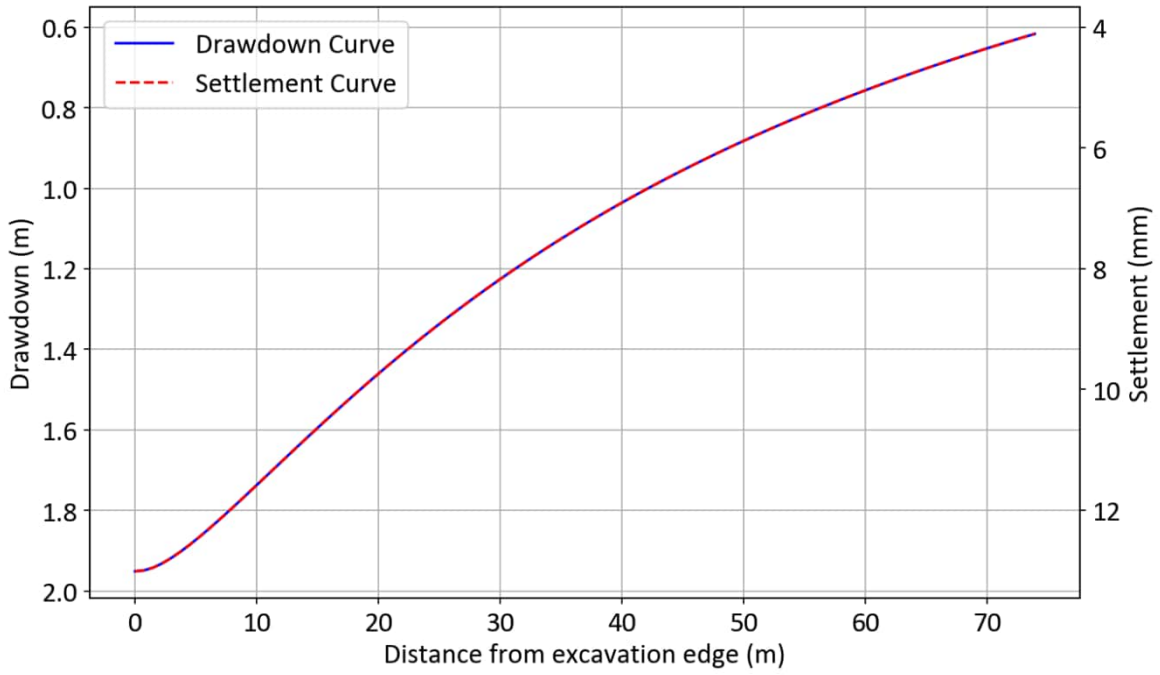
E3.2.2 Case 5

Appendix E Table 12: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
43.5 m RL	3.1 m RL	40.4 m bGL	78.5 m²

Appendix E Table 13: Soil compressibility

m RL bottom	Constrained modulus
41.0 m RL	5 MPa
38.6 m RL	20 MPa
35.6 m RL	50 MPa



Appendix Figure E.5: Calculated drawdown and drawdown-induced settlement

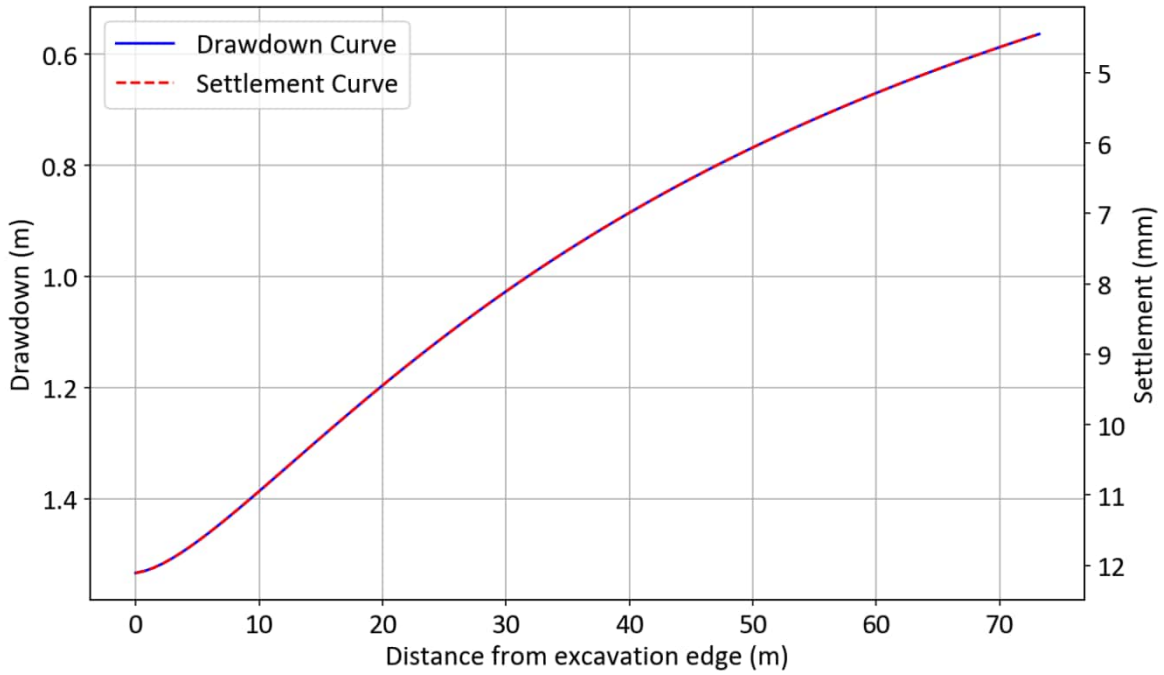
E3.2.3 Case 6

Appendix E Table 14: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
43.5 m RL	11.4 m RL	32.1 m bGL	78.5 m²

Appendix E Table 15: Excavation details

m RL bottom	Constrained modulus
41.0 m RL	4 MPa
38.6 m RL	20 MPa
35.6 m RL	50 MPa



Appendix Figure E.5: Calculated drawdown and drawdown-induced settlement

E3.3 Shaft 03

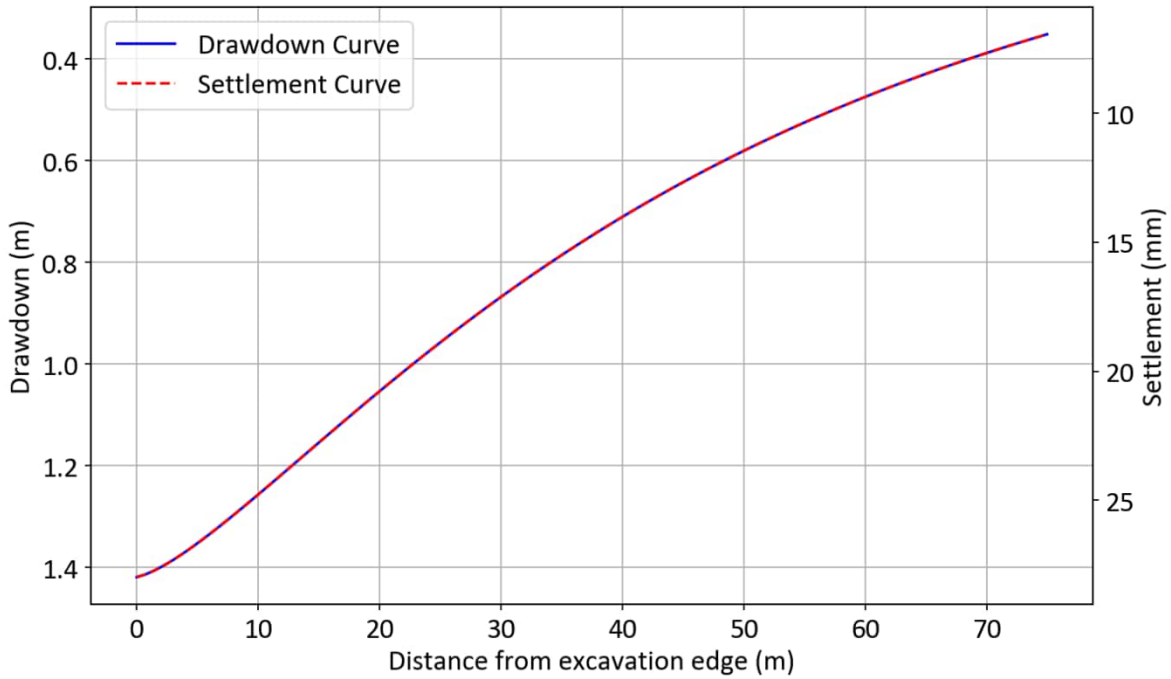
E3.3.1 Case 7

Appendix E Table 16: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
25.9 m RL	0.1 m RL	25.8 m bGL	28.2 m²

Appendix E Table 17: Soil compressibility

m RL bottom	Constrained modulus
23.0 m RL	5 MPa
17.5 m RL	4 MPa
14.7 m RL	50 MPa



Appendix Figure E.6: Calculated drawdown and drawdown-induced settlement

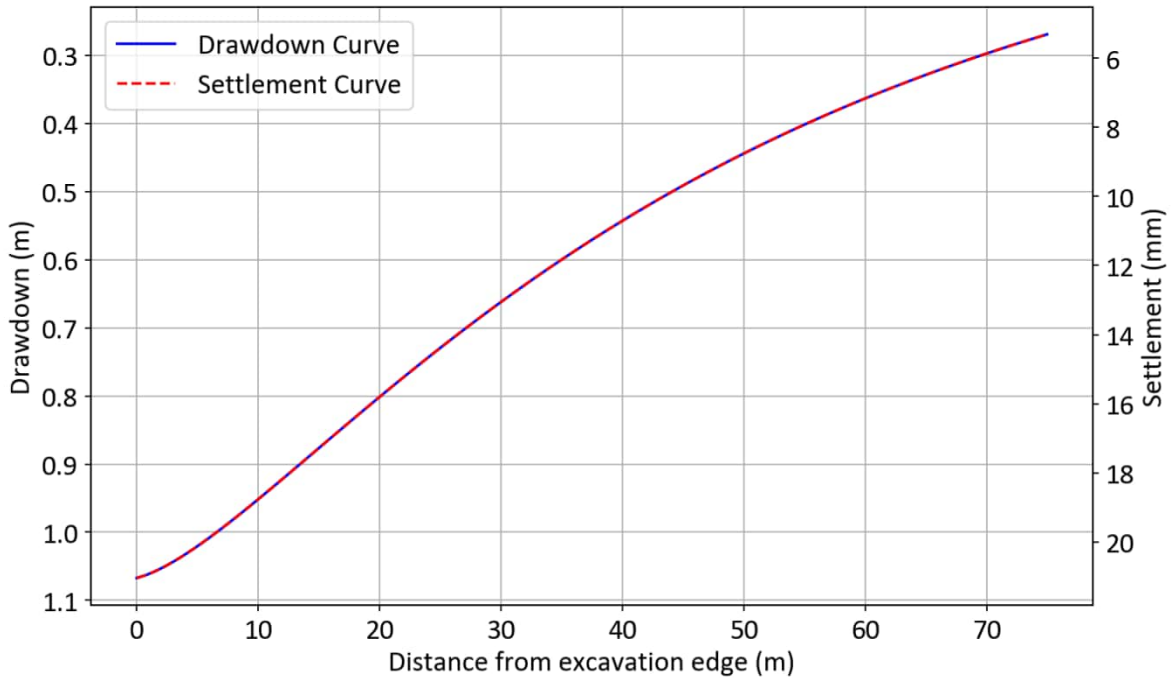
E3.3.2 Case 8

Appendix E Table 18: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
25.9 m RL	8.3 m RL	17.6 m bGL	28.2 m²

Appendix E Table 19: Soil compressibility

m RL bottom	Constrained modulus
23.0 m RL	5 MPa
17.5 m RL	4 MPa
14.7 m RL	50 MPa



Appendix Figure E.7: Calculated drawdown and drawdown-induced settlement

E3.4 Shaft 04

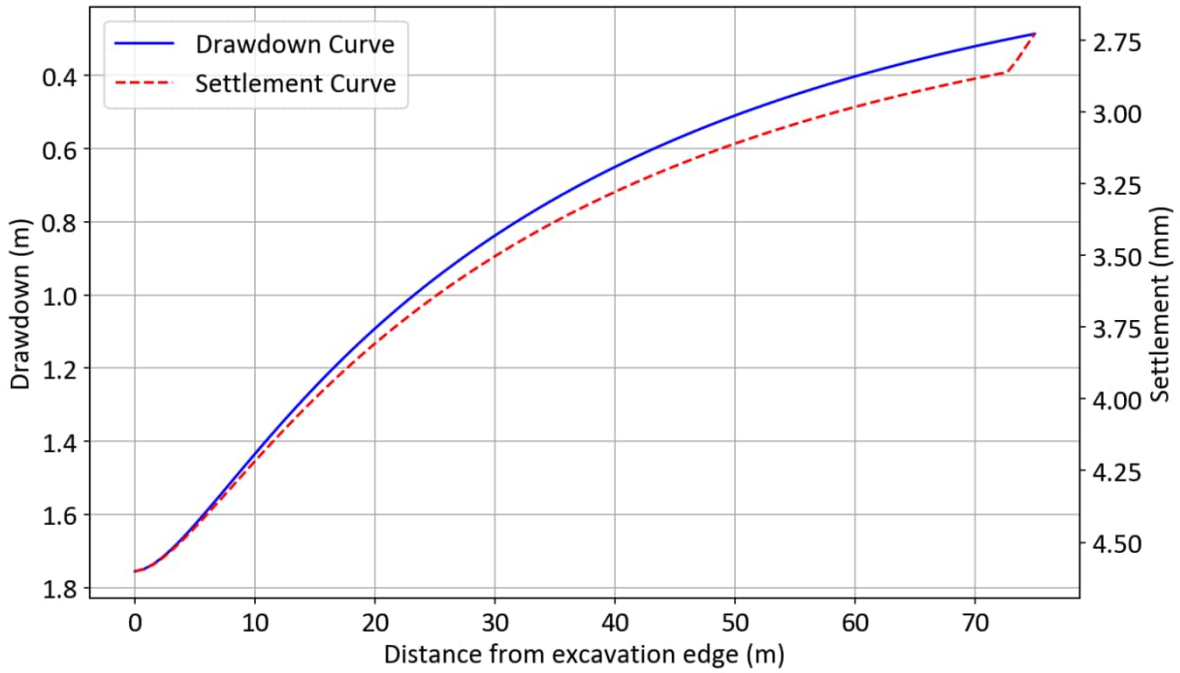
E3.4.1 Case 9

Appendix E Table 20: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
22.1 m RL	-2.7 m RL	24.8 m bGL	63.6 m²

Appendix E Table 19: Soil compressibility

m RL bottom	Constrained modulus
20.6 m RL	5 MPa
17.2 m RL	4 MPa
15.4 m RL	20 MPa
13.8 m RL	50 MPa



Appendix Figure E.8: Calculated drawdown and drawdown-induced settlement

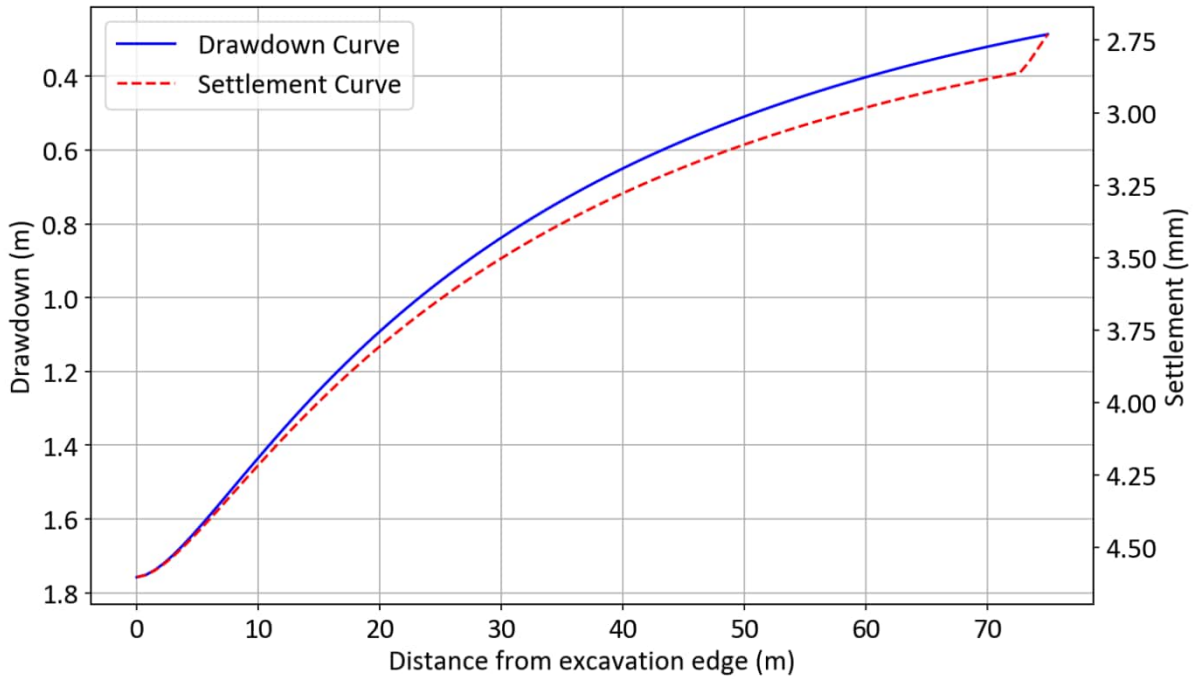
E.3.4.2 Case 10

Appendix E Table 22: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
22.1 m RL	-2.7 m RL	24.8 m bGL	63.6 m²

Appendix E Table 23: Soil compressibility

m RL bottom	Constrained modulus
20.6 m RL	5 MPa
17.2 m RL	4 MPa
15.4 m RL	20 MPa
13.8 m RL	50 MPa



Appendix Figure E.9: Calculated drawdown and drawdown-induced settlement

E3.5 Shaft 05

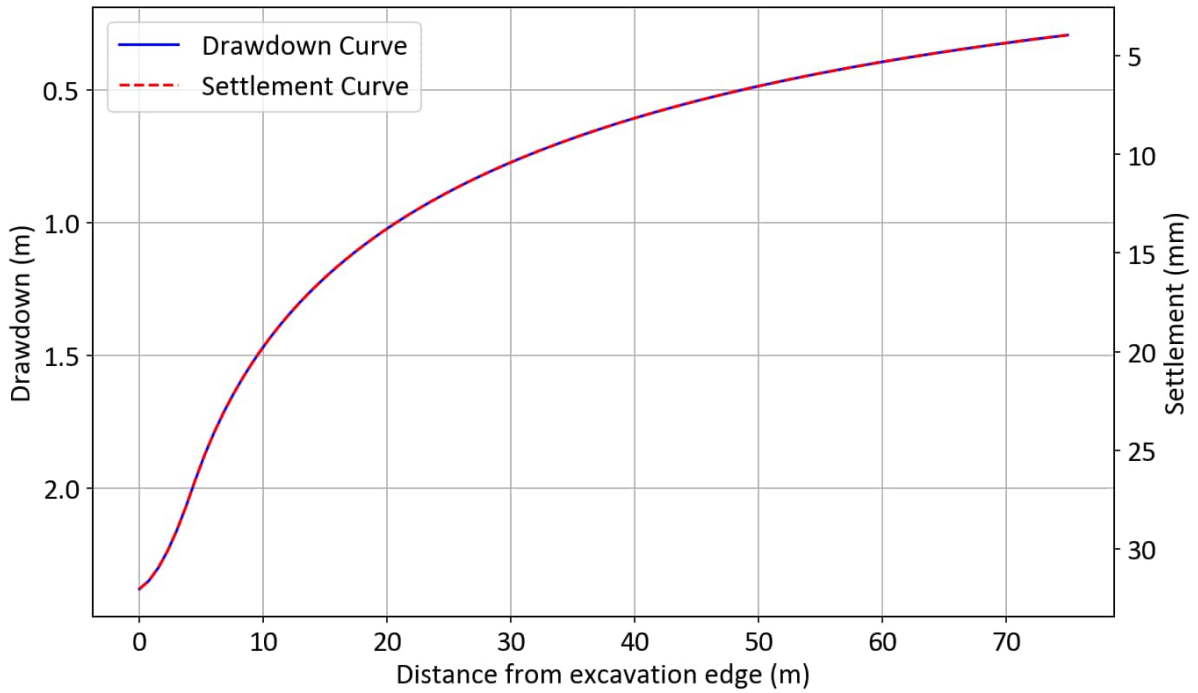
E3.5.1 Case 11

Appendix E Table 24: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
19.0 m RL	-4.1 m RL	23.1 m bGL	9.6 m²

Appendix E Table 25: Soil compressibility

m RL bottom	Constrained modulus
17.7 m RL	5 MPa
12.7 m RL	4 MPa
11.0 m RL	20 MPa
9.1 m RL	50 MPa



Appendix Figure E.10: Calculated drawdown and drawdown-induced settlement

E3.6 Shaft 06

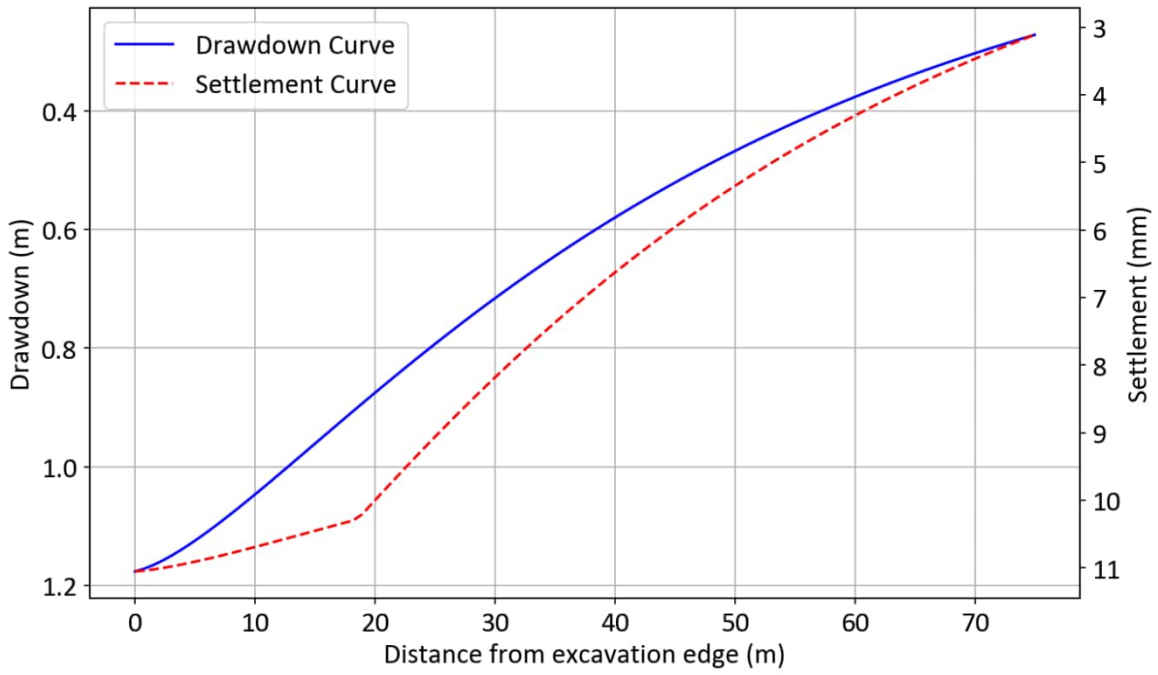
E3.6.1 Case 13

Appendix E Table 26: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
16.1 m RL	-6.7 m RL	22.8 m bGL	28.2 m²

Appendix E Table 27: Soil compressibility

m RL bottom	Constrained modulus
11.7 m RL	5 MPa
9.8 m RL	20 MPa
0.3 m RL	50 MPa



Appendix Figure E.11: Calculated drawdown and drawdown-induced settlement

E3.7 Shaft 07

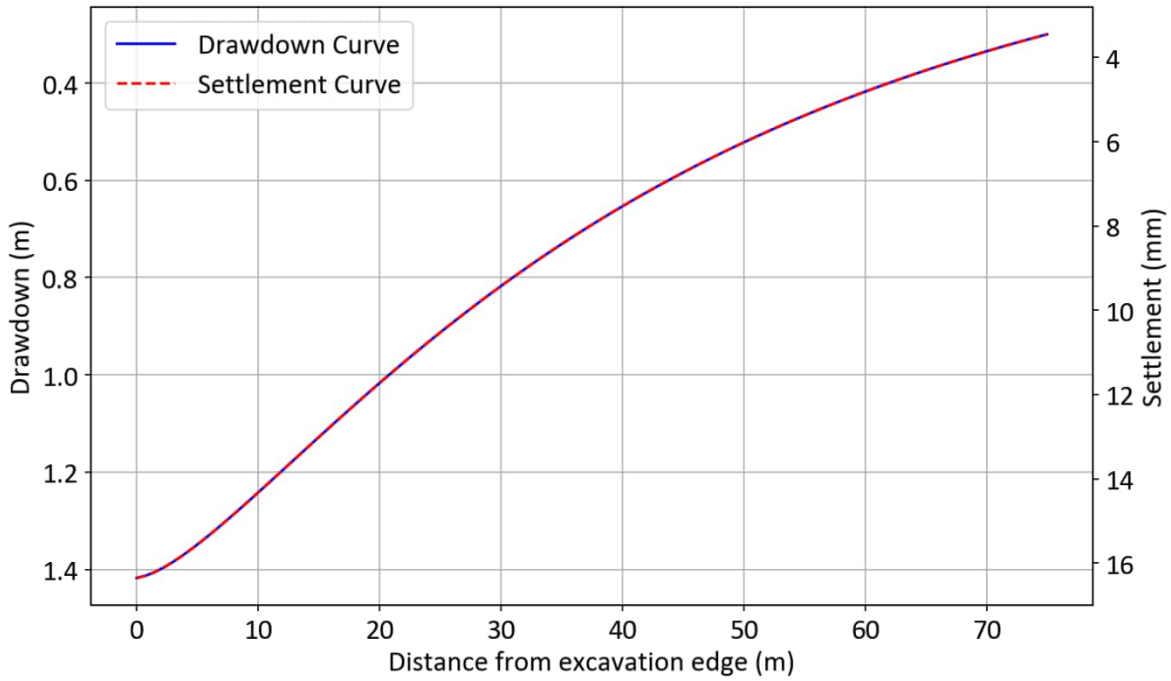
E3.7.1 Case 14

Appendix E Table 28: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
12.6 m RL	-8.4 m RL	21.0 m bGL	63.6 m²

Appendix E Table 29: Soil compressibility

m RL bottom	Constrained modulus
11.7 m RL	5 MPa
7.6 m RL	4 MPa
6.3 m RL	20 MPa
2.0 m RL	50 MPa



Appendix Figure E.11: Calculated drawdown and drawdown-induced settlement

E3.8 Shaft 07a

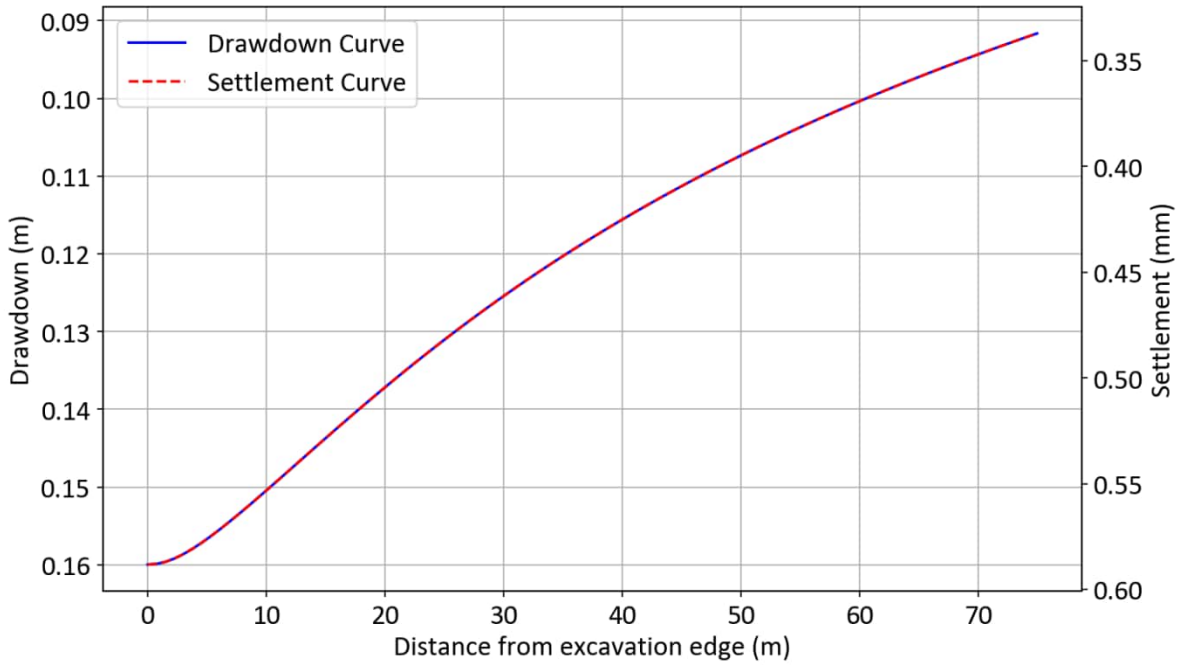
E3.8.1 Case 15

Appendix E Table 30: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
12.0 m RL	-9.3 m RL	21.3 m bGL	9.6 m²

Appendix E Table 31: Soil compressibility

m RL bottom	Constrained modulus
11.0 m RL	5 MPa
9.5 m RL	4 MPa



Appendix Figure E.12: Calculated drawdown and drawdown-induced settlement

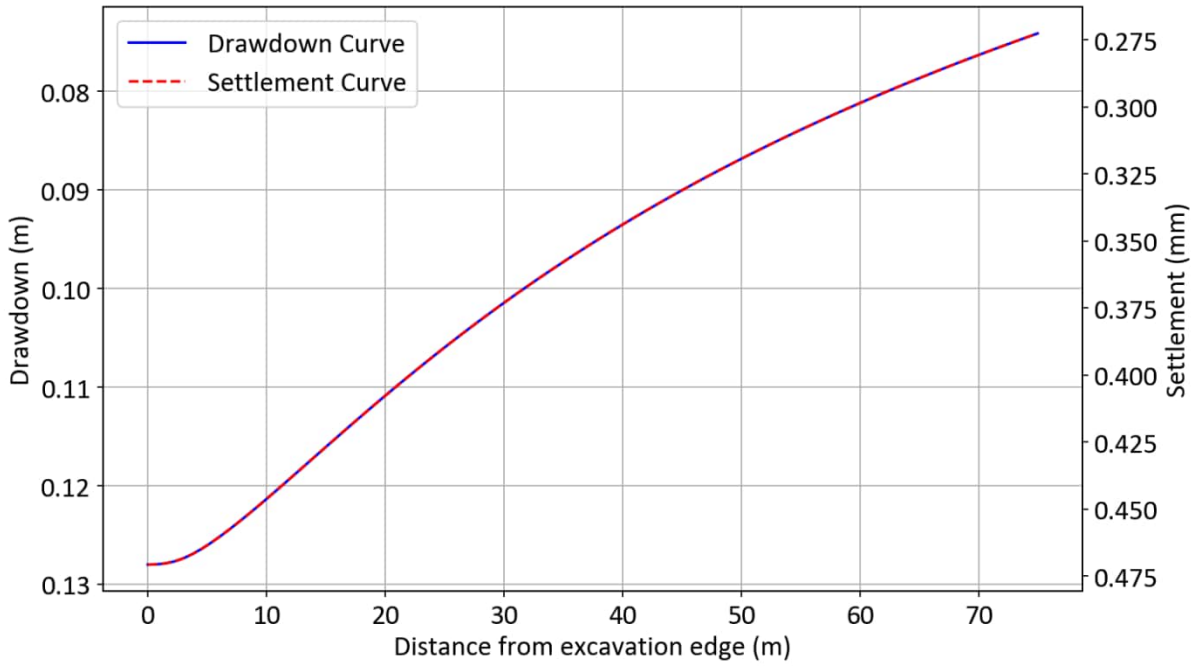
E3.8.2 Case 16

Appendix E Table 32: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
12.0 m RL	-9.3 m RL	21.3 m bGL	9.6 m²

Appendix E Table 33: Soil compressibility

m RL bottom	Constrained modulus
11.0 m RL	5 MPa
9.5 m RL	4 MPa
-3.7 m RL	200 MPa



Appendix Figure E.13: Calculated drawdown and drawdown-induced settlement

E3.9 Shaft 08

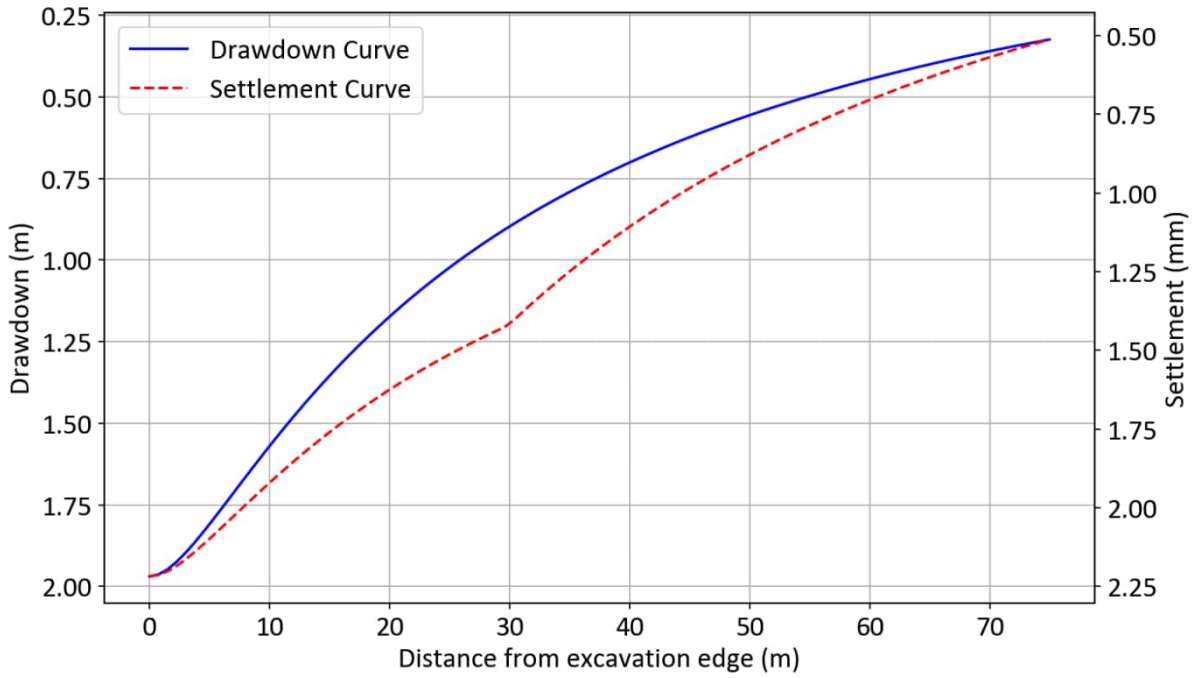
E3.9.1 Case 17

Appendix E Table 34: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
12.0 m RL	-13.3 m RL	25.3 m bGL	63.6 m²

Appendix E Table 35: Soil compressibility

m RL bottom	Constrained modulus
10.8 m RL	5 MPa
9.1 m RL	20 MPa
5.3 m RL	50 MPa



Appendix Figure E.14: Calculated drawdown and drawdown-induced settlement

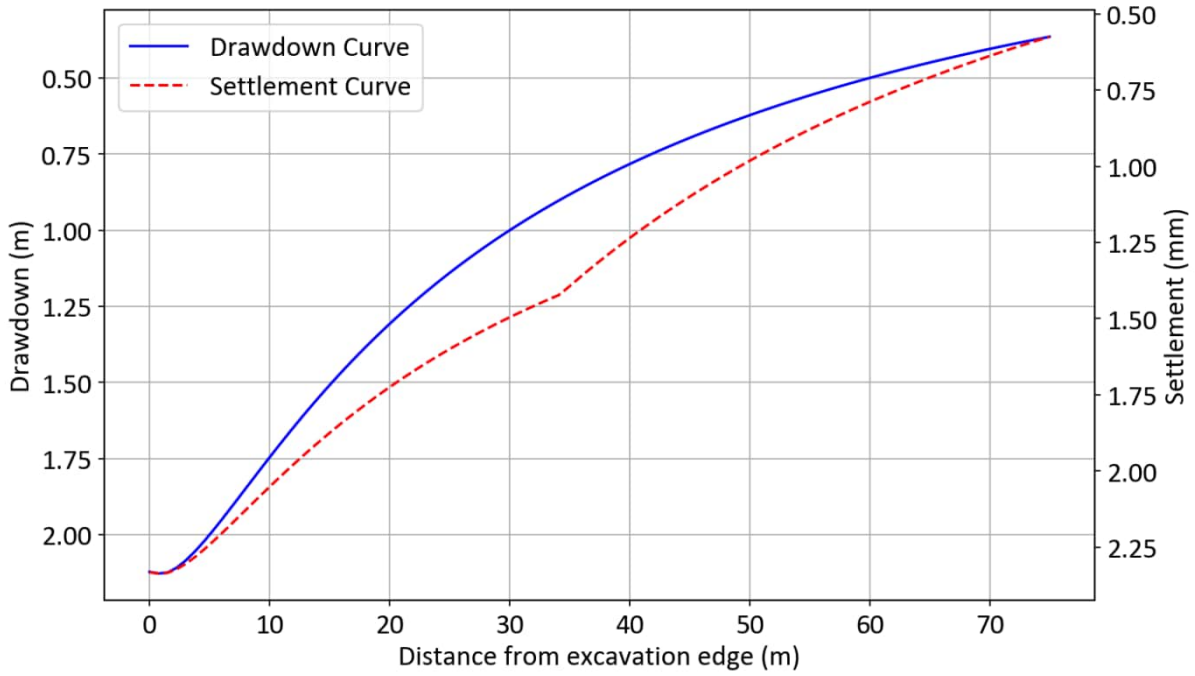
E3.9.2 Case 18

Appendix E Table 36: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
12.0 m RL	-13.3 m RL	25.3 m bGL	153.8 m²

Appendix E Table 37: Soil compressibility

m RL bottom	Constrained modulus
10.8 m RL	5 MPa
9.1 m RL	20 MPa
5.3 m RL	50 MPa



Appendix Figure E.15: Calculated drawdown and drawdown-induced settlement

E3.10 Shaft 09

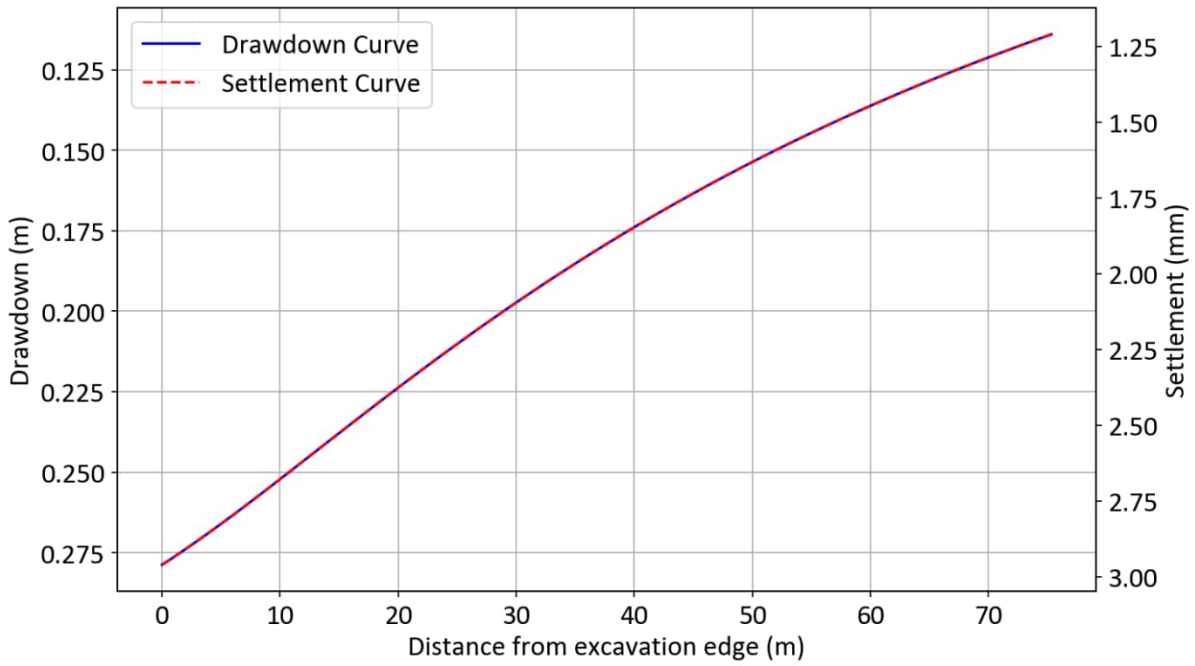
E3.10.1 Case 19

Appendix E Table 38: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
59.2 m RL	49.5 m RL	9.7 m bGL	24.0 m²

Appendix E Table 39: Soil compressibility

m RL bottom	Constrained modulus
54.9 m RL	5 MPa
52.6 m RL	20 MPa
47.2 m RL	50 MPa



Appendix Figure E.16: Calculated drawdown and drawdown-induced settlement

E3.11 Shaft 10

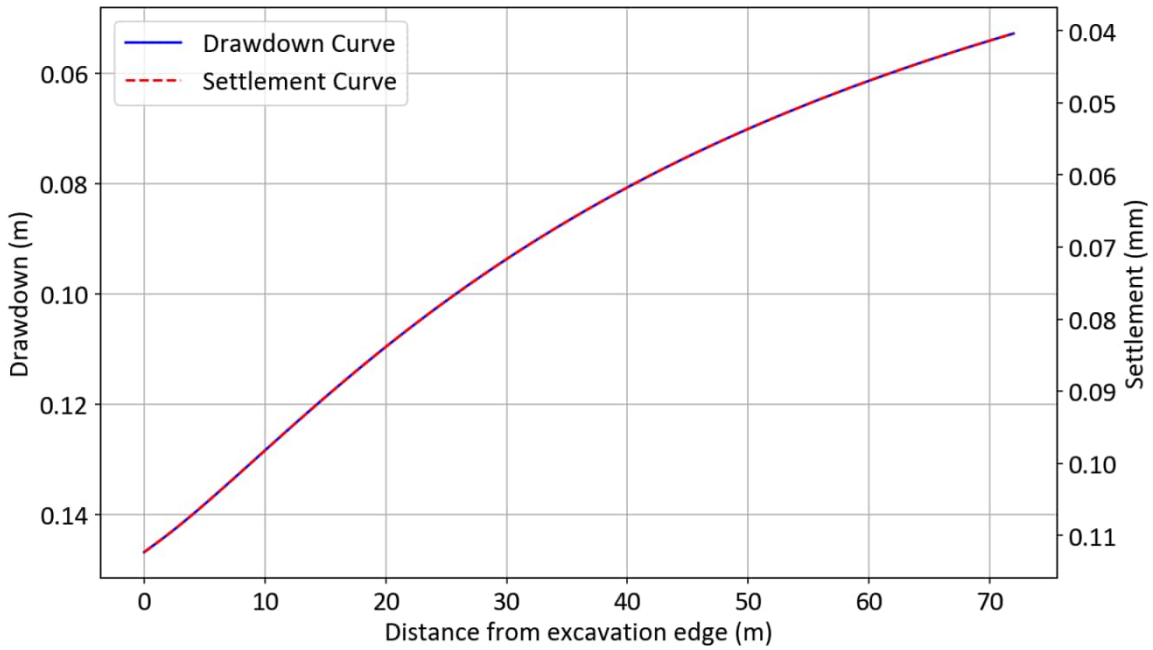
E3.11.1 Case 20

Appendix E Table 40: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
51.9 m RL	45.5 m RL	6.4 m bGL	24.0 m²

Appendix E Table 41: Soil compressibility

m RL bottom	Constrained modulus
48.3 m RL	5 MPa
47.7 m RL	20 MPa
45.3 m RL	50 MPa



Appendix Figure E.17: Calculated drawdown and drawdown-induced settlement

E3.12 Shaft 11

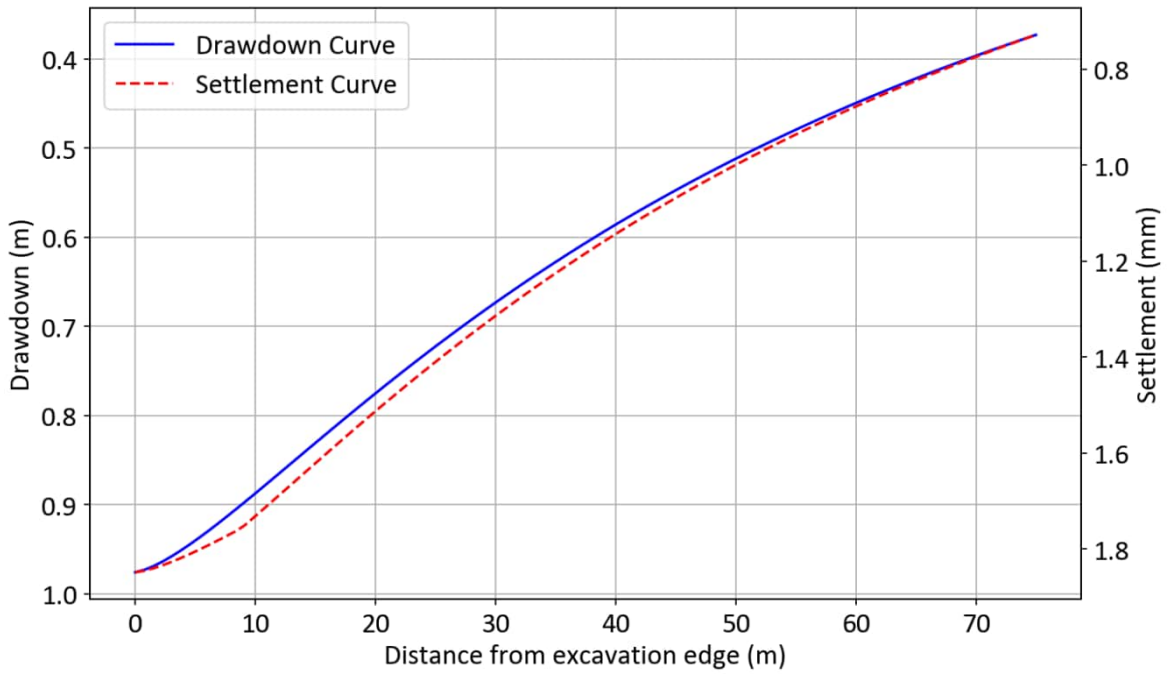
E3.12.1 Case 21

Appendix E Table 42: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
51.4 m RL	26.4 m RL	25.0 m bGL	28.2 m²

Appendix E Table 43: Soil compressibility

m RL bottom	Constrained modulus
49.5 m RL	5 MPa
48.0 m RL	20 MPa
41.8 m RL	50 MPa



Appendix Figure E.18: Calculated drawdown and drawdown-induced settlement

E3.13 Shaft 12

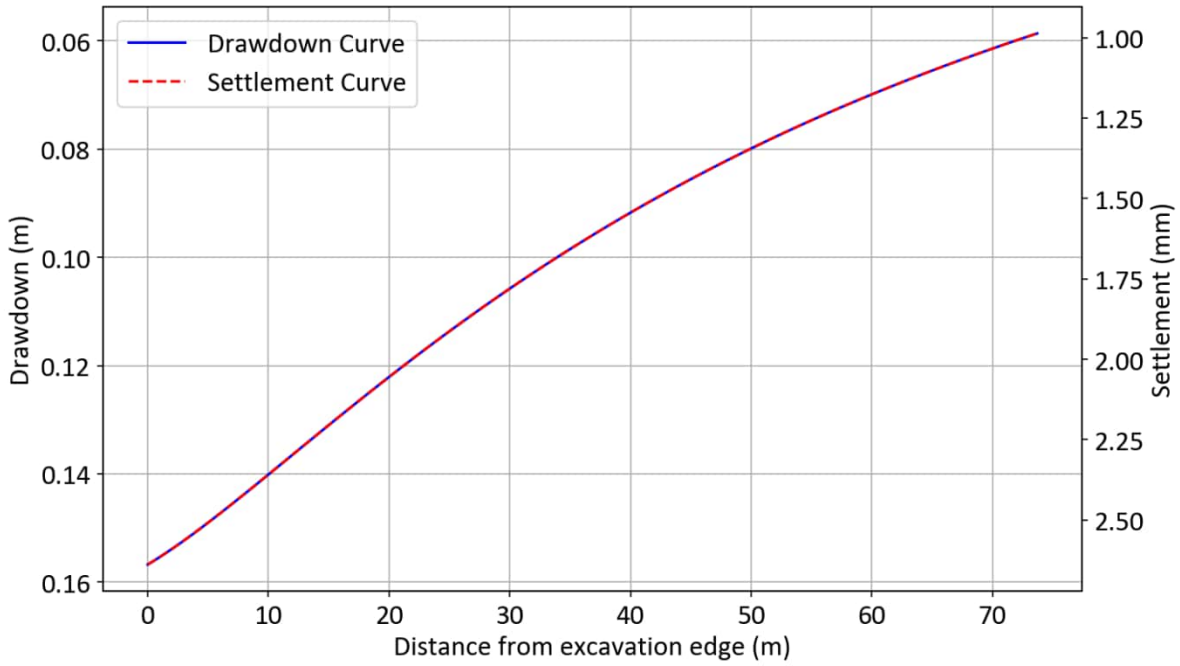
E.13.1 Case 22

Appendix E Table 44: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
50.3 m RL	42.1 m RL	8.2 m bGL	24.0 m²

Appendix E Table 45: Soil compressibility

m RL bottom	Constrained modulus
47.5 m RL	5 MPa
40.9 m RL	4 MPa
40.1 m RL	20 MPa
38.8 m RL	50 MPa



Appendix Figure E.19: Calculated drawdown and drawdown-induced settlement

E.3.14 Shaft 12a

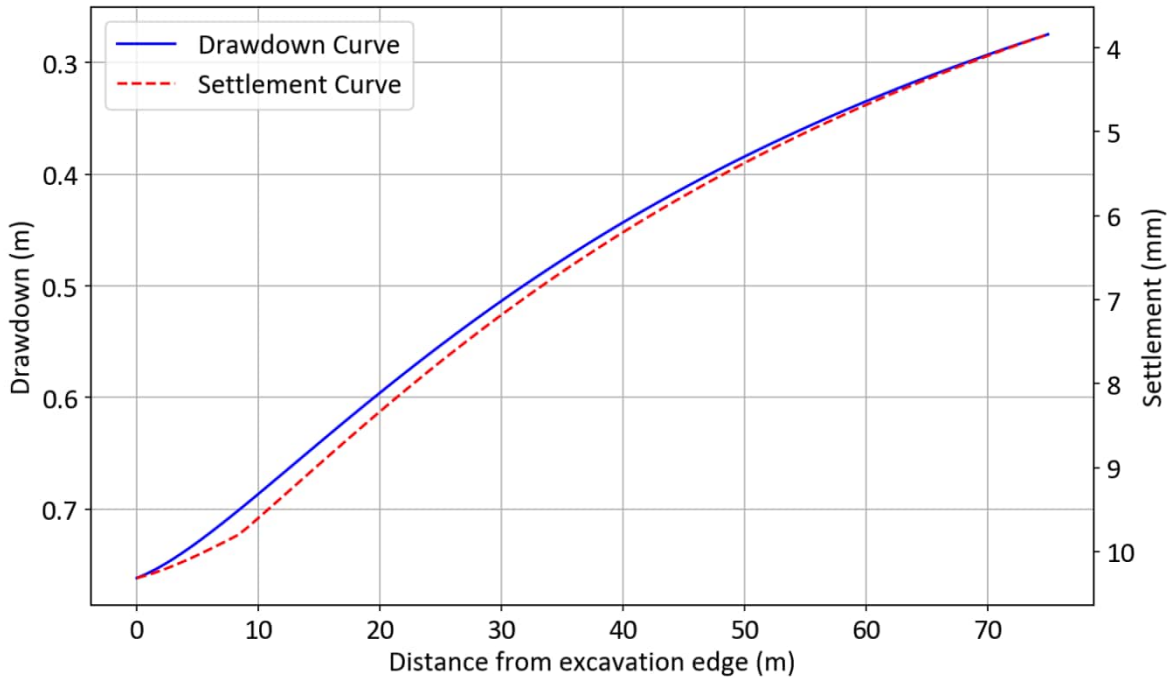
E3.14.1 Case 23

Appendix E Table 46: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
44.4 m RL	26.8 m RL	17.6 m bGL	28.2 m²

Appendix E Table 47: Soil compressibility

m RL bottom	Constrained modulus
41.6 m RL	5 MPa
38.4 m RL	4 MPa
37.8 m RL	20 MPa
36.0 m RL	50 MPa



Appendix Figure E.20: Calculated drawdown and drawdown-induced settlement

E3.15 Shaft 13

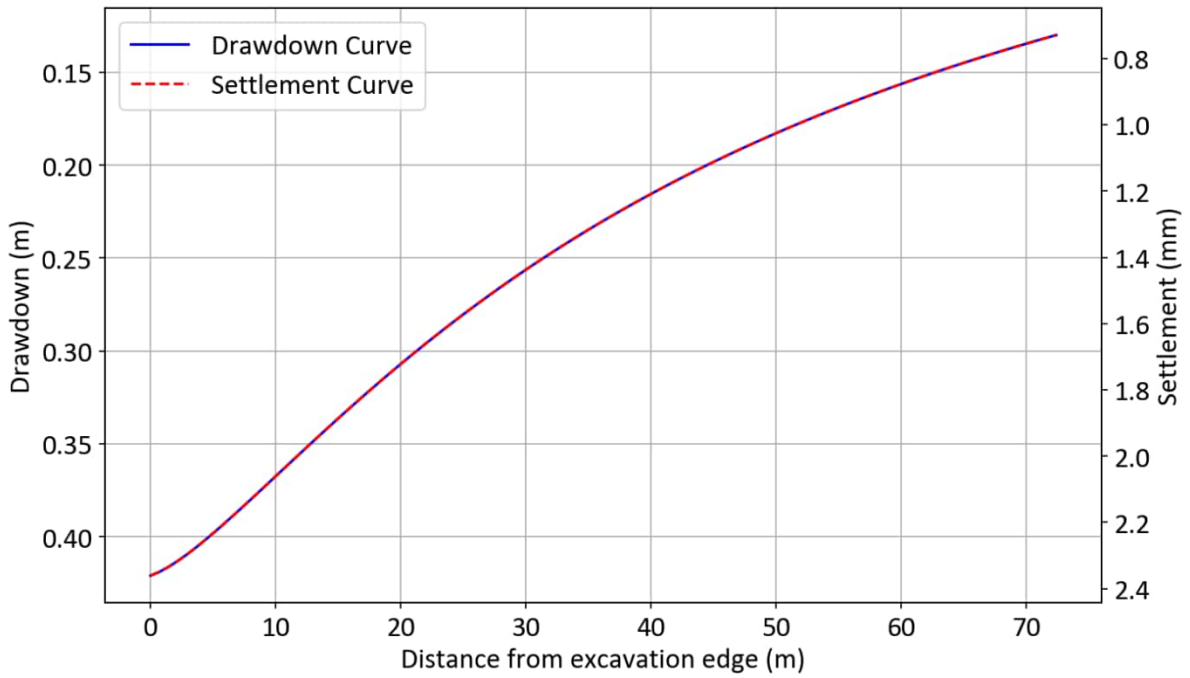
E3.15.1 Case 24

Appendix E Table 48: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
34.0 m RL	25.4 m RL	8.6 m bGL	24.0 m²

Appendix E Table 49: Soil compressibility

m RL bottom	Constrained modulus
31.5 m RL	5 MPa
30.7 m RL	20 MPa
29.1 m RL	50 MPa



Appendix Figure E.21: Calculated drawdown and drawdown-induced settlement

E3.16 Shaft 14

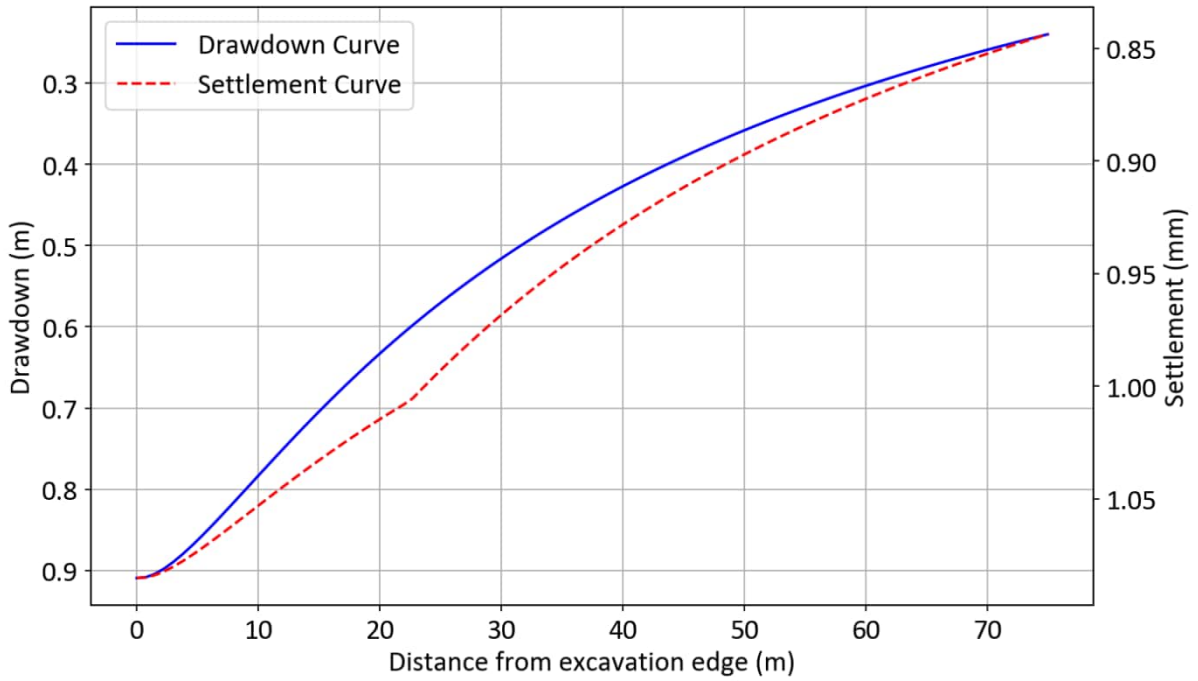
E3.16.1 Case 25

Appendix E Table 50: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
29.2 m RL	13.8 m RL	15.4 m bGL	28.2 m²

Appendix E Table 51: Soil compressibility

m RL bottom	Constrained modulus
28.5 m RL	5 MPa
27.0 m RL	4 MPa
26.6 m RL	20 MPa
25.3 m RL	50 MPa



Appendix Figure E.22: Calculated drawdown and drawdown-induced settlement

E3.17 Shaft 15

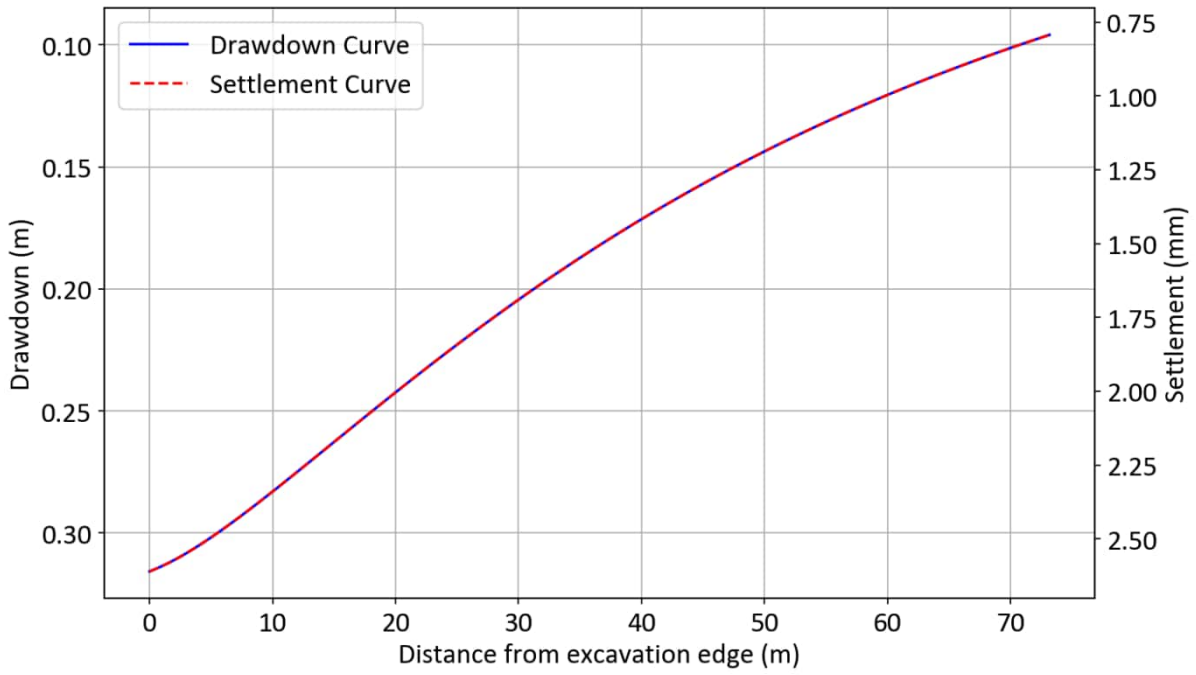
E3.17.1 Case 26

Appendix E Table 52: Excavation details

Ground level	Excavation level	Excavation depth	Excavation area
23.3 m RL	16.8 m RL	6.5 m bGL	24.0 m²

Appendix E Table 53: Soil compressibility

m RL bottom	Constrained modulus
20.9 m RL	5 MPa
14.4 m RL	20 MPa
12.5 m RL	50 MPa



Appendix Figure E.23: Calculated drawdown and drawdown-induced settlement

Appendix F– Shafts groundwater settlement analysis

F1 Introduction

This technical memorandum should be read in conjunction with report titled:

Tonkin & Taylor Ltd. (August 2025). Groundwater and Settlement Assessment of Effects – Motions Catchment Improvement Project. Prepared for Watercare Services Limited. Job No: 30552.5024

F1.1 Method

PLAXIS 2D Version 2024.2 has been used to model soil-structural interaction and estimate mechanical settlement profiles. Axisymmetric models have been run for circular shaft cases and plane strain used for the rectangular shafts.

F1.1 Model scenarios

Developed representative models for similar shafts to determine mechanical settlement effects at each location. This is based on the ground model, proposed shaft locations, and shaft dimensions and resulted in three “base” cases and two “sensitivity” cases, as summarised in Appendix F . The adoption of representative models at the other shaft locations is considered to be conservative and results in slight increases in calculated mechanical settlements.

Appendix F Table 1: Mechanical settlement analysis cases

Case ID	Base case shaft	Sensitivity cases	Reason for base case
A	SH01 + GWL from SH02	SH08 shaft dimensions	Largest shaft depth and diameter
B	SH05 + GWL from SH03	SH03 shaft dimensions	Largest alluvium and residual ECBF depth
C	SH09 + GWL from SH15	-	Rectangular excavation, with significant fill depth, and residual soil depth

Note: groundwater level has been abbreviated to GWL

Appendix F Table 2 outlines the ground profile, groundwater level, and shaft dimensions adopted at each of the shafts and the associated case assigned based on these parameters

Appendix F Table 2: Ground profile and representative modelling case

Case ID	Shaft ID	Shaft diameter (m)	Max shaft depth (m)[1]	Groundwater (m bgl)	Layer thickness (m)				
					Fill	Alluvium	Residual ECBF	Basalt	Weathered ECBF
A	SH01	12	45.51	3.9	2.1	3.1	2.4	-	1.7
A	SH02	10	40.34	0.5	2.5	-	2.4	-	3
B sensitivity	SH03	6	25.78	0.5	2.9	5.5	-	-	2.8
A sensitivity	SH04	9	24.92	4.7	1.5	3.4	1.8	-	1.6
B	SH05	3.5	23.16	2	1.3	5	1.7	-	1.9
B sensitivity	SH06	6	22.79	3.5	4.4	-	1.9	-	9.5
A sensitivity	SH07	9	20.98	2	0.9	4.1	1.3	-	4.3
B	SH07a	3.5	22.07	3	1	1.5	-	13.2	-
A sensitivity	SH08	14	25.20	2	1.2	-	1.7	-	3.8
C[2]	SH09	6 m x 4 m	9.71	3	4.3 [3.8]	-	2.3 [8.85]	-	5.4
C	SH10	6 m x 4 m	6.40	3.6	3.6	-	0.6	-	2.4
B sensitivity	SH11	6	25.02	2.5	1.9	-	1.5	-	6.2
C	SH12	6 m x 4 m	8.20	5	2.8	6.6	0.8	-	1.3
B sensitivity	SH12a	6	17.57	2	2.8	3.2	0.6	-	1.8
C	SH13	6 m x 4 m	8.64	2	2.5	-	0.8	-	1.6
B sensitivity	SH14	6	15.40	2	0.7	1.5	0.4	-	1.3
C	SH15	6 m x 4 m	6.60	1.3	2.4	-	6.5	-	1.9

Note:
1. Shaft depths shown are inclusive of 0.5 m of overdig.
2. Numbers in brackets [] outline alternative strata depths considered in the sensitivity analysis.
3. Red text denotes the base case shaft and the adopted groundwater levels.
4. Orange text denotes the sensitivity case shaft

F1.2 Material parameters

Appendix F Table 3 summarises the material parameters adopted based on the GIR[2], with the exception of the interface parameters which have been assumed based on experience with similar materials. Appendix F Table 4 summarises the case-specific parameters which have been derived assuming the layer depths for the modelled cases shown in Appendix F Table 2.

Appendix F Table 3: Material parameters adopted for PLAXIS 2D

Unit Name	Soil model	Drainage type	γ	E_{50}	E_{oed}	E_{ur}	v	c'_{ref}	phi'	R_{inter}
			kN/m³	kN/m²	kN/m²	kN/m²		kN/m²	deg	
Fill	Hardening soil	Drained	17.5	8000	8000	24000	0.3	4	30	0.7
Alluvium	Hardening soil	Drained	18	7000	7000	21000	0.3	5	28	0.7
Residual ECBF	Hardening soil	Drained	18.5	35000	35000	105000	0.3	10	30	0.7
W ECBF	Hardening soil	Drained	20	100000	100000	300000	0.3	12	35	0.7
SW-UW ECBF	Hardening soil	Drained	20.5	400000	400000	1200000	0.25	100	40	0.9

Appendix F Table 4: Case-specific material parameters

Unit Name	m (1)	Case A			Case B			Case C		
		E_{50}^{ref}	E_{oed}^{ref}	E_{ur}^{ref}	E_{50}^{ref}	E_{oed}^{ref}	E_{ur}^{ref}	E_{50}^{ref}	E_{oed}^{ref}	E_{ur}^{ref}
		MN/m²			MN/m²			MN/m²		
Fill	0	8	8	24	-	-	-	8	8	24
Alluvium	0.5	15	15	77	15	15	79	-	-	-
Residual ECBF	0.5	61	61	350	52	52	267	62	62	356
W ECBF	0.5	143	143	849	116	116	621	125	125	692
SW-UW ECBF	0	400	400	1200	400	400	1200	400	400	1200

Note 1: m = 1 - j where j is Janbu stress exponent

F1.3 Secant parameters and shaft excavation

For the purposes of modelling:

- The excavation width has been taken as the outer edge of the secant piles.
- Rock is taken to be slightly weathered to unweathered ECBF.
- Where the base of excavation is above the top of rock, the secants are assumed to extend to the rock surface
- Where the base of excavation is below the top of rock, the secants are assumed to extend 3 m below the rock surface

Secants are assumed to be 0.9 m diameters piles, alternating hard and soft piles, spaced at 0.75 m centres. Hard and soft piles are assumed to be 25 GPa and 20 GPa, respectively. A creep/relaxation factor of 0.75 has been applied to the full stiffness (EI) parameter to account for a cracked concrete section. Associated modelling parameters have been adopted as shown in Appendix F Table 5

Appendix F Table 5: Case-specific material parameters

Case ID	Plate ID	Material type	Unit weight (kN/m/m)	EA1 (kN/m)	EI (kNm2/m)	v
A, B, C	Secant wall	Elastic	4.5	18200000	701250[Note 1]	0.2
A, A sensitivity	Mesh and rock bolt	Elastic	1	300000	15000	0.2
B, B sensitivity	Mesh and rock bolt	Elastic	1	75000	3750	0.2

Note 1: Value shown is 0.75 of the uncracked EI for the secant piles

For rectangular shafts, props are assumed at 2 m bgl to support the walls of the shaft. Props are assumed to be 310UC158 beams manufactured by Steel and Tube. Associated prop parameters are shown in Appendix F Table 6.

Appendix F Table 6: PLAXIS 2D prop parameters

Anchor ID	$L_{spacing}$ (m)	EA (kN)
Prop	4	4020000

F1.4 Surcharge loading

Settlement arising from the construction surcharge will be generally limited to where the construction plant is operating. The load acting on the retention structure is not expected to materially result in further wall deflections and therefore, settlement.

Building surcharges have not been considered as they are not expected to materially impact on retaining wall deflections and therefore, settlement due to their distance away of the proposed excavations.

F1.5 Construction sequence

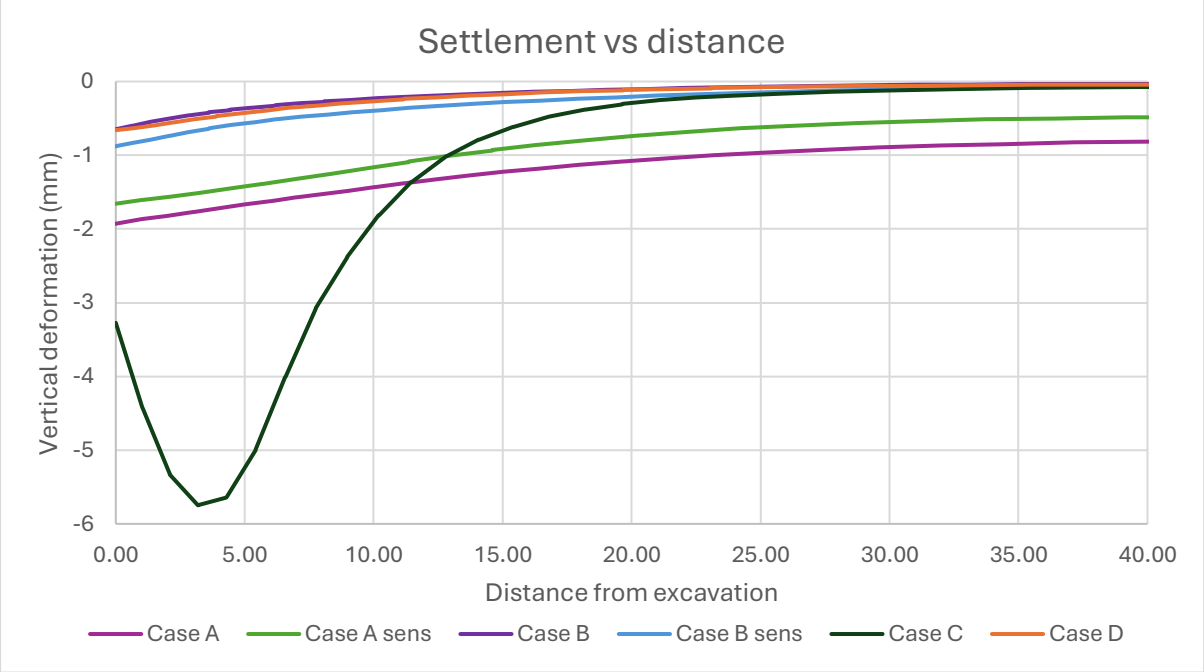
The following construction sequence has been assumed for the analysis:

1 Construct secant pile wall.

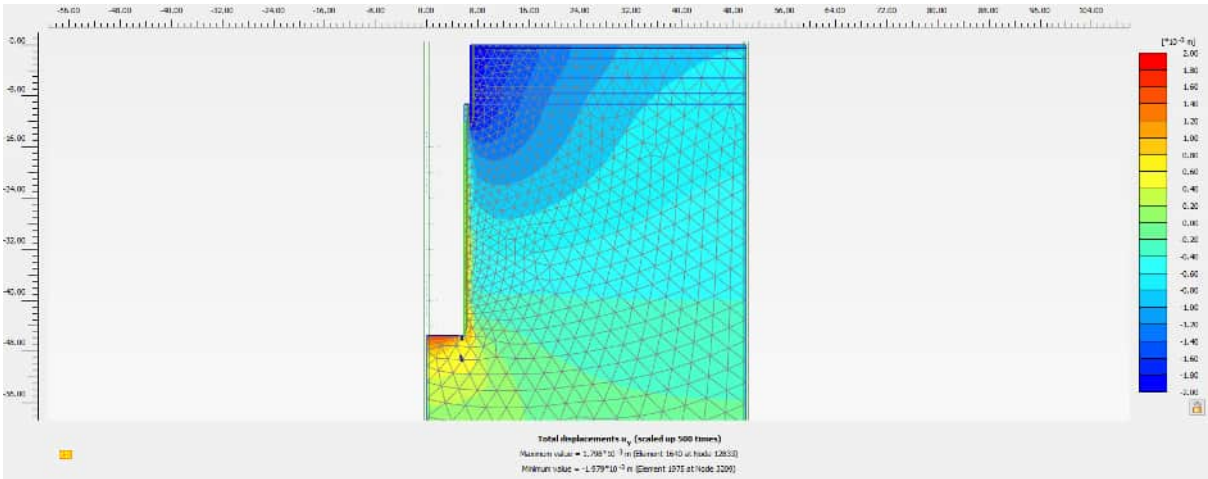
2 Excavate shafts in 4 m lifts and dewater groundwater within the shaft to the base of the lift. For rectangular shafts, a prop is placed at 2 m bgl during the first lift.

F1.6 Results

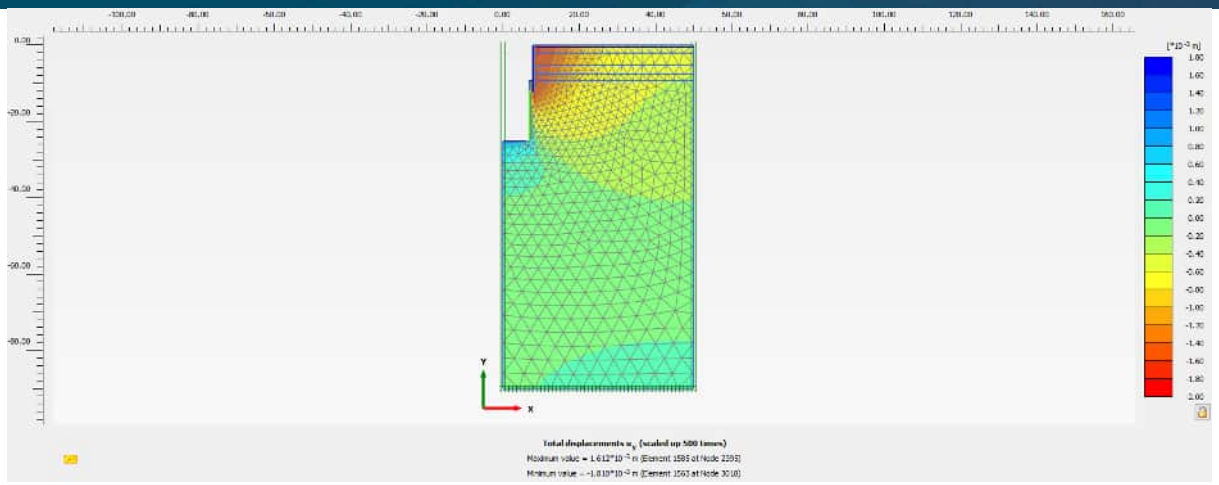
Appendix Figure F1 below presents the settlement predicted on the ground surface due to the shaft excavations. Appendix Figure F2 to Appendix Figure F6 present the vertical displacement plots from PLAXIS for each of the modelled cases.



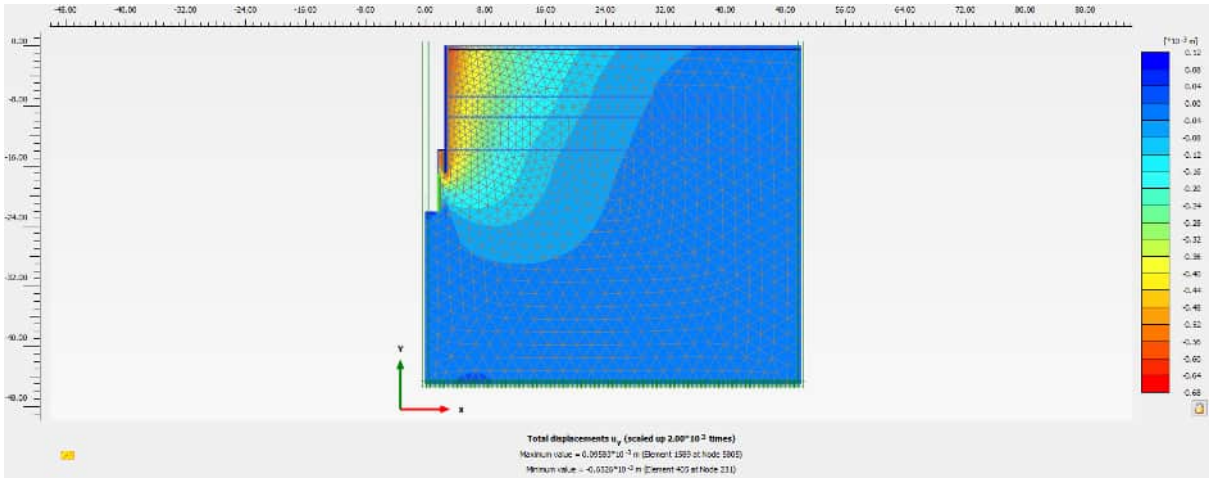
Appendix Figure F1: PLAXIS Results output graph



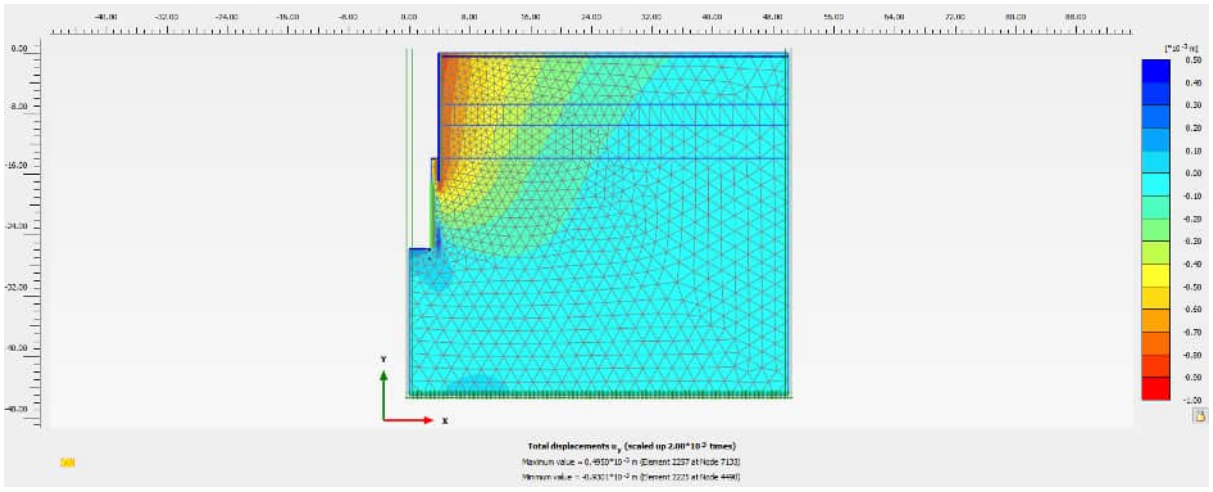
Appendix Figure F2: Case A vertical displacement plot



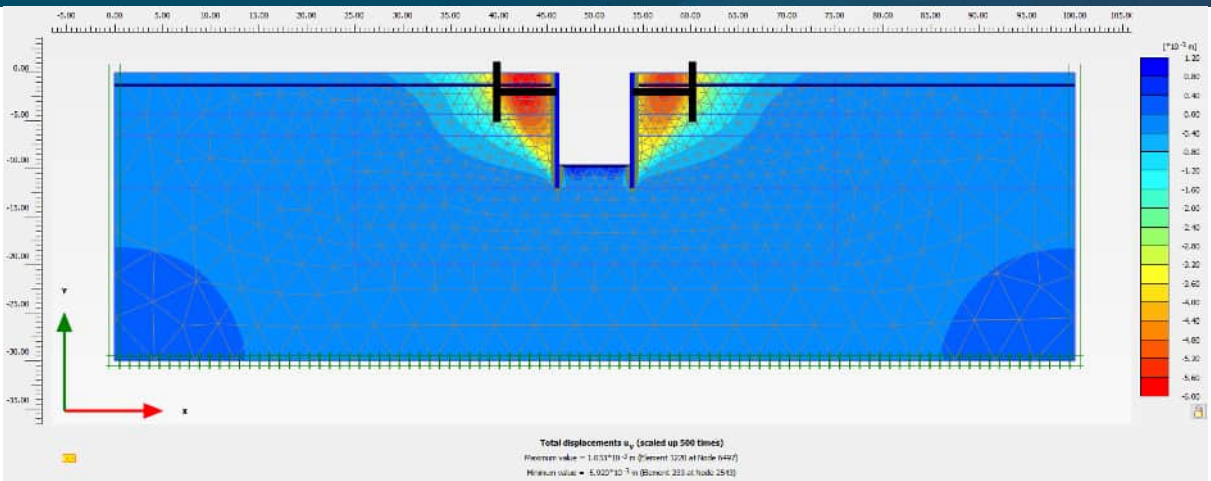
Appendix Figure F3: Case A sensitivity vertical displacement plot



Appendix Figure F4: Case B vertical displacement plot



Appendix Figure F5: Case B sensitivity vertical displacement plot



Appendix Figure F6: Case C vertical displacement plot

F1.3 Uncertainties and considerations for design

The below presents uncertainties that are considered acceptable for the purposes of assessing mechanical settlement for environmental effects, however, should be given further consideration during design.

1 For circular shafts, axisymmetric models have been used. This does not allow for the explicit modelling of unbalanced loading (variation in ground conditions, groundwater conditions or ground surcharges) and should be checked during design.

2 Any adverse effect from loss of contact between secant piles has not been analysed. Secant spacing should be select to ensure sufficient overlap to form an effective seal accounting for the potential of out of verticality tolerance. Sealing of any gaps between piles using grout according to good construction practice has been assumed.

3 Mechanical settlement associated with the construction of the tunnel connecting the shaft is considered to have a negligible contribution based on its size and depth. This should be considered as part of detailed design of the structure; however, is not considered to be consequential to the assessment of effects for the resource consent application.

4 Unbalanced pore pressures have been assumed between the base of the shaft and the retained material. Adopting an unbalanced pore pressure scenario with no dewatering of the groundwater from assumed levels is intended to present the worst-case scenario (i.e. greatest water pressure onto the wall). However, unbalanced pore pressures indicate potential for base heave and rock instability which has not been assessed at this stage and should be considered during detailed design.

5 Experience with ECBF Rock indicates it is likely for the quantum of rock relaxation to be low and the rate at which it occurs to be slow. Accordingly, there is potential for movement of the secant piles due to the build-up of water pressure behind the wall to be greater than the relaxation achieved in the underlying rock. Shunting of the secant piles and friction development between the secant piles and rock face should be checked during design.

6 Building surcharges have not been considered as they are not expected to materially impact on retaining wall deflections and therefore, settlement. The majority of building surcharges are well outside the zone of influence on the shaft. Where buildings exhibit loading onto the shaft, these loads are expected to be minimal due to their offset distance. However, the effects of building foundations should be assessed during design.

7 Construction loading has not been considered as settlement arising from the construction surcharge will be generally limited to where the construction plant is operating. The load acting on the retention structure is not expected to materially result in further wall deflections and therefore, settlement. However, we recommend that the effects of construction surcharge loading are checked during design, predominantly for design actions.

Appendix G– Shafts settlement damage assessment

G1 Shaft settlement assessment

This technical memorandum should be read in conjunction with report titled:

Tonkin & Taylor Ltd. (June 2025). Groundwater and Settlement Assessment of Effects – Motions Catchment Improvement Project. Prepared for Watercare Services Limited. Job No: 30552.5024.

G2 Method of assessment of geotechnical/groundwater effects

The proposed excavation has the potential to induce ground settlement due to a combination of groundwater drawdown and mechanical deformation, which may cause ground movements outside the retention system. The estimated ground settlements associated with these mechanisms have been assessed and are presented in preceding sections. The following section evaluates the potential implications of the estimated settlements on adjacent buildings, and neighbouring structures and underground utilities.

G2.1 Utilities damage assessment

The proposed excavations have the potential to affect utilities located within the assessed settlement zone of influence of the works.

While many utility types can tolerate relatively high levels of differential settlement, certain utilities may be more susceptible to damage. A utility's tolerance to settlement generally depends on factors such as construction type and material, current condition, and orientation relative to the excavation. Utilities that run perpendicular to the excavation are typically at higher risk, as they are more likely to experience significant differential settlement. In contrast, utilities running parallel and located near the excavation may be subject to vertical and/or horizontal displacement due to ground loss at the excavation face but generally experience less differential movement.

The methodology used to assess the potential effects on utilities is based on O'Rourke and Trautmann (1982)[7], which provides guidance on allowable differential settlement for various utility construction types. A summary of the recommended deformation tolerances for different utility types is provided in Appendix G Table 1.

Appendix G Table 1: Utilities damage risk assessment criteria

Utility description	Maximum allowable differential settlement (V:H)
Brick unlined	1:240
Welded steel pipe	1:120
Cast in-situ concrete	1:170
PVC & HDPE	1:70
Reinforced concrete pipe	1:230
Ductile iron pipe	1:230
Vitrified clay pipe	1:300

[7] O'Rourke, T D, and C H Trautmann. 1982. Buried pipeline response to tunnel ground movements. In Europipe 82 Conf., Basel, Switzerland, paper 1.

Utility description	Maximum allowable differential settlement (V:H)
Cast iron pipe (diameter category A)	1:150
Cast iron pipe (diameter category B)	1:500

G2.2 Buildings damage assessment

The proposed excavations have the potential to affect buildings located within the assessed settlement zone of influence of the works.

The Burland (2012)[8] building damage classification framework is widely referenced for assessing damage risk and establishing preliminary trigger levels for ground movement. This framework has been adopted in this assessment to define preliminary risk categories and associated threshold levels, as summarised in Appendix G Table 2.

However, it is important to appreciate that the Burland criteria represent generalised correlations and do not fully account for site-specific factors that may influence damage risk. Such factors include variability in the structural form and resilience of neighbouring buildings, the presence of pre-existing settlement or structural damage, and broader project-related considerations — for example, the potential commercial or programme implications of construction delays should damage occur, or differing levels of risk perception and acceptance among neighbouring property owners.

Accordingly, the preliminary trigger levels presented in Appendix G Table 2. should be regarded as an initial basis for monitoring and management. Further site-specific evaluation may lead to refinement of these threshold levels — either upward or downward — as part of the development of the Groundwater Settlement Monitoring and Contingency Plan (GSMCP), once additional design information, monitoring data, or risk considerations are incorporated.

Appendix G Table 2: Building damage risk assessment criteria

Risk Category (Burland 2012 & CIRIA 1996)	Total Settlement Range (CIRIA 1996)	Differential Settlement Range (CIRIA 1996)	Description of typical damage (Burland 2012)
1	Less than 10 mm	Less than 1:500	**Very Slight:** Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection. Typical crack widths up to 1 mm.

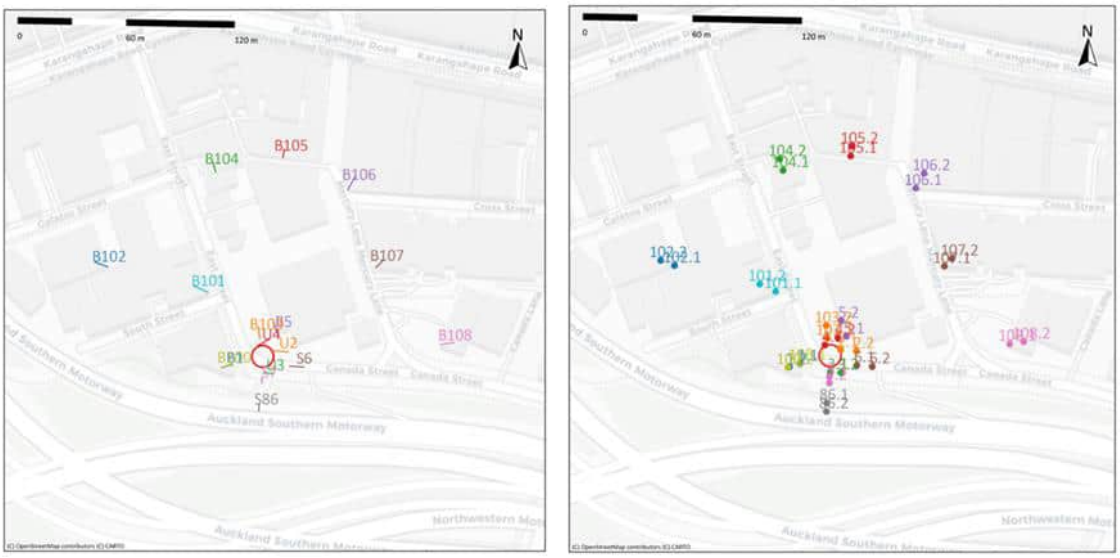
[8] Chapter 26 Building response to ground movements, John B.Burland, ICE manual of geotechnical engineering: Volume I. January 2012, 281-296

Risk Category (Burland 2012 & CIRIA 1996)	Total Settlement Range (CIRIA 1996)	Differential Settlement Range (CIRIA 1996)	Description of typical damage (Burland 2012)
2	10 to 50 mm	1:500 to 1:200	**Slight:** Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible, some repainting may be required for weather-tightness. Doors and windows may stick slightly. Typical crack widths up to 5 mm.
3	50 to 75 mm	1:200 to 1:50	**Moderate:** Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Brick pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired. Typical crack widths are 5 to 15 mm or several greater than 3 mm
4	Greater than 75 mm	Greater than 1:50	**Severe:** Extensive repair involving removal and replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted. Typical crack widths are 15 to 25 mm but also depend on the number of cracks.

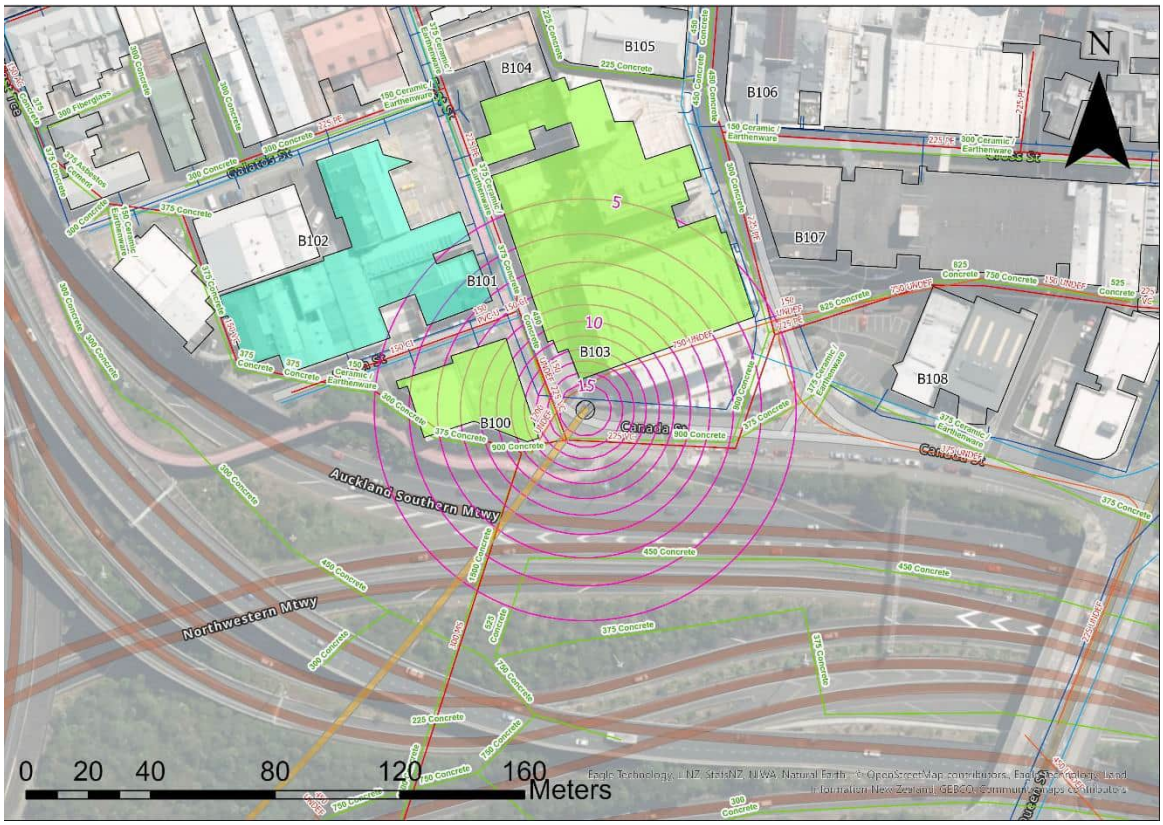
G3 Geotechnical and groundwater effects near shafts

G3.1 Shaft 01

G3.1.1 Case 1



Appendix Figure G1: Location of the proposed excexcavation, and point pairs used to calculate settlement and differential settlement



Appendix Figure G2: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 3: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
B1	12 mm	11 mm	6 m	1 in 5000	Industrial building, concrete columns and foundations.	1 in 500	Pass
B5	14 mm	12 mm	9 m	1 in 7500	Temporary industrial corrugated metal storage area	1 in 500	Pass
S6	13 mm	11 mm	9 m	1 in 4500	Canada Street Road	1 in 500	Pass
S7	14 mm	13 mm	3 m	1 in 3000	Nearby Pathway	1 in 500	Pass
S86	10 mm	10 mm	5 m	1 in 6000	Southern Motorway	1 in 500	Pass
B100	12 mm	11 mm	7 m	1 in 6000	29 East Street, 17 South Street	1 in 500	Pass
B101	7 mm	6 mm	10 m	1 in 9500	21 - 27 East Street, 2 - 10 South Street. 17 Galatos Street	1 in 500	Pass
B103	15 mm	13 mm	7 m	1 in 3000	16-20, 38 East Street, 9,11,13,17,21,23,27 Mercury Lane	1 in 500	Pass

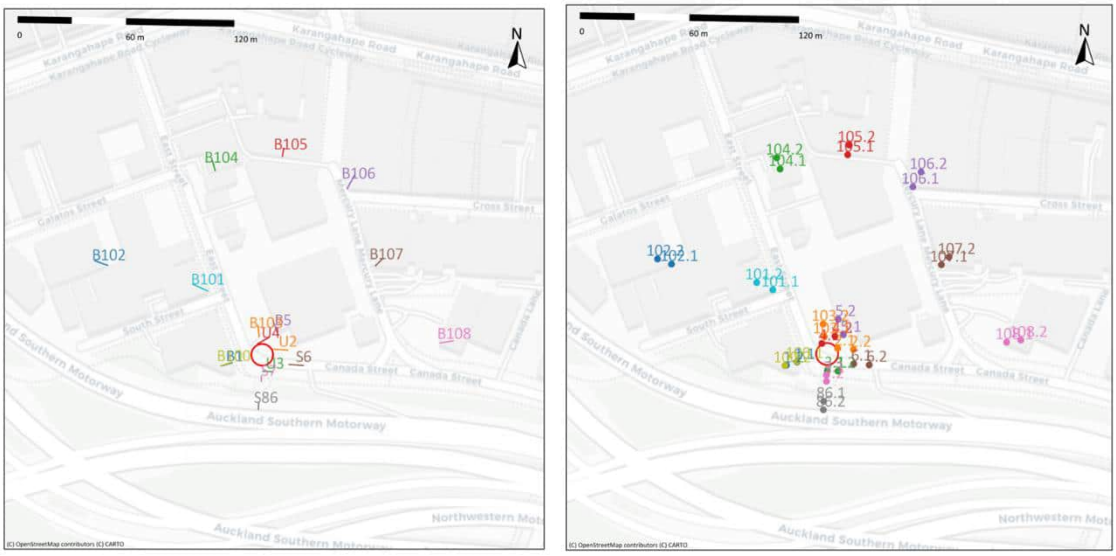
Appendix G Table 4: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U2	16 mm	13 mm	9 m	1 in 4000	150 AC Water Pipeline	1 in 500	Pass
U3	14 mm	14 mm	6 m	1 in 13500	900 Concrete Stormwater Pipeline	1 in 500	Pass
U4	16 mm	15 mm	8 m	1 in 8000	150 UNDEF Wastewater Pipelien	1 in 500	Pass

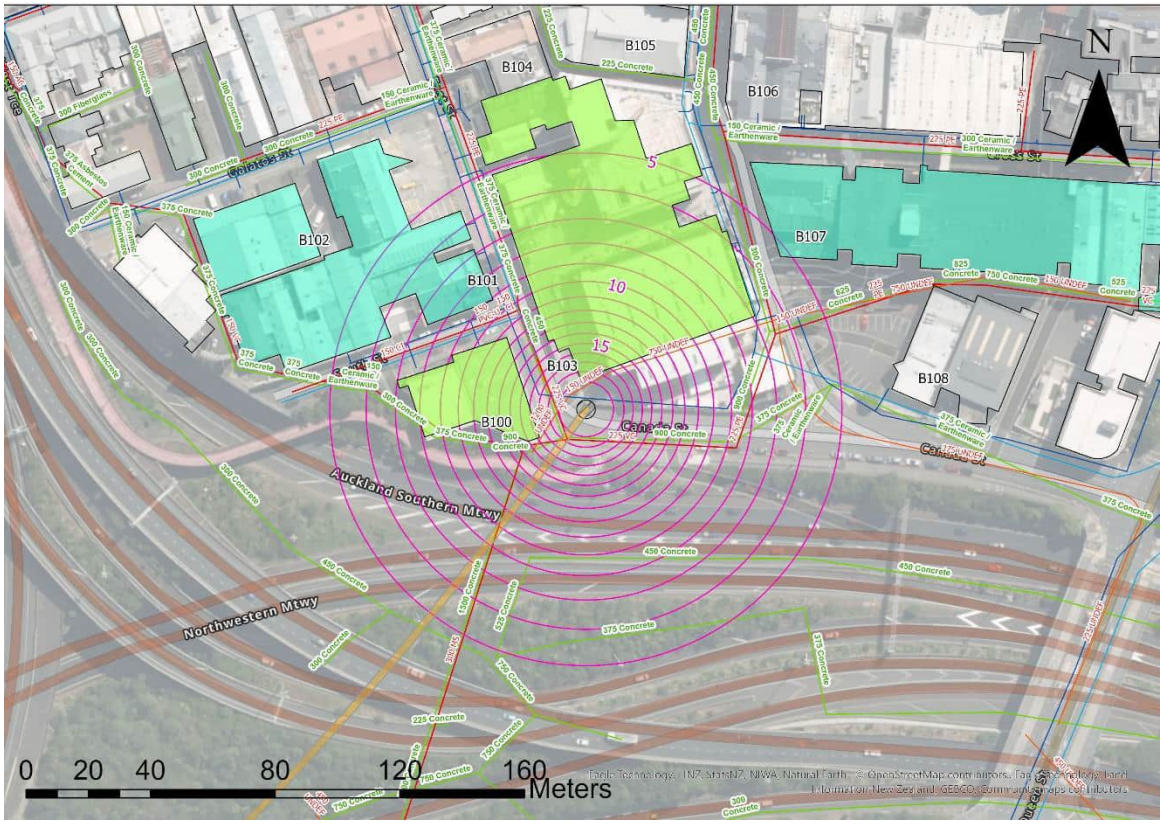
Appendix G Table 5: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B1	12 mm [risk category 2]	11 mm [risk category 2]	6 m	1 in 5000 [risk category 1]	Industrial building, concrete columns and foundations.	Slight [risk category 2]
B5	14 mm [risk category 2]	12 mm [risk category 2]	9 m	1 in 7500 [risk category 1]	Temporary industrial corrugated metal storage area	Slight [risk category 2]
B100	12 mm [risk category 2]	11 mm [risk category 2]	7 m	1 in 6000 [risk category 1]	29 East Street, 17 South Street	Slight [risk category 2]
B101	7 mm [risk category 1]	6 mm [risk category 1]	10 m	1 in 9500 [risk category 1]	21 - 27 East Street, 2 - 10 South Street. 17 Galatos Street	Negligible [risk category 1]
B103	15 mm [risk category 2]	13 mm [risk category 2]	7 m	1 in 3000 [risk category 1]	16-20, 38 East Street, 9,11,13,17,21,23,27 Mercury Lane	Slight [risk category 2]

G3.1.2 Case 2



Appendix Figure G3: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G4: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 6: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B1	16 mm	15 mm	6 m	1 in 5000	Industrial building, concrete columns and foundations.	1 in 500	Pass
B5	17 mm	15 mm	9 m	1 in 4500	Temporary industrial corrugated metal storage area	1 in 500	Pass
S6	17 mm	14 mm	9 m	1 in 3500	Canada Street Road	1 in 500	Pass
S7	18 mm	17 mm	3 m	1 in 2500	Nearby Pathway	1 in 500	Pass
S86	14 mm	13 mm	5 m	1 in 4000	Southern Motorway	1 in 500	Pass
B100	16 mm	14 mm	7 m	1 in 3500	29 East Street, 17 South Street	1 in 500	Pass
B101	9 mm	8 mm	10 m	1 in 6500	21 - 27 East Street, 2 - 10 South Street. 17 Galatos Street	1 in 500	Pass
B103	19 mm	16 mm	7 m	1 in 2500	16-20, 38 East Street, 9,11,13,17,21,23,27 Mercury Lane	1 in 500	Pass

Appendix G Table 7: Utilities differential settlement damage assessment

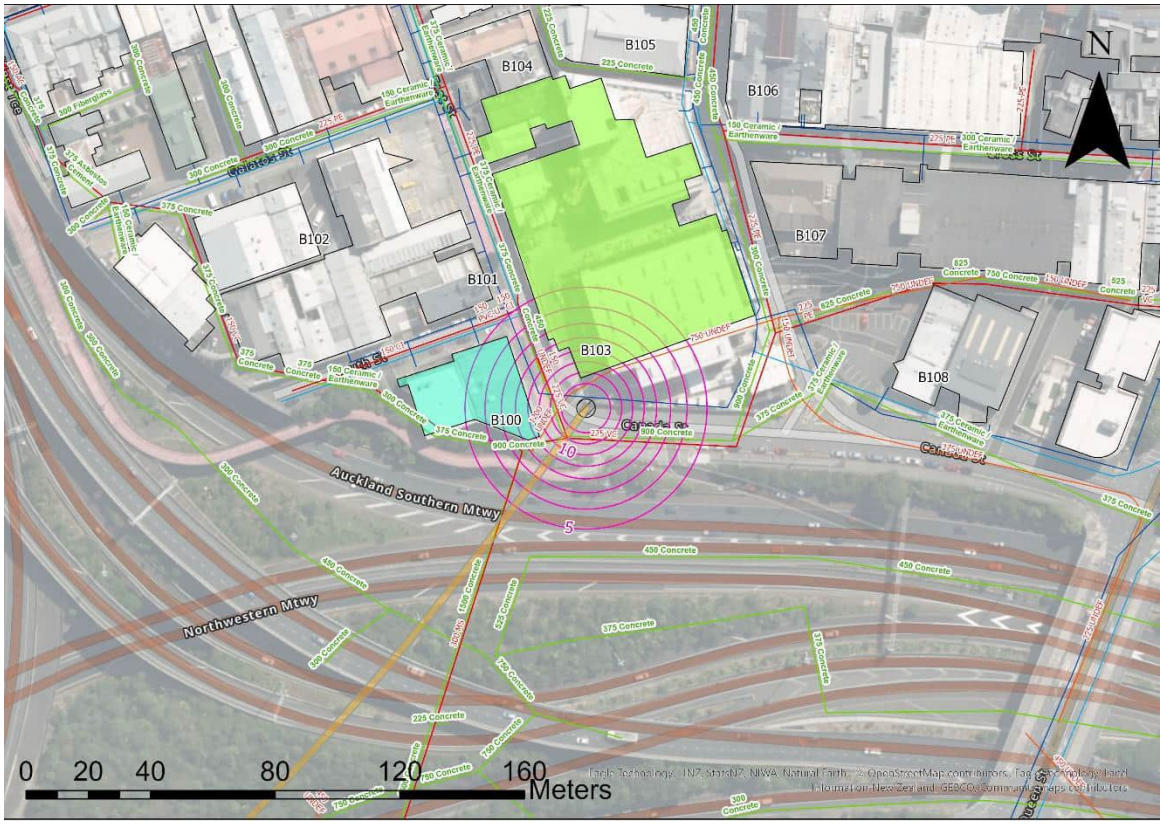
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U2	29 mm	17 mm	9 m	1 in 750	150 AC Water Pipeline	1 in 500	Pass
U3	19 mm	19 mm	6 m	1 in 18000	900 Concrete Stormwater Pipeline	1 in 500	Pass
U4	19 mm	19 mm	8 m	1 in 13000	150 UNDEF Wastewater Pipelien	1 in 500	Pass

Appendix G Table 8: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B1	16 mm [risk category 2]	15 mm [risk category 2]	6 m	1 in 5000 [risk category 1]	Industrial building, concrete columns and foundations.	Slight [risk category 2]
B5	17 mm [risk category 2]	15 mm [risk category 2]	9 m	1 in 4500 [risk category 1]	Temporary industrial corrugated metal storage area	Slight [risk category 2]
B100	16 mm [risk category 2]	14 mm [risk category 2]	7 m	1 in 3500 [risk category 1]	29 East Street, 17 South Street	Slight [risk category 2]
B101	9 mm [risk category 1]	8 mm [risk category 1]	10 m	1 in 6500 [risk category 1]	21 - 27 East Street, 2 - 10 South Street. 17 Galatos Street	Negligible [risk category 1]
B103	19 mm [risk category 2]	16 mm [risk category 2]	7 m	1 in 2500 [risk category 1]	16-20, 38 East Street, 9,11,13,17,21,23,27 Mercury Lane	Slight [risk category 2]

G3.13 Case 3

Appendix Figure G5: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G6: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 9: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B1	9 mm	8 mm	6 m	1 in 4000	Industrial building, concrete columns and foundations.	1 in 500	Pass
B5	10 mm	9 mm	9 m	1 in 5000	Temporary industrial corrugated metal storage area	1 in 500	Pass
S6	10 mm	8 mm	9 m	1 in 4000	Canada Street Road	1 in 500	Pass
S7	11 mm	10 mm	3 m	1 in 4000	Nearby Pathway	1 in 500	Pass
S86	7 mm	6 mm	5 m	1 in 5000	Southern Motorway	1 in 500	Pass
B100	9 mm	8 mm	7 m	1 in 4000	29 East Street, 17 South Street	1 in 500	Pass
B103	11 mm	10 mm	7 m	1 in 3500	16-20, 38 East Street, 9,11,13,17,21,23,27 Mercury Lane	1 in 500	Pass

Appendix G Table 10: Utilities differential settlement damage assessment

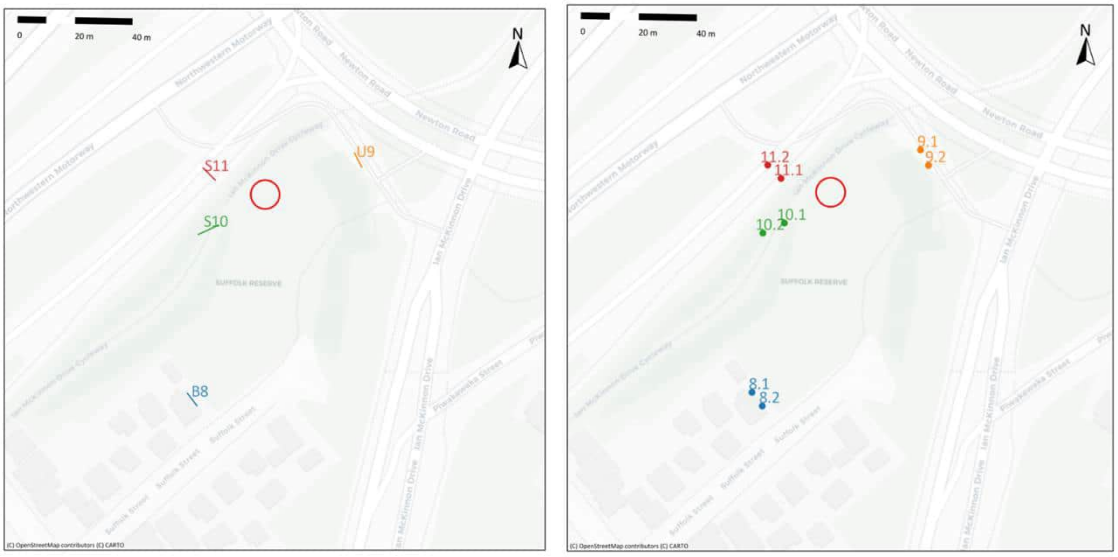
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U2	12 mm	10 mm	9 m	1 in 3500	150 AC Water Pipeline	1 in 500	Pass
U3	12 mm	11 mm	6 m	1 in 14000	900 Concrete Stormwater Pipeline	1 in 500	Pass
U4	12 mm	11 mm	8 m	1 in 8000	150 UNDEF Wastewater Pipelien	1 in 500	Pass

Appendix G Table 11: Building damage risk assessment and settlement analysis results

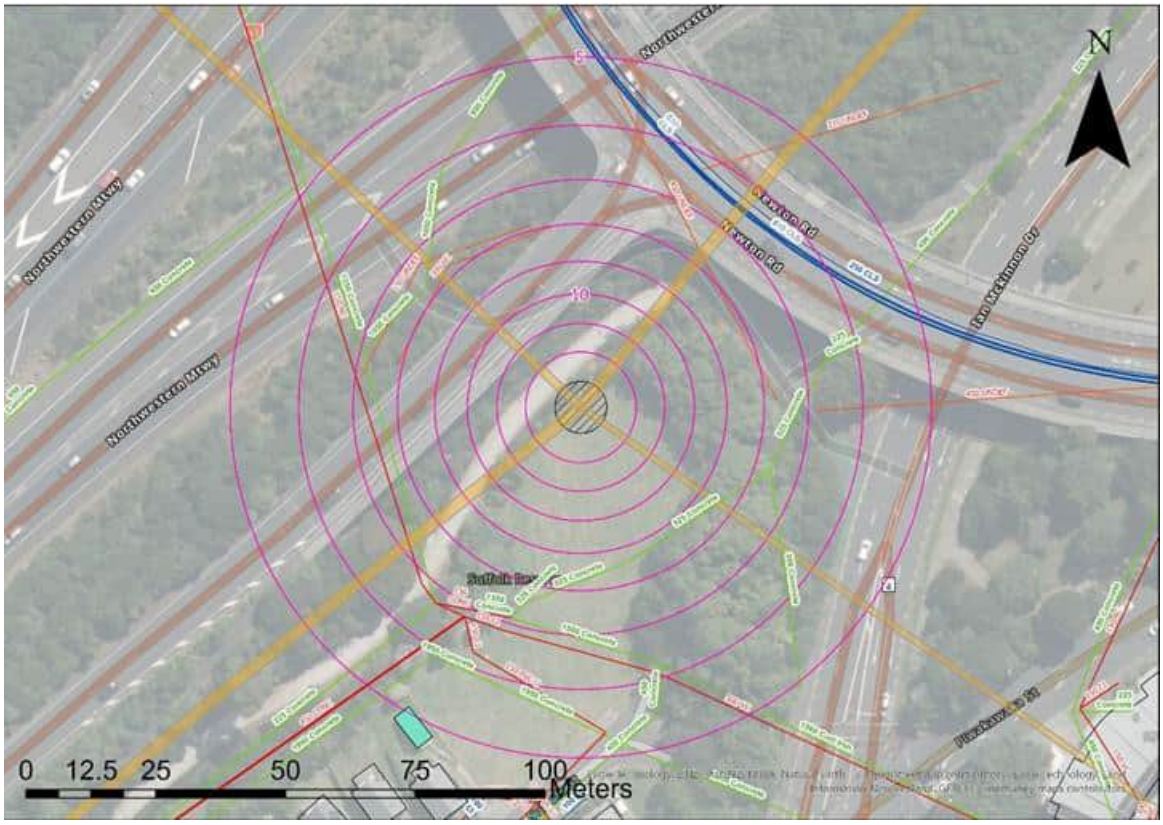
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on CIRIA 1996 criteria [highest reported risk category]
B1	9 mm [risk category 1]	8 mm [risk category 1]	6 m	1 in 4000 [risk category 1]	Industrial building, concrete columns and foundations.	Negligible [risk category 1]
B5	10 mm [risk category 2]	9 mm [risk category 1]	9 m	1 in 5000 [risk category 1]	Temporary industrial corrugated metal storage area	Slight [risk category 2]
B100	9 mm [risk category 1]	8 mm [risk category 1]	7 m	1 in 4000 [risk category 1]	29 East Street, 17 South Street	Negligible [risk category 1]

G3.2 Shaft 02

G3.2.1 Case 4



Appendix Figure G7: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G8: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 12: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B8	5 mm	4 mm	6 m	1 in 32000	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S10	10 mm	9 mm	8 m	1 in 6000	Highway bridge foundation pier	1 in 500	Pass
S11	11 mm	10 mm	6 m	1 in 6000	Adjacent pathway	1 in 500	Pass

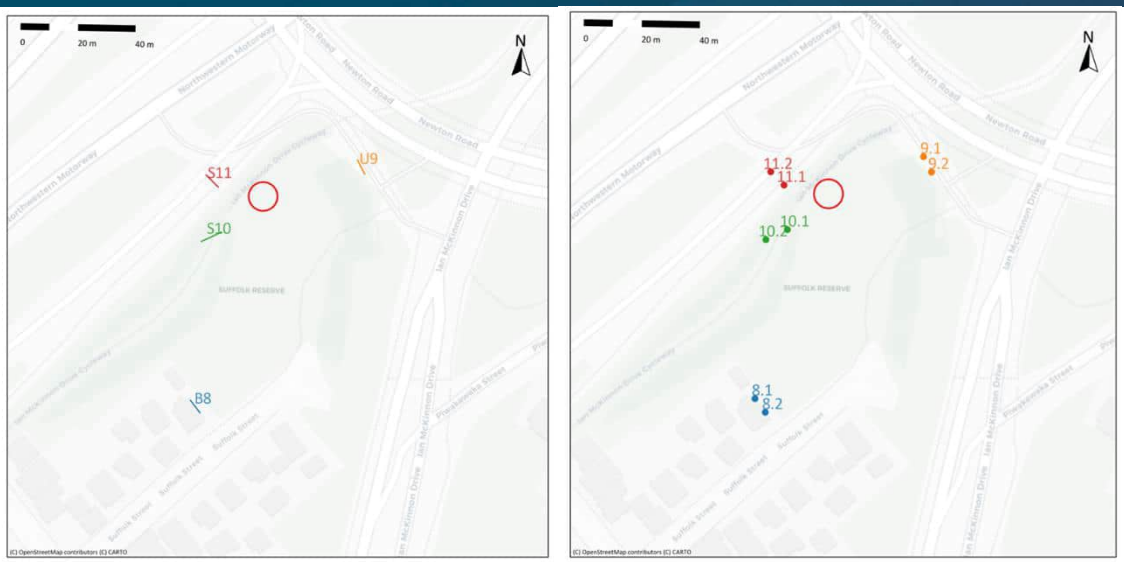
Appendix G Table 13: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U9	8 mm	8 mm	6 m	1 in 79000	450 UNDEF Wastewater Pipeline	1 in 500	Pass

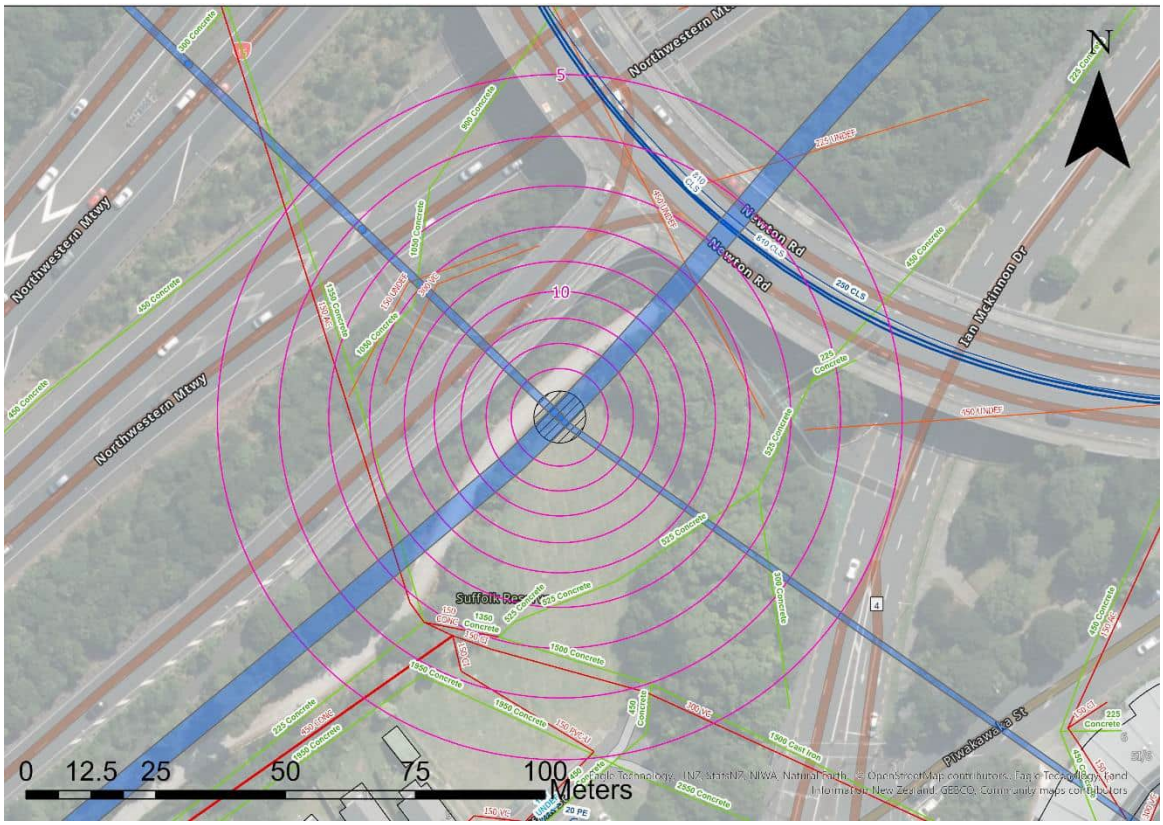
Appendix G Table 14: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B8	5 mm [risk category 1]	4 mm [risk category 1]	6 m	1 in 32000 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.2.2 Case 5



Appendix Figure G9: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G10: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 15: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B8	4 mm	4 mm	6 m	1 in 28000	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S10	11 mm	10 mm	8 m	1 in 6000	Highway bridge foundation pier	1 in 500	Pass
S11	12 mm	11 mm	6 m	1 in 5500	Adjacent pathway	1 in 500	Pass

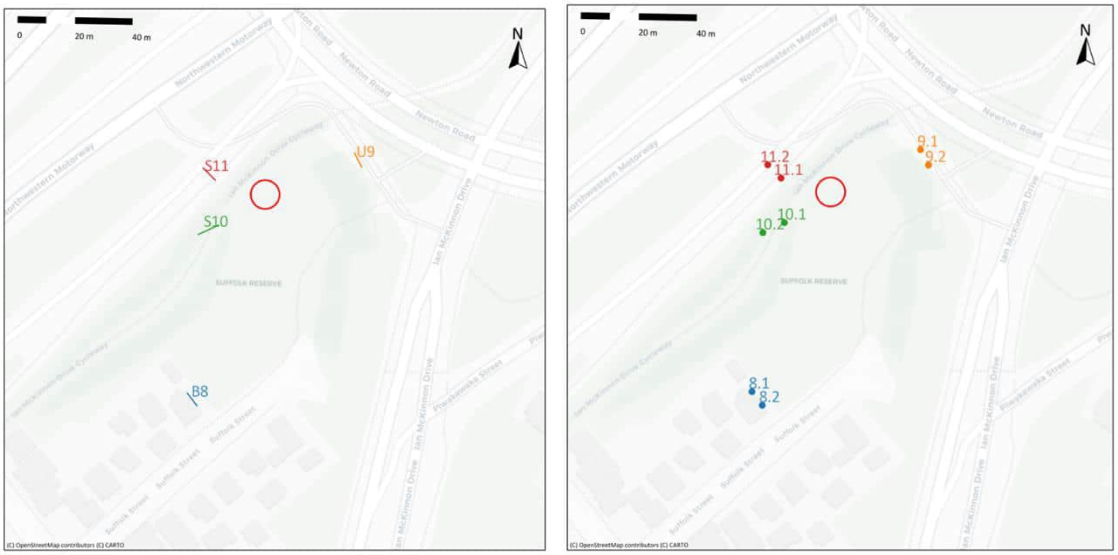
Appendix G Table 16: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U9	8 mm	8 mm	6 m	1 in 60000	450 UNDEF Wastewater Pipeline	1 in 500	Pass

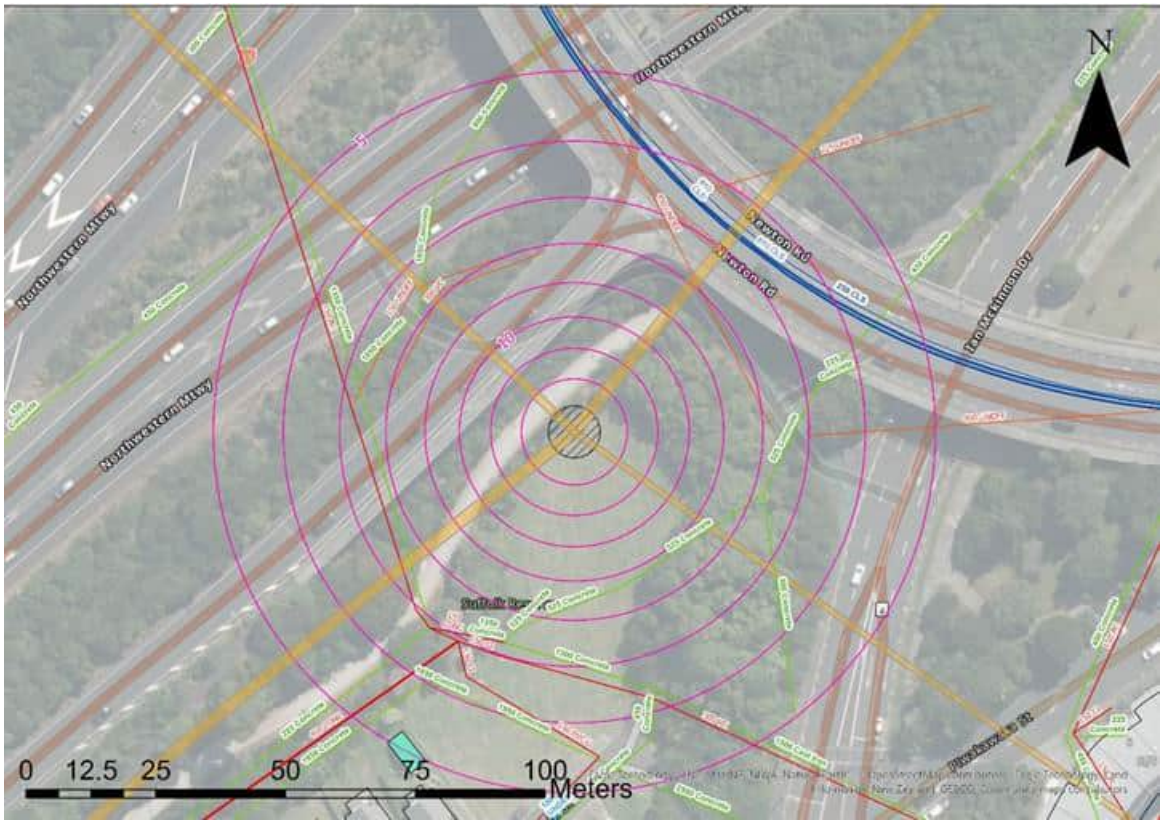
Appendix G Table 17: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B8	4 mm [risk category 1]	4 mm [risk category 1]	6 m	1 in 28000 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.2.3 Case 6



Appendix Figure G11: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G12: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 18: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B8	5 mm	5 mm	6 m	1 in 30500	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S10	10 mm	9 mm	8 m	1 in 6500	Highway bridge foundation pier	1 in 500	Pass
S11	11 mm	10 mm	6 m	1 in 7000	Adjacent pathway	1 in 500	Pass

Appendix G Table 19: Utilities differential settlement damage assessment

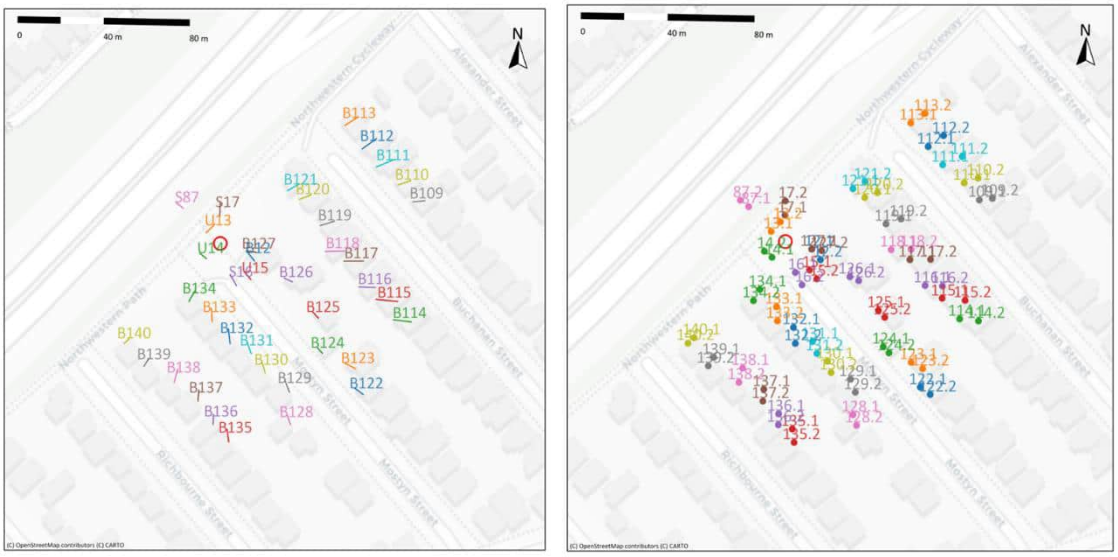
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U9	8 mm	8 mm	6 m	1 in 158000	450 UNDEF Wastewater Pipeline	1 in 500	Pass

Appendix G Table 20: Building damage risk assessment and settlement analysis results

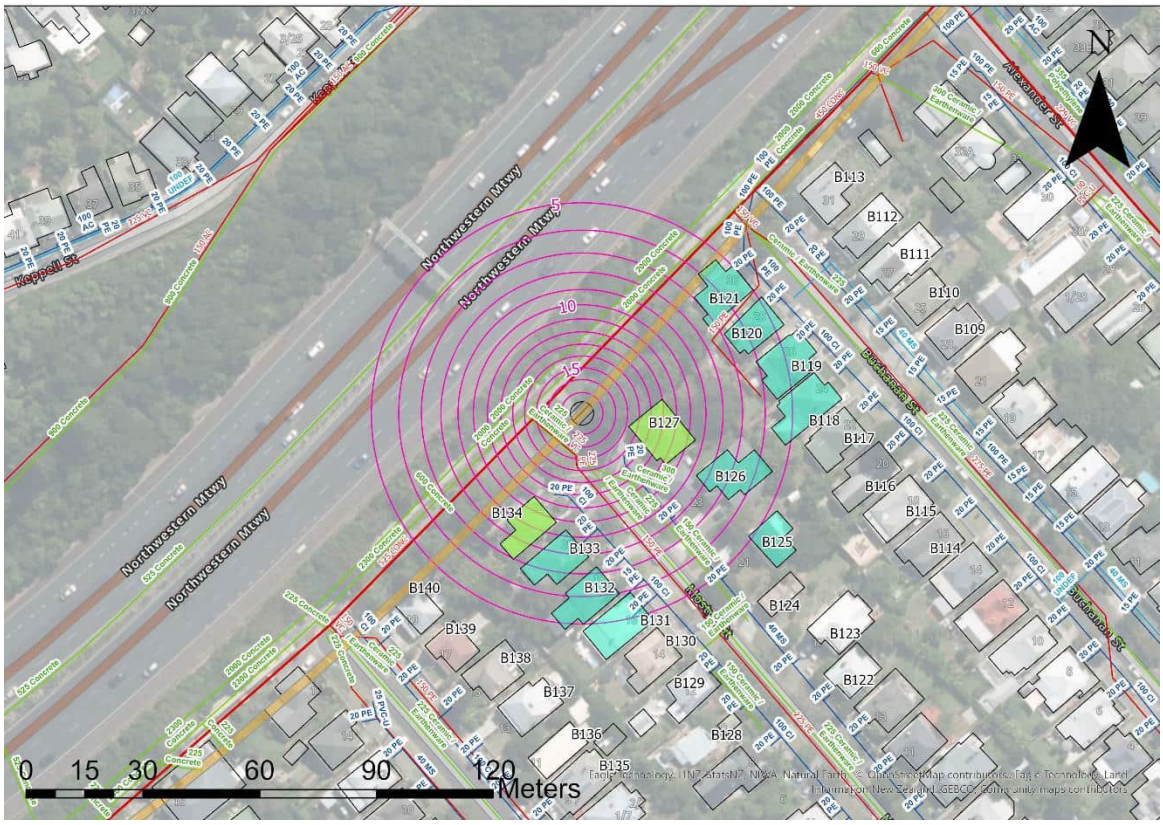
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B8	5 mm [risk category 1]	5 mm [risk category 1]	6 m	1 in 30500 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.3 Shaft 03

G3.3.1 Case 7



Appendix Figure G13: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G14: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 21: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B12	15 mm	13 mm	6 m	1 in 3500	1-storey dwelling, brick and plaster clad, tile roof	1 in 500	Pass
S16	14 mm	12 mm	6 m	1 in 3500	Mostyn Street Road	1 in 500	Pass
S17	15 mm	13 mm	7 m	1 in 3000	Nearby Pathway	1 in 500	Pass
S87	11 mm	10 mm	5 m	1 in 3500	Northwestern Motorway	1 in 500	Pass
B118	6 mm	4 mm	9 m	1 in 7500	24 Buchanan Street	1 in 500	Pass
B119	6 mm	5 mm	7 m	1 in 7000	26 Buchanan Street	1 in 500	Pass
B120	7 mm	6 mm	6 m	1 in 5500	28 Buchanan Street	1 in 500	Pass
B121	7 mm	6 mm	7 m	1 in 5500	30 Buchanan Street	1 in 500	Pass
B125	5 mm	5 mm	4 m	1 in 8000	21 Mostyn Street	1 in 500	Pass
B126	8 mm	8 mm	4 m	1 in 5000	23 Mostyn Street	1 in 500	Pass
B127	15 mm	13 mm	5 m	1 in 3000	25 Mostyn Street	1 in 500	Pass
B131	6 mm	5 mm	6 m	1 in 7000	16 Mostyn Street	1 in 500	Pass
B132	7 mm	6 mm	7 m	1 in 6000	18 Mostyn Street	1 in 500	Pass
B133	9 mm	8 mm	7 m	1 in 4500	20 Mostyn Street	1 in 500	Pass
B134	11 mm	9 mm	6 m	1 in 4000	22 Mostyn Street	1 in 500	Pass

Appendix G Table 22: Utilities differential settlement damage assessment

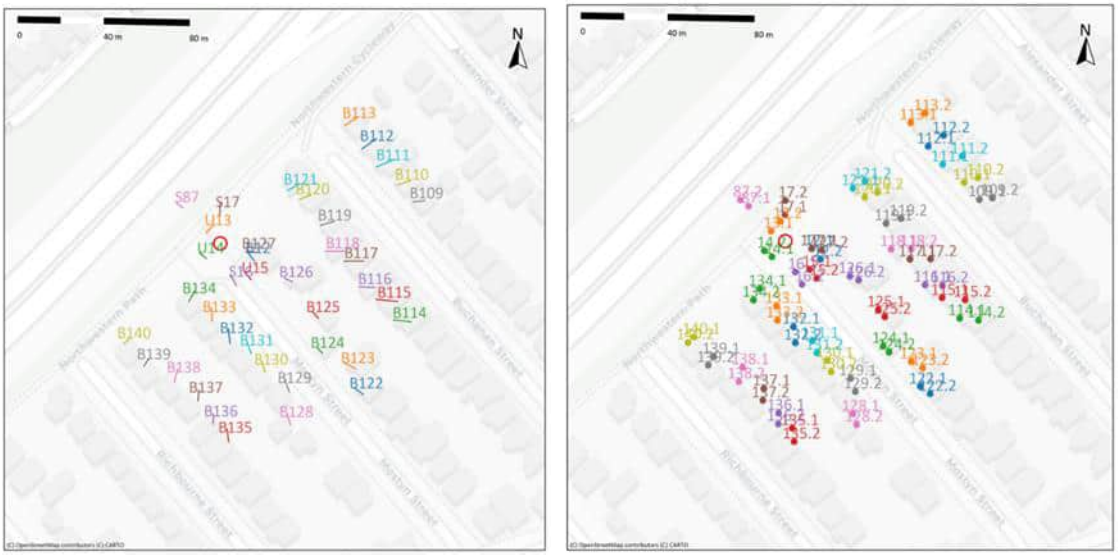
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U13	16 mm	16 mm	6 m	1 in 26000	525 CONC Wastewater Pipeline	1 in 500	Pass
U14	16 mm	15 mm	5 m	1 in 10500	225 Ceramic Earthenware Stormwater Pipeline	1 in 500	Pass
U15	13 mm	12 mm	5 m	1 in 3500	40 MS Water Pipeline	1 in 500	Pass

Appendix G Table 23: Building damage risk assessment and settlement analysis results

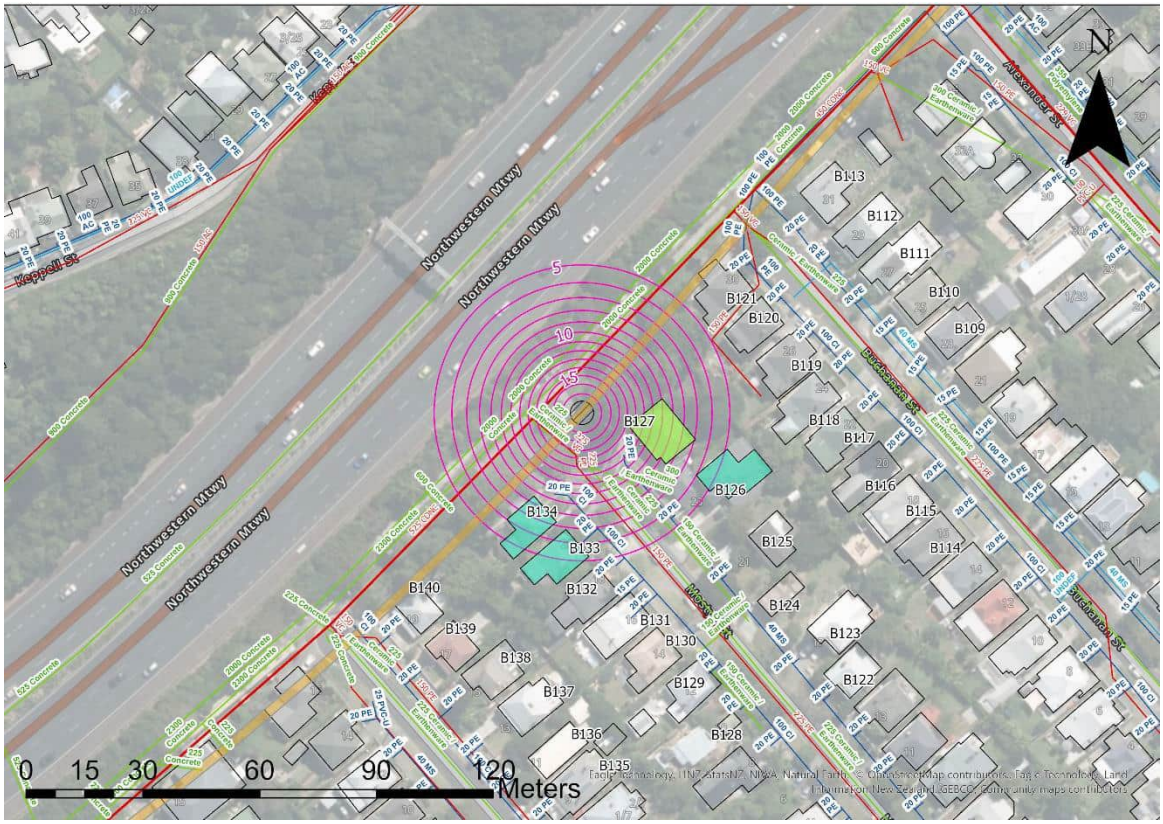
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B12	15 mm [risk category 2]	13 mm [risk category 2]	6 m	1 in 3500 [risk category 1]	1-storey dwelling, brick and plaster clad, tile roof	Slight [risk category 2]
B118	6 mm [risk category 1]	4 mm [risk category 1]	9 m	1 in 7500 [risk category 1]	24 Buchanan Street	Negligible [risk category 1]
B119	6 mm [risk category 1]	5 mm [risk category 1]	7 m	1 in 7000 [risk category 1]	26 Buchanan Street	Negligible [risk category 1]
B120	7 mm [risk category 1]	6 mm [risk category 1]	6 m	1 in 5500 [risk category 1]	28 Buchanan Street	Negligible [risk category 1]
B121	7 mm [risk category 1]	6 mm [risk category 1]	7 m	1 in 5500 [risk category 1]	30 Buchanan Street	Negligible [risk category 1]
B125	5 mm [risk category 1]	5 mm [risk category 1]	4 m	1 in 8000 [risk category 1]	21 Mostyn Street	Negligible [risk category 1]
B126	8 mm [risk category 1]	8 mm [risk category 1]	4 m	1 in 5000 [risk category 1]	23 Mostyn Street	Negligible [risk category 1]
B127	15 mm [risk category 2]	13 mm [risk category 2]	5 m	1 in 3000 [risk category 1]	25 Mostyn Street	Slight [risk category 2]
B131	6 mm [risk category 1]	5 mm [risk category 1]	6 m	1 in 7000 [risk category 1]	16 Mostyn Street	Negligible [risk category 1]

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B132	7 mm [risk category 1]	6 mm [risk category 1]	7 m	1 in 6000 [risk category 1]	18 Mostyn Street	Negligible [risk category 1]
B133	9 mm [risk category 1]	8 mm [risk category 1]	7 m	1 in 4500 [risk category 1]	20 Mostyn Street	Negligible [risk category 1]
B134	11 mm [risk category 2]	9 mm [risk category 1]	6 m	1 in 4000 [risk category 1]	22 Mostyn Street	Slight [risk category 2]

G3.3.2 Case 8



Appendix Figure G15: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G16: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 24: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B12	13 mm	11 mm	6 m	1 in 2500	1-storey dwelling, brick and plaster clad, tile roof	1 in 500	Pass
S16	12 mm	10 mm	6 m	1 in 2500	Mostyn Street Road	1 in 500	Pass
S17	14 mm	11 mm	7 m	1 in 2000	Nearby Pathway	1 in 500	Pass
S87	9 mm	7 mm	5 m	1 in 3000	Northwestern Motorway	1 in 500	Pass
B126	6 mm	5 mm	4 m	1 in 4000	23 Mostyn Street	1 in 500	Pass
B127	13 mm	11 mm	5 m	1 in 2500	25 Mostyn Street	1 in 500	Pass
B133	7 mm	5 mm	7 m	1 in 4000	20 Mostyn Street	1 in 500	Pass
B134	9 mm	7 mm	6 m	1 in 3000	22 Mostyn Street	1 in 500	Pass

Appendix G Table 25: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U13	16 mm	15 mm	6 m	1 in 10000	525 CONC Wastewater Pipeline	1 in 500	Pass
U14	15 mm	15 mm	5 m	1 in 15500	225 Ceramic Earthenware Stormwater Pipeline	1 in 500	Pass
U15	12 mm	9 mm	5 m	1 in 2000	40 MS Water Pipeline	1 in 500	Pass

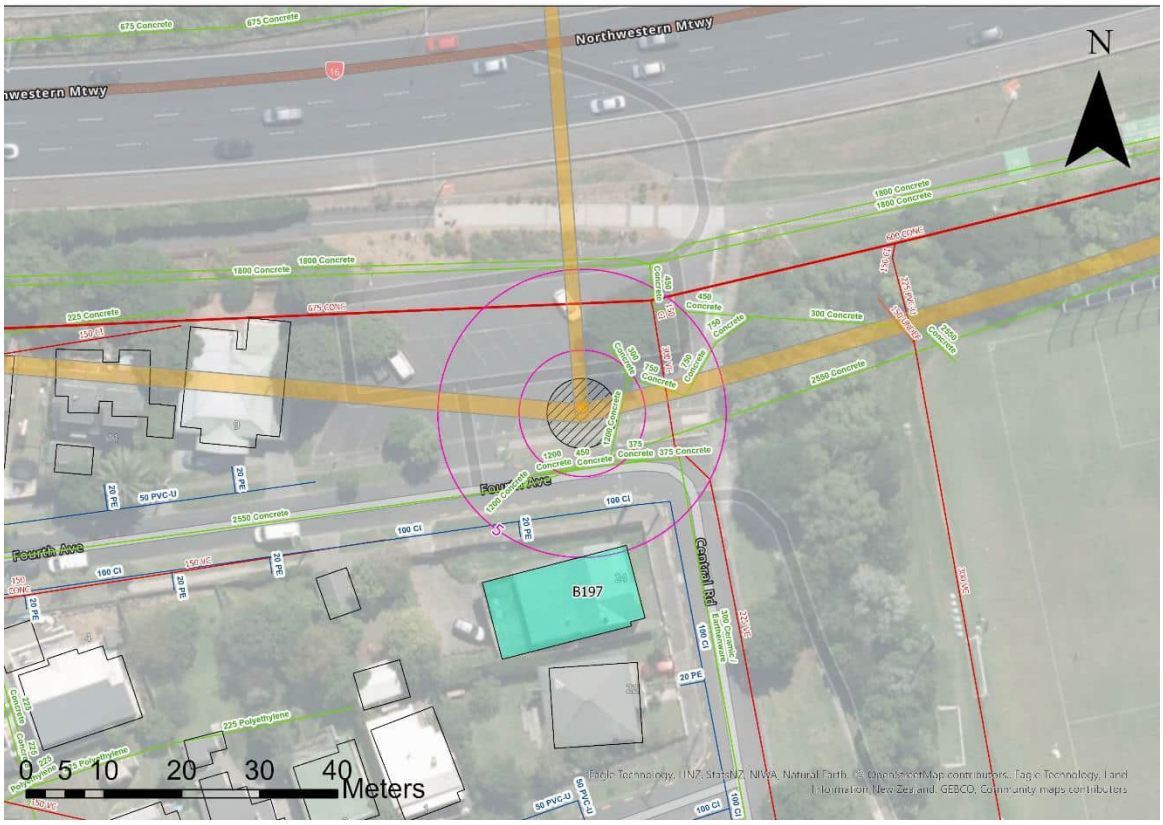
Appendix G Table 26: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B12	13 mm [risk category 2]	11 mm [risk category 2]	6 m	1 in 2500 [risk category 1]	1-storey dwelling, brick and plaster clad, tile roof	Slight [risk category 2]
B126	6 mm [risk category 1]	5 mm [risk category 1]	4 m	1 in 4000 [risk category 1]	23 Mostyn Street	Negligible [risk category 1]
B127	13 mm [risk category 2]	11 mm [risk category 2]	5 m	1 in 2500 [risk category 1]	25 Mostyn Street	Slight [risk category 2]
B133	7 mm [risk category 1]	5 mm [risk category 1]	7 m	1 in 4000 [risk category 1]	20 Mostyn Street	Negligible [risk category 1]
B134	9 mm [risk category 1]	7 mm [risk category 1]	6 m	1 in 3000 [risk category 1]	22 Mostyn Street	Negligible [risk category 1]

G3.4 Shaft 04

G3.4.1 Case 9

Appendix Figure G17: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G18: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 26: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B18	5 mm	5 mm	6 m	1 in 12000	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S21	5 mm	4 mm	7 m	1 in 6500	Fourth Avenue Road	1 in 500	Pass
S22	5 mm	4 mm	3 m	1 in 14500	Nearby Pathway	1 in 500	Pass
B197	5 mm	5 mm	6 m	1 in 12500	24 Central Road	1 in 500	Pass

Appendix G Table 27: Utilities differential settlement damage assessment

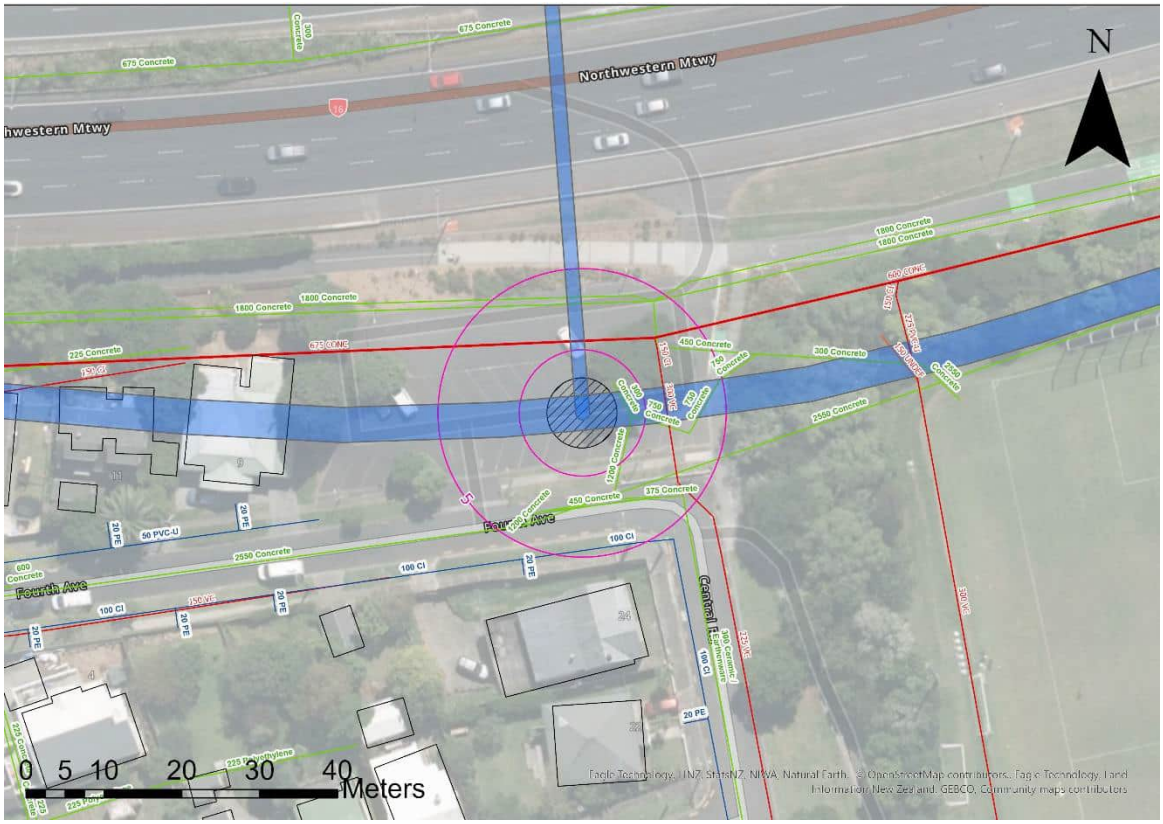
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U19	6 mm	6 mm	6 m	1 in 34000	120 Concrete Stormwater Pipeline	1 in 500	Pass
U20	5 mm	5 mm	7 m	1 in 29000	675 CONC Wastewater Pipeline	1 in 500	Pass

Appendix G Table 28: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B18	5 mm [risk category 1]	5 mm [risk category 1]	6 m	1 in 12000 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]
B197	5 mm [risk category 1]	5 mm [risk category 1]	6 m	1 in 12500 [risk category 1]	24 Central Road	Negligible [risk category 1]

G3.4.2 Case 10

Appendix Figure G19: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G20: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 29: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B18	5 mm	4 mm	6 m	1 in 15000	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S21	5 mm	4 mm	7 m	1 in 18500	Fourth Avenue Road	1 in 500	Pass
S22	5 mm	5 mm	3 m	1 in 15500	Nearby Pathway	1 in 500	Pass

Appendix G Table 30: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U19	6 mm	6 mm	6 m	1 in 40000	120 Concrete Stormwater Pipeline	1 in 500	Pass
U20	6 mm	6 mm	7 m	1 in 21500	675 CONC Wastewater Pipeline	1 in 500	Pass

Appendix G Table 31: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B18	5 mm [risk category 1]	4 mm [risk category 1]	6 m	1 in 15000 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.5 Shaft 05

G3.5.1 Case 11

Appendix Figure G21: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.

Appendix Figure G22: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 32: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B23	15 mm	13 mm	4 m	1 in 1600	1-storey dwelling, timber clad, corrugated metal roof	1 in 500	Pass
S26	17 mm	14 mm	4 m	1 in 1400	Kingsland Avenue Road	1 in 500	Pass
S27	11 mm	9 mm	6 m	1 in 2500	Northwestern Motorway	1 in 500	Pass
B143	7 mm	6 mm	6 m	1 in 4000	37 Kingsland Avenue	1 in 500	Pass
B144	10 mm	8 mm	5 m	1 in 2500	39 Kingsland Avenue	1 in 500	Pass
B145	11 mm	8 mm	7 m	1 in 2500	41 Kingsland Avenue	1 in 500	Pass
B148	15 mm	11 mm	7 m	1 in 1700	50 Kingsland Avenue	1 in 500	Pass
B149	23 mm	17 mm	6 m	1 in 850	52 Kingsland Avenue	1 in 500	Pass
B150	5 mm	4 mm	9 m	1 in 6500	50B Kingsland Avenue	1 in 500	Pass

Appendix G Table 33: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U24	28 mm	23 mm	5 m	1 in 900	225 Ceramic Earthenware Stormwater Pipeline	1 in 500	Pass
U25	28 mm	24 mm	4 m	1 in 1300	40 MS Water Pipeline	1 in 500	Pass

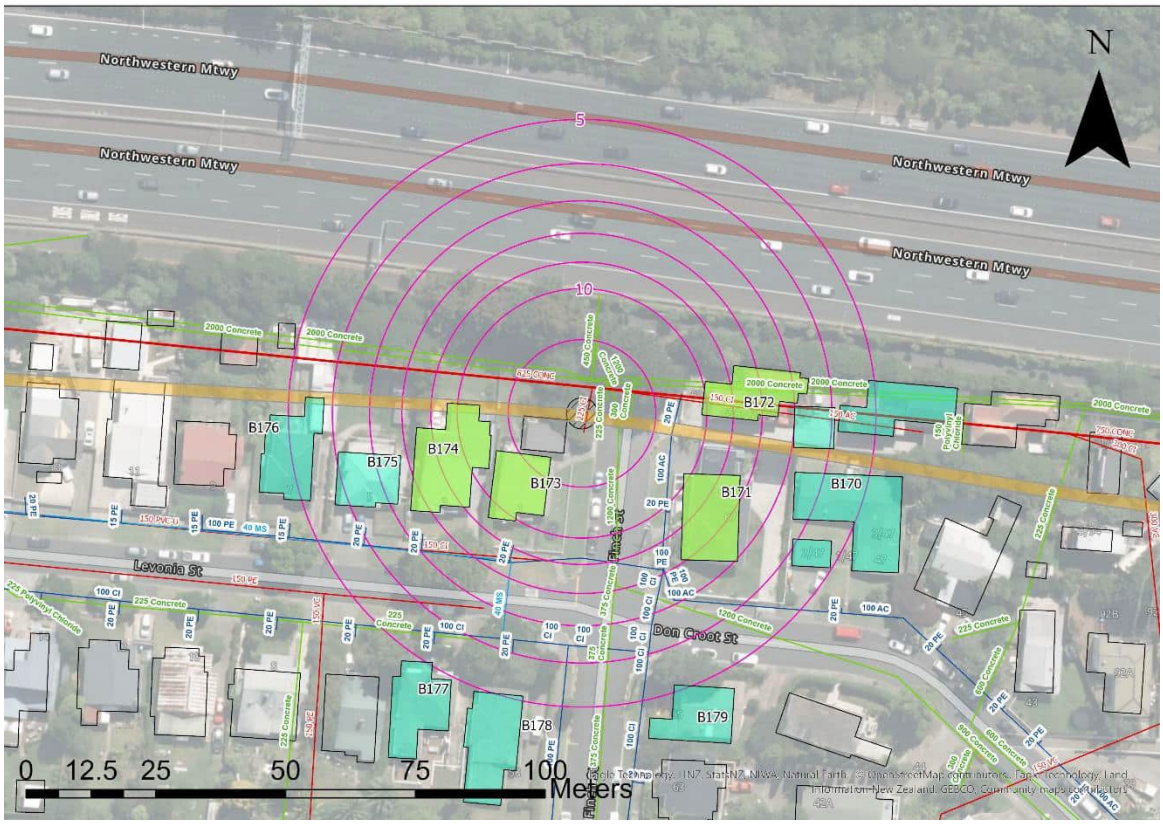
Appendix G Table 34: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B23	15 mm [risk category 2]	13 mm [risk category 2]	4 m	1 in 1600 [risk category 1]	1-storey dwelling, timber clad, corrugated metal roof	Slight [risk category 2]
B143	7 mm [risk category 1]	6 mm [risk category 1]	6 m	1 in 4000 [risk category 1]	37 Kingsland Avenue	Negligible [risk category 1]
B144	10 mm [risk category 2]	8 mm [risk category 1]	5 m	1 in 2500 [risk category 1]	39 Kingsland Avenue	Slight [risk category 2]
B145	11 mm [risk category 2]	8 mm [risk category 1]	7 m	1 in 2500 [risk category 1]	41 Kingsland Avenue	Slight [risk category 2]
B147	8 mm [risk category 1]	7 mm [risk category 1]	5 m	1 in 3000 [risk category 1]	48 Kingsland Avenue	Negligible [risk category 1]
B148	15 mm [risk category 2]	11 mm [risk category 2]	7 m	1 in 1700 [risk category 1]	50 Kingsland Avenue	Slight [risk category 2]
B149	23 mm [risk category 2]	17 mm [risk category 2]	6 m	1 in 850 [risk category 1]	52 Kingsland Avenue	Slight [risk category 2]
B150	5 mm [risk category 1]	4 mm [risk category 1]	9 m	1 in 6500 [risk category 1]	50B Kingsland Avenue	Negligible [risk category 1]

G3.6 Shaft 06

G3.6.1 Case 13

Appendix Figure G23: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G24: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 32: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B33	11 mm	11 mm	6 m	1 in 15500	1-storey dwelling, timber clad (weatherboard), corrugated metal roof, standalone garage	1 in 500	Pass
S36	11 mm	10 mm	5 m	1 in 10000	Finch Street Road	1 in 500	Pass
S37	10 mm	9 mm	5 m	1 in 5000	Nearby Pathway	1 in 500	Pass
S88	10 mm	9 mm	4 m	1 in 5000	Northwestern Motorway	1 in 500	Pass
B170	7 mm	5 mm	11 m	1 in 8000	47 Don Croot Street	1 in 500	Pass
B171	10 mm	9 mm	8 m	1 in 5000	67 Finch Street	1 in 500	Pass
B172	10 mm	9 mm	8 m	1 in 5000	69 Finch Street	1 in 500	Pass
B173	11 mm	11 mm	8 m	1 in 15000	1 Levonia Street	1 in 500	Pass
B174	11 mm	10 mm	6 m	1 in 8000	3 Levonia Street	1 in 500	Pass
B175	8 mm	7 mm	7 m	1 in 6000	5 Levonia Street	1 in 500	Pass
B176	6 mm	5 mm	8 m	1 in 8500	7 Levonia Street	1 in 500	Pass
B177	5 mm	4 mm	7 m	1 in 9000	4 Levonia Street	1 in 500	Pass
B178	5 mm	4 mm	7 m	1 in 10000	58 Finch Street	1 in 500	Pass
B179	5 mm	4 mm	9 m	1 in 10000	65 Finch Street	1 in 500	Pass

Appendix G Table 33: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U34	12 mm	12 mm	4 m	1 in 50500	825 CONC Wastewater Pipeline	1 in 500	Pass
U35	12 mm	11 mm	5 m	1 in 11500	225 Concrete Stormwater Pipeline	1 in 500	Pass

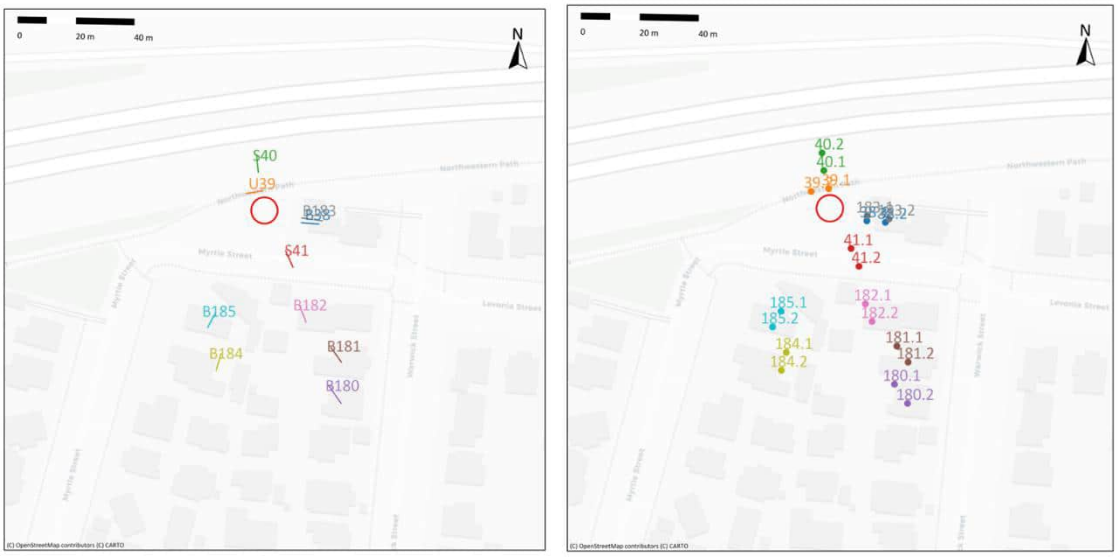
Appendix G Table 34: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B33	11 mm [risk category 2]	11 mm [risk category 2]	6 m	1 in 15500 [risk category 1]	1-storey dwelling, timber clad (weatherboard), corrugated metal roof, standalone garage	Slight [risk category 2]
B170	7 mm [risk category 1]	5 mm [risk category 1]	11 m	1 in 8000 [risk category 1]	47 Don Croot Street	Negligible [risk category 1]
B171	10 mm [risk category 2]	9 mm [risk category 1]	8 m	1 in 5000 [risk category 1]	67 Finch Street	Slight [risk category 2]
B172	10 mm [risk category 2]	9 mm [risk category 1]	8 m	1 in 5000 [risk category 1]	69 Finch Street	Slight [risk category 2]
B173	11 mm [risk category 2]	11 mm [risk category 2]	8 m	1 in 15000 [risk category 1]	1 Levonia Street	Slight [risk category 2]
B174	11 mm [risk category 2]	10 mm [risk category 1]	6 m	1 in 8000 [risk category 1]	3 Levonia Street	Slight [risk category 2]
B175	8 mm [risk category 1]	7 mm [risk category 1]	7 m	1 in 6000 [risk category 1]	5 Levonia Street	Negligible [risk category 1]
B176	6 mm [risk category 1]	5 mm [risk category 1]	8 m	1 in 8500 [risk category 1]	7 Levonia Street	Negligible [risk category 1]
B177	5 mm [risk category 1]	4 mm [risk category 1]	7 m	1 in 9000 [risk category 1]	4 Levonia Street	Negligible [risk category 1]
B178	5 mm [risk category 1]	4 mm [risk category 1]	7 m	1 in 10000 [risk category 1]	58 Finch Street	Negligible [risk category 1]
B179	5 mm [risk category 1]	4 mm [risk category 1]	9 m	1 in 10000 [risk category 1]	65 Finch Street	Negligible [risk category 1]
B33	11 mm [risk category 2]	11 mm [risk category 2]	6 m	1 in 15500 [risk category 1]	1-storey dwelling, timber clad (weatherboard), corrugated metal roof, standalone garage	Slight [risk category 2]
B170	7 mm [risk category 1]	5 mm [risk category 1]	11 m	1 in 8000 [risk category 1]	47 Don Croot Street	Negligible [risk category 1]

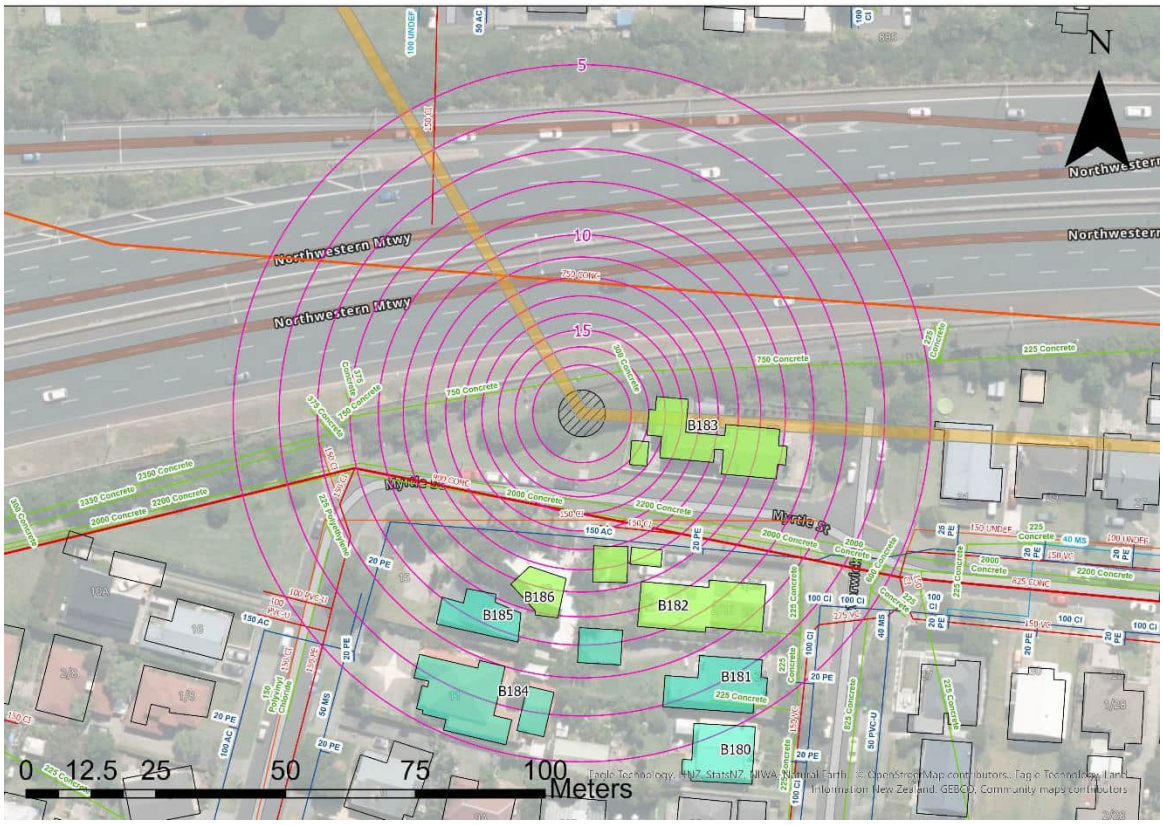
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B171	10 mm [risk category 2]	9 mm [risk category 1]	8 m	1 in 5000 [risk category 1]	67 Finch Street	Slight [risk category 2]
B172	10 mm [risk category 2]	9 mm [risk category 1]	8 m	1 in 5000 [risk category 1]	69 Finch Street	Slight [risk category 2]
B173	11 mm [risk category 2]	11 mm [risk category 2]	8 m	1 in 15000 [risk category 1]	1 Levonia Street	Slight [risk category 2]

G3.7 Shaft 07

G3.7.1 Case 14



Appendix Figure G25 Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G26: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 35: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B38	16 mm	14 mm	6 m	1 in 3500	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S40	16 mm	14 mm	6 m	1 in 3000	Myrtle Street Road	1 in 500	Pass
S41	15 mm	13 mm	7 m	1 in 3500	Northwestern Motorway	1 in 500	Pass
B180	5 mm	5 mm	8 m	1 in 10000	22 Warwick Street	1 in 500	Pass
B181	7 mm	6 mm	7 m	1 in 7500	24 Warwick Street	1 in 500	Pass
B182	10 mm	9 mm	6 m	1 in 5000	26 Warwick Street	1 in 500	Pass
B183	16 mm	14 mm	7 m	1 in 3000	30 Warwick Street	1 in 500	Pass
B184	7 mm	6 mm	6 m	1 in 7500	11 Myrtle Street	1 in 500	Pass
B185	9 mm	8 mm	6 m	1 in 5500	15 Myrtle Street	1 in 500	Pass
B186	11 mm	9 mm	6 m	1 in 4000	17 Myrtle Street	1 in 500	Pass

Appendix G Table 36: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U39	18 mm	17 mm	6 m	1 in 12000	750 Concrete Stormwater Pipeline	1 in 500	Pass

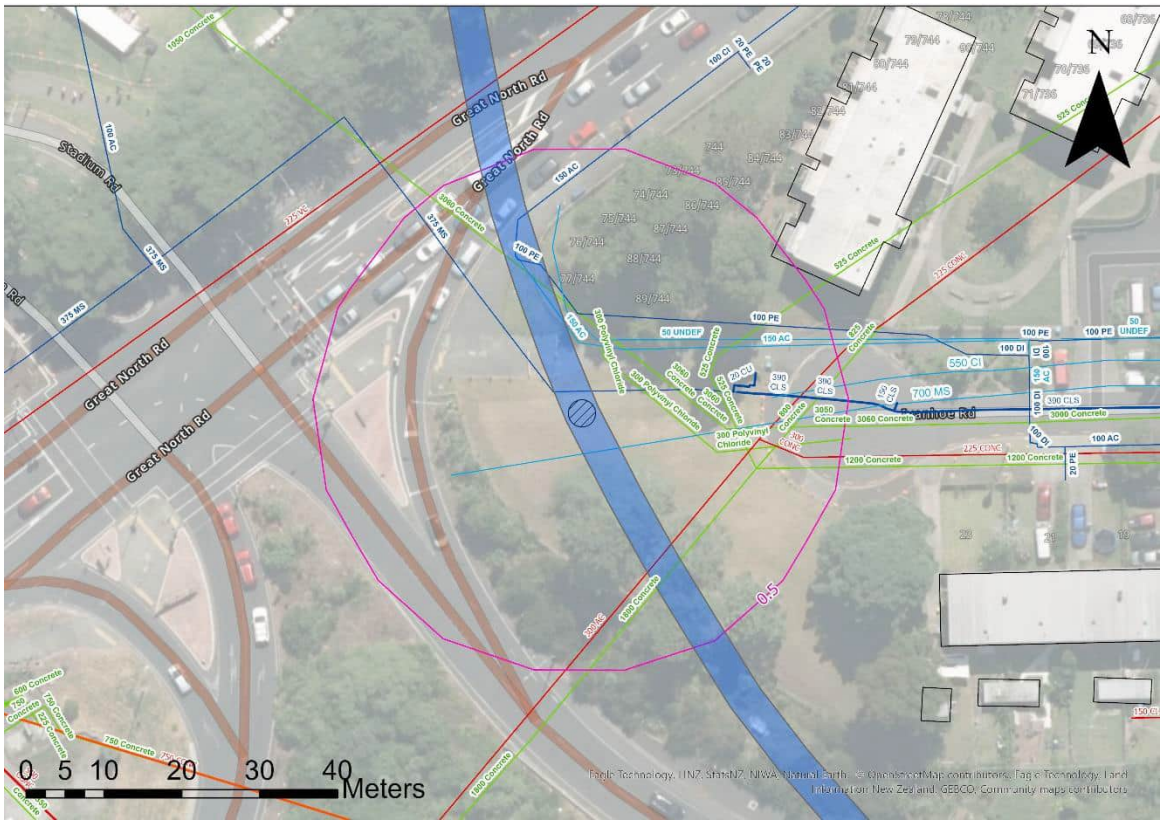
Appendix G Table 37: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B38	16 mm [risk category 2]	14 mm [risk category 2]	6 m	1 in 3500 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Slight [risk category 2]
B180	5 mm [risk category 1]	5 mm [risk category 1]	8 m	1 in 10000 [risk category 1]	22 Warwick Street	Negligible [risk category 1]
B181	7 mm [risk category 1]	6 mm [risk category 1]	7 m	1 in 7500 [risk category 1]	24 Warwick Street	Negligible [risk category 1]
B182	10 mm [risk category 1]	9 mm [risk category 1]	6 m	1 in 5000 [risk category 1]	26 Warwick Street	Negligible [risk category 1]
B183	16 mm [risk category 2]	14 mm [risk category 2]	7 m	1 in 3000 [risk category 1]	30 Warwick Street	Slight [risk category 2]
B184	7 mm [risk category 1]	6 mm [risk category 1]	6 m	1 in 7500 [risk category 1]	11 Myrtle Street	Negligible [risk category 1]
B185	9 mm [risk category 1]	8 mm [risk category 1]	6 m	1 in 5500 [risk category 1]	15 Myrtle Street	Negligible [risk category 1]
B186	11 mm [risk category 2]	9 mm [risk category 1]	6 m	1 in 4000 [risk category 1]	17 Myrtle Street	Slight [risk category 2]

G3.8 Shaft 07a

G3.8.1 Case 15

Appendix Figure G27: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G28: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 38: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B42	0.5 mm	0.5 mm	5 m	None	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S45	0.7 mm	0.5 mm	5 m	1 in 36500	Great North Road	1 in 500	Pass

Appendix G Table 39: Utilities differential settlement damage assessment

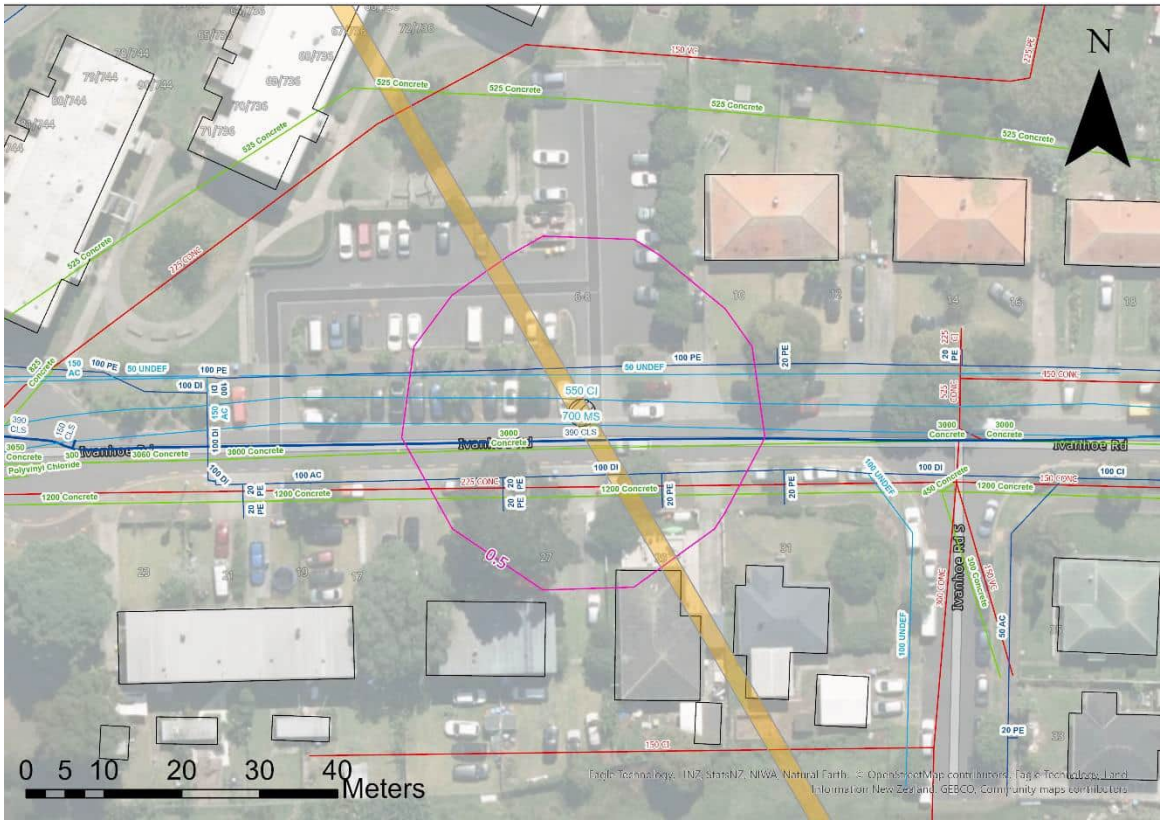
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U43	1.0 mm	1.0 mm	6 m	None	375 MS Water Pipeline	1 in 500	Pass
U44	1.0 mm	1.0 mm	6 m	None	300 PVC Stormwater Pipeline	1 in 500	Pass

Appendix G Table 40: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B42	0.5 mm [risk category 1]	0.5 mm [risk category 1]	5 m	None [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.8.2 Case 16

Appendix Figure G29: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G30: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 41: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B46	0.6 mm	0.5 mm	6 m	1 in 44500	1-storey dwelling, timber clad, tile roof	1 in 500	Pass
S49	0.9 mm	0.9 mm	6 m	None	Invahoe Road	1 in 500	Pass

Appendix G Table 42: Utilities differential settlement damage assessment

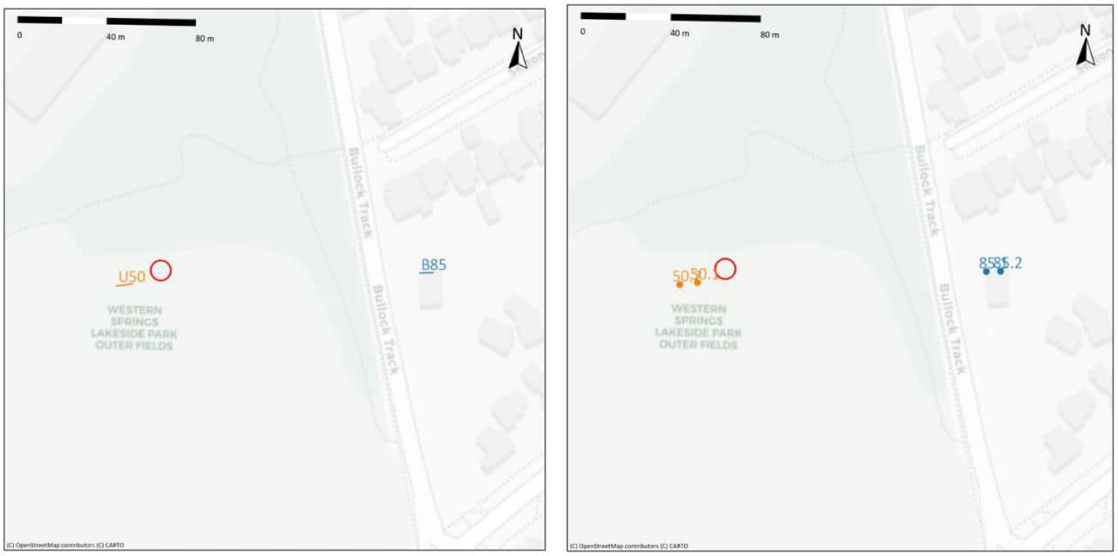
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U47	0.8 mm	0.8 mm	6 m	None	700 MS Water Pipeline	1 in 500	Pass
U48	0.9 mm	0.8 mm	6 m	1 in 118000	3000 Concrete Stormwater Pipeline	1 in 500	Pass

Appendix G Table 43: Building damage risk assessment and settlement analysis results

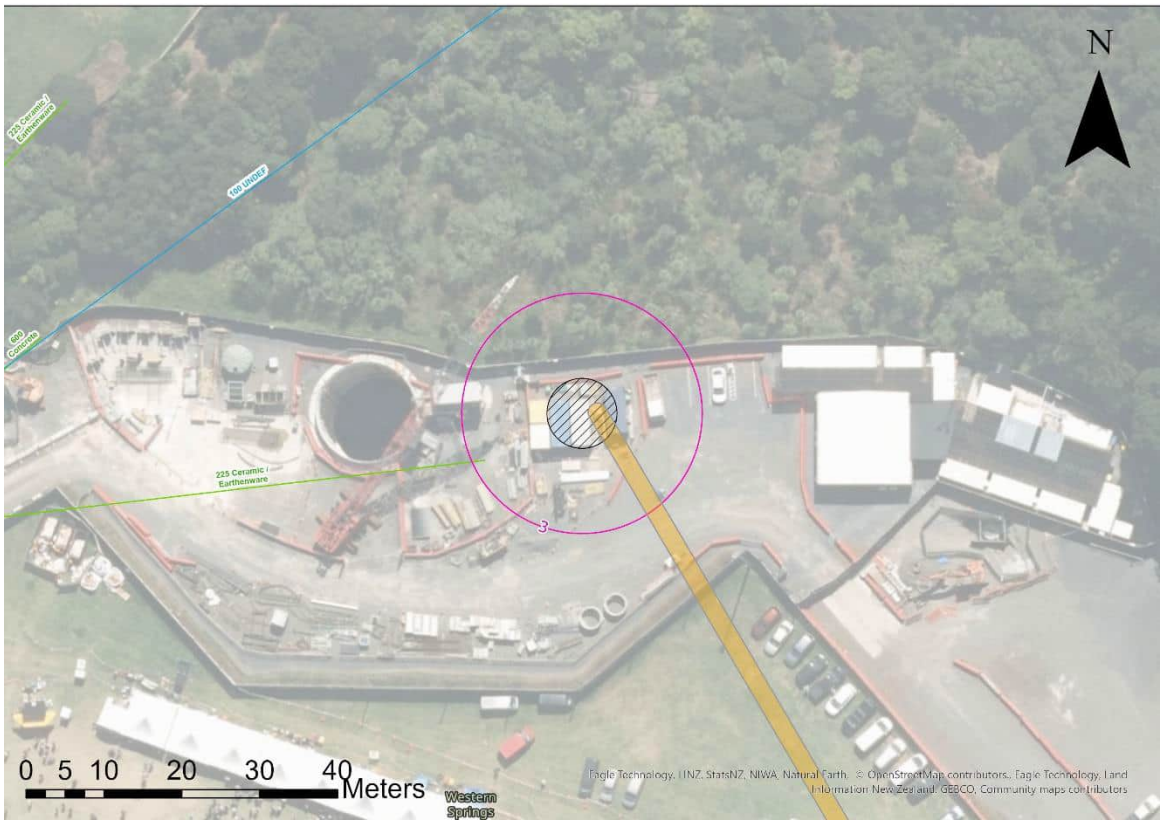
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B46	0.6 mm [risk category 1]	0.5 mm [risk category 1]	6 m	1 in 44500 [risk category 1]	1-storey dwelling, timber clad, tile roof	Negligible [risk category 1]

G3.9 Shaft 08

G3.9.1 Case 17



Appendix Figure G31: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G32: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 44: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B85	less than 1 mm	less than 1 mm	6 m	N/A	3-storey dwelling, timber clad and brick, corrugated metal roof	1 in 500	Pass

Appendix G Table 45: Utilities differential settlement damage assessment

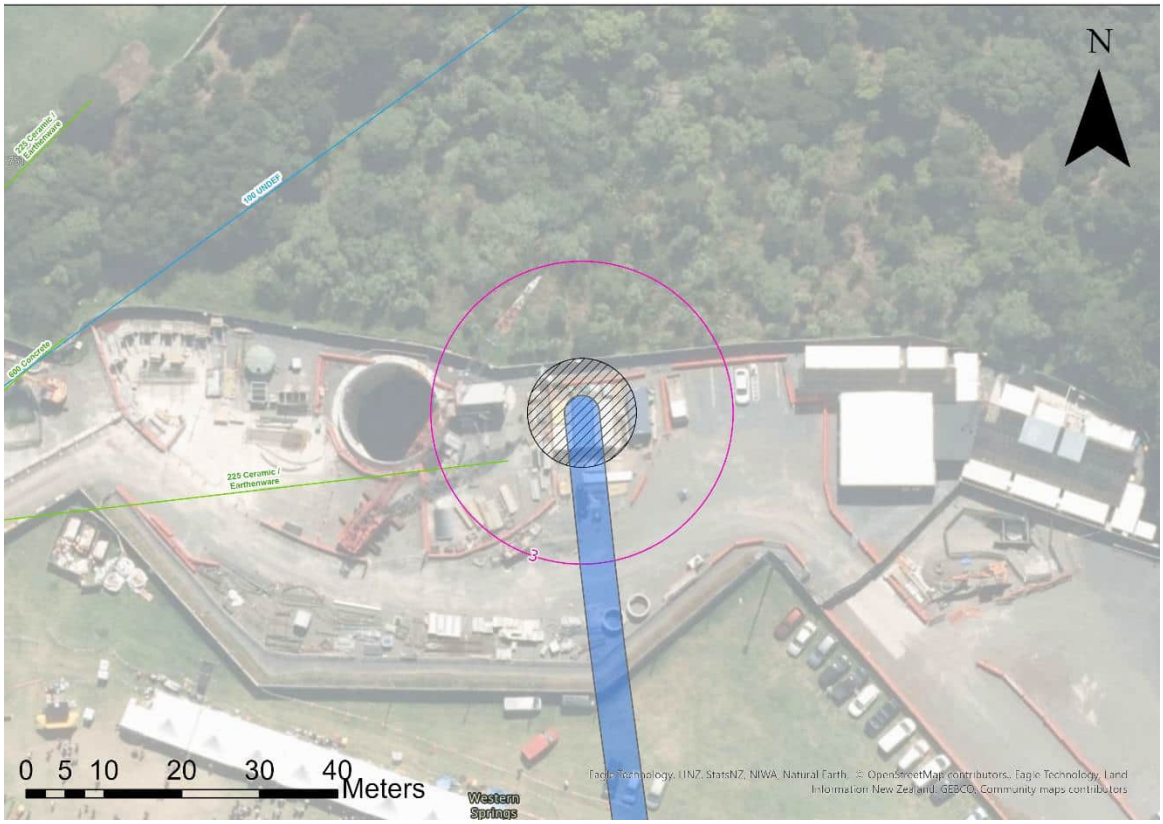
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U50	2 mm	2 mm	8 m	1 in 20500	225 Ceramic Earthenware Stormwater Pipeline	1 in 500	Pass

Appendix G Table 46: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on CIRIA 1996 criteria [highest reported risk category]	Description of risk based on Burland 2012 criteria [highest reported risk category]
B85	Outside settlement data bounds	Outside settlement data bounds	6 m	None	3-storey dwelling, timber clad and brick, corrugated metal roof	Not applicable	Not applicable

G3.9.2 Case 18

Appendix Figure G33: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G34: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 47: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B84	less than 1 mm	less than 1 mm	6 m	N/A	3-storey dwelling, timber clad and brick, corrugated metal roof	1 in 500	Pass

Appendix G Table 36: Utilities differential settlement damage assessment

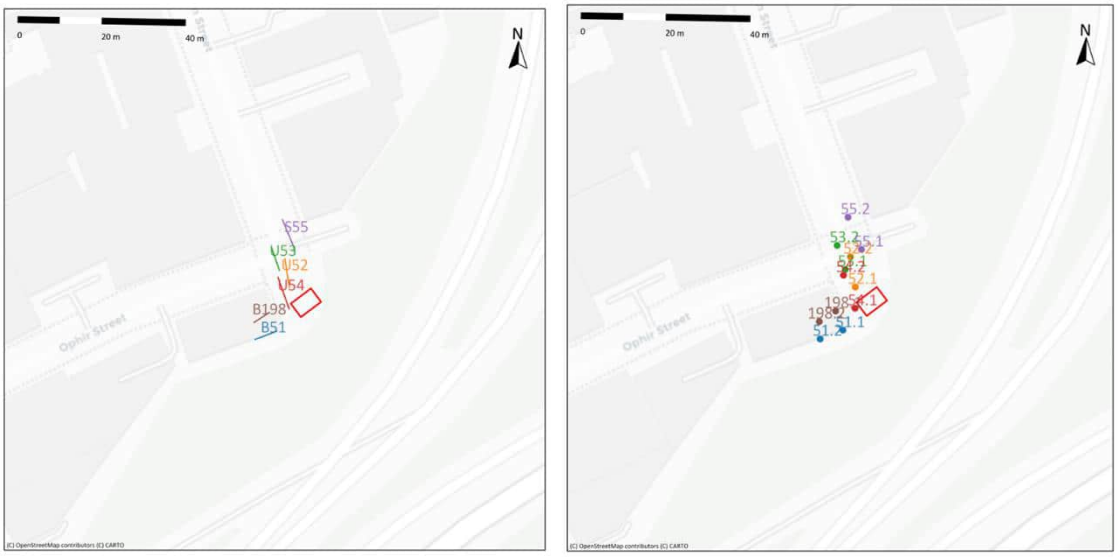
ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U50	3 mm	2 mm	8 m	1 in 16500	225 Ceramic Earthenware Stormwater Pipeline	1 in 500	Pass

Appendix G Table 37: Building damage risk assessment and settlement analysis results

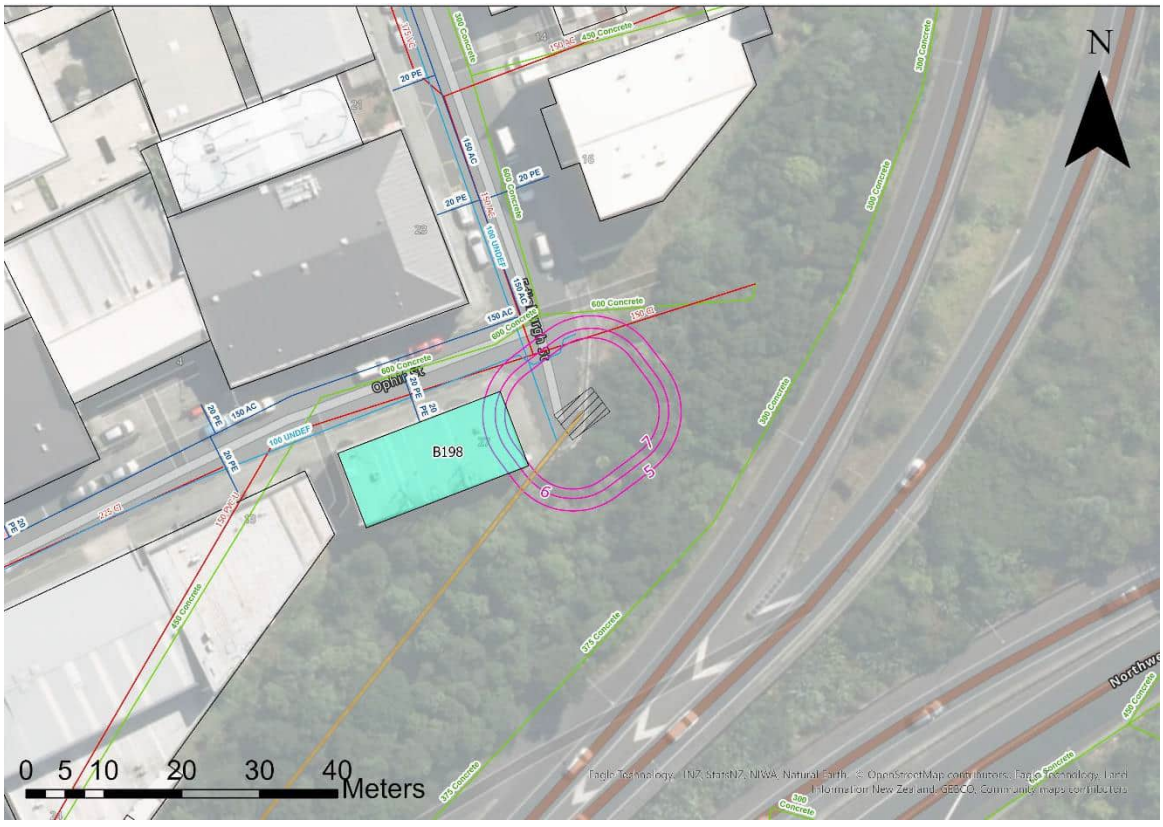
ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on CIRIA 1996 criteria [highest reported risk category]	Description of risk based on Burland 2012 criteria [highest reported risk category]
B84	Outside settlement data bounds	Outside settlement data bounds	6 m	None	3-storey dwelling, timber clad and brick, corrugated metal roof	Not applicable	Not applicable

G3.10 Shaft 09

G3.10.1 Case 19



Appendix Figure G35: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G36: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 44: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B51	7 mm	4 mm	6 m	1 in 1800	2-storey office building, brick and plaster clad	1 in 500	Pass
S55	5 mm	3 mm	8 m	1 in 4000	Edinburgh Street Road	1 in 500	Pass
B198	8 mm	5 mm	5 m	1 in 1500	42 Edinburugh Street	1 in 500	Pass

Appendix G Table 45: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U52	9 mm	5 mm	7 m	1 in 2000	600 Concrete Stormwater Pipeline	1 in 500	Pass
U53	6 mm	3 mm	6 m	1 in 2500	150 AC Wastewater Pipeline	1 in 500	Pass
U54	7 mm	7 mm	8 m	1 in 12000	100 UNDEF Water Pipeline	1 in 500	Pass

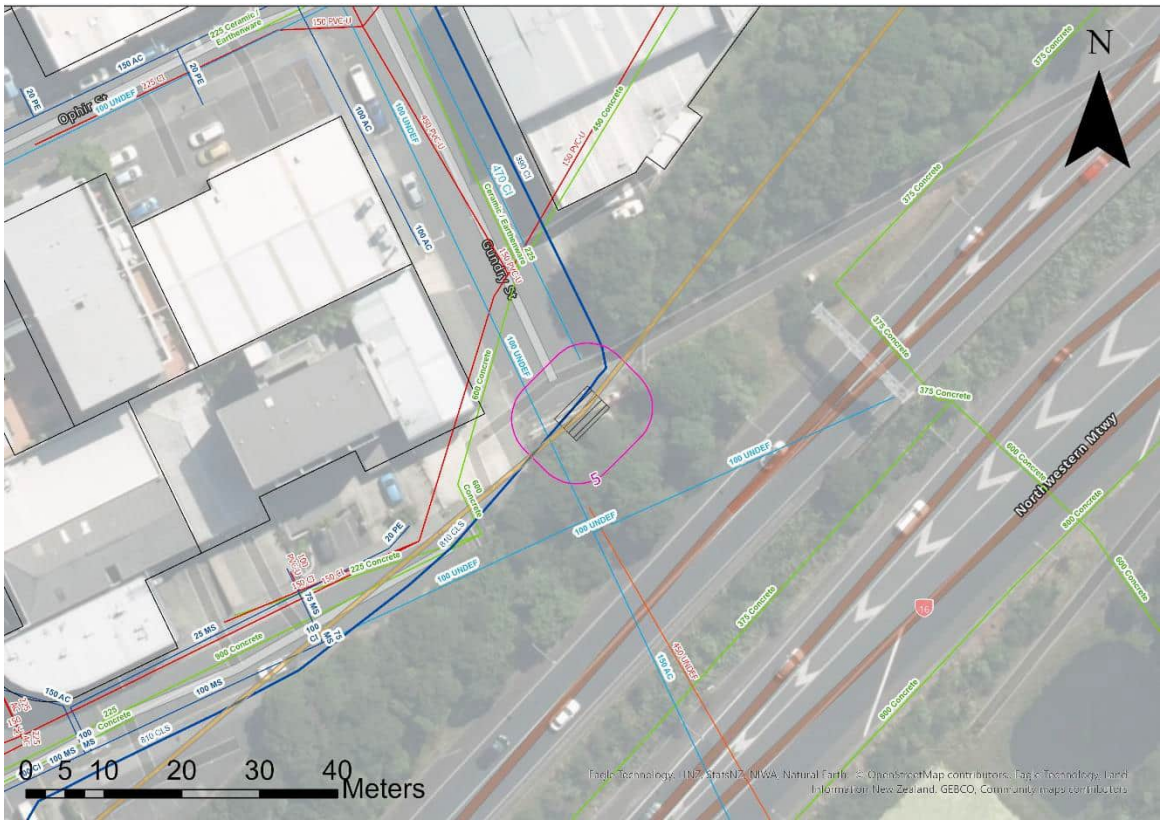
Appendix G Table 46: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B51	7 mm [risk category 1]	4 mm [risk category 1]	6 m	1 in 1800 [risk category 1]	2-storey office building, brick and plaster clad	Negligible [risk category 1]
B198	8 mm [risk category 1]	5 mm [risk category 1]	5 m	1 in 1500 [risk category 1]	42 Edinburugh Street	Negligible [risk category 1]

G3.11 Shaft 10

G3.11.1 Case 20

Appendix Figure G37: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G38: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 47: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B56	2 mm	0.8 mm	6 m	1 in 4000	1-storey office building, concrete plaster	1 in 500	Pass
S59	6 mm	1 mm	7 m	1 in 1700	Nearby Pathway	1 in 500	Pass
S60	5 mm	2 mm	8 m	1 in 2500	Gundry Street Road	1 in 500	Pass
S89	0.7 mm	0.4 mm	6 m	1 in 16000	Northwestern to Northern Link	1 in 500	Pass

Appendix G Table 48: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U57	6 mm	3 mm	6 m	1 in 2000	810 CLS Water Pipeline	1 in 500	Pass
U58	2 mm	1 mm	6 m	1 in 10000	600 Concrete Stormwater Pipeline	1 in 500	Pass

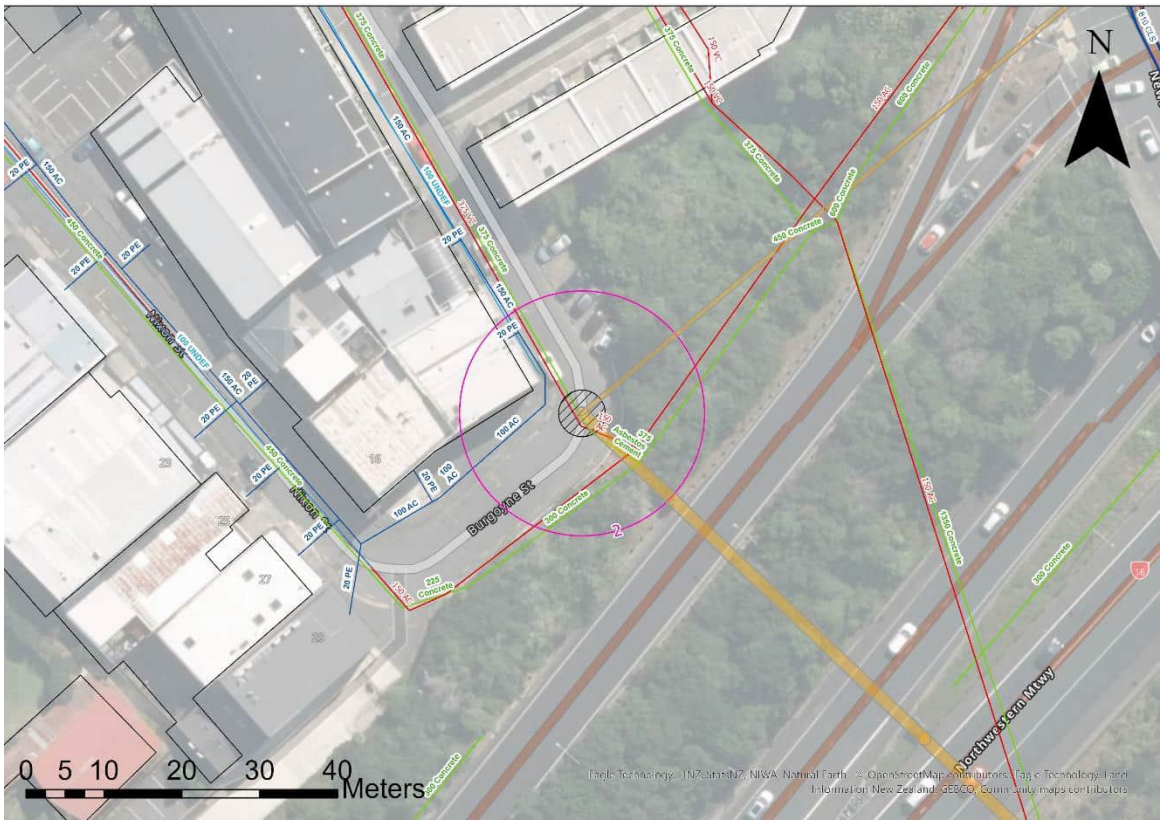
Appendix G Table 49: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B56	2 mm [risk category 1]	0.8 mm [risk category 1]	6 m	1 in 4000 [risk category 1]	1-storey office building, concrete plaster	Negligible [risk category 1]

G3.12 Shaft 11

G3.12.1 Case 21

Appendix Figure G39: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G40: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 50: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B61	2 mm	2 mm	6 m	1 in 21500	2-storey office building, brick, corrugated metal roof	1 in 500	Pass
S64	2 mm	2 mm	6 m	1 in 21000	Burgoyne Street Road	1 in 500	Pass
S65	2 mm	2 mm	7 m	1 in 26000	Newton Road Off Ramp	1 in 500	Pass

Appendix G Table 51: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U62	3 mm	2 mm	5 m	1 in 16500	375 VC Wastewater Pipeline	1 in 500	Pass
U63	3 mm	2 mm	5 m	1 in 15000	375 Concrete Stormwater Pipeline	1 in 500	Pass

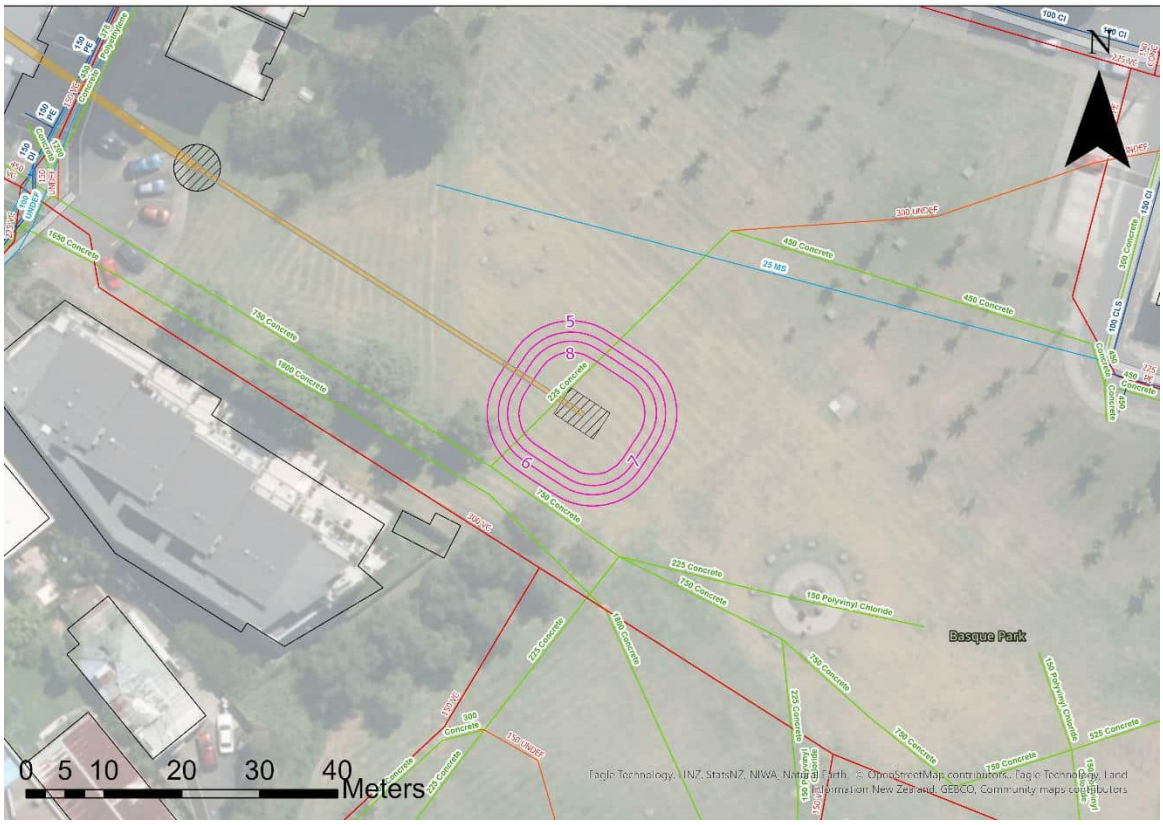
Appendix G Table 52: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B61	2 mm [risk category 1]	2 mm [risk category 1]	6 m	1 in 21500 [risk category 1]	2-storey office building, brick, corrugated metal roof	Negligible [risk category 1]

G3.13 Shaft 12

G3.13.1 Case 22

Appendix Figure G41: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G42: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 53: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B66	2 mm	2 mm	6 m	1 in 30000	5-storey apartment dwelling, concrete structure	1 in 500	Pass

Appendix G Table 54: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U67	6 mm	8 mm	5 m	1 in 2500	225 Concrete Stormwater Pipeline	1 in 500	Pass
U68	3 mm	2 mm	7 m	1 in 65000	300 VC Wastewater Pipeline	1 in 500	Pass

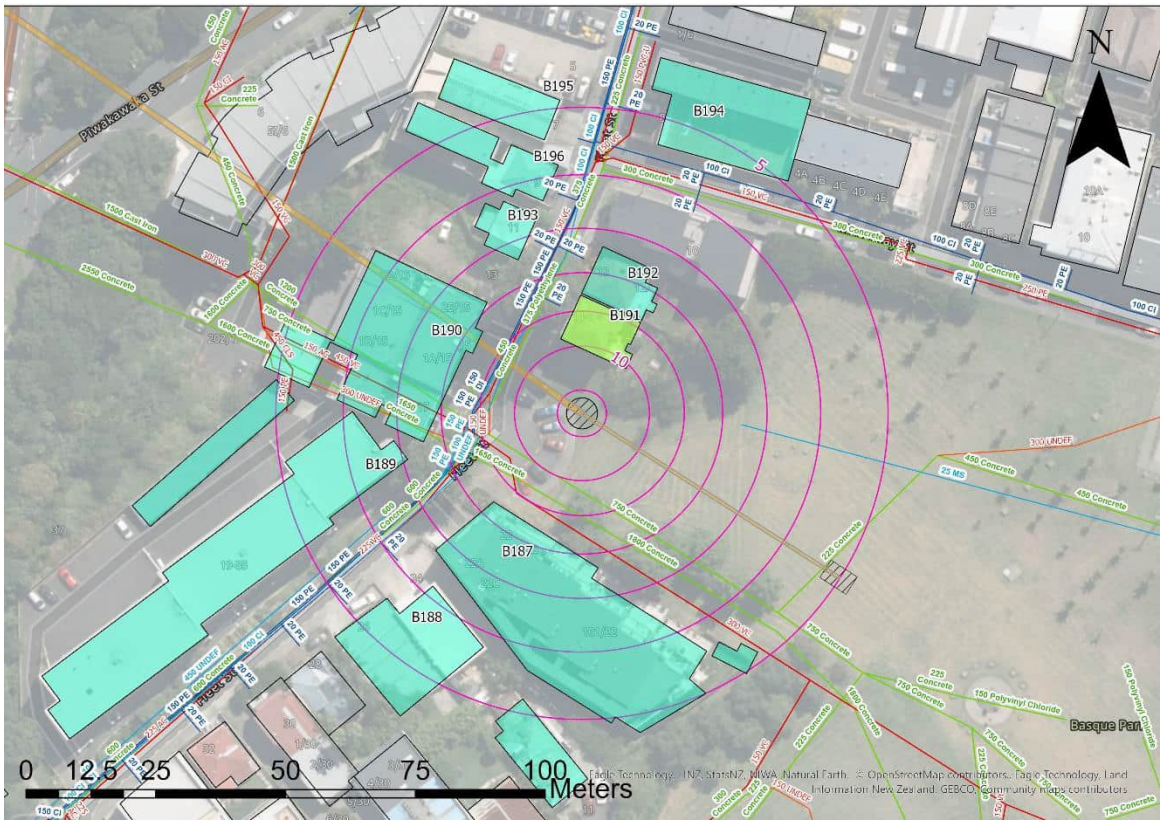
Appendix G Table 55: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B66	2 mm [risk category 1]	2 mm [risk category 1]	6 m	1 in 30000 [risk category 1]	5-storey apartment dwelling, concrete structure	Negligible [risk category 1]

G3.14 Shaft 12a

G3.14.1 Case 23

Appendix Figure G43: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G44: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 56: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B69	10 mm	9 mm	6 m	1 in 7000	3-storey dwelling, timber clad, corrugated metal roof	1 in 500	Pass
S72	10 mm	9 mm	8 m	1 in 7000	Fleet Street Road	1 in 500	Pass
B187	9 mm	7 mm	8 m	1 in 7500	22 Fleet Street	1 in 500	Pass
B188	6 mm	5 mm	9 m	1 in 12000	26 Fleet Street	1 in 500	Pass
B189	7 mm	6 mm	9 m	1 in 10000	19-35 Fleet Street	1 in 500	Pass
B190	8 mm	7 mm	7 m	1 in 8000	15,17 Fleet Street	1 in 500	Pass
B191	10 mm	9 mm	7 m	1 in 7000	14 Fleet Street	1 in 500	Pass
B192	9 mm	8 mm	6 m	1 in 7500	12 Fleet Street	1 in 500	Pass
B193	7 mm	7 mm	8 m	1 in 9500	11 Fleet Street	1 in 500	Pass
B194	5 mm	5 mm	7 m	1 in 15000	8 Fleet Street	1 in 500	Pass
B195	5 mm	5 mm	9 m	1 in 14500	7 Fleet Street	1 in 500	Pass
B196	6 mm	6 mm	8 m	1 in 11000	9 Fleet Street	1 in 500	Pass

Appendix G Table 57: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U70	10 mm	10 mm	5 m	1 in 17500	750 Concrete Stormwater Pipeline	1 in 500	Pass
U71	9 mm	9 mm	6 m	1 in 14500	300 VC Wastewater Pipeline	1 in 500	Pass

Appendix G Table 58: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B69	10 mm [risk category 2]	9 mm [risk category 1]	6 m	1 in 7000 [risk category 1]	3-storey dwelling, timber clad, corrugated metal roof	Slight [risk category 2]
B187	9 mm [risk category 1]	7 mm [risk category 1]	8 m	1 in 7500 [risk category 1]	22 Fleet Street	Negligible [risk category 1]
B188	6 mm [risk category 1]	5 mm [risk category 1]	9 m	1 in 12000 [risk category 1]	26 Fleet Street	Negligible [risk category 1]
B189	7 mm [risk category 1]	6 mm [risk category 1]	9 m	1 in 10000 [risk category 1]	19-35 Fleet Street	Negligible [risk category 1]
B190	8 mm [risk category 1]	7 mm [risk category 1]	7 m	1 in 8000 [risk category 1]	15,17 Fleet Street	Negligible [risk category 1]
B191	10 mm [risk category 2]	9 mm [risk category 1]	7 m	1 in 7000 [risk category 1]	14 Fleet Street	Slight [risk category 2]
B192	9 mm [risk category 1]	8 mm [risk category 1]	6 m	1 in 7500 [risk category 1]	12 Fleet Street	Negligible [risk category 1]
B193	7 mm [risk category 1]	7 mm [risk category 1]	8 m	1 in 9500 [risk category 1]	11 Fleet Street	Negligible [risk category 1]
B194	5 mm [risk category 1]	5 mm [risk category 1]	7 m	1 in 15000 [risk category 1]	8 Fleet Street	Negligible [risk category 1]
B195	5 mm [risk category 1]	5 mm [risk category 1]	9 m	1 in 14500 [risk category 1]	7 Fleet Street	Negligible [risk category 1]
B196	6 mm [risk category 1]	6 mm [risk category 1]	8 m	1 in 11000 [risk category 1]	9 Fleet Street	Negligible [risk category 1]

G3.15 Shaft 13

G3.15.1 Case 24

Appendix Figure G45: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.

Appendix Figure G46: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 59: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B73	5 mm	3 mm	6 m	1 in 3500	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S76	3 mm	2 mm	8 m	1 in 6000	Cooper Street Road	1 in 500	Pass
S77	3 mm	2 mm	9 m	1 in 12000	Nearby Pathway	1 in 500	Pass
B199	5 mm	3 mm	5 m	1 in 2500	43 Cooper Street	1 in 500	Pass

Appendix G Table 60: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U74	4 mm	2 mm	8 m	1 in 4000	150 AC Wastewater Pipeline	1 in 500	Pass
U75	4 mm	2 mm	9 m	1 in 5000	50 MS Water Pipeline	1 in 500	Pass

Appendix G Table 61: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B73	5 mm [risk category 1]	3 mm [risk category 1]	6 m	1 in 3500 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]
B199	5 mm [risk category 1]	3 mm [risk category 1]	5 m	1 in 2500 [risk category 1]	43 Cooper Street	Negligible [risk category 1]

G3.16 Shaft 14

G3.16.1 Case 25

Appendix Figure G47: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.

Appendix Figure G48: Estimated total settlement contours (mm) in pink. Excavation area shown with black hatch. Utilities sourced from Auckland Council GeoMaps. Building outlines sourced from LINZ. Aerial basemap sourced from OpenStreetMaps.

Appendix G Table 62: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B78	1 mm	1 mm	6 m	1 in 123000	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass

Appendix G Table 63: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U79	2 mm	2 mm	5 m	1 in 60500	225 AC Wastewater Pipeline	1 in 500	Pass

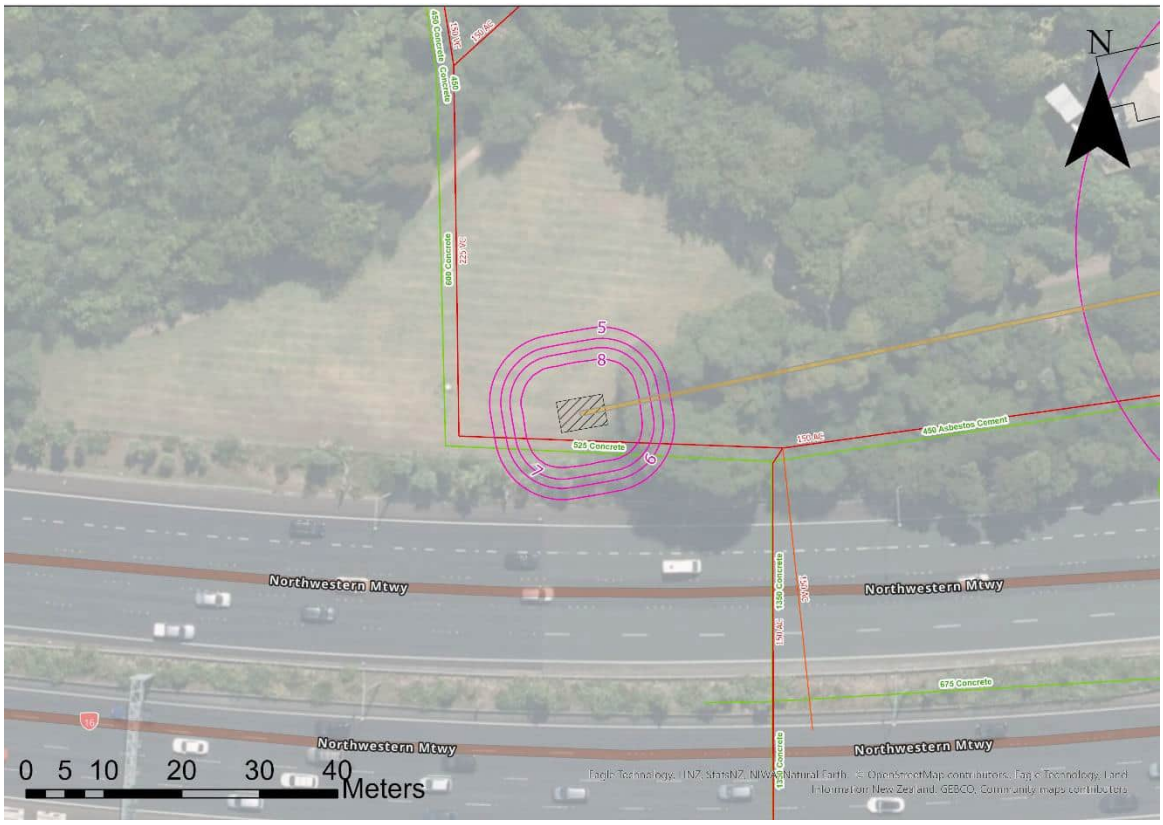
Appendix G Table 64: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on Burland 2012 criteria [highest reported risk category]
B78	1 mm [risk category 1]	1 mm [risk category 1]	6 m	1 in 123000 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]

G3.17 Shaft 15

G3.17.1 Case 26

Appendix Figure G49: Location of the proposed excavation, and point pairs used to calculate settlement and differential settlement.



Appendix Figure G50: Estimated total settlement contours (mm) shown in pink. Excavation area shown with black hatching. The green buildings are assessed to be at slight risk [Burland 2012 Risk Category 2]. The blue buildings are assessed as very slight risk [Burland 2012 Risk Category 1]. Utilities sourced from Auckland Council GeoMaps. Building outlines from LINZ. Aerial basemap from OpenStreetMap.

Appendix G Table 65: Differential settlement screening of structures

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Building or structure description	Maximum allowable differential settlement (V:H)	Assessment criteria (pass / fail)
B80	0.8 mm	0.7 mm	6 m	1 in 79500	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	1 in 500	Pass
S83	5 mm	3 mm	7 m	1 in 3000	Northwestern Motorway	1 in 500	Pass

Appendix G Table 66: Utilities differential settlement damage assessment

ID	Settlement at point 1	Settlement at point 2	Distance between point pairs	Differential settlement (V:H)	Utility description	Screening differential settlement (V:H)	Assessment criteria (pass / fail)
U81	7 mm	8 mm	7 m	1 in 10000	150 AC Wastewater Pipeline	1 in 500	Pass
U82	8 mm	8 mm	7 m	1 in 13000	525 Concrete Stormwater Pipeline	1 in 500	Pass

Appendix G Table 67: Building damage risk assessment and settlement analysis results

ID	Settlement at point 1 [risk category]	Settlement at point 2 [risk category]	Distance between point pairs	Differential settlement (V:H)	Building / structure description	Description of risk based on CIRIA 1996 criteria [highest reported risk category]	Description of risk based on Burland 2012 criteria [highest reported risk category]
B80	0.8 mm [risk category 1]	0.7 mm [risk category 1]	6 m	1 in 79500 [risk category 1]	2-storey dwelling, timber clad (weatherboard), corrugated metal roof	Negligible [risk category 1]	Very Slight [risk category 1]

Appendix H– Tunnelling settlement analysis

H1 Introduction

The technical memorandum should be read in conjunction with report title:

Tonkin & Taylor Ltd. (June 2025). Groundwater and Settlement Assessment of Effects – Motions Catchment Improvement Project. Prepared for Watercare Services Limited. Job No: 30552.5024

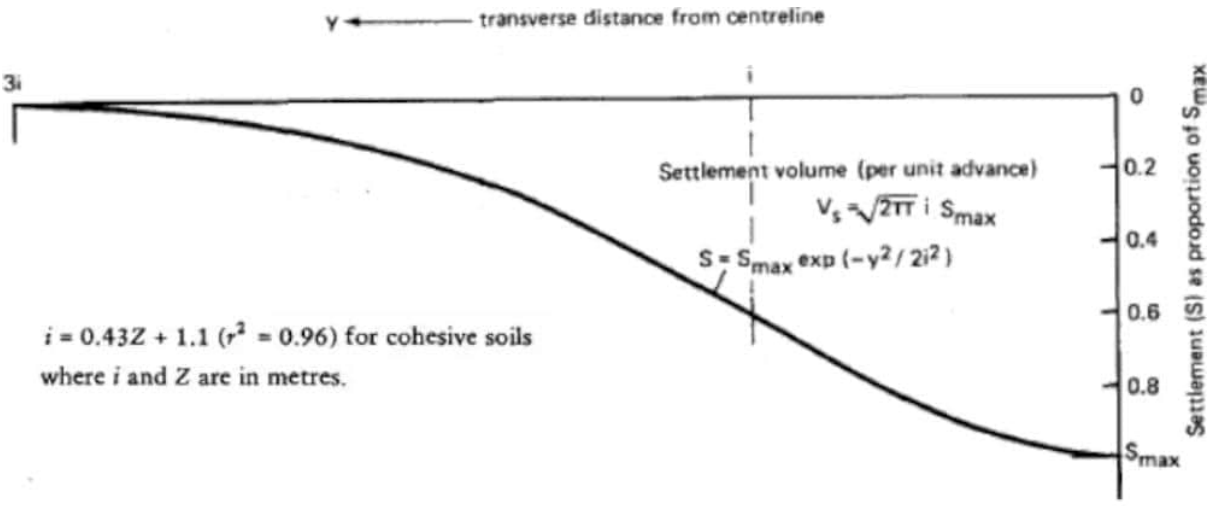
H2 Method

Mechanical settlement has been modelled following the methodology of O'Reilly and New (1982). This is a semi-empirical methodology derived from case history data from tunnel excavations in the United Kingdom, together with the assumption of a Gaussian-shaped settlement trough. These case histories were used to develop linear regressions for the radius of the trough, 3i, as a function of tunnel axis depth, Z. The relevant regression for cohesive soils is:

$$i = 0.43\ Z + 1.1\text{m}$$

Where i is the standard deviation of the Gaussian giving the settlement trough's shape.

An analytic method based on geometric considerations gives the maximum settlement based on tunnel diameter, trough width, and ground loss. This modelling approach is illustrated in Appendix Figure Appendix H1.



Appendix Figure H1: Modelled Gaussian settlement through (reproduced with modification from Fig.1 and Eq.121, O'Reilly and New, 1992).

The methodology relies on an estimate for the ground loss to obtain the unit settlement volume, V_S. The ground loss is estimated based on the ground conditions and the tunnel construction method. For this analysis, a ground loss percentage 0.5% has been adopted for areas of the tunnel which are contained in the weathered to unweathered ECBF rock material. A higher percentage of 2.0% has been used for other areas which contain more compressible material.

This is mapped in Appendix Figure H2.

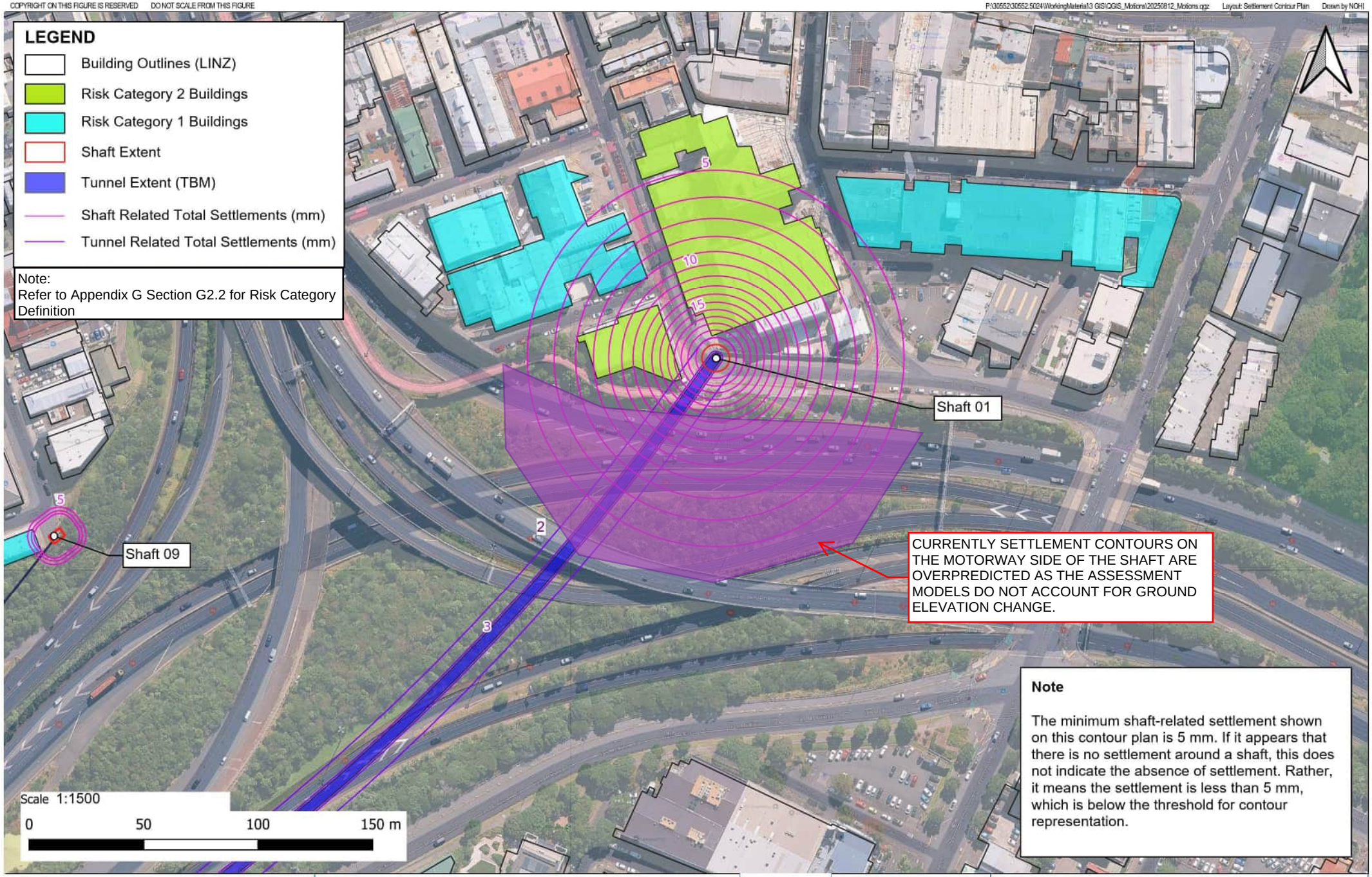
Appendix Figure H2: The modelled Ground Loss across the tunnel network. Tunnel Segments contained in rock are considered to have lower ground loss.

H3 Results

Mechanical settlement calculations were performed using this methodology at 1m increments along the tunnel. Settlements contours are presented in Appendix **. Settlements are typically less than 2 mm, although the segments with higher modelled ground loss of 2.0% have maximum settlements of up to 5 mm.

Appendix I– Overall Settlement Contour Plan

P:\30552\30552.5024\WorkingMaterial\3 GIS\QGIS_Motions\20250812_Motions.qgz Layout: Settlement Contour Plan Drawn by NOHI



Note

The minimum shaft-related settlement shown on this contour plan is 5 mm. If it appears that there is no settlement around a shaft, this does not indicate the absence of settlement. Rather, it means the settlement is less than 5 mm, which is below the threshold for contour representation.

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NOTES:
Notes and data attributions goes here.

REV	DESCRIPTION	GIS	CHK	DATE
0	First version	NOHI		23/08/25

LOCATION PLAN APPROVED DATE

PROJECT No.	30552.5024	
DESIGNED	NOHI	AUG 25
DRAWN	NOHI	AUG 25
CHECKED		

CLIENT **WATERCARE SERVICES LIMITED**
PROJECT **MOTIONS - CC2**
TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1:1500 FIG No. FIGURE 1 REV 0

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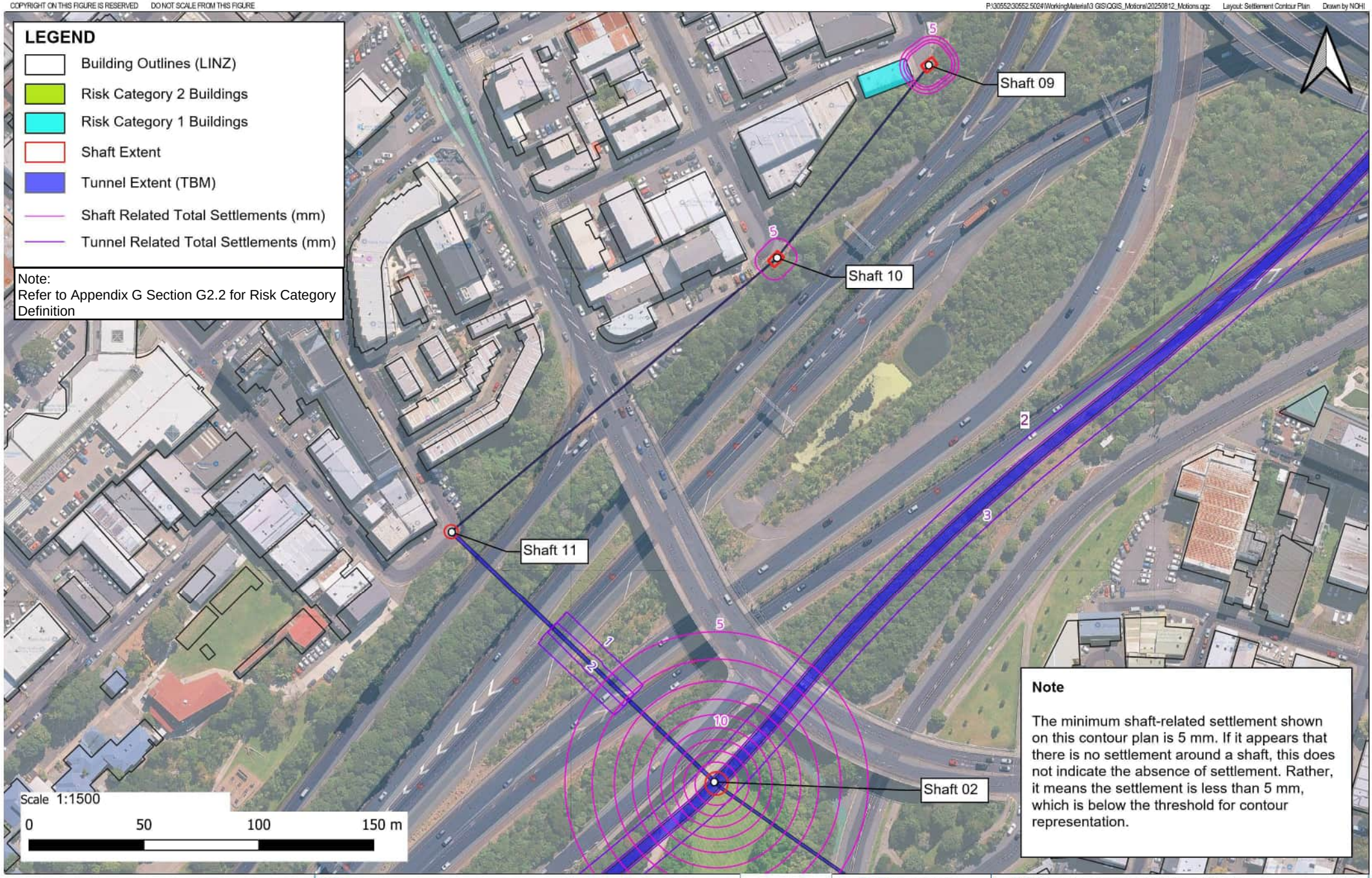

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PROJECT No.	30552.5024	
DESIGNED	NOHI	AUG 25
DRAWN	NOHI	AUG 25
CHECKED		
APPROVED		DATE

LOCATION PLAN

CLIENT **WATERCARE SERVICES LIMITED**
PROJECT **MOTIONS - CC2**
TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 2 REV 0

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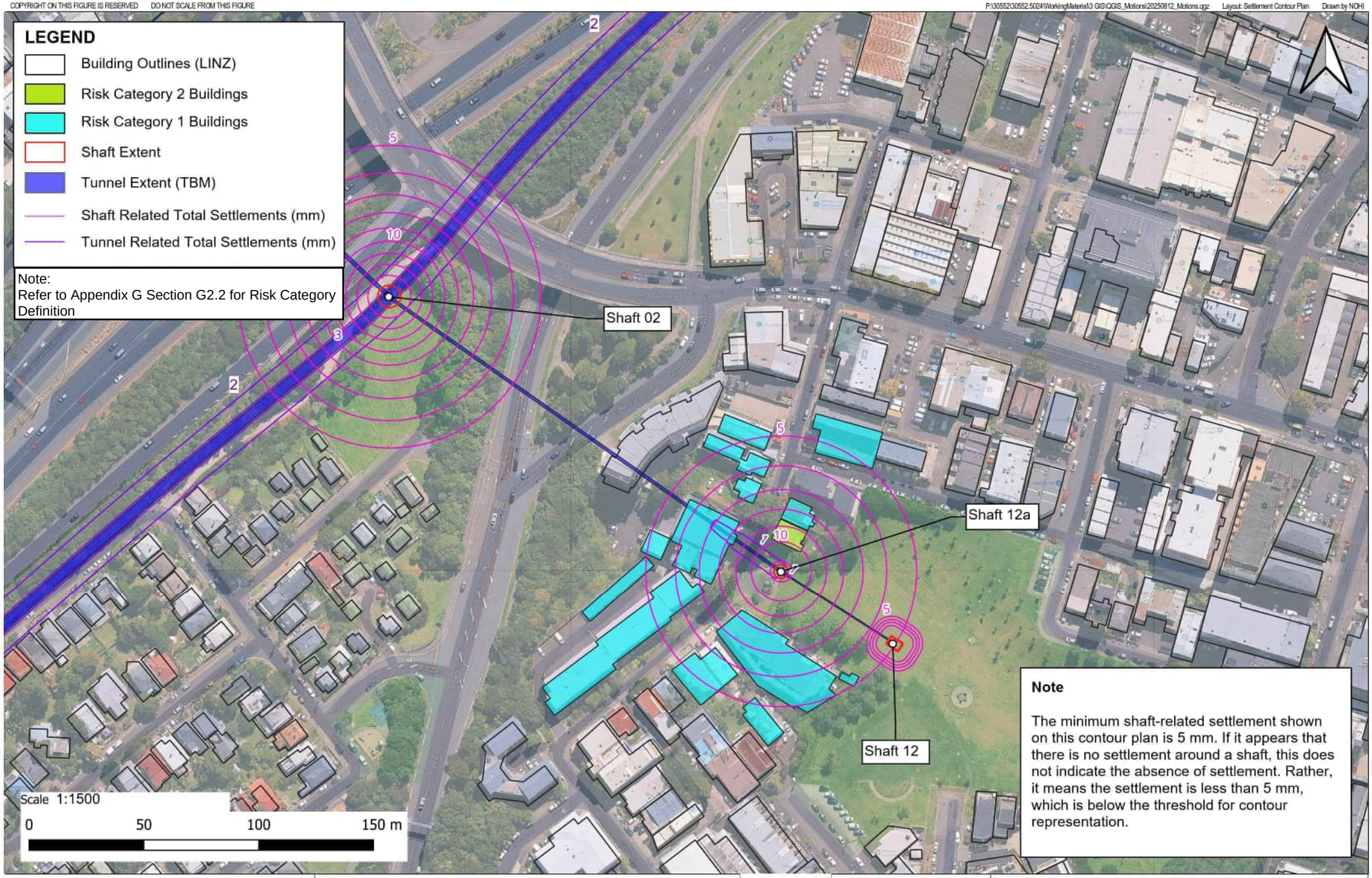

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LOCATION PLAN

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DESIGNED	NOHI	AUG 25
DRAWN	NOHI	AUG 25
CHECKED		
APPROVED		DATE

CLIENT **WATERCARE SERVICES LIMITED**
PROJECT **MOTIONS - CC2**
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TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 3 REV 0

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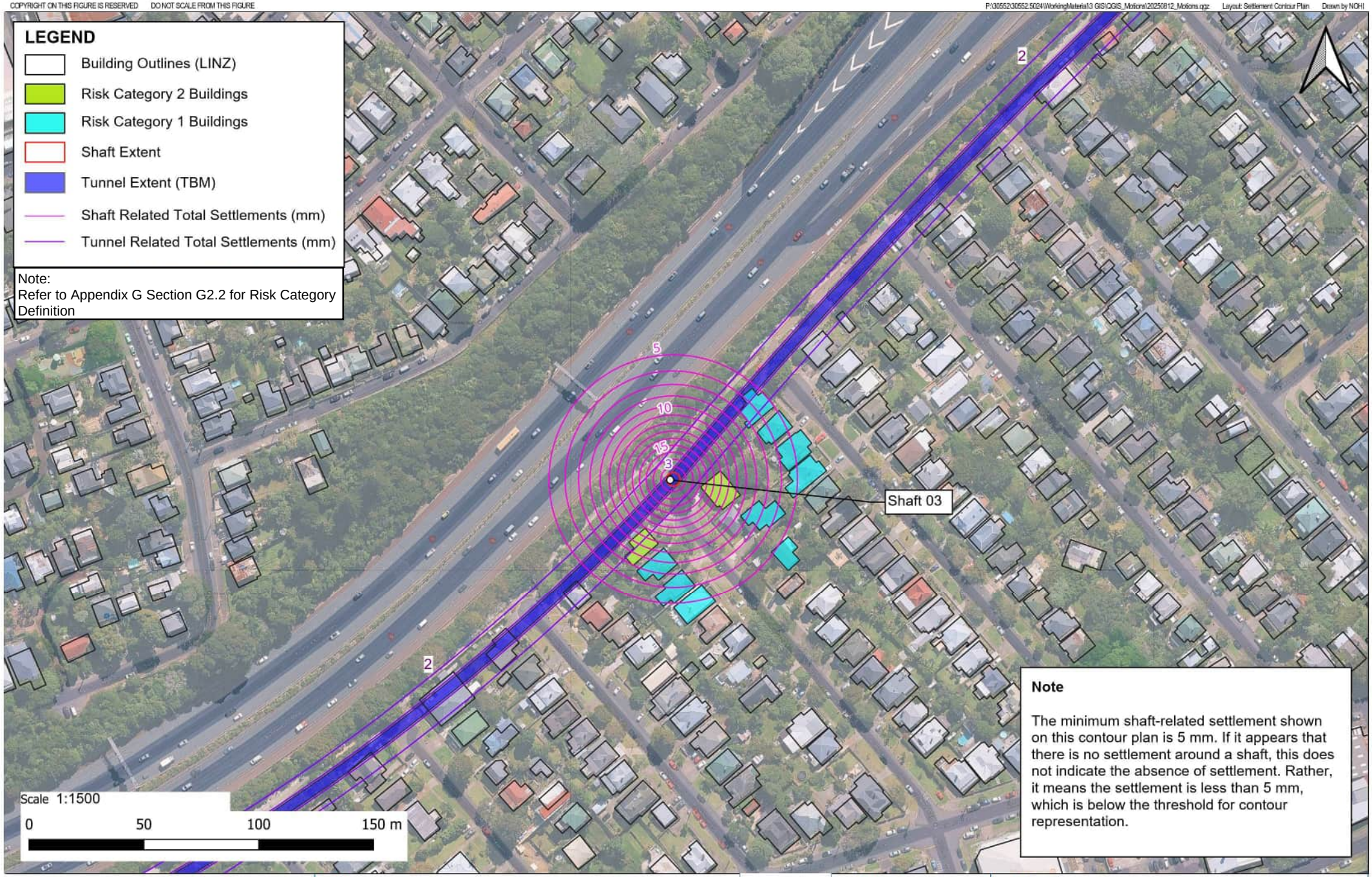

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NOTES:
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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	NOHI		23/08/25

LOCATION PLAN

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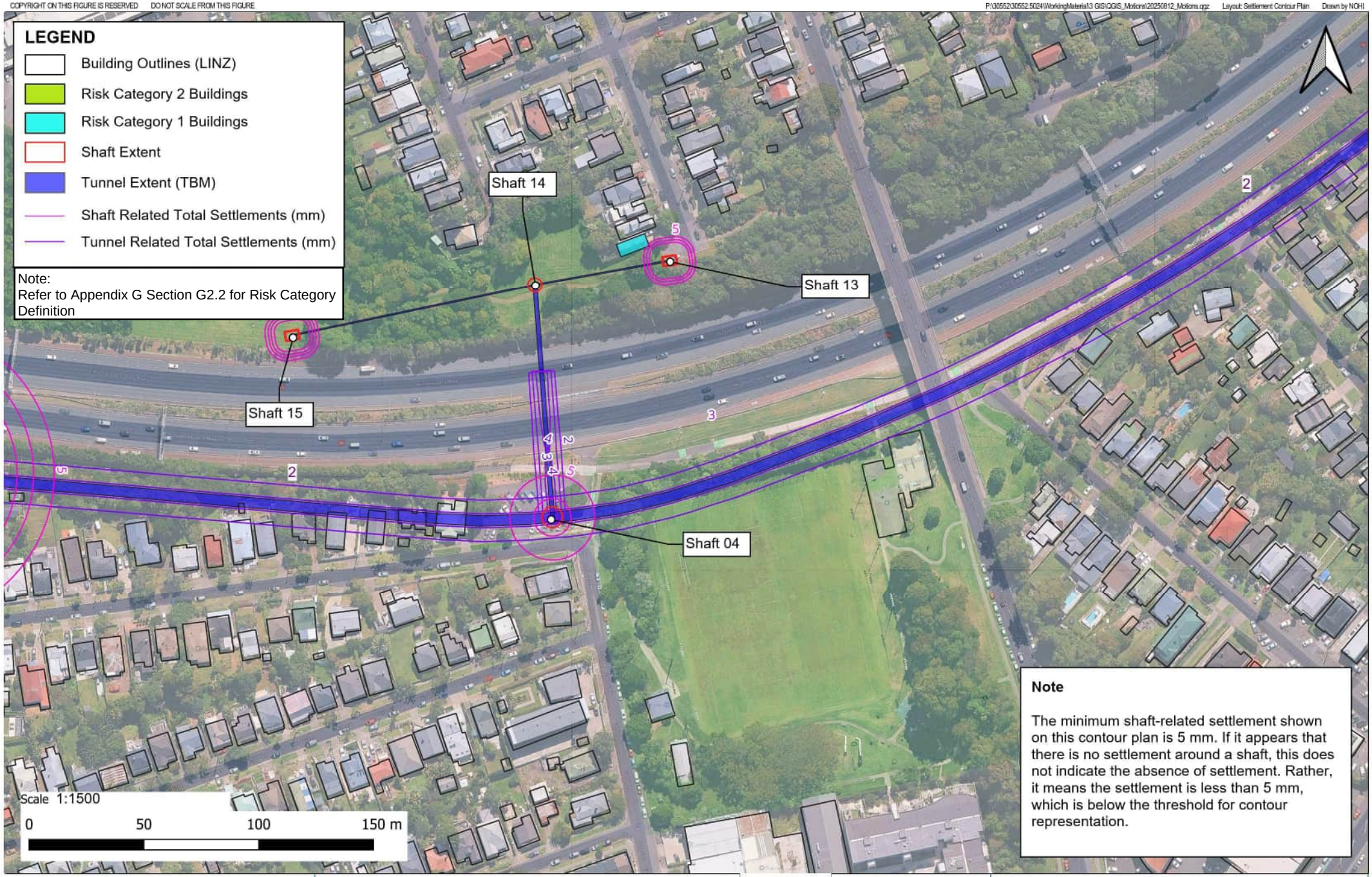
PROJECT **MOTIONS - CC2**
TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 4 REV 0

P:\30552\30552.5024\Working\Material\3 GIS\QGIS_Motions\20250812_Motions.qgz Layout: Settlement Contour Plan Drawn by NOHI



Note

The minimum shaft-related settlement shown on this contour plan is 5 mm. If it appears that there is no settlement around a shaft, this does not indicate the absence of settlement. Rather, it means the settlement is less than 5 mm, which is below the threshold for contour representation.

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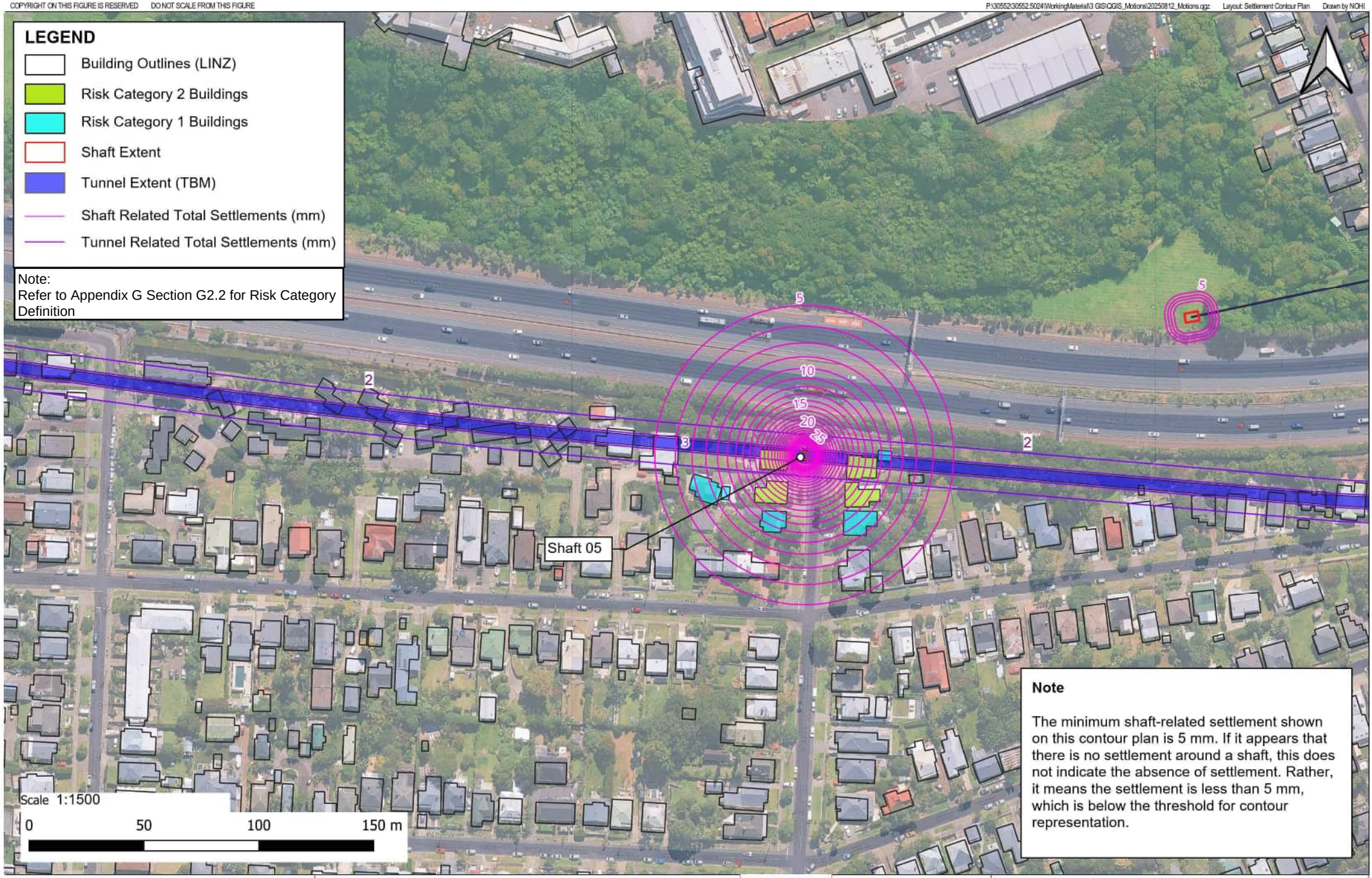
TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 5 REV 0

P:\30552\30552.5024\WorkingMaterial\3 GIS\QGIS_Motions\20250812_Motions.qgz Layout: Settlement Contour Plan Drawn by NOHI



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TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 6 REV 0

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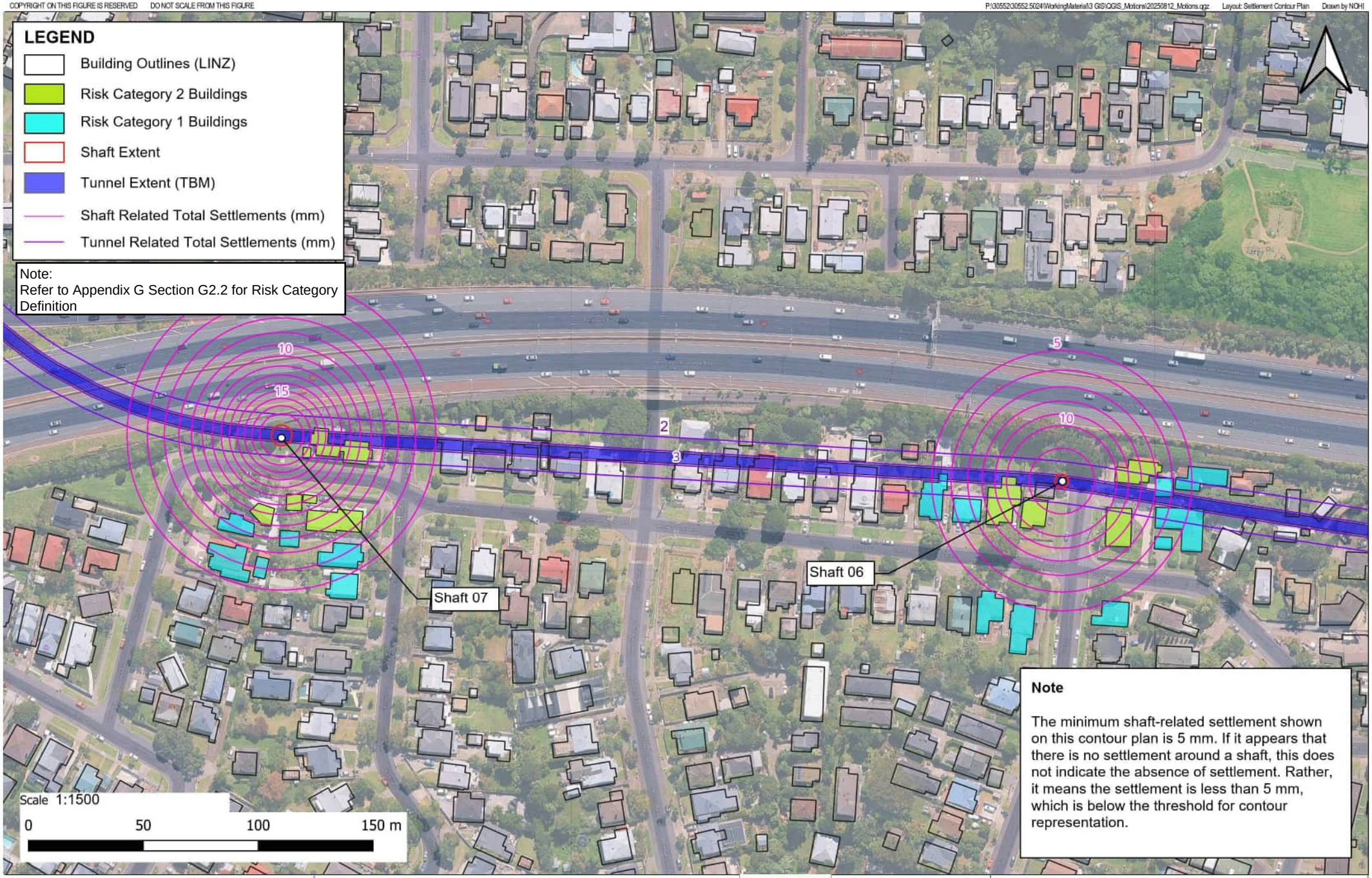

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TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 7 REV 0

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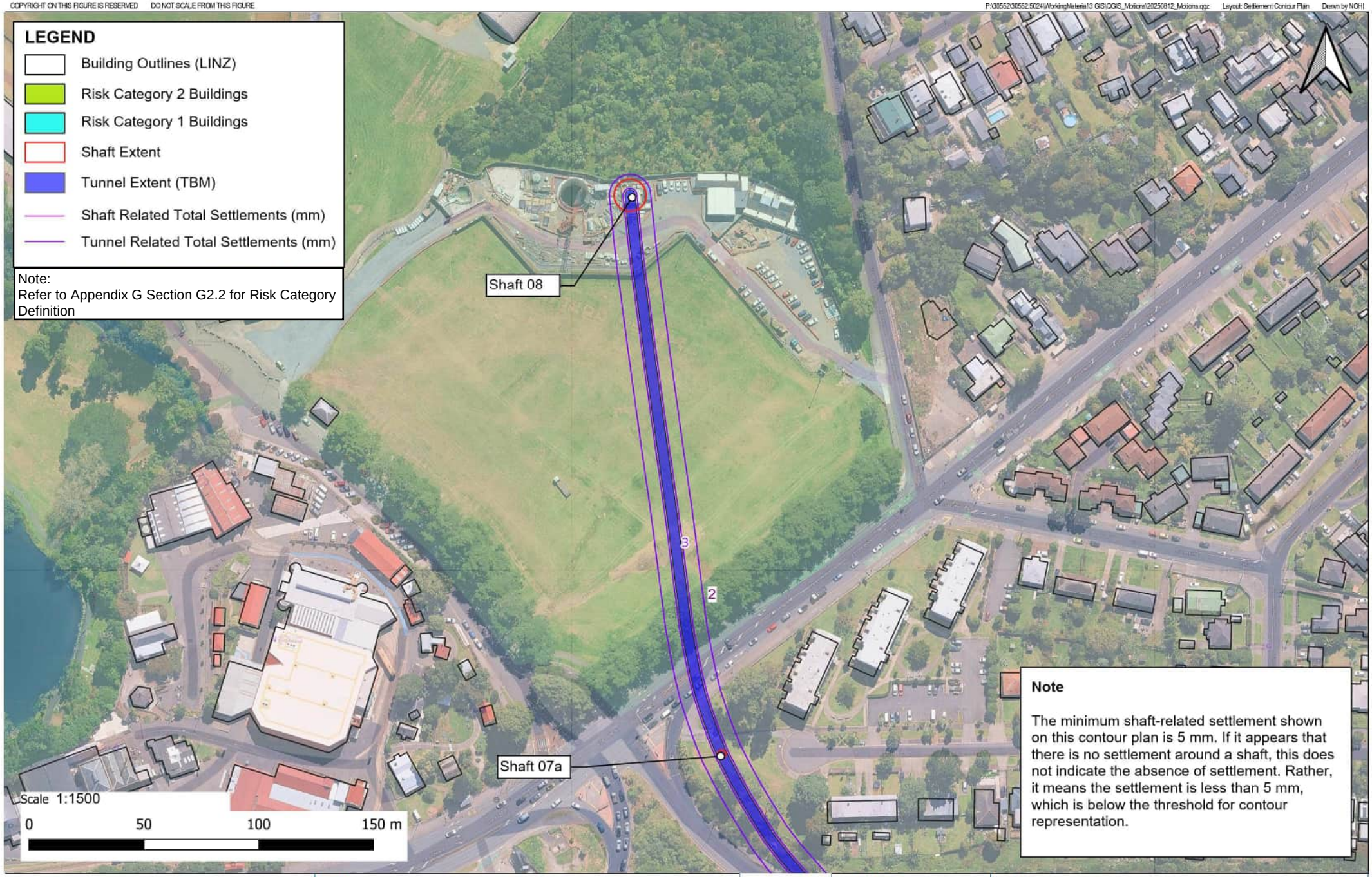

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TITLE SETTLEMENT CONTOUR PLAN
TBM OPTION
SCALE (A3) 1: 1500 FIG No. FIGURE 8 REV 0

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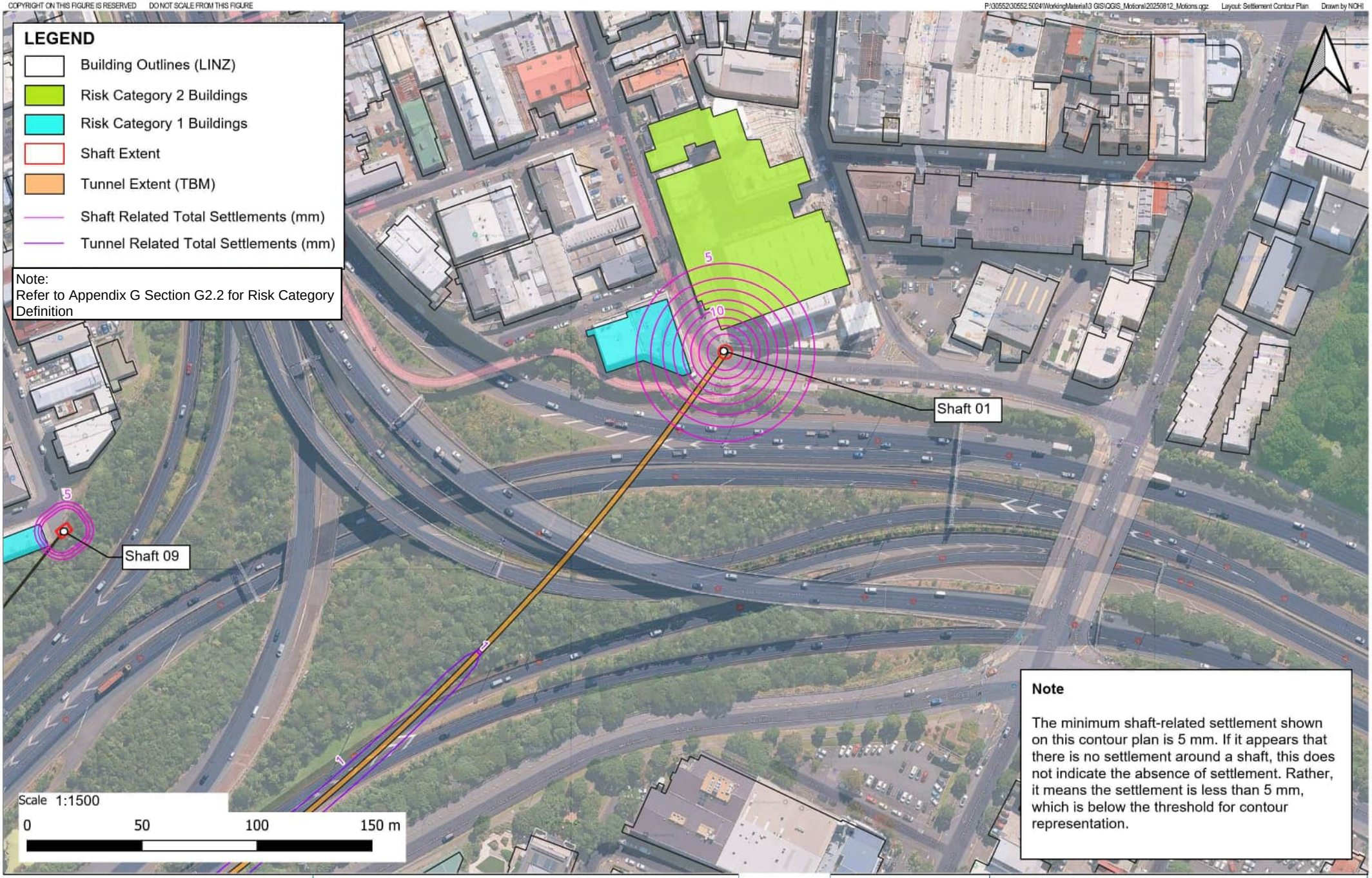

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 9 REV 0

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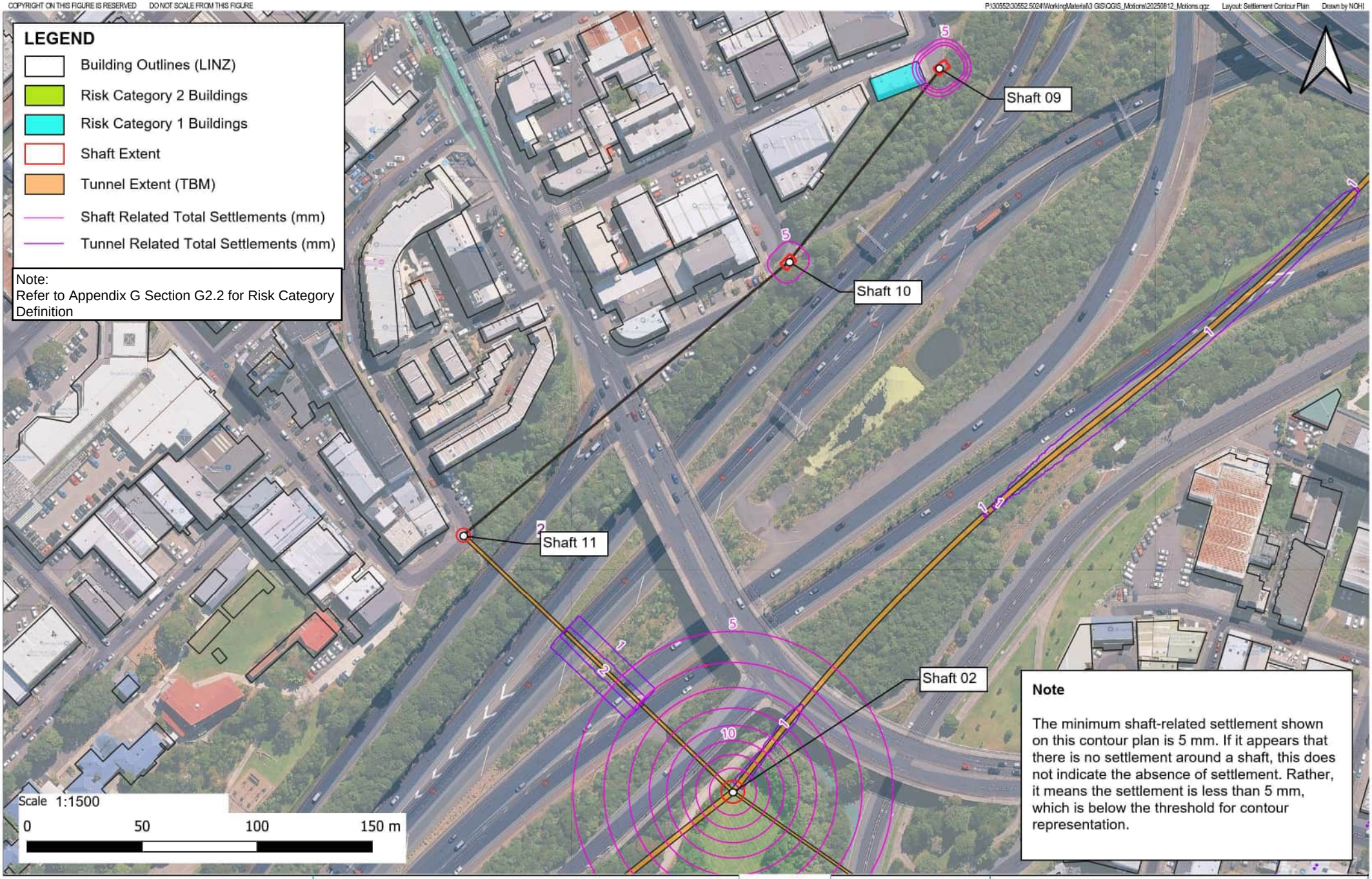

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 10 REV 0

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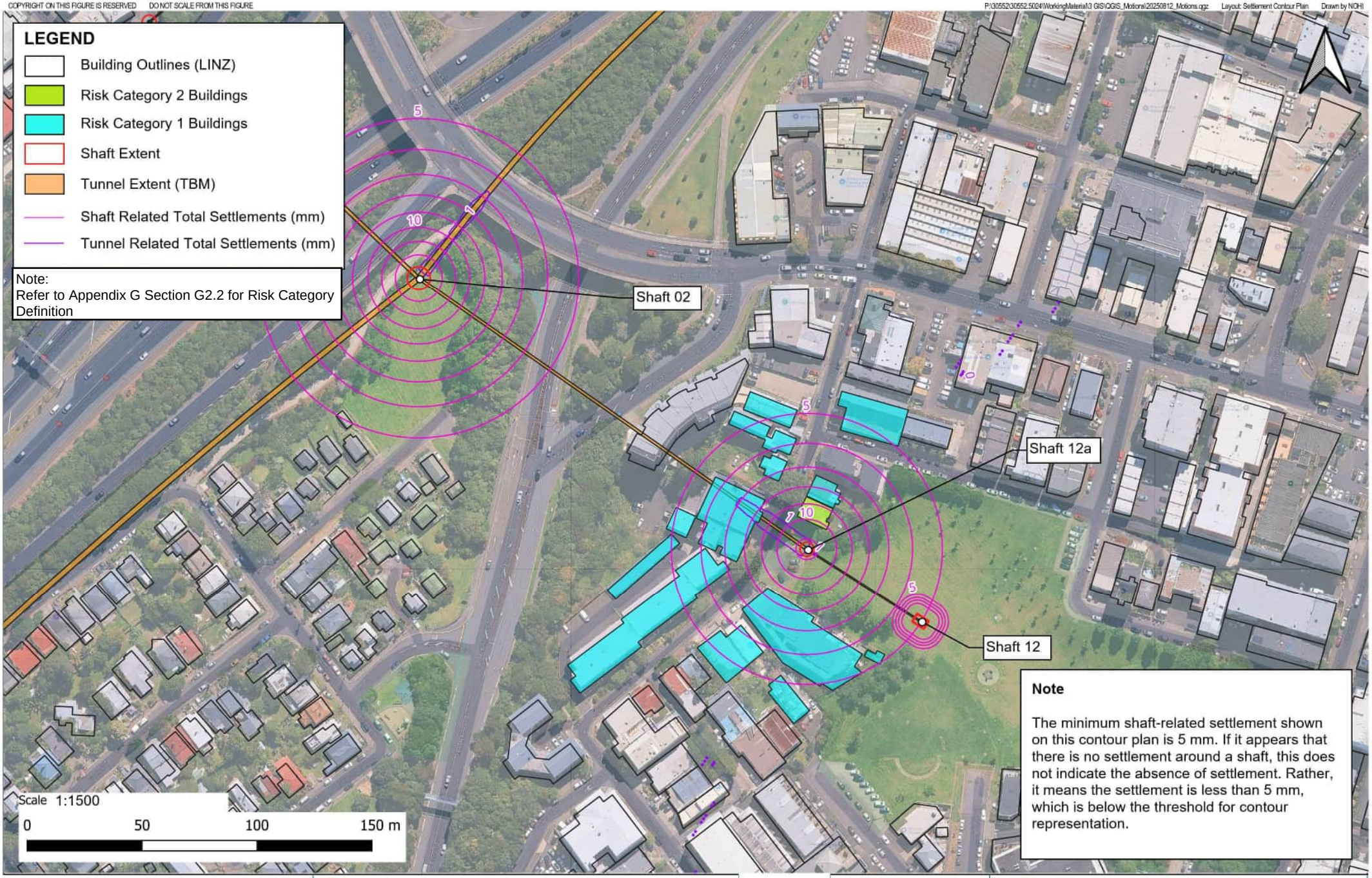

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 11 REV 0

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PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 12 REV 0

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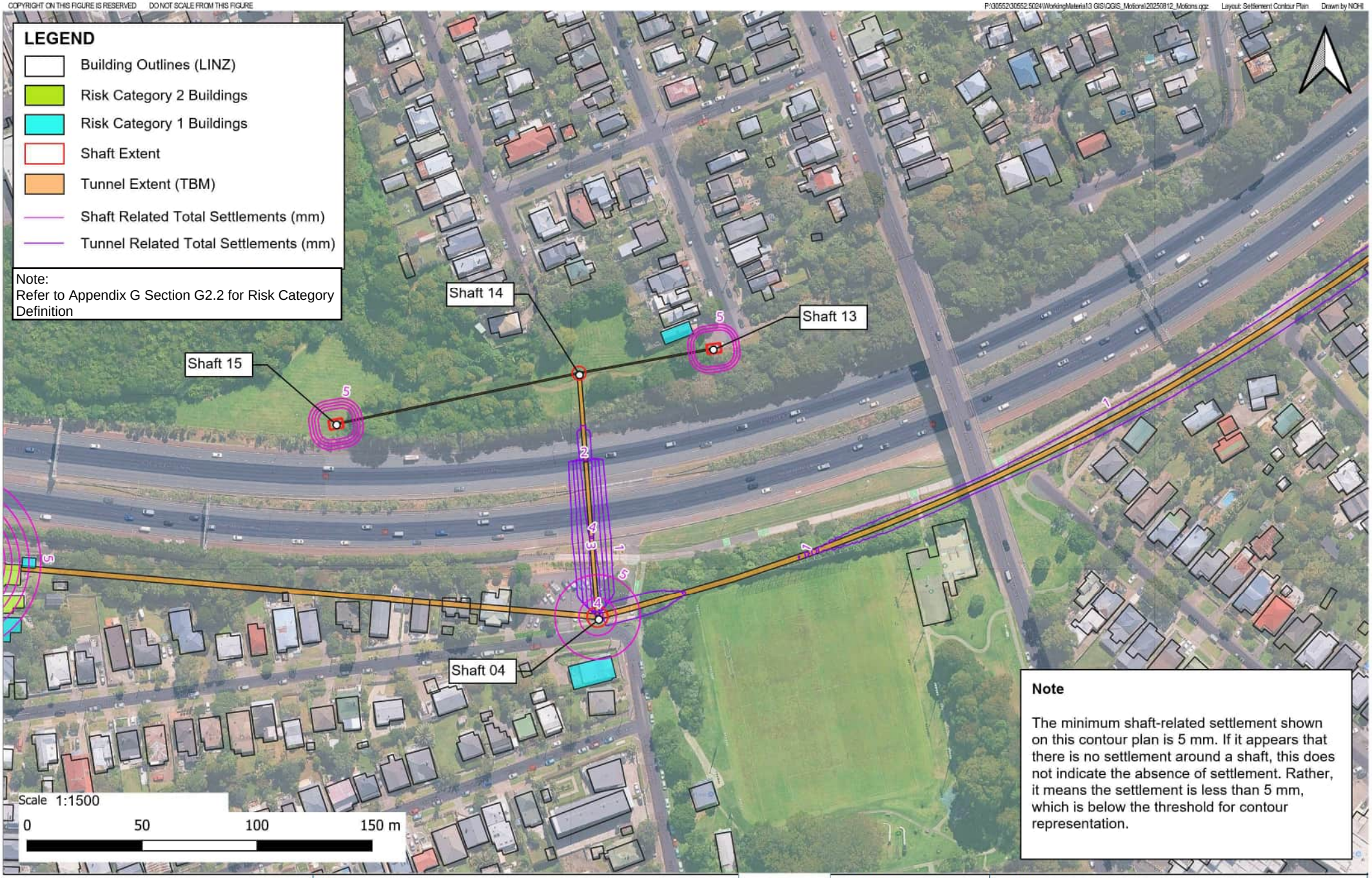

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PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 13 REV 0

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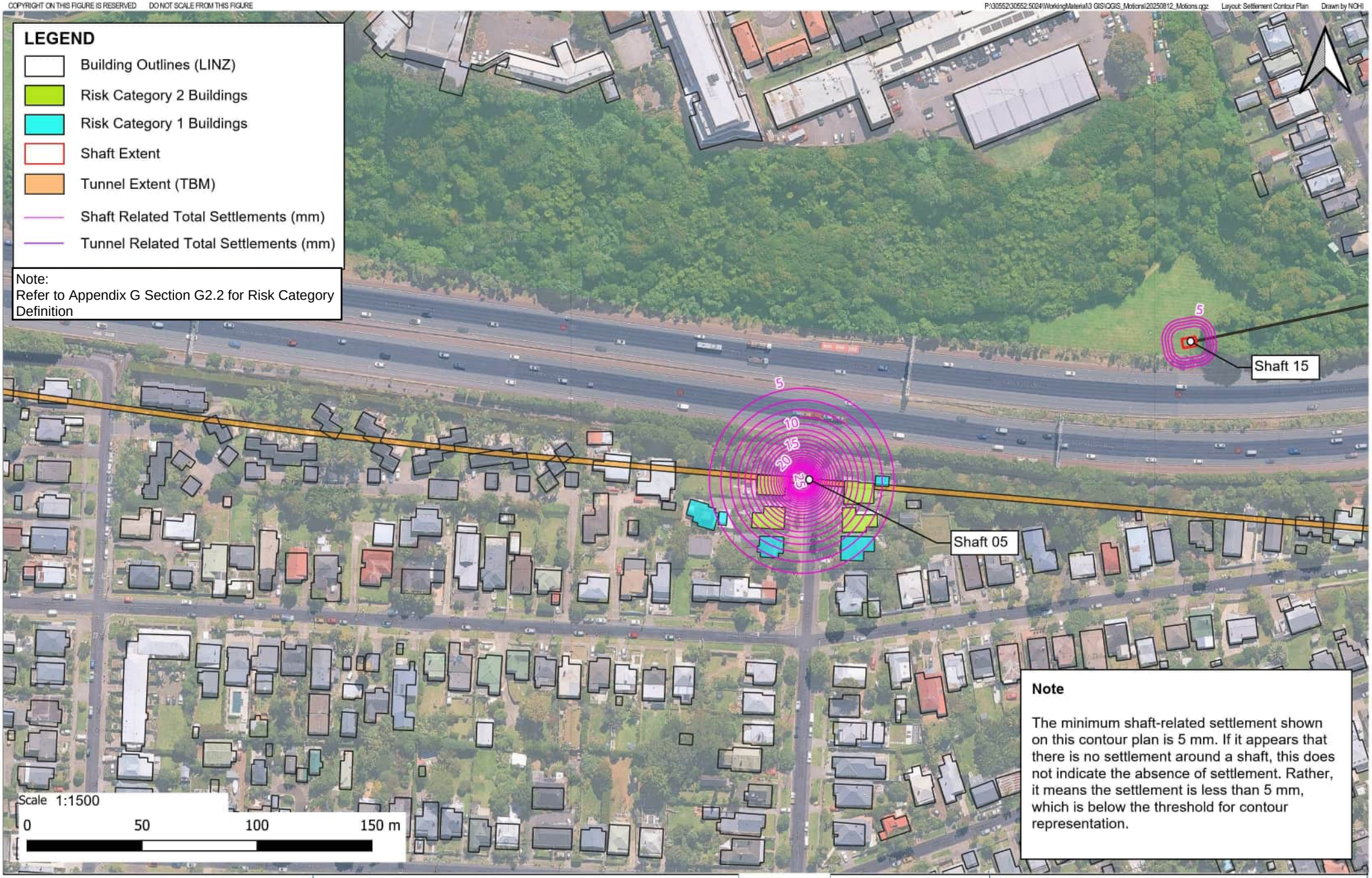

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1

SCALE (A3) 1: 1500 FIG No. FIGURE 14 REV 0

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1
SCALE (A3) 1: 1500 FIG No. FIGURE 15 REV 0

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B1

SCALE (A3) 1: 1500 FIG No. FIGURE 16 REV 0

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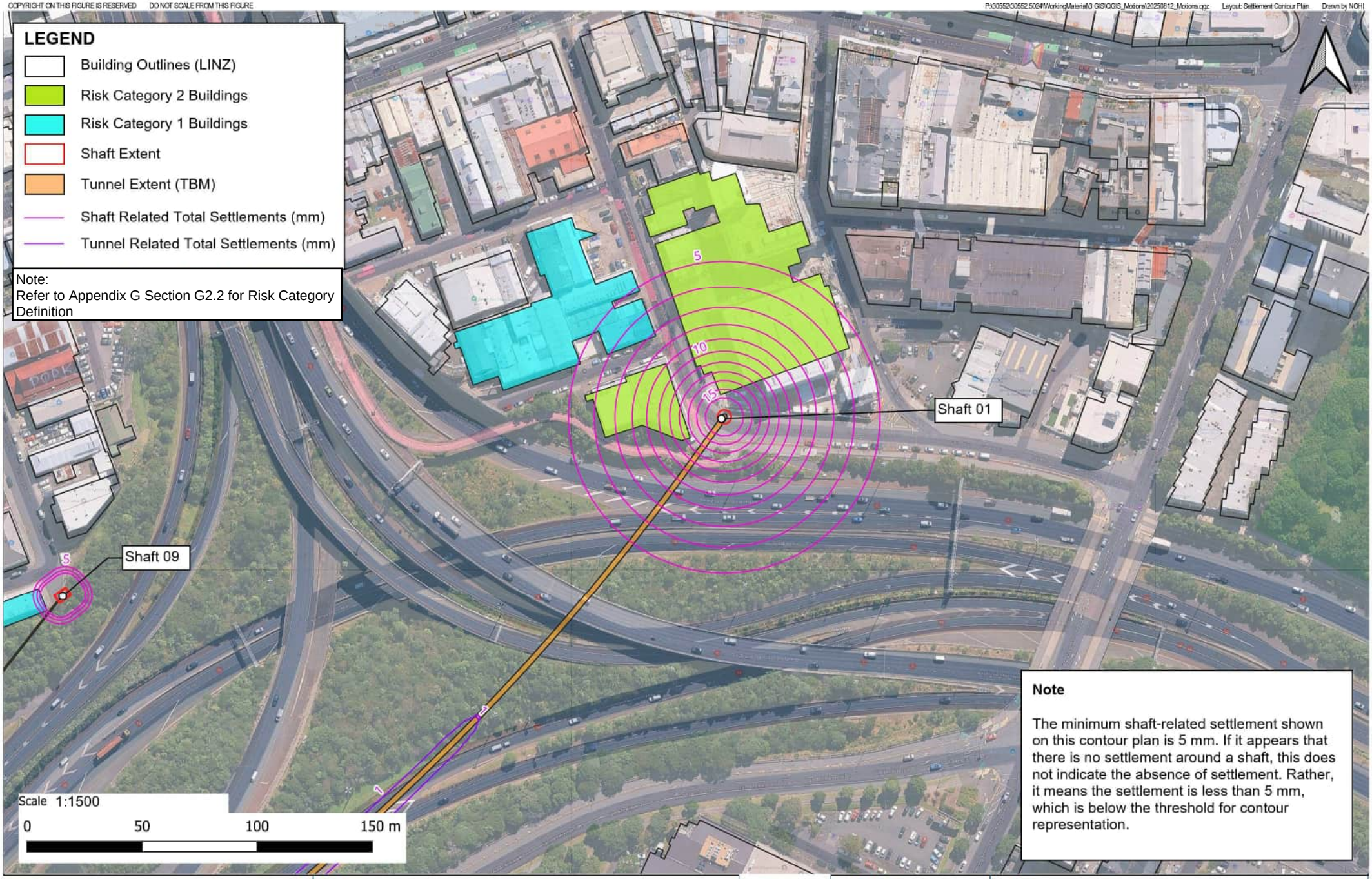

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PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 17 REV 0

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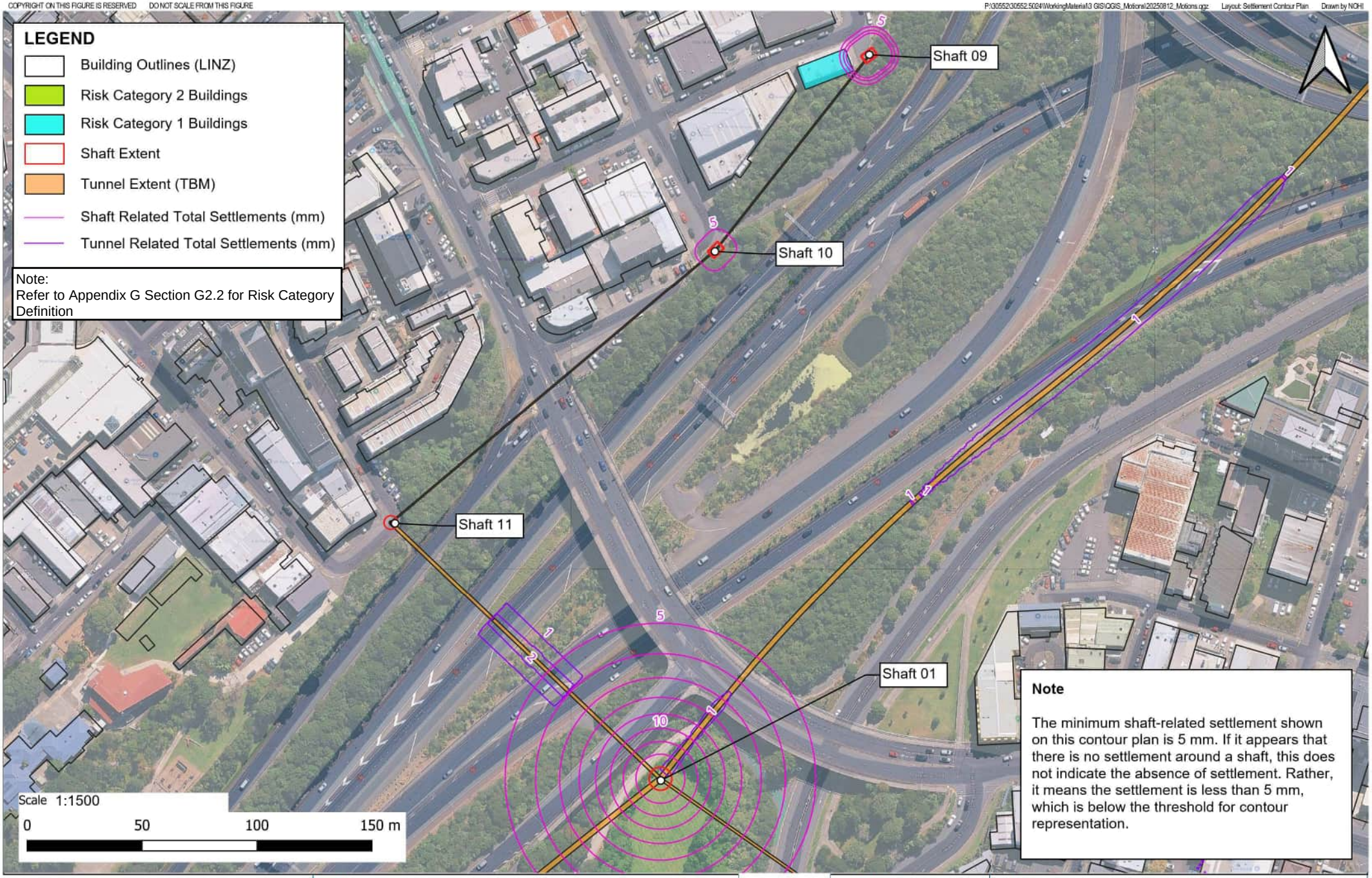

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PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 18 REV 0

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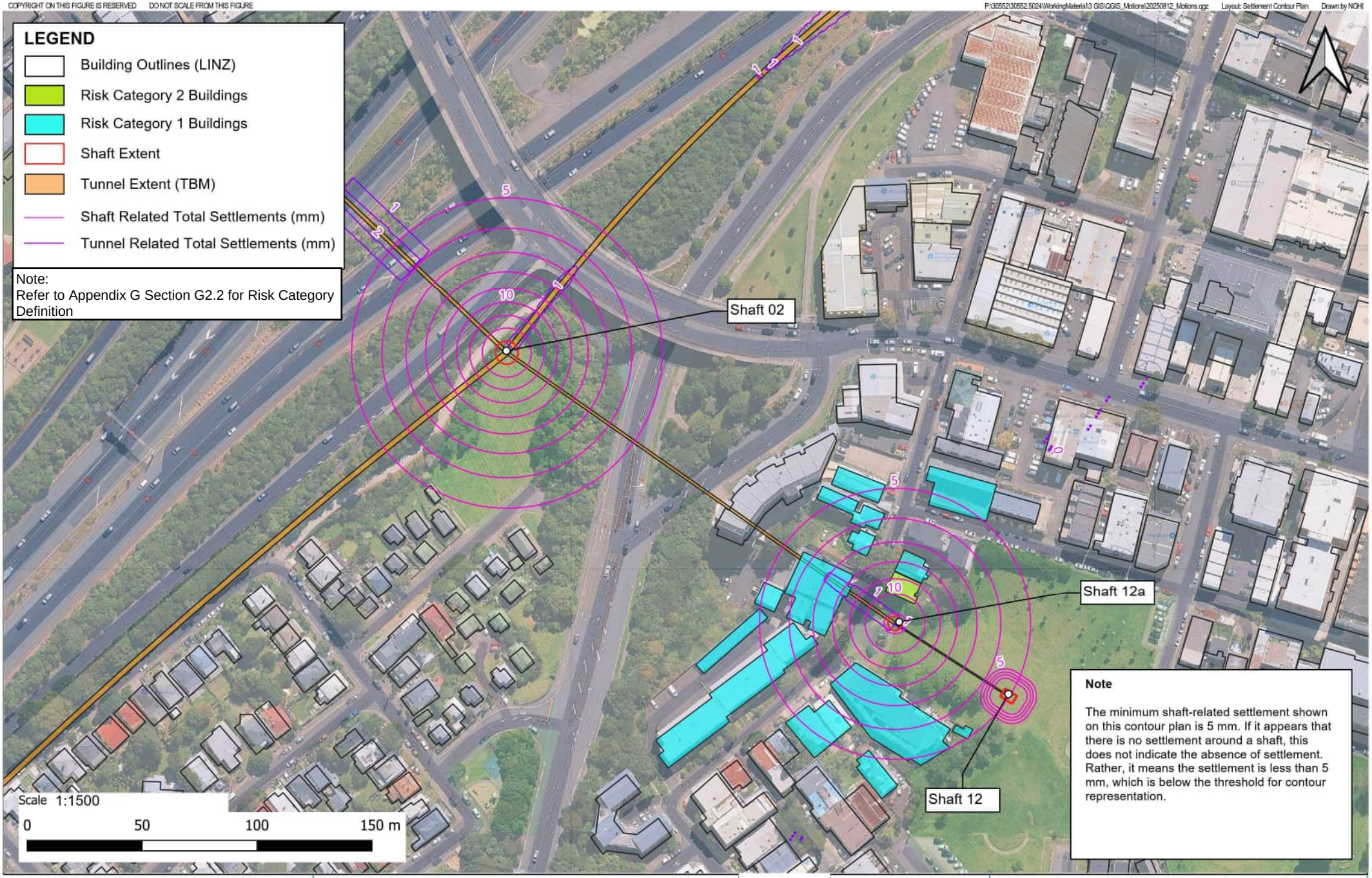

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PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 19 REV 0

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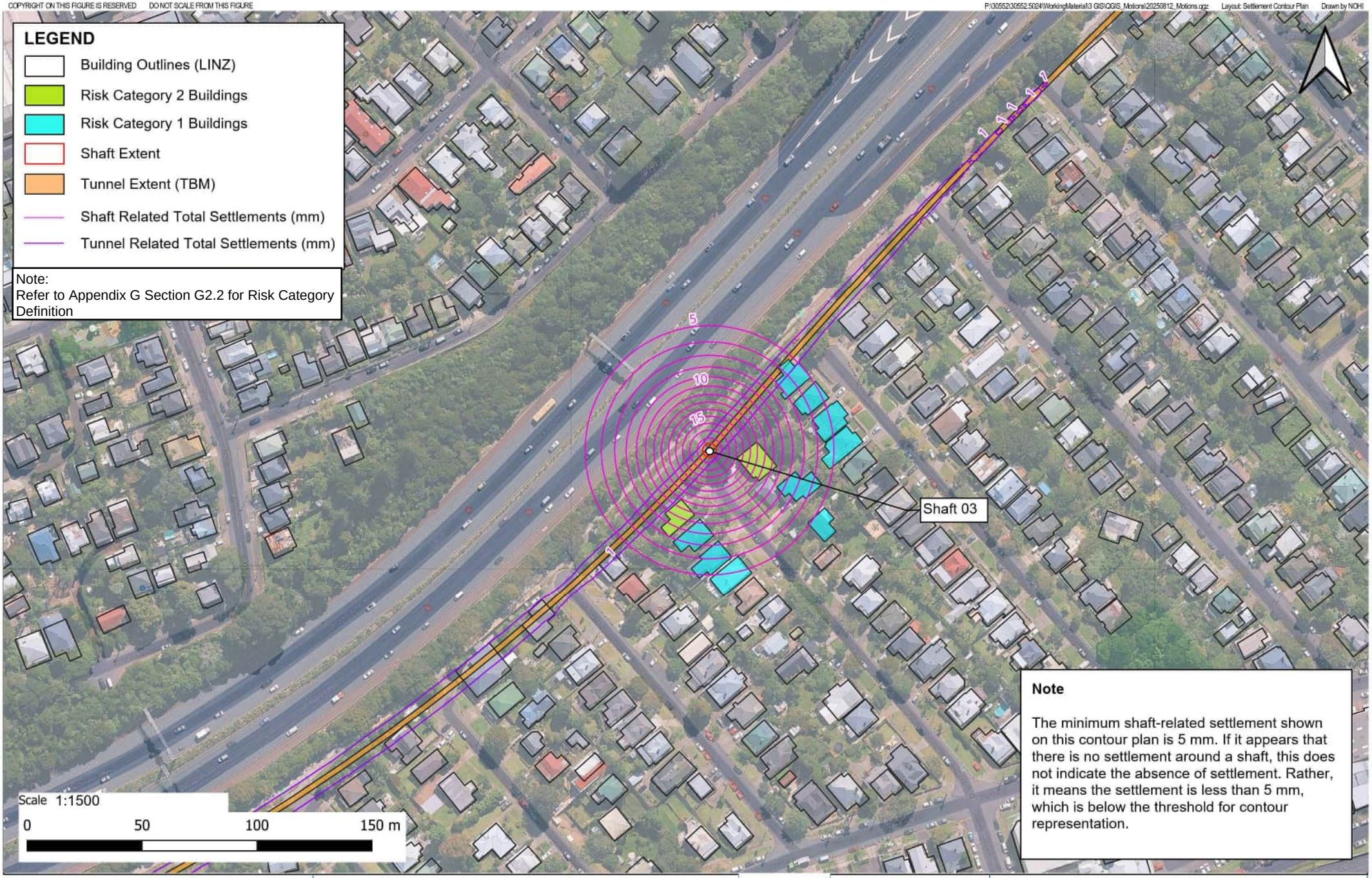

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PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 20 REV 0

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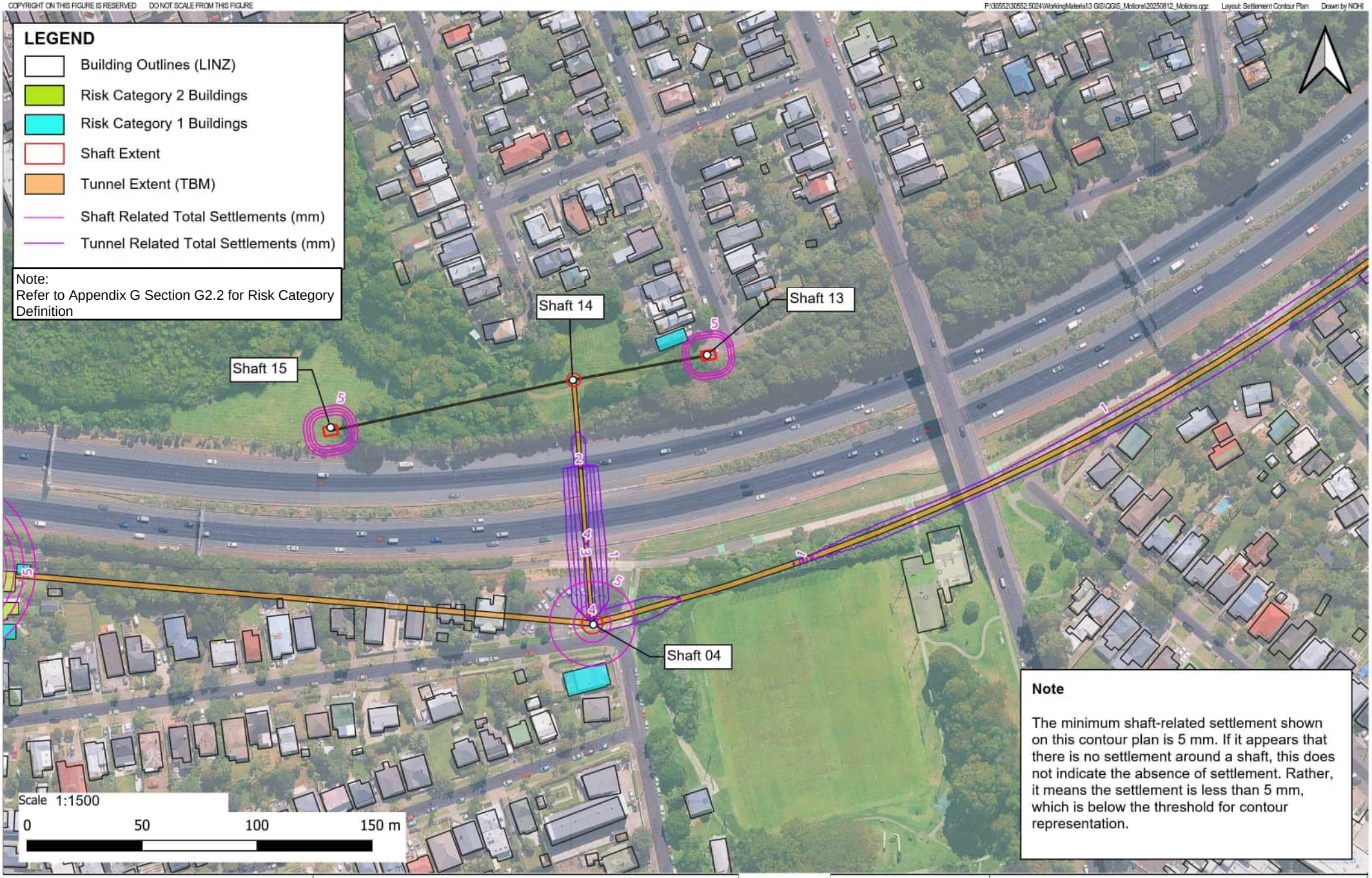

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 21 REV 0

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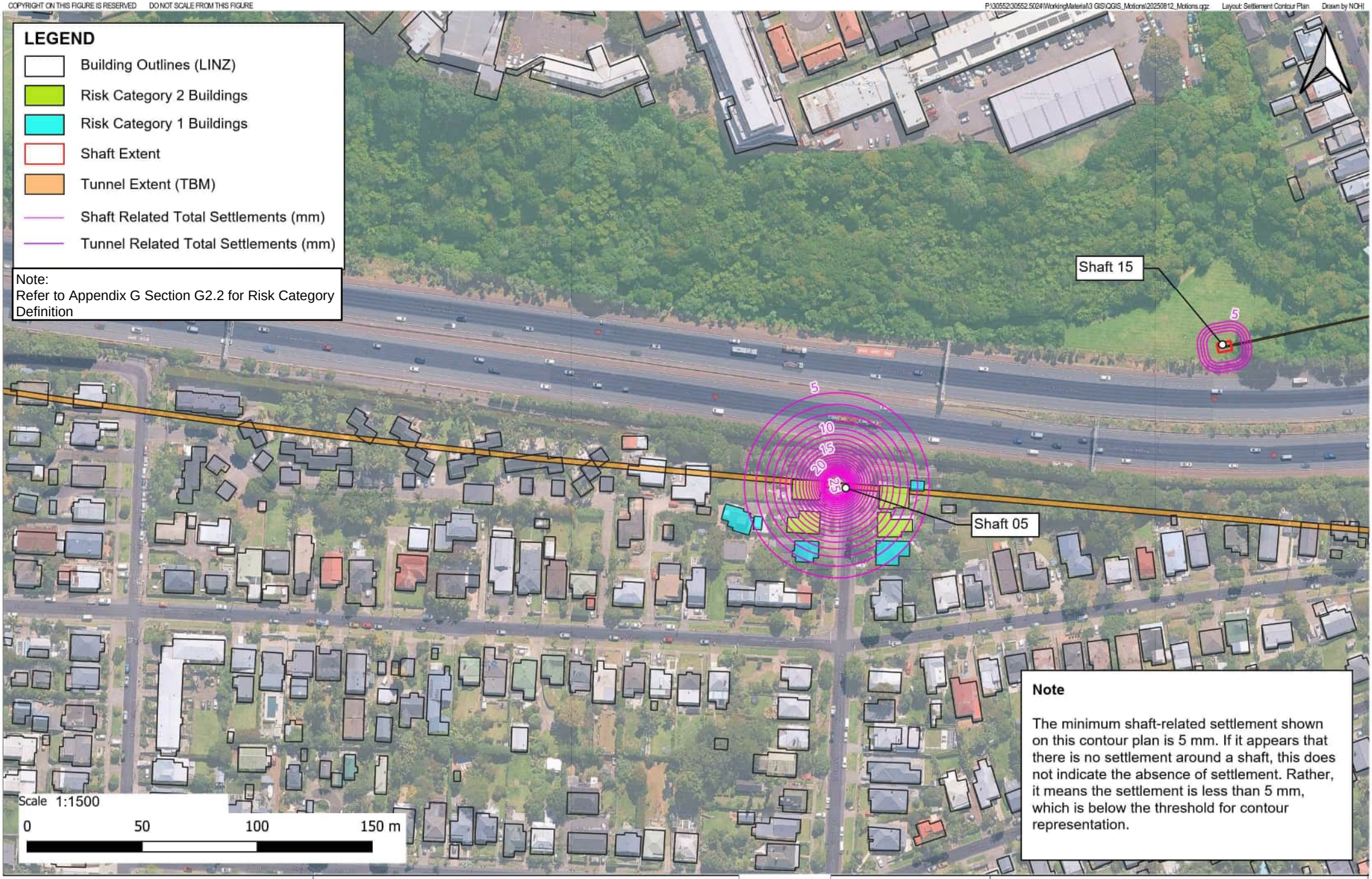

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PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 22 REV 0

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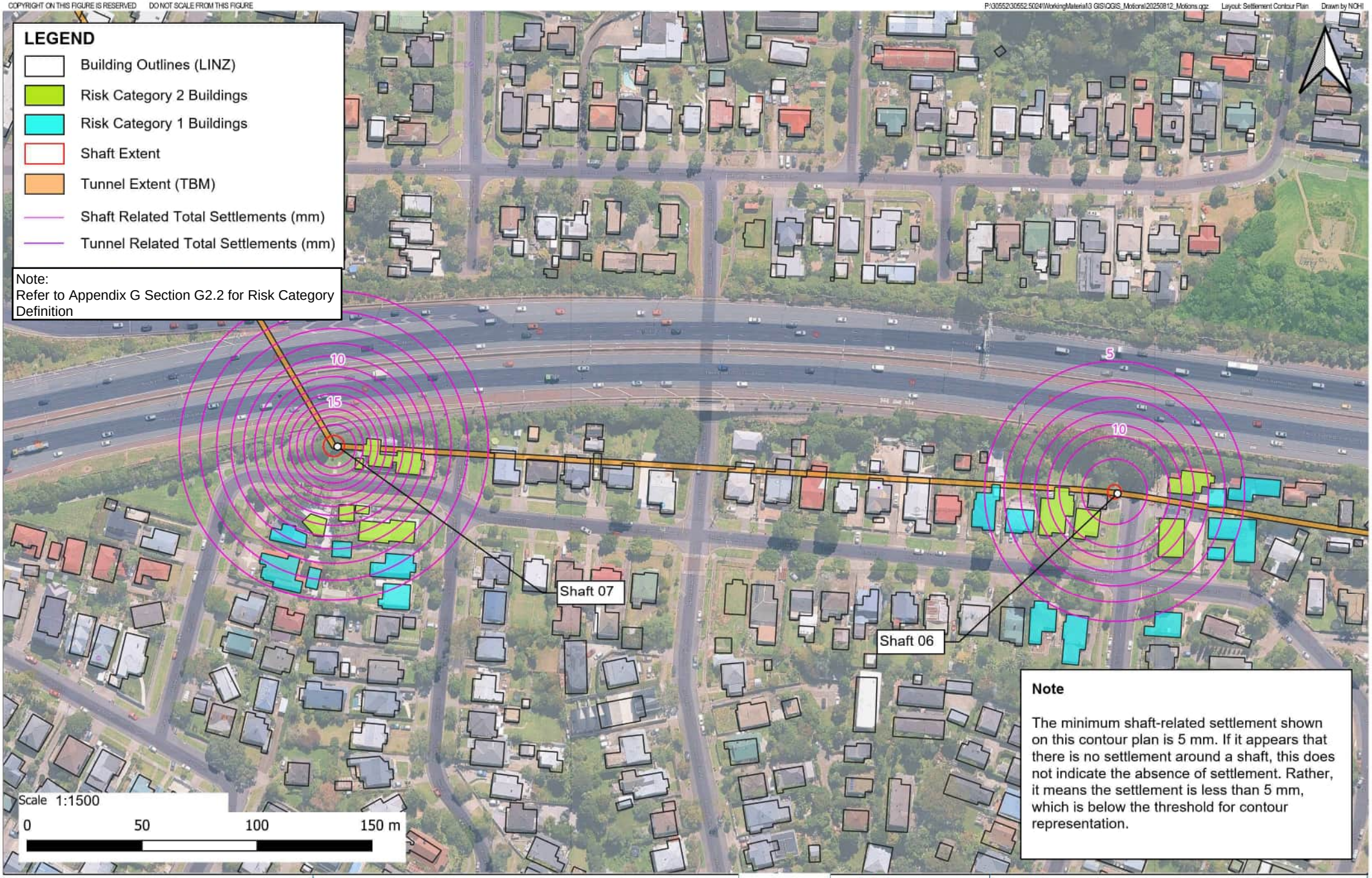

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B2
SCALE (A3) 1: 1500 FIG No. FIGURE 23 REV 0

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TITLE SETTLEMENT CONTOUR PLAN
PIPE JACKING OPTION B2

SCALE (A3) 1: 1500 FIG No. FIGURE 24 REV 0

Appendix J– Visual Building Summary Near Shafts

Recorded Field	Site Observation
Shaft Number	1
Address and type of use (ie residential, commercial, etc)	2a South Street
Number of levels	2
Does it have a basement?	Not Likely
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick + Timber frame
Cladding type	Corrugated Steel
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, parking lot at rear. Fair condition

Recorded Field	Site Observation
Shaft Number	1
Address and type of use (ie residential, commercial, etc)	17 South Street
Number of levels	2
Does it have a basement?	Under structure parking not underground
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick + Concrete
Cladding type	Brick + Glazing
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Pile
Any notable retaining structures	Small pile wall supporting path near driveway
Any notable driveways/pathways and general condition	Yes, driveway to under structure parking lot, good condition

Recorded Field	Site Observation
Shaft Number	1
Address and type of use (ie residential, commercial, etc)	29 East Street
Number of levels	3
Does it have a basement?	Under structure parking not underground
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Concrete beam and columns
Cladding type	Brick + Glazing + aluminium panel
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Carpark underneath structure, good condition

Recorded Field	Site Observation
Shaft Number	1
Address and type of use (ie residential, commercial, etc)	27 East Street
Number of levels	2
Does it have a basement?	No
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber boards
General conditions (poor, good, excellent)	Good
Likely foundation type	Strip/Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	22 Buchanan Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame + Brick
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Piles
Any notable retaining structures	Yes, Timber pile wall nearby to driveway
Any notable driveways/pathways and general condition	Yes, very steep into property, good condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	24 Buchanan Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Pile
Any notable retaining structures	Yes, bounding neighbours property
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	**3**
Address and type of use (ie residential, commercial, etc)	26 Buchanan Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Plaster + Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Pile
Any notable retaining structures	Yes, bounding neighbours property
Any notable driveways/pathways and general condition	Yes, Good condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	28 Buchanan Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Poor
Likely foundation type	Pile
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	30 Buchanan Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Pile
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	14 Mostyn Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Pile
Any notable retaining structures	Yes, Masonry retaining wall, currently leaning
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	16 Mostyn Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Strip/Slab
Any notable retaining structures	Yes, rock matrix retaining wall, good condition
Any notable driveways/pathways and general condition	Yes, small parking space in front, good condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	18 Mostyn Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Strip/Slab
Any notable retaining structures	Yes, Timber pile wall and masonry block wall at front of property, both in good condition
Any notable driveways/pathways and general condition	Yes, small parking space in front, good condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	20 Mostyn Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Strip/Slab
Any notable retaining structures	Yes, masonry retaining wall on boundary to 19 Mostyn
Any notable driveways/pathways and general condition	Yes, fair condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	21 Mostyn Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Fair
Likely foundation type	Piles
Any notable retaining structures	Yes, Stone wall at rear of structure
Any notable driveways/pathways and general condition	Yes, fair condition, cracked

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	22 Mostyn Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Strip/Slab
Any notable retaining structures	Small pile wall at road side
Any notable driveways/pathways and general condition	Yes, fair condition

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	23 Mostyn Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Piles
Any notable retaining structures	Yes, Pile wall, supporting driveway
Any notable driveways/pathways and general condition	Yes, fair condition, mismatched repair

Recorded Field	Site Observation
Shaft Number	3
Address and type of use (ie residential, commercial, etc)	25 Mostyn Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick + Timber Frame
Cladding type	Plaster + Faux Brick façade
General conditions (poor, good, excellent)	Poor
Likely foundation type	Strip/Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, Fairly sloped, good condition

Recorded Field	Site Observation
Shaft Number	4
Address and type of use (ie residential, commercial, etc)	24 Central Road
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Fair
Likely foundation type	Pile
Any notable retaining structures	Masonry wall at rear
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	37 Kingsland Road
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Poor
Likely foundation type	Piles
Any notable retaining structures	Yes, short concrete wall
Any notable driveways/pathways and general condition	Yes, fair condition

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	39 Kingsland Road
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Piles
Any notable retaining structures	Yes, short concrete wall
Any notable driveways/pathways and general condition	Yes, poor condition

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	41 Kingsland Road
Number of levels	1
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Fair
Likely foundation type	Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	48 Kingsland Road
Number of levels	1
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Piles/Slab
Any notable retaining structures	Yes, small wooden pile wall
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	50 Kingsland Ave
Number of levels	1
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Piles
Any notable retaining structures	Yes, difficult to see behind fence
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	5
Address and type of use (ie residential, commercial, etc)	52 Kingsland Ave
Number of levels	1
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, cracked

Recorded Field	Site Observation
Shaft Number	6
Address and type of use (ie residential, commercial, etc)	1 Levonia Street
Number of levels	1.5
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Fair – Good
Likely foundation type	Piles + Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	6
Address and type of use (ie residential, commercial, etc)	3 Levonia Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, cracked

Recorded Field	Site Observation
Shaft Number	6
Address and type of use (ie residential, commercial, etc)	67 Finch Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Excellent
Likely foundation type	Slab + Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, good condition

Recorded Field	Site Observation
Shaft Number	6
Address and type of use (ie residential, commercial, etc)	69a Finch Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Plaster
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab on grade
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, fair condition

Recorded Field	Site Observation
Shaft Number	7
Address and type of use (ie residential, commercial, etc)	17 Myrtle Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	7
Address and type of use (ie residential, commercial, etc)	26 Myrtle Street (Garage)
Number of levels	1
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick
Cladding type	Brick
General conditions (poor, good, excellent)	Fair
Likely foundation type	Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	7
Address and type of use (ie residential, commercial, etc)	30 Myrtle Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	9
Address and type of use (ie residential, commercial, etc)	23 Edinburgh Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick
Cladding type	Plaster
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab/Pile
Any notable retaining structures	None
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	9
Address and type of use (ie residential, commercial, etc)	27 Edinburgh Street
Number of levels	2
Does it have a basement?	Yes
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick + Precast concrete
Cladding type	Plaster
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab
Any notable retaining structures	Yes, small pile wall at rear of structure
Any notable driveways/pathways and general condition	Yes, fair condition private parking

Recorded Field	Site Observation
Shaft Number	10
Address and type of use (ie residential, commercial, etc)	19 Gundry Street
Number of levels	1.5
Does it have a basement?	Potentially ½
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Brick + Concrete panels
Cladding type	Plaster
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Pile
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, at front servicing carpark at rear

Recorded Field	Site Observation
Shaft Number	13
Address and type of use (ie residential, commercial, etc)	43 Cooper Street
Number of levels	2
Does it have a basement?	None
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Fair – Poor
Likely foundation type	Strip
Any notable retaining structures	Yes, medium sized pile wall around the property
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	12A
Address and type of use (ie residential, commercial, etc)	14 & 14B Fleet Street
Number of levels	2.5
Does it have a basement?	Potentially ½
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Timber frame
Cladding type	Timber board
General conditions (poor, good, excellent)	Poor
Likely foundation type	Slab + Piles
Any notable retaining structures	Yes, Pile wall at rear
Any notable driveways/pathways and general condition	None

Recorded Field	Site Observation
Shaft Number	12A
Address and type of use (ie residential, commercial, etc)	15 Fleet Street
Number of levels	5
Does it have a basement?	Potentially
Likely principal construction material (ie timber frame, steel frames, masonry block etc)	Concrete + Brick
Cladding type	Mixed: Weatherboard, concrete, plaster
General conditions (poor, good, excellent)	Good
Likely foundation type	Slab + Piles
Any notable retaining structures	None
Any notable driveways/pathways and general condition	Yes, two in fair condition