REPORT

Tonkin+Taylor

Downtown West - Downtown Car Park Redevelopment

Geotechnical and Groundwater Assessment Report

Prepared for
Precinct Properties Holdings Limited
Prepared by
Tonkin & Taylor Ltd
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Executive summary

Precinct Properties Holding Limited (Precinct) has engaged Tonkin and Taylor Limited (T+T) to provide conceptual geotechnical, environmental engineering, civil and infrastructure consultancy services for the proposed Downtown West – Downtown Car Park Redevelopment. This report presents the concept geotechnical design and groundwater assessment for the development of the Downtown Car Park site as per our proposal dated 14 February 2023, with the key findings and conclusions summarised in the table below.

Sections within the main body of the report contains further information and discussion, which puts into context the findings that are encapsulated within this summary. The findings and conclusions presented in this concept report will be updated during the next stage of design.

Key Consideration	Key findings and conclusions
Ground and groundwater model	The ground conditions beneath the Downtown Carpark site generally consists of Reclamation Fill, marine sediments and Tauranga Group sediments overlying East Coast Bays Formation (ECBF) rock. The elevation of the rock typically varies between RL -2 m on the south-east corner to RL -7 m over the north-west portion of the site. A 6-level basement is estimated to be at least 7 m below the deepest rock level. 5-levels of basement extend across the site footprint with the finished floor level for the 5th level at RL -14.3 m and the base of the excavation assumed to be at RL -16.3 m to accommodate the basement slab and over excavation for the foundation works. Basement level six accommodates the lift pits and water tanks, with the excavation level for these works extending up to RL -21 m. Groundwater levels for concept design are based on groundwater monitoring from the Quay Street Seawall strengthening project to the north, Commercial Bay and CRL tunnel projects to the east. The groundwater regime for the site is governed by the presence of the Waitemata Harbour 50 to 150 m north of the site, and in particular tidal recharge through service conduits. The site may also be impacted by the infilling of the graving dock and the conduit it may provide to the Waitemata Harbour. For concept design, a design static groundwater level has been adopted at **RL 1.4 m**. An elevated groundwater level has been adopted at **RL 2.5 m**. Further information on the ground and groundwater model is provided in **Section 3.** Both the ground and groundwater models will be confirmed in subsequent design phases through additional site-specific geotechnical investigations.
Retaining wall type for basement excavation	Sheet pile walls and diaphragm walls have been considered to retain the proposed basement excavation for concept design. Key requirements for the concept design include: • Top-down construction at the northern end of the site utilising permanent floor slab and temporary diagonal props. The permanent floor slab used to prop the northern side will extend part way along the north-eastern and north-western boundaries to transfer the loads acting on the floor slab from the northern wall. • Bottom-up construction for the remaining portion of the site providing access to the excavation from the south. • Anchored sheet piles along the southern and south-eastern sides of the site where rock is shallow (typically between RL -2 to -4 m). To achieve groundwater cut-off, the sheet piles are proposed to be embedded a minimum 1 m into the ECBF rock. The exposed rock face will be spot bolted and meshed as required. • 800 mm wide diaphragm wall that is either tied back using anchors or internally propped for the remaining excavation sides where rock is deeper. The

Key Consideration	Key findings and conclusions
	diaphragm wall is proposed to be full depth and taken a minimum 4 m below the base of the excavation (i.e. at least to RL -20.3 m). Further discussion and details for the proposed retention solution is provided in **Section 4.4**. Note there remains an option to use diaphragm wall instead of the proposed sheet piles or consider other retention options (such as secant pile walls), as the design for the overall development develops. The retaining wall options will be developed further in subsequent design phases.
Assessment of deformation and settlement effects	The potential for surface deformation of the surrounding ground due to the development has been assessed, with the key findings as follows. • The estimated ground settlement below neighbouring structures is estimated to be less than 12 mm, with differential gradients generally less than 1V:500H. Risk Category 1 in accordance with CIRIA PR30, with negligible damage to surrounding buildings expected due to the proposed development. • Total settlement less than 20 mm is estimated for surrounding pavement and underground services. The differential gradients, from settlements where services are oriented perpendicular to the excavation, are likely to be less than 1V:1,000H and is within the allowable tolerance for the various types of underground services surrounding the site.
Earthworks and construction considerations	The soil and rock materials are excavatable using conventional equipment and plant. Due to the complex historical land-use of the site, in-ground obstructions can be present in the form of cobbles, boulders and construction waste in the reclamation fill, remnants of the graving dock, old seawalls and associated structures, reinforced concrete piles for the existing Downtown Carpark building, and remnant foundations of historical commercial and workshop buildings that occupied the north-western and south-eastern portions of the site. Noise and vibration, due to driving of sheet pile walls, will also need to be considered as part of the construction noise and vibration monitoring plan.

1 Introduction

Precinct Properties Holding Limited (Precinct) has engaged Tonkin and Taylor Limited (T+T) to provide conceptual geotechnical, environmental engineering, civil and infrastructure consultancy services for the proposed Downtown West – Downtown Car Park Redevelopment (Downtown West).

This report presents the concept geotechnical design and groundwater assessment for the development of the Downtown Car Park site as per our proposal dated 14 February 2023. This report is intended to be used to support the Resource Consent application for Downtown West and should be read in conjunction with the civil infrastructure and flooding concept design report and the preliminary contaminated land site management report.

1.1 Scope of work

This concept geotechnical report is based on a desk study of existing geotechnical and groundwater information available at and near the site and our historical knowledge of the site and surrounding areas. Site-specific geotechnical investigations will be undertaken in subsequent design phases to confirm the ground and groundwater conditions assumed for the concept design.

The scope of work that has been undertaken for this concept design is as follows.

1 Development of preliminary ground and groundwater models using existing geotechnical information.
2 Development of preliminary soil and rock parameters for concept design.
3 Development of conceptual retaining wall types for the basement excavation, and a discussion of benefits and limitation of each retaining wall type for the site-specific constraints.
4 Development of conceptual foundation types and foundation capacities for preliminary geotechnical and structural design.
5 Preliminary assessment of effects due to the basement excavation on surrounding structures including impact of groundwater drawdown.
6 Discussion of construction methodologies and construction considerations.
7 Recommendations for geotechnical investigations during the preliminary design phase and further work required during subsequent design stages.

A draft groundwater and settlement monitoring and contingency plan has also been prepared for the site and is provided in Appendix B.

The current understanding of the proposed development is provided in Section 1.3 below. The geotechnical design for the redevelopment will be developed in parallel to the architectural, structural, civil and infrastructure design of the development.

1.2 Site description

The Downtown West site is located at 2 Lower Hobson Street, at the corner of Lower Hobson Street and Customs Street West within the Auckland CBD (legal description Lot 9 DP 60151. The proposed site to be developed is approximately 6,442 m^2 in area, with the site on land reclaimed in stages between 1850 and 1920 by the Auckland Harbour Board.

The site is relatively level, with the ground surrounding the site varying from RL 4 m to RL 5 m. A 9-storey (1 below ground level and 8 suspended floors) public carpark building known as the Downtown Carpark currently occupies the site. The carpark building was designed in 1968 and the concrete superstructure is supported on belled reinforced concrete piles with precast flooring. The building is approximately 70 m wide (parallel to Customs Street West) and 88 m long (parallel to Lower Hobson Street). The building is surrounded by MSocial Hotel immediately to the north, HSBC

and Aon Towers to the east, Custom Street West and Lower Hobson Street to the south and west respectively. Figure 1.1 shows the location of the site. The historical Tepid Baths are located across Lower Hobson Street to the west.

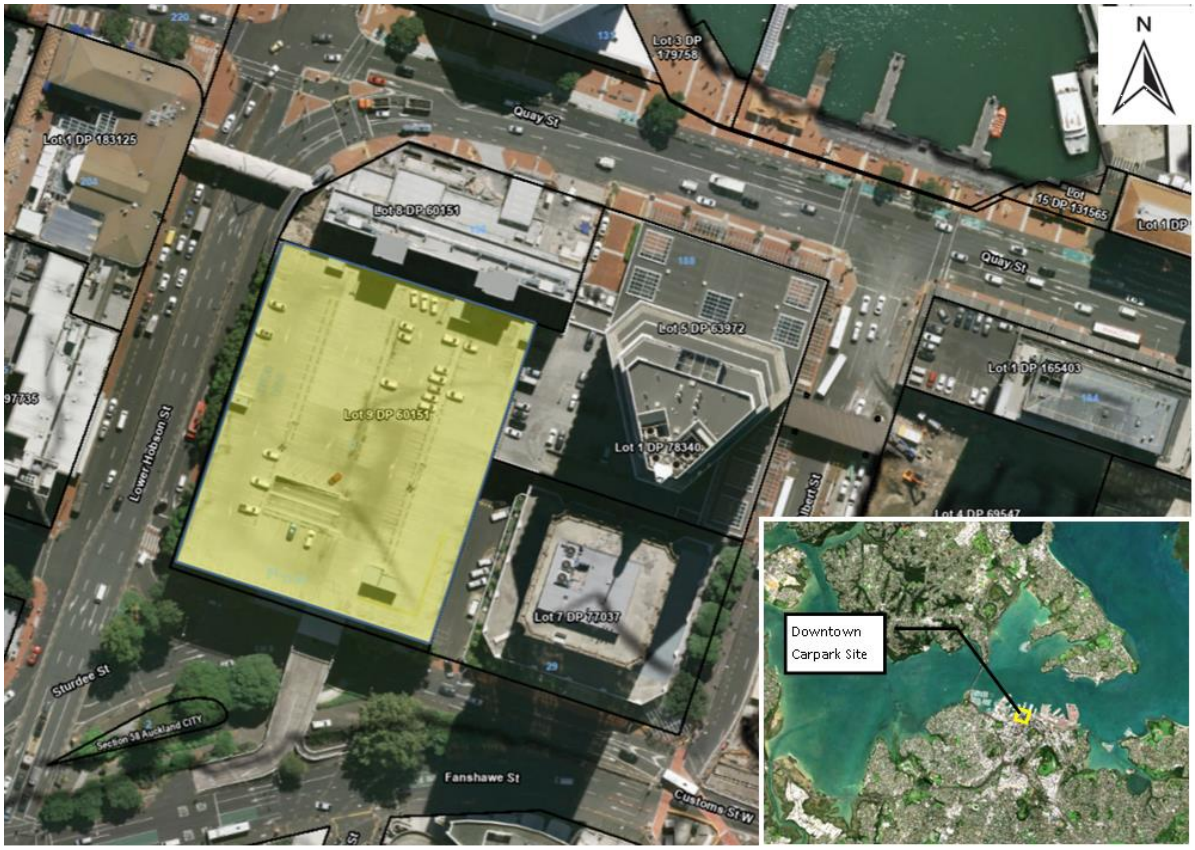

Figure 1.1: Downtown West site.

1.3 Proposed development

The proposed development includes the demolition of the existing downtown carpark building (together with the Lower Hobson Street pedestrian bridge and Customs Street West vehicle ramp located within part of the road reserve) and redevelopment of the site to provide for a mixed-use precinct providing for commercial, residential, retail, food and beverage and civic uses. The redevelopment involves three podium buildings, two towers and six levels of shared basement, including new public spaces and a new laneway network to provide connectivity within the city centre. In addition, the proposed development involves modifications to the podia of existing adjacent buildings (HSBC and AON) to facilitate the new laneway network.

The basement floor levels, and footprint are based on the Proposed Architectural Drawings for Resource Consent provided by the Architect, Warren and Mahoney and dated 9 December 2024. The following design floor levels have been adopted for this assessment:

- B5 Basement Level: FFL -14.3 m RL.
- B4 Basement Level: FFL -9.7 m RL.
- B3 Basement Level: FFL -5.1 m RL.
- B2 Basement Level: FFL -2.1 m RL.
- B1 Basement Level: FFL +0.90 m RL.
- GF Level: FFL +4.5 m RL.

An excavation level to -16.3 m RL has been adopted to allow for the basement slab and any over excavation.

An additional basement level B6 accommodates lift pits and water tanks, with the finished floor level for the lift pits and water tanks varying from FFL -17.3 m to FFL -19.8 m. The excavation for B6 level is located away from the perimeter of the site. It has been assumed that the excavation may need to extend up to -21.0 m RL to accommodate these works.

2 Site history

Historical information relating to the site has been collected from a variety of sources including the Auckland Council property file, site contamination enquiry, historical aerial photographs, archaeological assessments, and T+T project archives. This history focuses on on-site activities, except for the aerial photograph review where comments are also provided on readily observable surrounding land use. The information reviewed is summarised in the following sections.

2.1 Archaeological information

Reclamation to provide additional land, in addition to deeper harbours, was a central part of the early vision for Auckland. Figure 2.1 shows the original coastline relative to the subject site.

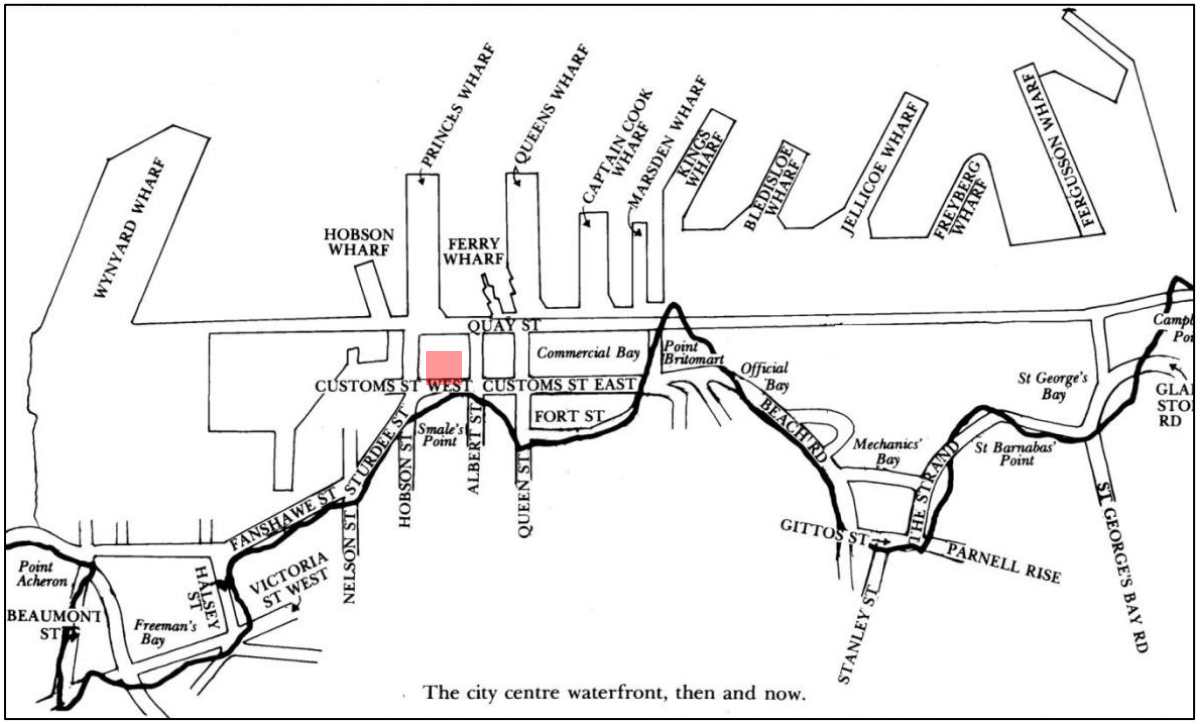

Figure 2.1: Reclamation and historical features in project area (from Barnett, 1981[1]).

Archaeological assessments completed by Clough & Associates[2,3,4] provide detailed accounts of the history of Auckland CBD, including the process of reclamation. The key findings are summarised below:

- Reclamation has been carried out in stages since the 1850s, with the first major reclamation to infill the area between Fort Street and Custom Street East starting in 1859. The process of construction involved creation of a seawall along what is now Customs Street East, with the use of material from Smales Point (the western headland) to provide fill.
- Throughout the 1870s, and early 1880s, a basalt sea wall along present-day Quay Street was constructed. Point Britomart was demolished, with manual labour (including horse drawn

[1] Barnett, S. 1981. A Picture Book of Old Auckland. Auckland: Benton Ross Ltd.
[2] Clough & Associates Ltd (2012), Key Historical Themes in the Development of the CBD Waterfront. Report prepared for Auckland Council.
[3] Clough & Associates Ltd (2014), Proposed Redevelopment, Downtown Shopping Centre, Queen Street, Auckland Central: Archaeological Assessment. Report prepared for RCP and Precinct Properties Ltd, dated October 2014.
[4] Clough & Associates Ltd (2018), Quay Street Seawall Upgrade Princes Wharf Section: Archaeological Assessment. Report prepared for Auckland Transport, dated April 2018.

carts) used to move the excess materials to points of ongoing reclamation. Dredging waste and construction debris were also noted to be used as infill.

- Throughout the 1870s-1900 existing wharves were removed, and drains constructed throughout the reclamations. Commercial/industrial buildings were constructed once the infill had stabilised, and the reclamation was complete. The site extends over an old graving dock which was backfilled, and the area above developed in the early 1900's (see Figure 2.2).

2.2 Historical aerial photographs

Historical aerial photographs from the T+T library and other sources (as shown in Table 2.1) have been reviewed. Relevant features of the site and surrounding land are summarised from each aerial photograph in Table 2.1.

Table 2.1: Summary of aerial photograph review

Date, run number and source	Key site features	Surrounding land features
1940 Auckland Council GeoMaps	Sturdee Street divides the site in a south-west to north-east alignment. The larger northern section of the site is vacant and appears to be either grass or gravel covered. Parts of it is being used for materials lay down / parking purposes. The smaller, triangular shaped southern section of the site is occupied by a single commercial building.	General port activities occupy the surrounds to the north. Commercial buildings occupy the immediate surrounds to the west, east and south.
1950 T+T Library (Run 1917 Photo 29)	A large commercial building has been established on the northern part of site.	No significant changes are evident.
1959 Auckland Council GeoMaps	No significant changes are evident.	No significant changes are evident.
1961 T+T Library (Run 3234 Photo 38)	No significant changes are evident.	No significant changes are evident.
1972 T+T Library (Run 4600 photo 11)	Sturdee Street no longer divides the site. The buildings that formerly occupied the northern and southern sections of the site have been removed and replaced by a single structure built over the entire site footprint including the former Sturdee Street road reserve.	A high rise building has been constructed immediately to the north between the site and Quay Street. And further development and construction of buildings has occurred in areas east of the site.
1980 T+T Library (Run SN5783/M14)	No significant changes are evident.	A large high-rise has been constructed immediately east of the site, replacing the smaller buildings that were established sometime between 1940 and 1950.
1987 T+T Library (Run SN8772/K4)	For the first time vehicles are visible parked on the roof of the building but no significant changes are evident.	Some redevelopment of buildings to the north and west, but no other significant changes are evident.

Date, run number and source	Key site features	Surrounding land features
1996 Auckland Council GeoMaps	No significant changes are evident.	Some redevelopment of buildings to the west, but no other significant changes are evident.
2001 Auckland Council GeoMaps	No significant changes are evident.	PWC tower, adjoining the sites north-eastern corner, is under construction.
2003 to 2016 Auckland Council GeoMaps	No significant changes are evident.	No significant changes are evident.
2017 Auckland Council GeoMaps	No significant changes are evident.	Former Downtown Shopping Centre has been removed and redevelopment of the site, located to the east, is underway.

2.3 Council property file review

The following information was identified during review of the property file:

- An undated plan hand annotated with dates from 1911 and 1912 show a “dock” covers most of the site. This is consistent with Ports of Auckland records and early photographs of Auckland City T+T has obtained for other projects which indicate that a boat graving dock (dry dock) was originally constructed at the site in the 1870s. The graving dock was subsequently infilled, prior to the reclamation of Quay Street (between Princess Wharf and the site) in 1923. Figure 2.2 below provides the timeline for the construction and reclamation of the graving dock.
- Plans dated from 1911 through 1947 show that a 3 level “warehousing” building occupied the south-eastern corner of the site, to the south of the graving dock and Sturdee Street. The Harbour Board workshops were also constructed in the north-western corner in the early 1940s.
- Plans dated 1968 show the proposed development of a “Car Parking Station” for Auckland City Council. The building includes 8 levels of parking, including the basement and roof levels, with a “service station” shown to occupy the south-western corner of the ground floor.
- Plans dated 1970 prepared for Shell Oil New Zealand Limited show the general layout of the “Downtown Service Station” within the “Downtown Parking Building”.
- Correspondence dated 1973 and 1975 refer to the transfer of the service station operations from “Dock Site Service Centre Ltd.” To “Paine Services Ltd.” With the addition of a rental vehicle operation, including “a limited amount of servicing of rental vehicles”.
- A dangerous goods license dated 1996 refers to the removal of 2 underground tanks, of 13,000 and 18,000 litre capacities, from a site occupied by “Downtown Auto Services”. The site is noted as being used as “Service station” with the future use proposed to be a “Garage”.
- Subsequent records relate to:
  - Alterations to the former service station/garage area for occupation by various restaurants and bars.
  - A barbers shop is noted as occupying a tenancy within the wider site.
  - Various alterations and improvements, including the addition of two floors, to the car parking facilities.

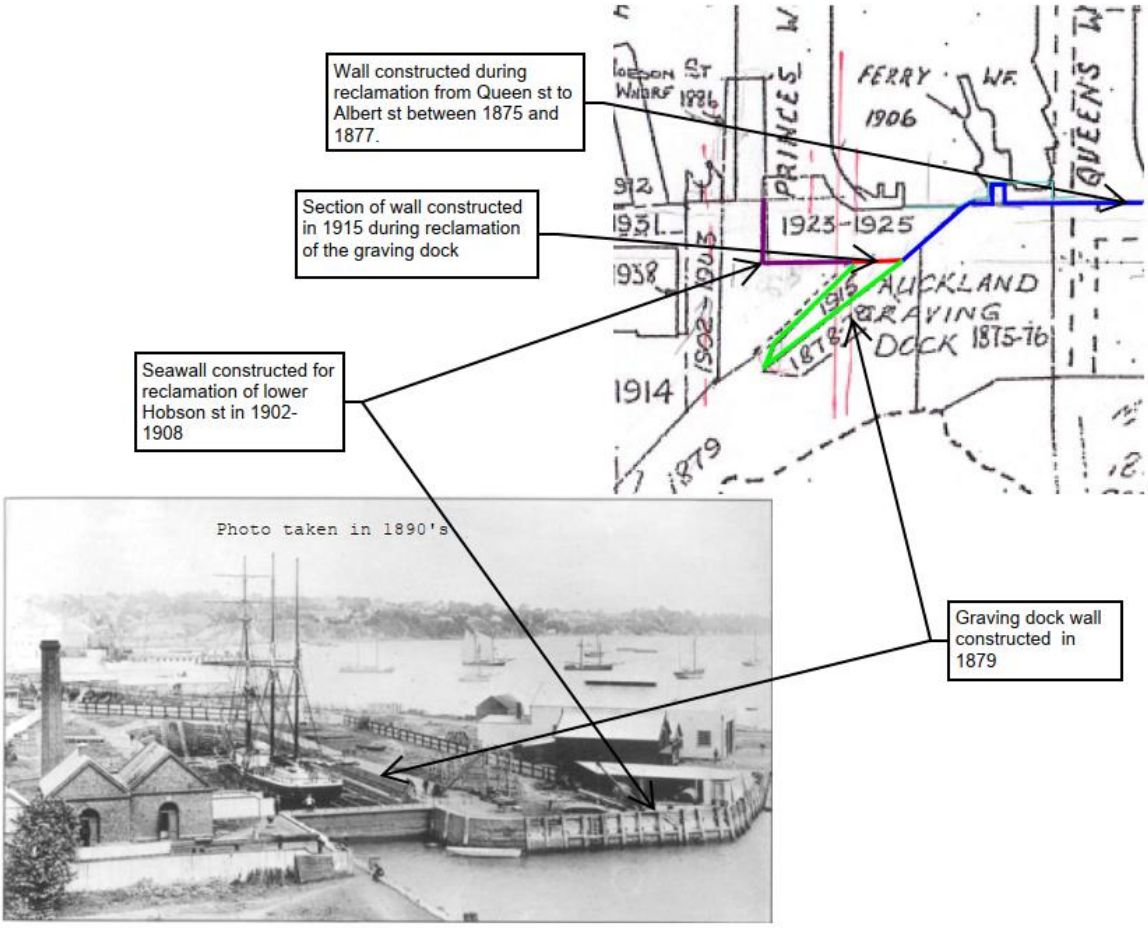

Figure 2.2: Construction and reclamation of the graving dock at the site.

2.4 Existing structure and remnant foundations

The existing carpark was designed in 1968 and comprises a concrete super structure with precast flooring and is founded on belled reinforced concrete piles. The ground floor of the structure is staggered where the south half is at a lower elevation than the north half. Building records indicate that the ground floor of the structure is a concrete slab on-grade, with some Fill likely beneath the floor slab.

The original 1968 design drawings show the length of piles are between 5.6 to 13.9 m, the shaft diameters are between 0.9 to 1.4 m and the bell diameters are between 1.5 to 2.3 m. These design drawings indicate that the pile lengths were to be adjusted during construction based on actual depth of rock. Based on geotechnical investigations in the area and the inferred elevation of the East Coast Bays Formation (ECBF) rock surface, and assuming a typical pile embedment of 3 m in the (ECBF) rock, the total pile lengths are estimated to vary between 6 m to 11 m. Pile lengths typically increase towards the north and west with the longest piles located in the northwest corner of the building where the depth to rock is deepest.

Design drawings for the existing Downtown Carpark structure showing the foundation layout are provided in Appendix C.

Prior to development of the Downtown Carpark structure, it is understood two multi-level structures occupied the site in south-east and north-west corners with the site split diagonally through the centre by Sturdee St. It is possible remnant foundations from these structures will still be present

below the site. Available records for the south-eastern structure (Appendix C) indicate the structure was built on shallow pad foundations. No records are available for the north-western structure, but it is likely to have been founded on driven timber pile foundations.

The majority of the piles will be exposed during the basement excavations but, where they conflict with the perimeter retaining walls or building piles installed from existing ground level, the piles may need to be removed to enable the new works.

3 Geotechnical model

3.1 Historical site investigations

Existing geotechnical and groundwater investigations at and near the Downtown West site have been used to develop a preliminary ground model for concept design, including:

- 8 No. machine drilled boreholes that were undertaken within the Downtown West footprint prior to construction of the existing carpark building in 1968.
- 2 No. machine drilled boreholes undertaken within the Downtown West footprint for the seismic assessment of the existing carpark building in 2020.
- Investigations at adjacent sites including investigations for the Millennium and Copthorne Hotels (now the MSocial Hotel) to the north, investigations for the Quay Street Seawall strengthening, and investigations for the development of the HSBC, AON, Commercial Bay developments, Watermark (85 Custom Street West) and Tepid Baths.

Existing groundwater monitoring information include groundwater levels measured using standpipe piezometers and vibrating wire piezometers over a period varying from 3 months to 3 years. The groundwater monitoring from the Quay Street seawall strengthening, Commercial Bay development and the CRL cut-and-cover tunnel excavation works has been used for this concept design.

A plan showing existing site investigations in the vicinity of the site is provided in Appendix A.

The ground and groundwater model for this concept design report was also supported by our historical knowledge of the area based on geotechnical and ground contamination assessment we have carried out in the vicinity between 1999 to 2022. An outline of these relevant works in the area are summarised in Table 3.1 below.

Table 3.1: Previous T+T investigations in the vicinity of the Downtown West.

Site	T+T Job Reference	Information sources
PwC Tower	16930	AMP Waterfront Tower Project – Geotechnical Report. Report prepared for AMP Asset Management Ltd, dated 1999.
Quay Street	28557.002	Quay Street Seawall Geotechnical and Ground Contamination Assessment. Report prepared for Auckland Transport, dated September 2012.
Copthorne Hotel	29493.1000vA	Ground Contamination Assessment, 196 Quay St, Auckland. Report prepared for Millennium & Copthorne Hotels NZ Ltd, dated November 2014. T+T reference no. 29493.1000; and Site Management Plan for Ground Contamination, 196 Quay St, Auckland. Report prepared for Millennium & Copthorne Hotels NZ Ltd, dated December 2014.
Tepid Baths	26753.001	Tepid Baths Redevelopment Geotechnical Report. Report prepared for Auckland City Council, dated September 2010.
West Plaza Centre, Albert Street	24700	3-15 Albert Street, Auckland Central, Geotechnical and Ground Contamination Desk Study Report. Report prepared for West Plaza Centre Limited, dated August 2007.
Precinct Downtown Shopping Centre	30108.3000v3	Downtown Development, Auckland, Preliminary Ground Contamination Assessment. Report prepared for Precinct Properties New Zealand Limited, dated January 2015.
Downtown Carpark	1012134	Downtown Carpark, Rock Level Investigation. Report prepared for Auckland Transport (AT), dated September 2020.

3.2 Geological setting

The ground conditions beneath the Downtown West generally consists of Reclamation Fill, marine sediments and Tauranga Group sediments overlying East Coast Bays Formation (ECBF) rock. The nature of these units is discussed in more detail in Section 3.3.

The geological boundary for the ECBF near the surface is located south of the site and is broadly consistent with the original "coastline" or cliff" that was shown in Figure 2.1. In addition, the geological map for Auckland shows Late Pliocene to mid-Pleistocene pumiceous river deposits belonging to the Tauranga Group immediately to the south of the site and Auckland Volcanic Field deposits consists of basalt and ash south east of the site.

Figure 3.1 presents an extract from the 1:250,000 geological map for the Auckland area is provided below showing the high-level geological setting in the vicinity of the site.

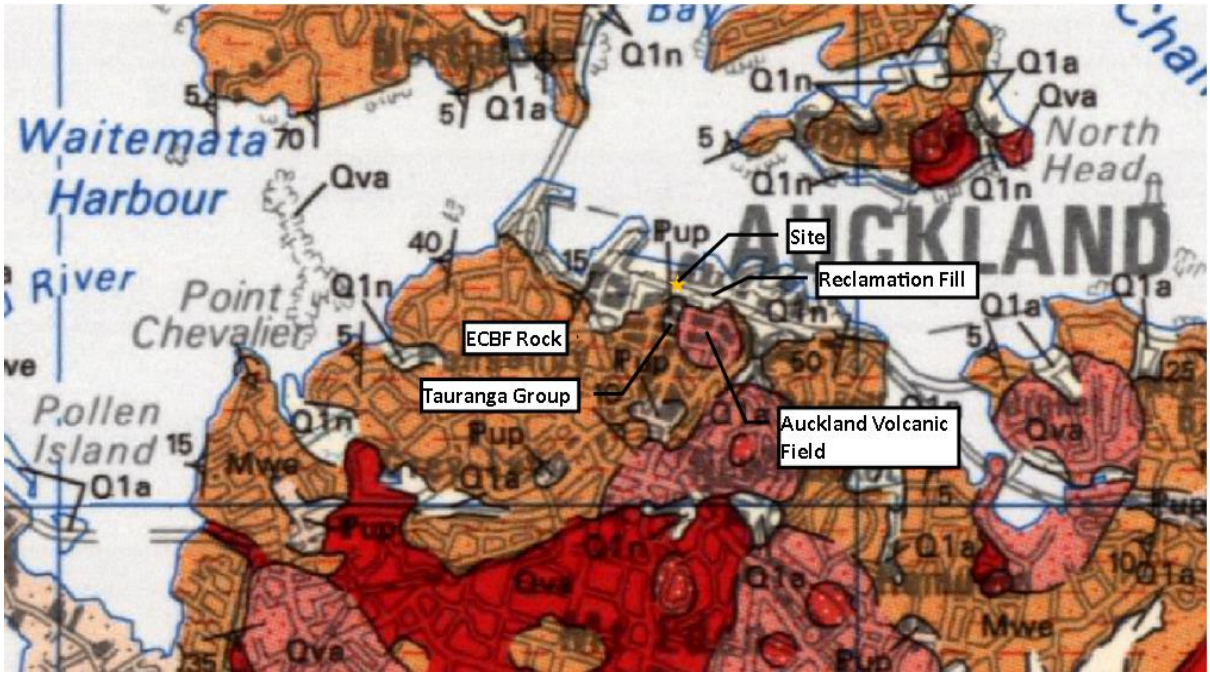

Figure 3.1: 1:250,000 Geological map of the Auckland area (Edbrooke, 2001).

3.3 Ground model

Based on historical investigations available at and near the site, the underlying ground conditions broadly consist of:

- Reclamation Fill; overlying.
- Recent marine sediments and Alluvium from the Tauranga Group; overlying.
- East Coast Bays Formation from the Waitemata group.

A discussion of each of the above units is provided below. Preliminary geotechnical cross-sections showing the variability in ground conditions is provided Appendix A. Note that the nature and continuity of the subsoils away from investigations locations is inferred, and it must be appreciated that actual conditions could vary from the assumed model. Further site investigations are proposed in the preliminary design stage to refine the geotechnical cross-sections presented here further.

Geotechnical parameters that have been adopted for the concept analysis and design are provided in Section 4.

3.3.1 Reclamation fill

Reclamation fill materials are present below ground level across the site. The thickness of the reclamation fill varies between 4 and 9 m and is generally comprised of both locally sourced and imported fill materials, dredged materials and Reclamation fill together with debris from earlier construction of seawalls and structures. The available records from boreholes within the site indicate that variable gravels, sands and soft to very stiff silts and clays will be encountered within the fill layers, with occasional basalt boulders, organics, timber, brick, porcelain, and other rubble.

As noted previously, the graving dock that was located across the site was infilled in 1923. The fill within the old graving dock was excavated from local sources of regional basement rock, typically comprising fine-grained cohesive soils (silts and clays). The old seawalls are reported to have been constructed using timber and masonry breast works constructed on rock rubble. Auckland Harbour Board drawings indicate that the graving dock walls may have later been replaced with mass concrete wall. It is unknown whether all or part of the walls were removed and to what extent any remnants of these walls were encountered during construction of the existing structure. As such, remnants of these walls may still be present at the site and encountered during the excavation of the basement for the Downtown West development, see also further discussion in Section 4.6.4.

3.3.2 Recent Marine Sediments and Alluvium (Takaanini Formation)

Tauranga Group sediments include recent marine “muds” typically comprising soft to stiff sandy silts and clays with significant organic content; and underlying Pleistocene-era alluvial sediments typically comprising soft to stiff pumiceous clays, silts and sands with some organic layers. Based on available geotechnical investigations this layer typically varies between 1 and 4 m in thickness.

3.3.3 East Coast Bays Formation rock

ECBF rock underlies the Auckland CBD, and typically comprises interbedded very weak to weak siltstone and sandstone. This unit often shows a well-developed weathering profile consisting of sands, silts and clays depending on the original parent lithology.

Historical records indicate the former sea cliffs prior to land reclamation were present to the south of the site (see Figure 2.1). The weathering profile in the top of the rock at the site has been affected by the historical coastal erosion processes in this area. The pre-European shoreline at the Downtown West site is more or less along the boundary with Customs Street, and as a result the rock in this area is highly variable, because of the presence of wave cut platforms, and possible caves and small cliffs or other steep rock interfaces. Natural Tauranga Group sediments and manmade fill were subsequently deposited over this rock surface.

3.4 Groundwater model

The groundwater model for the concept design is based on historical ground monitoring available from the Quay Street seawall, Commercial Bay development and CRL cut and cover tunnel works. The available monitoring data are discussed further below. Further site-specific ground water monitoring will be undertaken in the subsequent design phases to confirm the groundwater levels for design and construction.

Broadly the groundwater regime for the site is governed by the presence of the Waitemata Harbour 50 to 150 m north of the site, and in particular tidal recharge through service conduits. The site may also be impacted by the infilling of the graving dock and the conduit it may provide to the Waitemata Harbour. The site-specific groundwater levels are also considered to be impacted by the drained basements at the HSBC tower (formerly the PWC tower) to the east and West Plaza to the south-south east that extend below historical regional groundwater levels.

For concept design and resource consent application, groundwater levels have been adopted based on historical groundwater monitoring available in the vicinity of the site as presented in Appendix E. The monitoring results available from these positions, which include a number multi-level vibrating wire piezometer (VWP) installations, are plotted on Figure 3.2 below. The following conclusions can be drawn from the data:

- Static groundwater levels across the site up to RL 1.4 m have been observed. Groundwater pressures observed with depth across the multi-level VWP installations indicate full-hydrostatic pressures are not developed. Monitoring indicates the pressures are at approximately 85% of hydrostatic pressure.
- The groundwater levels are influenced by tides, however negligible fluctuations are observed (100 – 200 mm) within the VWP monitoring records available.
- Due to the close proximity to the harbour, it is considered that rainfall events have a negligible effect on the groundwater level but flows within fill material and stormwater pipes may locally affect groundwater levels. There is also potential for high connectivity with the harbour through open joints / faults which may be present within the ECBF rock.

For concept design, a design static groundwater level has been adopted at **RL 1.4 m**. An elevated groundwater level has been adopted at RL 2.5 m. These design cases should be confirmed by site-specific groundwater monitoring in subsequent design phase.

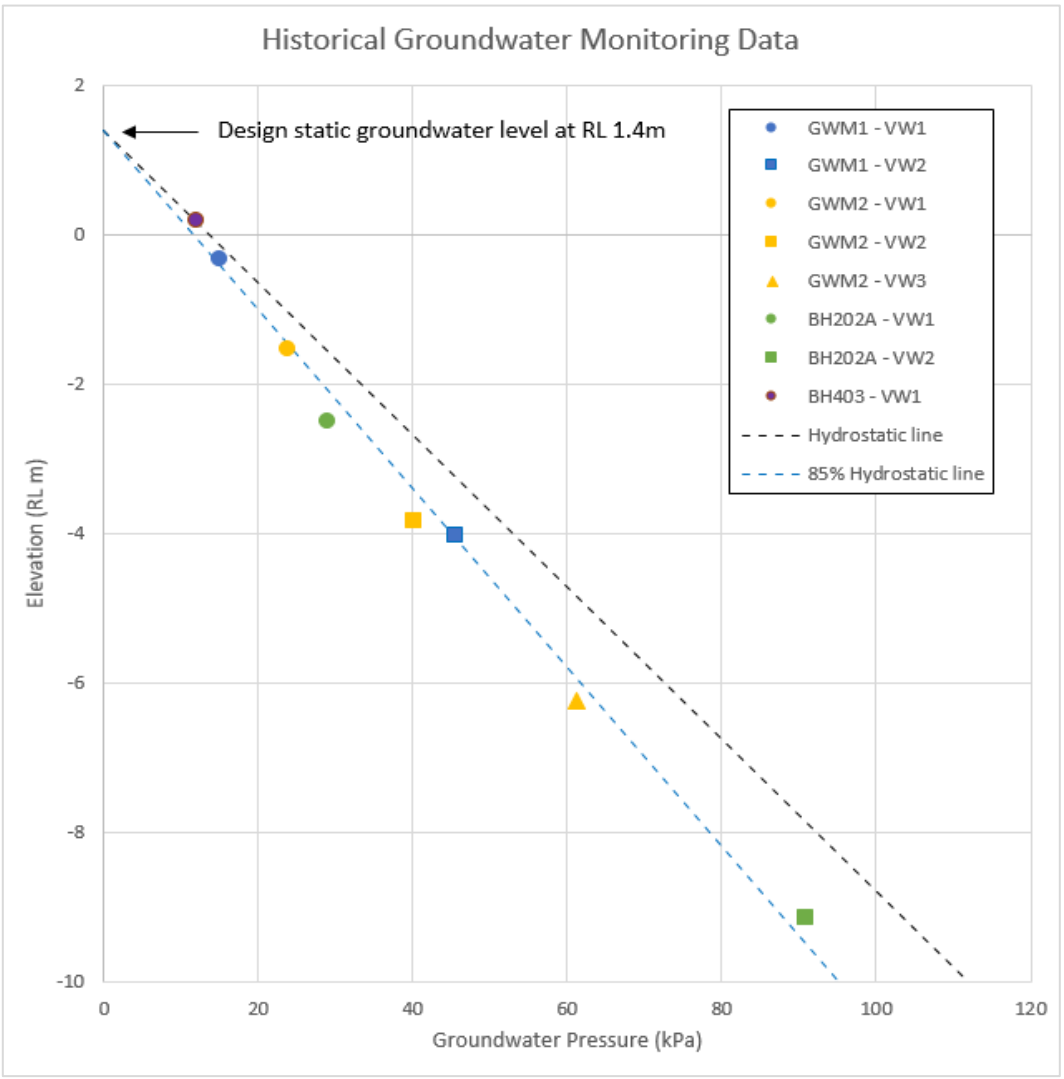

Figure 3.2: Historical groundwater monitoring records in the site vicinity.

4 Geotechnical implications for concept design

The assessment presented in this report is for the redevelopment of the site with a new structure consisting of up to six levels of basement, a podium structure over the site footprint and two towers.

For this assessment, the B5 basement, which extends over the site footprint, FFL has been assumed at RL -14.3 m. The bulk excavation level has been assumed at RL -16.3 m (allowing 1 m for basement slab and subbase, and 1 m over-excavation). The over excavation allows for site concrete, waterproofing, temporary sumps / underdrains and potential adjustments of excavation level as the design develops. This does not include local excavations for ground beams, water tanks and/or lift pits which are remote from the perimeter but may extend below this level. The likely localised excavation for water tanks and/ or lift pits has been accounted for in the groundwater drawdown assessment, with a localised excavation level of -21.0 m RL adopted. As the localised excavations are away from the perimeter walls, they are not expected to impact the retaining wall design.

For the assumptions noted above, a discussion of suitable foundation options, temporary and permanent groundwater considerations, retention options, seismic considerations and construction considerations are presented in subsequent sections.

4.1 Seismic considerations

4.1.1 Seismic shaking hazard

Seismic accelerations to be resisted by a structure are dependent upon the stiffness of the underlying soil/rock. Soft soils have the potential to amplify ground accelerations, requiring the structures built upon them to be designed to resist a higher seismic coefficient.

The ECBF rock level is expected to vary between approximate RL of -2 m to -7 m over the site footprint, and it is anticipated that the entire basement footprint would be founded upon ECBF rock (or at least <3 m weathered ECBF soil). Therefore, the site is considered to be classified as subsoil **Class B – Rock** in accordance with NZS 1170.5:2004 for the **design of building foundations**.

For the **design of retention structures** and to assess lateral actions on the basement walls, a subsoil **Class C – Shallow soil site** is considered appropriate to allow for the amplification of seismic accelerations within the retained Reclamation fill / marine sediments behind the wall.

The PGA for geotechnical design has been calculated in accordance with MBIE/ NZGS Module 1[5] and are summarised in Table 4.1 below. We have assumed a structure design life of 50 years and the new structure will be classified as Importance Level (IL) 3 to calculate the peak ground accelerations (PGA) for geotechnical design. The structure design life and IL should be confirmed with the structural engineer and architect as the design of the development progresses.

[5] MBIE/ NZGS Module 1. (2021). Overview of the guidelines.

Table 4.1: Design peak ground accelerations for geotechnical design

Design Element	Site Subsoil Class	Annual exceedance probability		PGA	Magnitude
Building Foundations	B – Rock	SLS	1 in 25	0.05	5.9
		ULS	1 in 1000	0.20 (0.19)	5.9 (6.5)
Retaining Walls	C – Shallow soil site	SLS	1 in 25	0.05	5.9
		ULS	1 in 1000	0.20 (0.19)	5.9 (6.5)

The lower bound PGA and Magnitude as per Module 1 (2021) is provided as bracketed values.

4.1.2 Liquefaction assessment

Liquefaction describes a process where significant excess pore water pressures are generated in typically loose, saturated, generally cohesionless soil during earthquake shaking, causing the soil to undergo a partial to near complete loss in strength and stiffness. The occurrence of liquefaction is dependent on several factors, including the intensity and duration of ground shaking, soil density, particle size distribution and the elevation of groundwater.

Based on our experience at the site and surrounding area, we expect thin layers within the Reclamation Fill and marine sediments may liquefy under ULS levels of earthquake shaking. Liquefaction is not expected to occur under SLS levels of earthquake shaking. Under ULS levels of earthquake shaking, typically only pockets of material are likely to liquefy and continuous liquefiable layers are unlikely to occur.

Liquefaction may occur within the soil retained by the perimeter retaining walls. Site specific investigations and more detailed analyses will be undertaken during detailed design to consider any increased lateral pressure loading on the basement walls if the surrounding material was to liquefy.

4.2 Foundation design considerations

Concept designs for the development indicate the superstructure will comprise two towers and three podium structures extending between approximately 30 m and 230 m above existing ground level, comprising up to 56 floor levels. Structures of this size will impose significant foundation loading, including large uplift loads from wind / seismic loading and groundwater uplift (where tanked basements are implemented).

The B5 and B6 basement levels are likely to be founded entirely below ECBF rock level across the site. This allows for consideration of either (or a combination of) the following foundation options:

- Shallow strip, pad or raft foundations bearing directly upon ECBF rock. Where required, ground anchors and/or tension piles may be required to resist high uplift loads.
- Piled foundations – comprising either driven steel piles or bored cast insitu concrete piles.

Further details on each option are provided in subsequent sections.

4.2.1 Shallow foundations

The subgrade across the assumed B5 and B6 basement level is anticipated to comprise of slightly to unweathered ECBF rock. Shallow foundations comprising of strip, pad or raft foundations bearing upon this stratum are considered suitable to support anticipated design loads.

A geotechnical ultimate bearing capacity of 4 MPa, with a strength reduction factor of ϕ_g = 0.5 may be used for preliminary design where the shallow foundations are directly bearing on ECBF rock. Foundations settlements are anticipated to be within typical building tolerances where the above values are adopted.

Where shallow foundations are considered, ground anchors or tension piles may be required to resist uplift loads. For the preliminary design of ground anchors that have a fixed length within ECBF rock, a geotechnical ultimate capacity of 1000 kPa, with a strength reduction factor of ϕ_g = 0.5 may be used. The minimum free length, maximum fixed length, borehole and strand diameters and the corrosion protection details for the ground anchors should be confirmed as part of detailed design.

Note the strength reduction factors noted above may be increased with site testing to prove ultimate geotechnical capacities.

4.2.2 Driven UC Piles

Driven steel UC piles embedded in ECBF rock are considered to be an appropriate founding method, although noise and vibration issues will need to be addressed as discussed further in Section 4.6.

Preliminary geotechnical design capacities for various UC pile sizes are presented in Table 4.2 below. The UCs should be driven to refusal with an appropriately sized hammer.

In accordance with AS2159[6], a strength reduction factor of ϕ_g = 0.5 should be applied to the geotechnical ultimate capacity, although the strength reduction factor could be increased to ϕ_g = 0.7 if 10% of the piles undergo Pile Dynamic Analysis (PDA) testing.

Table 4.2: Design parameters for Driven UC Piles into ECBF Rock

Pile Type	Geotechnical ultimate capacity (kN)	Maximum ULS load if PDA testing not undertaken (ϕ_g = 0.5) (kN)	Maximum ULS load if 10% of piles subjected to PDA testing (ϕ_g = 0.7) (kN)
310UC97	2,330	1,165	1,630
310UC137	3,390	1,645	2,370
310UC158	3,800	1,900	2,660
310UC198	4,750	2,375	3,325
305x305x240	5,760	2,880	4,030
356x406x287	6,890	3,445	4,820
356x406x393	9,430	4,715	6,600

Note: Larger steel sections may be used but are not available ex stock in NZ. Equipment is presently available to drive sections up to a maximum of 202 kg/m.

Installation of driven piles will generate significant noise and vibrations which will need to be considered. This is discussed further in Section 4.6.2.

4.2.3 Bored reinforced concrete pile foundations

Bored reinforced concrete piles embedded in the underlying ECBF rock are an alternative to shallow foundations. Table 4.3 presents geotechnical parameters for the design of bored pile foundations. These have been assessed based on published correlations with in-situ strength tests and our experience with similar geological units.

[6] AS2159 – 2009. *Australian Standard: Piling - Design and Installation*. SANZ

Table 4.3: Preliminary bored pile design parameters

Geological unit	Anticipated level of unit (RL m)	Geotechnical ultimate capacity (kPa)		Ultimate Limit State (ULS) capacity ϕg = 0.5 (kPa)	
		Skin friction[(2)]	End Bearing[(1,3)]	Skin friction[(2)]	End Bearing[(1,3)]
ECBF rock	-2 to -7	500 (smooth) 700 (grooved)	6,000	250 (smooth) 350 (grooved)	3,000

Notes:

1. Requires an embedment of at least 3 pile diameters into geological unit to mobilise end bearing capacity, otherwise reduce end bearing to ⅔ of recommended values

2. When assessing pile uplift capacity, a further reduction factor of 0.67 should be applied to the presented skin friction values.

3. Based on our experience with ECBF rock in Auckland CBD, including pile load testing undertaken as part of the Britomart station, a geotechnical ultimate bearing capacity of up to 8 MPa may be able to be achieved. Additional site-specific investigations and strength testing (i.e. UCS testing) will be necessary to confirm the competency of the ECBF rock at basement formation level.

Where piles are installed from current site levels, temporary support (i.e., casing / fluid support) will be required to support the Reclamation Fill, Marine sediments and Pleistocene Alluvium. Excavations with ECBF rock are expected to remain open during pile construction.

The basement retention presented in Section 4.4 has not been designed to support building loadings. Where this is proposed to be adopted also as a building foundation, the Structural engineer should review the vertical capacity and embedment accordingly.

Vertical spring stiffness values were estimated based on T+T records of testing a 600 mm diameter pile installed within very weak East Coast Bays Formation rock at a nearby site[7].

An appropriate vertical stiffness value (k_v) for grooved piles in Unweathered ECBF is 175 kPa/mm, up to a maximum displacement of 4 mm (i.e. 700 kPa/4 mm). To calculate a spring stiffness, this value should be multiplied by the corresponding pile diameter and spring spacing (nominated by the structural engineer).

Elastic shortening of the pile should be considered by the structural engineer. Based on preliminary load information, it is anticipated that elastic pile shortening will have a similar magnitude as the anticipated pile settlement/displacement.

4.3 Groundwater drawdown

4.3.1 General

The proposed six level basement excavation will extend below the groundwater and require temporary dewatering.

Dewatering of the site (and beyond) has the potential to cause settlement of the surrounding ground due to the additional pressure applied to the soil skeleton as groundwater is removed. The Reclamation fill and underlying marine deposits are considered highly compressible, and control of groundwater drawdown within these units is a key settlement risk. Groundwater drawdown within the ECBF bedrock underlying these deposits has been observed to result in negligible settlements in nearby projects such as Commercial Bay and City Rail Link (CRL).

A partially drained site is expected to be used for construction with an impermeable perimeter wall installed prior to earthworks to provide groundwater cut-off to the excavation. For concept design,

[7] Concrete Construction Group Pty (May 1998). Britomart Transport Centre Pile Load Test Report Rev 1.

the perimeter cut-off walls are to be founded within embedment into the ECBF rock to minimise potential drawdown of the overlying compressible soils. For the permanent structure, both a drained and tanked basement has been considered at this stage.

For conceptual design, a temporary excavation level has been adopted at **RL -16.3 m**, to allow for over dig, site concrete, waterproofing, temporary sumps / underdrains and potential adjustments of excavation level. Localised excavation to accommodate lift pits, water tanks etc. has also been considered for groundwater drawdown assessment (where appropriate, with a maximum excavation level of RL -21.0 m considered).

4.3.2 Methodology

Numerical analysis was undertaken using GeoStudio the finite element software package[8]. SEEP/w was used to assess the effects of the basement excavation on the surrounding groundwater regime and change in effective stress, which was then modelled in SIGMA/w to estimate ground settlement. A total of 4 No. analysis sections of groundwater drawdown and settlement have been undertaken as summarised below, and presented on Figure 4.1:

- Section 1a (West) – located at the south-west corner of the basement excavation. Modelled to assess the impact on underground services within Lower Hobson Street and Tepid Baths / Watermark Buildings. Diaphragm cut-off wall modelled.
- Section 1b (East) – located at the south-east corner of the basement excavation. Modelled to assess the impact on the neighbouring AON tower. Sheet pile cut-off wall modelled.
- Section 2a (West) – located at the north-west corner of the basement excavation. Modelled to assess the impact of excavation on underground services within Lower Hobson Street, 204 Quay Street and the MSocial Building to the north. Diaphragm cut-off wall modelled.
- Section 2b (East) – located in the north-east corner of the basement excavation. Modelled to assess the impact on the neighbouring HSBC and AON tower. Diaphragm cut-off wall modelled.

[8] GeoStudio 2021.3 SEEP/W & SIGMA/W module; version 11.2.2.23310.

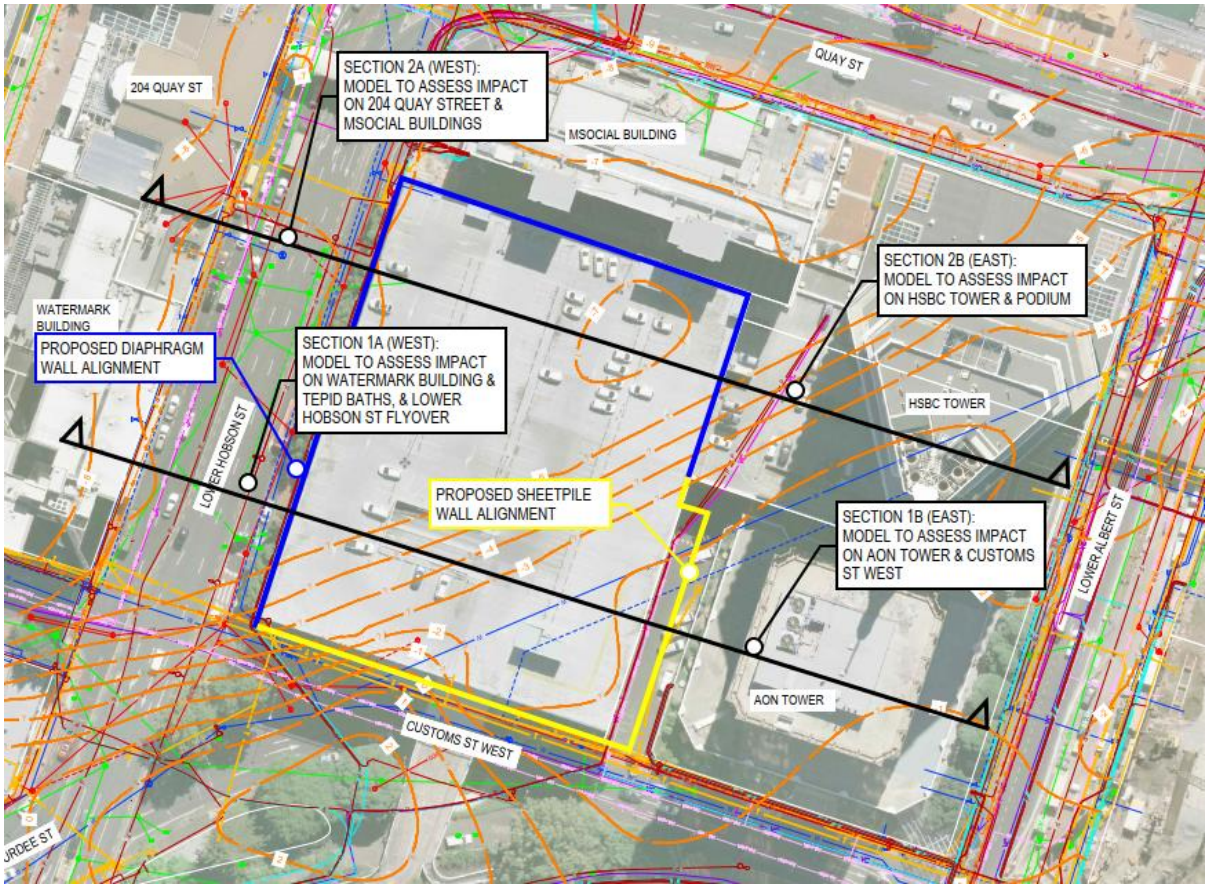

Figure 4.1: Indicative alignments of the groundwater drawdown analysis sections.

The following design cases were considered:

- Transient analysis for a 12-month drained construction period.
- Steady-state analysis for options of both a permanent drained and tanked basement.

4.3.3 Hydrogeological design parameters

Hydrogeological design parameters are presented in Table 4.4 below. These have been adopted based on the parameters derived and adopted from CRL and Commercial Bay developments in proximity to the site.

For concept design, settlements were assessed in SIGMA/W adopting 'isotropic elastic' soil models to model the stiffness of the soil / rock. Elastic modulus values were derived based on available in-situ testing from borehole and CPTs undertaken in proximity to the site, alongside our experience with similar geological units.

Table 4.4: Design parameters for groundwater and settlement assessment

Geological unit	Horizontal Permeability, k_h (m/s)	Vertical Permeability, k_v (m/s)	Equivalent Stiffness (MPa)
Reclamation Fill / Marine Sediments	3×10^{-5}	1×10^{-6}	6
Pleistocene Alluvium	2×10^{-7}	4×10^{-9}	20
Weathered ECBF	2×10^{-7}	4×10^{-9}	40
ECBF Rock	5×10^{-7}	5×10^{-8}	200

4.3.4 Initial groundwater conditions & historical drawdown

The initial groundwater conditions were defined in the SEEP/w model by applying the adopted groundwater pressures with depth at the model boundaries. The resulting modelled pre-construction groundwater levels have then been checked against available groundwater level monitoring records in the area.

When estimating potential settlements due to dewatering, it is important to allow for historical human and natural influences, otherwise settlements will likely be greatly overestimated. The historical changes in effective stresses mean that the soil has been effectively preconsolidated to some extent, and significant consolidation settlements due to groundwater drawdown are only expected to occur once groundwater decreases below previous low groundwater levels. Historical excavations at or near the site would have caused groundwater drawdown and settlement in the area of the site previously. Drawdown within this historical variation range is likely to result in negligible to minor settlements, as most consolidation settlements associated with this groundwater change have already occurred.

Given the high-density of development in the area surrounding the site, including the neighbouring 2-level basement at 188 Quay Street (HSBC Tower) and CRL tunnel excavation less than 100 m east of the site, it is anticipated significant historical drawdown / settlement has occurred.

4.3.5 Retaining wall permeability design parameters

Two wall types have been modelled for concept design:

Diaphragm Wall

An 800 mm diameter wide diaphragm wall has been modelled. The wall has been extended a minimum of 4 m below temporary excavation level to RL -20.3 m. **The design embedment of the wall will be confirmed during detailed design.**

The permeability of the walls has been modelled assuming some leakage during construction by assuming a permeability significantly greater than that of concrete. The following permeability values have been adopted:

- Construction phase: 1×10^{-10} m/s
- Permanent (i.e. where waterproofed above excavation level): 1×10^{-12} m/s (effectively impermeable)

Sheet pile walls

Sheet pile walls have been modelled in the south-east and south basement perimeter where ECBF rock is inferred to be encountered at shallower depths. The design has allowed for a minimum embedment into the ECBF rock of 1 m, which is anticipated to be achievable for a sheet pile for the

section size modelled (Arcelor AU25). A 1 m wide rock shelf and tie-back near the toe of the sheet pile has been assumed to protect the toe of the sheet pile.

For this assessment we have assumed a permeability of $k_s = 8 \times 10^{-9}$ m/s over a thickness of 0.25 m for the sheet piles. In practice, the permeability of the sheet piles will depend on the water tightness of the interlock between sheets. Leakage could occur at joints unless adequate sealants are applied to reduce flow.

4.3.6 Analysis results

Analysis results are summarised in Table 4.5 below.

Table 4.5: Summary of SEEP/W & SIGMA/W analyses

Design case		Maximum pressure head reduction (m)		Maximum Drawdown Settlement (mm)
		Surficial Deposits	ECBF Rock	
Section 1a (West)	Construction (12 months)	0.7	11.5	5
	Permanent Drained	0.7	11.4	
	Permanent Tanked	0.0	0.0	
Section 1b (East)	Construction (12 months)	0.4	18.2	2
	Permanent Drained	0.2	16.0	
	Permanent Tanked	0.0	0.0	
Section 2a (West)	Construction (12 months)	0.6	11.0	2
	Permanent Drained	0.6	11.0	
	Permanent Tanked	0.0	0.0	
Section 2b (East)	Construction (12 months)	0.3	10.7	2
	Permanent Drained	0.3	10.7	
	Permanent Tanked	0.0	0.0	

4.3.7 Hydrostatic uplift of basement slab

Where a tanked basement is adopted, the basement slab will also require assessment for hydrostatic uplift pressures should the basement be tanked. These uplifts pressures should consider potential long-term groundwater levels which may be expected over the life of the structure (i.e. sea level rise etc.).

These uplift pressures can be resisted using bored piles (refer to Table 4.3 for preliminary capacities) or through the use of tension anchors (refer Section 4.2.1).

4.3.8 Groundwater inflows

Inflow estimates are provided in Table 4.6 below.

Table 4.6: Construction stage and permanent groundwater inflows

Wall Type	Design inflow (assuming 90 m x 70 m floor area) (m^3/day)
Sheet Pile + ECBF open-cut	30 to 60
Diaphragm wall (full-length)	20 to 40

The upper range for construction allows for typically higher rates of inflow observed shortly after excavation has occurred while the lower rate is more typical summer conditions. Inflow rates exclude surface water and rainfall, which should be assessed separately. Groundwater stored within the soil material will also drain as the material is excavated and an allowance should be made to capture this as the excavation proceeds.

While significant inflows during construction through walls can be sealed (grouted) as the excavation progresses, groundwater inflows into the excavation could be significantly affected by the quality of the diaphragm and sheet pile wall construction. This risk can be mitigated by adopting good construction practices (such as sufficient overlap between the joint between the diaphragm and sheet pile wall) to ensure groundwater cut-off is achieved.

Significant inflows may occur due to presence of persistent faulting / open joints within the basement excavation which provide connectivity to the Waitemata Harbour, as was encountered during the Britomart Station excavation. If encountered, grouting of these features would be required to stop the flow, which may add significant cost / time delay to the project.

Where a fully drained basement is considered, an underdrainage system should be installed discharging via gravity or pumping to a reticulated stormwater system suitable to discharge groundwater flows estimated in Table 4.6 above. This drainage system should be designed by a suitably qualified engineer, and may typically comprise of:

- Minimum 200 mm thick permeable hardfill layer across the basement slab.
- 200 mm deep by 200 mm wide subsoil drains with perforated drain pipes (110 mm dia drainage coil) installed at approximately 6m centres north-south beneath the basement slab, interconnected for redundancy.
- Inspection points should be available at the ends of each subsoil pipe for clearing where required.

A subsoil collector drain should be installed inside the perimeter of the basement retaining wall to collect groundwater flow and re-direct to a discharge point.

4.3.9 Potential for groundwater mounding

Lateral groundwater flow may be impeded by the installation of diaphragm and sheet pile walls for the basement excavation. However, the potential for groundwater mounding is considered to be low given the reasonably high horizontal permeability of the reclamation fill and marine sediments, and as groundwater flow to the harbour are not impeded along Lower Hobson Street, along the eastern boundary of the site, and Lower Albert Street.

The potential for groundwater mounding will be considered further during detailed design, and if required mitigation measures such as installation of highly permeable trenches around the wall perimeter to redivert groundwater flows will be considered.

4.4 Retaining wall design considerations

4.4.1 General

To support the proposed basement excavation, the following retention options have been modelled:

- Diaphragm wall – to support the entire western and northern extents, and the northern section of the eastern perimeter wall.
- Steel sheet pile walls – to support the entire southern extent, and the southern section of the eastern perimeter wall.

Groundwater cut-off will be required to be maintained where the two wall types join. This may be done during construction by casting a steel sheet into the outside edge of the diaphragm wall. Should noise and vibration concerns not permit the use of the steel sheet piles (as discussed in Section 4.6), a diaphragm wall and/or secant pile walls may also be considered in these areas.

Geotechnical analyses of the retaining walls have been undertaken using pseudo non-linear finite element software WALLAP[9]. The design of the retaining walls has been undertaken to achieve an adequate factor of safety during construction and the long-term / permanent case, and to minimise wall deflections and potential ground settlement.

Retaining wall analyses for 3 No. design sections has been completed for the proposed basement excavation. The following summarises these design sections:

- Section 1 – north-west corner of the basement. This section represents the top-down construction methodology adopting an 800 mm thick Diaphragm wall and internal props/ permanent floor slabs across the northern section of the basement perimeter and the northeast and northwest extents as shown in Figure 4.2. The concept design allows for diagonal props from the pile capping beam to B01 basement level, however corner propping may be adopted as an alternative where possible.
- Section 2 – western basement perimeter. This section represents bottom-up construction methodology adopting an 800 mm thick Diaphragm wall and multi-level ground anchors to provide lateral restraint.
- Section 3 – eastern and southern basement perimeter. This section represents bottom-up construction methodology adopting a sheet pile wall and multi-level ground anchors to provide lateral restraint.

The location of the above sections is shown on Figure 4.2 below. The following sections provide details of the analysis undertaken.

Figure 4.2: Retaining wall modelling design section alignment.

[9] Geosolve (2013). *WALLAP. Anchored and Cantilevered Retaining Wall Analysis Program.* Version 6.05.

4.4.2 Geotechnical parameters

The parameters presented in Table 4.7 have been adopted for this assessment, which are based on the available geotechnical investigations in the site area and our experience with similar geological units.

Table 4.7: Retention geotechnical design parameters

Design parameter		Units	Reclamation Fill / Marine Sediments	Pleistocene Sediments	Weathered ECBF	ECBF rock
Unit weight	γ	kN/m^3	16.5	17.5	19	21
Effective friction angle	ϕ	deg	28	30	32	40
Effective cohesion	c'	kPa	3	5	7	100
Poisson's ratio	v'	-	0.3	0.3	0.3	0.25
Equivalent linear modulus of elasticity [(1)]	E'	MPa	6	20	40	400

To calculate the active and passive pressure coefficient, the following wall friction coefficients have been assumed for the wall types modelled:

- Concrete: assumed to be 2/3 of the soil friction angle on the active side, and ½ of the soil friction angle on the passive side of the wall.
- Steel: assumed to be ½ of the soil friction angle on the active side, and 1/3 of the soil friction angle on the passive side of the wall.

4.4.3 Wall structural parameters

Two wall types have been modelled for concept design:

An 800 mm diameter wide diaphragm wall has been modelled. The stiffness of the fully embedded retaining wall has been calculated adopting the following cracked section moduli for each stage in accordance with CIRIA guidance[10]:

- Construction stage – 75% of gross value.
- Long-term / elevated groundwater case – 50% of gross value.
- Seismic case – 25% of gross value.

Arcelor AU25 sheet piles have been modelled for preliminary design of the sheet pile wall.

The wall section properties adopted in the analysis are summarised in Table 4.8 below.

Table 4.8: Wall structural properties

Wall type	Modulus of Elasticity (GPa)	Second moment of inertia, I_{gross} (m^4 / m run)	Wall Flexural Stiffness (kNm^2 / m run)
800 mm thick D-wall	27.4	4.27×10^{-2}	1,170,000
Arcelor AU25 Sheet piles	210	5.62×10^{-4}	118,100

[10] CIRIA (2017). *CIRIA C760. Guidance on embedded retaining wall design.*

4.4.4 Temporary lateral support properties

Adopted temporary prop / anchor support parameters are given in Table 4.9 below.

Table 4.9: Temporary prop properties

Prop Type	Section area (m^2)	Elastic modulus, E (GPa)
B01 and B03 Partial floor support constructed top-down	0.4 x 1.0	27.4
310UC118 steel section	1.5×10^{-2}	210
450 x 9.53 CHS	1.34×10^{-2}	210
5 x 15.2 mm VSL strand anchors	7.17×10^{-4}	210
7 x 15.2 mm VSL strand anchors	1.003×10^{-3}	210
12 x 15.2 mm VSL strand anchors	1.720×10^{-3}	210

It is assumed that internal props or anchors installed at or near the ground level will be supported at the perimeter capping beam. Where lateral supports are installed at lower elevations, walers may be required to be incorporated as part of the design to distribute the loading between piles.

In the top-down case, partially constructed floors are modelled conservatively as continuous 0.4 m thick slabs of reinforced concrete. It is anticipated the floors may be construction in a 'U-shape' around the perimeter of the excavation to maintain and open pit near the centre of the excavation. However, to transfer shear load from the west and east walls, temporary propping may be required spanning across the southern extent of the floor slabs.

In WALLAP, the temporary floors are applied at the mid-slab elevation, modelled with a span equal to total basement width for each section.

4.4.5 Permanent lateral supports

The permanent floors are modelled as continuous slabs of reinforced concrete. The GF, B02, and B04 levels, which were not were not utilised as top-down supports, were modelled as 0.2 m thick slabs. The B05 floor has been modelled as a 0.8 m thick foundation. In WALLAP, the permanent floors are applied at the mid-slab elevation and the prop free length was adopted as a span equal to half of the basement width for each section (or maximum 30 m).

The following summarises the floor levels assumed for concept design:

- B05 Basement Level: FFL -14.3 m RL.
- B04 Basement Level: FFL -9.7 m RL.
- B03 Basement Level: FFL -5.1 m RL.
- B02 Basement Level: FFL -2.1 m RL.
- B01 Basement Level: FFL +0.9 m RL.
- GF Level: FFL +4.5 m RL.

4.4.6 Construction methodology

The following construction methodologies have been assumed in the Concept Design. The bulk excavation level provides an allowance for up to 1.0 m excavation below the B05 basement formation level for the base slab and sub-slab build up, drainage and contingency for disturbance / over-dig.

At the northern end of the site construction will be top-down with installation of the perimeter wall and internal plunge piles. Temporary diagonal props to the internal plunge piles will be installed prior to excavation to B01 level and construction of the floor slab. Similarly, temporary diagonal prop below the B04 basement level extending to the base of the excavation will be installed prior to construction of the basement floor slab and B04 basement floor. Corner props, as an alternative to diagonal props, may be utilised. Access for excavation will be from the south.

At the western end of the site, the basement excavation will be retained by a Diaphragm wall with four-rows of ground anchors founded within the ECBF rock and/or internal props.

The southern and south-eastern perimeter, a sheet pile wall is proposed with three-rows of ground anchors founded within the ECBF rock. Once excavation proceeds to be ECBF rock, a 1 m wide shelf would be formed below the wall and an open-cut excavation would be undertaken vertically within the ECBF. Temporary support with rock bolts with mesh facing and/or shotcrete may be required to stabilise the rock cut as excavation proceeds. Horizontal drains may also be required in the rock cut to temporarily relieve groundwater pressures near the cut face. Alternatively, a diaphragm wall with three-rows of ground anchors and/or internal props may be considered.

The concept design basement retention layout is presented in Appendix G, and design sketches for the respective WALLAP sections are also provided.

The following summarises the construction methodology assumed for the WALLAP analysis:

<u>Section 1 – Top-down Diaphragm wall</u>

1 Install 800 mm thick Diaphragm wall with a toe level at RL -20.3 m.
2 Excavate no deeper than RL 0.0 m and form 1(v):2(h) temporary berm to B01 FFL (RL +0.90 m).
3 Install 310UC118 temporary prop founding upon internal plunge piles at 5 m c/c spacing (or alternatively corner propping).
4 Excavate berm and continue excavation no deeper than RL 0.0 m and install 400 mm thick B01 level floor slab.
5 Excavate no deeper than RL -6.0 m and install 400 mm thick B03 level floor slab.
6 Excavate to no deeper than RL -10.7 m and form 1(v):1(h) temporary berm to basement excavation level (RL -16.3 m).
7 Install 450x9.53 temporary prop founding on the basement excavation floor (or leave berm in place until B04 slab construction).
8 Excavate berm and continue excavation to no deeper than RL -16.3 m and install B05 level slab.
9 Install B04 and B02 level slab.
10 Remove the lower and upper-level temporary prop and install GF slab.
11 Apply elevated groundwater design scenario.
12 Apply seismic design scenario.

<u>Section 2 – Anchored Diaphragm wall</u>

1 Install 800 mm thick Diaphragm wall with a toe level at RL -20.3 m.
2 Excavate no deeper than RL 2.0 m and install 7 x 15.2 mm VSL strand ground anchors at 2.5 m c/c spacing, at RL 2.5 m. Pre-stress anchor to 150 kN.
3 Continue excavation to no deeper than RL -1.8 m and install 7 x 15.2 mm VSL strand ground anchors at 2.5 m c/c spacing, at RL -1.3 m. Pre-stress anchor to 200 kN.

4 Excavate no deeper than RL -6.5 m and install 12 x 15.2 mm VSL strand ground anchors at 2.0 m c/c spacing, at RL -6.0 m. Pre-stress anchor to 400 kN.

5 Excavate no deeper than RL -11.0 m and install 7 x 15.2 mm VSL strand ground anchors at 2.5 m c/c spacing, at RL -10.5 m. Pre-stress anchor to 200 kN.

6 Excavate to no deeper than RL -16.3 m and install B05 slab.

7 Install B4 and B3 slabs, and remove low-level ground anchors at RL -10.5 m and RL -6.0 m.

8 Install B2 slab and remove ground anchor at RL -1.3 m.

9 Install B1 and GF slab and remove ground anchor at RL 2.5 m.

10 Apply elevated groundwater design scenario.

11 Apply seismic design scenario.

Section 3 – Anchored Sheet pile wall

1 Install Arcelor AU25 sheet piles with a minimum toe embedment of 1 m into ECBF rock.

2 Excavate no deeper than RL 2.0 m and install 5 x 15.2 mm VSL strand ground anchor at RL 2.5 m. Pre-stress anchor to 150 kN.

3 Continue excavation to no deeper than RL -1.0 m and 5 x 15.2 mm VSL strand ground anchor at RL -0.5 m. Pre-stress anchor to 200 kN.

4 Continue excavation to no deeper than RL -4.5 m and 5 x 15.2 mm VSL strand ground anchor at RL -4.0 m. These are to act as passive anchors.

5 Install 1 m wide level bench at RL -4.5 m and excavate vertical rock-cut (with temporary support with rock bolts and mesh / shotcrete as required) to no deeper than RL -16.3 m.

6 Install permanent basement wall and internal floor slabs. Backfill between sheet piles and permanent wall.

The section analysed above represents the 'critical' section adopting the highest depth to rock based on the current ground profile. The elevation of the rock shelf and anchor supports will be adjusted as the depth to rock and ground level behind the excavation changes (generally rising to the south / east). This will be considered during detailed design.

4.4.7 Surcharge loading

The analyses have been undertaken adopting a design construction traffic surcharge of 12 kPa. The neighbouring structures in close proximity to the development are all anticipated to be on piled foundations, and therefore will impose negligible surcharges at the ground surface.

4.4.8 Seismic loading

For the design of piled retaining walls permanently propped by the internal basement structure recommendations for 'stiff' walls (i.e. deflection<0.4%H) have been adopted as recommended by NZGS Module 6: Earthquake Resistant Retaining Wall Design. This seismic load component is calculated by the following formula and applied midway up the retained height (i.e. modelled as uniform distribution):

$\Delta P_E = 0.6.K_h.\gamma.H^2$

Where: K_h is the earthquake acceleration design coefficient determined from MBIE module 6 eq.5-1
γ = bulk unit weight of retained soil (adopt typical 17.5 kN/m^3)
H = Permanent retained height

4.4.9 Analysis Results

Analysis results are summarised in Table 4.10 below.

Table 4.10: WALLAP Analysis Results

	Section			**Design Section 1**	**Design Section 2**	**Design Section 3**
	Location			Northern section	Western perimeter	South and south-east perimeter
Wall	Retained ground level		mRL	4.0	4.0	4.0
	Design pile toe		mRL	-20.3	-20.3	-5.5
	Wall Type			800 mm D-Wall	800 mm D-Wall	AU25 Sheet pile
Description of props	Prop / anchor 1	Prop Type	-	310UC118	7 x 15.2 mm VSL ground anchor	5 x 15.2 mm VSL ground anchor
		Level	mRL	4.3	2.5	2.5
		Spacing	m	5.0	2.5	3.0
		Inclination	deg.	27	30	45
		Pre-stress	kN	-	150	200
	Prop / anchor 2	Prop Type	-	0.4 m thick floor slab (B01)	7 x 15.2 mm VSL ground anchor	5 x 15.2 mm VSL ground anchor
		Level	mRL	0.9	-1.8	-0.5
		Spacing	m	-	2.0	3.0
		Inclination	deg.	0	30	35
		Pre-stress	kN	-	200	200
	Prop / anchor 3	Prop Type	-	0.4 m thick floor slab (B03)	12 x 15.2 mm VSL ground anchor	5 x 15.2 mm VSL ground anchor
		Level	mRL	-5.1	-6.0	-4.0
		Spacing	m	-	2.5	3.0
		Inclination	deg.	0	20	20
		Pre-stress	kN	-	400	0
	Prop / anchor 4	Prop Type	-	450 x 9.53	7 x 15.2 mm VSL ground anchor	-
		Level	mRL	-10.3	-10.5	
		Spacing	m	5.0	2.5	
		Inclination	deg.	45	20	
		Pre-stress	kN	-	200	
Design actions – temporary	Deflection (ground level)		mm	8	20	17
	Deflection (maximum)		mm	22	21	17
	Max. Deflection Level		mRL	-10.9	-0.35	+4.0
	Bending moment (max)		kNm/m	690	525	140
	Shear force (maximum)		kN/m	690	515	155
	Max. force at support **(horizontal loads[(1)])**	Prop / anchor 1	kN/m	260	270	210
		Prop / anchor 2	kN/m	1090	180	250
		Prop / anchor 3	kN/m	450	1790	325

	Section			**Design Section 1**	**Design Section 2**	**Design Section 3**
	Location			Northern section	Western perimeter	South and south-east perimeter
		Prop / anchor 4	kN/m	1770	1070	-
Actions – **static/seismic**	Bending moment (max)		kNm/m	630	320	
	Shear force (maximum)		kN/m	680	530	-
	Static force applied to prop	GF	kN/m	45	60	-
		B01	kN/m	285	170	-
		B02	kN/m	65	200	-
		B03	kN/m	1075	685	-
		B04	kN/m	675	725	-
		B05	kN/m	915	930	-

(1) Prop / anchor forces are presented as horizontal forces at the wall face only. Where supports are installed at an inclination, the actual force within the support will need to be calculated.

4.4.10 Further Retaining Wall design considerations

The retaining wall design presented meets the minimum requirements to achieve acceptable deflections for both groundwater and mechanical settlements, for the purposes of a Resource Consent application.

During preliminary design, detailed analysis using finite element software will be undertaken to consider the following:

1 The wall design currently allows for a minimum 4 m toe embedment for the diaphragm wall sections, and minimum 1 m toe embedment for the sheet pile wall sections. Detailed design will test sensitivity for a fault zone / joint at the base of the excavation. This may require a contingency for an extension of the pile embedment, or installation of low-level anchors / props to stabilise the base of the wall. Further analysis should be undertaken to confirm suitable design options as part of detailed design.

2 There is potential for water pressures within the ECBF rock to cause the diaphragm wall panels to 'lift' off the rock face (i.e. wall deflection in excess of relaxation in the rock). This could result in a gap to form between the wall and the rock face affecting shear transfer and affecting leakage flows. This may require consideration of pre-stressing of the lower floor levels (B04 / B05) and/or installation of low-level ground anchors and will be considered as part of detailed design.

3 The south-east portion of the site is located at the former land cliff-edge prior to the reclamation of the Downtown area, and at the top of a rock-cut platform. It is anticipated the rock surface will be highly variable, with local erosional features at the top of the rock forming an undulating rock surface and localised 'hard' areas of higher strength rock that were more resistant to erosion. This may result in an increase in retained height or a reduced pile embedment into ECBF rock, respectively, and may require contingency to install additional low-level anchors to control deflections and/or prevent failure at the toe of the piles.

4.5 Assessment of deformations and settlement effects

4.5.1 Mechanisms of settlement effects

The potential for surface deformation of the surrounding ground due to the development has been assessed as detailed in the following sections. The main contributing factors potentially causing ground settlements near the site that could impact on the immediately adjacent buildings, services or infrastructure include:

1 Excavation will extend below groundwater levels and so will result in local groundwater drawdown. Consolidation of the ground due to groundwater drawdown may occur due to the reduction in porewater pressures and increase in effective stress in the soil as groundwater seeps into the excavation and will be dependent on time.
2 As the excavation proceeds and the perimeter walls take load from the retained soil, lateral deflections will result. Mechanical settlement of the ground is associated with the deformation of the retaining walls. The associated ground settlements will occur relatively quickly and are expected to rapidly diminish with distance from the excavation.

4.5.2 Deformation criteria for buildings

Ground deformation can affect adjacent buildings and infrastructure (buried services and road pavements) through changes in grade and elongation/horizontal strain. A risk level of Aesthetic Damage of 'negligible' to 'slight damage' as defined in CIRIA PR30[11] is considered appropriate for neighbouring buildings. The limiting criteria of less than 1(V):500(H) differential settlement and less than 10 mm total settlement (i.e., negligible effects) have been adopted for this preliminary assessment.

Table 4.11: Typical values of maximum settlements for building damage risk assessment

Risk cat.	Maximum Differential Settlement	Maximum Settlement of Building (mm)	Description of Risk
1	Less than 1 in 500	Less than 10	Negligible: superficial damage unlikely
2	1 in 500 to 1 in 200	10 to 50	Slight: possible superficial damage which is unlikely to have structural significance
3	1 in 200 to 1 in 50	50 to 75	Moderate: expected superficial damage and possible structural damage to building, possible damage to relatively rigid pipelines.
4	Greater than 1 in 50	Greater than 75	High: expected structural damage to buildings and rigid pipelines or possible damage to other pipelines.

Where 'slight damage' risk (category 2) may occur, further assessment, as per Burland (2012)[12] will be required to considered to assess likely effects on potentially affected structures.

[11] CIRIA (1996). *Project Report 30: Prediction and effects of ground movements caused by tunnelling in soft ground beneath urban areas*. March 1996.
[12] Burland, J.B. (2012). *Chapter 26 Building Response to Ground Movements* in ICE Manual of Geotechnical Engineering. Institution of Civil Engineers.

4.5.3 Deformation criteria for underground services

While many types of utilities can accommodate high levels of differential settlement, certain types can be susceptible to damage. In general, a utility's tolerance to settlement depends upon the construction type/material, existing condition, and whether the utility runs parallel or perpendicular to the excavation. Utilities running perpendicular to the excavation works are considered to be at the highest risk of damage. Utilities which run parallel and are near the excavation works may experience horizontal displacement associated with ground loss at the excavation face; however, they will experience a much gentler differential settlement.

The methodology to assess the effects on utilities is based on the method on O'Rourke and Trautman (1982)[13] – which provides guidance on allowable differential settlement for various utility construction types.

Table 4.12: Allowable differential settlement based on utility type

Utility type	Maximum allowable differential settlement (V:H)
Brick unlined	1:245
Welded steel pipe	1:122
Cast in-situ concrete	1:173
PVC & HDPE	1:67
Reinforced concrete pipe	1:229
Ductile iron pipe	1:229
Vitrified clay pipe	1:299
Cast iron pipe	1:150 – 1:500 (varies based on diameter)

Estimations of potential damage to a utility have been based off the calculated ground surface settlement profiles perpendicular to the excavation. This is likely to over-estimate the actual differential settlement experienced by the utility as:

- Where a utility crosses oblique to the alignment, the estimated differential settlement is expected to be lower than if the utility was crossing perpendicular to the alignment.
- It has been assumed that the differential settlement affecting each recorded utility is equal to the differential settlement at the ground surface. In reality the differential settlements at depth are likely to be less than at the ground surface, and consequently the settlement estimates are conservative.

4.5.4 Cumulative settlement and effects on neighbouring buildings

Table 4.13 below presents a summary of the estimated total and differential settlements resulting from the combined effects of wall deformations and groundwater induced settlements on the neighbouring structures surrounding the development. Settlement profiles with distance perpendicular to the excavation are presented in Appendix H.

This assessment indicates the potential effects due to the proposed basement excavation are generally within Risk Category 1 – Negligible in accordance with CIRIA PR30, and negligible damage is expected to occur as a result.

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

Table 4.13: Estimated settlements below neighbouring structures

Building	Basement + Foundation Types	Date of Construction	Estimated ground settlement below structure (mm)		Assessed Risk of Building Damage due to Ground Settlement[1]
			Total	Differential	
MSocial Building	Main Tower – piled foundations to rock. Front of house – shallow foundations.	1970s (upgraded in 2017, including external re-cladding).	<12	<1(v):1,000(h)	Very low – modern building on piled foundations socketed into rock. Front of house building is over 15 m from the excavation and groundwater is controlled/ recharged by the harbour.
HSBC Tower	Main Tower – 2-Level basement + piled foundations to rock. Podium – piled foundations.	2002	<12 <8	<1(v):1,000(h) <1(v):3,000(h)	Very low – modern building on piled foundations socketed into rock. Groundwater is controlled/ recharged by the harbour.
AON Tower	Double level basement + pad foundations bearing on rock.	1970s	<10	<1(v):600(h)	Very low – modern building with two level basement, bearing on rock. Basement floor slab higher tolerance to deformations. Groundwater is controlled/ recharged by the harbour.
204 Quay Street	Unknown.	1940s	<5	<1(v):5,000(h)	Very low – 30 m+ distant from excavation and very low total and differential ground settlement assessed. Groundwater is controlled/ recharged by the harbour.

Building	Basement + Foundation Types	Date of Construction	Estimated ground settlement below structure (mm)		Assessed Risk of Building Damage due to Ground Settlement[1]
			Total	Differential	
Tepid Baths	Composite shallow + driven piled foundations.	1914 (upgraded in 2010, including upgrades to piled foundations).	<7	<1(v):4,000(h)	Very low – 40 m+ distant from excavation and Low total and differential ground settlement assessed. Main structure is supported on piled foundations socketed into rock. Limited existing historic fabric generally supported by the new structure.
Watermark Building (85 Customs St West)	Partial level basement + piled foundations.	2000	<7	<1(v):4,000(h)	Very low – modern building, 30 m+ distant, piled foundations socketed into rock. Low total and differential ground settlement assessed. ground water control/ recharge by harbour.
Hobson St Flyover	Piled foundations.	Late 1980s / early 1990s.	<12	<1(v):1,000(h)	Very low – piled foundations and low differential movements assessed.

Note:

1. onsidering maximum total and different ground settlement, foundation type and age of structure. Assessed risk of building damage is a joint assessment by Geotechnical and Structural Engineer.

4.5.5 Settlement effects on underground services and pavements

Table 4.14 below presents a summary of the estimated total and differential settlements beneath services surround the development. Settlement profiles with distance perpendicular to the excavation are presented in Appendix H.

Table 4.14: Estimated settlement below services within pavement

Street	Services within pavement	Service orientation to excavation	Estimated ground settlement below structure (mm)	
			Total	Differential*
Customs St West	Wastewater – 150VC / CONC & 225AC	Parallel	9	-
	Stormwater – 225 Ceramic	Parallel	4	-
	Water – 250/600 CLS & 175CI	Parallel	1	-
	Telecommunications – Chorus + Vodafone	Parallel + Perpendicular	8 – 10	-
	Vector – Gas	Parallel	9	
Lower Hobson St	Wastewater – 225VC / AC	Parallel + Perpendicular	13 – 17	<1(v):1,000(h)
	Stormwater – 300 to 1050 CONC	Parallel + Perpendicular	13 – 17	<1(v):1,000(h)
	Water – 200CLS	Parallel	13 – 17	-
	Power & Telecommunications (Chorus + Vodafone)	Parallel + Perpendicular	13 – 17	-
Private Accessway between HSBC Tower / AON Tower	Power & Telecommunications (Vector + Vodafone)	Parallel	10 – 12	-

* Differential settlements estimated for services which are orientated perpendicular to the excavation only. Where the services run parallel to the excavation face, negligible differential settlements are expected to occur.

4.6 Other construction considerations

4.6.1 Earthworks and excavating through rock

The underlying ground conditions at the site are likely to be excavatable using conventional equipment and plant, such as a 20-tonne digger with a toothed bucket. The ECBF rock generally has an unconfined compressive strength of 1 to 5 MPa, with possible seams of cemented rock of up to 20 MPa strength.

Sections of the basement excavation are proposed to be supported by sheet piles as shown in Figure 4.2 above. An open excavation through rock is proposed in these areas. The use of vertical open cuts with spot bolting as required has been adopted for a number of basement projects in the Auckland CBD. Allowances should be made for mapping of the vertical rock face, installation of rock bolts and grouting as the excavation proceeds, to support the rock and reduce groundwater seepage respectively.

4.6.2 Earthworks volumes

Approximate volumes for the bulk excavation are provided below for the purpose of construction planning. These approximate volumes are based on the current understanding of basement footprint (Resource consent draft drawing dated 07-06-2024), current basement level and existing geotechnical investigations at the site. We recommend an appropriate contingency is applied to these volumes including bulking factors for storage of material or transport away from the site.

- Total estimated bulk excavation – 130,000 m^3.
- Estimated volume for plunge columns and DWalls - 4500 m^3.

Split based on geological unit:

- Fill/ Reclamation Fill/ Marine Sediments – 54,000 m^3.
- East Coast Bays Formation soil – 3,500 m^3.
- East Coast Bays Formation rock – 72,500 m^3.

4.6.3 Noise & vibrations

Anchored sheet piles have been considered as a potential retention solution along the southern and south-eastern perimeter of the site. The sheet piles are proposed to be driven through the reclamation fill and marine sediments with an embedment of at least 1 m into the ECBF rock. The noise and vibration that will be generated during the driving of the sheet piles, particularly into the ECBF rock, will need to be considered as part of the construction noise and vibration monitoring plan.

Pertinent structures that are likely to be impacted by noise and vibration due to sheet piling include:

- The AON building which is located within 10 m of the proposed sheet piles and is supported on pile foundations that are embedded into ECBF rock.
- The HSBC building, Tepid Baths and the Watermark buildings (85 Custom Street West), which are located between 30 and 50 m from the proposed sheet piles. All of the buildings are expected to be supported on pile foundation embedded into ECBF rock.

M-Social and other neighbouring structures are located greater than 50 m from the proposed sheet piling and the impact on these structures are expected to be minimal.

4.6.4 In-ground obstructions

Due to the extensive historical land-use across the site, consideration of in-ground obstructions will be required for design and construction, including; foundation layout, basement excavation, and pile / perimeter wall construction. The following historical land-uses should be considered:

Reclamation Fill & Graving Dock

The Reclamation Fill is likely to be highly variable and is inferred to consist of fine-grained soils through to cobbles, boulders and construction waste material. The graving dock which extended across majority of the site was infilled in 1923. The material used to infill this is not known and remnants of the graving dock and associated structure may still be present at the site. Therefore, potential construction issues may arise due to obstruction from large boulders within the Reclamation Fill, old graving dock structure, relict wharfs and old seawalls. In particular this may impact the driveability of sheet piles and/or excavation of bored piles. Further investigations and assessment are proposed in subsequent design phases to assess this.

Existing Downtown Car Park foundations

The existing belled reinforced concrete pile foundations will also need to be removed as the excavation proceeds. The existing piles may need to be cut down where they conflict with construction of the foundations for the proposed development and to reduce the potential for hard points beneath the B5 floor level. Appendix C provides the historical pile layout for the existing carpark building.

The presence of these existing foundations should be considered as part of the foundation / superstructure design and set-out to avoid pile clashes where possible, particularly if piled foundations are adopted for the development with installation undertaken at existing ground levels.

Historical (pre-carpark) foundations

Remnants of the old seawalls and graving dock walls may still be present at the site and can be encountered during the excavation of the basement for the Downtown West development.

In addition, prior to construction of the existing carpark building, commercial/ workshop buildings were noted to occupy the northwestern and southeastern portions of the site. It is not known if the foundations of these structures were fully removed during the construction of the existing Downtown Carpark structure and may still be present and encountered during the excavation of the basement for the Downtown West development.

4.6.5 Potential contamination

There may be contaminants within the basement excavation spoil that limits disposal to a clean landfill site. A preliminary site investigation (PSI) study and a preliminary contamination site management plan (CSMP) have been undertaken for the site and are provided separately.

5 Auckland Unitary Plan – Operative in Part

We have reviewed the Auckland Unitary Plan (AUP) rules regarding the take, use, damming and diversion of groundwater that are relevant to the proposed basement excavation. The AUP provides for the take, using damming and diversion of groundwater and drilling in association with excavation. The AUP includes several requirements that must be met for developments to be considered as a permitted activities with regard to groundwater, which are listed in Activity Table E7.4.1 and Permitted Activity Standards E7.6.1.10 and E7.6.1.6.

The assessment of compliance with these rules is summarised below and identifies a number of non-compliances. On the basis of our assessment the project is likely to be considered as a restricted discretionary activity in accordance with AUP, Table E7.4.1 (A20) and (A28).

Table 5.1: AUP E7 engineering assessment

E7 Taking, using, damming and diversion of water and drilling - E7.6.1 PERMITTED ACTIVITY STANDARDS		
E7.6.1.6 Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10, all of the following must be met.		
(A27) Permitted Activity Standards: Exemptions	**Geotechnical Interpretation of Compliance**	**Permitted activity compliance**
(1) The water take must not be geothermal water;	Geothermal water not expected at the site.	Yes
(2) The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock; and	Groundwater diversion/ take will be for a period greater than 30 days.	No
(3) The water take must only occur during construction.	Groundwater take may extend beyond construction if drained basement is adopted	No
E7 Taking, using, damming and diversion of water and drilling - E7.6.1 PERMITTED ACTIVITY STANDARDS		
E7.6.1.10. Diversion of Groundwater Caused by any Excavation (including trench), or tunnel		
(A27) Permitted Activity Standards: Exemptions	**Geotechnical Interpretation of Compliance**	**Permitted activity compliance**
(1) All of the following activities are exempt from the Standards E7.6.1.10(2) – (6):		
(a) pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2 m in external diameter;	There are not expected to be any pipes cables or tunnels ≥1.2 m.	Yes
(b) pipes including associated structures up to 1.5m in external diameter where a closed face or earth pressure balanced machine is used;	N/A due to compliance with 1(a) above.	Yes
(c) piles up to 1.5 m in external diameter are exempt from these standards;	All piles are expected to be <1.5 m diameter.	Yes
(d) diversions for no longer than 10 days; or	Groundwater diversion due to construction of the basement will be longer than 10 days.	No
(e) diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised	The groundwater diversion is for purposes other than network utilities and road network linear trenching activities.	No

E7 Taking, using, damming and diversion of water and drilling - E7.6.1 PERMITTED ACTIVITY STANDARDS		
E7.6.1.6 Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10, all of the following must be met.		
(A27) Permitted Activity Standards: Exemptions	**Geotechnical Interpretation of Compliance**	**Permitted activity compliance**
where the part of the trench that is open at any given time is no longer than 10 days.		
(2) Any excavation that extends below natural groundwater level, must not exceed:		
(a) 1ha in total area: and	(a) The development area does not exceed 1ha in total area	Yes
(b) 6m depth below the natural ground level	(b) The maximum excavation depths will be greater than 6 m below existing ground levels	No
(3) The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	(3) The natural groundwater level in the surficial soils is not expected to be reduced by more than 2 m at the site boundary.	Yes
(4) Any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the site must not:		
(a) impede the flow of groundwater over a length of more than 20 m; and	(a) The development will impede the flow of groundwater over a length of more than 20 m (site measures approximately 88 m by 70 m)	No
(b) extend more than 2 m below the natural groundwater level.	(b) The structure will extend more than 2 m below natural groundwater levels	No
(5) The distance to any existing building or structure (excluding timber fences and small structures on the boundary) on an adjoining site from the edge of any:		
(a) trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation;	(a) Several neighbouring structures will be inside the specified envelope.	No
(b) tunnel or pipe with an external diameter of 0.2 - 1.5 m that extends below natural groundwater level must be offset 2 m or greater; or	(b) Any site connections are likely to be greater than 2 m from neighbouring structures.	Yes
(c) a tunnel or pipe with an external diameter of up to 0.2 m that extends below natural groundwater level has no separation requirement.	(c) No comment required	Yes
(6) The distance from the edge of any excavation that extends below natural groundwater level, must not be less than:		
(a) 50 m from the Wetland Management Areas Overlay;	The proposed excavation that extends below natural groundwater level is located more than 50m from Wetland Management Areas Overlay	Yes
(b) 10 m from a scheduled Historic Heritage Overlay; or	The proposed excavation that extends below natural groundwater level is	Yes

E7 Taking, using, damming and diversion of water and drilling - E7.6.1 PERMITTED ACTIVITY STANDARDS		
E7.6.1.6 Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10, all of the following must be met.		
(A27) Permitted Activity Standards: Exemptions	**Geotechnical Interpretation of Compliance**	**Permitted activity compliance**
	approximately 30m from the closest scheduled Historic Heritage overlay	
(c) 10 m from a lawful groundwater take	(c) A specific search of groundwater takes adjacent to the site has not been undertaken. However, we expect a groundwater take consent may have been required for the current HSBC building present immediately to the north-west (188 Quay Street) and West Plaza development to the south-west (3-15 Albert Street). Groundwater take consent also existing for the Commerical Bay precinct development further to the east.	No

6 Recommendations for site investigations and monitoring work

6.1 Recommendations for site investigations

Further geotechnical site investigations are proposed during the preliminary design stage. The site investigations will be used to confirm the geotechnical and groundwater model that have been adopted for this concept design. Additional site investigations to inform detailed design will consist of:

- Four machine drilled boreholes to a depth of 20 m below ground level. Unconfined compressive strength (UCS) tests and other suitable laboratory tests will be undertaken to confirm design parameters.

  The location of the boreholes will be finalised based on access to machinery and following further detailed review of underground services. However, generally the boreholes will be located as follows:

  - Two boreholes near the north-east corner and perimeter of the site. There is currently limited information in this area and rock levels may be impacted by the graving dock. These boreholes will also be used to assess impact on the groundwater regime due to the backfilling of the graving dock.
  - One borehole near the south-west corner to confirm depth to rock and for groundwater monitoring at the southern perimeter of the proposed excavation.
  - If feasible, one borehole within the building footprint and in the south-west portion of the building. This will be used to refine the depth to rock in an area where there is currently limited information.
- The four machine boreholes will be completed with a nested standpipe piezometer to monitor groundwater levels in the upper reclamation fills and marine sediments, and groundwater levels in the ECBF rock. These groundwater monitoring wells will be part of the long-term groundwater monitoring system during construction.
- Up to four cone penetration tests (CPTs) are proposed to refusal (typically 5 m to 11 m). The CPTs will be used mainly to confirm the design parameters and liquefaction assessment presented in this concept design report.
- These investigations should be coordinated with contamination sampling and testing.

6.2 Construction survey and monitoring

A draft GSMCP is provided in Appendix B. The GSMCP provides draft proposed monitoring of the basement excavation works and surrounding areas to assess if the ground and groundwater conditions are consistent with the design analyses and the response of structures are within design tolerances.

7 Risk register

Presents identified geotechnical risks and opportunities for the proposed development of the Downtown West. The presented risks are those identified at this time and may not be a complete list. Risks (including Safety in Design considerations) should be regularly reviewed by the project team as the design and construction progresses.

Table 7.1: Geotechnical risk register

ID	Risk	Further assessment proposed	Residual risk	Likelihood of residual risk
1	The depth to unweathered ECBF rock varies from that assumed for basement retention design and pile embedment	Further site-specific investigations proposed in preliminary design. Detailed design will consider contingencies to extend diaphragm wall, sheet pile and foundation piles should rock be deeper than expected. Consider proof drilling at pile locations during construction, particularly where sheet pile retention is proposed (i.e. south and south-east perimeter). Sheet pile retention design to consider contingency options where sheet piles extend deeper than ground model allows. This may include additional low-level ground anchor supports.	Depth to rock varies over short distances (i.e. erosional channels in rock)	Low to medium
2	Obstructions during excavation works from the existing carpark pile foundations, historical foundations (pre-carpark), remnants of old seawalls and boulders and waste material that may be present in the reclamation fill	Detailed design of the proposed foundations for the development to consider current carpark foundation layout, particularly for any piles that are to be formed from ground surface. Existing reinforced concrete piles to be cut down below the B4 floor levels Design to consider contingency if obstructions impact the driveability of sheet piles or interference during diaphragm wall / secant pile installation.	Unknown location, magnitude and size of obstructions	Medium to high
3	Collapse of pile shaft and anchor bores within the reclamation fill and marine sediments	Temporary support of pile shafts required through reclamation fill and marine sediments. Options include using temporary casing or drilling with a slurry (bentonite or polymer)	Collapsing of pile or anchor holes	Medium
4	Storage of excavated soil on site, such as stockpiling of soil above the proposed retaining walls may cause excessing wall deformation	Maintain a designated area behind the back of the retaining walls where storage of soil or plant and machinery is not permitted	Due to limited space available at the site, designated areas to stockpile fill may be difficult	Low
5	Clash between proposed temporary	Pile layouts for neighbouring buildings are known. Design to consider anchor	Unexpected differences	Low

ID	Risk	Further assessment proposed	Residual risk	Likelihood of residual risk
	ground anchors and the pile foundation of neighbouring building	inclination and length so that they generally do not extend into the neighbouring building footprint. If this is not feasible design shall consider the layout of ground anchors to avoid clashes with the existing pile foundations beneath neighbouring structures	between actual foundation locations and available as-built plans	
6	High groundwater inflows during construction due to open joints / fault zone through ECBF rock providing hydraulic connection to harbour	Frequent geotechnical observations during basement excavation to identify risk areas. Contingency option to grout joint / fault zones to provide seal and reduce groundwater inflows.	Construction difficulties installing grout seal. Grout volumes required to provide seal.	Low
7	Strong Calcite cemented bed making drilling, excavation and driven pile installation difficult	Further geotechnical investigations proposed to assess competency of ECBF rock within basement excavation. Detailed design of sheet pile retention to consider contingency options should minimum 1 m embedment into ECBF rock not be achieved. This may include additional low-level anchors and/or pre-augering of the sheet-piles.	Isolated beds of strong cemented material not identified during investigation	Low
8	Water pressures in ECBF rock causing the diaphragm wall to 'lift' off the rock face. Impacts on shear transfer between wall and rock interface and affecting leakage flows	Detailed design to consider impacts and contingency options, including pre-stressing of lower floor levels and/or installation of low-level ground anchors.	Gaps between the ECBF rock and diaphragm results in increased likelihood of leakage.	Low

8 Applicability

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

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

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Ric Wilkinson
Geotechnical Engineer

Report reviewed by:

.....

Ananth Balachandra
Senior Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

.....

Peter Millar
Project Director

6-Dec-24
p:\1016043\1016043.1000\2 geotechnical\issueddocuments\geotechnical and groundwater_dtc_concept design_december 2024_rev 6_final.docx

Appendix A Site Plan and Geological Cross-sections

C:\12dSynergy\data\ALBTCAD\DCR Concept and Resource Consent Stage_1352\CAD\FIG\1016043.1000-GEO-F1.dwg 2023-Jun-08 9:33:11 PM Plotted By: JONALD CASTRO

LEGEND

- PROPERTY BOUNDARY
- ECBF CONTOUR (1m INTERVAL)
- GEOMAPS WATER LINE
- GEOMAPS ABANDONED WATER LINE
- WATER HYDRANT
- WATER VALVE
- GEOMAPS STORMWATER LINE
- GEOMAPS ABANDONED STORMWATER LINE
- STORMWATER CATCHPIT
- STORMWATER MANHOLE
- GEOMAPS WASTEWATER LINE
- GEOMAPS ABANDONED WASTEWATER LINE
- WASTEWATER MANHOLE
- CRL UNDERGROUND ROUTE
- CHORUS
- VECTOR COMMUNICATION - UNDERGROUND ROUTE TRENCH
- VECTOR COMMUNICATION - UNDERGROUND INSTALLED IN PLACE
- GAS
- GAS VALVE
- VODAFONE
- FIBRE OPTIC
- POWER
- LAMP
- EXISTING BOREHOLE LOCATIONS
- EXISTING CONE PENETRATION TEST LOCATIONS

204 QUAY ST
QUAY ST
MSOCIAL
DOWNTOWN CARPARK SITE
WATERMARK BUILDINGS
LOWER HOBSON ST
HSBC TOWER
AON TOWER
TEPID BATHS
STURDEE ST
LOWER ALBERT ST
FANSHAWE ST

BH_64279, CPT_TT2811, BH_64270, CPT_TT2810, CPT_TT2835, CPT_TT48734, CPT_TT48735, CPT_TT2809, 801_BH11, BH_64269, 801_BH7, CPT_TT48731, CPT_TT2808, CPT_TT2807, BH_64268, BH_64278, CPT_TT48732, 16930_BH6, CPT_TT2806, BH_64274, 15000_166, CPT_TT48730, 15000_165, CPT_TT2832, CPT_TT48733, CPT_TT2824, 8676_BH3, 15000_167, CPT_TT48729, 801_BH10, 15000_171, 16930_BH5, 15000_164, BH_64277, 801_BH12, 15000_168, 15000_BH26, 16930_BH4, CPT_TT2830, CPT_TT2828, 15000_169, CPT_TT2823, BH_64266, CPT_TT2812, 2020_BH02, CPT_TT2822, 801_BH5, 15000_170, 16930_BH1, BH_64276, 801_BH14, BH_64267, CPT_TT2813, CPT_TT2821, CPT_TT2814, BH_66381, CPT_TT2829, 16930_BH2, CPT_TT2820, 801_BH13, CPT_TT2815, 26753_BH1, BH_127924, 801_BH6, 2020_BH01, CPT_TT2819, 801_BH15, CPT_TT2816, BH_127794, CPT_TT2818, 801_BH18, 26753_BH2, CPT_TT2817, BH_66380, 15000_105, BH_66390

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)
ORIGINAL IN COLOUR

CHECK PRINT		
BACKDRAFTING REQUIRED		
READY TO ISSUE	INITIAL	DATE
CAD SELF CHECK		
DESIGN CHECK		
DRAFTING CHECK		
BACKDRAFTER - EDITS MADE		
BACKCHECKER - EDITS CONFIRMED		

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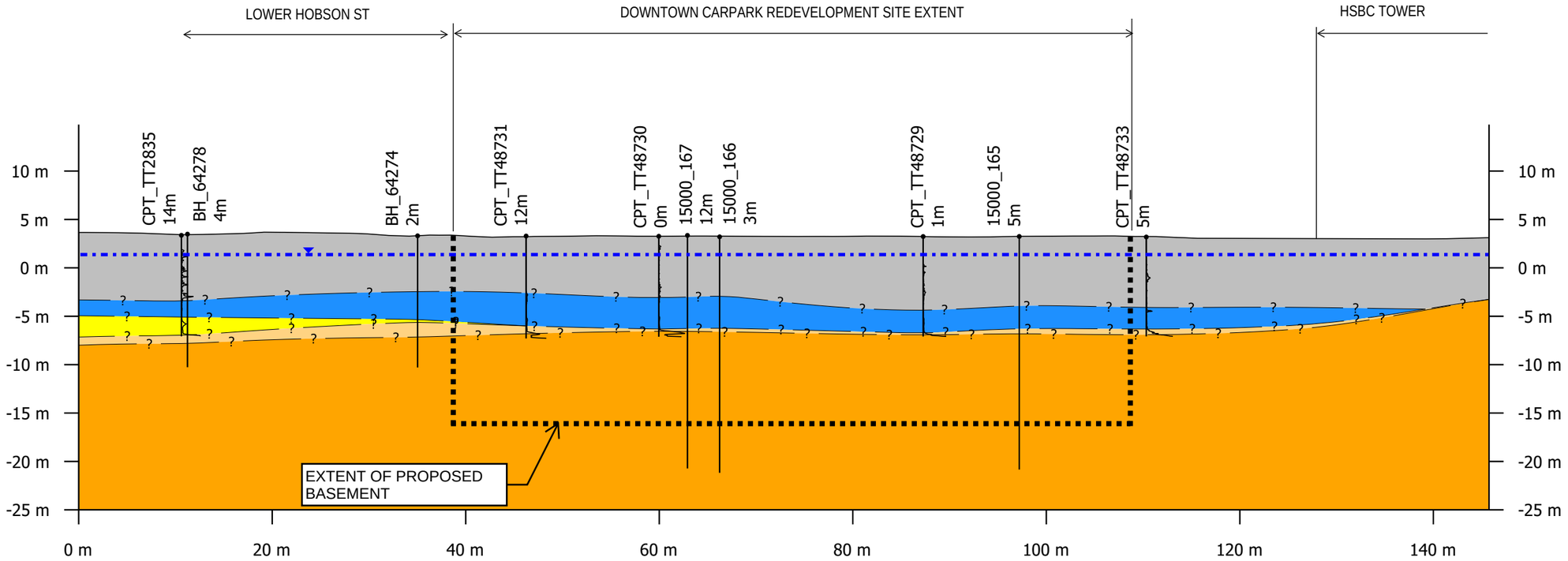
NOTES:
1. AERIAL PHOTO, STORMWATER LINE, WASTEWATER LINE AND WATER LINE SOURCED FROM AUCKLAND COUNCIL GEOMAPS, LICENSED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). CAPTURE DATE 24/05/2023.
2. VODAFONE AND CRL INFORMATION SUPPLIED BY BEFORE U DIG. REF 11197173 - Vodafone Plan.pdf AND "11197172 - CityLink Plan (002).pdf".
3. CHORUS INFORMATION SUPPLIED BY CHORUS, REF "CHORUS.pdf".
4. VECTOR POWER, COMMUNICATION AND GAS SUPPLIED BY VECTOR, REF "VECTOR ELECTRICITY.pdf" , "VECTOR COMMUNICATION.pdf" AND "VECTOR GAS.pdf".

PROJECT No.	1016043.1000	
DESIGNED	KASC	May.23
DRAWN	JC	May.23
CHECKED		
APPROVED		DATE

CLIENT PRECINCT PROPERTIES HOLDINGS LIMITED
PROJECT DOWNTOWN CARPARK REDEVELOPMENT
TITLE GEOTECHNICAL LAYOUT PLAN
UNDER REVISION 1
SCALE (A3) 1:750 FIG No. FIGURE 1 REV 1



Section 1

Legend

- Fill
- Marine Sediments
- Tauranga Group
- Weathered ECBF
- ECBF N>50

Scale: 1:500

Vertical exaggeration: 1x

0m 40m

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NOTES

REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE

DESIGNED	JOWI	8.6.23	DRAWING STATUS: FOR INFORMATION
DRAWN	JOWI	8.6.23	
DESIGN CHECKED	ABL	Xxx. XX	PROJECT PHASE: CONCEPT
DRAWING CHECKED	ABL	Xxx. XX	

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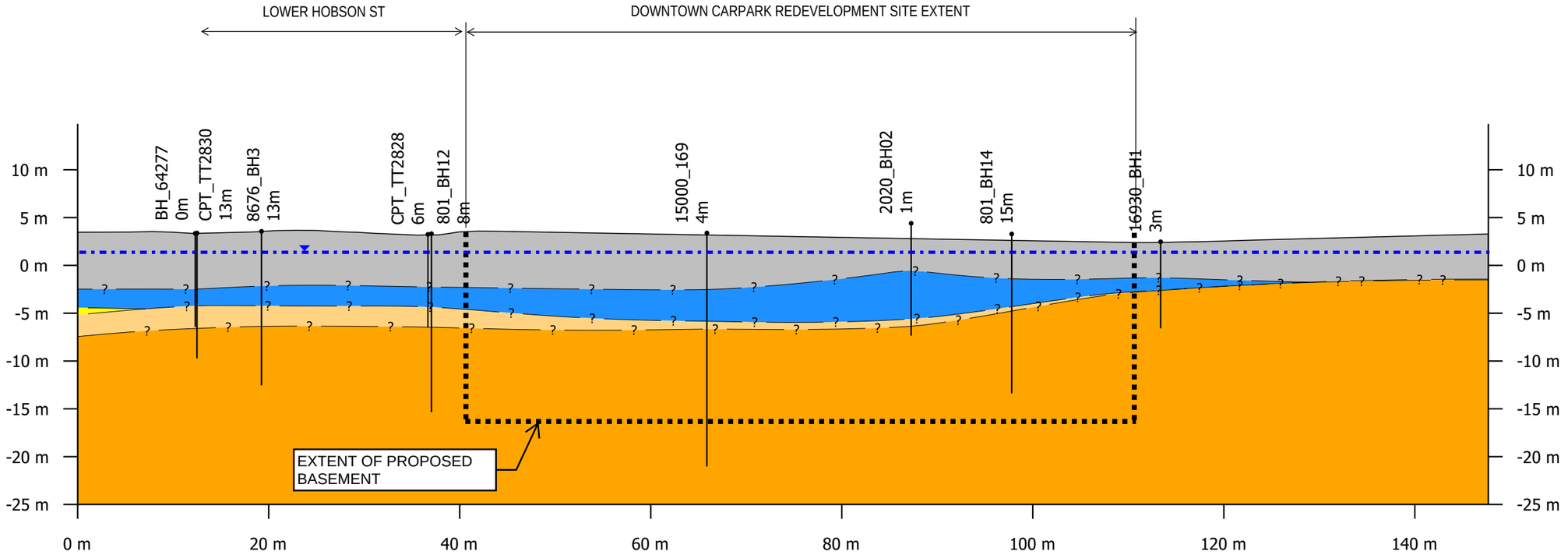
CLIENT **PRECINCT PROPERTIES HOLDINGS LIMITED**

PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

TITLE GEOLOGICAL SECTION
SECTION 1

SCALE (A3) 1:500 REV A



Section 2

Legend

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- Marine Sediments
- Tauranga Group
- Weathered ECBF
- ECBF N>50

Scale: 1:500

Vertical exaggeration: 1x

0m 40m

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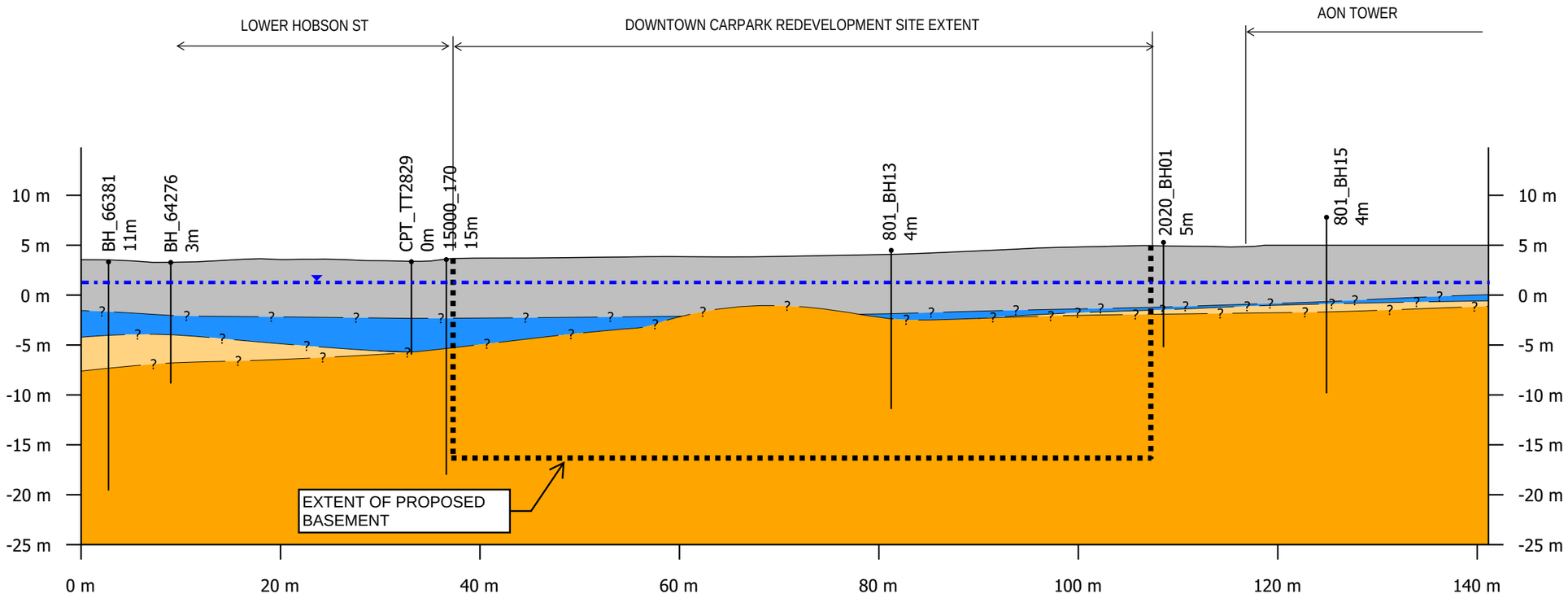
PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

TITLE GEOLOGICAL SECTION
SECTION 2

SCALE (A3) 1:500 REV A



Section 3

Legend

- Fill
- Marine Sediments
- Tauranga Group
- Weathered ECBF
- ECBF N>50

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Vertical exaggeration: 1x

0m 40m

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	NOTES					

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DRAWN	JOWI	8.6.23	FOR INFORMATION
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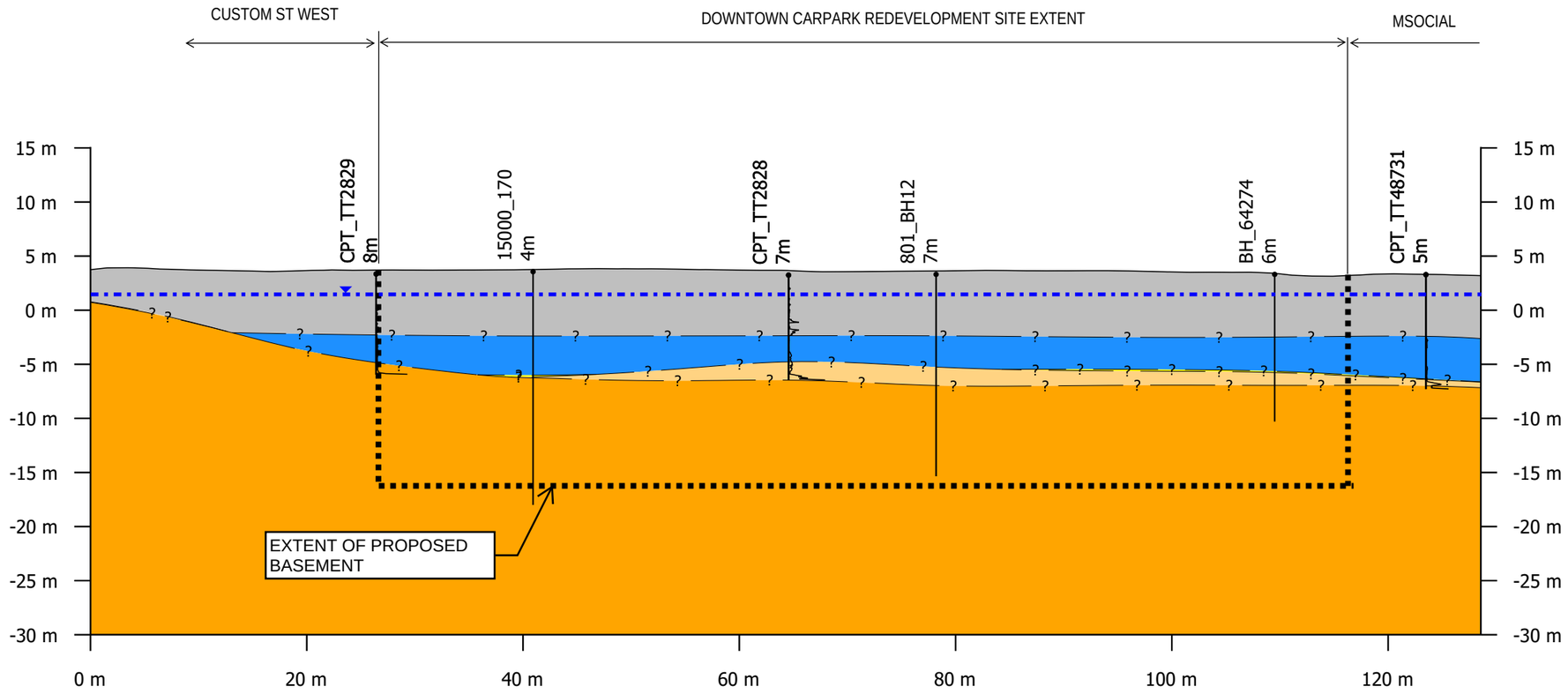
PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

TITLE GEOLOGICAL SECTION
SECTION 3

SCALE (A3) 1:500 REV A



Section 4

Legend

- Fill
- Marine Sediments
- Tauranga Group
- Weathered ECBF
- ECBF N>50

Scale: 1:500

Vertical exaggeration: 1x

0m 40m

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NOTES

REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE

DESIGNED	JOWI	8.6.23	DRAWING STATUS: FOR INFORMATION
DRAWN	JOWI	8.6.23	
DESIGN CHECKED	ABL	Xxx. XX	PROJECT PHASE: CONCEPT
DRAWING CHECKED	ABL	Xxx. XX	

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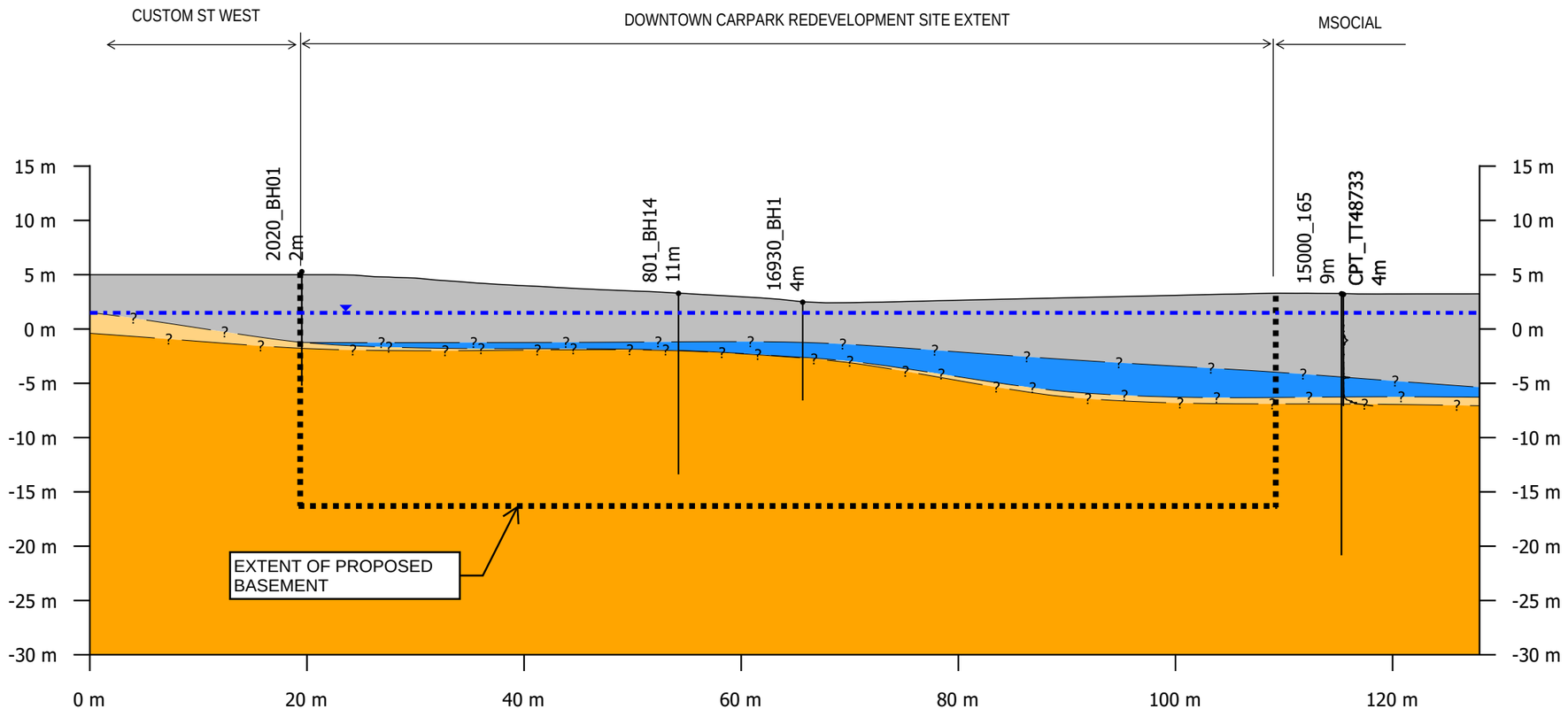
PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

TITLE GEOLOGICAL SECTION
SECTION 4

SCALE (A3) 1:500 REV A



Section 5

Legend

- Fill
- Marine Sediments
- Tauranga Group
- Weathered ECBF
- ECBF N>50

Scale: 1:500

Vertical exaggeration: 1x

0m 40m

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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
	NOTES					

DESIGNED	JOWI	8.6.23	DRAWING STATUS
DRAWN	JOWI	8.6.23	FOR INFORMATION
DESIGN CHECKED	ABL	Xxx. XX	PROJECT PHASE
DRAWING CHECKED	ABL	Xxx. XX	CONCEPT

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PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

TITLE GEOLOGICAL SECTION
SECTION 5

SCALE (A3) 1:500 REV A

Appendix B Draft groundwater and settlement monitoring and contingency plan

REPORT

Tonkin+Taylor

Downtown West - Downtown Car Park Redevelopment

Groundwater and Settlement Monitoring and Contingency Plan

Prepared for
Precinct Properties Holding Limited
Prepared by
Tonkin & Taylor Ltd
Date
December 2024
Job Number
1016043.1000 v4

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Document control

Title: Downtown West - Downtown Car Park Redevelopment					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
June 2023	0	50% Draft for Client Review	ABL	PJM	PJM
September 2023	1	100% Draft for Client Review	ABL	PJM	PJM
June 2024	2	Updated 100% Draft for Client Review	ABL	PJM	PJM
July 2024	3	Final issue	ABL	PJM	PJM
December 2024	4	Updated final issue following s92 comments	ABL	PJM	PJM

Distribution:

Precinct Properties Holding Limited	PDF copy
RCP Limited	PDF copy
Tonkin & Taylor Ltd (FILE)	electronic copy

Table of contents

Appendix C **Piezometer construction records**

Appendix D **Groundwater monitoring records**

1 Introduction

Precinct Properties Holding Limited (Precinct) has engaged Tonkin and Taylor Limited (T+T) to prepare a Groundwater and Settlement Monitoring Contingency Plan (GSMCP) for the proposed basement construction at the Downtown West - Downtown Car Park Redevelopment site (Downtown West).

This draft GSMCP is applicable for up to six levels of basement construction and assumes a basement excavation generally to RL -16.3 m, though with localised excavation of up to RL -21 m to accommodate water tanks and lift pits. This draft GSMCP has been prepared to supplement the resource consent application for the Downtown West and will be updated as the design for the project develops. This draft GSMCP should be read in conjunction with the concept geotechnical and groundwater assessment report for the Downtown West development.

1.1 Project description

The Downtown West site is located at 2 Lower Hobson Street, at the corner of Lower Hobson Street and Customs Street West within the Auckland CBD (legal description Lot 9 DP 60151). The proposed site to be developed is approximately 6,442 m^2 in area, with the site on land reclaimed in stages between 1850 and 1920 by the Auckland Harbour Board.

The site is relatively level, with the ground surrounding the site varying from RL 4 m to RL 5 m. A 9-storey (1 below ground level and 8 suspended floors) public carpark building known as the Downtown Carpark currently occupies the site. The building is surrounded by MSocial Hotel immediately to the north, HSBC and Aon Towers to the east, Custom Street West and Lower Hobson Street to the south and west respectively. Figure 1.1 shows the location of the site. The historical Tepid Baths are located across Lower Hobson Street to the west.

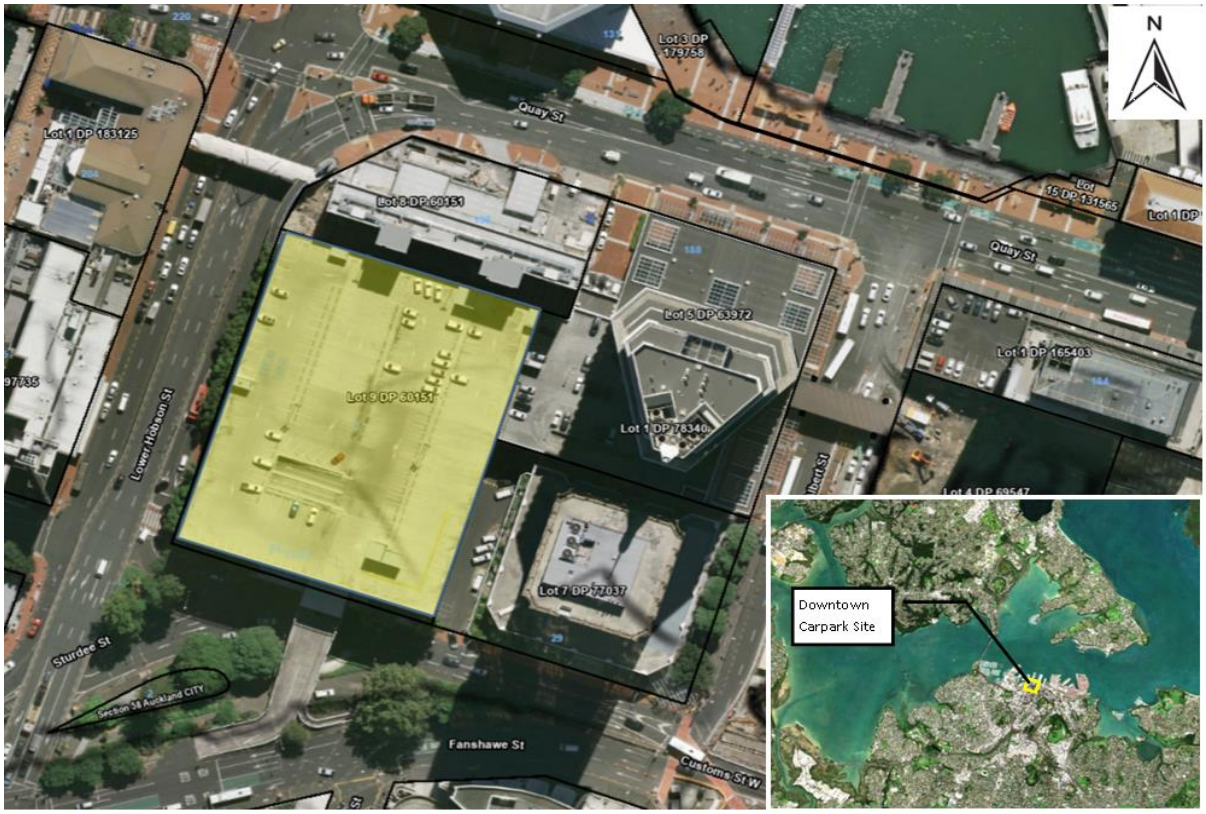


Figure 1.1: Downtown West site.

The proposed development for the site consists of two multi-storey towers, three podium structures and up to six level basement that extends across the full footprint of the site (with the exception of the sixth level of basement which is a localised level to accommodate water tanks and lift pits).

1.2 Definitions

AC	The Auckland Council.
Commencement of dewatering	Excavation below the groundwater table and/or commencing taking any groundwater from the basement excavation excluding the installation of the pile walls.
Completion of excavation	When all bulk excavation below groundwater level has been completed. The permanent retaining walls have been propped with the building floors and all foundation/footing excavations within 10 m of the retaining wall have been completed.
Completion of temporary dewatering	When all the external base slab and basement walls are essentially completed, with permanent drainage systems in place, and the structures internal support mechanisms, including basement floors have been completed.
Completion of construction	When the Certificate of Completion is issued by AC.
Significant damage	When damage is considered to affect serviceability or structural integrity.
Serviceability damage	The degree of damage is minor i.e. when doors and windows start sticking.
Damage	Includes aesthetic, serviceability and significant damage.
Alert Level	Monitoring reaches a level close to, or equal to the design value, which is above the level where potential damage could occur, and requires a review to assess the future trend.
Alarm Level	Monitoring reaches the design value, and/or level close to which damage could occur, and requires immediate action including the cessation of ground dewatering and other construction activities that may have an effect on ground deformation.
The Council	Auckland Council (Team Leader, Water Allocation, NRSI) or nominated AC staff acting on The Team Leader's behalf.
NRSI	Natural Resources and Specialist Input, Auckland Council.
RL	Reduced Level.

Services	Includes for example fibre optic cables, sanitary drainage, gas and water mains, power and telephone, road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture.

2 Monitoring

2.1 Summary

Monitoring of the excavation works and surroundings shall be undertaken to check that the ground deformations and groundwater conditions are consistent with the design analyses and that the response of neighbouring structures are within adopted design tolerances.

The monitoring requirements include location of monitoring points, frequency of monitoring, action trigger levels, response procedures and reporting requirements are detailed in the following sections. Survey monitoring locations are shown in the Construction Monitoring Instrumentation Plan Figure 1, Appendix A.

The proposed construction phase monitoring to assess the effects on ground surrounding the site and of the services and structures identified above shall include:

- Pre and post-basement construction condition surveys of the potentially affected building and services.
- Regular visual external survey of the surrounding ground, pavement, associated street infrastructure and structures during construction to identify any deterioration of pre-construction baseline conditions.
- Precise levelling survey of markers/pins on the buildings and maintained existing retention structures surrounding the excavation. The marks shall be set as low as practicable on structures on elements in direct connection with the foundation level (i.e. columns or perimeter footings).
- Precise levelling survey of pavement line levels surrounding the site at ground deformation marks.
- Survey of the retaining wall capping beam at approximately 15 m spacing. The number and spacing of locations may be altered depending on the layout including lateral support spacing and basement access points.
- Retaining wall deformation profile measurement via inclinometers installed within the walls at critical locations, allowing for site access constraints that limit where measurements may be safely undertaken.
- Groundwater monitoring of piezometer installations to assess any relationship between groundwater drawdown and ground deformation.

Monitoring results will be collated by the project Geotechnical Engineer and compared with the specified trigger levels. These records will be held by the project Geotechnical Engineer and will be available for inspection as required.

2.2 Reporting of monitoring records

2.2.1 General

Survey points will be monitored by the Contractor and results will be provided to a qualified Geotechnical Engineer for their review at the frequency set out in the Resource Consent conditions and the following sections. Survey results should be submitted to the project Geotechnical Engineer within three working days of taking the readings.

Monitoring results will be collated by the project Geotechnical Engineer and compared with the specified trigger levels. These records will be held by the project Geotechnical Engineer and will be available for inspection as required. If results exceed the trigger levels mitigation measures will be implemented and results will be reported to the Consents Manager as described in Section 7 to 8.

2.2.2 Pre-dewatering baseline readings

Building dilapidation and pre-condition surveys will be required prior to commencement of construction.

Baseline readings for ground and building deformation and retaining wall deformation shall be established prior to commencement of excavation.

Baseline readings for groundwater shall be established with weekly readings for at least one month prior to the commencement of dewatering. These baseline readings shall be submitted to the Council for approval prior to the commencement of excavation.

2.2.3 Reporting intervals and requirements

During excavation, all monitoring records as detailed in this report shall be compiled and submitted to the Council at **three monthly intervals** from the commencement of excavation until **six months** after the completion of basement construction, when the basement is sealed (or at such time following the completion of basement construction that stable measurements are demonstrated and written approval is granted from the Council).

Each report shall include the following:

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

3 Groundwater monitoring

3.1 Monitoring piezometer details and proposed drawdown trigger levels

Groundwater levels shall be monitored at four planned locations, as set out in Table 3.1, subject to accessibility to the locations and more detailed underground service location check. Measurements shall be accurate to ±100mm for all readings.

Table 3.1: Groundwater drawdown planned locations and drawdown trigger levels

ID	Location	Screen Depth (mRL)[2]	Trigger limits below lowest baseline level[1] (m)	
			Alert Trigger Level 1	Alert Trigger Level 2
MW01	Northeast corner of the site targeting infilled graving dock	-4 to 3	0.7	1.0
MW02	Southeast corner of the site	-1 to 3	0.7	1.0
MW03	Southwest corner of the site	-4 to 3	0.7	1.0
MW04	Northwestern corner – to be confirmed based on access	-4 to 3	0.7	1.0

Note:

1 Baseline readings shall be agreed upon in writing with the Council prior to dewatering.

2 The screen for the monitoring wells are proposed within the reclamation fill and marine sediments. The screen depths will be be confirmed following drilling of the boreholes.

See Figure 1 in Appendix A for the monitoring well planned locations.

Should any of the monitoring bores be damaged and become inoperable during the basement construction monitoring period, then the Council is to be informed and a new monitoring bore is to be drilled at a nearby location in consultation with the Team Leader.

3.2 Groundwater monitoring intervals

The groundwater level in the piezometers shall be measured at the following intervals:

Prior to dewatering	Weekly in the month prior to commencement of dewatering.
During temporary dewatering	Weekly, until the completion of temporary dewatering, or at such time following the completion of excavation that stable measurements are demonstrated and written approval is granted from The Team Leader (AC) to reduce monitoring frequency.
After completion of dewatering for construction	Monthly for minimum six (6) months or until a consistent pattern of groundwater records are obtained in which no evidence of adverse effects is apparent and groundwater levels are above alert trigger levels.

The monitoring frequency may be changed if approved by the Team Leader Central Monitoring. Any change shall be specified in the GSMCP. In addition, the monitoring period post Completion of Temporary Dewatering may be extended, by the Team Leader, Central Monitoring, Resource Consenting and Compliance, if measured groundwater levels are not consistent with inferred seasonal trends or predicted groundwater movement.

The project Geotechnical Engineer will review the results of this monitoring and compare with the trigger levels detailed in the Resource Consent Conditions. If the alert or alarm levels in Table 4.1 are reached, the actions outlined in Section 7 shall be carried out.

4 Retaining wall deflection monitoring

4.1 General

The retention system shall be monitored via survey monitoring points installed along the perimeter capping beam at approximately 15 m spacing, and deformation down the retaining wall will be measured via inclinometers installed within the walls at critical locations. The number and spacing of locations may be altered depending on the layout including lateral support spacing and basement access points.

Proposed locations of the survey monitoring points are shown in Figure 1 in Appendix A.

Survey measurements shall be accurate to ±2 mm. A record of the survey results should be submitted to the Geotechnical Engineer within one working day.

4.2 Retaining wall monitoring intervals

Surveys shall be carried out at the following intervals:

Prior to dewatering	At least two baseline surveys to establish baseline readings
During dewatering, until one month after completion of excavation	Weekly (minimum) and at each 2 metres depth of excavation or when changes to the propping system are being carried out
From one month after completion of excavation, until completion of temporary dewatering	Fortnightly until completion of temporary dewatering.

Monitoring frequency may be reduced if stable measurements are demonstrated and written approval is granted from the Council.

4.3 Retaining wall deflection trigger levels

The results of this monitoring are to be compared with the design assumptions and baseline readings. Trigger levels at which actions are required to be undertaken are summarised in Table 4.1. If the Trigger Levels are reached, the actions outlined in Section 7 shall be carried out.

Table 4.1: Trigger levels for retaining wall deflections

Monitoring ID	Location	Alert trigger level	Alarm trigger level
Survey peg on retaining wall	Top of wall along northern boundary	15 mm	20 mm
	Top of wall along western and eastern boundary	20 mm	25 mm
	Top of wall along southern boundary	15 mm	20 mm
Inclinometers (01 to 03)	Inclinometer in the retaining walls	20 mm	25 mm

Note: Inclinometers are proposed to be installed within the Diaphragm wall. Inclinometers are currently not allowed for along the southern and southeastern perimeter where anchored sheet piles are proposed. However, inclinometer over this section will be considered as required.

5 Ground and building deformation monitoring

5.1 General

Ground and building deformation monitoring marks shall be established on the pavements and buildings surrounding the excavation area at the locations shown on Figure 1 in Appendix A, subject to permission from neighbouring properties.

Survey measurements shall be accurate to ±2 mm. A record of the survey results should be maintained on site and forwarded to the project Geotechnical Engineer within one working day.

5.2 Settlement monitoring intervals

Surveys shall be carried out at the following intervals:

Prior to dewatering	At least two baseline surveys to establish baseline readings.
During temporary dewatering	Weekly.
Post temporary dewatering	Monthly for six months or until such a time following the completion of temporary dewatering that stable measurements are demonstrated and written approval is granted from the Council.

Monitoring frequency may be reduced following the completion of excavation if stable measurements are demonstrated and written approval is granted from the Council.

5.3 Settlement trigger levels

Monitoring data are to be compared with the design assumptions and baseline readings. Alert and Alarm Levels at which actions are required to be undertaken are summarised in Table 5.1. If the alert or alarm levels in Table 4.2 are reached, the actions outlined in Section 7 shall be carried out.

Table 5.1: Ground and building deformation mark trigger levels

Settlement survey mark ID	Location	Total settlement (mm)		Differential settlement	
		Alert level	Alarm level	Alert level	Alarm level
Ground survey pins	Custom Street West	14	20	1V:500H[1]	1V:250H[1]
	Lower Hobson Street	17	25		
	Private accessway between site and AON/ HSBC tower	14	20		
Building survey pins	MSocial	8	12	1:1000 between any two Building deformation marks	1:500 between any two Building deformation marks
	HSBC Tower	8	12		
	AON Tower	8	12		
	Hobson St Flyover	8	12		
	204 Quay Street	7	10		
	Tepid Baths	7	10		
	Watermark Building (85 Custom St West)	7	10		

6 Condition surveys

6.1 Underground service condition surveys

6.1.1 General

The condition surveys should comprise pressure testing or leak detection (acoustic) surveys carried out on the water main and pressure testing or CCTV inspection of the stormwater and wastewater pipes within 20 m of the site.

6.1.2 Condition survey intervals

A condition survey of the public services immediately adjacent to the site shall be carried out before the commencement of dewatering. The survey shall be repeated no earlier than six months after the completion of basement construction.

Following the post-construction survey, a report shall be submitted to the Council within 15 working days demonstrating that the services surveyed have not been damaged.

If the survey indicates damage to the services since the pre-construction survey, a determination of the cause of damage identified shall be reported by a Chartered Professional Engineer, together with a methodology for repair of any damage caused wholly or in part by the construction works.

6.2 Building condition surveys

6.2.1 Accessibility

If a structural condition survey requires access to a building or property, then in the event that access is declined by the owner or subject to unreasonable terms, the Council shall be notified as soon as is practicable. A report from a Chartered Professional Engineer shall be provided identifying whether any alternate risk monitoring options are available that do not involve access to the third party property. The report shall clearly state whether the identified alternative monitoring options will be sufficient to monitor any settlement risk to the property/s to which the monitoring relates and whether they will provide sufficient early detection warning to enable contingency measures to be implemented. Written approval from the Council must be obtained before any alternative monitoring option is implemented.

6.2.2 Recommended building condition survey locations

A visual inspection of the surrounding ground and buildings within 20 m of the project boundary. Survey shall be carried out for the structures in the immediate vicinity of the development, as set out in the following table. For the internal building survey, the survey shall cover the basement levels and the ground floor.

Table 6.1: List of buildings requiring condition surveys

Address	Legal Title	External survey	Internal Survey	Settlement Pins (Yes/No)
MSocial (196 Quay St)	Lot 8 DP 60151	✓	✓	Yes
HSBC Tower (188 Quay St)	Lot 5 DP 63972 and Lot 1 DP 7834	✓	✓	Yes
AON Tower (21/29 Custom St West)	Lot 7 DP 77037	✓	✓	Yes
Tepid Baths (100 Custom St West)	Lot 2 DP 184176	✓	✓	Yes
Watermark (85 Custom St West/ 1 Lower Hobson St)	Lot 2 DP 197735	✓	×	Yes
204 Quay Street	Lot 1 DP 183125	✓	×	No
Lower Hobson Street flyover	N/A	✓	×	Yes

6.2.3 Pre and post-construction condition survey

A pre-construction condition survey of the specified buildings shall be carried out prior to the commencement of dewatering.

The survey report shall confirm the existing condition of the building and enable the sensitivity of the buildings to potential damage caused by groundwater and ground settlement changes to be accurately determined. Major features of the building and site developments shall be recorded including location, type of construction, age and present conditions including defects.

The survey shall include, but not be limited to, the following:

1 A description of the type of foundations.

2 A description of existing levels of damage considered to be of an aesthetic or superficial nature.

3 A description of existing levels of damage considered affecting the serviceability of the building where visually apparent without recourse to intrusive or destructive investigation.

4 An assessment as to whether existing damage may or may not be associated with actual structural damage and an assessment of the susceptibility of the buildings/structures to further movement and damage, to the extent predicted.

5 Photographic evidence of existing observable damage.

6 Confirmation of the installation of deformation pins as required by this specification.

7 A review of proposed Alarm and Alert Levels to confirm they are appropriately set and confirmation that any ground settlement less than the Alarm Level will not cause damage.

8 An assessment of whether the monitoring frequency is appropriate.

9 An assessment of whether the location and density of existing deformation pins is adequate and appropriate for the effective detection of change to building and structure condition.

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

A copy of the pre and post-construction reports shall be forwarded to the Council within 15 working days of completing the reports along with a certificate from the Chartered Surveyor or Chartered Professional Engineer who has certified that the survey has been completed in a professional manner and is an accurate assessment of the condition of the building concerned.

6.2.4 Construction phase inspections

A visual inspection undertaken by the Principal Contractor at regular intervals shall monitor any deterioration or further cracking of any pre-existing cracks on the following:

- The ground within 10 m of the excavation.
- External facades of the buildings identified for structural condition surveys.

A photographic record of the surveys is to be maintained including the time, date and any observations for each inspection. This record is to be maintained on site and forwarded to T+T typically monthly but within one day if any deterioration or cracking is observed.

6.2.5 Condition survey intervals

A visual inspection of the surrounding ground and specified buildings shall be carried out at the following intervals:

Prior to dewatering	Pre-construction survey as detailed in Section 6.2.3.
From Commencement of Dewatering to Completion of Dewatering	Weekly visual inspections as detailed in Section 6.2.4.
After completion of basement construction	Post-construction survey within six months of completion of construction as detailed in Section 6.2.3.

6.3 Underground service condition surveys

6.3.1 General

The condition surveys should comprise pressure testing or leak detection (acoustic) surveys carried out on the water main and pressure testing or CCTV inspection of the stormwater and wastewater pipes within 20 m of the site.

6.3.2 Condition survey intervals

A condition survey of the public services immediately adjacent to the site shall be carried out before the commencement of dewatering. The survey shall be repeated no earlier than six months after the completion of basement construction.

Following the post-construction survey, a report shall be submitted to the Council within 15 working days demonstrating that the services surveyed have not been damaged.

If the survey indicates damage to the services since the pre-construction survey, a determination of the cause of damage identified shall be reported by a Chartered Professional Engineer, together with a methodology for repair of any damage caused wholly or in part by the construction works.

7 Alert and alarm trigger level response procedures

7.1 Response procedure if the alert trigger levels are exceeded

If any of the monitoring alert settlement trigger levels are reached then one or more of the contingency options described in Section 8 of this plan should be carried out together with:

1 Notify the Project Manager.

2 Notify the Council, in writing within one working day of the trigger level being exceeded, with details of any actions being undertaken.

3 Survey all monitoring marks within a 50 m radius of the monitoring point, and compare them to settlement trigger levels.

4 Review the monitoring data, as-built details and geology and compare against the assumptions made in the design analyses.

5 Submit a report by a Chartered Professional Engineer to the Council for approval, within one week of trigger level exceedance, which provides analyses of all monitoring data, including wall deflection monitoring, relating to the exceedance of any of the trigger levels and any recommendations for remedial actions and time frames for implementing these actions. If no remedial actions are considered necessary, then justification for this viewpoint is required.

6 All monitoring pins and groundwater levels within 50 m shall be surveyed at two day intervals until such time the written report in (5) has been approved by the Council.

If considered necessary:

1 Increase monitoring frequency.

2 Develop a detailed contingency plan and submit to the Council.

7.2 Response procedure if the alarm trigger levels are exceeded

If any of the monitoring alarm settlement trigger levels are reached then the following shall be carried out in addition to the actions outlined in the previous section:

1 Cease further lowering of the water table or any other activity which has the potential to cause further deformations.

2 Submit a written report by a Chartered Professional Engineer to the Council for approval, within one week of alarm trigger Level exceedance, which provides analyses of all monitoring data and any recommendations for remedial action.

3 Once approved by the Council the recommendations shall be implemented.

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

8 Contingency Options

8.1 General

If any of the monitoring trigger levels are exceeded the general response will be as detailed in Section 7. Specific actions will be selected depending on the exact nature of the problem. Possible contingency actions are detailed in the following sections.

8.2 Retaining wall deflection contingency measures

In the event of retaining wall deflections exceeding the monitoring trigger levels, a review of the retaining design model shall be carried out to assess the potential increased load in the wall, anchors and existing props, and potential increase in mechanical ground deformations.

If required, the following actions may be taken:

1 Reduce load on the wall by allowing water to drain from behind the wall. This would be temporary while one of the other mitigation measures is undertaken.

2 Place a temporary berm of soil in front of the wall.

3 Install additional props and/ or anchors.

8.3 Groundwater drawdown contingency measures

8.3.1 Groundwater recharge during construction

One option to lessen the effect of groundwater dewatering during the excavation in a local area is to inject further water into the ground through shallow injection wells or a trench.

The shallow well injection system will likely consist of the following:

1 2 m to 6 m deep, 150 mm diameter wells spaced at approximately 10 m centres (depending on degree of drawdown).

2 A water supply manifold connected to a header tank with float valve and flow meter.

The location of the wells will be dependent on where the groundwater has been drawn down. Following the implementation of the injection wells the groundwater levels will be monitored closely.

8.3.2 Options to reduce temporary and permanent drawdown

In the event of groundwater drawdown exceeding the monitoring trigger levels, one or more of the following actions may be taken:

1 Grout anchor points, wall connections or other areas of excessive seepage.

2 Shallow reinjection wells to inject potable water into the ground to mitigate the change in groundwater level (groundwater recharge).

3 Construct a grout curtain to reduce inflow.

4 Install an impermeable wall inside the diaphragm/ sheet pile wall, designed to resist hydraulic pressure.

5 Locally tank floor to extend the drainage path.

6 Convert to a tanked basement.

8.4 Ground and building deformation contingency measures

In the event of ground or building deformation exceeding the monitoring trigger levels, one or more of the following actions shall be taken:

1 Check public safety is maintained.

2 Review the potential causes for ground of building deformations.

3 Discuss the situation with the property/service owner that may be affected.

4 Monitor the rate of settlement (assuming that other steps have been undertaken to address the cause).

5 Undertake remedial works including foundation strengthening.

6 Accept and reinstate resultant damage.

9 Applicability

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

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

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

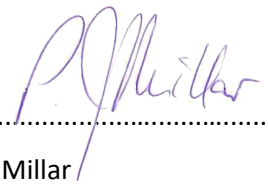
Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Ananth Balachandra
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:



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Peter Millar
Project Director

6-Dec-24
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Appendix A Construction Monitoring and Instrumentation plan

C:\12dSynergy\data\ALBTCAD\DCR Concept and Resource Consent Stage_1352\CAD\FIG\1016043.1000-GEO-F1.dwg 2023-May-26 9:36:57 AM Plotted By: JONALD CASTRO

LEGEND

- PROPERTY BOUNDARY
- ECBF CONTOUR (1m INTERVAL)
- GEOMAPS WATER LINE
- GEOMAPS ABANDONED WATER LINE
- WATER HYDRANT
- WATER VALVE
- GEOMAPS STORMWATER LINE
- GEOMAPS ABANDONED STORMWATER LINE
- STORMWATER CATCHPIT
- STORMWATER MANHOLE
- GEOMAPS WASTEWATER LINE
- GEOMAPS ABANDONED WASTEWATER LINE
- WASTEWATER MANHOLE
- CRL UNDERGROUND ROUTE
- CHORUS
- VECTOR COMMUNICATION - UNDERGROUND ROUTE TRENCH
- VECTOR COMMUNICATION - UNDERGROUND INSTALLED IN PLACE
- GAS
- GAS VALVE
- VODAFONE
- FIBRE OPTIC
- POWER
- LAMP

LEGEND FOR MONITORING

- PROPOSED GROUNDWATER MONITORING WELL
- PROPOSED RETAINING WALL INCLINOMETER
- PROPOSED GROUND SURVEY PEG (NUMBERING TBC)
- PROPOSED BUILDING SURVEY PIN (NUMBERING TBC)
- PROPOSED SURVEY PEG ON RETAINING WALL (NUMBERING TBC)

QUAY ST
MSocial
MW04
IN01
MW01
IN03
IN02
HSBC Tower
LOWER HOBSON ST
MW03
Watermark Building
Tepid Baths
AON Tower
MW02
LOWER ALBERT ST
STURDEE ST
FANSHAWE ST

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

ORIGINAL IN COLOUR

DRAFT

CHECK PRINT	INITIAL	DATE
BACKDRAFTING REQUIRED		
READY TO ISSUE		
CAD SELF CHECK		
DESIGN CHECK		
DRAFTING CHECK		
BACKDRAFTER - EDITS MADE		
BACKCHECKER - EDITS CONFIRMED		

Tonkin+Taylor
Exceptional thinking together www.tonkintaylor.co.nz

NOTES:
1. AERIAL PHOTO, STORMWATER LINE, WASTEWATER LINE AND WATER LINE SOURCED FROM AUCKLAND COUNCIL GEOMAPS, LICENSED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). CAPTURE DATE 24/05/2023.
2. VODAFONE AND CRL INFORMATION SUPPLIED BY BEFORE U DIG. REF 11197173 - Vodafone Plan.pdf AND "11197172 - CityLink Plan (002).pdf".
3. CHORUS INFORMATION SUPPLIED BY CHORUS, REF "CHORUS.pdf".
4. VECTOR POWER, COMMUNICATION AND GAS SUPPLIED BY VECTOR, REF "VECTOR ELECTRICITY.pdf" , "VECTOR COMMUNICATION.pdf" AND "VECTOR GAS.pdf".

PROJECT No.	1016043.1000	
DESIGNED	ABL	May.23
DRAWN	JC	May.23
CHECKED		
APPROVED		DATE

CLIENT **PRECINCT PROPERTIES HOLDINGS LIMITED**
PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**
TITLE CONSTRUCTION MONITORING AND INSTRUMENTATION PLAN
SCALE (A3) 1:750 FIG No. FIGURE 1 REV 1

Appendix B Summary of monitoring requirements

[Placeholder]

Appendix C Piezometer construction records

[Placeholder]

Appendix D Groundwater monitoring records

[Placeholder]

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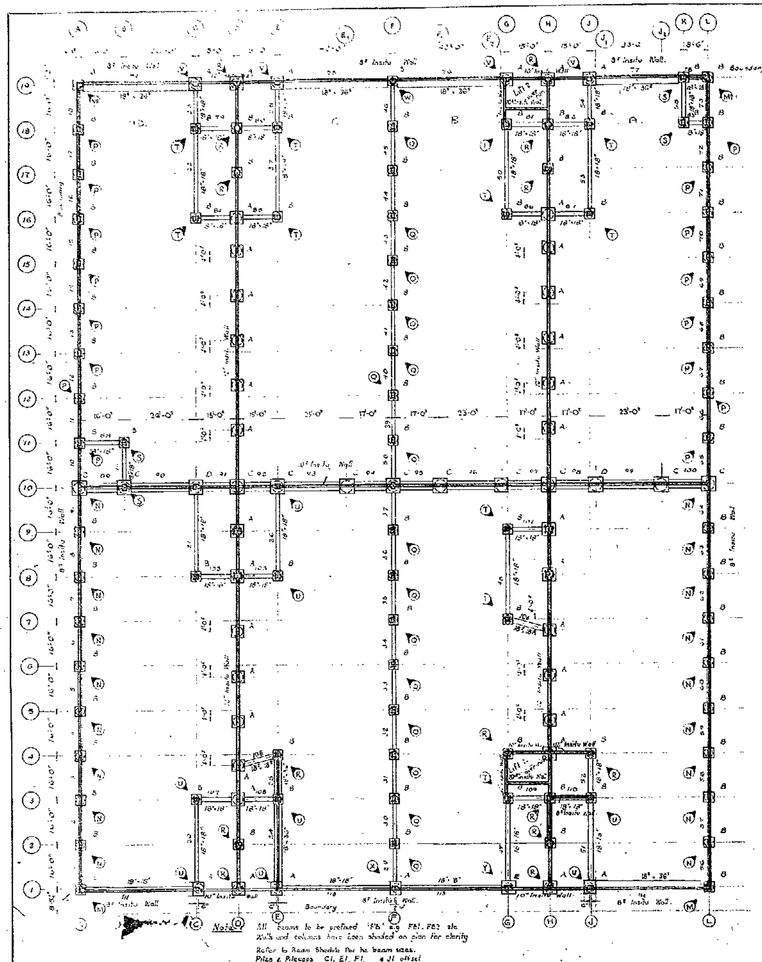
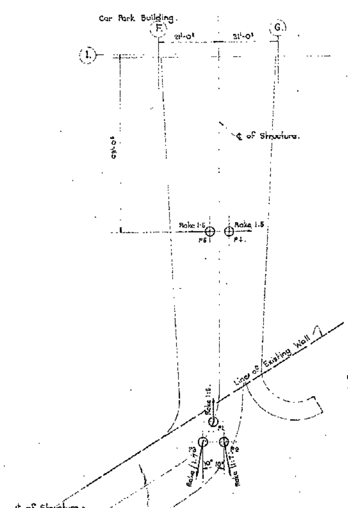
Appendix C Foundation plans for the existing carpark

Zone A
Zone B
Zone C





BRIDGE · PILE LAYOUT.
Scale: 1/8" = 1'-0"

TOP OF PILE CAPS & PILE CUT OFF LEVELS

Grid	Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	Top of Pile Cap Level	7.0	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	[illegible]	[illegible]
	Pile Cut Off Level	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	1.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50	[illegible]	[illegible]
B	Top of Pile Cap Level										4.75	4.75								
	Pile Cut Off Level										1.00	2.50								
C	Top of Pile Cap Level	7.00		8.00					8.00		2.75						4.75		[illegible]	[illegible]
	Pile Cut Off Level	3.25		5.15					5.75		4.75						2.50		[illegible]	[illegible]
D	Top of Pile Cap Level	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
	Pile Cut Off Level	4.25	[illegible]	4.25	4.25	4.25	4.25	4.25	4.25	4.25	-3.75	-3.75	-3.75	-3.75	-3.75	-3.75	[illegible]	[illegible]	[illegible]	[illegible]
E	Top of Pile Cap Level	8.00		8.00	8.00				8.00		0.00						0.00		[illegible]	[illegible]
	Pile Cut Off Level	4.25		5.75	5.75				5.75		-3.75						-2.25		[illegible]	[illegible]
E_1	Top of Pile Cap Level										0.00									
	Pile Cut Off Level										-3.75									
F	Top of Pile Cap Level	9.50	10.50	11.00	11.00	11.00	11.00	11.00	11.00	11.00	0.00	1.25	1.25	1.25	1.25	1.25	1.25	1.25	[illegible]	[illegible]
	Pile Cut Off Level	5.75	6.25	6.75	6.75	6.75	6.75	6.75	6.75	6.75	-3.75	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	[illegible]	[illegible]
F_1	Top of Pile Cap Level										0.00									
	Pile Cut Off Level										-3.75									
G	Top of Pile Cap Level	9.50		9.50	2.00			10.25		10.25							0.00		[illegible]	[illegible]
	Pile Cut Off Level	5.75		7.25	-0.25			8.00		8.00							-2.25		[illegible]	[illegible]
H	Top of Pile Cap Level	11.00	9.50	9.50	2.00	10.25	10.25	10.25	10.25	10.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]
	Pile Cut Off Level	7.25	7.25	7.25	-1.75	6.50	6.50	6.50	6.50	6.50	-3.75	-3.75	-3.75	-3.75	-3.75	-3.75	-3.75	[illegible]	[illegible]	[illegible]
J	Top of Pile Cap Level	11.00		9.50	15.00												4.75		[illegible]	[illegible]
	Pile Cut Off Level	7.25		7.25	11.75												2.50		[illegible]	[illegible]
J_1	Top of Pile Cap Level										2.75									
	Pile Cut Off Level										-1.75									
K	Top of Pile Cap Level																		[illegible]	[illegible]
	Pile Cut Off Level																		[illegible]	[illegible]
L	Top of Pile Cap Level	11.00	11.00	11.00	6.00	6.00	6.00	6.00	6.00	6.00	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	[illegible]	[illegible]
	Pile Cut Off Level	6.75	6.75	6.75	3.75	3.75	3.75	3.75	3.75	3.75	1.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50	[illegible]	[illegible]
F_2	Top of Pile Cap Level										0.00									
	Pile Cut Off Level										-3.75									
J_2	Top of Pile Cap Level										4.75									
	Pile Cut Off Level										1.00									

Beam	Size
1-18	18"·14"
19-23, 26-55	18"·18"
56-73	18"·14"
24,25,74-77	15"·36"
78-88	18"·18"
89-100	24"·36"
101-118	18"·18"
111	18"·36"

Beams FB49 & FB106 omitted

TIE BEAM SCHEDULE

PILE CAP TYPES

A 4'0" · 4'0" · 4'0" DEEP
B 3'6" · 3'6" · 2'6" DEEP
C 4'6" · 4'6" · 4'0" DEEP
D 4'6" · 4'6" · 4'9" DEEP
E 5'6" · 4'0" · 4'0 DEEP

PEDESTAL TYPES INDICATED THUS (P)

For all Pedestal types see drg N°45

No.	Amendments		
D.	Boundary dimensions amended		
C.	Tie Beam Schedule amended		
B.	Bridge Pile Layout added		
A.	Pedestal types added · Beams 24 & 25 altered		

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE.
FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALE

AUCKLAND DOWNTO[WN]
REDEVELOPMENT
STAGE 1

CAR PARKING STATION
FOR
AUCKLAND CITY COUNCIL

DRAWING TITLE
LAYOUT OF BORED PILES

DRAWN M.S. | DATE JULY 19?? | CS 03??
DESIGN R.N.? | SCALES 1/16", 1/8" = 1'-0"
CHECKED

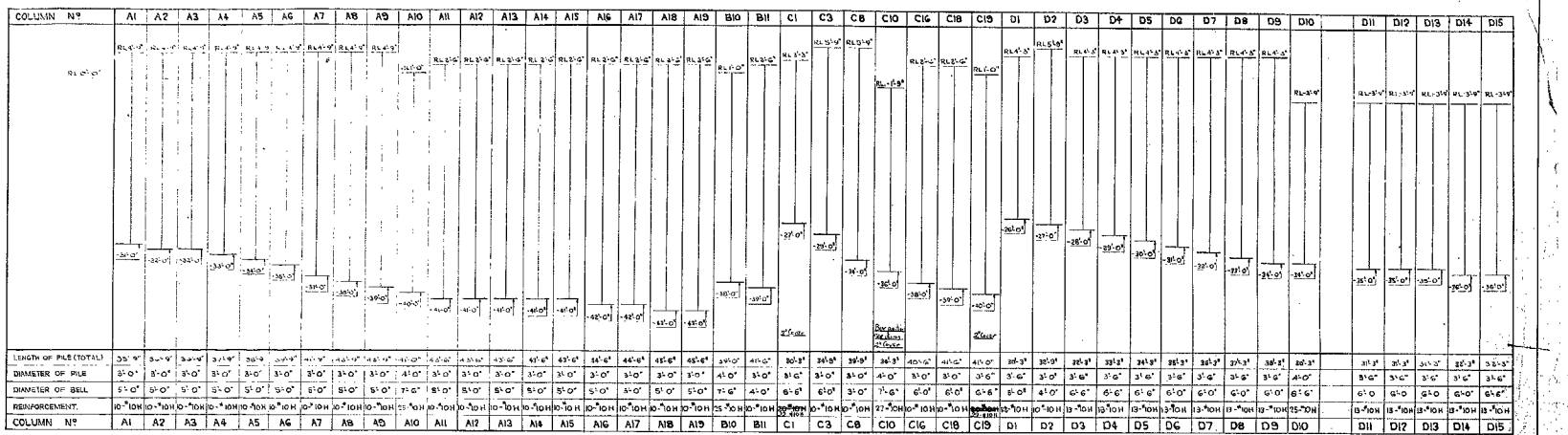
CONSULTING ENGINEERS
RANKINE & HILL
19 MILLER STREET,
NORTH SYDNEY, N.S.W.

BRICKELL, MOSS, RANKINE & HILL

RECEIVED 6 JAN 1969

(A0)
73-81 Customs Street West
P. no 956

84 of 90



COLUMN Nº	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	B10	B11	C1	C3	C8	C10	C16	C18	C19	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
LENGTH OF PILE (TOTAL)	35'-9"	34'-9"	34'-9"	34'-9"	34'-9"	34'-9"	41'-9"	41'-9"	41'-9"	41'-9"	41'-9"	41'-9"	41'-9"	41'-6"	42'-6"	42'-6"	44'-6"	45'-6"	45'-6"	39'-0"	41'-0"	30'-3"	34'-9"	39'-9"	36'-3"	40'-0"	40'-0"	41'-0"	26'-3"	30'-3"	28'-3"	33'-3"	34'-3"	35'-3"	36'-3"	37'-3"	38'-3"	40'-0"	31'-3"	31'-3"	31'-3"	35'-3"	33'-3"
DIAMETER OF PILE	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	3'-6"	3'-6"	3'-0"	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"	4'-0"	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"
DIAMETER OF BELL	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	6'-0"	5'-0"	5'-0"	7'-6"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	7'-6"	4'-0"	6'-6"	6'-0"	3'-0"	7'-6"	6'-0"	6'-0"	6'-6"	5'-0"	4'-0"	6'-6"	6'-6"	6'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-6"
REINFORCEMENT	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	25-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	25-#10H	10-#10H	20-#10H R-#10H	10-#10H	10-#10H	27-#10H	10-#10H	10-#10H	See Sch R-#10H	10-#10H	10-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H	25-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H
COLUMN Nº	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	B10	B11	C1	C3	C8	C10	C16	C18	C19	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15

COLUMN Nº	D16	D17	D18	D19	E1	E3	E4	E8	E10	E16	E18	E19	$E_1$10	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	$F_1$10	F11	F12	F13	F14	F15	F16	F17	F18	F19	$F_2$10	G1	G3	G4
LENGTH OF PILE (TOTAL)	35'-3"	34'-3"	34'-3"	34'-3"	24'-3"	31'-3"	32'-3"	28'-3"	28'-3"	32'-3"	34'-3"	34'-3"	27'-3"	29'-3"	30'-3"	30'-3"	31'-3"	31'-3"	31'-3"	33'-3"	33'-3"	35'-3"	28'-3"	22'-3"	29'-0"	30'-0"	30'-0"	31'-0"	32'-0"	32'-0"	32'-0"	34'-0"	35'-0"	26'-3"	24'-9"	26'-3"	10'-3"
DIAMETER OF PILE	3'-6"	3'-0"	3'-0"	3'-0"	3'-6"	3'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	4'-0"	3'-6"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	4'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	3'-6"	3'-0"	3'-0"
DIAMETER OF BELL	6'-0"	4'-0"	6'-0"	5'-0"	6'-6"	6'-0"	4'-0"	3'-0"	7'-6"	6'-0"	6'-0"	6'-6"	7'-6"	6'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-6"	7'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	7'-6"	6'-6"	6'-0"	4'-0"
REINFORCEMENT	8-#10H	10-#10H	10-#10H	12-#10H	See Sch 22-#10H	10-#10H	10-#10H	10-#10H	27-#10H	10-#10H	10-#10H	See Sch 22-#10H	27-#10H	10-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	25-#10H	27-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	See Sch R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	10-#10H R-#10H	27-#10H	See Sch 33-#10H	10-#10H	10-#10H
COLUMN Nº	D16	D17	D18	D19	E1	E3	E4	E8	E10	E16	E18	E19	$E_1$10	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	$F_1$10	F11	F12	F13	F14	F15	F16	F17	F18	F19	$F_2$10	G1	G3	G4

(A0)
73-81 Customs Street West
P.no 956

No.	AMENDMENTS	BY	DATE	CHCK
A	Piles revised throughout		4.10.68	

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE
FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALE

AUCKLAND DOWNTOWN REDEVELOPMENT
STAGE 1

CAR PARKING STATION
FOR
AUCKLAND CITY COUNCIL

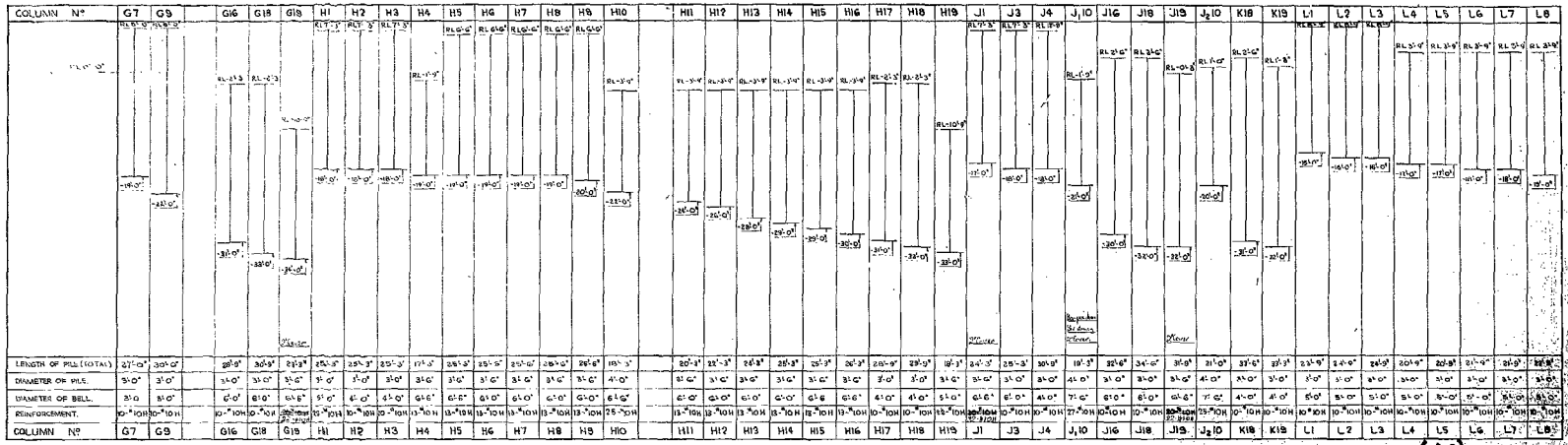
DRAWING TITLE
BORED PILES
PART SCHEDULE

DRAWN IGH	DATE 31-5-68	JOB No. CS 0023
DESIGN R.N.T.	SCALES NTS.	DWG. No. 24
CHECKED	APPROVED	

CONSULTING ENGINEERS
BRICKELL, MOSS, RANKINE & HILL
40 MILLER STREET, NORTH SYDNEY, N.S.W. TEL.: 92-0655
A.M.P. HOUSE, 205 QUEEN STREET, AUCKLAND, N.Z. TEL.: 49-868

35 of 90

ARCHITECTS
ARGLE THORP & WALKER
RESIDENT PARTNER • CHARLES ANDERSON • ARCHITECT
27 QUEEN STREET, AUCKLAND TEL.71-***

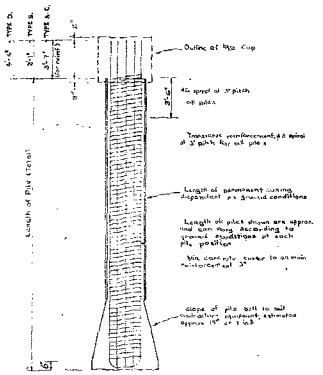


COLUMN N°	G7	G9	G16	G18	G19	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	J1	J3	J4	J1,10	J16	J18	J19	J2,10	K18	K19	L1	L2	L3	L4	L5	L6	L7	L8
LENGTH OF PILE (TOTAL)	27'-0"	30'-0"	28'-9"	30'-9"	28'-9"	28'-3"	28'-3"	28'-3"	17'-3"	26'-3"	25'-3"	25'-3"	26'-3"	26'-6"	18'-3"	20'-3"	22'-3"	24'-3"	26'-3"	28'-3"	28'-9"	29'-9"	29'-9"	18'-3"	24'-3"	25'-3"	30'-3"	19'-3"	32'-6"	34'-0"	36'-0"	31'-0"	33'-6"	33'-3"	23'-9"	24'-9"	20'-9"	20'-9"	21'-9"	21'-9"	21'-9"	21'-9"
DIAMETER OF PILE	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	4'-0"	6'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	5'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	4'-0"	3'-0"	3'-0"	3'-0"	5'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
DIAMETER OF BELL	3'-0	3'-0"	6'-0"	6'-0"	6'-6"	5'-0"	6'-0"	6'-0"	6'-6"	6'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-6"	6'-0"	6'-0"	6'-0"	6'-0"	6'-6"	6'-6"	6'-6"	6'-0"	6'-0"	6'-6"	6'-0"	6'-0"	7'-0"	8'-0"	8'-0"	6'-6"	7'-0"	4'-0"	4'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"
REINFORCEMENT	10-#10H	10-#10H	10-#10H	10-#10H	20-#10H 25-#10H	10-#10H	10-#10H	10-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H	13-#10H	25-#10H	13-#10H	13-#10H	13-#10H	13-#10H	10-#10H	10-#10H	10-#10H	12-#10H	19-#10H	10-#10H	10-#10H	27-#10H	10-#10H	10-#10H	20-#10H 20-#16H	25-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H
COLUMN N°	G7	G9	G16	G18	G19	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	J1	J3	J4	J1,10	J16	J18	J19	J2,10	K18	K19	L1	L2	L3	L4	L5	L6	L7	L8

(A0)

73-81 Customs Street West

P.no 956



NOTES:

1. All concrete in piles to be 40MPa min. crushing strength in accordance with NZSS 1900 Chapter 9.3 'Concrete placing under water', whereby max. water - cement ratio by weight = 0.60 and min. cement content 475 lb/cu.yd. of conc. for High Grade Concrete.
2. Main (vert) reinforcement to be 60,000 psi. yield strength steel (marked 'H') (NZSS 87 & 108), secondary reinf. (spirals) to be structural grade mild steel.
3. Laps for main reinforcement to be 30 dia. of bar where unavoidable, but use continuous bars if possible.
4. Casing shown for full length of pile as permanent, but contractor may withdraw casing if approved by the Engineer. Contractor should also refer to Quantity Surveyors schedule.
5. Length of pile is the measurement between Founding level & levels shown at top of pile. (See typical pile.)
6. All levels are to NZC datum (See 'Foundation Investigation' - Bloage & Auckland Harbour Board Central Area Properties Redevelopment - Auckland NZ.)
7. Founding levels of piles shown in schedule are based on information given in the above 'Foundation Investigation....' but it may vary according to ground conditions at each pile.
8. Design bearing pressure: DL + LL + Seismic = 24 T/sq.ft., DL + LL = 20 T/sq.ft.

COLUMN N°	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	P1	P2	P3	P4	P5	P6
LENGTH OF PILE (TOTAL)	23'-3"	21'-0"	22'-6"	25'-6"	30'-6"	27'-6"	29'-6"	31'-0"	33'-0"	33'-6"	33'-3"	22'-4"	20'-11"	20'-1"	30'-1"	30'-1"	37'-1"
DIAMETER OF PILE	3'-0"	4'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
DIAMETER OF BELL	5'-0"	7'-6"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	6'-0"
REINFORCEMENT	10-#10H	25-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	10-#10H	16-#9	10#9	10-#9	15-#9	10-#9	42-#10
COLUMN N°	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	P1	P2	P3	P4	P5	P6

Pile Types see Bridge Plan on Drg N° 1.

No.	Amendments	By	Date	Check
A	Piles revised throughout. Bridge Piles added.		3/10	

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE. FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALE.

AUCKLAND DOWNTOWN REDEVELOPMENT

STAGE 1

CAR PARKING STATION
AUCKLAND CITY COUNCIL

Drawing Title: BORED PILES PART SCHEDULE

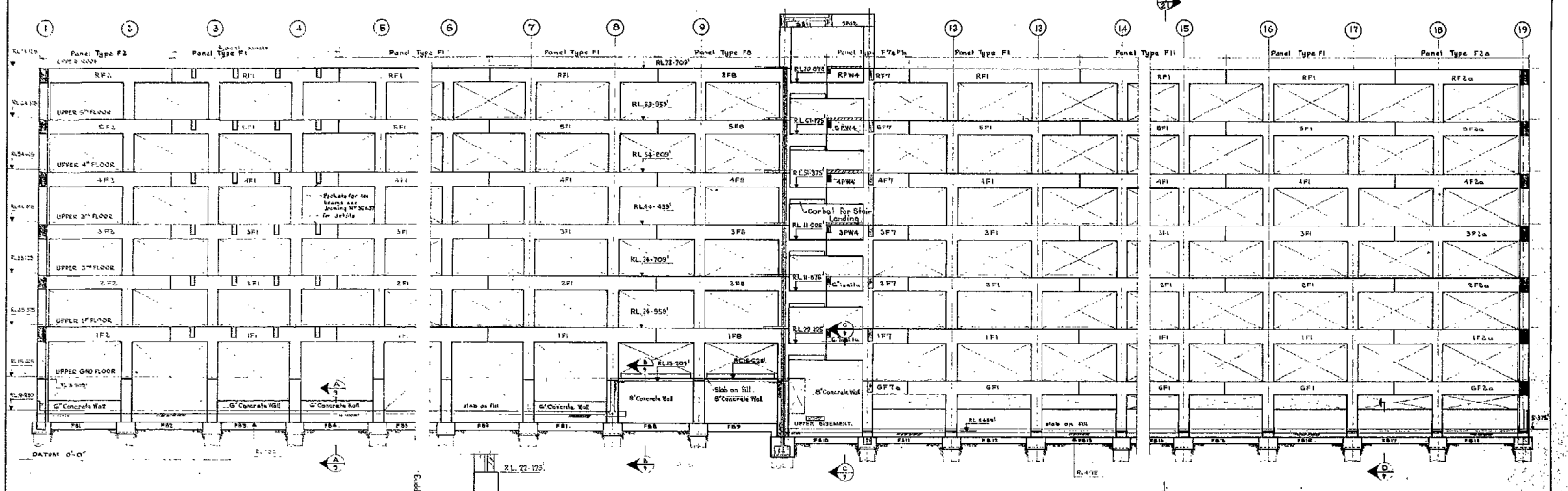
Drawn: IGH.	Date: 21-5-68	Job No.: 68 0023
Design: R.N.T.	Scales: ALT.S.	Dwg. No.: 3A
Checked: [illegible]	Approved:	

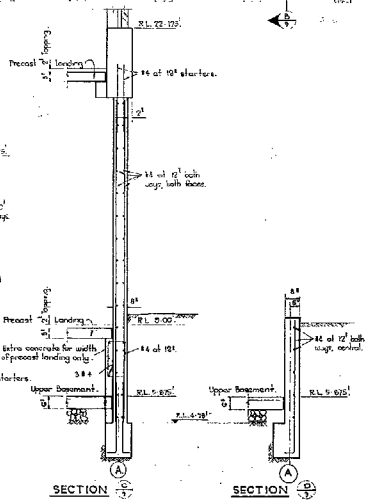
CONSULTING ENGINEERS
RANKINE & HILL
46 MILLER STREET, NORTH SYDNEY, N.S.W. TEL.: 92-5555

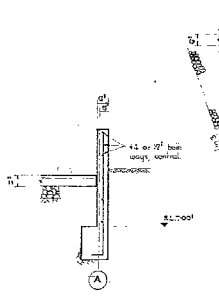
BRICKELL, MOIR, RANKINE & HILL
AUCK. OFFICE 205 QUEEN STREET, AUCKLAND, N.Z. TEL.: 33-600

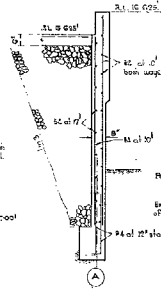
866 90

PEDDLE THORP & WALKER
RESIDENT PARTNER - CHARLES ANDERSON - ARCHITECT
97 QUEEN STREET, AUCKLAND

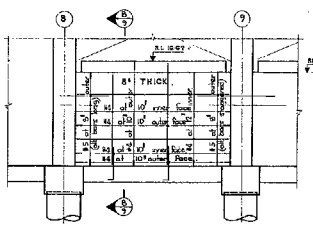








ELEVATION GRID A



TYPICAL WALL BETWEEN GRIDS 8 & 10

Notes:
All Retaining walls have been designed assuming granular back fill.
All walls over 5'-0" high & walls on Grids D & 11 to be back filled with approved granular material, see foundation report.

(AO)
73-81 Customs Street West
P.no 956

For General Notes see Drawing No 080029-0.
At block walls are omitted for clarity.
For reinforcing steel in typical perimeter kerbs refer to drg No 27
For reinforcement of precast panels see drg No SC 4 87

No.	AMENDMENTS	BY	DATE	CHECK
A	Sections B & C amended			

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE
FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALE

AUCKLAND DOWNTOWN REDEVELOPMENT
STAGE 1

CAR PARKING STATION
AUCKLAND CITY COUNCIL

DRAWING TITLE
ELEVATION - GRID A.

DRAWN E.G.H.	DATE JULY 1988	JOB No. CS 0023
DESIGN R.N.Z.	SCALES 1/8 & 1'-0"	DWG. No. 9.A
CHECKED	APPROVED	

CONSULTING ENGINEERS
RANKINE & HILL
40 MILLER STREET, NORTH SYDNEY, N.S.W. TEL: 92-0600

BRICKELL, MOSS, RANKINE & HILL
LAKE HOUSE, 280 QUEEN STREET, AUCKLAND, N.Z. TEL: 43-660

PEDDLE THORP & WALKER
RESIDENT ARCHITECT - A. CUMMINS ANDERSON - ARCHITECTS
87 QUEEN STREET, AUCKLAND TEL 89-689

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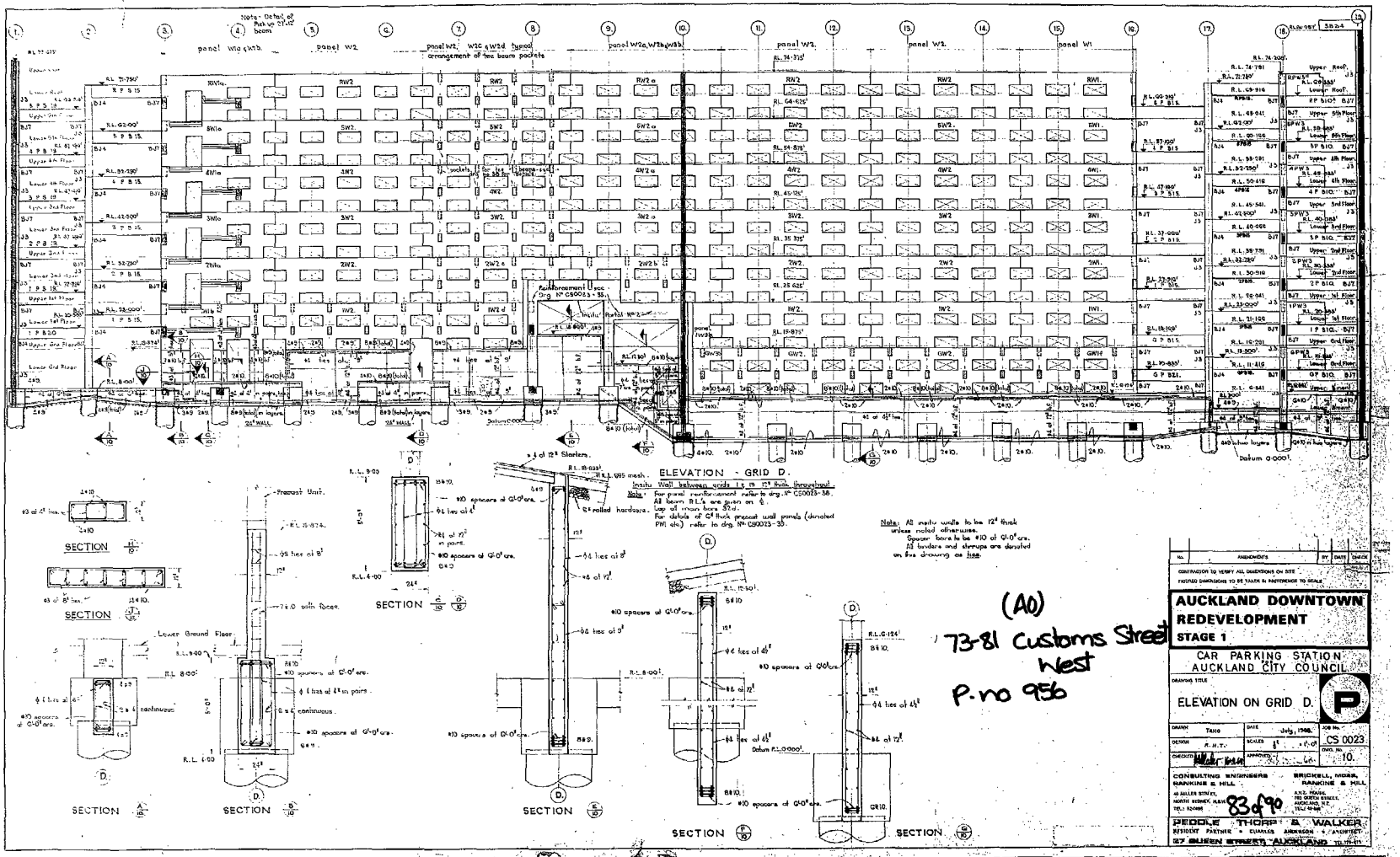
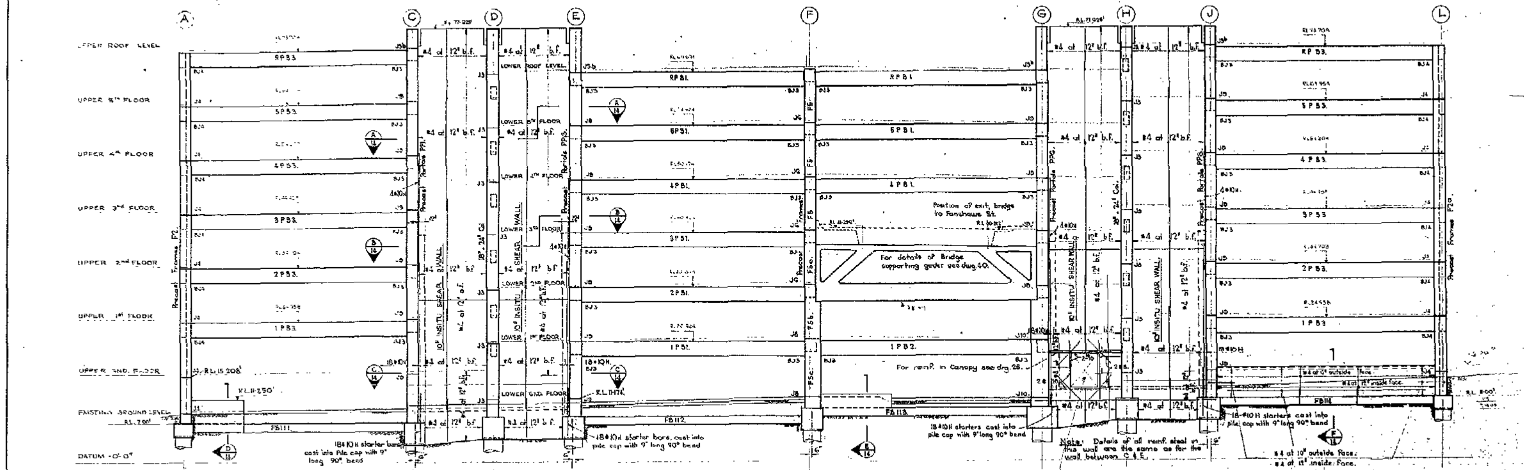
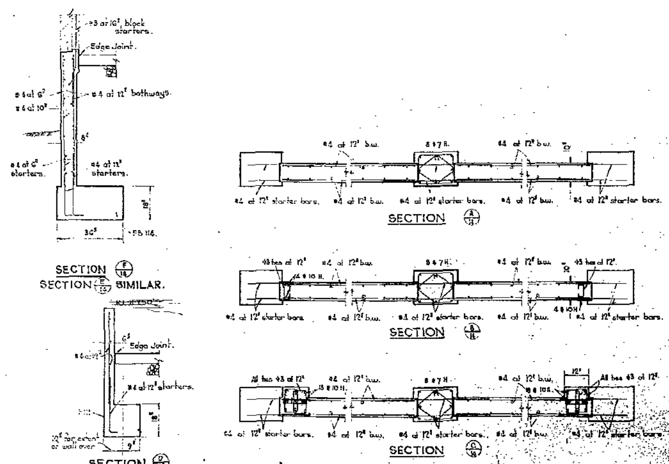

ELEVATION - GRID D.
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
Note: All insitu walls to be 12" thick unless noted otherwise.
Spacer bars to be #10 at 0'-0" ctrs.
All binders and stirrups are detailed on this drawing as typ.
(A0)
73-81 Customs Street West
P.no 956
AUCKLAND DOWNTOWN REDEVELOPMENT
STAGE 1
CAR PARKING STATION
AUCKLAND CITY COUNCIL
ELEVATION ON GRID D.
CS 0023
10.
CONSULTING ENGINEERS
RANKINE & HILL
BRICKELL, MOIR, RANKINE & HILL
PEDDLE THORP & WALKER
83 of 90



ELEVATION GRID 1.

For details of precast beams, refer drg. 39.
Beam Joints denoted by 'BJ', e.g. BJ3.
Column Joints denoted by 'J', e.g. J6.
All connections between precast columns & 10" insitu shear walls must have a keyed surface cast into the precast columns, through the height of the shear wall.
For details of precast column splice, J3 & J3b refer drg. 16.
For reinforcement in Perimeter Kerbs see drg No 27.



(A0)
73-81 Customs Street West
P. no 956

No.	AMENDMENTS	BY	DATE	CHECK

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE
FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALE

AUCKLAND DOWNTOWN REDEVELOPMENT
STAGE 1

CAR PARKING STATION
AUCKLAND CITY COUNCIL

DRAWING TITLE
ELEVATION - GRID 1

DRAWN I.G.H.	DATE JULY 1969	JOB No. CS.0023
DESIGN R.N.T.	SCALES 1/8" = 1'-0"	DWG. No. 14
CHECKED	APPROVED	

CONSULTING ENGINEERS
RANKINE & HILL
BRICKELL, MOSS, RANKINE & HILL
A.N.Z. HOUSE, QUEEN STREET, AUCKLAND, N.Z.

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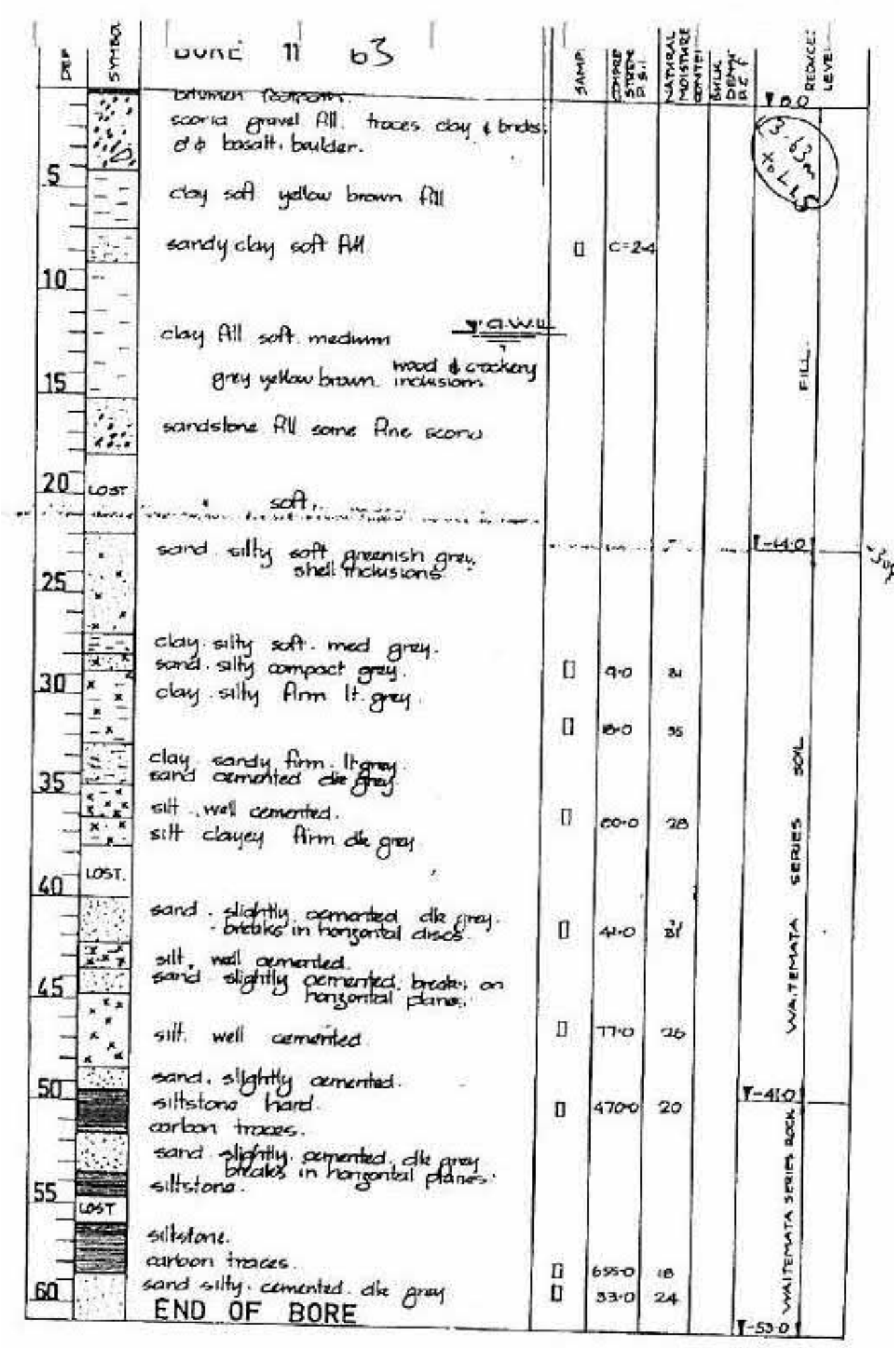
PEDDLE THORP & WALKER
RESIDENT PARTNER · CHARLES ANDERSON · ARCHITECT
97 QUEEN STREET, AUCKLAND

Appendix D Previous ground investigation results

801_BH11

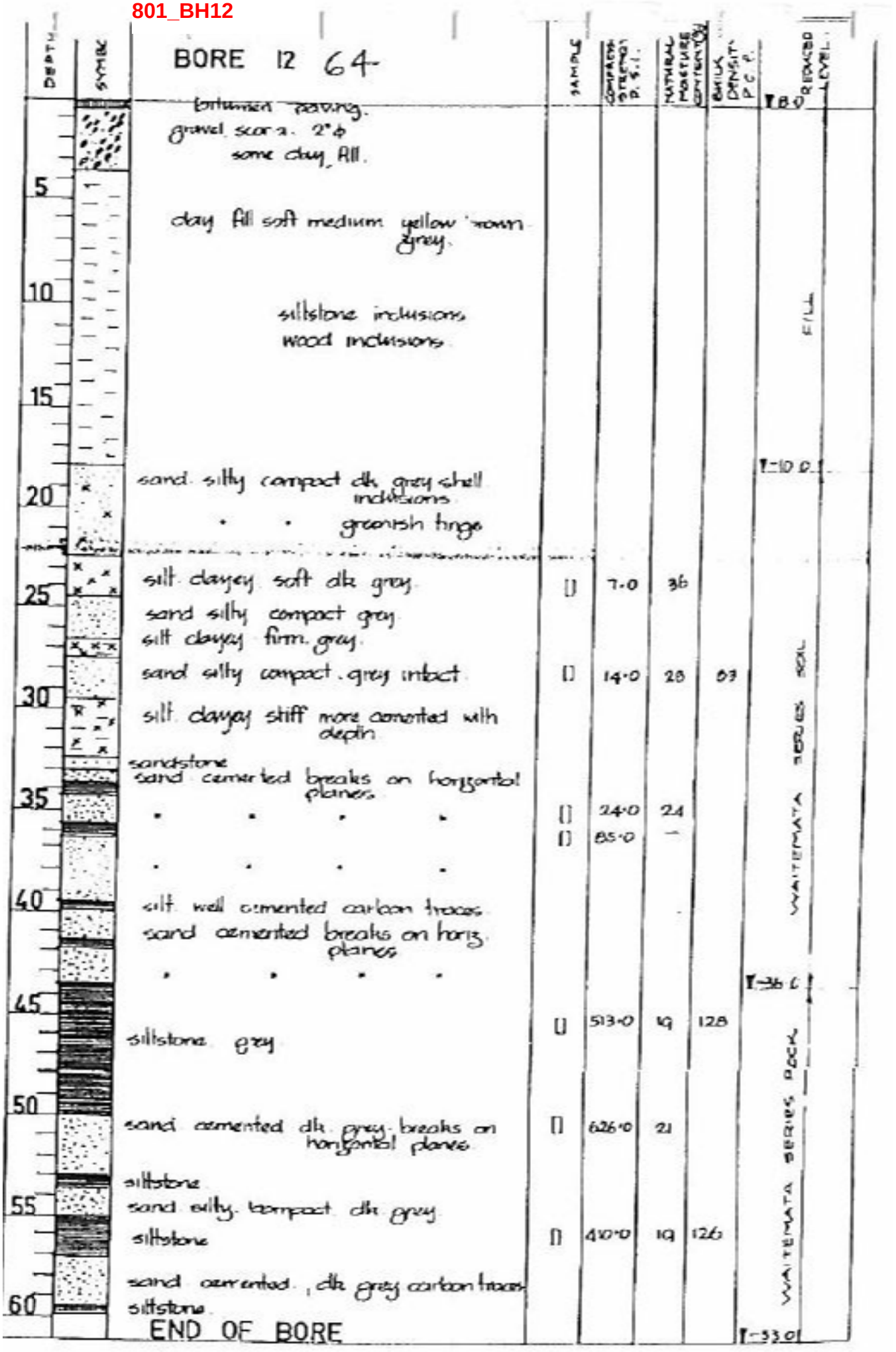
BH_TT66664

BH_64334



BH_TT66665

801_BH12



BH_64335

BH_TT66657

TONKIN & TAYLOR LTD.

D/Base N° 88

BOREHOLE LOG

BOREHOLE NO 3

SHEET 1 OF 2

PROJECT: Lower Hobson St. Bridge LOCATION: Lower Hobson St. JOB NO: 8676

CO-ORDINATES: See Dwg 8676-1

RL: 3.90m

DATUM: L & S

DRILL TYPE Mayhew 250

DRILL METHOD: Open-barrel HMLC

DRILL FLUID: Water

HOLE STARTED: 16/7/88

HOLE FINISHED: 16/7/88

DRILLED BY: Drillwell Ltd

LOGGED BY MH CHECKED BY: CJF

DRILLING AND TESTS						ENGINEERING DESCRIPTION						GEOLOGICAL	
FLUID LOSS	WATER	CORE RECOVERY	METHOD/CASING	SAMPLES, TESTS	RL (m) DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
		0	WASH		1.0			NO CORE : Cuttings are GRAVELS (Basecourse?) 1.0m ? ?					
		100	OPEN BARREL	• 96kPa *LV	2.0			CLAY, silty, yellow-brown and grey mottles, some pockets of SILT - some pieces of mudstone & sandstone h.w. > 50mm		St - Vst		FILL fine texture	FILL
		100		• 121kPa	3.0			Matrix of ROCK (80%) and SOIL (20%) Rock is sandstone and mudstone, HW, weakly cemented. Soil is SILT and CLAY yellow-brown mottles	Extremely Low (Rock)		N/A	FILL Rock and Silt	
		100		• Too Hard	4.0								
		100		• Too Hard									
		100		• Too Hard	5.0								
		0		N=5				SAND (fine), dark grey, some sea shells				Marine Sediments	KAIHU GROUP
		100			6.0				VL-L		N/A		
					7.0			- grades silty, some bands of SAND, clayey, silty					
		100		N=5	8.0			- grades clayey					
								CLAY, plastic, lt grey-brown, some dk brown mottles minor silt	S - F?				
	30				9.0								
					10.0			Rock and soil (PTO)					

BH_64327

D/Base N° 88

TOMKIN & TAYLOR LTD.

BOREHOLE LOG

BOREHOLE NO 3
SHEET 2 OF 2

PROJECT: Lower Hobson St Bridge
LOCATION: Lower Hobson St
JOB NO: 8676
CO-ORDINATES: See Dwg 8676-1
DRILL TYPE: Mayhew 250
DRILL METHOD: Open-barrel HMLC
RL: 3.90m
DATUM: L & S
DRILL FLUID: Water
HOLE STARTED: 16/7/88
HOLE FINISHED: 16/7/88
DRILLED BY: Drillwell Ltd
LOGGED BY: MH CHECKED BY: CJF

DRILLING AND TESTS						ENGINEERING DESCRIPTION					GEOLOGICAL	
FLUID LOSS	WATER	CORE RECOVERY	METHOD/CASING	SAMPLES, TESTS	RL (m) DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
		100		N=70+				NO CORE : SOIL?					
		66		UC	11.0			ROCK and SOIL : Rock is interbedded SAND-STONE and MUDSTONE, SW., weakly to moderately cemented, dk grey Soil is SAND (fine) dk grey, silty.		Ext. Low - Very Low Strength (ROCK)	N/A	ROCK and SOIL	Waitemata Group Formation
		0		N=100+	12.0								
	100				13.0								
		100		N=100+	14.0								
	100				15.0								
		100		N=100+	16.0			End of Borehole @ 16.1m					

BH_66381

ARTP76

NEW ZEALAND GEOLOGICAL SURVEY

LOG OF DRILL HOLE

HOLE No. ART 43

PROJECT Auckland Rapid Transit FEATURE tunnel alignment LOCATION Customs St West

GRID REF. M.O.W. CO-ORD 703810.6N 299896.4E DATUM L & S RL GROUND 3.73m

ANGLE FROM HORIZONTAL 90° DIRECTION PHOTO FILE No. COLLAR

DESCRIPTION OF CORE	STRUCTURES
FORMATION NAME / ROCK TYPE / DESCRIPTION OF CORE	JOINTS; VEINS; SEAMS; SHATTER; SHEAR & CRUSH ZONES; FOLIATION; SCHISTOSITY; LINEATIONS.
FILL	concrete pavement
	fill, stiff clays and weathered Waitemata Gp sands
	basalt sand layer
	Fe stained sands and silts, occ corestones of sandst and siltst
	well cem sst frags
	Fe stained
MARINE SANDS	grey/green marine sands with numerous shell frag
	sands loose
	stiff grey clays
	interb uncem sands
	f sands grad to med sst poorly cemented
	interb w siltst
WAITEMATA GROUP	f sst gr to med sst rel uncemented
	siltst with concr layer
	rel well cem f sst interb siltst
	f sst gr to med sst with interb siltst
	med and f sst well cem siltst
	f sst grad to med sst
	siltst with thin layers of f sst
	f sst with siltst lenses
	siltstone
	fine sandstone grading to coarse sst mod cem
	siltst with interb cem f sst
	med sst gr to c sst, mod cem
	siltstone in thick layer
	fine sandstone
	grad to c sandstone

tube sample

soft material washed by drilling

fractures at 70° in clay

2 jts partly cem dip 60° and 70°

bedding horizontal

fracture in sandstone dips 70° v rough surface

bedding dips 20°

bedding dips 30°

R.Q.D.
79
91
87
54
70
82
100
77
27

WEATHERING: UW Unweathered; SW Slightly Weathered; MW Moderately Weathered; HW Highly Weathered; CW Completely Weathered

HARDNESS: VH Very Hard; H Hard; MH Moderately Hard; M Medium; S Soft; VS Very Soft

1 10 20 10^2 10^3 _ nat fractures/m of core

COMMENTS: grinding of core

ENGINEERING GEOLOGY SECTION

LOGGED I.R.Brown DRILLED G.Hadfield

DATE 28/5/74 DATE 16-17/5/7

TRACED B.R. DRILL Acker

CHECKED CORE BOXES

LENGTH 22.86m

2020_BH01

BOREHOLE LOG

BOREHOLE No.: BH01

SHEET: 1 OF 3

Tonkin+Taylor

PROJECT: Downtown Car Park
JOB No.: 1012134.1000
LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5920984.16 mN 1757327.82 mE (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND:
R.L. COLLAR:
DATUM:
SURVEY: GIS\Web map viewer

DRILLED BY: Lei
LOGGED BY: JELE
CHECKED: CRB
START DATE: 05/09/2020
FINISH DATE: 05/09/2020
CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering (UW SW MW HW CW)	Rock Strength (VS S MS W EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000 600 200 60 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25 50 75)	Water Level	Casing	Installation	Core Box No
Fill	CONCRETE: 0.00 - 0.15m						5	0										
	HYDRO-EXCAVATION (NO RECOVERY): 0.15 - 2.00 m Sandy GRAVEL [INFERRED].			HVAC	0		4	0.5										
	2.00 - 2.10 m: Clayey SILT with minor gravel; brown. Firm, moist, low plasticity. Gravel: angular, medium.							1.0										
	2.20 - 3.30 m: Silty CLAY with minor gravel; brown. Firm, moist, medium to high plasticity. Gravel: fine to medium.			HQTT	100		3	1.5										
	3.30 - 3.60 m: Silty fine SAND; grey. Moist, well graded.							2.0										
	3.60 - 4.00 m: Silty CLAY; brownish grey. Soft to firm, moist, medium to high plasticity.							2.5							05/09/2020			
	4.00 - 4.50 m: Core loss.			HQTT	66		2	3.0										
								3.5										
							1	4.0										
								4.5										

COMMENTS: Water level inferred at 2.65m b.g.l. by driller.

Hole Depth 10.5m

Scale 1:25

File: 1012134.1000 General Log - 4/11/2020 9:21:00 AM - Produced with Core-GS by GeRoc

2020_BH01

BOREHOLE LOG

BOREHOLE No.: BH01

SHEET: 2 OF 3

Tonkin+Taylor

PROJECT: Downtown Car Park
JOB No.: 1012134.1000
LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5920984.16 mN, 1757327.82 mE (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND:
R.L. COLLAR:
DATUM:
SURVEY: GIS\Web map viewer

DRILLED BY: Lei
LOGGED BY: JELE
CHECKED: CRB
START DATE: 05/09/2020
FINISH DATE: 05/09/2020
CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)
Fill	5.20 - 5.75 m: Silty CLAY with minor sand; grey. Soft to firm, moist, medium to high plasticity. Sand: fine.
Fill	5.75 - 6.00 m: Silty CLAY, light grey. Stiff, moist, medium plasticity. *6.00m:* Grades to soft to firm.
Fill	6.20 - 6.50 m: Silty CLAY with minor sand; brown. Firm, moist, low to medium plasticity. Sand: fine. *6.50m:* Trace of decomposed wood.
East Coast Bays Formation	6.50 - 6.90 m: Core loss.
East Coast Bays Formation	6.90 - 7.10 m: Clayey SILT; grey. Very stiff, moist, low plasticity. (Moderately to highly weathered SILTSTONE)
East Coast Bays Formation	7.10 - 7.50 m: Slightly to moderately weathered, grey, interbedded SILTSTONE and SANDSTONE. Extremely weak to very weak, weakly cemented, sub-horizontal.
East Coast Bays Formation	7.50 - 8.30 m: Slightly to moderately weathered, grey, SANDSTONE. Very weak, weakly cemented, sub-horizontal.
East Coast Bays Formation	8.30 - 9.00 m: Unweathered to slightly weathered, grey, SILTSTONE. Very weak, weakly cemented, sub-horizontal.
East Coast Bays Formation	9.00 - 10.50 m: Unweathered to slightly weathered, grey, interbedded SILTSTONE and SANDSTONE. Extremely weak to very weak, weakly cemented, sub-horizontal.

Rock Weathering: UW, EW, HW, MW, SW, CW
Rock Strength: ES, VS, S, MS, W, VW, EW
Sampling Method: HQTT
Core Recovery (%): 86, 73, 100
Testing
RL (m): 0, -1, -2, -3, -4
Depth (m): 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5
Graphic Log
ROCK DEFECTS: Defect Log; Fracture Spacing (mm): 2000, 600, 200, 60, 20; RQD (%)
Description & Additional Observations
Fluid Loss (%): 25, 50, 75
Water Level
Casing
Installation: Box 1, 0.0-6.1m; Box 2, 6.1-8.8m
Core Box No

COMMENTS: Water level inferred at 2.65m b.g.l. by driller.

Hole Depth 10.5m

SOURCE: NZGD

2020_BH01

BOREHOLE LOG

BOREHOLE No.: BH01

SHEET: 3 OF 3

PROJECT: Downtown Car Park

JOB No.: 1012134.1000

LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5920984.16 mN, 1757327.82 mE (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND:

R.L. COLLAR:

DATUM:

SURVEY: GIS\Web map viewer

DRILLED BY: Lei

LOGGED BY: JELE

CHECKED: CRB

START DATE: 05/09/2020

FINISH DATE: 05/09/2020

CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW, EW, HW, MW, SW)	Rock Strength (VS, S, MS, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	9.00 - 10.50 m: Unweathered to slightly weathered, grey, interbedded SILTSTONE and SANDSTONE. Extremely weak to very weak, weakly cemented, sub-horizontal.			HQTT	100		-5	10.5										Box 3, 8.8-10.5m
	10.5m: END OF BOREHOLE					12/38 for 75mm **N>=50** Solid	-6	11.0										
								11.5										
							-7	12.0										
								12.5										
							-8	13.0										
								13.5										
							-9	14.0										
								14.5										

COMMENTS: Water level inferred at 2.65m b.g.l. by driller.

Hole Depth 10.5m

Scale 1:25

Rev 0

General Log - 4/11/2020 9:21:01 AM - Produced with Core-GS by GeRoc

BH_TT166760

BH_150878

SOURCE: NZGD

2020_BH01

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: **BH01**

PROJECT: Downtown Car Park	LOCATION: 31 Customs Street West, Auckland	JOB No.: 1012134.1000
CO-ORDINATES: 5920984.16 mN (NZTM2000) 1757327.82 mE R.L.: DATUM:	DRILL TYPE: DRILL METHOD: RC	HOLE STARTED: 05/09/2020 HOLE FINISHED: 05/09/2020 DRILLED BY: McMillan Drilling LOGGED BY: JELE CHECKED: CRB

0.00-6.10m

6.10-8.80m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: **BH01**

PROJECT: Downtown Car Park	LOCATION: 31 Customs Street West, Auckland	JOB No.: 1012134.1000
CO-ORDINATES: 5920984.16 mN (NZTM2000) 1757327.82 mE R.L.: DATUM:	DRILL TYPE: DRILL METHOD: RC	HOLE STARTED: 05/09/2020 HOLE FINISHED: 05/09/2020 DRILLED BY: McMillan Drilling LOGGED BY: JELE CHECKED: CRB

8.80-10.50m

SOURCE: NZGD

2020_BH02

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 1 OF 3

Tonkin+Taylor

PROJECT: Downtown Car Park
JOB No.: 1012134.1000
LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5921037.30 mN, 1757320.80 mE (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND:
R.L. COLLAR:
DATUM:
SURVEY: GIS\Web map viewer

DRILLED BY: Andrew. K
LOGGED BY: VELA
CHECKED: CRB
START DATE: 28/08/2020
FINISH DATE: 31/08/2020
CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW SW MW HW EW)	Rock Strength (XS VS S MS W VW EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000 600 200 60 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25 50 75)	Water Level	Casing	Installation	Core Box No
Fill	CONCRETE: GL - 0.15m																	
	HYDRO-EXCAVATION (NO RECOVERY): 0.15 - 0.75m 0.15 - 0.22m: Dark brownish-black, fine to coarse, asphalt and greywacke GRAVEL with minor greywacke cobbles. 0.20 - 0.40m: Brown SAND with some silt. Moist. Sand is medium. 0.40 - 0.50m: Light brownish-grey CLAY 0.50 - 0.75m: Brown, fine to medium, SAND with sandstone fragments and basalt cobbles (sand is locally weakly cemented)			HVAC	0			0.5										
	SAND, some gravel; brown. Moist, poorly graded; sand, fine to medium; gravel, coarse, subangular, Brick, ceramic and concrete.			HA	100		4	1.0										
	Silty CLAY, minor gravel; brown. Soft to firm, moist, high plasticity; gravel, fine, subangular.							1.5										
	GRAVEL, some silt, minor clay and sand; brown. Moist, well graded; gravel, fine to coarse, subangular to angular, Brick, concrete and scoria; sand, fine.			HQTT	17		3	2.0										
	CORE LOSS: 1.71 - 2.70m (Brick fragment caught in core barrel)							2.5										
	GRAVEL; grey and reddish brown. Poorly graded; gravel, medium to coarse, subangular to angular, Concrete, basalt and scoria.			HQTT	50	● 32/13 kPa	2	3.0								120mm PQ		
	Gravelly CLAY, some silt; dark grey. Soft, moist, high plasticity; gravel, fine to medium, subangular to angular, Brick, basalt and mudstone; Slight organic odour.																	
	CORE LOSS: 3.20 - 3.70m (Concrete caught in core barrel driven into soft clay below)							3.5										
	GRAVEL & COBBLES; dark greyish-black. Poorly graded; gravel, coarse, subangular to angular, Basalt, cobbles, Basalt.			HQTT	30		1	4.0										
	CORE LOSS: 3.85 - 4.20m (Basalt cobble caught in core barrel)																	
	GRAVEL & COBBLES, minor silt; dark greyish black. Poorly graded; gravel, coarse, subangular to angular, Basalt, cobbles, Basalt.			HQTT	54								*4.20 - 4.70m:* Slow drilling progress due to basalt					
	CORE LOSS: 4.47 - 4.70m							4.5										
Marine Sediments	SILT, minor sand and clay; light greenish-grey. Very soft to soft, moist, low plasticity; sand, fine; Inclusions of shell fragments.						0											

COMMENTS: Hydro-excavation undertaken to 0.75m depth. Crew switched to hand auger to between 0.75m and 1.5m depth.Fill encountered between 8.5 - 9.05 m may be buttress fill placed at the time of the old seawall construction.

Hole Depth 11.75m

Scale 1:25

Rev 0

General Log - 4/11/2020 9:21:23 AM - Produced with Core-GS by GeRoc

BH_TT166761

BH_150879

2020_BH02

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 2 OF 3

Tonkin+Taylor

PROJECT: Downtown Car Park
JOB No.: 1012134.1000
LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5921037.30 mN, 1757320.80 mE (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND:
R.L. COLLAR:
DATUM:
SURVEY: GIS\Web map viewer

DRILLED BY: Andrew. K
LOGGED BY: VELA
CHECKED: CRB
START DATE: 28/08/2020
FINISH DATE: 31/08/2020
CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW, EW, HW, MW, SW)	Rock Strength (EIS, VS, S, MS, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log
Marine Sediments	Sandy SILT, trace clay; grey. Very soft to soft, moist, dilatant; sand, fine; Abundant inclusions of shell fragments.								
	Clayey SILT; grey. Soft, moist, medium plasticity.			HQTT	100			5.5	
	SILT, minor sand, trace clay; grey. Very soft to soft, moist, dilatant; sand, fine; Inclusions of shell fragments.					8/2 kPa	-1		
	CORE LOSS: 5.79 - 6.70m			HQTT	9			6.0	
								6.5	
	Clayey SILT; greyish-brown. Soft, moist, low plasticity.						-2		
	SILT, minor sand, trace clay; grey. Very soft to soft, wet, dilatant; sand, fine; Inclusions of shell fragments.			HQTT	40	0/0 kPa Sample turning in core barrel		7.0	
	CORE LOSS: 7.10 - 7.70m								
								7.5	
	SILT, some clay, minor sand; grey. Very soft to soft, wet; sand, fine; Inclusions of shell fragments.						-3		
	Silty SAND, trace clay; grey. Moist, dilatant. sand, fine; Inclusions of shell fragments.			HQTT	80			8.0	
	Clayey SILT; grey. Soft, moist, low plasticity.								
	CORE LOSS: 8.35 - 8.53m								
Fill	Gravelly COBBLES; dark grey and red. Loose, moist, poorly graded; cobbles, highly weathered to moderately weathered, basalt; gravel, medium to coarse, subangular, highly weathered to moderately weathered, basalt.							8.5	
	CORE LOSS: 8.65 - 8.75			HQTT	58		-4		
Marine Sediments	Gravelly COBBLES (as above)							9.0	
	CORE LOSS: 9.05 - 9.50								
	Clayey SILT, minor sand; grey. Very soft, wet, non-plastic; sand, fine to coarse, shell and volcanic.			HQTT	35			9.5	
	CORE LOSS: 9.70 - 9.85						-5		
	Clayey SILT, minor sand (as above)								

ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	(25, 50, 75)				
								Box 1, 0.0-7.7m

COMMENTS: Hydro-excavation undertaken to 0.75m depth. Crew switched to hand auger to between 0.75m and 1.5m depth.Fill encountered between 8.5 - 9.05 m may be buttress fill placed at the time of the old seawall construction.

Hole Depth 11.75m

Scale 1:25

Rev 2.7

General Log - 4/11/2020 9:21:24 AM - Produced with Core-GS by GeRoc

SOURCE: NZGD

2020_BH02

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 3 OF 3

Tonkin+Taylor

PROJECT: Downtown Car Park
JOB No.: 1012134.1000
LOCATION: 31 Customs Street West, Auckland

CO-ORDINATES: 5921037.30 mN, 1757320.80 mE (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND:
R.L. COLLAR:
DATUM:
SURVEY: GIS\Web map viewer

DRILLED BY: Andrew. K
LOGGED BY: VELA
CHECKED: CRB
START DATE: 28/08/2020
FINISH DATE: 31/08/2020
CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW SW MW HW CW)	Rock Strength (VS S MS W EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000 600 200 60 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25 50 75)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	Highly weathered, grey, SILTSTONE. Extremely Weak, Recovered as (SILT with minor clay and trace sand, grey. Stiff to very stiff, wet to moist, low plasticity. Sand; fine.).			HQTT	31		-6	10.5										
	CORE LOSS: 10.15 - 10.70 (Due to basalt cobble being caught in barrel.																	
	Moderately weathered, grey, SILTSTONE. Extremely Weak, Recovered as (SILT with some sand and minor clay, grey. Very stiff, moist, non plastic. Sand; fine.).			HQTT	100							0						
	Slightly weathered, grey speckled white, SANDSTONE. Extremely Weak, sub-horizontal, moderately cemented, Recovered as (SAND, with minor silt and clay, grey speckled white. Dense, moist, poorly graded.).			HQTT	100			11.0				95	11.00m: DD 11.12m: DD 11.16m: DD 11.21m: J, 15° dip, PL, SM, VN 11.25m: BF, 0° dip, PL, SM 11.37m: DD 11.43m: J, 25° dip, PL, R, VN, VE(Silt) 11.62m: DD					Box 2, 7.7-11.8m
	Unweathered, grey, SANDSTONE. Very Weak, sub-horizontal. - INTERBEDDED WITH - Unweathered, grey, SILTSTONE. Very Weak, sub-horizontal, moderately thick.						-7	11.5										
	11.75m: END OF BOREHOLE						-8	12.0 12.5 13.0										
							-9	13.5 14.0										
							-10	14.5										

COMMENTS: Hydro-excavation undertaken to 0.75m depth. Crew switched to hand auger to between 0.75m and 1.5m depth.Fill encountered between 8.5 - 9.05 m may be buttress fill placed at the time of the old seawall construction.

Hole Depth 11.75m

Scale 1:25

Rev 0.7

BH_TT166761

BH_150879

SOURCE: NZGD

2020_BH02

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: **BH02**

SHEET: 1 OF 1

PROJECT: Downtown Car Park	LOCATION: 31 Customs Street West, Auckland	JOB No.: 1012134.1000
CO-ORDINATES: 5921037.30 mN (NZTM2000) 1757320.80 mE R.L.: DATUM:	DRILL TYPE: Portable DRILL METHOD: RC	HOLE STARTED: 28/08/2020 HOLE FINISHED: 31/08/2020 DRILLED BY: McMillan Drilling LOGGED BY: VELA CHECKED: CRB

0.00-7.70m

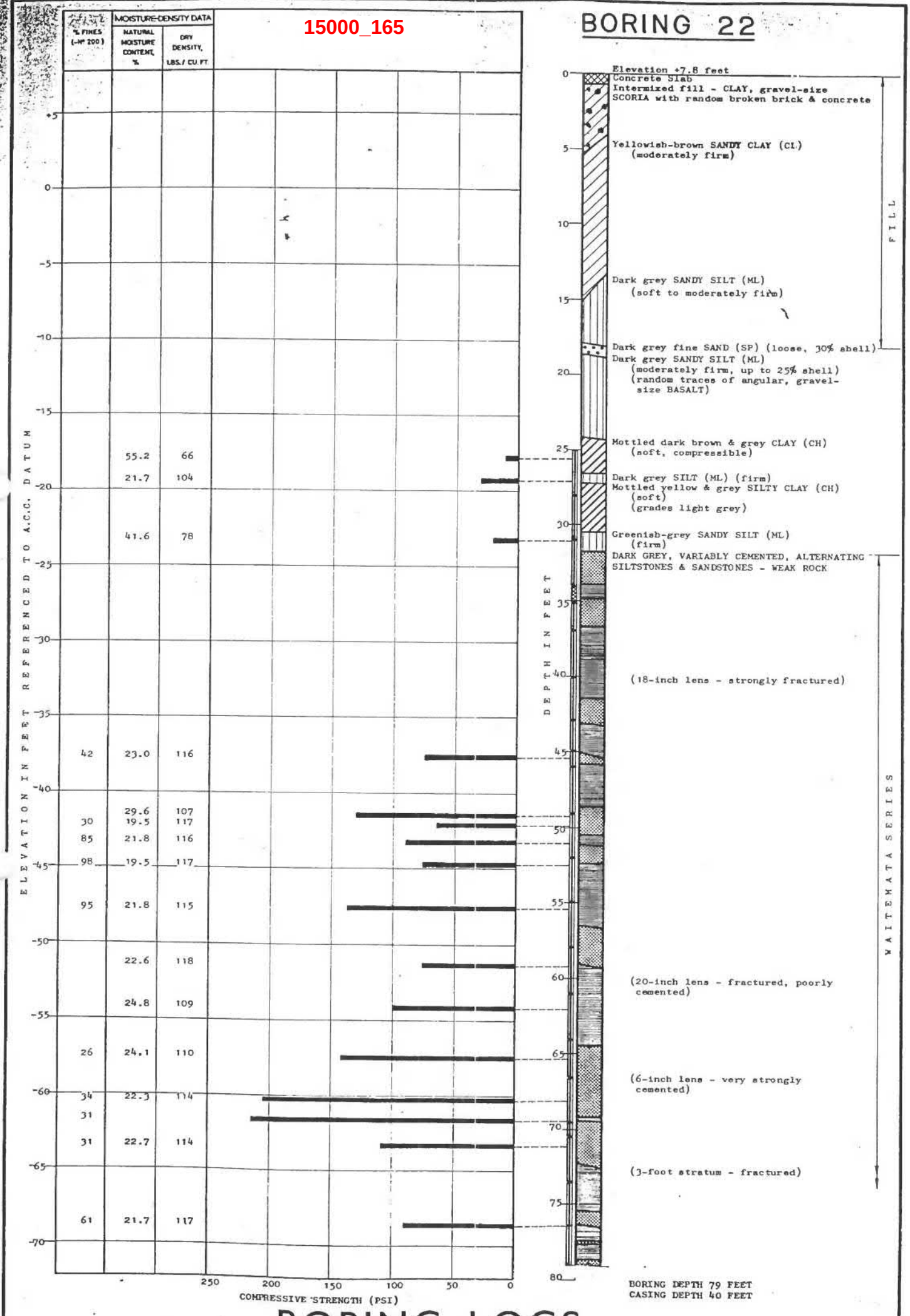
7.70-11.75m

BH_TT166761

BH_150879

15000_165

BORING 22



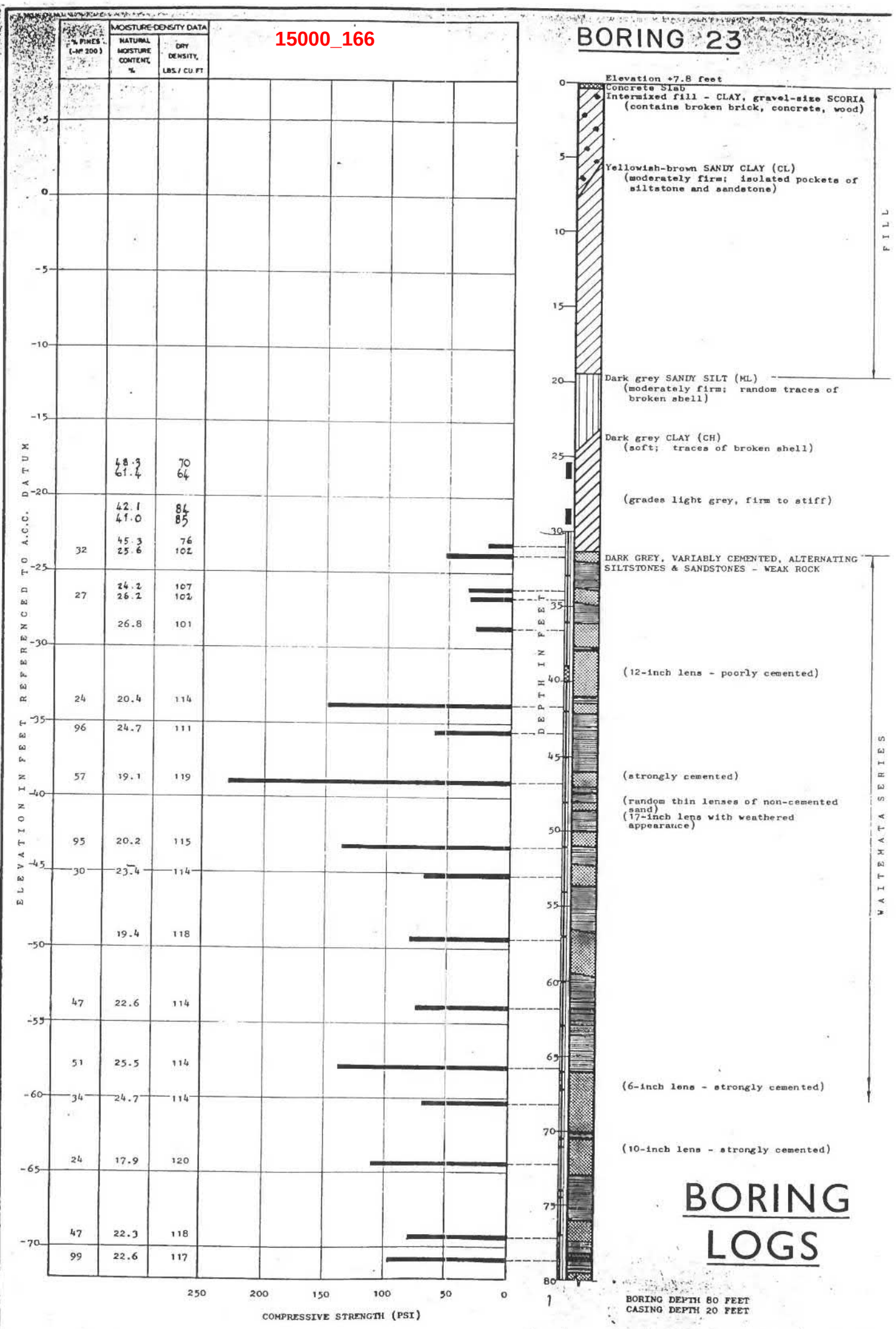
BORING DEPTH 79 FEET
CASING DEPTH 40 FEET

BORING LOGS

BRICKELL, MOSS, RANKINE & HILL

15000_166

BORING 23



BORING LOGS

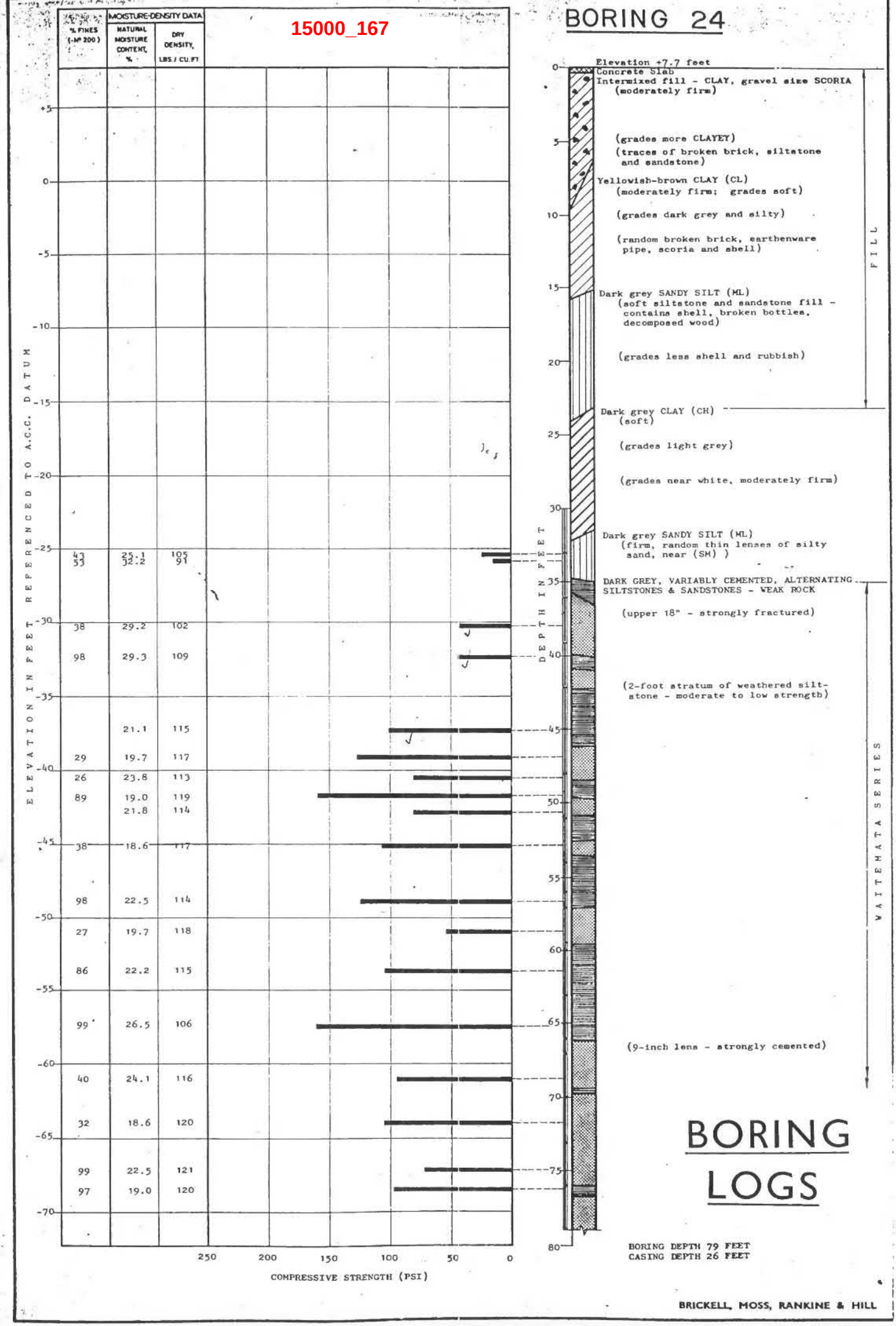
BORING DEPTH 80 FEET
CASING DEPTH 20 FEET

BRICKELL, MOSS, RANKINE & HILL

PLATE B-21

15000_167

BORING 24



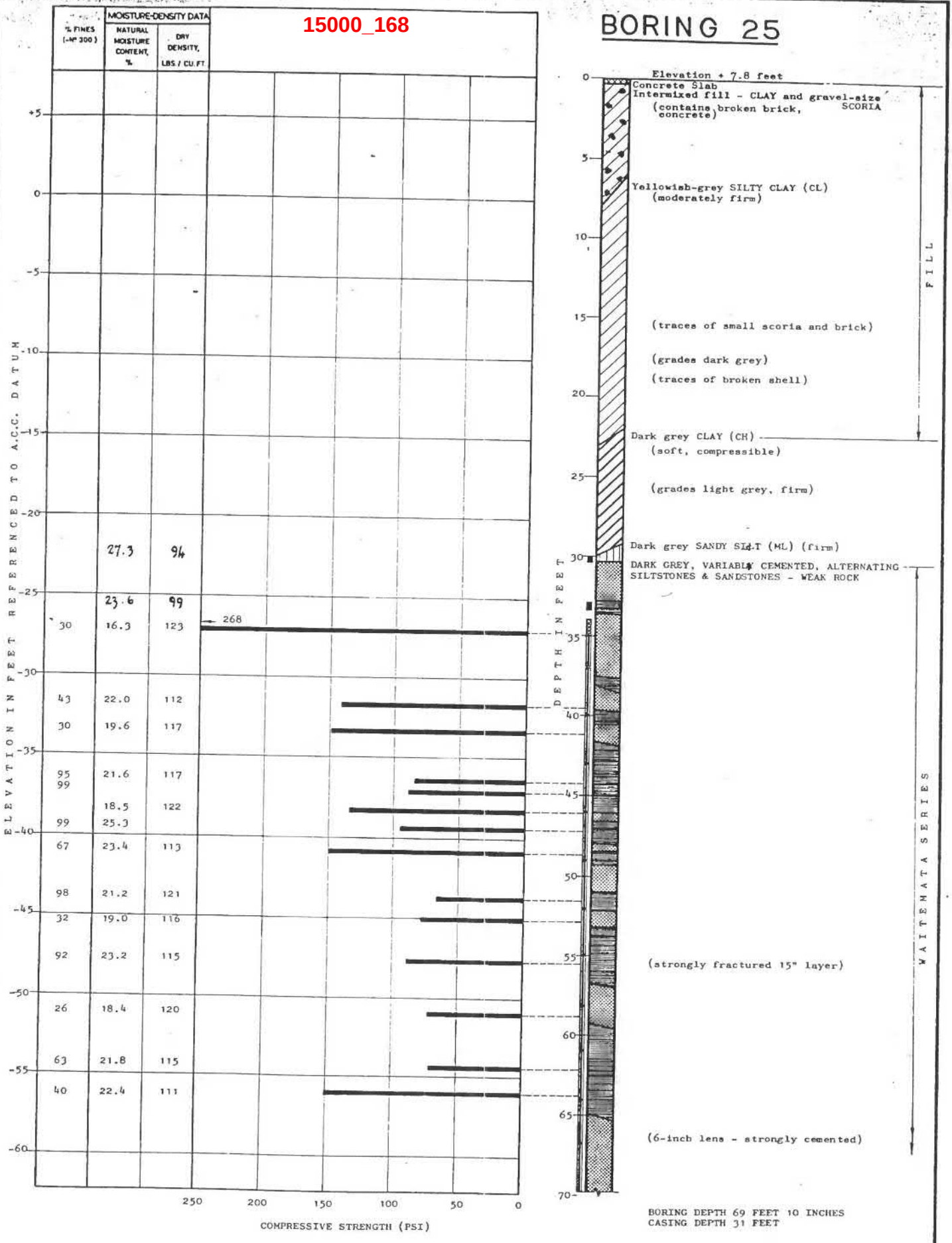
BORING LOGS

BORING DEPTH 79 FEET
CASING DEPTH 26 FEET

BRICKELL, MOSS, RANKINE & HILL

15000_168

BORING 25



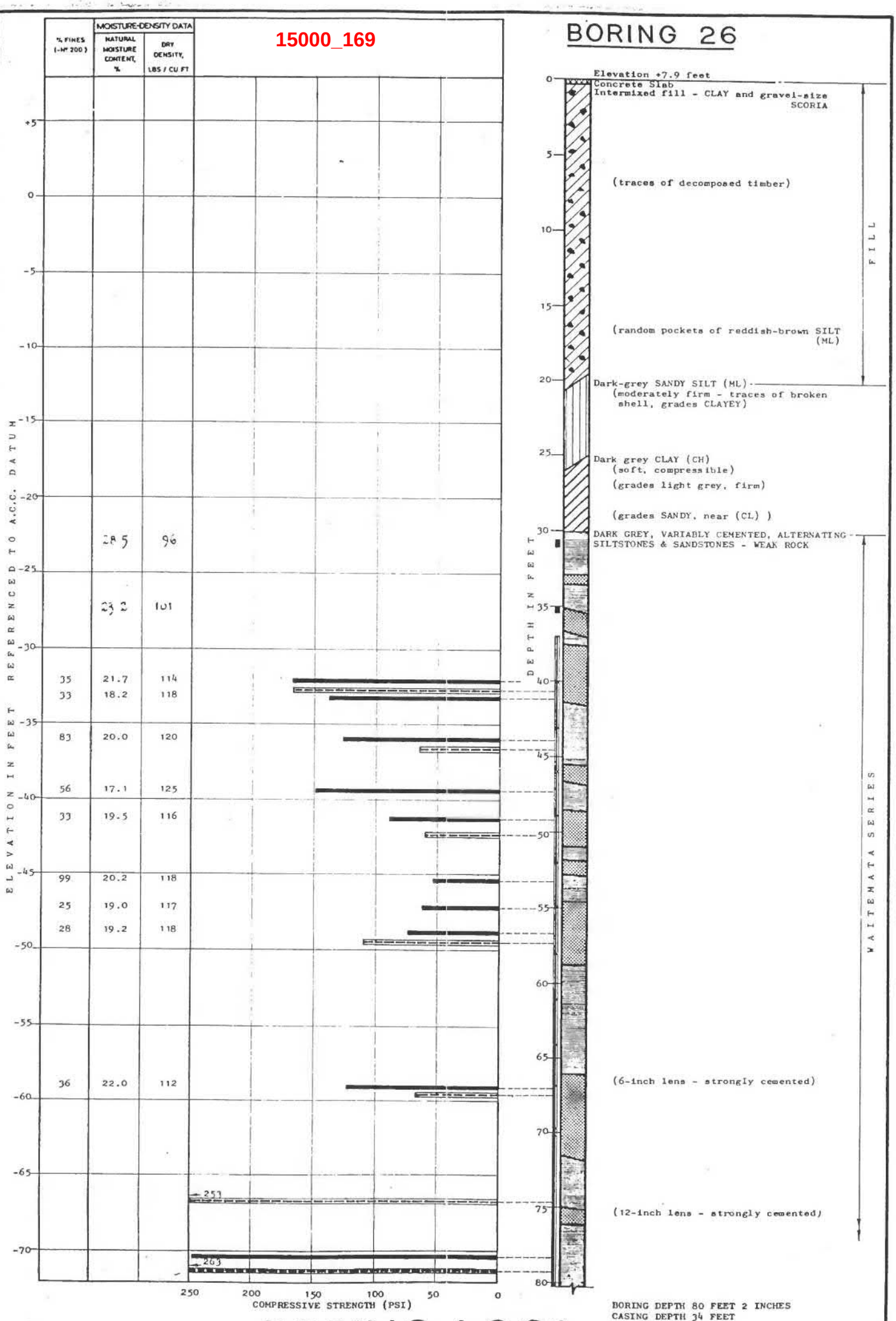
BORING DEPTH 69 FEET 10 INCHES
CASING DEPTH 31 FEET

BORING LOGS

BRICKELL, MOSS, RANKINE & HILL

15000_169

BORING 26



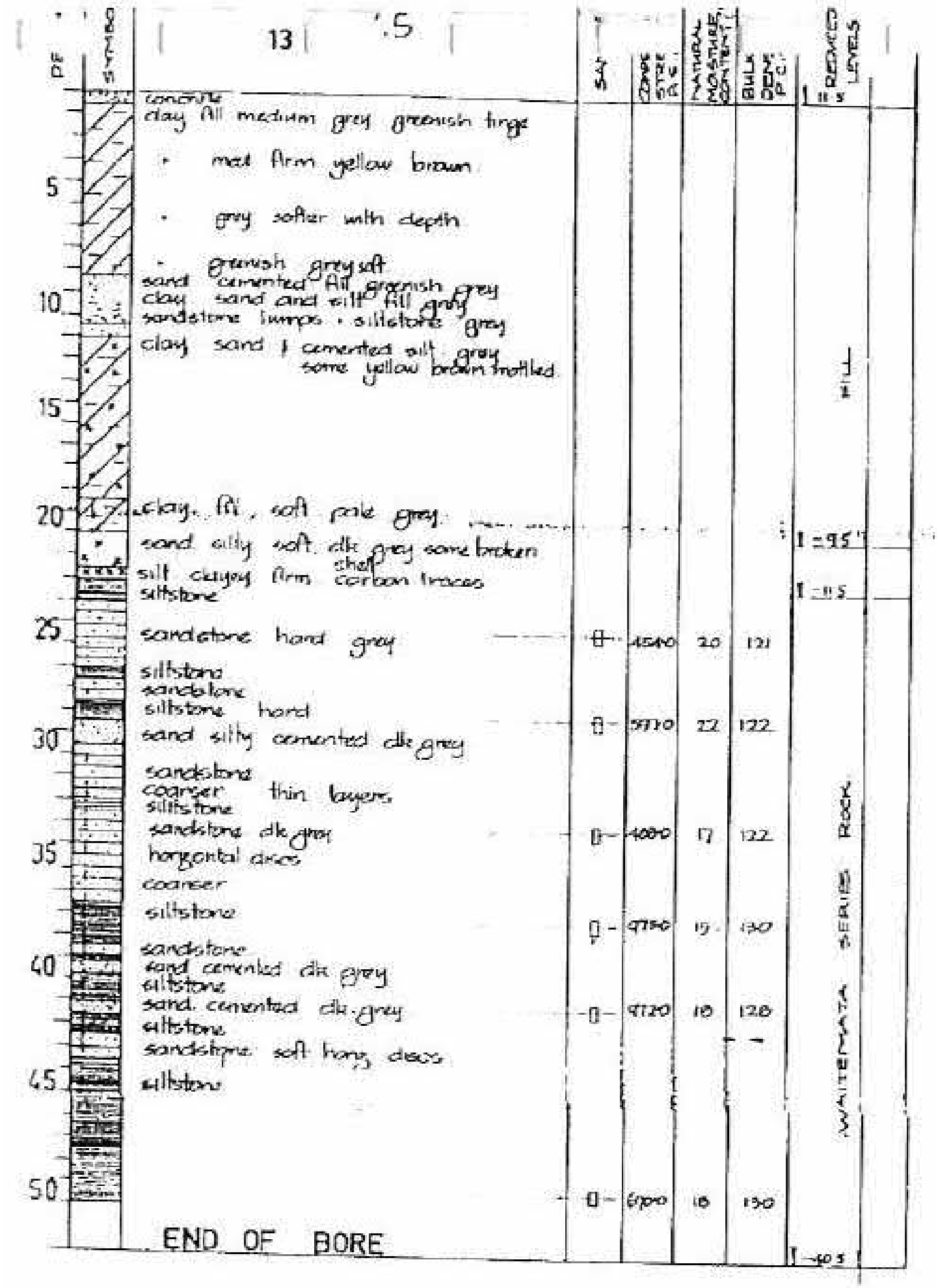
BORING DEPTH 80 FEET 2 INCHES
CASING DEPTH 34 FEET

BORING LOGS

BRICKELL, MOSS, RANKINE & HILL

801_BH13

BH_TT66666

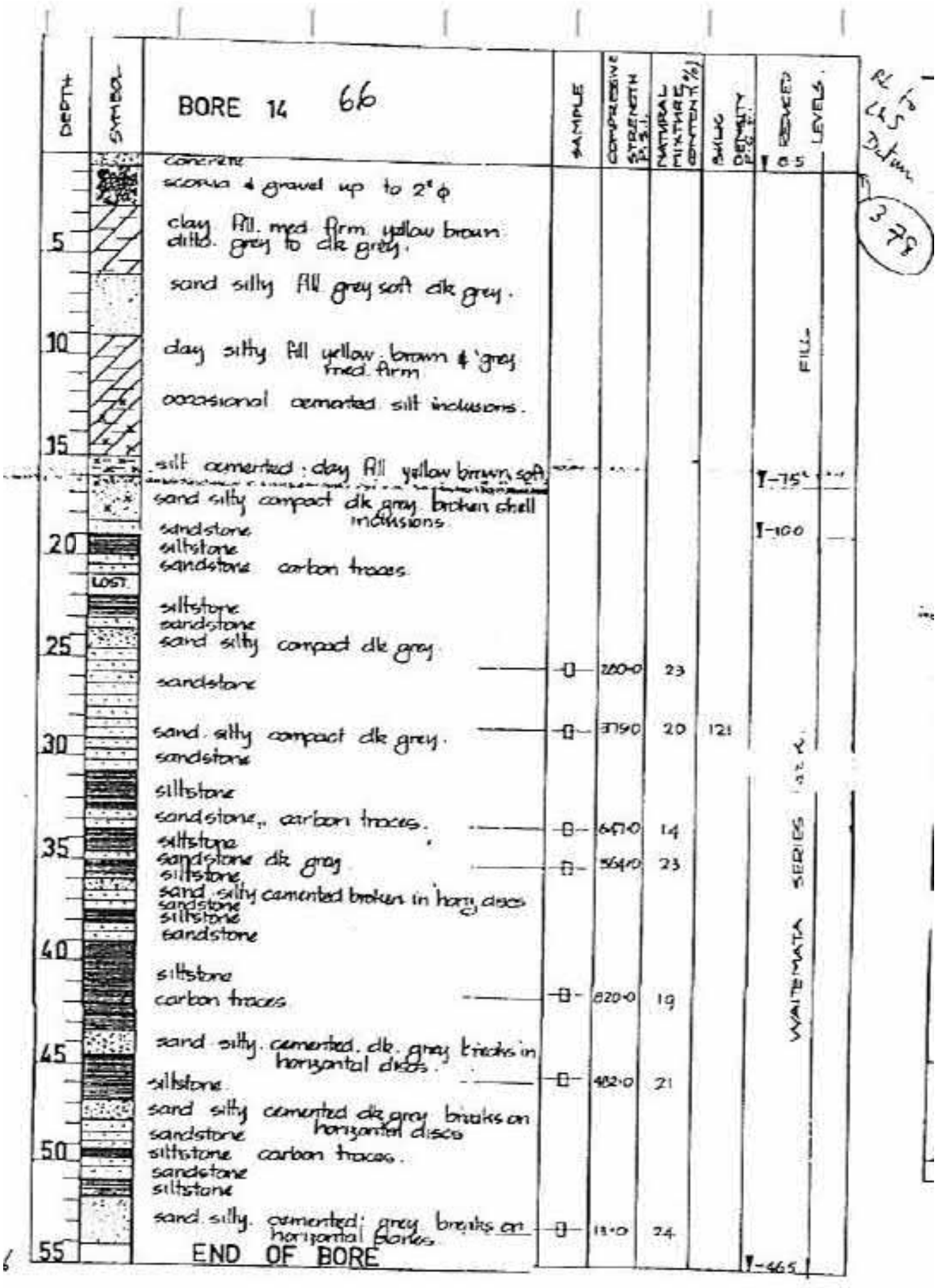


BH_64336

801_BH14

BH_TT66667

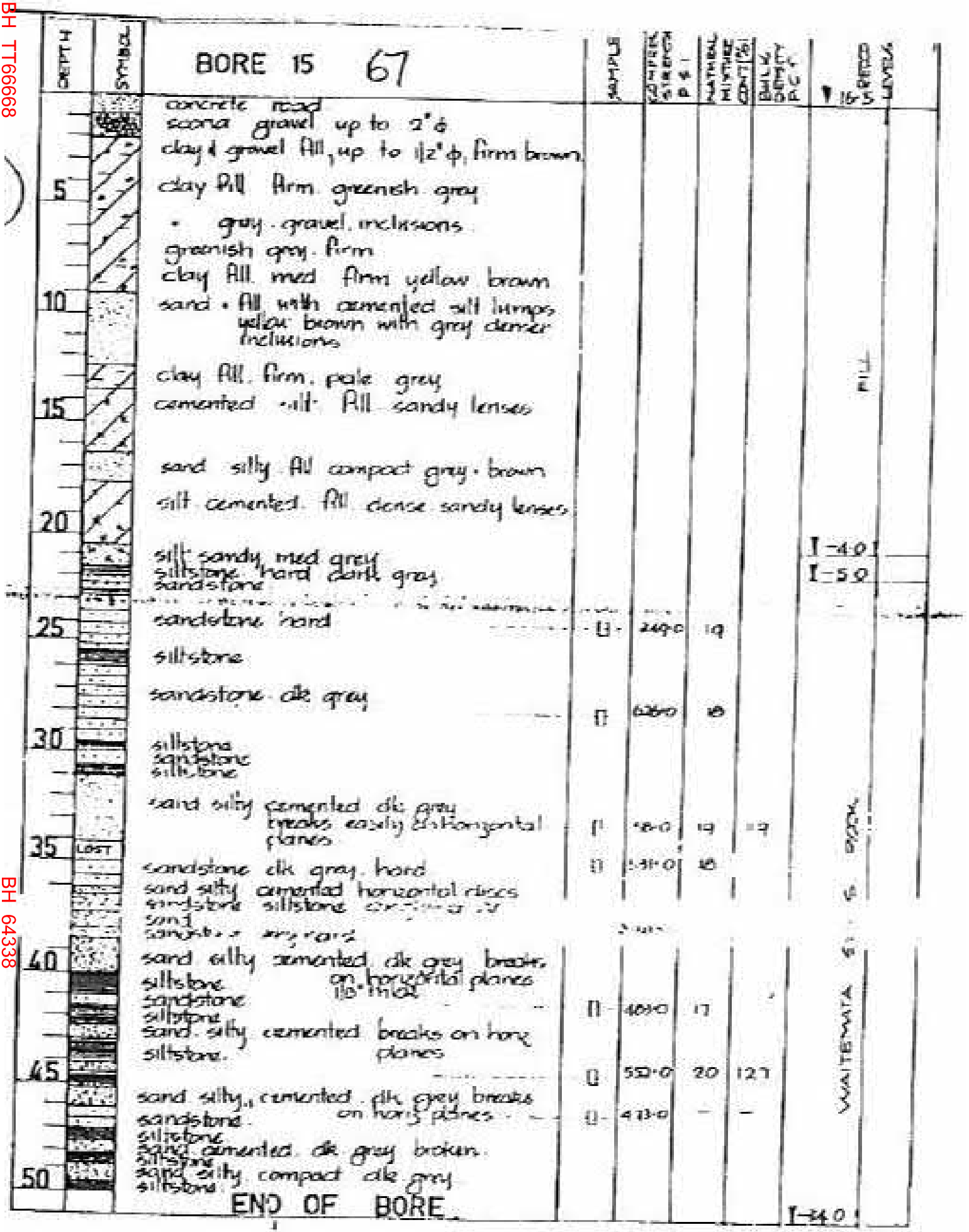
BH_64337



801_BH15

BH_TT66668

BH_64338



RECORD OF BOREHOLE 211

SHEET 1 OF 3 | BH211

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson Street

COORDS : 6482788.40N, 2667722.90E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH (m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH (m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			0.00 Asphaltic Concrete	3.59	0.00				OB
			0.15 Medium dense grey GRAVEL,moderately weathered,moderately strong,subangular Basalt [FILL]	3.44					
1			0.80 Loose reddish brown sandy fine to medium GRAVEL,moderately weathered,moderately strong vesicular Basalt [FILL]	2.79					
			1.50 becoming brown	2.09					
2			2.50 Firm orange brown mottled grey/black/white SILT-CLAY,some fine sand,trace shells,moist,highly plastic, intermixed with fine to medium gravel sized silt clasts and grey SAND,some silt,wet,non plastic [FILL]	1.09	2.50	↕			
3			3.00 becoming grey	0.59	3.00	●	1 6 4 10	C = 44 CR= 10	
					3.50	↕			
4			4.00 with clasts of coarse gravel sized SILTSTONE and SANDSTONE	-0.41	4.00	↕			
					4.50	●	1 1 1 2	C = 30 CR= 8	

OBSERVATIONS:

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm, N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR3969

DATE STARTED : 5-Apr-98 CORE DIA.: 90 mm RIG : Trailer

DATE FINISHED: 5-Apr-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 211

SHEET 2 OF 3 | BH211

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson Street

COORDS : 6482788.40N, 2667722.90E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH(m)	STRATA LGD	STRATA SYM	STRATA DESCRIPTION	ELEVATN (meters)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
					5.50	‡		C = 40 CR= 18	
			5.60 — with trace wood	-2.01					
			5.80 Very loose dark grey SAND,minor fine gravel sized shell fragments;saturated,non plastic, intermixed with orange brown mottled white SILT-CLAY,trace fine sand,moist,highly	-2.21					
6			6.00 plastic [TAURANGA GROUP SEDIMENTS(Upper)]	-2.41	6.00		1	C = 16	OB
			No recovery				1		
							1		
							2		
			6.50 No recovery, washings indicate grey silty SAND	-2.91					
7									
			7.50 Soft grey SILT-CLAY,some fine sand,moist,highly plastic [TAURANGA GROUP SEDIMENTS(Upper)]	-3.91	7.50	●	0		OB
							0		
							0		
							0		
8			9.00 Loose grey greenish brown SAND,trace fine gravel sized shells;moist,non plastic [TAURANGA GROUP SEDIMENTS(Upper)]	-4.41	8.00	‡			
			8.50 Firm light grey mottled green and dark grey speckled white SILT,minor fine sand,minor clay,trace rootlets;moist, moderately plastic [TAURANGA GROUP SEDIMENTS(Lower)]	-4.91	8.50	‡		C = 26	
			8.80 Dense light grey mottled orange and speckled white faintly bedded silty SAND,minor clay,moist,non plastic [WAITEMATA	-5.21					
9			9.00 GROUP] very stiff	-5.41	9.00	●	1	C = 130	+
							3		
							4		
							7		
			9.60 — becoming dark grey	-6.01					
					9.80	‡			
			9.95 — bedding disturbed,grey layer of 10mm moderately weathered,extremely weak SILTSTONE	-6.36					

OBSERVATIONS:

SAMPLES

- ● Small disturbed sample
- ‡ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS

- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR3969

DATE STARTED : 5-Apr-98 CORE DIA.: 90 mm RIG : Trailer

DATE FINISHED: 5-Apr-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 211

SHEET 3 OF 3 | BH211

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson Street

COORDS : 6482788.40N, 2667722.90E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH (m)	LSD	SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH (m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER	
			10.00 wavy orange SILT-CLAY seam 3mm, soft sediment deformation?	-6.41						
			10.20 with 10mm seam, subhorizontal light grey mottled orange SILT-CLAY; moist, highly plastic	-6.61	10.10		25		TT	SPT=25/80mm
			10.50 Grey moderately weathered, extremely weak SANDSTONE [WAITEMATA GROUP]	-6.91			26			
							25			
							51+			
11			11.00 Grey moderately weathered, extremely weak SILTSTONE [WAITEMATA GROUP]	-7.41	11.00					
			11.40 Grey moderately weathered, extremely weak SANDSTONE [WAITEMATA GROUP]	-7.81						
			11.60 becoming slightly weathered, very weak	-8.01	11.50					
			11.90 with subhorizontal laminated layers of brown carbonaceous material	-8.31						
12					12.00		50			SPT=50/150
							50+			
					12.50					
			12.85 Grey slightly weathered, very weak SANDSTONE [WAITEMATA GROUP]	-9.26						
13			12.95	-9.36						
			13.00	-9.41	13.00					
			13.10 Grey slightly weathered, very weak SILTSTONE [WAITEMATA GROUP]	-9.51						
			13.20 becoming extremely weak	-9.61						
			13.40 Grey slightly weathered, very weak SANDSTONE	-9.81						
			becoming weak		13.50		50			SPT=50/90mm
			Grey slightly weathered, very weak SILTSTONE [WAITEMATA GROUP]				50+			
			END OF BOREHOLE 211 . 13.59m BELOW GROUND SURFACE							
14										

OBSERVATIONS:

SAMPLES
- Small disturbed sample
- Large disturbed sample
- Undisturbed tube sample
- Undisturbed core sample
- SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm, N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR3969

DATE STARTED : 5-Apr-98 CORE DIA.: 90 mm RIG : Trailer

DATE FINISHED: 5-Apr-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

BH_64274

15000_170

BORING 27

% FINES (-Nº 200)	MOISTURE-DENSITY DATA: NATURAL MOISTURE CONTENT, %	MOISTURE-DENSITY DATA: DRY DENSITY, LBS./CU.FT.	COMPRESSIVE STRENGTH (PSI)
	40.8	78	
	29.4	93	
	32.7	85	
	31.3	93	
	38.8	79	
	21.8	121	362
			285
	20.00	116	
	20.8	113	
	23.1	112	
25	22.8	113	
35	19.4	117	

ELEVATION IN FEET REFERENCED TO A.C.C. DATUM

+5, 0, -5, -10, -15, -20, -25, -30, -35, -40, -45, -50, -55, -60, -65

250 200 150 100 50 0

COMPRESSIVE STRENGTH (PSI)

DEPTH IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75

Elevation +8.7 feet

Scoria fill
(moderately dense)

Yellowish-brown SANDY CLAY (CL)
(soft, random traces of gravel)

(grades very soft)

(pockets of siltstone and sandstone)

FILL

Bluish-grey CLAYEY SILTY SAND (SM)
(loose to moderately dense; random broken shell and decomposed timber)

(grades loose, pockets of siltstone and sandstone)

(grades very loose, near SANDY SILT (ML))

Greenish-grey CLAYEY SILT (ML)
(firm; 20% very decomposed wood)

Bluish-grey SILTY fine SAND (SM)
(moderately dense)

Light grey SANDY CLAYEY SILT (ML)
(firm; random traces of broken shell)

(grades no shell)

DARK GREY, VARIABLY CEMENTED, ALTERNATING SILTSTONES & SANDSTONES - WEAK ROCK

(random thin lenses of decomposed organic material - very stiff)

(6-inch lens - weakly cemented)

(3-inch lens - strongly cemented)

BORING DEPTH 70 FEET 9 INCHES
CASING DEPTH 28 FEET

WAITEMATA SERIES

*LCC datum elevation -3.87ft = MSL

170

BORING LOGS

BRICKELL, MOSS, RANKINE & HILL

RECORD OF BOREHOLE 213

SHEET 1 OF 3 | BH213

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482721.30N, 2667672.10E

ELEV.: 3.54 DATUM: LANDS & SURVEY

DEPTH (m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			0.00 Asphaltic Concrete	3.54					
			0.10 Brown GRAVEL,some sand,minor silt,trace clay,moist,non plastic. Gravel,brown grey moderately weathered,moderately strong subangular Basalt.	3.44					
			0.80 with red brown scoriaceous Basalt	2.74					
1			0.95 with some reddish brown silty SAND	2.59					
			1.00	2.54	1.00	↕			OB
			1.10 Loose brown silty sandy GRAVEL,minor clay,moist,moderately plastic	2.44					
			Firm orange brown SAND,some silt,minor clay,minor fine to medium gravel,moist,non plastic Gravel,grey,moderately weathered,very weak to extremely weak SILTSTONE						
			1.35	2.19					
			1.45	2.09					
			Soft orange mottled white,red/orange and grey SILT-CLAY,minor fine sand,moist,highly plastic		1.50	▮		C = 36 CR= 24	
			with some orange brown fine sand,wet [FILL]						
2					2.00	↓	0 1 1/2		
			2.35 with a moderately thick layer of reddish brown highly weathered, extremely weak SANDSTONE	1.19					
			2.55 with some coarse GRAVEL,grey mottled orange and orange brown moderately to highly weathered,very weak to extremely weak SILTSTONE, with carbonaceous flecks [FILL]	0.99	2.50	↕			
			2.85	0.69					
3			Loose bluish grey mottled black and greenish brown/grey silty fine SAND,minor clay,moist,moderately plastic [FILL]		3.00	▮		C = 70 CR= 14	
			3.45 bottom of tube contains grey fine SAND,moist,non plastic,	0.09					
			3.50 intermixed with reddish brown highly weathered extremely weak SANDSTONE and stiff greenish brownish grey SILT-CLAY,moist,highly plastic.	0.04	3.50	↓	3 3 4/7		
4			Firm greenish brownish grey highly weathered,very weak SANDSTONE and reddish brown highly weathered,extremely weak SANDSTONE [FILL]						
			4.00	-0.46	4.00	↕			
			with a thin layer of soft grey mottled white and orange brown SILT-CLAY,some gravel,moist,highly plastic Gravel,coarse,grey,moderately weathered,very weak SILTSTONE						
			4.40	-0.86					
			Firm grey mottled reddish orange and brown moderately weathered extremely weak SANDSTONE [FILL]		4.50	↓	1 2 2/4		THP

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm.N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 21-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 21-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 213	SHEET 2 OF 3	BH213
JOB NAME : Quay Street West Underpass	LOCATION : Lower Hobson St	
CLIENT : Auckland City Council	COORDS : 6482721.30N, 2667672.10E	
JOB NO. : 2409275	ELEV.: 3.54 DATUM: LANDS & SURVEY	

DEPTH (m)	STRATA LGD	STRATA SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH (m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
					5.00	↕			
			5.45 Grey coarse GRAVEL,moderately weathered weak SILTSTONE	-1.91					
			5.50 Loose grey speckled white fine SAND,some silt,minor clay,minor fine gravel,moist,non plastic. Gravel,shells. [TAURANGA GROUP SEDIMENTS(Upper)]	-1.96	5.50	↕			
6					6.00	▮		C = 38 CR= 14	
			6.50 bottom of tube contains stiff grey SILT-CLAY,moist,highly plastic	-2.96	6.50	↓	3		
			6.65 Medium dense grey fine SAND,wet,non plastic,intermixed with grey SILT-CLAY,wet,highly plastic. [TAURANGA GROUP SEDIMENTS(Upper)]	-3.11			4		
							6		
							10		
7			7.00 Medium dense grey fine to medium SAND,wet,non plastic. [TAURANGA GROUP SEDIMENTS(Upper)]	-3.46	7.00	↕			
			7.35 Hard grey SILT-CLAY,wet,highly plastic. [WAITEMATA GROUP]	-3.81					
			7.50 Medium dense grey silty fine SAND,minor clay,wet,moderately plastic, intermixed with grey SILT-CLAY,wet,highly plastic. [WAITEMATA GROUP]	-3.96	7.50	↓	6		THP
							8		
							12		
							20		
			7.95 with some fine gravel sized wood fragments	-4.41					
8			8.00 Dense grey fine SAND,some silt,trace clay,wet,non plastic [WAITEMATA GROUP]	-4.46	8.00	↕			
					8.50	↕			
9			9.00 Intermixed dense grey fine SAND,some silt,trace clay,wet,non plastic with very stiff grey SILT-CLAY,wet,highly plastic [WAITEMATA GROUP]	-5.46	9.00	↕	5		
							15		
							40		
							55		
					9.50				TT

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 21-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted
DATE FINISHED: 21-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

BH_64276

RECORD OF BOREHOLE 213

SHEET 3 OF 3 | BH213

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482721.30N, 2667672.10E

ELEV.: 3.54 DATUM: LANDS & SURVEY

DEPTH (m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			10.09 Moderately thickly interbedded with grey slightly weathered very weak SILTSTONE and grey moderately weathered, extremely weak SANDSTONE [WAITEMATA GROUP]	-6.46	10.00				
					10.50		28		SPT=22 95mm
							22 50+		
11					11.00				
					11.50				
			11.70 — laminated with carbonaceous material	-8.16					
12					12.00		50 50+		SPT=50/125mm
			END OF BOREHOLE 213 , 12.13m BELOW GROUND SURFACE						
13									
14									

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- Small disturbed sample
- Large disturbed sample
- Undisturbed tube sample
- Undisturbed core sample
- SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm, N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 21-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 21-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 214

SHEET 1 OF 3 | BH214

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482760.10N, 2667686.50E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH (m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (meters)	SAMPLE DEPTH (m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			0.00 Asphaltic Concrete	3.59					
			0.15 Grey fine to coarse GRAVEL;moderately weathered,moderately strong,sub angular Basalt.	3.44					
					0.50	↕			
			0.70	2.89	0.70				OB
			0.80 Dark grey gravelly SILT-CLAY,minor sand,wet,highly plastic,organic odour present. Gravel,grey,moderately weathered,moderately streng,sub angular Basalt.	2.79	0.80			C = 70 CR= 40	
1			1.00 Orange brown sandy GRAVEL,some silt, minor clay;wet,non plastic. Gravel,reddish brown highly weathered weak basalt. [FILL]	2.59	1.00	↕			
			Soft to very stiff orange brown mottled grey and orange fine sandy SILT-CLAY intermixed with grey moderately weathered extremely weak SILTSTONE and orange grey highly weathered extremely weak SANDSTONE. [FILL]						
			1.50 with mottles of white	2.09	1.50	↓	0	C = 100	+
							0		
							1 / 1		
2									
			2.40 Soft to firm orange brown mottled white,grey and brown SILT-CLAY with clasts of fine gravel sized moderately weathered,very weak SILTSTONE. [FILL]	1.19	2.40	↕			
					2.50			C = 40 CR= 8	
			2.85 Very stiff to hard grey mottled brown grey and orange highly weathered,extremely weak SILTSTONE [FILL]	0.74					
3			3.00 with a thin layer of brown sandy fine GRAVEL,wet,non plastic.	0.59 / 0.49	3.00	↓	1		THP
			3.10 with a thin layer of black silty SAND,minor clay,wet,moderately plastic, with a thin layer of medium gravel sized red brick				1		
							1 / 2		
			Soft grey mottled orange brown SILT-CLAY,some fine sand,some fine to medium gravel,wet,highly plastic Gravel,orange brownish grey,moderately weathered,very weak SANDSTONE and grey moderately weathered weak SILTSTONE.						
4			4.00 with a thin layer of soft dark grey silty SAND,minor clay;wet,moderately plastic, and with a lense of stiff brown SILT-CLAY,trace fibrous material,moist,highly plastic.	-0.41	4.00	↕			
			4.15	-0.56					
			Stiff grey mottled orange brownish grey intermixed grey moderately weathered very weak SILTSTONE and brownish grey mottled orange highly weathered,very weak SANDSTONE [FILL]		4.50	↓	3		THP
							4		
							5 / 9		

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 20-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 214

SHEET 2 OF 3 | BH214

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482760.10N, 2667686.50E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH(m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (meters)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			5.50 No recovery	-1.91	5.50	↕			
			5.65 Hard grey moderately weathered, very weak SANDSTONE with a thin layer of brownish orange highly weathered extremely weak SANDSTONE. [FILL]	-2.06					
			5.75	-2.16					
			5.85	-2.21					
			5.90 with a thin layer of brownish orange SANDSTONE	-2.31					
6			6.00 Hard grey moderately weathered very weak SILTSTONE	-2.41	6.00	↓	0		
			Medium dense dark grey SAND, some silt, minor clay, minor fine gravel; wet, non plastic. Gravel; shell fragments. [FILL]				1		
							1/2		
			6.50 Loose grey SAND, minor fine to medium gravel; wet, non plastic intermixed with soft grey SILT-CLAY, trace fine sand, wet, highly plastic. Gravel; shell fragments and wood. [FILL]	-2.91	6.50	▮			
			No recovery in tube						
7			7.00 Loose grey SAND, minor fine to medium gravel, moist, non plastic, intermixed with soft grey SILT-CLAY, trace fine sand, moist, highly plastic. Gravel, shell fragments. [TAURANGA GROUP SEDIMENTS (Upper)]	-3.41	7.00	↕		C = 12 CR= 6	
			7.35 with a thin layer of very stiff orange brown SILT-CLAY, trace fine sand, moist, highly plastic	-3.76					
			7.40	-3.81					
			7.55 with a thin layer of firm bluish grey SILT-CLAY, minor fine sand; wet, highly plastic, speckled dark brown with organics	-3.96	7.50	↓	2	C = 66 CR= 10	
			Loose grey silty fine SAND, trace clay; wet, non plastic. [WAITEMATA GROUP]				3		
			7.90 becoming medium dense	-4.31			4/7		
8					8.00	↕			
			8.15 becoming dense	-4.56					
					8.50	↕			
9					9.00	↓	4		
							6		
							9/15		
			9.55 intermixed with grey slightly weathered, very weak SILTSTONE and slightly weathered very weak SANDSTONE	-5.96					
					9.99		40		SPT=50/152mm

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS (10/50+)
- SPT = Standard Penetration Test (blows/150mm, N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 20-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 214

SHEET 3 OF 3 | BH214

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482760.10N, 2667686.50E

ELEV.: 3.59 DATUM: LANDS & SURVEY

DEPTH(m)	STRATA LGD	STRATA SYM	STRATA DESCRIPTION	ELEVATN (meters)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER	
			10.00	-6.41	10.00				TT	
			Moderately thickly interbedded with grey slightly weathered very weak SANDSTONE and grey slightly weathered, very weak SILTSTONE		10.40					
11					11.00					
					11.50					
			11.65 — laminated with carbonaceous material	-8.06						
12					12.00		28			SPT=22/25mm
							22/50+			
					12.40					
13					13.00		50/50+			SPT=50/95mm
			END OF BOREHOLE 214 . 13.10m BELOW GROUND SURFACE							
14										

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- Small disturbed sample
- Large disturbed sample
- Undisturbed tube sample
- Undisturbed core sample
- SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 20-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 215

SHEET 1 OF 3 | BH215

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482794.50N, 2667699.80E

ELEV.: 3.69 DATUM: LANDS & SURVEY

DEPTH(m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			0.00 Asphaltic Concrete	3.69					
			0.15 Dense brownish grey GRAVEL,fine to coarse,moderately weathered,moderately strong,vesicular,subangular Basalt	3.54					
			0.70 Loose orange mottled light brown silty clayey SAND,wet,moderately plastic [FILL]	2.99	0.70	‡			OB
			0.90 mottled with black SILT-CLAY,wet,highly plastic	2.79					
			0.95	2.74					
1			1.00 becoming hard greenish brown SILT-CLAY	2.69	1.00	‡			
			Very stiff brown mottled reddish orange and grey SILT-CLAY,some sand,trace gravel,moist,highly plastic. Gravel,reddish orange,highly weathered,weak Basalt.						
			1.50 Soft, brownish grey and orange extremely weathered,extremely weak SILTSTONE [FILL]	2.19	1.50	↓	1 1 1 2		THP
2			2.50 Brownish greenish grey highly weathered,extremely weak SANDSTONE,intermixed with soft grey SILT-CLAY;moist,highly plastic and loose brownish grey SAND,some silt,minor clay,moist,non plastic [FILL]	1.19	2.50	‡			
					3.00	↓	1 1 2 3		THP
4			4.00 Soft to very stiff brownish grey mottled orange and grey SILT-CLAY,trace fine sand,moist,highly plastic with pockets of grey,moderately weathered very weak SILTSTONE [FILL]	-0.31	4.00	‡			
			4.15 with a moderately thin layer of grey,moderately weathered to highly weathered,very weak SANDSTONE,stained orange along defects	-0.46					
			4.50	-0.81	4.50	↓	1 4 4 8		THP
			4.60 Stiff grey brown SILT-CLAY,trace fine sand,moist,highly plastic. Grey,moderately weathered,extremely weak SILTSTONE	-0.91					

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- Small disturbed sample
- ‡ Large disturbed sample
- Undisturbed tube sample
- Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows.300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 19-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

BH_64278

RECORD OF BOREHOLE 215

SHEET 2 OF 3 | BH215

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482794.50N, 2667699.80E

ELEV.: 3.69 DATUM: LANDS & SURVEY

DEPTH (m)	STRATA LGD	STRATA SYM	STRATA DESCRIPTION	ELEVATN (metres)	SAMPLE DEPTH (m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
					-				
			5.50 Medium dense grey mottled orange SAND,wet,non plastic,intermixed with very stiff to hard grey SILT-CLAY,trace fine sand,wet,highly plastic [FILL]	-1.81	5.50	‡			
6					6.00	↓	0		THP
							0		
							1		
							1		
					6.50	▮			
7			7.00 Loose grey SAND,minor silt,minor fine gravel sized shells,trace clay;wet,non plastic. [TAURANGA GROUP SEDIMENTS(Upper)]	-3.31	7.00	‡			
					7.50	▮		C = 30 CR= 10	
8			8.00 Soft grey sandy SILT-CLAY,trace fine gravel sized shells,wet,highly plastic [TAURANGA GROUP SEDIMENTS(Upper)]	-4.31	8.00	↓	1		
							2		
							1		
							1		
			8.50 Stiff light grey mottled brownish orange speckled white SILT-CLAY,some fine sand,moist,highly plastic [TAURANGA GROUP SEDIMENTS(Lower)]	-4.81	8.50	‡			
9					9.00	↓	5	C = 150+	
							7		
							10		
							17		
					9.50	‡			
			9.79 — with trace fine sand	-6.21					

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ‡ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 19-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

BECA CARTER HOLLINGS AND FERNER LTD. Ph: (09) 3773 410

RECORD OF BOREHOLE 215

SHEET 3 OF 3 | BH215

JOB NAME : Quay Street West Underpass

CLIENT : Auckland City Council

JOB NO. : 2409275

LOCATION : Lower Hobson St

COORDS : 6482794.50N, 2667699.80E

ELEV.: 3.69 DATUM: LANDS & SURVEY

DEPTH (m)	LGD	SYM	STRATA DESCRIPTION	ELEVATN (meters)	SAMPLE DEPTH(m)	SAMPLE TYPE	FIELD TESTS SPT	FIELD TESTS VANE	FIELD TESTS OTHER
			10.00 Brownish pinkish grey mottled orange SILT-CLAY,minor fine sand,trace gravel sized wood,moist,highly plastic.	-6.31	10.00	↕		C = 56 CR= 28	
			10.20 Medium dense grey silty clayey SAND;wet,moderately plastic.	-6.51					
			10.30	-6.61					
			10.35 Very stiff grey SILT-CLAY,trace fine sand,moist,highly plastic.	-6.66					
			Dense grey SAND;wet,non plastic (WAITEMATA GROUP)		10.50	↓	31		THP
							21/52		
11					11.00				TT
			11.50 Moderately thickly interbedded with grey slightly weathered,very weak SILTSTONE and SANDST	-7.81					
12					12.00		50/50+		SPT=50/115mm
			12.55 thinly laminated with carbonaceous material	-8.86	12.50	▯			
13					13.00	▯			
					13.50		32		SPT=20/35mm
			END OF BOREHOLE 215 , 13.70m BELOW GROUND SURFACE				20/52+		
14									

OBSERVATIONS:
THP=Too Hard to Penetrate with shear vane

SAMPLES
- ● Small disturbed sample
- ↕ Large disturbed sample
- ▮ Undisturbed tube sample
- ▯ Undisturbed core sample
- ↓ SPT Split spoon sample

FIELD TESTS
- SPT = Standard Penetration Test (blows/150mm,N=blows/300mm)
- C = Cohesion as measured direct with shear vane (kPa)
- CR = Remoulded C
- CC = Corrected Reading (kPa)

PILCON VANE DIAL NO.: DR2122

DATE STARTED : 19-Jan-98 CORE DIA.: 90 mm RIG : Trailer Mounted

DATE FINISHED: 20-Jan-98 LOGGED BY: M.Watson CONTRACTOR: Prodrill

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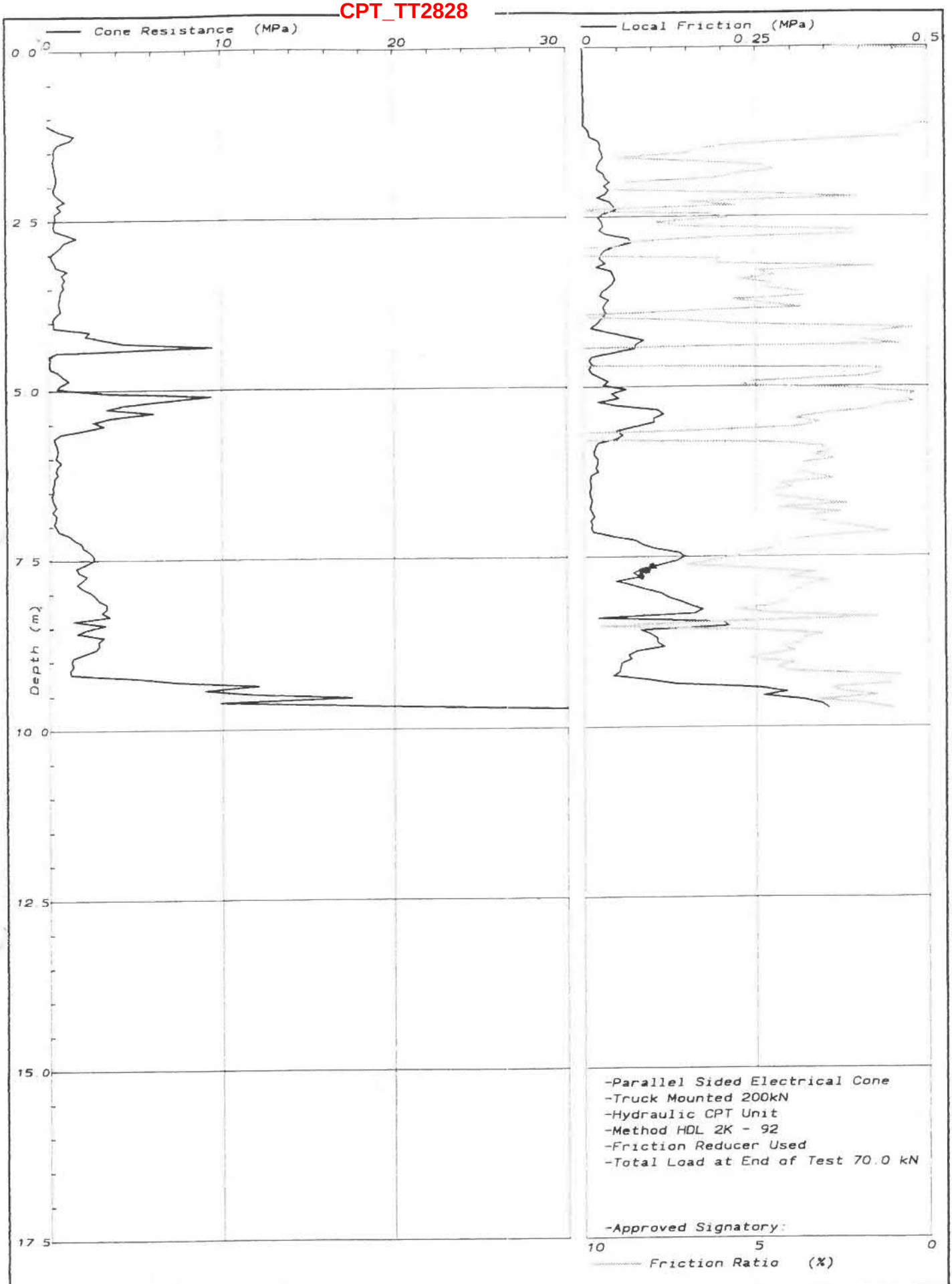

OPUS	BECA CARTER QUAY STREET WEST GEOTECH INVESTIGATION	2-68210.82	LR98/210/002
		6/4/1998	G E BAIRD
		Sheet of	CPT 229

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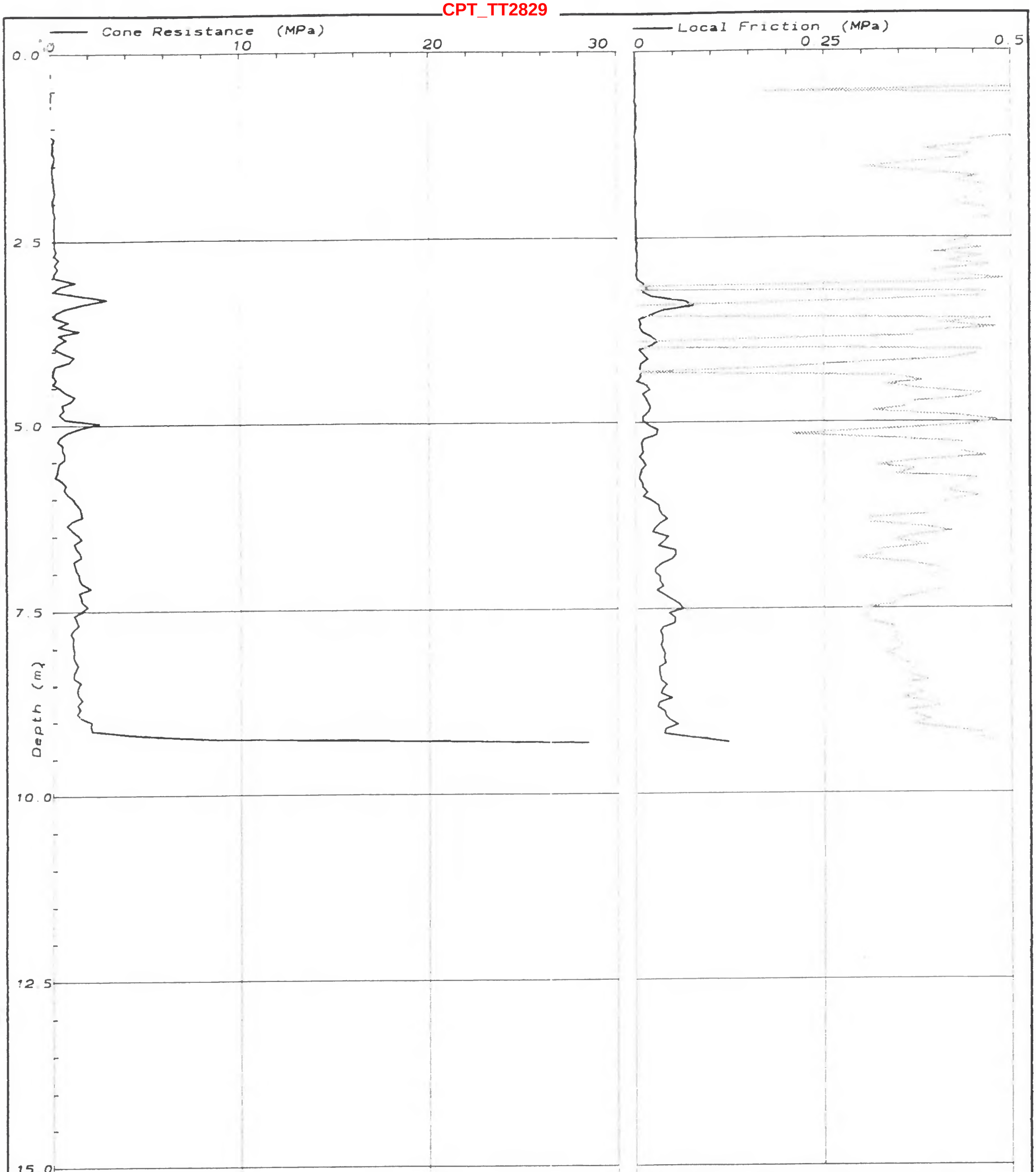

OPUS	BECA CARTER QUAY STREET WEST GEOTECH INVESTIGATION	2-68210.82	LR98/210/002
		6/4/1998	G E BAIRD
		Sheet of	CPT 230

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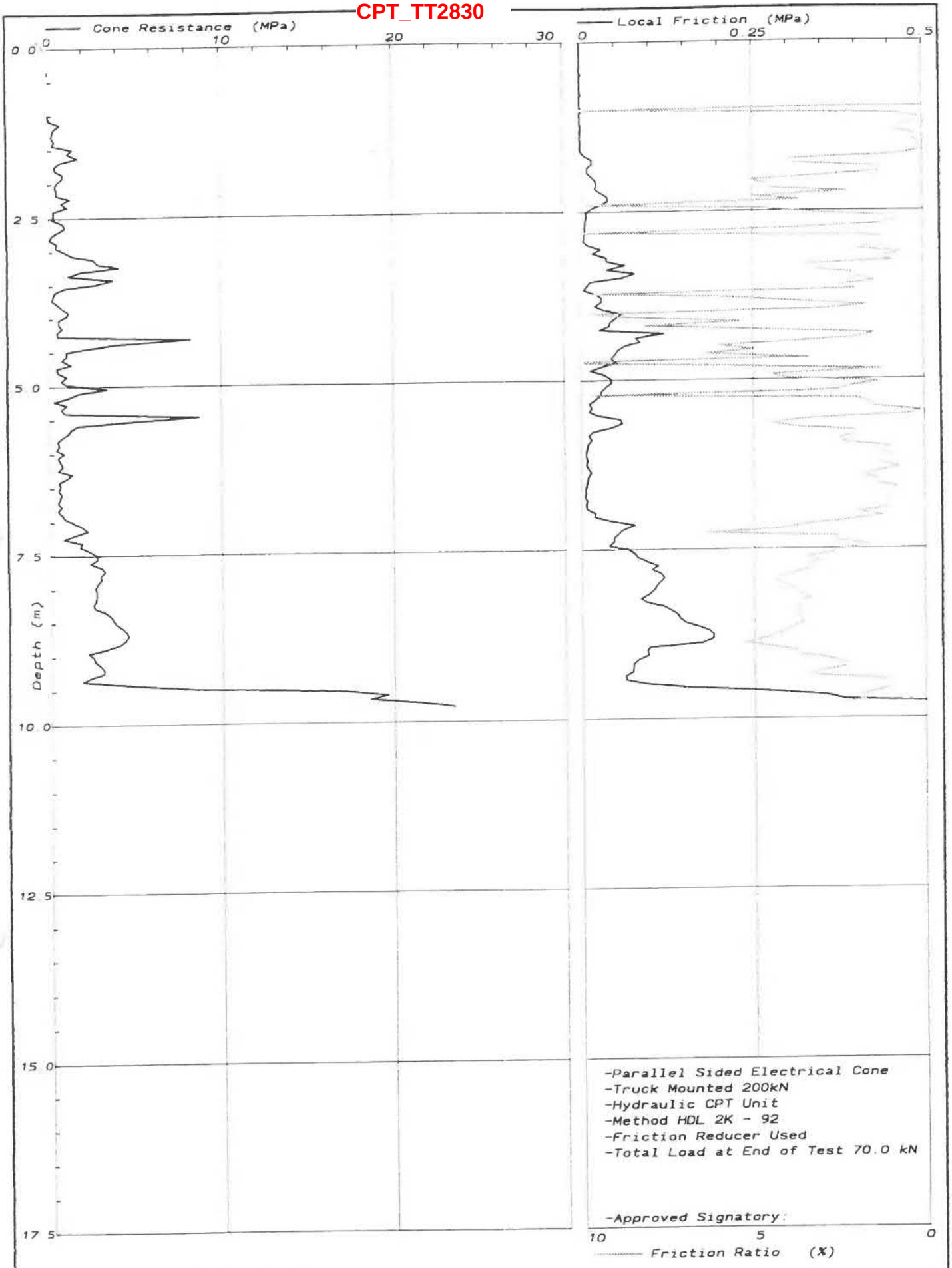

OPUS	BECA CARTER QUAY STREET WEST GEOTECH INVESTIGATION	2-68210.82	LR98/210/002
		6/4/1998	G E BAIRD
		Sheet of	CPT 231

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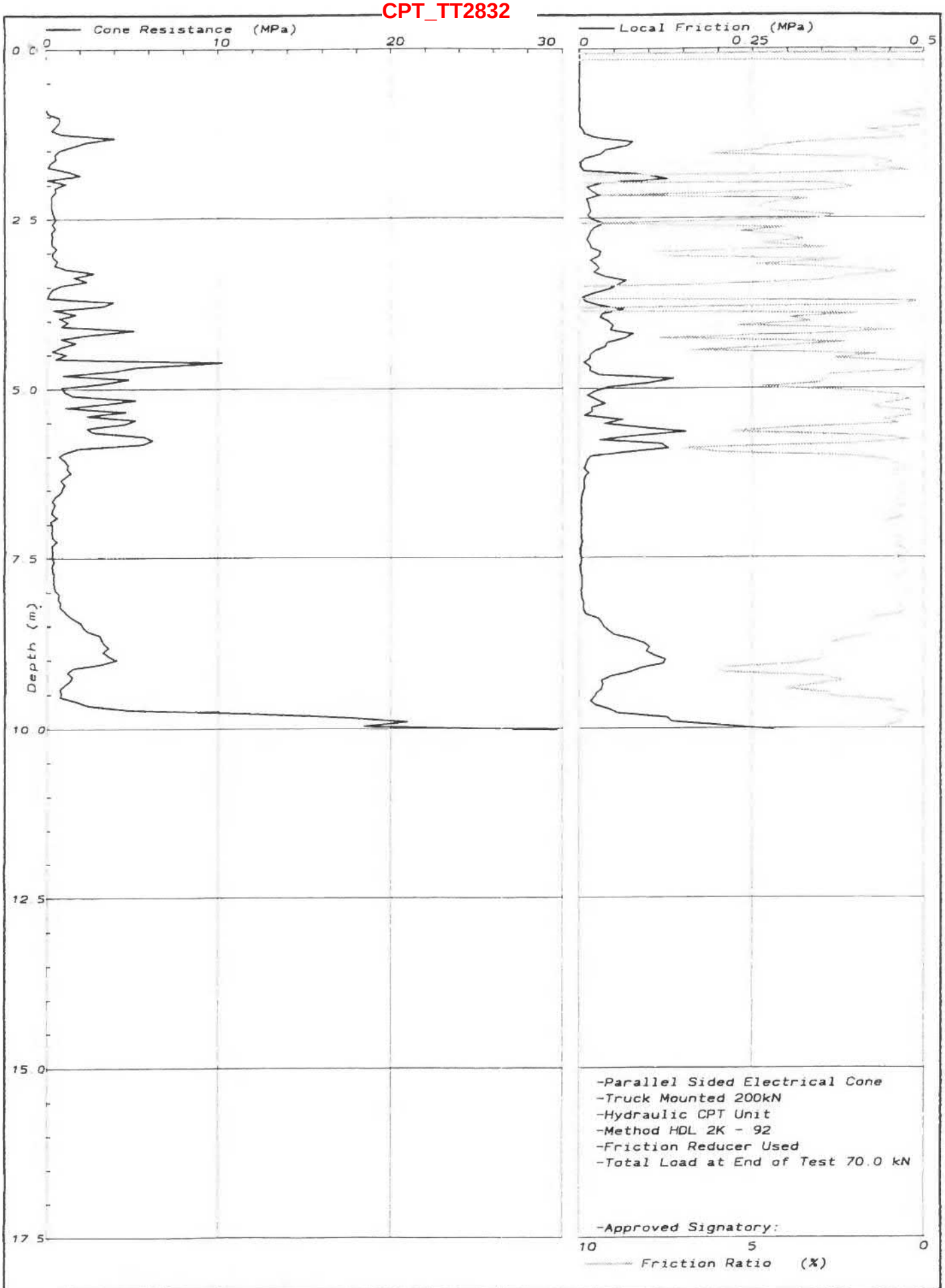
CPT_TT2832



OPUS	BECA CARTER QUAY STREET WEST GEOTECH INVESTIGATION	2-68210.82	LR98/210/002
		6/4/1998	G E BAIRD
		Sheet of	CPT 232

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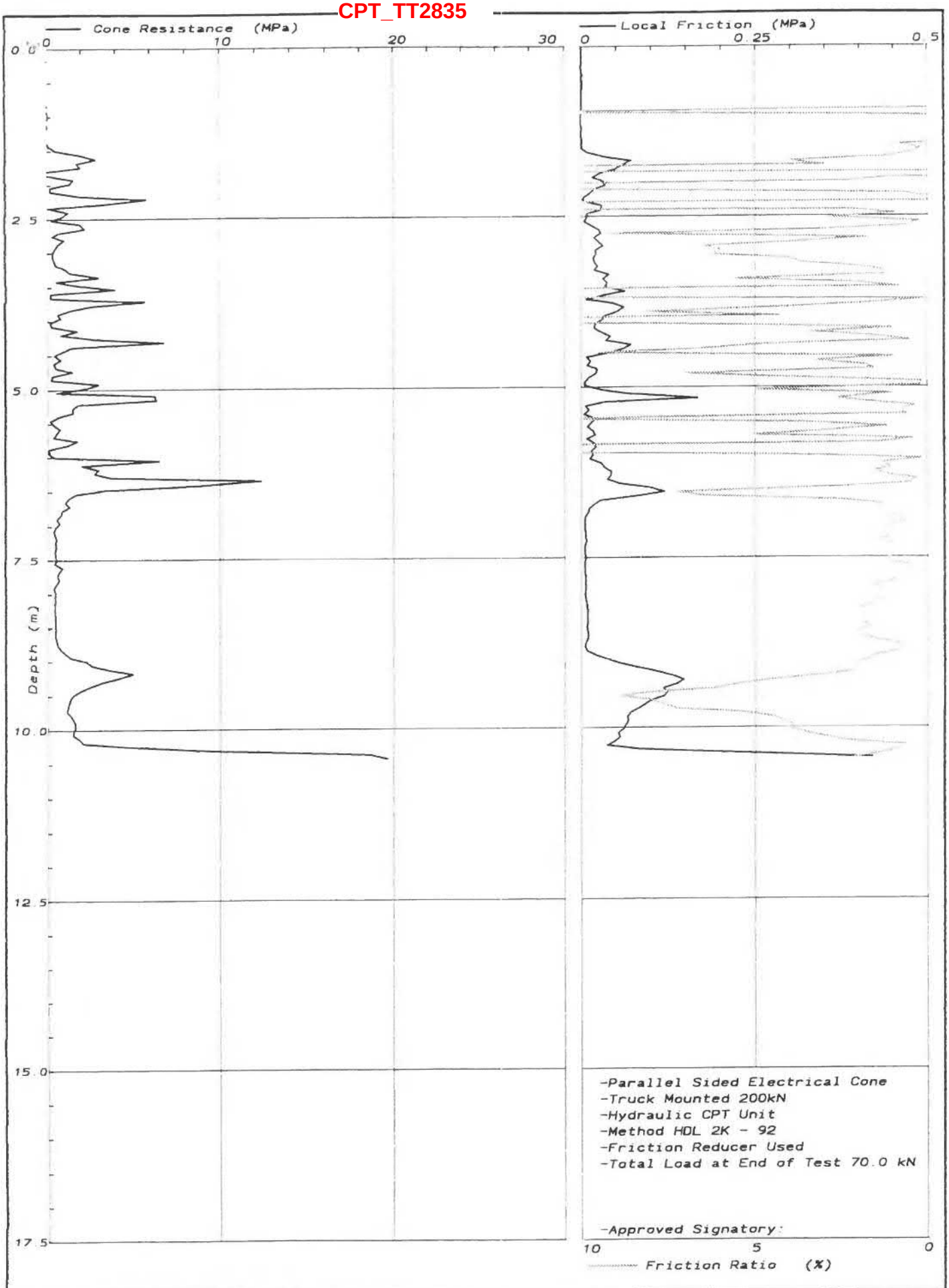

OPUS	BECA CARTER	2-68210.82	LR98/210/002
	QUAY STREET WEST	6/4/1998	G E BAIRD
	GEOTECH INVESTIGATION	Sheet of	CPT 233

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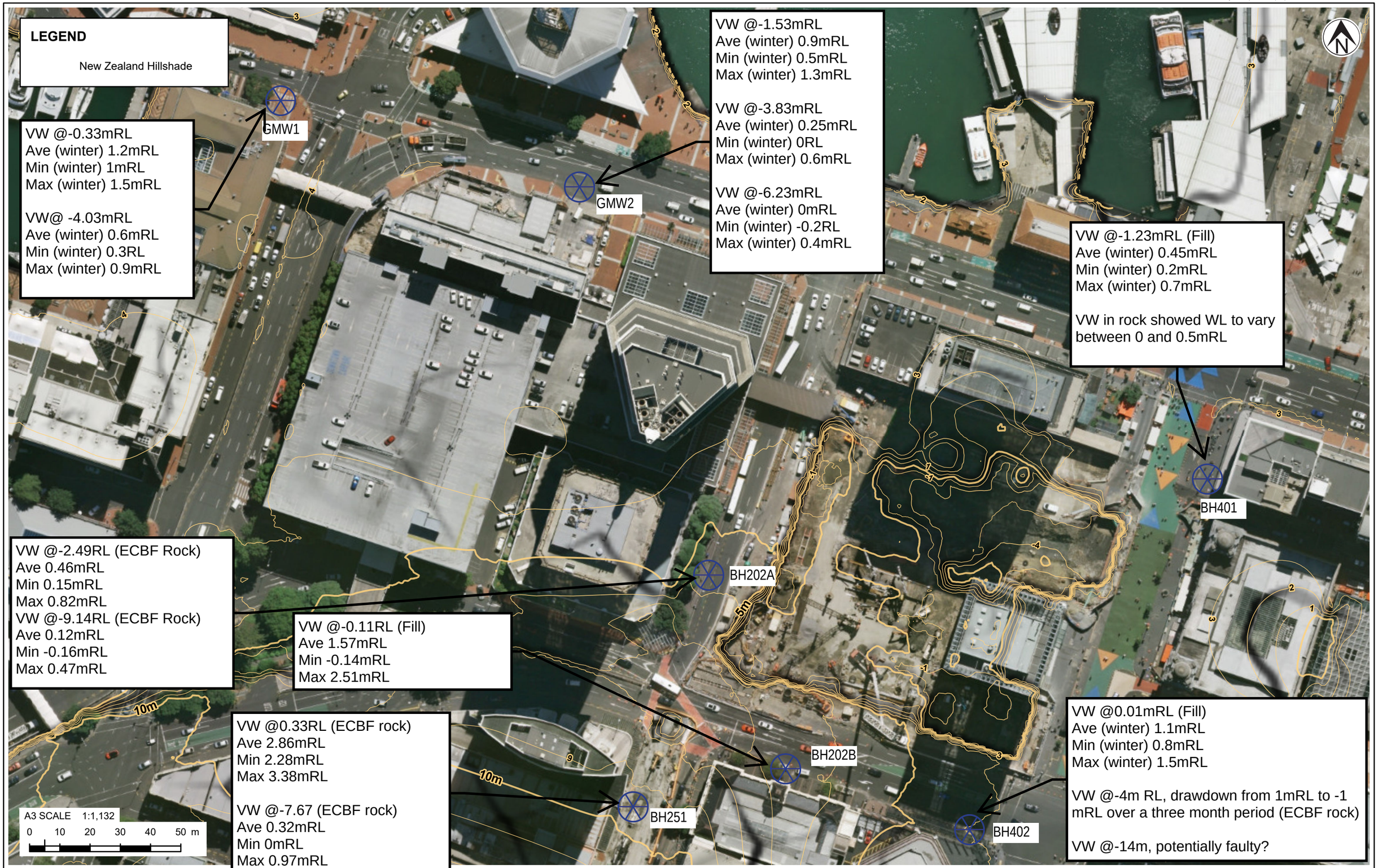
Appendix E Historical Groundwater Monitoring

Source: Tonkin + Taylor Map Viewer (NZ) Date: 19/04/2023 5:33 PM



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Exceptional thinking together www.tonkintaylor.co.nz

NOTES:

CRS: NZGD 2000 New Zealand Transverse Mercator Credits: Eagle Technology, Land Information New Zealand, Earthstar Geographics, Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

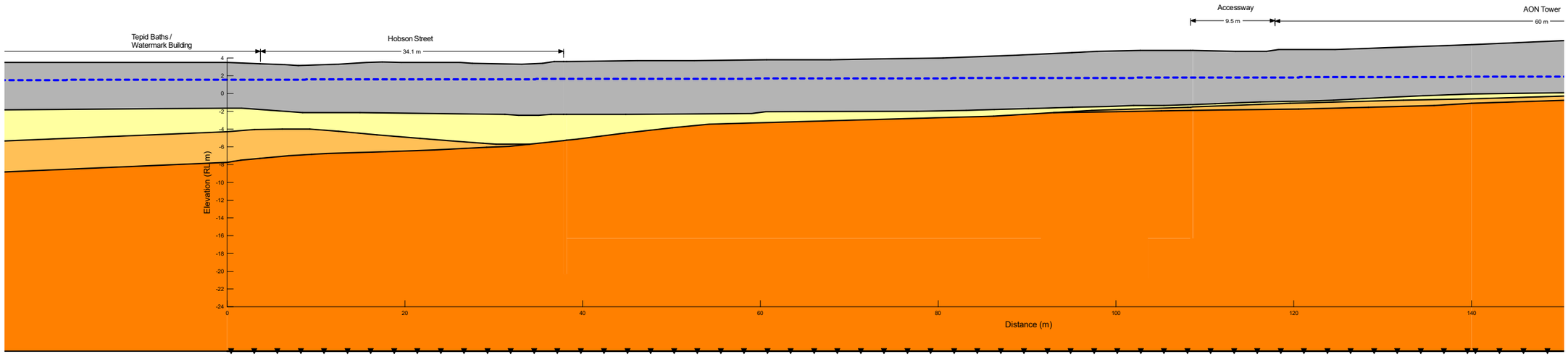
LOCATION PLAN

PROJECT No.	1016043.1000		
DESIGNED	ABL	APR.23	
DRAWN	-WEB-	APR.23	
CHECKED			
APPROVED		DATE	

CLIENT	**PRECINCT**
PROJECT	**DOWNTOWN CARPARK DEVELOPMENT**
TITLE	GROUNDWATER MONITORING INFO
SCALE (A3)	1:1,132
FIG No.	FIGURE 1.
REV	0

Appendix F Groundwater Seepage Analysis

Color	Name	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	ECBF rock	0.1
	Hydraulic Fill	Hydraulic Fill	0.0333
	Marine Sediments	Marine Sediments	0.0333
	Weathered ECBF	Weathered ECBF	0.02



Tonkin+Taylor

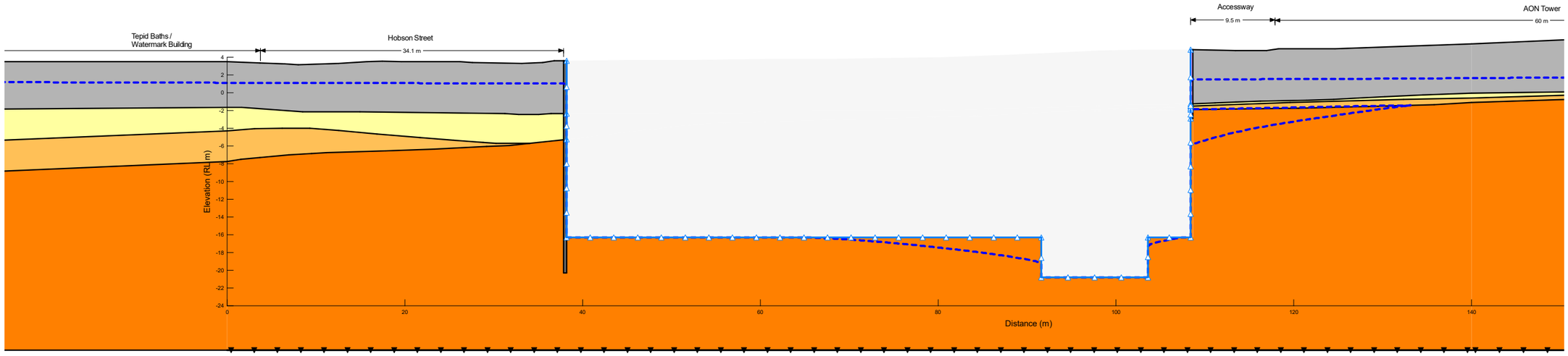
Project: 1. Section 1 - South (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Details:
1. Analysis Scenario: 1a. Existing Condition
2. Method: Steady-State
3. Elapsed Time: 0 d

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev3 - July24\

Color	Name	Sat Kx (m/sec)	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock		ECBF rock	0.1
	Hydraulic Fill		Hydraulic Fill	0.0333
	Marine Sediments		Marine Sediments	0.0333
	Secant (construction)	1e-10		1
	Sheetpiles	8.4e-09		1
	Weathered ECBF		Weathered ECBF	0.02



Tonkin+Taylor

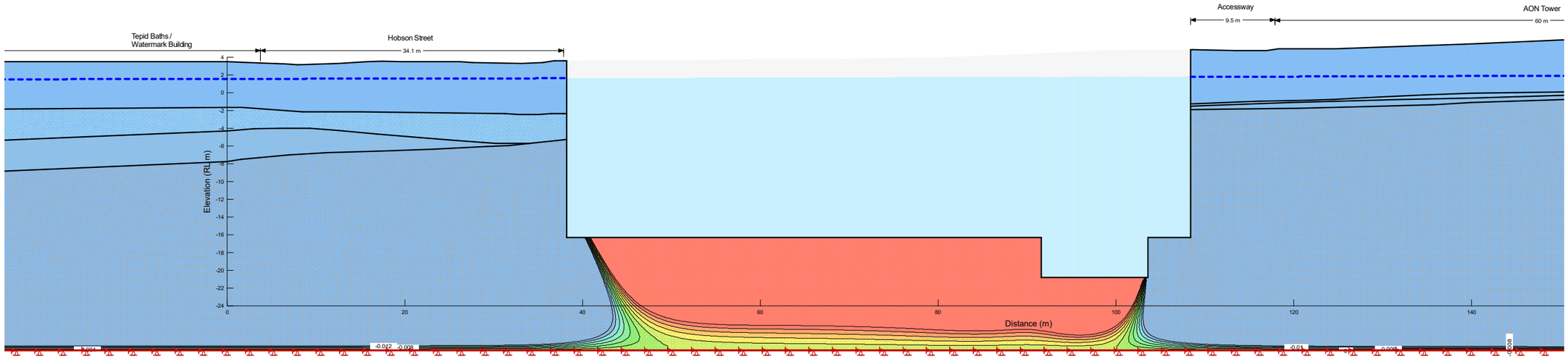
Project: 1. Section 1 - South (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Details:
1. Analysis Scenario: 1b. Temporary Excavation
2. Method: Transient
3. Elapsed Time: 365 d

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev3 - July24\

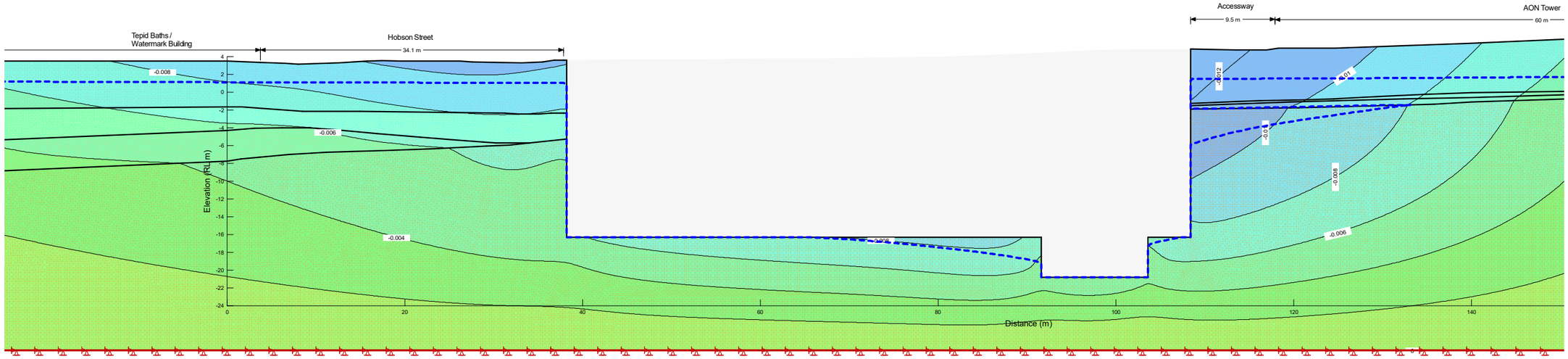
Color	Name	Stress Material Model	Unit Weight (kN/m³)	Effective Elastic Modulus (kPa)	Effective Poisson's Ratio	K0	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	Isotropic Elastic	21	200,000	0.3	1	ECBF rock	0.1
	Hydraulic Fill	Isotropic Elastic	16	6,000	0.35	1	Hydraulic Fill	0.0333
	Marine Sediments	Isotropic Elastic	16	6,000	0.35	1	Marine Sediments	0.0333
	Weathered ECBF	Isotropic Elastic	19	40,000	0.3	1	Weathered ECBF	0.02



Tonkin+Taylor	Project: 1. Section 1 - South (West to East).gsz		Analysis Description:
	Project Number: 1016043.1000		
	A3 Scale: 1:500	Vertical Exaggeration: 1	
	Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra	

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev3 - July24\

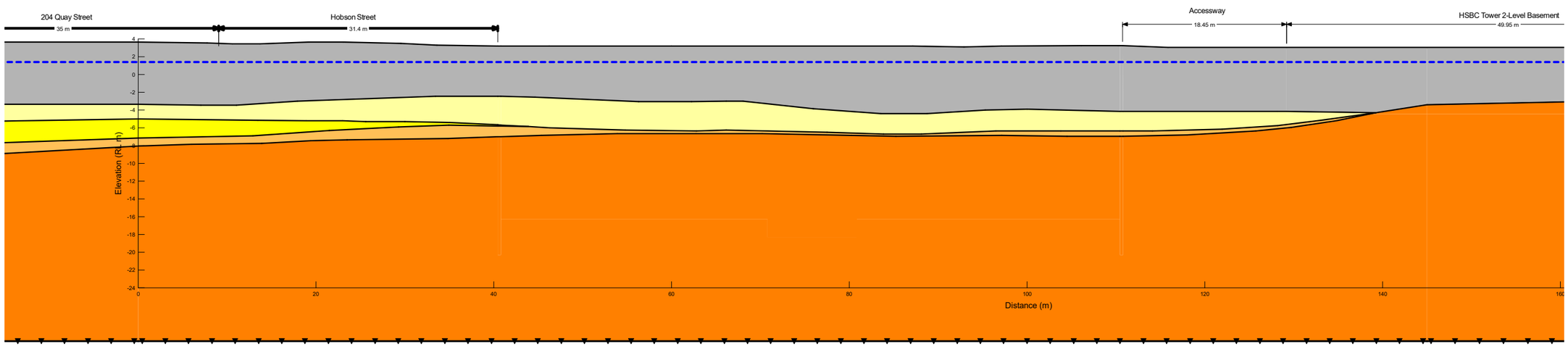
Color	Name	Stress Material Model	Unit Weight (kN/m³)	Effective Elastic Modulus (kPa)	Effective Poisson's Ratio	K0	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	Isotropic Elastic	21	200,000	0.3	1	ECBF rock	0.1
	Hydraulic Fill	Isotropic Elastic	16	6,000	0.35	1	Hydraulic Fill	0.0333
	Marine Sediments	Isotropic Elastic	16	6,000	0.35	1	Marine Sediments	0.0333
	Weathered ECBF	Isotropic Elastic	19	40,000	0.3	1	Weathered ECBF	0.02



Tonkin+Taylor	Project: 1. Section 1 - South (West to East).gsz		Analysis Description: Ground settlement profile due to groundwater drawdown
	Project Number: 1016043.1000		
	A3 Scale: 1:500	Vertical Exaggeration: 1	
	Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra	

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev3 - July24\

Color	Name	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	ECBF rock	0.1
	Hydraulic Fill	Hydraulic Fill	0.0333
	Marine Sediments	Marine Sediments	0.0333
	Pleistocene Alluvium	Pleistocene Alluvium	0.02
	Weathered ECBF	Weathered ECBF	0.02



Tonkin+Taylor

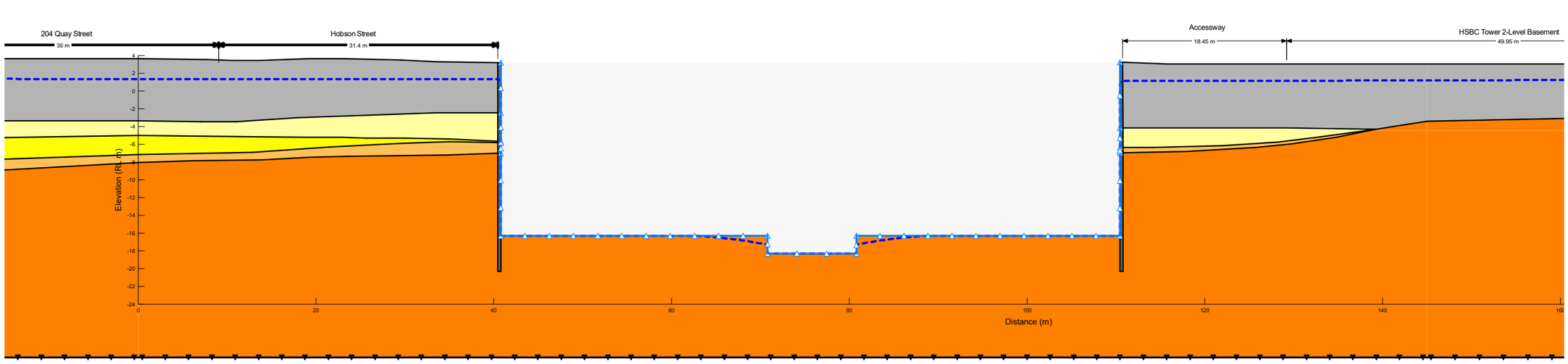
Project: 2. Section 2 - North (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Details:
1. Analysis Scenario: 1a. Existing Condition
2. Method: Steady-State
3. Elapsed Time: 0 d

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev4 - S92\

Color	Name	Sat Kx (m/sec)	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock		ECBF rock	0.1
	Hydraulic Fill		Hydraulic Fill	0.0333
	Marine Sediments		Marine Sediments	0.0333
	Pleistocene Alluvium		Pleistocene Alluvium	0.02
	Secant (construction)	1e-10		1
	Weathered ECBF		Weathered ECBF	0.02



Tonkin+Taylor

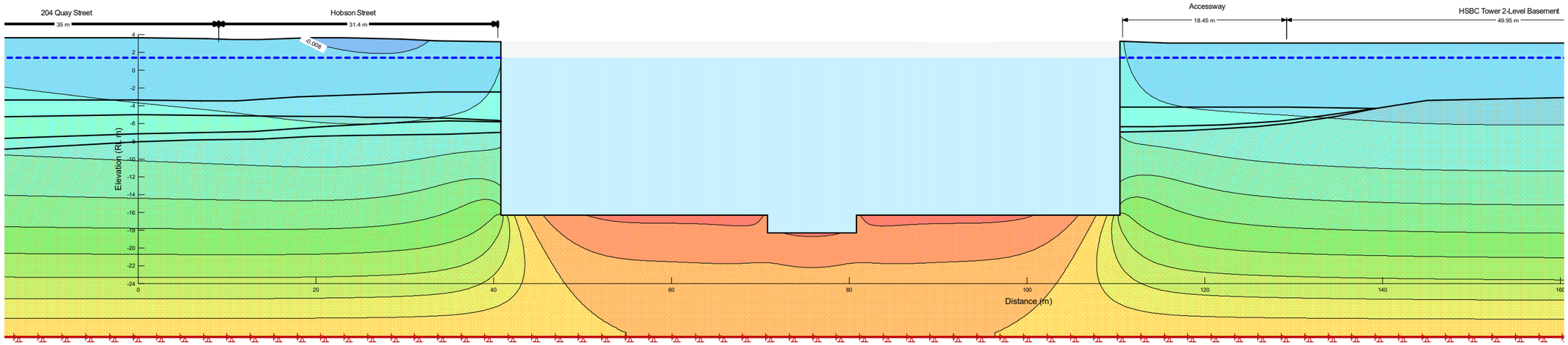
Project: 2. Section 2 - North (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Details:
1. Analysis Scenario: 1b. Temporary Excavation
2. Method: Transient
3. Elapsed Time: 365 d

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev4 - S92\

Color	Name	Stress Material Model	Unit Weight (kN/m³)	Effective Elastic Modulus (kPa)	Effective Poisson's Ratio	K0	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	Isotropic Elastic	21	200,000	0.3	1	ECBF rock	0.1
	Hydraulic Fill	Isotropic Elastic	16	6,000	0.35	1	Hydraulic Fill	0.0333
	Marine Sediments	Isotropic Elastic	16	6,000	0.35	1	Marine Sediments	0.0333
	Pleistocene Alluvium	Isotropic Elastic	17.5	20,000	0.35	1	Pleistocene Alluvium	0.02
	Weathered ECBF	Isotropic Elastic	19	40,000	0.3	1	Weathered ECBF	0.02



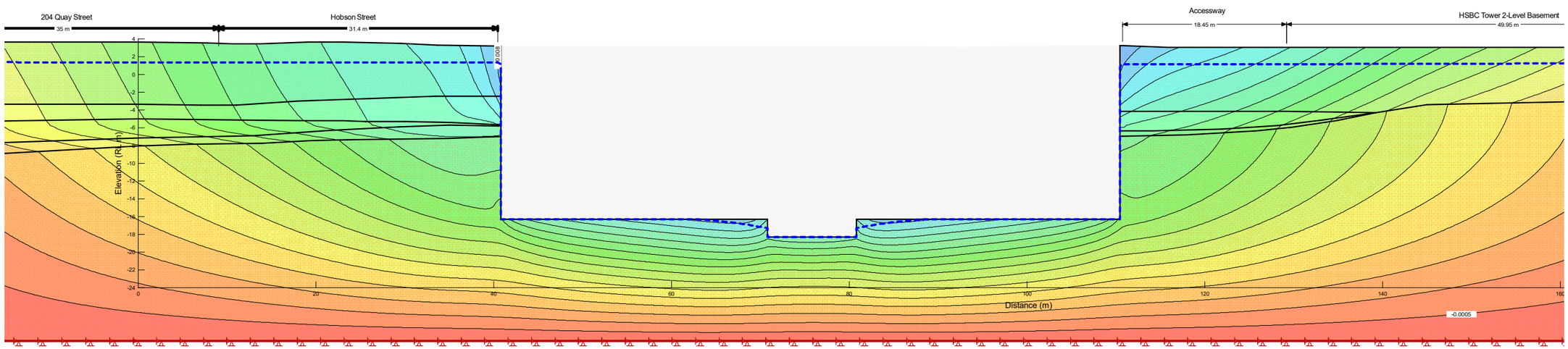
Tonkin+Taylor

Project: 2. Section 2 - North (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev4 - S92\

Color	Name	Stress Material Model	Unit Weight (kN/m³)	Effective Elastic Modulus (kPa)	Effective Poisson's Ratio	K0	Vol. WC. Function	Ky'/Kx' Ratio
	ECBF rock	Isotropic Elastic	21	200,000	0.3	1	ECBF rock	0.1
	Hydraulic Fill	Isotropic Elastic	16	6,000	0.35	1	Hydraulic Fill	0.0333
	Marine Sediments	Isotropic Elastic	16	6,000	0.35	1	Marine Sediments	0.0333
	Pleistocene Alluvium	Isotropic Elastic	17.5	20,000	0.35	1	Pleistocene Alluvium	0.02
	Weathered ECBF	Isotropic Elastic	19	40,000	0.3	1	Weathered ECBF	0.02



Tonkin+Taylor

Project: 2. Section 2 - North (West to East).gsz	
Project Number: 1016043.1000	
A3 Scale: 1:500	Vertical Exaggeration: 1
Analysed by: Ric Wilkinson	Checked By: Ananth Balachandra

Analysis Details:
1. Analysis Scenario: Load/Deformation
2. Method: Load/Deformation
3. Elapsed Time: 1 d
4. Initial Stress and PWP Conditions from Parent Analysis: In Situ [(last)]
5. Final PWP Conditions from Other GeoStudio Analysis: 1b. Temporary Excavation [(last)]

Analysis Description:

Directory: C:\Users\rxsw\OneDrive - Tonkin + Taylor Group Ltd\Desktop\Downtown Carpark - SEEPW\Rev4 - S92\

Appendix G Basement Retention Analysis

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LEGEND

- PROPERTY BOUNDARY
- ECBF CONTOUR (1m INTERVAL)
- GEOMAPS WATER LINE
- GEOMAPS ABANDONED WATER LINE
- WATER HYDRANT
- WATER VALVE
- GEOMAPS STORMWATER LINE
- GEOMAPS ABANDONED STORMWATER LINE
- STORMWATER CATCHPIT
- STORMWATER MANHOLE
- GEOMAPS WASTEWATER LINE
- GEOMAPS ABANDONED WASTEWATER LINE
- WASTEWATER MANHOLE
- CRL UNDERGROUND ROUTE
- CHORUS
- VECTOR COMMUNICATION - UNDERGROUND ROUTE TRENCH
- VECTOR COMMUNICATION - UNDERGROUND INSTALLED IN PLACE
- GAS
- GAS VALVE
- VODAFONE
- FIBRE OPTIC
- POWER
- LAMP

204 QUAY ST

QUAY ST

MSOCIAL BUILDING

DESIGN SECTION 1
800mm THICK D-WALL WITH TOP-DOWN CONSTRUCTION OF B1 LEVELS AND TEMPORARY HIGH-LEVEL AND LOW-LEVEL PROP SUPPORTS

DESIGN SECTION 2
800mm THICK D-WALL WITH FOUR ROWS OF GROUND ANCHORS EMBEDDED INTO ECBF ROCK

WATERMARK BUILDING

GROUND ANCHORS MAY BE RESTRICTED DUE TO NEIGHBOURING BASEMENT + DEPTH TO ECBF ROCK

HSBC TOWER

HOBSON ST

4m

TEMPORARY PROP MAY BE REQUIRED FOR LOAD TRANSFER IN THE EAST-WEST DIRECTION.

DESIGN SECTION 3

OPTION 1: AU25 SHEETPILE WALL EMBEDDED 1M INTO ECBF ROCK WITH THREE ROWS OF GROUND ANCHORS INTO ECBF ROCK. FORM 1m WIDE BENCH AND OPEN-CUT WITHIN ROCK TO FORMATION LEVEL.

OPTION 2: FULLY EMEDDED 800mm THICK D-WALL WITH FOUR ROWS OF GROUND ANCHORS EMBEDDED INTO ECBF ROCK

TEPID BATHS

AON TOWER

CUSTOMS ST WEST

STURDEE ST

FANSHAWE ST

A3 SCALE 1:750

0 5 10 15 20 25 30 35 40 (m)

ORIGINAL IN COLOUR

BACKDRAFTING REQUIRED	CHECK PRINT	
READY TO ISSUE	INITIAL	DATE
CAD SELF CHECK		
DESIGN CHECK		
DRAFTING CHECK		
BACKDRAFTER - EDITS MADE		
BACKCHECKER - EDITS CONFIRMED		

Tonkin & Taylor

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NOTES:
1. AERIAL PHOTO, STORMWATER LINE, WASTEWATER LINE AND WATER LINE SOURCED FROM AUCKLAND COUNCIL GEOMAPS, LICENSED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). CAPTURE DATE 24/05/2023.
2. VODAFONE AND CRL INFORMATION SUPPLIED BY BEFORE U DIG. REF 11197173 - Vodafone Plan.pdf AND "11197172 - CityLink Plan (002).pdf".
3. CHORUS INFORMATION SUPPLIED BY CHORUS, REF "CHORUS.pdf".
4. VECTOR POWER, COMMUNICATION AND GAS SUPPLIED BY VECTOR, REF "VECTOR ELECTRICITY.pdf" , "VECTOR COMMUNICATION.pdf" AND "VECTOR GAS.pdf".

PROJECT No.	1016043.1000	
DESIGNED	KASC	May.23
DRAWN	JC	May.23
CHECKED		
APPROVED		DATE

CLIENT **PRECINCT PROPERTIES HOLDINGS LIMITED**

PROJECT **DOWNTOWN CARPARK REDEVELOPMENT**

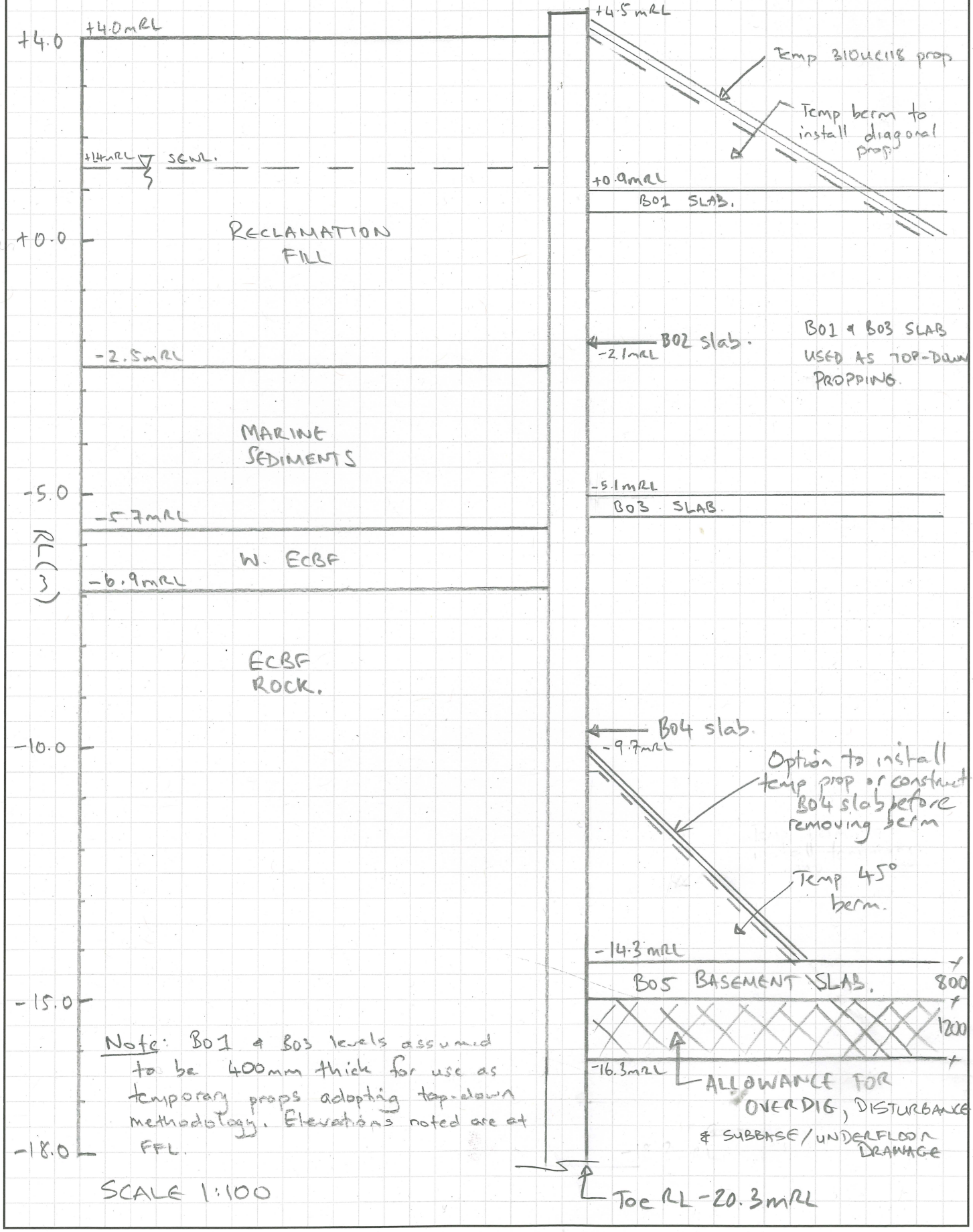
TITLE GEOTECHNICAL LAYOUT PLAN

UNDER REVISION 1

SCALE (A3) 1:750 FIG No. FIGURE 1 REV 1

Tonkin+Taylor	Project: Downtown Carpark	Computed: RXSW 23/5/2024	Office: AKL
Description:		Checked: 20	Job No: 1016043.1
		Revised: 20	File:
		Checked: 20	Sheet No.

SECTION 1 - TOP DOWN CONSTRUCTION



Note: B01 & B03 levels assumed to be 400mm thick for use as temporary props adopting top-down methodology. Elevations noted are at FFL.

SCALE 1:100

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	4.00	1 Fill	1 Fill
2	-2.50	2 Marine Sediment	2 Marine Sediment
3	-5.70	5 Weathered ECBF	3 Pleistocene Alluvium
4	-6.90	4 ECBF	4 ECBF

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	16.50	6000	0.530	OC (0.300)	0.309 (1.300)	3.868 (5.395)	3.000d
2	Marine Sediment	16.50	6000	0.530	OC (0.300)	0.309 (1.300)	4.369 (5.836)	3.000d
3	Pleistocene Alluvium	17.50	20000	0.500	OC (0.300)	0.283 (1.241)	4.369 (5.836)	5.000d
4	ECBF	21.00	400000	0.357	OC (0.250)	0.180 (0.978)	8.892 (9.405)	100.0d
5	Weathered ECBF	19.00	40000	0.470	OC (0.300)	0.259 (1.185)	4.964 (6.343)	7.000d
6	Engineered Fill	19.00	40000	0.384	OC (0.300)	0.197 (1.027)	7.588 (8.432)	0.0d

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill	28.00	0.670	0.00	28.00	0.500	0.00
2	Marine Sediment	28.00	0.670	0.00	30.00	0.500	0.00
3	Pleistocene Alluvium	30.00	0.670	0.00	30.00	0.500	0.00
4	ECBF	40.00	0.670	0.00	40.00	0.500	0.00
5	Weathered ECBF	32.00	0.670	0.00	32.00	0.500	0.00
6	Engineered Fill	38.00	0.670	0.00	38.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.40	1.40

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	1.40	1.40	0.0	1	0.00	0.00	0.0
2	1	1.40	1.40	0.0	1	-6.00	-6.00	0.0
3	1	1.40	1.40	0.0	1	-16.30	-16.30	0.0
	2	-5.90	1.40	73.0				
	3	-20.30	-11.30	90.0				
4	1	2.50	2.50	0.0	1	-15.10	-15.10	0.0
5	1	1.40	1.40	0.0	1	-15.10	-15.10	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = -20.30
Maximum finite element length = 1.20 m
Youngs modulus of wall E = 2.7400E+07 kN/m2
Moment of inertia of wall I = 0.042700 m4/m run
E.I = 1.1700E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	0.70	1.00	0.400000	2.740E+07	30.00	0.00	0	Strut	No	R
2	-5.30	1.00	0.400000	2.740E+07	30.00	0.00	0	Strut	No	R
3	4.30	5.00	0.015000	2.100E+08	9.80	27.00	0	Strut	No	R
4	-14.70	1.00	0.800000	2.740E+07	30.00	0.00	0	Strut	No	R
5	-9.80	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
6	-2.20	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
7	4.40	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
8	-10.30	5.00	0.013400	2.000E+08	6.10	45.00	100.0	Strut	No	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load kN/m run	Moment load kN.m/m run	Moment restraint kN.m/m/rad	Partial factor (Category)
1	-13.20	61.50	0	0	N/A
2	-10.90	61.50	0	0	N/A
3	-8.60	61.50	0	0	N/A
4	-6.30	61.50	0	0	N/A
5	-4.00	61.50	0	0	N/A
6	-1.70	61.50	0	0	N/A
7	0.60	61.50	0	0	N/A
8	2.90	61.50	0	0	N/A

SURCHARGE LOADS

Surch -arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	4.00	2.00(L)	100.00	20.00	12.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 877500 kN.m2/m run Reset wall displacements to zero at this stage
2	Apply surcharge no.1 at elevation 4.00
3	Apply water pressure profile no.1 No analysis at this stage
4	Excavate to elevation 4.00 on RIGHT side Toe of berm at elevation 0.00 Width of top of berm = 0.01 Width of toe of berm = 8.00
5	Install strut or anchor no.3 at elevation 4.30
6	Excavate to elevation 0.00 on RIGHT side
7	Install strut or anchor no.1 at elevation 0.70
8	Apply water pressure profile no.2 No analysis at this stage
9	Excavate to elevation -6.00 on RIGHT side
10	Install strut or anchor no.2 at elevation -5.30
11	Apply water pressure profile no.3 No analysis at this stage
12	Excavate to elevation -10.70 on RIGHT side Toe of berm at elevation -16.30 Width of top of berm = 0.30 Width of toe of berm = 5.90
13	Install strut or anchor no.8 at elevation -10.30
14	Excavate to elevation -16.30 on RIGHT side
15	Fill to elevation -15.10 on RIGHT side with soil type 6
16	Install strut or anchor no.4 at elevation -14.70
17	Install strut or anchor no.5 at elevation -9.80
18	Remove strut or anchor no.8 at elevation -10.30
19	Install strut or anchor no.6 at elevation -2.20
20	Remove strut or anchor no.3 at elevation 4.30
21	Install strut or anchor no.7 at elevation 4.40
22	Change EI of wall to 585000 kN.m2/m run Allow wall to relax with new modulus value
23	Apply water pressure profile no.4
24	Apply water pressure profile no.5
25	Change EI of wall to 292500 kN.m2/m run Allow wall to relax with new modulus value
26	Apply load no.1 at elevation -13.20
27	Apply load no.2 at elevation -10.90
28	Apply load no.3 at elevation -8.60
29	Apply load no.4 at elevation -6.30
30	Apply load no.5 at elevation -4.00
31	Apply load no.6 at elevation -1.70
32	Apply load no.7 at elevation 0.60
33	Apply load no.8 at elevation 2.90

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - Strength Factor method
 Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
 Minimum equivalent fluid density = 5.00 kN/m3
 Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
 Method - 2-D finite element model
 Open Tension Crack analysis? - No
 Active limit arching modelled? - Yes
 Non-linear Modulus Parameter (L) = 24.80 m

Boundary conditions:
 Length of wall (normal to plane of analysis) = 1000.00 m

 Width of excavation on Left side of wall = 60.00 m
 Width of excavation on Right side of wall = 60.00 m

 Distance to rigid boundary on Left side = 60.00 m
 Distance to rigid boundary on Right side = 60.00 m

Elevation of rigid lower boundary = -47.75

Lower rigid boundary at elevation -47.75 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 877500kN.m2/m run	No	No	No
2	Apply surcharge no.1 at elev. 4.00	No	No	No
3	Apply water pressure profile no.1	No	No	No
4	Excav. to elev. 4.00 on RIGHT side	Yes	No	No
5	Install prop no.3 at elev. 4.30	No	No	No
6	Excav. to elev. 0.00 on RIGHT side	Yes	Yes	Yes
7	Install prop no.1 at elev. 0.70	No	No	No
8	Apply water pressure profile no.2	No	No	No
9	Excav. to elev. -6.00 on RIGHT side	Yes	Yes	Yes
10	Install prop no.2 at elev. -5.30	No	No	No
11	Apply water pressure profile no.3	No	No	No
12	Excav. to elev. -10.70 on RIGHT side	No	No	No
13	Install prop no.8 at elev. -10.30	No	No	No
14	Excav. to elev. -16.30 on RIGHT side	Yes	Yes	Yes
15	Fill to elev. -15.10 on RIGHT side	No	No	No
16	Install prop no.4 at elev. -14.70	No	No	No
17	Install prop no.5 at elev. -9.80	No	No	No
18	Remove prop no.8 at elev. -10.30	No	No	No
19	Install prop no.6 at elev. -2.20	No	No	No
20	Remove prop no.3 at elev. 4.30	No	No	No
21	Install prop no.7 at elev. 4.40	No	No	No
22	Change EI of wall to 585000kN.m2/m run	No	No	No
23	Apply water pressure profile no.4	No	No	No
24	Apply water pressure profile no.5	No	No	No
25	Change EI of wall to 292500kN.m2/m run	No	No	No
26	Apply load no.1 at elev. -13.20	No	No	No
27	Apply load no.2 at elev. -10.90	No	No	No
28	Apply load no.3 at elev. -8.60	No	No	No
29	Apply load no.4 at elev. -6.30	No	No	No
30	Apply load no.5 at elev. -4.00	No	No	No
31	Apply load no.6 at elev. -1.70	No	No	No
32	Apply load no.7 at elev. 0.60	No	No	No
33	Apply load no.8 at elev. 2.90	Yes	No	No
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 4 Excavate to elevation 4.00 on RIGHT side
Toe of berm at elevation 0.00
Width of top of berm = 0.01
Width of toe of berm = 8.00

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetration	Direction of failure
4	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m	EI of wall kN.m2/m
1	4.40	0.00	0.006	3.30E-04	0.0	-0.0		877500
2	4.30	0.00	0.006	3.30E-04	0.0	-0.0		877500
3	4.00	0.00	0.006	3.30E-04	0.0	0.0		877500
		-2.52	0.006	3.30E-04	0.0	0.0		
4	2.90	-4.62	0.005	3.31E-04	-3.9	-1.5		877500
5	2.50	-4.14	0.005	3.32E-04	-5.7	-3.4		877500
6	1.40	-3.08	0.005	3.42E-04	-9.7	-12.0		877500
7	0.70	1.55	0.004	3.54E-04	-10.2	-19.1		877500
8	0.60	2.30	0.004	3.57E-04	-10.0	-20.1		877500
9	0.00	6.19	0.004	3.72E-04	-7.4	-25.5		877500
10	-0.85	6.79	0.004	3.99E-04	-1.9	-29.5		877500
11	-1.70	7.33	0.003	4.27E-04	4.1	-28.7		877500
12	-2.20	7.67	0.003	4.42E-04	7.8	-25.7		877500
13	-2.50	7.97	0.003	4.51E-04	10.2	-23.0		877500
14	-3.25	8.39	0.003	4.66E-04	16.3	-13.2		877500
15	-4.00	8.82	0.002	4.71E-04	22.8	1.4		877500
16	-4.65	9.18	0.002	4.64E-04	28.6	18.1		877500
17	-5.30	9.38	0.002	4.43E-04	34.6	38.6		877500
18	-5.70	8.25	0.002	4.22E-04	38.2	53.3		877500
		-8.74	0.002	4.22E-04	38.2	53.3		
19	-6.00	-4.25	0.002	4.02E-04	36.2	64.3		877500
20	-6.30	-0.85	0.001	3.78E-04	35.5	75.0		877500
21	-6.90	0.92	0.001	3.20E-04	35.5	96.1		877500
		-86.41	0.001	3.20E-04	35.5	96.1		
22	-7.75	-33.61	0.001	2.27E-04	-15.5	95.1		877500
23	-8.60	1.71	0.001	1.47E-04	-29.1	69.7		877500
24	-9.80	9.08	0.001	7.54E-05	-22.6	36.0		877500
25	-10.30	9.66	0.001	5.77E-05	-17.9	25.9		877500

(continued)

Stage No.4 Excavate to elevation 4.00 on RIGHT side
Toe of berm at elevation 0.00
Width of top of berm = 0.01
Width of toe of berm = 8.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.70	8.80	0.001	4.74E-05	-14.2	19.5		877500
27	-10.90	7.00	0.001	4.33E-05	-12.7	16.8		877500
28	-12.05	4.50	0.001	2.78E-05	-6.0	6.9		877500
29	-13.20	2.19	0.001	2.14E-05	-2.2	2.9		877500
30	-13.95	0.98	0.001	1.93E-05	-1.0	1.9		877500
31	-14.70	0.56	0.001	1.80E-05	-0.4	1.4		877500
32	-15.10	0.17	0.001	1.74E-05	-0.3	1.2		877500
33	-16.30	0.07	0.001	1.58E-05	-0.2	1.0		877500
34	-17.15	-0.07	0.000	1.49E-05	-0.2	0.9		877500
35	-18.00	-0.11	0.000	1.41E-05	-0.2	0.7		877500
36	-19.15	-0.04	0.000	1.34E-05	-0.3	0.4		877500
37	-20.30	0.46	0.000	1.32E-05	-0.1	0.0		0
38	-20.60	0.06	0.000	0	0.0	0.0		0
39	-24.70	0.00	0.000	0	0.1	0.0		0
40	-28.80	0.01	0.000	0	0.2	0.0		0
41	-33.60	-0.00	0.000	0	0.2	0.0		0
42	-38.40	-0.00	0.000	0	0.1	0.0		0
43	-43.08	-0.00	0.000	0	0.1	0.0		0
44	-47.75	-0.05	0.000	0	-0.0	0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	0.00	0.00a	5999
4	2.90	0.00	18.76	1.90	88.77	7.44	7.44	5999
5	2.50	0.00	26.00	4.14	116.75	11.31	11.31	5999
6	1.40	0.00	46.19	10.38	194.86	21.89	21.89	5999
7	0.70	7.00	51.88	12.13	216.89	24.87	31.87	5999
8	0.60	8.00	52.68	12.38	219.97	25.33	33.33	5999
9	0.00	14.00	57.37	13.83	238.12	27.80	41.80	5999
10	-0.85	22.50	63.79	15.81	262.95	31.22	53.72	5999
11	-1.70	31.00	70.00	17.73	286.97	34.56	65.56	5999
12	-2.20	36.00	73.58	18.84	300.80	36.52	72.52	5999
13	-2.50	39.00	75.70	19.49	309.01	37.74	76.74	5999
		39.00	75.70	19.49	348.27	37.74	76.74	5999
14	-3.25	46.50	80.94	21.11	371.18	40.60	87.10	5999
15	-4.00	54.00	86.11	22.71	393.76	43.46	97.46	5999
16	-4.65	60.50	90.54	24.08	413.12	45.91	106.41	5999
17	-5.30	67.00	94.93	25.44	432.31	48.28	115.28	5999
18	-5.70	71.00	97.62	26.27	444.04	48.97	119.97	5999
		71.00	97.62	17.04	528.95	32.87	103.87	39991
19	-6.00	74.00	100.38	17.75	542.63	37.47	111.47	39991
20	-6.30	77.00	103.13	18.47	556.28	41.06	118.06	39991
21	-6.90	83.00	108.61	19.89	583.51	44.99	127.99	39991
		83.00	108.61	0.00	1906.20	0.00	83.00a	399914
22	-7.75	91.50	118.05	0.00	1990.12	19.47	110.97	399914
23	-8.60	100.00	127.46	0.00	2073.75	40.01	140.01	399914
24	-9.80	112.00	140.69	0.00	2191.39	48.26	160.26	399914
25	-10.30	117.00	146.19	0.00	2240.29	50.45	167.45	399914

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.4 Excavate to elevation 4.00 on RIGHT side
Toe of berm at elevation 0.00
Width of top of berm = 0.01
Width of toe of berm = 8.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
26	-10.70	121.00	150.58	0.00	2279.35	51.57	172.57	399914
27	-10.90	123.00	152.77	0.00	2298.87	51.43	174.43	399914
28	-12.05	134.50	165.38	0.00	2410.95	54.67	189.17	399914
29	-13.20	146.00	177.96	0.00	2522.78	57.99	203.99	399914
30	-13.95	153.50	186.15	0.00	2595.60	60.31	213.81	399914
31	-14.70	161.00	194.33	0.00	2668.35	63.04	224.04	399914
32	-15.10	165.00	198.69	0.00	2707.12	64.40	229.40	399914
33	-16.30	177.00	211.76	0.00	2823.35	69.03	246.03	399914
34	-17.15	185.50	221.01	0.00	2905.60	72.29	257.79	399914
35	-18.00	194.00	230.26	0.00	2987.80	75.59	269.59	399914
36	-19.15	205.50	242.76	0.00	3098.95	80.11	285.61	399914
37	-20.30	217.00	255.25	0.00	3210.04	84.85	301.85	399914
38	-20.60	220.00	258.51	0.00	3239.02	85.82	305.82	399914
39	-24.70	261.00	303.03	0.00	3634.84	101.79	362.79	399914
40	-28.80	302.00	347.54	0.00	4030.63	117.80	419.80	399914
41	-33.60	350.00	399.69	0.00	4494.29	136.53	486.53	399914
42	-38.40	398.00	451.89	0.00	4958.42	155.28	553.28	399914
43	-43.08	444.75	502.78	0.00	5410.96	173.55	618.30	399914
44	-47.75	491.50	553.73	1.64	5863.98	191.81	683.31	399914

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	4.97b	2.52	2.52	5999
4	2.90	0.00	18.15	1.71	26.16b	12.06	12.06	5999
5	2.50	0.00	24.75	3.75	32.14b	15.45	15.45	5999
6	1.40	0.00	42.90	9.36	51.81b	24.98	24.98	5999
7	0.70	0.00	54.45	12.93	63.96b	30.32	30.32	5999
8	0.60	0.00	56.10	13.44	65.55b	31.03	31.03	5999
9	0.00	0.00	66.00	16.50	74.37b	35.61	35.61	5999
10	-0.85	8.50	71.53	18.20	86.17b	38.42	46.92	5999
11	-1.70	17.00	77.05	19.91	104.74b	41.23	58.23	5999
12	-2.20	22.00	80.30	20.92	118.74b	42.85	64.85	5999
13	-2.50	25.00	82.25	21.52	125.58b	43.77	68.77	5999
		25.00	82.25	21.52	177.32b	43.77	68.77	5999
14	-3.25	32.50	87.13	23.02	178.18b	46.22	78.72	5999
15	-4.00	40.00	92.00	24.53	183.27b	48.64	88.64	5999
16	-4.65	46.50	96.23	25.84	202.56b	50.74	97.24	5999
17	-5.30	53.00	100.45	27.14	219.22b	52.90	105.90	5999
18	-5.70	57.00	103.05	27.95	229.59b	54.72	111.72	5999
		57.00	103.05	22.99	303.90b	55.61	112.61	19996
19	-6.00	60.00	105.30	23.63	285.52b	55.72	115.72	19996
20	-6.30	63.00	107.55	24.27	270.64b	55.91	118.91	19996
21	-6.90	69.00	112.05	25.54	283.64b	58.06	127.06	19996
		69.00	112.05	0.00	1936.77	100.41	169.41	399914
22	-7.75	77.50	121.40	0.00	2019.90	67.08	144.58	399914

(continued)

Stage No.4 Excavate to elevation 4.00 on RIGHT side
Toe of berm at elevation 0.00
Width of top of berm = 0.01
Width of toe of berm = 8.00

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
23	-8.60	86.00	130.75	0.00	1916.67	52.30	138.30	399914
24	-9.80	98.00	143.95	0.00	1843.64b	53.18	151.18	399914
25	-10.30	103.00	149.45	0.00	1788.75b	54.78	157.78	399914
26	-10.70	107.00	153.85	0.00	1826.90b	56.77	163.77	399914
27	-10.90	109.00	156.05	0.00	1857.85b	58.43	167.43	399914
28	-12.05	120.50	168.70	0.00	1960.74b	64.16	184.66	399914
29	-13.20	132.00	181.35	0.00	2069.62b	69.81	201.81	399914
30	-13.95	139.50	189.60	0.00	2146.73b	73.34	212.84	399914
31	-14.70	147.00	197.85	0.00	2217.08b	76.47	223.47	399914
32	-15.10	151.00	202.25	0.00	2265.99b	78.23	229.23	399914
33	-16.30	163.00	215.45	0.00	2373.64b	82.97	245.97	399914
34	-17.15	171.50	224.80	0.00	2459.71b	86.35	257.85	399914
35	-18.00	180.00	234.15	0.00	2545.14b	89.69	269.69	399914
36	-19.15	191.50	246.80	0.00	2655.27b	94.15	285.65	399914
37	-20.30	203.00	259.45	0.00	2761.65b	98.39	301.39	399914
38	-20.60	206.00	262.75	0.00	2822.86b	99.76	305.76	399914
39	-24.70	247.00	307.85	0.00	3196.82b	115.79	362.79	399914
40	-28.80	288.00	352.95	0.00	3601.91b	131.79	419.79	399914
41	-33.60	336.00	405.75	0.00	4067.45b	150.53	486.53	399914
42	-38.40	384.00	458.55	0.00	4536.59b	169.28	553.28	399914
43	-43.08	430.75	509.98	0.00	4994.61b	187.55	618.30	399914
44	-47.75	477.50	561.40	3.02	5433.47b	205.86	683.36	399914

Note: 83.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
5433.47 b Passive limit reduced because of berm

Units: kN,m

Stage No. 6 Excavate to elevation 0.00 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	FoS for toe elev. = -20.30: Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetr-ation	Direction of failure
6	4.00	0.00	4.30	12.455	n/a	-1.91	1.91	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.007	-8.80E-04	0.0	0.0		877500
2	4.30	0.00	0.007	-8.80E-04	0.0	-0.0	-89.2	877500
		0.00	0.007	-8.80E-04	-89.2	0.0		
3	4.00	0.00	0.008	-8.75E-04	-89.2	-26.8		877500
		3.33	0.008	-8.75E-04	-89.2	-26.8		
4	2.90	8.82	0.009	-7.83E-04	-82.5	-120.9		877500
5	2.50	10.72	0.009	-7.21E-04	-78.6	-153.1		877500
6	1.40	20.04	0.010	-4.80E-04	-61.7	-230.9		877500
7	0.70	29.14	0.010	-2.81E-04	-44.5	-268.4		877500
8	0.60	30.12	0.010	-2.50E-04	-41.5	-272.7		877500
9	0.00	38.19	0.010	-5.74E-05	-21.0	-291.7		877500
		29.93	0.010	-5.74E-05	-21.0	-291.7		
10	-0.85	28.22	0.010	2.28E-04	3.7	-298.7		877500
11	-1.70	27.67	0.010	5.11E-04	27.5	-285.3		877500
12	-2.20	27.69	0.009	6.68E-04	41.3	-268.1		877500
13	-2.50	28.01	0.009	7.58E-04	49.7	-254.4		877500
14	-3.25	28.61	0.008	9.56E-04	70.9	-209.3		877500
15	-4.00	29.44	0.008	1.10E-03	92.7	-148.1		877500
16	-4.65	30.19	0.007	1.19E-03	112.0	-81.6		877500
17	-5.30	30.52	0.006	1.22E-03	131.8	-2.4		877500
18	-5.70	28.53	0.006	1.21E-03	143.6	52.7		877500
		-21.25	0.006	1.21E-03	143.6	52.7		
19	-6.00	-8.93	0.005	1.18E-03	139.0	94.8		877500
20	-6.30	-0.06	0.005	1.14E-03	137.7	136.2		877500
21	-6.90	6.83	0.004	1.02E-03	139.7	218.8		877500
		-218.13	0.004	1.02E-03	139.7	218.8		
22	-7.75	-107.34	0.003	7.96E-04	1.4	258.8		877500
23	-8.60	-28.41	0.003	5.64E-04	-56.3	221.2		877500
24	-9.80	11.80	0.002	3.21E-04	-66.3	133.2		877500
25	-10.30	23.12	0.002	2.55E-04	-57.5	101.5		877500
26	-10.70	23.38	0.002	2.13E-04	-48.2	80.3		877500

(continued)

Stage No.6 Excavate to elevation 0.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
27	-10.90	20.55	0.002	1.96E-04	-43.8	71.2		877500
28	-12.05	14.71	0.002	1.27E-04	-23.6	34.3		877500
29	-13.20	8.19	0.002	9.35E-05	-10.4	16.9		877500
30	-13.95	4.24	0.002	8.14E-05	-5.7	11.4		877500
31	-14.70	2.72	0.002	7.30E-05	-3.1	8.3		877500
32	-15.10	1.16	0.002	6.94E-05	-2.3	7.3		877500
33	-16.30	0.61	0.002	6.08E-05	-1.3	5.3		877500
34	-17.15	-0.06	0.001	5.61E-05	-1.0	4.4		877500
35	-18.00	-0.35	0.001	5.23E-05	-1.2	3.5		877500
36	-19.15	-0.14	0.001	4.88E-05	-1.5	1.8		877500
37	-20.30	2.19	0.001	4.75E-05	-0.3	0.0		0
38	-20.60	0.12	0.001	0	0.0	0.0		0
39	-24.70	0.01	0.001	0	0.3	0.0		0
40	-28.80	0.04	0.001	0	0.4	0.0		0
41	-33.60	0.01	0.001	0	0.5	0.0		0
42	-38.40	-0.00	0.001	0	0.5	0.0		0
43	-43.08	0.00	0.000	0	0.5	0.0		0
44	-47.75	-0.22	0.000	0	-0.0	0.0		---

At elev. 4.30 Prop force = 89.2 kN/m run (horiz.)
= 100.1 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	3.33	3.33	5999
4	2.90	0.00	18.76	1.90	88.77	8.82	8.82	5999
5	2.50	0.00	26.00	4.14	116.75	10.72	10.72	5999
6	1.40	0.00	46.19	10.38	194.86	20.04	20.04	5999
7	0.70	7.00	51.88	12.13	216.89	22.14	29.14	5999
8	0.60	8.00	52.68	12.38	219.97	22.12	30.12	5999
9	0.00	14.00	57.37	13.83	238.12	24.19	38.19	5999
10	-0.85	22.50	63.79	15.81	262.95	27.20	49.70	5999
11	-1.70	31.00	70.00	17.73	286.97	30.33	61.33	5999
12	-2.20	36.00	73.58	18.84	300.80	32.25	68.25	5999
13	-2.50	39.00	75.70	19.49	309.01	33.53	72.53	5999
		39.00	75.70	19.49	348.27	33.53	72.53	5999
14	-3.25	46.50	80.94	21.11	371.18	36.51	83.01	5999
15	-4.00	54.00	86.11	22.71	393.76	39.56	93.56	5999
16	-4.65	60.50	90.54	24.08	413.12	42.17	102.67	5999
17	-5.30	67.00	94.93	25.44	432.31	44.52	111.52	5999
18	-5.70	71.00	97.62	26.27	444.04	44.73	115.73	5999
		71.00	97.62	17.04	528.95	4.61	75.61A	39991
19	-6.00	74.00	100.38	17.75	542.63	15.00	89.00A	39991
20	-6.30	77.00	103.13	18.47	556.28	22.45	99.45	39991
21	-6.90	83.00	108.61	19.89	583.51	30.31	113.31	39991
		83.00	108.61	0.00	1906.20	0.00	83.00a	399914
22	-7.75	91.50	118.05	0.00	1990.12	0.00	91.50a	399914
23	-8.60	100.00	127.46	0.00	2073.75	14.81	114.81	399914
24	-9.80	112.00	140.69	0.00	2191.39	39.17	151.17	399914
25	-10.30	117.00	146.19	0.00	2240.29	46.58	163.58	399914
26	-10.70	121.00	150.58	0.00	2279.35	48.22	169.22	399914
27	-10.90	123.00	152.77	0.00	2298.87	47.51	170.51	399914

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.6 Excavate to elevation 0.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
28	-12.05	134.50	165.38	0.00	2410.95	49.02	183.52	399914
29	-13.20	146.00	177.96	0.00	2522.78	50.21	196.21	399914
30	-13.95	153.50	186.15	0.00	2595.60	51.14	204.64	399914
31	-14.70	161.00	194.33	0.00	2668.35	53.30	214.30	399914
32	-15.10	165.00	198.69	0.00	2707.12	54.06	219.06	399914
33	-16.30	177.00	211.76	0.00	2823.35	58.48	235.48	399914
34	-17.15	185.50	221.01	0.00	2905.60	61.46	246.96	399914
35	-18.00	194.00	230.26	0.00	2987.80	64.64	258.64	399914
36	-19.15	205.50	242.76	0.00	3098.95	69.25	274.75	399914
37	-20.30	217.00	255.25	0.00	3210.04	74.92	291.92	399914
38	-20.60	220.00	258.51	0.00	3239.02	75.05	295.05	399914
39	-24.70	261.00	303.03	0.00	3634.84	91.09	352.09	399914
40	-28.80	302.00	347.54	0.00	4030.63	107.22	409.22	399914
41	-33.60	350.00	399.69	0.00	4494.29	126.13	476.13	399914
42	-38.40	398.00	451.89	0.00	4958.42	145.10	543.10	399914
43	-43.08	444.75	502.78	0.00	5410.96	163.61	608.36	399914
44	-47.75	491.50	553.73	1.64	5863.98	182.03	673.53	399914

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	8.26	8.26	5999
10	-0.85	8.50	5.53	0.00	37.56	12.98	21.48	5999
11	-1.70	17.00	11.05	0.00	58.93	16.66	33.66	5999
12	-2.20	22.00	14.30	0.52	71.51	18.55	40.55	5999
13	-2.50	25.00	16.25	1.12	79.05	19.52	44.52	5999
		25.00	16.25	1.12	88.52	19.52	44.52	5999
14	-3.25	32.50	21.13	2.63	109.83	21.90	54.40	5999
15	-4.00	40.00	26.01	4.14	131.15	24.12	64.12	5999
16	-4.65	46.50	30.24	5.45	149.63	25.98	72.48	5999
17	-5.30	53.00	34.47	6.75	168.12	28.00	81.00	5999
18	-5.70	57.00	37.07	7.56	179.50	30.20	87.20	5999
		57.00	37.07	4.30	191.17	39.86	96.86	19996
19	-6.00	60.00	39.33	4.94	201.02	37.93	97.93	19996
20	-6.30	63.00	41.58	5.58	210.87	36.51	99.51	19996
21	-6.90	69.00	46.09	6.85	230.57	37.48	106.48	19996
		69.00	46.09	0.00	1350.30	232.13	301.13	399925
22	-7.75	77.50	55.46	0.00	1433.59	121.34	198.84	399925
23	-8.60	86.00	64.83	0.00	1516.92	57.23	143.23	399925
24	-9.80	98.00	78.07	0.00	1634.62	41.37	139.37	399925
25	-10.30	103.00	83.59	0.00	1683.69	37.46	140.46	399925
26	-10.70	107.00	88.00	0.00	1722.95	38.83	145.83	399925
27	-10.90	109.00	90.21	0.00	1742.59	40.95	149.95	399925

(continued)

Stage No.6 Excavate to elevation 0.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
28	-12.05	120.50	102.92	0.00	1855.56	48.31	168.81	399925
29	-13.20	132.00	115.63	0.00	1968.62	56.02	188.02	399925
30	-13.95	139.50	123.93	0.00	2042.40	60.89	200.39	399925
31	-14.70	147.00	132.23	0.00	2116.24	64.58	211.58	399925
32	-15.10	151.00	136.66	0.00	2155.63	66.91	217.91	399925
33	-16.30	163.00	149.97	0.00	2273.90	71.87	234.87	399925
34	-17.15	171.50	159.40	0.00	2357.74	75.53	247.03	399925
35	-18.00	180.00	168.83	0.00	2441.64	78.99	258.99	399925
36	-19.15	191.50	181.61	0.00	2555.27	83.39	274.89	399925
37	-20.30	203.00	194.40	0.00	2669.00	86.73	289.73	399925
38	-20.60	206.00	197.74	0.00	2698.69	88.93	294.93	399925
39	-24.70	247.00	243.47	0.00	3105.27	105.08	352.08	399925
40	-28.80	288.00	289.36	0.00	3513.34	121.19	409.19	399925
41	-33.60	336.00	343.29	0.00	3992.82	140.13	476.13	399925
42	-38.40	384.00	397.39	0.00	4473.91	159.10	543.10	399925
43	-43.08	430.75	450.23	0.00	4943.71	177.60	608.35	399925
44	-47.75	477.50	503.17	0.00	5414.43	196.25	673.75	399925

Note: 91.50 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
89.00A Arching - soil pressure below active limit

Units: kN,m

Stage No. 9 Excavate to elevation -6.00 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
9	4.00	-6.00		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.006	-1.28E-03	0.0	0.0		877500
2	4.30	0.00	0.006	-1.28E-03	0.0	-0.0	-17.0	877500
		0.00	0.006	-1.28E-03	-17.0	0.0		
3	4.00	0.00	0.006	-1.28E-03	-17.0	-5.1		877500
		6.21	0.006	-1.28E-03	-17.0	-5.1		
4	2.90	11.99	0.008	-1.27E-03	-7.0	-18.0		877500
5	2.50	13.92	0.008	-1.26E-03	-1.8	-19.7		877500
6	1.40	23.05	0.010	-1.24E-03	18.6	-11.2		877500
7	0.70	31.85	0.011	-1.24E-03	37.8	8.3	-259.7	877500
		31.85	0.011	-1.24E-03	-222.0	8.3		
8	0.60	32.36	0.011	-1.24E-03	-218.8	-13.7		877500
9	0.00	39.71	0.011	-1.19E-03	-197.1	-138.7		877500
10	-0.85	50.03	0.012	-9.83E-04	-159.0	-290.3		877500
11	-1.70	60.53	0.013	-6.46E-04	-112.0	-405.8		877500
12	-2.20	66.65	0.013	-4.01E-04	-80.2	-454.0		877500
13	-2.50	70.27	0.013	-2.42E-04	-59.7	-475.0		877500
14	-3.25	80.14	0.013	1.73E-04	-3.3	-499.0		877500
15	-4.00	90.13	0.013	5.91E-04	60.6	-478.0		877500
16	-4.65	98.91	0.013	9.23E-04	122.0	-419.0		877500
17	-5.30	107.54	0.012	1.19E-03	189.1	-318.2		877500
18	-5.70	113.25	0.011	1.32E-03	233.3	-233.8		877500
		71.00	0.011	1.32E-03	233.3	-233.8		
19	-6.00	74.00	0.011	1.38E-03	255.0	-160.6		877500
		46.91	0.011	1.38E-03	255.0	-160.6		
20	-6.30	48.25	0.011	1.43E-03	269.3	-81.9		877500
21	-6.90	59.39	0.010	1.42E-03	301.6	88.3		877500
		-304.58	0.010	1.42E-03	301.6	88.3		
22	-7.75	-170.66	0.009	1.27E-03	99.6	234.7		877500
23	-8.60	-66.33	0.008	1.03E-03	-1.1	257.7		877500
24	-9.80	-22.08	0.007	7.14E-04	-54.1	208.6		877500
25	-10.30	-1.58	0.006	6.04E-04	-60.1	178.8		877500

(continued)

Stage No.9 Excavate to elevation -6.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.70	5.50	0.006	5.28E-04	-59.3	154.6		877500
27	-10.90	13.53	0.006	4.94E-04	-57.4	142.9		877500
28	-12.05	15.96	0.005	3.44E-04	-40.4	85.8		877500
29	-13.20	12.82	0.005	2.55E-04	-23.9	49.9		877500
30	-13.95	8.57	0.005	2.19E-04	-15.9	35.6		877500
31	-14.70	6.36	0.005	1.92E-04	-10.3	26.1		877500
32	-15.10	3.59	0.005	1.81E-04	-8.3	22.5		877500
33	-16.30	2.22	0.004	1.56E-04	-4.8	15.1		877500
34	-17.15	0.50	0.004	1.43E-04	-3.6	11.9		877500
35	-18.00	-0.40	0.004	1.32E-04	-3.6	9.0		877500
36	-19.15	-0.11	0.004	1.24E-04	-3.9	4.6		877500
37	-20.30	5.43	0.004	1.21E-04	-0.8	0.0		0
38	-20.60	0.16	0.004	0	0.0	0.0		0
39	-24.70	0.02	0.003	0	0.4	0.0		0
40	-28.80	0.07	0.003	0	0.6	0.0		0
41	-33.60	0.03	0.003	0	0.8	0.0		0
42	-38.40	0.01	0.002	0	0.9	0.0		0
43	-43.08	0.02	0.001	0	1.0	0.0		0
44	-47.75	-0.44	0.000	0	0.0	0.0		---

At elev. 4.30 Prop force = 17.0 kN/m run (horiz.)
= 19.0 kN/m run (inclined)

At elev. 0.70 Prop force = 259.7 kN/m run

		LEFT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	6.21	6.21	5999
4	2.90	0.00	18.76	1.90	88.77	11.99	11.99	5999
5	2.50	0.00	26.00	4.14	116.75	13.92	13.92	5999
6	1.40	0.00	46.19	10.38	194.86	23.05	23.05	5999
7	0.70	7.00	51.88	12.13	216.89	24.85	31.85	5999
8	0.60	8.00	52.68	12.38	219.97	24.36	32.36	5999
9	0.00	14.00	57.37	13.83	238.12	25.71	39.71	5999
10	-0.85	22.50	63.79	15.81	262.95	27.53	50.03	5999
11	-1.70	31.00	70.00	17.73	286.97	29.53	60.53	5999
12	-2.20	36.00	73.58	18.84	300.80	30.65	66.65	5999
13	-2.50	39.00	75.70	19.49	309.01	31.27	70.27	5999
		39.00	75.70	19.49	348.27	31.27	70.27	5999
14	-3.25	46.50	80.94	21.11	371.18	33.64	80.14	5999
15	-4.00	54.00	86.11	22.71	393.76	36.13	90.13	5999
16	-4.65	60.50	90.54	24.08	413.12	38.41	98.91	5999
17	-5.30	67.00	94.93	25.44	432.31	40.54	107.54	5999
18	-5.70	71.00	97.62	26.27	444.04	42.25	113.25	5999
		71.00	97.62	17.04	528.95	0.00	71.00A	39991
19	-6.00	74.00	100.38	17.75	542.63	0.00	74.00A	39991
20	-6.30	77.00	103.13	18.47	556.28	2.74	79.74A	39991
21	-6.90	83.00	108.61	19.89	583.51	13.98	96.98A	39991
		83.00	108.61	0.00	1906.20	0.00	83.00a	399914
22	-7.75	91.50	118.05	0.00	1990.12	0.00	91.50a	399914
23	-8.60	100.00	127.46	0.00	2073.75	0.00	100.00a	399914
24	-9.80	112.00	140.69	0.00	2191.39	0.00	112.00a	399914
25	-10.30	117.00	146.19	0.00	2240.29	0.00	117.00a	399914

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.9 Excavate to elevation -6.00 on RIGHT side

		LEFT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
26	-10.70	121.00	150.58	0.00	2279.35	2.79	123.79	399914
27	-10.90	123.00	152.77	0.00	2298.87	7.52	130.52	399914
28	-12.05	134.50	165.38	0.00	2410.95	13.15	147.65	399914
29	-13.20	146.00	177.96	0.00	2522.78	16.02	162.02	399914
30	-13.95	153.50	186.15	0.00	2595.60	16.79	170.29	399914
31	-14.70	161.00	194.33	0.00	2668.35	18.61	179.61	399914
32	-15.10	165.00	198.69	0.00	2707.12	18.77	183.77	399914
33	-16.30	177.00	211.76	0.00	2823.35	22.77	199.77	399914
34	-17.15	185.50	221.01	0.00	2905.60	25.23	210.73	399914
35	-18.00	194.00	230.26	0.00	2987.80	28.10	222.10	399914
36	-19.15	205.50	242.76	0.00	3098.95	32.75	238.25	399914
37	-20.30	217.00	255.25	0.00	3210.04	40.03	257.03	399914
38	-20.60	220.00	258.51	0.00	3239.02	38.56	258.56	399914
39	-24.70	261.00	303.03	0.00	3634.84	54.63	315.63	399914
40	-28.80	302.00	347.54	0.00	4030.63	70.86	372.86	399914
41	-33.60	350.00	399.69	0.00	4494.29	89.92	439.92	399914
42	-38.40	398.00	451.89	0.00	4958.42	109.10	507.10	399914
43	-43.08	444.75	502.78	0.00	5410.96	127.88	572.63	399914
44	-47.75	491.50	553.73	1.64	5863.98	146.51	638.01	399914

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	29.18	27.09	27.09	19997
20	-6.30	3.00	2.25	0.00	39.01	28.48	31.48	19997
21	-6.90	9.00	6.75	0.00	58.67	28.60	37.60	19997
		9.00	6.75	0.00	1000.49	378.58	387.58	399934
22	-7.75	17.50	16.10	0.00	1083.64	244.66	262.16	399934
23	-8.60	26.00	25.46	0.00	1166.81	140.33	166.33	399934
24	-9.80	38.00	38.67	0.00	1284.29	96.08	134.08	399934
25	-10.30	43.00	44.18	0.00	1333.26	75.58	118.58	399934
26	-10.70	47.00	48.58	0.00	1372.45	71.29	118.29	399934
27	-10.90	49.00	50.79	0.00	1392.06	67.99	116.99	399934

(continued)

Stage No.9 Excavate to elevation -6.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
28	-12.05	60.50	63.47	0.00	1504.83	71.20	131.70	399934
29	-13.20	72.00	76.17	0.00	1617.73	77.20	149.20	399934
30	-13.95	79.50	84.46	0.00	1691.45	82.23	161.73	399934
31	-14.70	87.00	92.76	0.00	1765.24	86.24	173.24	399934
32	-15.10	91.00	97.19	0.00	1804.62	89.18	180.18	399934
33	-16.30	103.00	110.49	0.00	1922.92	94.55	197.55	399934
34	-17.15	111.50	119.93	0.00	2006.85	98.72	210.22	399934
35	-18.00	120.00	129.39	0.00	2090.91	102.50	222.50	399934
36	-19.15	131.50	142.20	0.00	2204.83	106.85	238.35	399934
37	-20.30	143.00	155.04	0.00	2319.00	108.59	251.59	399934
38	-20.60	146.00	158.39	0.00	2348.83	112.40	258.40	399934
39	-24.70	187.00	204.45	0.00	2758.34	128.60	315.60	399934
40	-28.80	228.00	250.92	0.00	3171.55	144.79	372.79	399934
41	-33.60	276.00	305.87	0.00	3660.09	163.90	439.90	399934
42	-38.40	324.00	361.36	0.00	4153.49	183.09	507.09	399934
43	-43.08	370.75	415.86	0.00	4638.12	201.87	572.62	399934
44	-47.75	417.50	470.74	0.00	5126.04	220.94	638.44	399934

Note: 117.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
96.98A Arching - soil pressure below active limit

Units: kN,m

Stage No. 12 Excavate to elevation -10.70 on RIGHT side
Toe of berm at elevation -16.30
Width of top of berm = 0.30
Width of toe of berm = 5.90

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetration	Direction of failure
12	4.00	-10.70		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -47.75 Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.006	-1.19E-03	0.0	0.0		877500
2	4.30	0.00	0.006	-1.19E-03	0.0	-0.0	-25.3	877500
		0.00	0.006	-1.19E-03	-25.3	0.0		
3	4.00	0.00	0.006	-1.19E-03	-25.3	-7.6		877500
		6.68	0.006	-1.19E-03	-25.3	-7.6		
4	2.90	12.73	0.008	-1.17E-03	-14.6	-29.3		877500
5	2.50	15.02	0.008	-1.15E-03	-9.0	-34.1		877500
6	1.40	24.45	0.010	-1.11E-03	12.7	-32.8		877500
7	0.70	33.53	0.010	-1.09E-03	33.0	-17.1	-176.0	877500
		33.53	0.010	-1.09E-03	-143.0	-17.1		
8	0.60	34.31	0.010	-1.09E-03	-139.6	-31.3		877500
9	0.00	42.03	0.011	-1.04E-03	-116.7	-108.4		877500
10	-0.85	52.95	0.012	-9.02E-04	-76.3	-190.7		877500
11	-1.70	64.03	0.013	-6.96E-04	-26.6	-235.0		877500
12	-2.20	70.58	0.013	-5.61E-04	7.0	-240.0		877500
13	-2.50	74.57	0.013	-4.79E-04	28.8	-234.7		877500
14	-3.25	84.88	0.013	-2.97E-04	88.6	-191.1		877500
15	-4.00	95.37	0.013	-1.73E-04	156.2	-99.9		877500
16	-4.65	104.59	0.014	-1.44E-04	221.2	22.4		877500
17	-5.30	113.74	0.014	-2.23E-04	292.1	188.8	-650.2	877500
		113.74	0.014	-2.23E-04	-358.1	188.8		
18	-5.70	121.25	0.014	-2.78E-04	-311.1	54.9		877500
		124.34	0.014	-2.78E-04	-311.1	54.9		
19	-6.00	112.87	0.014	-2.82E-04	-275.5	-32.8		877500
20	-6.30	105.55	0.014	-2.57E-04	-242.7	-110.4		877500
21	-6.90	108.90	0.014	-1.39E-04	-178.4	-236.8		877500
		246.70	0.014	-1.39E-04	-178.4	-236.8		
22	-7.75	75.18	0.014	1.28E-04	-41.6	-315.0		877500

(continued)

Stage No.12 Excavate to elevation -10.70 on RIGHT side
Toe of berm at elevation -16.30
Width of top of berm = 0.30
Width of toe of berm = 5.90

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
23	-8.60	76.19	0.014	4.43E-04	22.8	-335.3		877500
24	-9.80	77.60	0.013	8.51E-04	115.0	-262.6		877500
25	-10.30	78.19	0.013	9.82E-04	154.0	-196.1		877500
26	-10.70	78.67	0.012	1.05E-03	185.4	-128.4		877500
		-162.33	0.012	1.05E-03	185.4	-128.4		
27	-10.90	-51.22	0.012	1.08E-03	164.0	-94.5		877500
28	-12.05	-48.95	0.011	1.10E-03	106.4	60.4		877500
29	-13.20	-68.24	0.010	9.66E-04	39.0	150.6		877500
30	-13.95	-51.85	0.009	8.33E-04	-6.0	160.7		877500
31	-14.70	-19.94	0.008	7.03E-04	-32.9	141.7		877500
32	-15.10	0.03	0.008	6.42E-04	-36.9	126.9		877500
33	-16.30	9.31	0.007	4.99E-04	-31.3	82.8		877500
34	-17.15	7.83	0.007	4.30E-04	-24.0	59.0		877500
35	-18.00	3.64	0.007	3.82E-04	-19.2	40.7		877500
36	-19.15	1.15	0.006	3.42E-04	-16.4	19.6		877500
37	-20.30	21.72	0.006	3.29E-04	-3.3	0.0		0
38	-20.60	0.15	0.006	0	0.0	0.0		0
39	-24.70	0.03	0.005	0	0.4	0.0		0
40	-28.80	0.09	0.004	0	0.6	0.0		0
41	-33.60	0.05	0.003	0	1.0	0.0		0
42	-38.40	0.03	0.003	0	1.1	0.0		0
43	-43.08	0.04	0.002	0	1.3	0.0		0
44	-47.75	-0.59	0.000	0	0.0	0.0		---

At elev. 4.30 Prop force = 25.3 kN/m run (horiz.)
= 28.3 kN/m run (inclined)
At elev. 0.70 Prop force = 176.0 kN/m run
At elev. -5.30 Prop force = 650.2 kN/m run

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	6.68	6.68	5999
4	2.90	0.00	18.76	1.90	88.77	12.73	12.73	5999
5	2.50	0.00	26.00	4.14	116.75	15.02	15.02	5999
6	1.40	0.00	46.19	10.38	194.86	24.45	24.45	5999
7	0.70	7.00	51.88	12.13	216.89	26.53	33.53	5999
8	0.60	8.00	52.68	12.38	219.97	26.31	34.31	5999
9	0.00	14.00	57.37	13.83	238.12	28.03	42.03	5999
10	-0.85	22.50	63.79	15.81	262.95	30.45	52.95	5999
11	-1.70	31.00	70.00	17.73	286.97	33.03	64.03	5999
12	-2.20	36.00	73.58	18.84	300.80	34.58	70.58	5999
13	-2.50	39.00	75.70	19.49	309.01	35.57	74.57	5999
		39.00	75.70	19.49	348.27	35.57	74.57	5999
14	-3.25	46.50	80.94	21.11	371.18	38.38	84.88	5999
15	-4.00	54.00	86.11	22.71	393.76	41.37	95.37	5999
16	-4.65	60.50	90.54	24.08	413.12	44.09	104.59	5999
17	-5.30	67.00	94.93	25.44	432.31	46.74	113.74	5999
18	-5.70	71.00	97.62	26.27	444.04	50.25	121.25	5999
		71.00	97.62	17.04	528.95	53.34	124.34	39991

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.12 Excavate to elevation -10.70 on RIGHT side
Toe of berm at elevation -16.30
Width of top of berm = 0.30
Width of toe of berm = 5.90

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
19	-6.00	73.12	101.26	17.98	547.01	39.75	112.87	39991
20	-6.30	73.47	106.65	19.38	573.79	32.08	105.55	39991
21	-6.90	74.18	117.43	22.18	627.29	34.72	108.90	39991
		74.18	117.43	0.00	1984.62	172.52	246.70	399914
22	-7.75	75.18	134.37	0.00	2135.20	0.00	75.18a	399914
23	-8.60	76.19	151.27	0.00	2285.48	0.00	76.19a	399914
24	-9.80	77.60	175.08	0.00	2497.22	0.00	77.60a	399914
25	-10.30	78.19	184.99	0.00	2585.33	0.00	78.19a	399914
26	-10.70	78.67	192.91	0.00	2655.76	0.00	78.67a	399914
27	-10.90	78.90	196.87	0.00	2690.97	0.00	78.90a	399914
28	-12.05	80.26	219.62	0.00	2893.22	0.00	80.26a	399914
29	-13.20	81.62	242.34	0.00	3095.23	0.00	81.62a	399914
30	-13.95	82.50	257.14	0.00	3226.87	3.24	85.75	399914
31	-14.70	83.39	271.94	0.00	3358.43	22.61	106.00	399914
32	-15.10	83.86	279.83	0.00	3428.57	34.06	117.92	399914
33	-16.30	85.28	303.48	0.00	3638.90	45.03	130.31	399914
34	-17.15	86.28	320.23	0.00	3787.80	51.44	137.72	399914
35	-18.00	87.28	336.97	0.00	3936.66	56.70	143.98	399914
36	-19.15	88.64	359.61	0.00	4137.99	65.77	154.42	399914
37	-20.30	90.00	382.25	0.00	4339.27	86.63	176.63	399914
38	-20.60	93.00	385.51	0.00	4368.24	76.28	169.28	399914
39	-24.70	134.00	430.03	0.00	4764.06	91.21	225.21	399914
40	-28.80	175.00	474.54	0.00	5159.86	106.49	281.49	399914
41	-33.60	223.00	526.69	0.00	5623.52	125.08	348.08	399914
42	-38.40	271.00	578.89	6.16	6087.64	144.12	415.12	399914
43	-43.08	317.75	629.78	15.30	6540.18	163.01	480.76	399914
44	-47.75	364.50	680.73	24.45	6993.21	181.81	546.31	399914

RIGHT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.12 Excavate to elevation -10.70 on RIGHT side
Toe of berm at elevation -16.30
Width of top of berm = 0.30
Width of toe of berm = 5.90

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
21	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26	-10.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.04b	241.00	241.00	399946
27	-10.90	0.00	4.20	0.00	130.12b	130.12	130.12p	399946
28	-12.05	0.00	28.35	0.00	129.21b	129.21	129.21p	399946
29	-13.20	0.00	52.51	0.00	149.86b	149.86	149.86p	399946
30	-13.95	0.00	68.27	0.00	162.59b	137.60	137.60	399946
31	-14.70	0.00	84.03	0.00	176.12b	125.94	125.94	399946
32	-15.10	0.00	92.44	0.00	182.16b	117.89	117.89	399946
33	-16.30	0.00	117.69	0.00	550.53b	121.00	121.00	399946
34	-17.15	8.50	127.09	0.00	1101.60b	121.39	129.89	399946
35	-18.00	17.00	136.50	0.00	1191.78b	123.34	140.34	399946
36	-19.15	28.50	149.25	0.00	1298.49b	124.77	153.27	399946
37	-20.30	40.00	162.04	0.00	1395.23b	114.91	154.91	399946
38	-20.60	43.00	165.38	0.00	1512.55b	126.13	169.13	399946
39	-24.70	84.00	211.32	0.00	1846.22b	141.18	225.18	399946
40	-28.80	125.00	257.84	0.00	2270.97b	156.40	281.40	399946
41	-33.60	173.00	313.12	0.00	2752.38b	175.03	348.03	399946
42	-38.40	221.00	369.33	0.00	3251.43b	194.08	415.08	399946
43	-43.08	267.75	424.90	0.00	3747.59b	212.97	480.72	399946
44	-47.75	314.50	481.18	0.00	4201.61b	232.40	546.90	399946

Note: 81.62 a Soil pressure at active limit
149.86 p Soil pressure at passive limit
4201.61 b Passive limit reduced because of berm

Units: kN,m

Stage No. 14 Excavate to elevation -16.30 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
14	4.00	-16.30		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.006	-1.11E-03	0.0	0.0		877500
2	4.30	0.00	0.006	-1.11E-03	0.0	-0.0	-35.8	877500
		0.00	0.006	-1.11E-03	-35.8	0.0		
3	4.00	0.00	0.007	-1.10E-03	-35.8	-10.8		877500
		7.11	0.007	-1.10E-03	-35.8	-10.8		
4	2.90	13.49	0.008	-1.07E-03	-24.5	-43.9		877500
5	2.50	16.19	0.008	-1.05E-03	-18.6	-52.5		877500
6	1.40	25.96	0.009	-9.82E-04	4.6	-61.1		877500
7	0.70	35.33	0.010	-9.37E-04	26.1	-50.7	-104.1	877500
		35.33	0.010	-9.37E-04	-78.1	-50.7		
8	0.60	36.40	0.010	-9.31E-04	-74.5	-58.3		877500
9	0.00	44.48	0.011	-8.78E-04	-50.2	-95.9		877500
10	-0.85	55.99	0.011	-7.73E-04	-7.5	-120.9		877500
11	-1.70	67.66	0.012	-6.64E-04	45.1	-105.5		877500
12	-2.20	74.65	0.012	-6.12E-04	80.6	-74.2		877500
13	-2.50	79.02	0.013	-5.92E-04	103.7	-46.6		877500
14	-3.25	89.79	0.013	-5.95E-04	167.0	54.3		877500
15	-4.00	100.80	0.013	-7.06E-04	238.5	205.7		877500
16	-4.65	110.50	0.014	-9.24E-04	307.1	382.6		877500
17	-5.30	120.10	0.015	-1.29E-03	382.1	606.2	-1012.7	877500
		120.10	0.015	-1.29E-03	-630.7	606.2		
18	-5.70	127.71	0.015	-1.51E-03	-581.1	363.7		877500
		167.44	0.015	-1.51E-03	-581.1	363.7		
19	-6.00	152.82	0.016	-1.60E-03	-533.1	196.9		877500
20	-6.30	140.80	0.016	-1.64E-03	-489.0	43.9		877500
21	-6.90	135.79	0.017	-1.58E-03	-406.0	-223.9		877500
		515.58	0.017	-1.58E-03	-406.0	-223.9		
22	-7.75	218.66	0.018	-1.28E-03	-94.0	-398.5		877500
23	-8.60	86.43	0.019	-8.93E-04	35.7	-411.6		877500
24	-9.80	77.60	0.020	-3.95E-04	134.1	-315.9		877500
25	-10.30	78.19	0.020	-2.37E-04	173.1	-240.0	-352.8	877500
		78.19	0.020	-2.37E-04	-179.8	-240.0		

(continued)

Stage No.14 Excavate to elevation -16.30 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.70	78.67	0.020	-1.13E-04	-148.4	-305.7		877500
27	-10.90	78.90	0.020	-4.01E-05	-132.7	-334.5		877500
28	-12.05	80.26	0.020	4.63E-04	-41.1	-434.8		877500
29	-13.20	81.62	0.019	1.02E-03	51.9	-424.1		877500
30	-13.95	82.50	0.018	1.36E-03	113.5	-363.2		877500
31	-14.70	83.39	0.017	1.62E-03	175.7	-255.9		877500
32	-15.10	83.86	0.017	1.72E-03	209.2	-179.2		877500
33	-16.30	85.28	0.014	1.75E-03	310.6	133.2		877500
		-336.22	0.014	1.75E-03	310.6	133.2		
34	-17.15	-214.78	0.013	1.56E-03	76.5	275.1		877500
35	-18.00	-91.47	0.012	1.30E-03	-53.7	261.9		877500
36	-19.15	-10.93	0.010	1.03E-03	-112.6	138.2		877500
37	-20.30	163.95	0.009	9.47E-04	-24.6	0.0		0
38	-20.60	0.10	0.009	0	0.0	0.0		0
39	-24.70	0.03	0.007	0	0.3	0.0		0
40	-28.80	0.09	0.006	0	0.5	0.0		0
41	-33.60	0.07	0.005	0	0.9	0.0		0
42	-38.40	0.06	0.004	0	1.2	0.0		0
43	-43.08	0.06	0.003	0	1.5	0.0		0
44	-47.75	-0.70	0.000	0	0.0	0.0		---

At elev. 4.30 Prop force = 35.8 kN/m run (horiz.)
= 40.2 kN/m run (inclined)
At elev. 0.70 Prop force = 104.1 kN/m run
At elev. -5.30 Prop force = 1012.7 kN/m run
At elev. -10.30 Prop force = 352.8 kN/m run (horiz.)
= 499.0 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	7.11	7.11	5999
4	2.90	0.00	18.76	1.90	88.77	13.49	13.49	5999
5	2.50	0.00	26.00	4.14	116.75	16.19	16.19	5999
6	1.40	0.00	46.19	10.38	194.86	25.96	25.96	5999
7	0.70	7.00	51.88	12.13	216.89	28.33	35.33	5999
8	0.60	8.00	52.68	12.38	219.97	28.40	36.40	5999
9	0.00	14.00	57.37	13.83	238.12	30.48	44.48	5999
10	-0.85	22.50	63.79	15.81	262.95	33.49	55.99	5999
11	-1.70	31.00	70.00	17.73	286.97	36.66	67.66	5999
12	-2.20	36.00	73.58	18.84	300.80	38.65	74.65	5999
13	-2.50	39.00	75.70	19.49	309.01	40.02	79.02	5999
		39.00	75.70	19.49	348.27	40.02	79.02	5999
14	-3.25	46.50	80.94	21.11	371.18	43.29	89.79	5999
15	-4.00	54.00	86.11	22.71	393.76	46.80	100.80	5999
16	-4.65	60.50	90.54	24.08	413.12	50.00	110.50	5999
17	-5.30	67.00	94.93	25.44	432.31	53.10	120.10	5999
18	-5.70	71.00	97.62	26.27	444.04	56.71	127.71	5999
		71.00	97.62	17.04	528.95	96.44	167.44	39991
19	-6.00	73.12	101.26	17.98	547.01	79.70	152.82	39991
20	-6.30	73.47	106.65	19.38	573.79	67.32	140.80	39991
21	-6.90	74.18	117.43	22.18	627.29	61.61	135.79	39991
		74.18	117.43	0.00	1984.62	441.39	515.58	399914

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.14 Excavate to elevation -16.30 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
22	-7.75	75.18	134.37	0.00	2135.20	143.47	218.66	399914
23	-8.60	76.19	151.27	0.00	2285.48	10.25	86.43	399914
24	-9.80	77.60	175.08	0.00	2497.22	0.00	77.60a	399914
25	-10.30	78.19	184.99	0.00	2585.33	0.00	78.19a	399914
26	-10.70	78.67	192.91	0.00	2655.76	0.00	78.67a	399914
27	-10.90	78.90	196.87	0.00	2690.97	0.00	78.90a	399914
28	-12.05	80.26	219.62	0.00	2893.22	0.00	80.26a	399914
29	-13.20	81.62	242.34	0.00	3095.23	0.00	81.62a	399914
30	-13.95	82.50	257.14	0.00	3226.87	0.00	82.50a	399914
31	-14.70	83.39	271.94	0.00	3358.43	0.00	83.39a	399914
32	-15.10	83.86	279.83	0.00	3428.57	0.00	83.86a	399914
33	-16.30	85.28	303.48	0.00	3638.90	0.00	85.28a	399914
34	-17.15	86.28	320.23	0.00	3787.80	0.00	86.28a	399914
35	-18.00	87.28	336.97	0.00	3936.66	35.65	122.94	399914
36	-19.15	88.64	359.61	0.00	4137.99	73.13	161.77	399914
37	-20.30	90.00	382.25	0.00	4339.27	163.79	253.79	399914
38	-20.60	93.00	385.51	0.00	4368.24	75.76	168.76	399914
39	-24.70	134.00	430.03	0.00	4764.06	82.97	216.97	399914
40	-28.80	175.00	474.54	0.00	5159.86	92.67	267.67	399914
41	-33.60	223.00	526.69	0.00	5623.52	108.57	331.57	399914
42	-38.40	271.00	578.89	6.16	6087.64	126.27	397.27	399914
43	-43.08	317.75	629.78	15.30	6540.18	144.70	462.45	399914
44	-47.75	364.50	680.73	24.45	6993.21	163.50	528.00	399914

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
21	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.14 Excavate to elevation -16.30 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
26	-10.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27	-10.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	-12.05	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29	-13.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30	-13.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31	-14.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32	-15.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
33	-16.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	940.47	421.50	421.50	399965
34	-17.15	8.50	9.35	0.00	1023.61	292.56	301.06	399965
35	-18.00	17.00	18.70	0.00	1106.78	197.41	214.41	399965
36	-19.15	28.50	31.37	0.00	1219.38	144.21	172.71	399965
37	-20.30	40.00	44.05	0.00	1332.12	49.85	89.85	399965
38	-20.60	43.00	47.36	0.00	1361.57	125.66	168.66	399965
39	-24.70	84.00	92.83	0.00	1765.88	132.93	216.93	399965
40	-28.80	125.00	138.88	0.00	2175.33	142.59	267.59	399965
41	-33.60	173.00	193.80	0.00	2663.63	158.50	331.50	399965
42	-38.40	221.00	249.99	0.00	3163.23	176.21	397.21	399965
43	-43.08	267.75	305.99	0.00	3661.19	194.63	462.38	399965
44	-47.75	314.50	363.20	0.00	4169.88	214.20	528.70	399965

Note: 86.28 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 15 Fill to elevation -15.10 on RIGHT side with soil type 6

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
15	4.00	-15.10		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.006	-1.11E-03	0.0	0.0		877500
2	4.30	0.00	0.006	-1.11E-03	0.0	-0.0	-35.8	877500
		0.00	0.006	-1.11E-03	-35.8	0.0		
3	4.00	0.00	0.007	-1.11E-03	-35.8	-10.7		877500
		7.11	0.007	-1.11E-03	-35.8	-10.7		
4	2.90	13.48	0.008	-1.07E-03	-24.4	-43.8		877500
5	2.50	16.18	0.008	-1.05E-03	-18.5	-52.4		877500
6	1.40	25.94	0.009	-9.83E-04	4.7	-60.9		877500
7	0.70	35.31	0.010	-9.38E-04	26.1	-50.4	-104.6	877500
		35.31	0.010	-9.38E-04	-78.5	-50.4		
8	0.60	36.38	0.010	-9.32E-04	-75.0	-58.1		877500
9	0.00	44.46	0.011	-8.79E-04	-50.7	-96.0		877500
10	-0.85	55.96	0.011	-7.74E-04	-8.0	-121.4		877500
11	-1.70	67.63	0.012	-6.64E-04	44.5	-106.5		877500
12	-2.20	74.60	0.012	-6.12E-04	80.1	-75.5		877500
13	-2.50	78.97	0.013	-5.91E-04	103.1	-48.1		877500
14	-3.25	89.74	0.013	-5.92E-04	166.4	52.4		877500
15	-4.00	100.75	0.013	-7.02E-04	237.8	203.3		877500
16	-4.65	110.45	0.014	-9.18E-04	306.4	379.7		877500
17	-5.30	120.04	0.015	-1.28E-03	381.3	602.9	-1009.7	877500
		120.04	0.015	-1.28E-03	-628.3	602.9		
18	-5.70	127.67	0.015	-1.50E-03	-578.8	361.3		877500
		167.15	0.015	-1.50E-03	-578.8	361.3		
19	-6.00	152.54	0.016	-1.59E-03	-530.8	195.2		877500
20	-6.30	140.53	0.016	-1.63E-03	-486.9	42.9		877500
21	-6.90	135.58	0.017	-1.57E-03	-404.0	-223.8		877500
		513.45	0.017	-1.57E-03	-404.0	-223.8		
22	-7.75	216.85	0.018	-1.27E-03	-93.7	-397.4		877500
23	-8.60	84.76	0.019	-8.83E-04	34.5	-410.8		877500
24	-9.80	77.60	0.020	-3.85E-04	131.9	-317.8		877500
25	-10.30	78.19	0.020	-2.25E-04	170.9	-242.9	-350.2	877500
		78.19	0.020	-2.25E-04	-179.3	-242.9		

(continued)

Stage No.15 Fill to elevation -15.10 on RIGHT side with soil type 6

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.70	78.67	0.020	-9.98E-05	-147.9	-308.5		877500
27	-10.90	78.90	0.020	-2.62E-05	-132.2	-337.2		877500
28	-12.05	80.26	0.020	4.80E-04	-40.6	-436.9		877500
29	-13.20	81.78	0.019	1.04E-03	52.5	-425.6		877500
30	-13.95	83.62	0.018	1.38E-03	114.6	-364.3		877500
31	-14.70	85.32	0.017	1.64E-03	177.9	-255.9		877500
32	-15.10	86.92	0.016	1.74E-03	212.4	-178.1		877500
33	-16.30	79.55	0.014	1.77E-03	312.2	138.0		877500
		-340.53	0.014	1.77E-03	312.2	138.0		
34	-17.15	-216.23	0.013	1.57E-03	75.6	279.7		877500
35	-18.00	-91.65	0.012	1.30E-03	-55.2	265.3		877500
36	-19.15	-10.62	0.010	1.04E-03	-114.0	139.7		877500
37	-20.30	165.72	0.009	9.51E-04	-24.9	0.0		0
38	-20.60	0.11	0.009	0	0.0	0.0		0
39	-24.70	0.03	0.007	0	0.3	0.0		0
40	-28.80	0.09	0.006	0	0.6	0.0		0
41	-33.60	0.06	0.005	0	0.9	0.0		0
42	-38.40	0.05	0.004	0	1.2	0.0		0
43	-43.08	0.06	0.002	0	1.5	0.0		0
44	-47.75	-0.68	0.000	0	0.0	0.0		---

At elev. 4.30 Prop force = 35.8 kN/m run (horiz.)
= 40.1 kN/m run (inclined)
At elev. 0.70 Prop force = 104.6 kN/m run
At elev. -5.30 Prop force = 1009.7 kN/m run
At elev. -10.30 Prop force = 350.2 kN/m run (horiz.)
= 495.2 kN/m run (inclined)

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	7.11	7.11	5999
4	2.90	0.00	18.76	1.90	88.77	13.48	13.48	5999
5	2.50	0.00	26.00	4.14	116.75	16.18	16.18	5999
6	1.40	0.00	46.19	10.38	194.86	25.94	25.94	5999
7	0.70	7.00	51.88	12.13	216.89	28.31	35.31	5999
8	0.60	8.00	52.68	12.38	219.97	28.38	36.38	5999
9	0.00	14.00	57.37	13.83	238.12	30.46	44.46	5999
10	-0.85	22.50	63.79	15.81	262.95	33.46	55.96	5999
11	-1.70	31.00	70.00	17.73	286.97	36.63	67.63	5999
12	-2.20	36.00	73.58	18.84	300.80	38.60	74.60	5999
13	-2.50	39.00	75.70	19.49	309.01	39.97	78.97	5999
		39.00	75.70	19.49	348.27	39.97	78.97	5999
14	-3.25	46.50	80.94	21.11	371.18	43.24	89.74	5999
15	-4.00	54.00	86.11	22.71	393.76	46.75	100.75	5999
16	-4.65	60.50	90.54	24.08	413.12	49.95	110.45	5999
17	-5.30	67.00	94.93	25.44	432.31	53.04	120.04	5999
18	-5.70	71.00	97.62	26.27	444.04	56.67	127.67	5999
		71.00	97.62	17.04	528.95	96.15	167.15	39991
19	-6.00	73.12	101.26	17.98	547.01	79.42	152.54	39991
20	-6.30	73.47	106.65	19.38	573.79	67.06	140.53	39991
21	-6.90	74.18	117.43	22.18	627.29	61.40	135.58	39991
		74.18	117.43	0.00	1984.62	439.27	513.45	399914

Run ID. 1_North_800DWall_topdown+propped_gw2 | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Top Down + Propped | Checked :

(continued)

Stage No.15 Fill to elevation -15.10 on RIGHT side with soil type 6

LEFT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
22	-7.75	75.18	134.37	0.00	2135.20	141.67	216.85	399914
23	-8.60	76.19	151.27	0.00	2285.48	8.57	84.76	399914
24	-9.80	77.60	175.08	0.00	2497.22	0.00	77.60a	399914
25	-10.30	78.19	184.99	0.00	2585.33	0.00	78.19a	399914
26	-10.70	78.67	192.91	0.00	2655.76	0.00	78.67a	399914
27	-10.90	78.90	196.87	0.00	2690.97	0.00	78.90a	399914
28	-12.05	80.26	219.62	0.00	2893.22	0.00	80.26a	399914
29	-13.20	81.62	242.34	0.00	3095.23	0.16	81.78	399914
30	-13.95	82.50	257.14	0.00	3226.87	1.12	83.62	399914
31	-14.70	83.39	271.94	0.00	3358.43	1.93	85.32	399914
32	-15.10	83.86	279.83	0.00	3428.57	3.05	86.92	399914
33	-16.30	85.28	303.48	0.00	3638.90	4.13	89.40	399914
34	-17.15	86.28	320.23	0.00	3787.80	4.82	91.10	399914
35	-18.00	87.28	336.97	0.00	3936.66	40.57	127.85	399914
36	-19.15	88.64	359.61	0.00	4137.99	77.96	166.60	399914
37	-20.30	90.00	382.25	0.00	4339.27	169.17	259.17	399914
38	-20.60	93.00	385.51	0.00	4368.24	80.04	173.04	399914
39	-24.70	134.00	430.03	0.00	4764.06	87.05	221.05	399914
40	-28.80	175.00	474.54	0.00	5159.86	96.63	271.63	399914
41	-33.60	223.00	526.69	0.00	5623.52	112.49	335.49	399914
42	-38.40	271.00	578.89	6.16	6087.64	130.18	401.18	399914
43	-43.08	317.75	629.78	15.30	6540.18	148.63	466.38	399914
44	-47.75	364.50	680.73	24.45	6993.21	167.44	531.94	399914

RIGHT side

Node no.	Y coord	Effective stresses: Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.65	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
21	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.15 Fill to elevation -15.10 on RIGHT side with soil type 6

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
26	-10.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27	-10.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	-12.05	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29	-13.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30	-13.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31	-14.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32	-15.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	39996
33	-16.30	0.00	22.80	4.50	173.01	9.86	9.86	39996
		0.00	22.80	0.00	1143.21	429.93	429.93	399961
34	-17.15	8.50	32.16	0.00	1226.39	298.83	307.33	399961
35	-18.00	17.00	41.52	0.00	1309.62	202.50	219.50	399961
36	-19.15	28.50	54.20	0.00	1422.36	148.72	177.22	399961
37	-20.30	40.00	66.90	0.00	1535.29	53.45	93.45	399961
38	-20.60	43.00	70.21	0.00	1564.79	129.93	172.93	399961
39	-24.70	84.00	115.80	0.00	1970.07	137.02	221.02	399961
40	-28.80	125.00	161.98	0.00	2380.71	146.54	271.54	399961
41	-33.60	173.00	217.04	0.00	2870.29	162.42	335.42	399961
42	-38.40	221.00	273.31	0.00	3370.64	180.13	401.13	399961
43	-43.08	267.75	329.31	0.00	3868.54	198.57	466.32	399961
44	-47.75	314.50	386.41	0.00	4376.21	218.13	532.63	399961

Note: 80.26 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Summary of results

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

				FoS for toe elev. = -20.30		Toe elev. for FoS = 1.000		
Stage No.	Ground level Act.	Pass.	Prop Elev.	Factor of Safety	Moment equilib. at elev.	Toe elev.	Wall Penetr -ation	Direction of failure
1	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
2	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
3	4.00	4.00		No analysis at this stage				
4	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
5	4.00	4.00		No analysis at this stage				
6	4.00	0.00	4.30	12.455	n/a	-1.91	1.91	L to R
7	4.00	0.00		No analysis at this stage				

All remaining stages have more than one prop - FoS calculation n/a

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -47.75 Rough boundary

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	4.40	0.008	-0.000	0.0	-0.0	0.0	-45.0
2	4.30	0.009	-0.000	0.3	-3.1	0.0	-89.2
3	4.00	0.009	-0.000	1.1	-26.8	0.0	-89.2
4	2.90	0.009	-0.000	9.3	-120.9	26.2	-82.5
5	2.50	0.010	-0.000	15.5	-153.1	31.9	-78.6
6	1.40	0.010	-0.000	47.7	-230.9	55.4	-61.7
7	0.70	0.011	-0.000	94.9	-268.4	77.6	-222.0
8	0.60	0.011	-0.000	76.7	-272.7	0.1	-218.8
9	0.00	0.011	-0.000	17.2	-291.7	0.1	-197.1
10	-0.85	0.012	-0.000	0.2	-298.7	5.6	-159.0
11	-1.70	0.013	-0.000	0.3	-405.8	58.6	-112.0
12	-2.20	0.013	-0.000	12.5	-454.0	94.5	-80.2
13	-2.50	0.013	-0.000	36.9	-475.0	117.7	-59.7
14	-3.25	0.013	-0.000	130.3	-499.0	181.6	-3.3
15	-4.00	0.013	-0.000	274.8	-478.0	253.6	0.0
16	-4.65	0.014	-0.000	450.5	-419.0	322.9	0.0
17	-5.30	0.015	-0.000	684.5	-318.2	398.5	-691.5
18	-5.70	0.016	-0.000	420.0	-233.8	233.3	-638.0
19	-6.00	0.017	-0.000	237.1	-160.6	255.0	-585.6
20	-6.30	0.018	-0.000	136.2	-111.4	269.3	-539.6
21	-6.90	0.019	0.000	218.8	-263.5	301.6	-453.6
22	-7.75	0.021	0.000	258.8	-439.1	99.6	-122.2
23	-8.60	0.023	0.000	257.7	-471.0	194.3	-56.3
24	-9.80	0.024	0.000	208.6	-414.7	328.4	-362.1
25	-10.30	0.024	0.000	178.8	-473.1	173.1	-301.1
26	-10.70	0.024	0.000	154.6	-505.2	185.4	-252.4
27	-10.90	0.024	0.000	142.9	-517.2	164.0	-227.4
28	-12.05	0.024	0.000	85.8	-520.7	106.4	-41.1
29	-13.20	0.022	0.000	150.6	-425.6	226.9	-23.9
30	-13.95	0.020	0.000	160.7	-364.3	359.8	-15.9
31	-14.70	0.018	0.000	254.3	-255.9	547.5	-379.4
32	-15.10	0.017	0.000	148.6	-179.2	212.4	-256.8
33	-16.30	0.015	0.000	181.7	-0.0	312.2	-31.3
34	-17.15	0.014	0.000	297.0	-0.0	76.5	-24.0
35	-18.00	0.013	0.000	269.4	-0.0	0.0	-66.0
36	-19.15	0.012	0.000	139.7	-0.0	0.0	-115.8
37	-20.30	0.011	0.000	0.0	0.0	0.0	-24.9
38	-20.60	0.011	0.000	0.0	0.0	0.0	-14.7
39	-24.70	0.009	0.000	0.0	0.0	0.4	-14.4
40	-28.80	0.008	0.000	0.0	0.0	0.6	-14.2
41	-33.60	0.007	0.000	0.0	0.0	1.0	-13.8
42	-38.40	0.005	0.000	0.0	0.0	1.2	-13.5
43	-43.08	0.004	0.000	0.0	0.0	1.5	-13.3

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Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
44	-47.75	0.000	0.000	0.0	0.0	0.0	-14.7

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	1.1	-5.70	-1.3	-8.60	0.4	-9.80	-2.3	-6.90
2	30.4	-6.90	-6.5	-0.85	11.6	-5.70	-9.2	-8.60
3	No calculation at this stage							
4	96.1	-6.90	-29.5	-0.85	38.2	-5.70	-29.1	-8.60
5	No calculation at this stage							
6	258.8	-7.75	-298.7	-0.85	143.6	-5.70	-89.2	4.30
7	No calculation at this stage							
8	No calculation at this stage							
9	257.7	-8.60	-499.0	-3.25	301.6	-6.90	-222.0	0.70
10	No calculation at this stage							
11	No calculation at this stage							
12	188.8	-5.30	-335.3	-8.60	292.1	-5.30	-358.1	-5.30
13	185.5	-5.30	-332.7	-8.60	291.4	-5.30	-355.6	-5.30
14	606.2	-5.30	-434.8	-12.05	382.1	-5.30	-630.7	-5.30
15	602.9	-5.30	-436.9	-12.05	381.3	-5.30	-628.3	-5.30
16	No calculation at this stage							
17	No calculation at this stage							
18	684.5	-5.30	-520.3	-12.05	398.5	-5.30	-686.0	-5.30
19	No calculation at this stage							
20	664.8	-5.30	-520.7	-12.05	374.9	-5.30	-683.3	-5.30
21	No calculation at this stage							
22	615.6	-5.30	-424.9	-12.05	366.4	-5.30	-636.8	-5.30
23	675.5	-5.30	-506.8	-12.05	533.8	-14.70	-691.5	-5.30
24	657.4	-5.30	-500.7	-12.05	508.1	-14.70	-674.5	-5.30
25	573.4	-5.30	-391.2	-12.05	474.4	-14.70	-597.7	-5.30
26	577.0	-5.30	-411.0	-12.05	517.7	-14.70	-600.7	-5.30
27	583.0	-5.30	-430.5	-12.05	540.0	-14.70	-605.7	-5.30
28	594.5	-5.30	-428.3	-12.05	545.2	-14.70	-619.1	-5.30
29	603.5	-5.30	-427.6	-12.05	547.5	-14.70	-659.2	-5.30
30	617.4	-5.30	-427.8	-12.05	532.7	-14.70	-676.5	-5.30
31	626.2	-5.30	-427.8	-12.05	532.5	-14.70	-679.4	-5.30
32	627.2	-5.30	-427.9	-12.05	532.5	-14.70	-679.9	-5.30
33	626.1	-5.30	-427.8	-12.05	532.5	-14.70	-679.6	-5.30

Summary of results (continued)

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	elev.	minimum	elev.	Stage description
	m		m		
1	0.000	-20.30	-0.000	4.40	Change EI of wall to 877500kN.m2/m run
2	0.002	4.40	0.000	4.40	Apply surcharge no.1 at elev. 4.00
3	No calculation at this stage				Apply water pressure profile no.1
4	0.006	4.40	0.000	4.40	Excav. to elev. 4.00 on RIGHT side
5	No calculation at this stage				Install prop no.3 at elev. 4.30
6	0.010	0.00	0.000	4.40	Excav. to elev. 0.00 on RIGHT side
7	No calculation at this stage				Install prop no.1 at elev. 0.70
8	No calculation at this stage				Apply water pressure profile no.2
9	0.013	-3.25	0.000	4.40	Excav. to elev. -6.00 on RIGHT side
10	No calculation at this stage				Install prop no.2 at elev. -5.30
11	No calculation at this stage				Apply water pressure profile no.3
12	0.014	-7.75	0.000	4.40	Excav. to elev. -10.70 on RIGHT side
13	0.014	-7.75	0.000	4.40	Install prop no.8 at elev. -10.30
14	0.020	-10.90	0.000	4.40	Excav. to elev. -16.30 on RIGHT side
15	0.020	-10.90	0.000	4.40	Fill to elev. -15.10 on RIGHT side
16	No calculation at this stage				Install prop no.4 at elev. -14.70
17	No calculation at this stage				Install prop no.5 at elev. -9.80
18	0.022	-10.70	0.000	4.40	Remove prop no.8 at elev. -10.30
19	No calculation at this stage				Install prop no.6 at elev. -2.20
20	0.022	-10.70	0.000	4.40	Remove prop no.3 at elev. 4.30
21	No calculation at this stage				Install prop no.7 at elev. 4.40
22	0.022	-10.70	0.000	4.40	Change EI of wall to 585000kN.m2/m run
23	0.023	-10.90	0.000	4.40	Apply water pressure profile no.4
24	0.023	-10.90	0.000	4.40	Apply water pressure profile no.5
25	0.024	-10.90	0.000	4.40	Change EI of wall to 292500kN.m2/m run
26	0.024	-10.90	0.000	4.40	Apply load no.1 at elev. -13.20
27	0.024	-10.90	0.000	4.40	Apply load no.2 at elev. -10.90
28	0.024	-10.90	0.000	4.40	Apply load no.3 at elev. -8.60
29	0.024	-10.90	0.000	4.40	Apply load no.4 at elev. -6.30
30	0.024	-10.90	0.000	4.40	Apply load no.5 at elev. -4.00
31	0.024	-10.90	0.000	4.40	Apply load no.6 at elev. -1.70
32	0.024	-10.90	0.000	4.40	Apply load no.7 at elev. 0.60
33	0.024	-10.90	0.000	4.40	Apply load no.8 at elev. 2.90

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Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	Strut no. 1 at elev. 0.70		Strut no. 2 at elev.-5.30		Strut no. 3 at elev. 4.30	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
6	---	---	---	---	89.18	445.89
9	259.75	259.75	---	---	16.96	84.80
12	175.97	175.97	650.20	650.20	25.26	126.29
13	176.56	176.56	647.03	647.03	25.18	125.89
14	104.11	104.11	1012.73	1012.73	35.84	179.20
15	104.64	104.64	1009.68	1009.68	35.76	178.80
18	90.11	90.11	1084.53	1084.53	37.73	188.65
20	151.35	151.35	1058.20	1058.20	---	---
22	160.11	160.11	1003.19	1003.19	---	---
23	178.83	178.83	1087.78	1087.78	---	---
24	152.40	152.40	1050.67	1050.67	---	---
25	175.84	175.84	954.81	954.81	---	---
26	175.72	175.72	959.08	959.08	---	---
27	174.63	174.63	965.76	965.76	---	---
28	172.21	172.21	982.04	982.04	---	---
29	170.74	170.74	1024.10	1024.10	---	---
30	176.23	176.23	1066.10	1066.10	---	---
31	197.76	197.76	1074.86	1074.86	---	---
32	249.88	249.88	1073.87	1073.87	---	---
33	284.83	284.83	1072.41	1072.41	---	---

Stage no.	Strut no. 4 at elev.-14.70		Strut no. 5 at elev.-9.80		Strut no. 6 at elev.-2.20	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
18	190.97	190.97	232.42	232.42	---	---
20	193.12	193.12	235.94	235.94	slack	slack
22	243.68	243.68	307.93	307.93	slack	slack
23	779.51	779.51	477.48	477.48	slack	slack
24	728.08	728.08	456.99	456.99	slack	slack
25	785.85	785.85	559.84	559.84	0.68	0.68
26	852.51	852.51	584.87	584.87	slack	slack
27	896.67	896.67	631.11	631.11	slack	slack
28	907.75	907.75	663.33	663.33	slack	slack
29	912.29	912.29	675.43	675.43	slack	slack
30	912.02	912.02	674.32	674.32	17.96	17.96
31	911.65	911.65	673.16	673.16	54.52	54.52
32	911.63	911.63	673.04	673.04	62.87	62.87
33	911.72	911.72	673.24	673.24	59.03	59.03

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Stage no.	Strut no. 7 at elev. 4.40		Strut no. 8 at elev.-10.30	
	kN/m run	kN/prop	kN/m run	kN/prop
13	---	---	14.14	70.71
14	---	---	352.83	1764.16
15	---	---	350.17	1750.87
22	1.67	1.67	---	---
23	2.17	2.17	---	---
24	3.27	3.27	---	---
25	1.21	1.21	---	---
26	1.30	1.30	---	---
27	1.62	1.62	---	---
28	2.21	2.21	---	---
29	2.41	2.41	---	---
30	14.72	14.72	---	---
31	11.49	11.49	---	---
32	13.66	13.66	---	---
33	44.98	44.98	---	---

*** Convergence errors have occurred in at least one Construction Stage.
The errors are cumulative, and the results of all stages must be inspected for significant out of balance moment or shear at the toe of the wall.

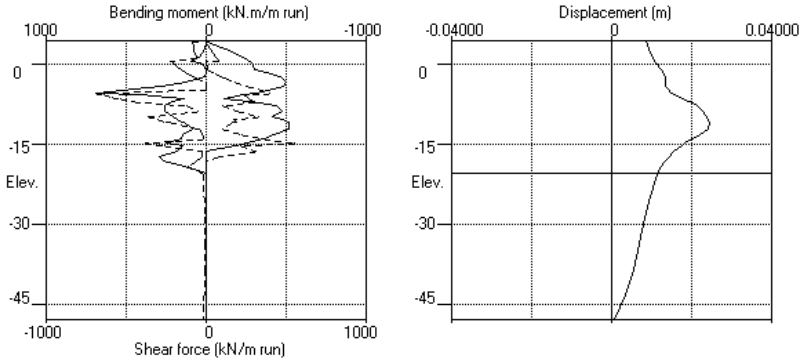
Failure of the iterative procedure to converge to an equilibrium solution may be due to a very high ratio of soil stiffness to wall stiffness. The data should be reviewed to see if realistic values have been specified

Out of balance shear forces.

Percentage Error	Interpretation
< 2%	Generally acceptable
2% to 4%	Use with caution
> 4%	Should not be used

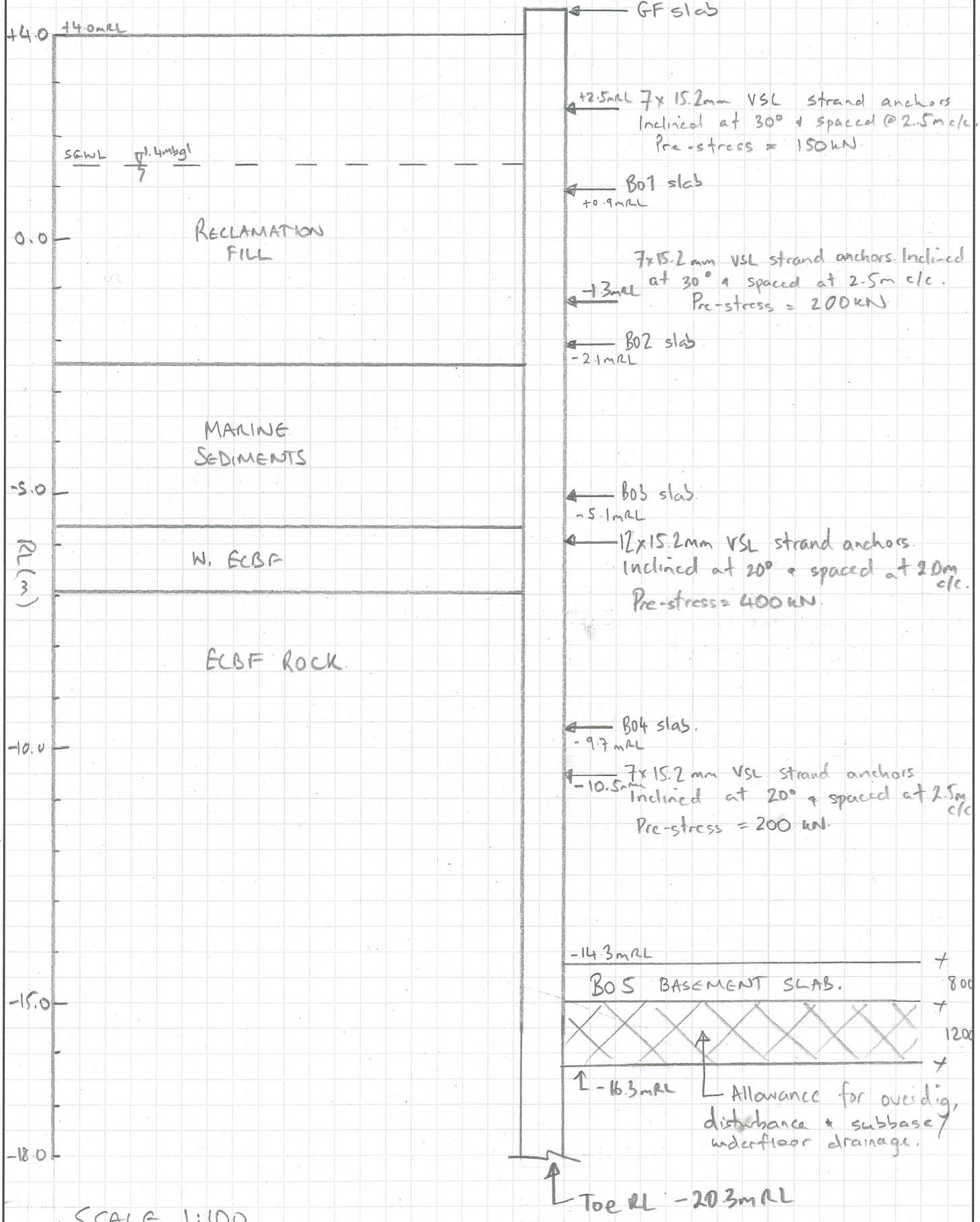
Units: kN,m

Bending moment, shear force, displacement envelopes



Tonkin+Taylor	Project: Downtown Carpark	Computed: RKSW 27/5/20 24	Office: AKL
Description:		Checked: 20	Job No: 1016043.1
		Revised: 20	File:
		Checked: 20	Sheet No.

SECTION 2 - WESTERN WALL (SOUTHERN PORTION)



SCALE 1:100

TONKIN + TAYLOR LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1016043
Licensed from GEOSOLVE | Made by : rxsw
Data filename/Run ID: 2_West_800DWall_anchored_gw |
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	4.00	1 Fill	1 Fill
2	-2.50	2 Marine Sediment	2 Marine Sediment
3	-5.70	5 Weathered ECBF	3 Tauranga Group
4	-6.90	4 ECBF	4 ECBF

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	16.50	6000	0.530	OC (0.300)	0.309 (1.300)	3.868 (5.395)	3.000d
2	Marine Sediment	16.50	6000	0.530	OC (0.300)	0.309 (1.300)	4.369 (5.836)	3.000d
3	Tauranga Group	17.50	20000	0.500	OC (0.300)	0.283 (1.241)	4.369 (5.836)	5.000d
4	ECBF	21.00	400000	0.357	OC (0.250)	0.180 (0.978)	8.892 (9.405)	100.0d
5	Weathered ECBF	19.00	40000	0.470	OC (0.300)	0.259 (1.185)	4.964 (6.343)	7.000d
6	Engineered Fill	19.00	40000	0.840	OC (0.300)	0.197 (1.027)	7.588 (8.432)	0.0d

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill	28.00	0.670	0.00	28.00	0.500	0.00
2	Marine Sediment	28.00	0.670	0.00	30.00	0.500	0.00
3	Tauranga Group	30.00	0.670	0.00	30.00	0.500	0.00
4	ECBF	40.00	0.670	0.00	40.00	0.500	0.00
5	Weathered ECBF	32.00	0.670	0.00	32.00	0.500	0.00
6	Engineered Fill	38.00	0.670	0.00	38.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.40	1.40

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	1.40	1.40	0.0	1	-1.80	-1.80	0.0
2	1	1.40	1.40	0.0	1	-6.50	-6.50	0.0
3	1	1.40	1.40	0.0	1	-11.00	-11.00	0.0
4	1	1.40	1.40	0.0	1	-16.30	-16.30	0.0
	2	-5.90	1.40	73.0				
	3	-20.30	-11.30	90.0				
5	1	2.50	2.50	0.0	1	-15.10	-15.10	0.0
6	1	1.40	1.40	0.0	1	-15.10	-15.10	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = -20.30
Maximum finite element length = 1.20 m
Youngs modulus of wall E = 2.7400E+07 kN/m2
Moment of inertia of wall I = 0.042700 m4/m run
E.I = 1.1700E+06 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	2.50	2.50	0.001003	2.100E+08	18.00	30.00	150.0	Anchor	n/a	R
2	-1.30	2.50	0.001003	2.100E+08	9.00	30.00	200.0	Anchor	n/a	R
3	-6.00	2.00	0.001720	2.100E+08	1.00	20.00	400.0	Anchor	n/a	R
4	-14.70	1.00	0.800000	2.740E+07	30.00	0.00	0	Strut	No	R
5	-9.80	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
6	-5.20	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
7	-2.20	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
8	0.80	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
9	4.40	1.00	0.200000	2.740E+07	30.00	0.00	0	Strut	No	R
10	-10.50	2.50	0.001003	2.100E+08	1.00	20.00	200.0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load kN/m run	Moment load kN.m/m run	Moment restraint kN.m/m/rad	Partial factor (Category)
1	-13.20	61.50	0	0	N/A
2	-10.90	61.50	0	0	N/A
3	-8.60	61.50	0	0	N/A
4	-6.30	61.50	0	0	N/A
5	-4.00	61.50	0	0	N/A
6	-1.70	61.50	0	0	N/A
7	0.60	61.50	0	0	N/A
8	2.90	61.50	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	4.00	2.00(L)	100.00	20.00	12.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 877500 kN.m2/m run
	Reset wall displacements to zero at this stage
2	Apply surcharge no.1 at elevation 4.00
3	Excavate to elevation 2.00 on RIGHT side
4	Install strut or anchor no.1 at elevation 2.50
5	Apply water pressure profile no.1
	No analysis at this stage
6	Excavate to elevation -1.80 on RIGHT side
7	Install strut or anchor no.2 at elevation -1.30
8	Apply water pressure profile no.2
	No analysis at this stage
9	Excavate to elevation -6.50 on RIGHT side
10	Install strut or anchor no.3 at elevation -6.00
11	Apply water pressure profile no.3
	No analysis at this stage
12	Excavate to elevation -11.00 on RIGHT side
13	Install strut or anchor no.10 at elevation -10.50
14	Apply water pressure profile no.4
	No analysis at this stage
15	Excavate to elevation -16.30 on RIGHT side
16	Fill to elevation -15.10 on RIGHT side with soil type 6
17	Install strut or anchor no.4 at elevation -14.70
18	Install strut or anchor no.5 at elevation -9.80
19	Install strut or anchor no.6 at elevation -5.20
20	Remove strut or anchor no.3 at elevation -6.00
21	Remove strut or anchor no.10 at elevation -10.50
22	Install strut or anchor no.7 at elevation -2.20
23	Remove strut or anchor no.2 at elevation -1.30
24	Install strut or anchor no.8 at elevation 0.80
25	Install strut or anchor no.9 at elevation 4.40
26	Remove strut or anchor no.1 at elevation 2.50
27	Change EI of wall to 585000 kN.m2/m run
	Allow wall to relax with new modulus value
28	Apply water pressure profile no.5
29	Apply water pressure profile no.6
30	Change EI of wall to 292500 kN.m2/m run
	Allow wall to relax with new modulus value
31	Apply load no.1 at elevation -13.20
32	Apply load no.2 at elevation -10.90
33	Apply load no.3 at elevation -8.60
34	Apply load no.4 at elevation -6.30
35	Apply load no.5 at elevation -4.00
36	Apply load no.6 at elevation -1.70
37	Apply load no.7 at elevation 0.60
38	Apply load no.8 at elevation 2.90

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - Strength Factor method
 Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
 Minimum equivalent fluid density = 5.00 kN/m3
 Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
 Method - 2-D finite element model
 Open Tension Crack analysis? - No
 Active limit arching modelled? - Yes
 Non-linear Modulus Parameter (L) = 24.30 m

Boundary conditions:
 Length of wall (normal to plane of analysis) = 1000.00 m

 Width of excavation on Left side of wall = 60.00 m
 Width of excavation on Right side of wall = 60.00 m

 Distance to rigid boundary on Left side = 60.00 m
 Distance to rigid boundary on Right side = 60.00 m
 Elevation of rigid lower boundary = -47.75

 Lower rigid boundary at elevation -47.75 - Rough
 Rigid boundary on Left side - Rough
 Rigid boundary on Right side - Rough
 Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 877500kN.m2/m run	No	No	No
2	Apply surcharge no.1 at elev. 4.00	No	No	No
3	Excav. to elev. 2.00 on RIGHT side	Yes	Yes	Yes
4	Install prop no.1 at elev. 2.50	No	No	No
5	Apply water pressure profile no.1	No	No	No
6	Excav. to elev. -1.80 on RIGHT side	Yes	Yes	Yes
7	Install prop no.2 at elev. -1.30	No	No	No
8	Apply water pressure profile no.2	No	No	No
9	Excav. to elev. -6.50 on RIGHT side	Yes	Yes	Yes
10	Install prop no.3 at elev. -6.00	No	No	No
11	Apply water pressure profile no.3	No	No	No
12	Excav. to elev. -11.00 on RIGHT side	No	No	No
13	Install prop no.10 at elev. -10.50	No	No	No
14	Apply water pressure profile no.4	No	No	No
15	Excav. to elev. -16.30 on RIGHT side	Yes	No	No
16	Fill to elev. -15.10 on RIGHT side	No	No	No
17	Install prop no.4 at elev. -14.70	No	No	No
18	Install prop no.5 at elev. -9.80	No	No	No
19	Install prop no.6 at elev. -5.20	No	No	No
20	Remove prop no.3 at elev. -6.00	No	No	No
21	Remove prop no.10 at elev. -10.50	No	No	No
22	Install prop no.7 at elev. -2.20	No	No	No
23	Remove prop no.2 at elev. -1.30	No	No	No
24	Install prop no.8 at elev. 0.80	No	No	No
25	Install prop no.9 at elev. 4.40	No	No	No
26	Remove prop no.1 at elev. 2.50	No	No	No
27	Change EI of wall to 585000kN.m2/m run	No	No	No
28	Apply water pressure profile no.5	No	No	No
29	Apply water pressure profile no.6	No	No	No
30	Change EI of wall to 292500kN.m2/m run	No	No	No
31	Apply load no.1 at elev. -13.20	No	No	No
32	Apply load no.2 at elev. -10.90	No	No	No
33	Apply load no.3 at elev. -8.60	No	No	No
34	Apply load no.4 at elev. -6.30	No	No	No
35	Apply load no.5 at elev. -4.00	No	No	No
36	Apply load no.6 at elev. -1.70	No	No	No
37	Apply load no.7 at elev. 0.60	No	No	No
38	Apply load no.8 at elev. 2.90	Yes	No	No
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 3 Excavate to elevation 2.00 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	FoS for toe elev. = -20.30: Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetration	Direction of failure
3	4.00	2.00	Cant.	9.133	-17.45	1.25	0.75	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries:	Left side 60.00 from wall	Rough boundary
	Right side 60.00 from wall	Rough boundary
Lower rigid boundary at elevation -47.75		Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m	EI of wall kN.m2/m
1	4.40	0.00	0.019	1.61E-03	0.0	0.0		877500
2	4.00	0.00	0.018	1.61E-03	0.0	-0.0		877500
3	2.90	1.90	0.016	1.61E-03	1.0	2.0		877500
4	2.50	5.21	0.016	1.61E-03	2.5	2.7		877500
5	2.00	10.59	0.015	1.61E-03	6.4	4.7		877500
		-2.71	0.015	1.61E-03	6.4	4.7		
6	1.40	-0.61	0.014	1.61E-03	5.4	8.1		877500
7	0.80	1.11	0.013	1.60E-03	5.6	11.3		877500
8	0.60	2.65	0.013	1.60E-03	5.9	12.4		877500
9	-0.35	4.75	0.011	1.58E-03	9.5	19.4		877500
10	-1.30	6.71	0.009	1.55E-03	14.9	30.5		877500
11	-1.70	7.77	0.009	1.54E-03	17.8	37.0		877500
12	-1.80	8.37	0.009	1.53E-03	18.6	38.9		877500
13	-2.20	8.93	0.008	1.51E-03	22.1	47.0		877500
14	-2.50	9.84	0.008	1.50E-03	24.9	54.0		877500
15	-3.25	10.90	0.007	1.44E-03	32.7	75.5		877500
16	-4.00	12.28	0.005	1.36E-03	41.4	103.0		877500
17	-5.20	13.15	0.004	1.18E-03	56.6	161.5		877500
18	-5.70	10.07	0.003	1.08E-03	62.4	191.5		877500
		-25.14	0.003	1.08E-03	62.4	191.5		
19	-6.00	-15.11	0.003	1.01E-03	56.4	209.1		877500
20	-6.30	-8.60	0.003	9.44E-04	52.8	225.3		877500
21	-6.50	-3.50	0.003	8.92E-04	51.6	235.7		877500
22	-6.90	-3.72	0.002	7.80E-04	50.2	256.1		877500
		-161.32	0.002	7.80E-04	50.2	256.1		
23	-7.75	-73.97	0.002	5.39E-04	-49.8	240.4		877500
24	-8.60	9.54	0.001	3.40E-04	-77.2	171.4		877500
25	-9.80	25.21	0.001	1.64E-04	-56.4	85.6		877500
26	-10.50	23.90	0.001	1.09E-04	-39.2	52.3		877500
27	-10.90	20.98	0.001	8.89E-05	-30.2	38.6		877500
28	-11.00	16.34	0.001	8.47E-05	-28.3	35.6		877500

(continued)

Stage No.3 Excavate to elevation 2.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
29	-12.10	10.61	0.001	5.34E-05	-13.5	14.4		877500
30	-13.20	5.11	0.001	4.07E-05	-4.9	5.9		877500
31	-13.95	2.24	0.001	3.65E-05	-2.1	3.7		877500
32	-14.70	1.25	0.001	3.38E-05	-0.8	2.8		877500
33	-15.10	0.31	0.001	3.26E-05	-0.5	2.5		877500
34	-16.30	0.10	0.001	2.94E-05	-0.2	2.1		877500
35	-17.15	-0.19	0.001	2.74E-05	-0.3	2.0		877500
36	-18.00	-0.27	0.001	2.56E-05	-0.5	1.7		877500
37	-19.15	-0.12	0.001	2.40E-05	-0.7	0.9		877500
38	-20.30	1.07	0.001	2.34E-05	-0.2	0.0		0
39	-20.60	0.10	0.001	0	0.0	0.0		0
40	-24.70	0.00	0.000	0	0.2	0.0		0
41	-28.80	0.02	0.000	0	0.3	0.0		0
42	-33.60	0.00	0.000	0	0.3	0.0		0
43	-38.40	-0.00	0.000	0	0.3	0.0		0
44	-43.08	-0.00	0.000	0	0.3	0.0		0
45	-47.75	-0.14	0.000	0	0.0	0.0		---

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	0.00	0.00a	5999
3	2.90	0.00	18.76	1.90	88.77	1.90	1.90a	5999
4	2.50	0.00	26.00	4.14	116.75	5.21	5.21	5999
5	2.00	0.00	35.18	6.97	152.26	10.59	10.59	5999
6	1.40	0.00	46.19	10.38	194.86	16.96	16.96	5999
7	0.80	6.00	51.08	11.89	213.79	19.95	25.95	5999
8	0.60	8.00	52.68	12.38	219.97	21.35	29.35	5999
9	-0.35	17.50	60.04	14.66	248.46	25.80	43.30	5999
10	-1.30	27.00	67.10	16.84	275.75	30.12	57.12	5999
11	-1.70	31.00	70.00	17.73	286.97	32.04	63.04	5999
12	-1.80	32.00	70.72	17.96	289.75	32.67	64.67	5999
13	-2.20	36.00	73.58	18.84	300.80	34.35	70.35	5999
14	-2.50	39.00	75.70	19.49	309.01	35.84	74.84	5999
		39.00	75.70	19.49	348.27	35.84	74.84	5999
15	-3.25	46.50	80.94	21.11	371.18	38.98	85.48	5999
16	-4.00	54.00	86.11	22.71	393.76	42.26	96.26	5999
17	-5.20	66.00	94.26	25.23	429.37	46.85	112.85	5999
18	-5.70	71.00	97.62	26.27	444.04	46.52	117.52	5999
		71.00	97.62	17.04	528.95	16.55	87.55A	39992
19	-6.00	74.00	100.38	17.75	542.63	25.55	99.55	39992
20	-6.30	77.00	103.13	18.47	556.28	31.38	108.38	39992
21	-6.50	79.00	104.96	18.94	565.37	35.75	114.75	39992
22	-6.90	83.00	108.61	19.89	583.51	38.05	121.05	39992
		83.00	108.61	0.00	1906.20	0.00	83.00a	399915
23	-7.75	91.50	118.05	0.00	1990.12	0.03	91.53	399915
24	-8.60	100.00	127.46	0.00	2073.75	43.90	143.90	399915
25	-9.80	112.00	140.69	0.00	2191.39	56.03	168.03	399915
26	-10.50	119.00	148.38	0.00	2259.82	57.92	176.92	399915
27	-10.90	123.00	152.77	0.00	2298.87	57.96	180.96	399915
28	-11.00	124.00	153.87	0.00	2308.63	55.96	179.96	399915
29	-12.10	135.00	165.93	0.00	2415.82	57.35	192.35	399915
30	-13.20	146.00	177.96	0.00	2522.78	58.84	204.84	399915

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.3 Excavate to elevation 2.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
31	-13.95	153.50	186.15	0.00	2595.60	60.31	213.81	399915
32	-14.70	161.00	194.33	0.00	2668.35	62.72	223.72	399915
33	-15.10	165.00	198.69	0.00	2707.12	63.79	228.79	399915
34	-16.30	177.00	211.76	0.00	2823.35	68.37	245.37	399915
35	-17.15	185.50	221.01	0.00	2905.60	71.54	257.04	399915
36	-18.00	194.00	230.26	0.00	2987.80	74.81	268.81	399915
37	-19.15	205.50	242.76	0.00	3098.95	79.38	284.88	399915
38	-20.30	217.00	255.25	0.00	3210.04	84.47	301.47	399915
39	-20.60	220.00	258.51	0.00	3239.02	85.14	305.14	399915
40	-24.70	261.00	303.03	0.00	3634.84	101.14	362.14	399915
41	-28.80	302.00	347.54	0.00	4030.63	117.21	419.21	399915
42	-33.60	350.00	399.69	0.00	4494.29	136.04	486.04	399915
43	-38.40	398.00	451.89	0.00	4958.42	154.91	552.91	399915
44	-43.08	444.75	502.78	0.00	5410.96	173.31	618.06	399915
45	-47.75	491.50	553.73	1.64	5863.98	191.66	683.16	399915

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	13.30	13.30	5999
6	1.40	0.00	9.90	0.00	54.48	17.57	17.57	5999
7	0.80	6.00	13.80	0.37	69.57	18.84	24.84	5999
8	0.60	8.00	15.10	0.77	74.60	18.71	26.71	5999
9	-0.35	17.50	21.28	2.68	98.49	21.04	38.54	5999
10	-1.30	27.00	27.45	4.58	122.38	23.41	50.41	5999
11	-1.70	31.00	30.05	5.39	132.44	24.26	55.26	5999
12	-1.80	32.00	30.70	5.59	134.96	24.29	56.29	5999
13	-2.20	36.00	33.30	6.39	145.02	25.42	61.42	5999
14	-2.50	39.00	35.26	7.00	152.57	26.00	65.00	5999
		39.00	35.26	7.00	171.55	26.00	65.00	5999
15	-3.25	46.50	40.13	8.50	192.87	28.08	74.58	5999
16	-4.00	54.00	45.01	10.01	214.19	29.98	83.98	5999
17	-5.20	66.00	52.82	12.42	248.32	33.69	99.69	5999
18	-5.70	71.00	56.08	13.43	262.54	36.46	107.46	5999
		71.00	56.08	9.68	274.21	41.70	112.70	19996
19	-6.00	74.00	58.33	10.32	284.06	40.66	114.66	19996
20	-6.30	77.00	60.59	10.96	293.90	39.97	116.97	19996
21	-6.50	79.00	62.09	11.39	300.47	39.24	118.24	19996
22	-6.90	83.00	65.09	12.24	313.60	41.77	124.77	19996
		83.00	65.09	0.00	1519.26	161.32	244.32	399920
23	-7.75	91.50	74.46	0.00	1602.52	74.01	165.51	399920
24	-8.60	100.00	83.82	0.00	1685.80	34.36	134.36	399920
25	-9.80	112.00	97.05	0.00	1803.41	30.81	142.81	399920
26	-10.50	119.00	104.77	0.00	1872.04	34.01	153.01	399920
27	-10.90	123.00	109.18	0.00	1911.27	36.98	159.98	399920
28	-11.00	124.00	110.28	0.00	1921.07	39.62	163.62	399920
29	-12.10	135.00	122.42	0.00	2028.98	46.74	181.74	399920

(continued)

Stage No.3 Excavate to elevation 2.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
30	-13.20	146.00	134.56	0.00	2136.93	53.74	199.74	399920
31	-13.95	153.50	142.84	0.00	2210.56	58.06	211.56	399920
32	-14.70	161.00	151.13	0.00	2284.21	61.48	222.48	399920
33	-15.10	165.00	155.55	0.00	2323.51	63.49	228.49	399920
34	-16.30	177.00	168.81	0.00	2441.42	68.27	245.27	399920
35	-17.15	185.50	178.21	0.00	2524.99	71.73	257.23	399920
36	-18.00	194.00	187.61	0.00	2608.58	75.08	269.08	399920
37	-19.15	205.50	200.33	0.00	2721.74	79.49	284.99	399920
38	-20.30	217.00	213.07	0.00	2834.95	83.40	300.40	399920
39	-20.60	220.00	216.39	0.00	2864.49	85.04	305.04	399920
40	-24.70	261.00	261.84	0.00	3268.65	101.14	362.14	399920
41	-28.80	302.00	307.38	0.00	3673.53	117.19	419.19	399920
42	-33.60	350.00	360.78	0.00	4148.36	136.04	486.04	399920
43	-38.40	398.00	414.27	0.00	4623.93	154.91	552.91	399920
44	-43.08	444.75	466.42	0.00	5087.67	173.31	618.06	399920
45	-47.75	491.50	518.62	0.00	5551.80	191.80	683.30	399920

Note: 83.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit
87.55A Arching - soil pressure below active limit

Units: kN,m

Stage No. 6 Excavate to elevation -1.80 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	FoS for toe elev. = -20.30: Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetr -ation	Direction of failure
6	4.00	-1.80	2.50	9.076	n/a	-5.11	3.31	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.024	8.59E-04	0.0	-0.0		877500
2	4.00	0.00	0.024	8.59E-04	0.0	-0.0		877500
		1.40	0.024	8.59E-04	0.0	0.0		
3	2.90	2.09	0.023	8.57E-04	1.9	2.8		877500
4	2.50	4.26	0.022	8.56E-04	3.2	3.9	-107.1	877500
		4.26	0.022	8.56E-04	-103.9	3.9		
5	2.00	8.84	0.022	8.68E-04	-100.6	-47.4		877500
6	1.40	14.35	0.021	9.20E-04	-93.7	-105.8		877500
7	0.80	22.69	0.021	1.01E-03	-82.6	-158.9		877500
8	0.60	25.40	0.021	1.04E-03	-77.7	-174.9		877500
9	-0.35	38.66	0.019	1.27E-03	-47.3	-235.3		877500
10	-1.30	51.94	0.018	1.53E-03	-4.3	-260.9		877500
11	-1.70	57.62	0.018	1.65E-03	17.6	-258.3		877500
12	-1.80	59.18	0.017	1.68E-03	23.5	-256.2		877500
		43.00	0.017	1.68E-03	23.5	-256.2		
13	-2.20	41.17	0.017	1.80E-03	40.3	-243.4		877500
14	-2.50	42.18	0.016	1.88E-03	52.8	-229.4		877500
15	-3.25	43.70	0.015	2.05E-03	85.0	-177.9		877500
16	-4.00	46.00	0.013	2.17E-03	118.6	-101.9		877500
17	-5.20	47.52	0.010	2.19E-03	174.8	73.6		877500
18	-5.70	43.98	0.009	2.12E-03	197.6	167.0		877500
		-15.03	0.009	2.12E-03	197.6	167.0		
19	-6.00	-11.02	0.009	2.05E-03	193.7	225.6		877500
20	-6.30	-4.98	0.008	1.97E-03	191.3	283.2		877500
21	-6.50	4.55	0.008	1.90E-03	191.3	321.4		877500
22	-6.90	9.29	0.007	1.73E-03	194.1	398.3		877500
		-341.52	0.007	1.73E-03	194.1	398.3		
23	-7.75	-152.04	0.006	1.33E-03	-15.7	439.8		877500
24	-8.60	-42.71	0.005	9.40E-04	-98.5	371.5		877500
25	-9.80	23.06	0.004	5.34E-04	-110.3	222.6		877500
26	-10.50	39.05	0.003	3.85E-04	-88.5	151.1		877500

(continued)

Stage No.6 Excavate to elevation -1.80 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
27	-10.90	38.71	0.003	3.24E-04	-73.0	118.8		877500
28	-11.00	33.12	0.003	3.10E-04	-69.4	111.7		877500
29	-12.10	24.04	0.003	2.06E-04	-37.9	55.4		877500
30	-13.20	13.54	0.003	1.53E-04	-17.3	28.2		877500
31	-13.95	7.10	0.003	1.33E-04	-9.5	19.0		877500
32	-14.70	4.54	0.003	1.19E-04	-5.2	13.9		877500
33	-15.10	1.90	0.003	1.13E-04	-3.9	12.2		877500
34	-16.30	1.02	0.002	9.93E-05	-2.1	8.8		877500
35	-17.15	-0.11	0.002	9.15E-05	-1.7	7.4		877500
36	-18.00	-0.59	0.002	8.50E-05	-2.0	5.9		877500
37	-19.15	-0.23	0.002	7.92E-05	-2.5	3.1		877500
38	-20.30	3.67	0.002	7.72E-05	-0.5	-0.0		0
39	-20.60	0.14	0.002	0	0.0	0.0		0
40	-24.70	0.01	0.002	0	0.3	0.0		0
41	-28.80	0.05	0.002	0	0.5	0.0		0
42	-33.60	0.01	0.001	0	0.6	0.0		0
43	-38.40	0.00	0.001	0	0.6	0.0		0
44	-43.08	0.01	0.001	0	0.7	0.0		0
45	-47.75	-0.29	0.000	0	0.0	0.0		---

At elev. 2.50 Prop force = 107.1 kN/m run (horiz.)
= 123.7 kN/m run (inclined)

		LEFT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	1.40	1.40	5999
3	2.90	0.00	18.76	1.90	88.77	2.09	2.09	5999
4	2.50	0.00	26.00	4.14	116.75	4.26	4.26	5999
5	2.00	0.00	35.18	6.97	152.26	8.84	8.84	5999
6	1.40	0.00	46.19	10.38	194.86	14.35	14.35	5999
7	0.80	6.00	51.08	11.89	213.79	16.69	22.69	5999
8	0.60	8.00	52.68	12.38	219.97	17.40	25.40	5999
9	-0.35	17.50	60.04	14.66	248.46	21.16	38.66	5999
10	-1.30	27.00	67.10	16.84	275.75	24.94	51.94	5999
11	-1.70	31.00	70.00	17.73	286.97	26.62	57.62	5999
12	-1.80	32.00	70.72	17.96	289.75	27.18	59.18	5999
13	-2.20	36.00	73.58	18.84	300.80	28.82	64.82	5999
14	-2.50	39.00	75.70	19.49	309.01	30.31	69.31	5999
		39.00	75.70	19.49	348.27	30.31	69.31	5999
15	-3.25	46.50	80.94	21.11	371.18	33.53	80.03	5999
16	-4.00	54.00	86.11	22.71	393.76	37.04	91.04	5999
17	-5.20	66.00	94.26	25.23	429.37	41.71	107.71	5999
18	-5.70	71.00	97.62	26.27	444.04	40.82	111.82	5999
		71.00	97.62	17.04	528.95	0.00	71.00A	39992
19	-6.00	74.00	100.38	17.75	542.63	0.00	74.00A	39992
20	-6.30	77.00	103.13	18.47	556.28	3.80	80.80A	39992
21	-6.50	79.00	104.96	18.94	565.37	11.27	90.27A	39992
22	-6.90	83.00	108.61	19.89	583.51	17.01	100.01A	39992
		83.00	108.61	0.00	1906.20	0.00	83.00a	399915
23	-7.75	91.50	118.05	0.00	1990.12	0.00	91.50a	399915
24	-8.60	100.00	127.46	0.00	2073.75	0.00	100.00a	399915
25	-9.80	112.00	140.69	0.00	2191.39	35.15	147.15	399915
26	-10.50	119.00	148.38	0.00	2259.82	45.38	164.38	399915

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.6 Excavate to elevation -1.80 on RIGHT side

		LEFT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
27	-10.90	123.00	152.77	0.00	2298.87	46.61	169.61	399915
28	-11.00	124.00	153.87	0.00	2308.63	44.01	168.01	399915
29	-12.10	135.00	165.93	0.00	2415.82	43.59	178.59	399915
30	-13.20	146.00	177.96	0.00	2522.78	42.46	188.46	399915
31	-13.95	153.50	186.15	0.00	2595.60	42.05	195.55	399915
32	-14.70	161.00	194.33	0.00	2668.35	43.63	204.63	399915
33	-15.10	165.00	198.69	0.00	2707.12	43.80	208.80	399915
34	-16.30	177.00	211.76	0.00	2823.35	48.01	225.01	399915
35	-17.15	185.50	221.01	0.00	2905.60	50.71	236.21	399915
36	-18.00	194.00	230.26	0.00	2987.80	53.76	247.76	399915
37	-19.15	205.50	242.76	0.00	3098.95	58.41	263.91	399915
38	-20.30	217.00	255.25	0.00	3210.04	64.85	281.85	399915
39	-20.60	220.00	258.51	0.00	3239.02	64.21	284.21	399915
40	-24.70	261.00	303.03	0.00	3634.84	80.24	341.24	399915
41	-28.80	302.00	347.54	0.00	4030.63	96.39	398.39	399915
42	-33.60	350.00	399.69	0.00	4494.29	115.35	465.35	399915
43	-38.40	398.00	451.89	0.00	4958.42	134.40	532.40	399915
44	-43.08	444.75	502.78	0.00	5410.96	153.03	597.78	399915
45	-47.75	491.50	553.73	1.64	5863.98	171.55	663.05	399915

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	16.18	16.18p	5999
13	-2.20	4.00	2.60	0.00	26.24	19.65	23.65	5999
14	-2.50	7.00	4.55	0.00	33.78	20.13	27.13	5999
		7.00	4.55	0.00	37.39	20.13	27.13	5999
15	-3.25	14.50	9.43	0.00	58.69	21.83	36.33	5999
16	-4.00	22.00	14.30	0.52	80.00	23.04	45.04	5999
17	-5.20	34.00	22.11	2.93	114.10	26.19	60.19	5999
18	-5.70	39.00	25.36	3.94	128.32	28.84	67.84	5999
		39.00	25.36	0.98	139.99	47.03	86.03	19996
19	-6.00	42.00	27.61	1.62	149.84	43.02	85.02	19996
20	-6.30	45.00	29.87	2.26	159.68	40.78	85.78	19996
21	-6.50	47.00	31.37	2.68	166.24	38.72	85.72	19996
22	-6.90	51.00	34.37	3.53	179.38	39.72	90.72	19996
		51.00	34.37	0.00	1246.12	373.52	424.52	399927
23	-7.75	59.50	43.74	0.00	1329.38	184.04	243.54	399927
24	-8.60	68.00	53.11	0.00	1412.69	74.71	142.71	399927
25	-9.80	80.00	66.34	0.00	1530.38	44.10	124.10	399927

(continued)

Stage No.6 Excavate to elevation -1.80 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
26	-10.50	87.00	74.07	0.00	1599.08	38.33	125.33	399927
27	-10.90	91.00	78.49	0.00	1638.35	39.89	130.89	399927
28	-11.00	92.00	79.59	0.00	1648.17	42.89	134.89	399927
29	-12.10	103.00	91.75	0.00	1756.26	51.55	154.55	399927
30	-13.20	114.00	103.92	0.00	1864.45	60.92	174.92	399927
31	-13.95	121.50	112.22	0.00	1938.29	66.94	188.44	399927
32	-14.70	129.00	120.53	0.00	2012.19	71.09	200.09	399927
33	-15.10	133.00	124.97	0.00	2051.63	73.90	206.90	399927
34	-16.30	145.00	138.29	0.00	2170.04	78.99	223.99	399927
35	-17.15	153.50	147.73	0.00	2254.02	82.83	236.33	399927
36	-18.00	162.00	157.18	0.00	2338.08	86.35	248.35	399927
37	-19.15	173.50	169.99	0.00	2451.96	90.65	264.15	399927
38	-20.30	185.00	182.82	0.00	2566.00	93.18	278.18	399927
39	-20.60	188.00	186.17	0.00	2595.77	96.07	284.07	399927
40	-24.70	229.00	232.07	0.00	3003.90	112.22	341.22	399927
41	-28.80	270.00	278.21	0.00	3414.21	128.34	398.34	399927
42	-33.60	318.00	332.53	0.00	3897.20	147.34	465.34	399927
43	-38.40	366.00	387.14	0.00	4382.69	166.40	532.40	399927
44	-43.08	412.75	440.54	0.00	4857.52	185.03	597.78	399927
45	-47.75	459.50	494.11	0.00	5333.85	203.84	663.34	399927

Note: 100.00 a Soil pressure at active limit
16.18 p Soil pressure at passive limit
100.01A Arching - soil pressure below active limit

Units: kN,m

Stage No. 9 Excavate to elevation -6.50 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
9	4.00	-6.50		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.023	2.36E-04	0.0	-0.0		877500
2	4.00	0.00	0.023	2.36E-04	0.0	-0.0		877500
		4.21	0.023	2.36E-04	0.0	0.0		
3	2.90	4.39	0.023	2.33E-04	4.7	4.5		877500
4	2.50	6.06	0.023	2.30E-04	6.8	6.9	-109.1	877500
		6.06	0.023	2.30E-04	-102.3	6.9		
5	2.00	10.29	0.023	2.41E-04	-98.2	-43.3		877500
6	1.40	15.45	0.023	2.90E-04	-90.5	-100.1		877500
7	0.80	23.51	0.022	3.76E-04	-78.8	-151.1		877500
8	0.60	25.88	0.022	4.12E-04	-73.9	-166.4		877500
9	-0.35	38.73	0.022	6.23E-04	-43.2	-222.9		877500
10	-1.30	51.52	0.021	8.76E-04	-0.3	-244.5	-111.7	877500
		51.52	0.021	8.76E-04	-112.0	-244.5		
11	-1.70	56.84	0.021	9.96E-04	-90.3	-285.0		877500
12	-1.80	58.13	0.021	1.02E-03	-84.6	-293.7		877500
13	-2.20	63.54	0.020	1.17E-03	-60.2	-322.7		877500
14	-2.50	67.63	0.020	1.28E-03	-40.6	-337.9		877500
15	-3.25	77.91	0.019	1.57E-03	14.0	-348.3		877500
16	-4.00	88.42	0.018	1.85E-03	76.4	-315.0		877500
17	-5.20	104.77	0.015	2.18E-03	192.3	-155.9		877500
18	-5.70	109.75	0.014	2.23E-03	245.9	-46.4		877500
		71.00	0.014	2.23E-03	245.9	-46.4		
19	-6.00	74.00	0.013	2.24E-03	267.7	30.6		877500
20	-6.30	77.00	0.013	2.21E-03	290.3	114.3		877500
21	-6.50	79.00	0.012	2.18E-03	305.9	173.9		877500
		49.82	0.012	2.18E-03	305.9	173.9		
22	-6.90	49.76	0.011	2.07E-03	325.9	300.3		877500
		-419.94	0.011	2.07E-03	325.9	300.3		
23	-7.75	-207.80	0.010	1.72E-03	59.1	425.5		877500
24	-8.60	-64.02	0.008	1.32E-03	-56.4	400.7		877500
25	-9.80	-7.95	0.007	8.54E-04	-99.6	286.9		877500

(continued)

Stage No.9 Excavate to elevation -6.50 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.50	19.53	0.007	6.54E-04	-95.6	215.2		877500
27	-10.90	28.56	0.006	5.64E-04	-86.0	178.5		877500
28	-11.00	29.78	0.006	5.44E-04	-83.0	170.0		877500
29	-12.10	25.96	0.006	3.77E-04	-52.4	96.7		877500
30	-13.20	17.61	0.005	2.82E-04	-28.4	54.8		877500
31	-13.95	10.74	0.005	2.42E-04	-17.8	38.4		877500
32	-14.70	7.56	0.005	2.14E-04	-10.9	28.1		877500
33	-15.10	3.89	0.005	2.02E-04	-8.6	24.3		877500
34	-16.30	2.31	0.005	1.74E-04	-4.9	16.7		877500
35	-17.15	0.34	0.005	1.60E-04	-3.8	13.3		877500
36	-18.00	-0.64	0.004	1.48E-04	-3.9	10.2		877500
37	-19.15	-0.22	0.004	1.38E-04	-4.4	5.3		877500
38	-20.30	6.27	0.004	1.35E-04	-0.9	-0.0		0
39	-20.60	0.16	0.004	0	0.0	0.0		0
40	-24.70	0.02	0.004	0	0.4	0.0		0
41	-28.80	0.07	0.003	0	0.6	0.0		0
42	-33.60	0.03	0.003	0	0.8	0.0		0
43	-38.40	0.01	0.002	0	0.9	0.0		0
44	-43.08	0.02	0.002	0	1.0	0.0		0
45	-47.75	-0.45	0.000	0	0.0	0.0		---

At elev. 2.50 Prop force = 109.1 kN/m run (horiz.)
= 126.0 kN/m run (inclined)

At elev. -1.30 Prop force = 111.7 kN/m run (horiz.)
= 128.9 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	4.21	4.21	5999
3	2.90	0.00	18.76	1.90	88.77	4.39	4.39	5999
4	2.50	0.00	26.00	4.14	116.75	6.06	6.06	5999
5	2.00	0.00	35.18	6.97	152.26	10.29	10.29	5999
6	1.40	0.00	46.19	10.38	194.86	15.45	15.45	5999
7	0.80	6.00	51.08	11.89	213.79	17.51	23.51	5999
8	0.60	8.00	52.68	12.38	219.97	17.88	25.88	5999
9	-0.35	17.50	60.04	14.66	248.46	21.23	38.73	5999
10	-1.30	27.00	67.10	16.84	275.75	24.52	51.52	5999
11	-1.70	31.00	70.00	17.73	286.97	25.84	56.84	5999
12	-1.80	32.00	70.72	17.96	289.75	26.13	58.13	5999
13	-2.20	36.00	73.58	18.84	300.80	27.54	63.54	5999
14	-2.50	39.00	75.70	19.49	309.01	28.63	67.63	5999
		39.00	75.70	19.49	348.27	28.63	67.63	5999
15	-3.25	46.50	80.94	21.11	371.18	31.41	77.91	5999
16	-4.00	54.00	86.11	22.71	393.76	34.42	88.42	5999
17	-5.20	66.00	94.26	25.23	429.37	38.77	104.77	5999
18	-5.70	71.00	97.62	26.27	444.04	38.75	109.75	5999
		71.00	97.62	17.04	528.95	0.00	71.00A	39992
19	-6.00	74.00	100.38	17.75	542.63	0.00	74.00A	39992
20	-6.30	77.00	103.13	18.47	556.28	0.00	77.00A	39992
21	-6.50	79.00	104.96	18.94	565.37	0.00	79.00A	39992
22	-6.90	83.00	108.61	19.89	583.51	3.83	86.83A	39992
		83.00	108.61	0.00	1906.20	0.00	83.00a	399915
23	-7.75	91.50	118.05	0.00	1990.12	0.00	91.50a	399915

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.9 Excavate to elevation -6.50 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
24	-8.60	100.00	127.46	0.00	2073.75	0.00	100.00a	399915
25	-9.80	112.00	140.69	0.00	2191.39	0.00	112.00a	399915
26	-10.50	119.00	148.38	0.00	2259.82	7.40	126.40	399915
27	-10.90	123.00	152.77	0.00	2298.87	13.24	136.24	399915
28	-11.00	124.00	153.87	0.00	2308.63	13.98	137.98	399915
29	-12.10	135.00	165.93	0.00	2415.82	16.11	151.11	399915
30	-13.20	146.00	177.96	0.00	2522.78	15.97	161.97	399915
31	-13.95	153.50	186.15	0.00	2595.60	15.29	168.79	399915
32	-14.70	161.00	194.33	0.00	2668.35	16.54	177.54	399915
33	-15.10	165.00	198.69	0.00	2707.12	16.17	181.17	399915
34	-16.30	177.00	211.76	0.00	2823.35	20.01	197.01	399915
35	-17.15	185.50	221.01	0.00	2905.60	22.27	207.77	399915
36	-18.00	194.00	230.26	0.00	2987.80	25.05	219.05	399915
37	-19.15	205.50	242.76	0.00	3098.95	29.72	235.22	399915
38	-20.30	217.00	255.25	0.00	3210.04	37.45	254.45	399915
39	-20.60	220.00	258.51	0.00	3239.02	35.50	255.50	399915
40	-24.70	261.00	303.03	0.00	3634.84	51.54	312.54	399915
41	-28.80	302.00	347.54	0.00	4030.63	67.74	369.74	399915
42	-33.60	350.00	399.69	0.00	4494.29	86.80	436.80	399915
43	-38.40	398.00	451.89	0.00	4958.42	106.01	504.01	399915
44	-43.08	444.75	502.78	0.00	5410.96	124.84	569.59	399915
45	-47.75	491.50	553.73	1.64	5863.98	143.52	635.02	399915

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
21	-6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	29.18	29.18	29.18p	19997
22	-6.90	4.00	3.00	0.00	42.29	33.07	37.07	19997
		4.00	3.00	0.00	967.15	498.94	502.94	399941
23	-7.75	12.50	12.35	0.00	1050.29	286.80	299.30	399941
24	-8.60	21.00	21.70	0.00	1133.45	143.02	164.02	399941

(continued)

Stage No.9 Excavate to elevation -6.50 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
25	-9.80	33.00	34.91	0.00	1250.90	86.95	119.95	399941
26	-10.50	40.00	42.62	0.00	1319.45	66.88	106.88	399941
27	-10.90	44.00	47.03	0.00	1358.63	63.68	107.68	399941
28	-11.00	45.00	48.13	0.00	1368.43	63.21	108.21	399941
29	-12.10	56.00	60.26	0.00	1476.27	69.15	125.15	399941
30	-13.20	67.00	72.40	0.00	1584.23	77.36	144.36	399941
31	-13.95	74.50	80.69	0.00	1657.92	83.55	158.05	399941
32	-14.70	82.00	88.98	0.00	1731.68	87.99	169.99	399941
33	-15.10	86.00	93.41	0.00	1771.05	91.28	177.28	399941
34	-16.30	98.00	106.71	0.00	1889.30	96.69	194.69	399941
35	-17.15	106.50	116.15	0.00	1973.21	100.93	207.43	399941
36	-18.00	115.00	125.60	0.00	2057.23	104.69	219.69	399941
37	-19.15	126.50	138.41	0.00	2171.12	108.94	235.44	399941
38	-20.30	138.00	151.24	0.00	2285.27	110.18	248.18	399941
39	-20.60	141.00	154.60	0.00	2315.09	114.34	255.34	399941
40	-24.70	182.00	200.65	0.00	2724.60	130.51	312.51	399941
41	-28.80	223.00	247.15	0.00	3137.97	146.67	369.67	399941
42	-33.60	271.00	302.14	0.00	3626.96	165.77	436.77	399941
43	-38.40	319.00	357.72	0.00	4121.12	185.00	504.00	399941
44	-43.08	365.75	412.34	0.00	4606.78	203.83	569.58	399941
45	-47.75	412.50	467.36	0.00	5095.99	222.97	635.47	399941

Note: 112.00 a Soil pressure at active limit
29.18 p Soil pressure at passive limit
86.83A Arching - soil pressure below active limit

Units: kN,m

Stage No. 12 Excavate to elevation -11.00 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = -20.30** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
12	4.00	-11.00		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -47.75 Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.019	-3.33E-05	0.0	-0.0		877500
2	4.00	0.00	0.019	-3.33E-05	0.0	-0.0		877500
		7.00	0.019	-3.33E-05	0.0	-0.0		
3	2.90	7.38	0.019	-3.72E-05	7.9	6.2		877500
4	2.50	9.21	0.019	-4.10E-05	11.2	10.1	-96.4	877500
		9.21	0.019	-4.10E-05	-85.1	10.1		
5	2.00	13.55	0.019	-3.50E-05	-79.5	-31.1		877500
6	1.40	18.81	0.019	1.63E-06	-69.8	-76.0		877500
7	0.80	26.97	0.019	6.66E-05	-56.0	-114.0		877500
8	0.60	29.46	0.019	9.37E-05	-50.4	-124.6		877500
9	-0.35	42.48	0.019	2.46E-04	-16.2	-157.2		877500
10	-1.30	55.48	0.019	4.13E-04	30.3	-151.5	-95.1	877500
		55.48	0.019	4.13E-04	-64.8	-151.5		
11	-1.70	60.94	0.019	4.87E-04	-41.5	-172.8		877500
12	-1.80	62.31	0.019	5.07E-04	-35.3	-176.6		877500
13	-2.20	67.82	0.018	5.89E-04	-9.3	-185.6		877500
14	-2.50	72.07	0.018	6.53E-04	11.7	-185.2		877500
15	-3.25	82.60	0.018	7.98E-04	69.7	-155.3		877500
16	-4.00	93.49	0.017	8.98E-04	135.7	-78.9		877500
17	-5.20	110.54	0.016	8.46E-04	258.2	155.1		877500
18	-5.70	117.52	0.016	7.17E-04	315.2	298.3		877500
		122.81	0.016	7.17E-04	315.2	298.3		
19	-6.00	117.81	0.015	5.98E-04	351.3	398.4	-762.7	877500
		117.81	0.015	5.98E-04	-411.4	398.4		
20	-6.30	113.57	0.015	4.82E-04	-376.7	280.3		877500
21	-6.50	108.36	0.015	4.26E-04	-354.5	207.2		877500
22	-6.90	108.75	0.015	3.62E-04	-311.1	74.3		877500
		302.19	0.015	3.62E-04	-311.1	74.3		
23	-7.75	91.50	0.015	3.75E-04	-143.8	-100.5		877500
24	-8.60	100.00	0.014	5.22E-04	-62.4	-202.4		877500
25	-9.80	112.00	0.013	8.06E-04	64.8	-212.9		877500

(continued)

Stage No.12 Excavate to elevation -11.00 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.50	119.00	0.013	9.47E-04	145.7	-140.8		877500
27	-10.90	123.00	0.012	9.95E-04	194.1	-73.0		877500
28	-11.00	124.00	0.012	1.00E-03	206.4	-53.0		877500
		-129.63	0.012	1.00E-03	206.4	-53.0		
29	-12.10	-91.78	0.011	9.76E-04	84.6	95.6		877500
30	-13.20	-44.78	0.010	8.32E-04	9.5	133.2		877500
31	-13.95	-17.94	0.010	7.21E-04	-14.0	127.7		877500
32	-14.70	-7.00	0.009	6.18E-04	-23.3	112.2		877500
33	-15.10	1.30	0.009	5.69E-04	-24.5	102.3		877500
34	-16.30	2.68	0.008	4.49E-04	-22.1	73.8		877500
35	-17.15	2.69	0.008	3.86E-04	-19.8	56.0		877500
36	-18.00	0.34	0.008	3.40E-04	-18.5	40.1		877500
37	-19.15	1.56	0.007	3.01E-04	-17.4	19.0		877500
38	-20.30	22.81	0.007	2.88E-04	-3.4	-0.0		0
39	-20.60	0.14	0.007	0	0.0	0.0		0
40	-24.70	0.03	0.006	0	0.4	0.0		0
41	-28.80	0.09	0.005	0	0.6	0.0		0
42	-33.60	0.05	0.005	0	1.0	0.0		0
43	-38.40	0.03	0.004	0	1.2	0.0		0
44	-43.08	0.04	0.002	0	1.3	0.0		0
45	-47.75	-0.60	0.000	0	0.0	0.0		---

At elev. 2.50 Prop force = 96.4 kN/m run (horiz.)
= 111.3 kN/m run (inclined)

At elev. -1.30 Prop force = 95.1 kN/m run (horiz.)
= 109.8 kN/m run (inclined)

At elev. -6.00 Prop force = 762.7 kN/m run (horiz.)
= 811.6 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	7.00	7.00	5999
3	2.90	0.00	18.76	1.90	88.77	7.38	7.38	5999
4	2.50	0.00	26.00	4.14	116.75	9.21	9.21	5999
5	2.00	0.00	35.18	6.97	152.26	13.55	13.55	5999
6	1.40	0.00	46.19	10.38	194.86	18.81	18.81	5999
7	0.80	6.00	51.08	11.89	213.79	20.97	26.97	5999
8	0.60	8.00	52.68	12.38	219.97	21.46	29.46	5999
9	-0.35	17.50	60.04	14.66	248.46	24.98	42.48	5999
10	-1.30	27.00	67.10	16.84	275.75	28.48	55.48	5999
11	-1.70	31.00	70.00	17.73	286.97	29.94	60.94	5999
12	-1.80	32.00	70.72	17.96	289.75	30.31	62.31	5999
13	-2.20	36.00	73.58	18.84	300.80	31.82	67.82	5999
14	-2.50	39.00	75.70	19.49	309.01	33.07	72.07	5999
		39.00	75.70	19.49	348.27	33.07	72.07	5999
15	-3.25	46.50	80.94	21.11	371.18	36.10	82.60	5999
16	-4.00	54.00	86.11	22.71	393.76	39.49	93.49	5999
17	-5.20	66.00	94.26	25.23	429.37	44.54	110.54	5999
18	-5.70	71.00	97.62	26.27	444.04	46.52	117.52	5999
		71.00	97.62	17.04	528.95	51.81	122.81	39992
19	-6.00	74.00	100.38	17.75	542.63	43.81	117.81	39992
20	-6.30	77.00	103.13	18.47	556.28	36.57	113.57	39992
21	-6.50	79.00	104.96	18.94	565.37	29.36	108.36	39992

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.12 Excavate to elevation -11.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
22	-6.90	83.00	108.61	19.89	583.51	25.75	108.75	39992
		83.00	108.61	0.00	1906.20	219.19	302.19	399915
23	-7.75	91.50	118.05	0.00	1990.12	0.00	91.50a	399915
24	-8.60	100.00	127.46	0.00	2073.75	0.00	100.00a	399915
25	-9.80	112.00	140.69	0.00	2191.39	0.00	112.00a	399915
26	-10.50	119.00	148.38	0.00	2259.82	0.00	119.00a	399915
27	-10.90	123.00	152.77	0.00	2298.87	0.00	123.00a	399915
28	-11.00	124.00	153.87	0.00	2308.63	0.00	124.00a	399915
29	-12.10	135.00	165.93	0.00	2415.82	0.00	135.00a	399915
30	-13.20	146.00	177.96	0.00	2522.78	0.00	146.00a	399915
31	-13.95	153.50	186.15	0.00	2595.60	0.00	153.50a	399915
32	-14.70	161.00	194.33	0.00	2668.35	0.00	161.00a	399915
33	-15.10	165.00	198.69	0.00	2707.12	0.00	165.00a	399915
34	-16.30	177.00	211.76	0.00	2823.35	0.00	177.00a	399915
35	-17.15	185.50	221.01	0.00	2905.60	0.00	185.50a	399915
36	-18.00	194.00	230.26	0.00	2987.80	0.00	194.00a	399915
37	-19.15	205.50	242.76	0.00	3098.95	4.12	209.62	399915
38	-20.30	217.00	255.25	0.00	3210.04	18.62	235.62	399915
39	-20.60	220.00	258.51	0.00	3239.02	7.77	227.77	399915
40	-24.70	261.00	303.03	0.00	3634.84	22.84	283.84	399915
41	-28.80	302.00	347.54	0.00	4030.63	38.23	340.23	399915
42	-33.60	350.00	399.69	0.00	4494.29	56.90	406.90	399915
43	-38.40	398.00	451.89	0.00	4958.42	75.99	473.99	399915
44	-43.08	444.75	502.78	0.00	5410.96	94.92	539.67	399915
45	-47.75	491.50	553.73	1.64	5863.98	113.74	605.24	399915

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
21	-6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.12 Excavate to elevation -11.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
24	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26	-10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27	-10.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	-11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	940.47	253.63	253.63	399951
29	-12.10	11.00	12.10	0.00	1048.07	215.78	226.78	399951
30	-13.20	22.00	24.21	0.00	1155.70	168.78	190.78	399951
31	-13.95	29.50	32.46	0.00	1229.12	141.94	171.44	399951
32	-14.70	37.00	40.73	0.00	1302.59	131.00	168.00	399951
33	-15.10	41.00	45.14	0.00	1341.80	122.70	163.70	399951
34	-16.30	53.00	58.38	0.00	1459.54	121.32	174.32	399951
35	-17.15	61.50	67.77	0.00	1543.06	121.31	182.81	399951
36	-18.00	70.00	77.18	0.00	1626.70	123.66	193.66	399951
37	-19.15	81.50	89.93	0.00	1740.07	126.56	208.06	399951
38	-20.30	93.00	102.71	0.00	1853.72	119.81	212.81	399951
39	-20.60	96.00	106.05	0.00	1883.42	131.63	227.63	399951
40	-24.70	137.00	151.97	0.00	2291.72	146.80	283.80	399951
41	-28.80	178.00	198.47	0.00	2705.22	162.14	340.14	399951
42	-33.60	226.00	253.76	0.00	3196.82	180.85	406.85	399951
43	-38.40	274.00	309.99	0.00	3696.77	199.96	473.96	399951
44	-43.08	320.75	365.61	0.00	4191.29	218.88	539.63	399951
45	-47.75	367.50	421.96	0.00	4692.37	238.34	605.84	399951

Note: 194.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 15 Excavate to elevation -16.30 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
15	4.00	-16.30		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.018	-1.18E-04	0.0	-0.0		877500
2	4.00	0.00	0.018	-1.18E-04	0.0	-0.0		877500
		8.03	0.018	-1.18E-04	0.0	-0.0		
3	2.90	8.53	0.018	-1.23E-04	9.1	6.8		877500
4	2.50	10.48	0.018	-1.27E-04	12.9	11.3	-92.8	877500
		10.48	0.018	-1.27E-04	-79.9	11.3		
5	2.00	14.88	0.018	-1.22E-04	-73.5	-27.2		877500
6	1.40	20.22	0.018	-9.01E-05	-63.0	-68.3		877500
7	0.80	28.44	0.018	-3.20E-05	-48.4	-101.9		877500
8	0.60	31.00	0.018	-7.75E-06	-42.5	-111.0		877500
9	-0.35	44.12	0.018	1.25E-04	-6.8	-135.4		877500
10	-1.30	57.23	0.018	2.63E-04	41.4	-120.0	-90.8	877500
		57.23	0.018	2.63E-04	-49.4	-120.0		
11	-1.70	62.76	0.018	3.21E-04	-25.4	-135.0		877500
12	-1.80	64.19	0.018	3.37E-04	-19.1	-137.2		877500
13	-2.20	69.74	0.018	4.00E-04	7.7	-139.5		877500
14	-2.50	74.07	0.018	4.47E-04	29.3	-134.0		877500
15	-3.25	84.72	0.017	5.43E-04	88.8	-90.3		877500
16	-4.00	95.78	0.017	5.81E-04	156.5	1.0		877500
17	-5.20	113.07	0.016	4.01E-04	281.8	261.6		877500
18	-5.70	120.13	0.016	2.08E-04	340.1	416.9		877500
		140.17	0.016	2.08E-04	340.1	416.9		
19	-6.00	135.09	0.016	4.74E-05	381.4	525.3	-895.8	877500
		135.09	0.016	4.74E-05	-514.4	525.3		
20	-6.30	128.60	0.016	-1.06E-04	-474.8	377.0		877500
21	-6.50	121.25	0.016	-1.82E-04	-449.8	284.6		877500
22	-6.90	116.85	0.016	-2.73E-04	-402.2	114.6		877500
		427.72	0.016	-2.73E-04	-402.2	114.6		
23	-7.75	175.22	0.017	-2.83E-04	-145.9	-92.9		877500
24	-8.60	127.77	0.017	-1.57E-04	-17.2	-166.9		877500
25	-9.80	87.57	0.017	2.79E-05	112.0	-104.9		877500

(continued)

Stage No.15 Excavate to elevation -16.30 on RIGHT side

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.50	78.43	0.017	7.22E-05	170.1	-6.1	-388.0	877500
		78.43	0.017	7.22E-05	-217.9	-6.1		
27	-10.90	78.90	0.017	9.35E-05	-186.4	-87.0		877500
28	-11.00	79.02	0.017	1.04E-04	-178.5	-105.2		877500
29	-12.10	80.32	0.016	3.33E-04	-90.9	-259.9		877500
30	-13.20	81.62	0.016	6.96E-04	-1.8	-318.9		877500
31	-13.95	82.50	0.015	9.60E-04	59.8	-299.3		877500
32	-14.70	83.39	0.014	1.18E-03	122.0	-231.9		877500
33	-15.10	83.86	0.014	1.28E-03	155.4	-176.7		877500
34	-16.30	85.28	0.012	1.35E-03	256.9	71.1		877500
		-257.78	0.012	1.35E-03	256.9	71.1		
35	-17.15	-172.27	0.011	1.22E-03	74.1	195.8		877500
36	-18.00	-77.44	0.010	1.03E-03	-32.0	195.9		877500
37	-19.15	-12.78	0.009	8.35E-04	-83.9	106.4		877500
38	-20.30	125.84	0.008	7.65E-04	-18.9	-0.0		0
39	-20.60	0.10	0.008	0	0.0	0.0		0
40	-24.70	0.03	0.007	0	0.3	0.0		0
41	-28.80	0.09	0.006	0	0.5	0.0		0
42	-33.60	0.07	0.005	0	0.9	0.0		0
43	-38.40	0.06	0.004	0	1.2	0.0		0
44	-43.08	0.06	0.002	0	1.5	0.0		0
45	-47.75	-0.70	0.000	0	0.0	0.0		---

At elev. 2.50 Prop force = 92.8 kN/m run (horiz.)
= 107.2 kN/m run (inclined)

At elev. -1.30 Prop force = 90.8 kN/m run (horiz.)
= 104.8 kN/m run (inclined)

At elev. -6.00 Prop force = 895.8 kN/m run (horiz.)
= 953.3 kN/m run (inclined)

At elev. -10.50 Prop force = 388.0 kN/m run (horiz.)
= 412.9 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	8.03	8.03	5999
3	2.90	0.00	18.76	1.90	88.77	8.53	8.53	5999
4	2.50	0.00	26.00	4.14	116.75	10.48	10.48	5999
5	2.00	0.00	35.18	6.97	152.26	14.88	14.88	5999
6	1.40	0.00	46.19	10.38	194.86	20.22	20.22	5999
7	0.80	6.00	51.08	11.89	213.79	22.44	28.44	5999
8	0.60	8.00	52.68	12.38	219.97	23.00	31.00	5999
9	-0.35	17.50	60.04	14.66	248.46	26.62	44.12	5999
10	-1.30	27.00	67.10	16.84	275.75	30.23	57.23	5999
11	-1.70	31.00	70.00	17.73	286.97	31.76	62.76	5999
12	-1.80	32.00	70.72	17.96	289.75	32.19	64.19	5999
13	-2.20	36.00	73.58	18.84	300.80	33.74	69.74	5999
14	-2.50	39.00	75.70	19.49	309.01	35.07	74.07	5999
		39.00	75.70	19.49	348.27	35.07	74.07	5999
15	-3.25	46.50	80.94	21.11	371.18	38.22	84.72	5999
16	-4.00	54.00	86.11	22.71	393.76	41.78	95.78	5999
17	-5.20	66.00	94.26	25.23	429.37	47.07	113.07	5999
18	-5.70	71.00	97.62	26.27	444.04	49.13	120.13	5999
		71.00	97.62	17.04	528.95	69.17	140.17	39992

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.15 Excavate to elevation -16.30 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
19	-6.00	73.12	101.26	17.98	547.01	61.97	135.09	39992
20	-6.30	73.47	106.65	19.38	573.79	55.13	128.60	39992
21	-6.50	73.71	110.25	20.31	591.64	47.54	121.25	39992
22	-6.90	74.18	117.43	22.18	627.29	42.67	116.85	39992
		74.18	117.43	0.00	1984.62	353.53	427.72	399915
23	-7.75	75.18	134.37	0.00	2135.20	100.04	175.22	399915
24	-8.60	76.19	151.27	0.00	2285.48	51.59	127.77	399915
25	-9.80	77.60	175.08	0.00	2497.22	9.96	87.57	399915
26	-10.50	78.43	188.95	0.00	2620.55	0.00	78.43a	399915
27	-10.90	78.90	196.87	0.00	2690.97	0.00	78.90a	399915
28	-11.00	79.02	198.85	0.00	2708.56	0.00	79.02a	399915
29	-12.10	80.32	220.61	0.00	2902.01	0.00	80.32a	399915
30	-13.20	81.62	242.34	0.00	3095.23	0.00	81.62a	399915
31	-13.95	82.50	257.14	0.00	3226.87	0.00	82.50a	399915
32	-14.70	83.39	271.94	0.00	3358.43	0.00	83.39a	399915
33	-15.10	83.86	279.83	0.00	3428.57	0.00	83.86a	399915
34	-16.30	85.28	303.48	0.00	3638.90	0.00	85.28a	399915
35	-17.15	86.28	320.23	0.00	3787.80	0.00	86.28a	399915
36	-18.00	87.28	336.97	0.00	3936.66	29.77	117.05	399915
37	-19.15	88.64	359.61	0.00	4137.99	62.64	151.29	399915
38	-20.30	90.00	382.25	0.00	4339.27	137.26	227.26	399915
39	-20.60	93.00	385.51	0.00	4368.24	70.16	163.16	399915
40	-24.70	134.00	430.03	0.00	4764.06	79.54	213.54	399915
41	-28.80	175.00	474.54	0.00	5159.86	90.82	265.82	399915
42	-33.60	223.00	526.69	0.00	5623.52	107.50	330.50	399915
43	-38.40	271.00	578.89	6.16	6087.64	125.61	396.61	399915
44	-43.08	317.75	629.78	15.30	6540.18	144.23	461.98	399915
45	-47.75	364.50	680.73	24.45	6993.21	163.08	527.58	399915

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.15 Excavate to elevation -16.30 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
21	-6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26	-10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27	-10.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	-11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29	-12.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30	-13.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31	-13.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32	-14.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
33	-15.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
34	-16.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	940.47	343.06	343.06	399965
35	-17.15	8.50	9.35	0.00	1023.61	250.06	258.56	399965
36	-18.00	17.00	18.70	0.00	1106.78	177.49	194.49	399965
37	-19.15	28.50	31.37	0.00	1219.38	135.57	164.07	399965
38	-20.30	40.00	44.05	0.00	1332.12	61.42	101.42	399965
39	-20.60	43.00	47.36	0.00	1361.57	120.06	163.06	399965
40	-24.70	84.00	92.83	0.00	1765.88	129.51	213.51	399965
41	-28.80	125.00	138.88	0.00	2175.33	140.73	265.73	399965
42	-33.60	173.00	193.80	0.00	2663.63	157.43	330.43	399965
43	-38.40	221.00	249.99	0.00	3163.23	175.56	396.56	399965
44	-43.08	267.75	305.99	0.00	3661.19	194.17	461.92	399965
45	-47.75	314.50	363.20	0.00	4169.88	213.78	528.28	399965

Note: 86.28 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 16 Fill to elevation -15.10 on RIGHT side with soil type 6

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -20.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
16	4.00	-15.10		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -47.75 — Rough boundary

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
1	4.40	0.00	0.018	-1.17E-04	0.0	-0.0		877500
2	4.00	0.00	0.018	-1.17E-04	0.0	-0.0		877500
		8.01	0.018	-1.17E-04	0.0	-0.0		
3	2.90	8.51	0.018	-1.21E-04	9.1	6.8		877500
4	2.50	10.46	0.018	-1.25E-04	12.9	11.2	-92.8	877500
		10.46	0.018	-1.25E-04	-80.0	11.2		
5	2.00	14.86	0.018	-1.21E-04	-73.6	-27.2		877500
6	1.40	20.19	0.018	-8.85E-05	-63.1	-68.4		877500
7	0.80	28.41	0.018	-3.03E-05	-48.5	-102.1		877500
8	0.60	30.98	0.018	-6.00E-06	-42.6	-111.2		877500
9	-0.35	44.09	0.018	1.27E-04	-6.9	-135.7		877500
10	-1.30	57.20	0.018	2.66E-04	41.2	-120.4	-90.8	877500
		57.20	0.018	2.66E-04	-49.7	-120.4		
11	-1.70	62.72	0.018	3.24E-04	-25.7	-135.6		877500
12	-1.80	64.15	0.018	3.40E-04	-19.3	-137.8		877500
13	-2.20	69.71	0.018	4.03E-04	7.4	-140.2		877500
14	-2.50	74.03	0.018	4.50E-04	29.0	-134.8		877500
15	-3.25	84.68	0.017	5.47E-04	88.5	-91.3		877500
16	-4.00	95.74	0.017	5.86E-04	156.2	-0.2		877500
17	-5.20	113.03	0.016	4.08E-04	281.4	259.9		877500
18	-5.70	120.09	0.016	2.16E-04	339.7	415.0		877500
		139.95	0.016	2.16E-04	339.7	415.0		
19	-6.00	134.86	0.016	5.61E-05	381.0	523.3	-893.1	877500
		134.86	0.016	5.61E-05	-512.2	523.3		
20	-6.30	128.37	0.016	-9.75E-05	-472.7	375.7		877500
21	-6.50	121.03	0.016	-1.72E-04	-447.7	283.7		877500
22	-6.90	116.67	0.016	-2.63E-04	-400.2	114.5		877500
		425.87	0.016	-2.63E-04	-400.2	114.5		
23	-7.75	173.58	0.016	-2.74E-04	-145.4	-92.0		877500
24	-8.60	126.18	0.017	-1.49E-04	-18.0	-166.2		877500
25	-9.80	85.79	0.017	3.71E-05	109.1	-106.4		877500

(continued)

Stage No.16 Fill to elevation -15.10 on RIGHT side with soil type 6

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m	kN.m2/m
26	-10.50	78.43	0.017	8.35E-05	166.6	-10.0	-383.6	877500
		78.43	0.017	8.35E-05	-217.0	-10.0		
27	-10.90	78.90	0.017	1.06E-04	-185.6	-90.6		877500
28	-11.00	79.02	0.017	1.17E-04	-177.7	-108.8		877500
29	-12.10	80.32	0.016	3.50E-04	-90.0	-262.5		877500
30	-13.20	81.62	0.016	7.16E-04	-1.0	-320.6		877500
31	-13.95	83.51	0.015	9.81E-04	61.0	-300.4		877500
32	-14.70	85.25	0.014	1.20E-03	124.2	-231.8		877500
33	-15.10	86.88	0.014	1.30E-03	158.7	-175.5		877500
34	-16.30	79.54	0.012	1.36E-03	258.5	76.0		877500
		-262.17	0.012	1.36E-03	258.5	76.0		
35	-17.15	-173.75	0.011	1.23E-03	73.3	200.5		877500
36	-18.00	-77.61	0.010	1.04E-03	-33.6	199.4		877500
37	-19.15	-12.46	0.009	8.40E-04	-85.4	107.9		877500
38	-20.30	127.64	0.008	7.70E-04	-19.1	-0.0		0
39	-20.60	0.11	0.008	0	0.0	0.0		0
40	-24.70	0.03	0.007	0	0.3	0.0		0
41	-28.80	0.09	0.006	0	0.6	0.0		0
42	-33.60	0.06	0.005	0	0.9	0.0		0
43	-38.40	0.05	0.004	0	1.2	0.0		0
44	-43.08	0.06	0.002	0	1.5	0.0		0
45	-47.75	-0.68	0.000	0	0.0	0.0		---

At elev. 2.50 Prop force = 92.8 kN/m run (horiz.)
= 107.2 kN/m run (inclined)

At elev. -1.30 Prop force = 90.8 kN/m run (horiz.)
= 104.9 kN/m run (inclined)

At elev. -6.00 Prop force = 893.1 kN/m run (horiz.)
= 950.4 kN/m run (inclined)

At elev. -10.50 Prop force = 383.6 kN/m run (horiz.)
= 408.3 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	16.18	8.01	8.01	5999
3	2.90	0.00	18.76	1.90	88.77	8.51	8.51	5999
4	2.50	0.00	26.00	4.14	116.75	10.46	10.46	5999
5	2.00	0.00	35.18	6.97	152.26	14.86	14.86	5999
6	1.40	0.00	46.19	10.38	194.86	20.19	20.19	5999
7	0.80	6.00	51.08	11.89	213.79	22.41	28.41	5999
8	0.60	8.00	52.68	12.38	219.97	22.98	30.98	5999
9	-0.35	17.50	60.04	14.66	248.46	26.59	44.09	5999
10	-1.30	27.00	67.10	16.84	275.75	30.20	57.20	5999
11	-1.70	31.00	70.00	17.73	286.97	31.72	62.72	5999
12	-1.80	32.00	70.72	17.96	289.75	32.15	64.15	5999
13	-2.20	36.00	73.58	18.84	300.80	33.71	69.71	5999
14	-2.50	39.00	75.70	19.49	309.01	35.03	74.03	5999
		39.00	75.70	19.49	348.27	35.03	74.03	5999
15	-3.25	46.50	80.94	21.11	371.18	38.18	84.68	5999
16	-4.00	54.00	86.11	22.71	393.76	41.74	95.74	5999
17	-5.20	66.00	94.26	25.23	429.37	47.03	113.03	5999
18	-5.70	71.00	97.62	26.27	444.04	49.09	120.09	5999
		71.00	97.62	17.04	528.95	68.95	139.95	39992

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
Downtown Carpark Redevelopment | Date:30-05-2024
800mm D-Wall - Anchored | Checked :

(continued)

Stage No.16 Fill to elevation -15.10 on RIGHT side with soil type 6

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
19	-6.00	73.12	101.26	17.98	547.01	61.74	134.86	39992
20	-6.30	73.47	106.65	19.38	573.79	54.90	128.37	39992
21	-6.50	73.71	110.25	20.31	591.64	47.32	121.03	39992
22	-6.90	74.18	117.43	22.18	627.29	42.49	116.67	39992
		74.18	117.43	0.00	1984.62	351.69	425.87	399915
23	-7.75	75.18	134.37	0.00	2135.20	98.39	173.58	399915
24	-8.60	76.19	151.27	0.00	2285.48	49.99	126.18	399915
25	-9.80	77.60	175.08	0.00	2497.22	8.19	85.79	399915
26	-10.50	78.43	188.95	0.00	2620.55	0.00	78.43a	399915
27	-10.90	78.90	196.87	0.00	2690.97	0.00	78.90a	399915
28	-11.00	79.02	198.85	0.00	2708.56	0.00	79.02a	399915
29	-12.10	80.32	220.61	0.00	2902.01	0.00	80.32a	399915
30	-13.20	81.62	242.34	0.00	3095.23	0.00	81.62a	399915
31	-13.95	82.50	257.14	0.00	3226.87	1.01	83.51	399915
32	-14.70	83.39	271.94	0.00	3358.43	1.86	85.25	399915
33	-15.10	83.86	279.83	0.00	3428.57	3.02	86.88	399915
34	-16.30	85.28	303.48	0.00	3638.90	4.12	89.40	399915
35	-17.15	86.28	320.23	0.00	3787.80	4.84	91.12	399915
36	-18.00	87.28	336.97	0.00	3936.66	34.70	121.99	399915
37	-19.15	88.64	359.61	0.00	4137.99	67.49	156.13	399915
38	-20.30	90.00	382.25	0.00	4339.27	142.66	232.66	399915
39	-20.60	93.00	385.51	0.00	4368.24	74.44	167.44	399915
40	-24.70	134.00	430.03	0.00	4764.06	83.63	217.63	399915
41	-28.80	175.00	474.54	0.00	5159.86	94.78	269.78	399915
42	-33.60	223.00	526.69	0.00	5623.52	111.42	334.42	399915
43	-38.40	271.00	578.89	6.16	6087.64	129.53	400.53	399915
44	-43.08	317.75	629.78	15.30	6540.18	148.16	465.91	399915
45	-47.75	364.50	680.73	24.45	6993.21	167.02	531.52	399915

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.16 Fill to elevation -15.10 on RIGHT side with soil type 6

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
21	-6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
22	-6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
23	-7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24	-8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25	-9.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26	-10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27	-10.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	-11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29	-12.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30	-13.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31	-13.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32	-14.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
33	-15.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	39996
34	-16.30	0.00	22.80	4.50	173.01	9.86	9.86	39996
		0.00	22.80	0.00	1143.21	351.57	351.57	399961
35	-17.15	8.50	32.16	0.00	1226.39	256.37	264.87	399961
36	-18.00	17.00	41.52	0.00	1309.62	182.60	199.60	399961
37	-19.15	28.50	54.20	0.00	1422.36	140.10	168.60	399961
38	-20.30	40.00	66.90	0.00	1535.29	65.02	105.02	399961
39	-20.60	43.00	70.21	0.00	1564.79	124.33	167.33	399961
40	-24.70	84.00	115.80	0.00	1970.07	133.60	217.60	399961
41	-28.80	125.00	161.98	0.00	2380.71	144.69	269.69	399961
42	-33.60	173.00	217.04	0.00	2870.29	161.35	334.35	399961
43	-38.40	221.00	273.31	0.00	3370.64	179.48	400.48	399961
44	-43.08	267.75	329.31	0.00	3868.54	198.10	465.85	399961
45	-47.75	314.50	386.41	0.00	4376.21	217.71	532.21	399961

Note: 81.62 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Summary of results

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = -20.30** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr-ation	Direction of failure
1	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
2	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
3	4.00	2.00	Cant.	9.133	-17.45	1.25	0.75	L to R
4	4.00	2.00	2.50	Conditions not suitable for FoS calc.				
5	4.00	2.00		No analysis at this stage				
6	4.00	-1.80	2.50	9.076	n/a	-5.11	3.31	L to R
7	4.00	-1.80		More than one prop. No FoS calc.				

All remaining stages have more than one prop - FoS calculation n/a

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries:	Left side 60.00 from wall	Rough boundary
	Right side 60.00 from wall	Rough boundary
Lower rigid boundary at elevation -47.75		Rough boundary

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	4.40	0.024	-0.000	0.0	-0.0	0.0	-57.1
2	4.00	0.024	-0.000	0.0	-25.0	0.0	-57.1
3	2.90	0.023	-0.000	7.9	-86.2	14.6	-46.9
4	2.50	0.023	-0.000	13.1	-81.8	18.4	-103.9
5	2.00	0.023	-0.000	4.7	-89.3	24.6	-100.6
6	1.40	0.023	-0.000	8.1	-105.8	34.9	-93.7
7	0.80	0.022	-0.000	11.3	-158.9	49.3	-122.2
8	0.60	0.022	-0.000	12.4	-174.9	5.9	-116.3
9	-0.35	0.022	-0.000	19.4	-235.3	9.5	-47.3
10	-1.30	0.021	-0.000	30.5	-260.9	44.4	-112.0
11	-1.70	0.021	-0.000	37.0	-285.0	115.7	-90.3
12	-1.80	0.021	-0.000	38.9	-293.7	122.0	-84.6
13	-2.20	0.021	-0.000	47.0	-322.7	148.8	-60.2
14	-2.50	0.021	-0.000	54.0	-337.9	52.8	-40.6
15	-3.25	0.021	-0.000	75.5	-348.3	88.8	0.0
16	-4.00	0.020	-0.000	103.0	-315.0	163.1	0.0
17	-5.20	0.020	-0.000	317.0	-155.9	289.7	-398.8
18	-5.70	0.020	-0.000	416.9	-46.4	340.1	-339.4
19	-6.00	0.021	-0.000	525.3	-4.5	381.4	-514.4
20	-6.30	0.021	-0.000	377.0	-66.9	290.3	-474.8
21	-6.50	0.021	0.000	321.4	-104.9	305.9	-449.8
22	-6.90	0.021	0.000	398.3	-167.1	325.9	-402.2
23	-7.75	0.021	0.000	439.8	-181.4	59.1	-145.9
24	-8.60	0.021	0.000	400.7	-202.4	198.7	-98.5
25	-9.80	0.021	0.000	286.9	-212.9	341.7	-384.2
26	-10.50	0.021	0.000	215.2	-140.8	176.8	-304.8
27	-10.90	0.021	0.000	178.5	-191.0	194.1	-261.6
28	-11.00	0.021	0.000	170.0	-207.8	206.4	-250.6
29	-12.10	0.020	0.000	96.7	-307.6	84.6	-131.5
30	-13.20	0.019	0.000	133.2	-320.6	201.6	-28.4
31	-13.95	0.017	0.000	127.7	-300.4	333.6	-17.8
32	-14.70	0.016	0.000	278.1	-231.9	528.8	-397.8
33	-15.10	0.015	0.000	154.6	-176.7	158.7	-273.0
34	-16.30	0.014	0.000	121.5	-0.0	258.5	-22.1
35	-17.15	0.013	0.000	215.4	-0.0	74.1	-19.8
36	-18.00	0.012	0.000	200.7	-0.0	0.0	-44.2
37	-19.15	0.011	0.000	107.9	-0.0	0.0	-85.9
38	-20.30	0.011	0.000	0.0	-0.0	0.0	-19.1
39	-20.60	0.011	0.000	0.0	0.0	0.0	0.0
40	-24.70	0.009	0.000	0.0	0.0	0.4	0.0
41	-28.80	0.008	0.000	0.0	0.0	0.6	0.0
42	-33.60	0.006	0.000	0.0	0.0	1.0	0.0
43	-38.40	0.005	0.000	0.0	0.0	1.2	0.0

Bending moment, shear force and displacement envelopes

Node	Y	Displacement		Bending moment		Shear force	
no.	coord	maximum	minimum	maximum	minimum	maximum	minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
44	-43.08	0.003	0.000	0.0	0.0	1.5	0.0
45	-47.75	0.000	0.000	0.0	0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	1.1	-5.70	-1.3	-8.60	0.3	-9.80	-2.3	-6.90
2	30.3	-6.90	-6.5	-1.30	11.6	-5.70	-9.1	-8.60
3	256.1	-6.90	-0.0	4.00	62.4	-5.70	-77.2	-8.60
4	138.2	-7.75	-63.3	-1.30	56.8	-5.70	-39.7	2.50
5	No calculation at this stage							
6	439.8	-7.75	-260.9	-1.30	197.6	-5.70	-110.3	-9.80
7	347.5	-7.75	-197.6	-2.20	174.3	-6.90	-88.1	-9.80
8	No calculation at this stage							
9	425.5	-7.75	-348.3	-3.25	325.9	-6.90	-112.0	-1.30
10	350.5	-7.75	-292.6	-2.50	297.4	-6.00	-97.6	2.50
11	No calculation at this stage							
12	398.4	-6.00	-212.9	-9.80	351.3	-6.00	-411.4	-6.00
13	388.0	-6.00	-191.5	-8.60	348.9	-6.00	-400.0	-6.00
14	No calculation at this stage							
15	525.3	-6.00	-318.9	-13.20	381.4	-6.00	-514.4	-6.00
16	523.3	-6.00	-320.6	-13.20	381.0	-6.00	-512.2	-6.00
17	No calculation at this stage							
18	No calculation at this stage							
19	No calculation at this stage							
20	199.2	-17.15	-290.2	-13.20	259.5	-5.20	-304.8	-10.50
21	233.5	-5.20	-269.8	-12.10	269.5	-5.20	-324.6	-5.20
22	No calculation at this stage							
23	275.6	-5.20	-271.2	-12.10	267.0	-5.20	-336.3	-5.20
24	No calculation at this stage							
25	No calculation at this stage							
26	281.0	-5.20	-271.6	-12.10	262.6	-5.20	-338.5	-5.20
27	271.2	-5.20	-233.9	-12.10	252.7	-5.20	-328.2	-5.20
28	309.6	-5.20	-307.6	-12.10	493.6	-14.70	-372.2	-5.20
29	303.5	-5.20	-302.1	-12.10	467.7	-14.70	-359.6	-5.20
30	278.4	-5.20	-258.7	-12.10	454.7	-14.70	-343.4	-14.70
31	281.2	-5.20	-278.9	-12.10	497.7	-14.70	-366.4	-14.70
32	286.4	-5.20	-297.3	-12.10	519.5	-14.70	-387.8	-14.70
33	295.7	-5.20	-295.3	-12.10	524.4	-14.70	-393.2	-14.70
34	302.7	-5.20	-294.2	-12.10	528.4	-14.70	-397.6	-5.20
35	307.0	-5.20	-294.2	-12.10	528.8	-14.70	-397.8	-14.70
36	314.9	-5.20	-294.2	-12.10	528.7	-14.70	-397.6	-14.70
37	317.0	-5.20	-294.3	-12.10	528.7	-14.70	-398.7	-5.20
38	316.7	-5.20	-294.3	-12.10	528.7	-14.70	-398.8	-5.20

Summary of results (continued)

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	-20.30	-0.000	4.40	Change EI of wall to 877500kN.m2/m run
2	0.002	4.40	0.000	4.40	Apply surcharge no.1 at elev. 4.00
3	0.019	4.40	0.000	4.40	Excav. to elev. 2.00 on RIGHT side
4	0.007	4.40	0.000	4.40	Install prop no.1 at elev. 2.50
5	No calculation at this stage				Apply water pressure profile no.1
6	0.024	4.40	0.000	4.40	Excav. to elev. -1.80 on RIGHT side
7	0.019	4.40	0.000	4.40	Install prop no.2 at elev. -1.30
8	No calculation at this stage				Apply water pressure profile no.2
9	0.023	4.40	0.000	4.40	Excav. to elev. -6.50 on RIGHT side
10	0.022	4.40	0.000	4.40	Install prop no.3 at elev. -6.00
11	No calculation at this stage				Apply water pressure profile no.3
12	0.019	1.40	0.000	4.40	Excav. to elev. -11.00 on RIGHT side
13	0.019	1.40	0.000	4.40	Install prop no.10 at elev. -10.50
14	No calculation at this stage				Apply water pressure profile no.4
15	0.018	0.60	0.000	4.40	Excav. to elev. -16.30 on RIGHT side
16	0.018	0.60	0.000	4.40	Fill to elev. -15.10 on RIGHT side
17	No calculation at this stage				Install prop no.4 at elev. -14.70
18	No calculation at this stage				Install prop no.5 at elev. -9.80
19	No calculation at this stage				Install prop no.6 at elev. -5.20
20	0.020	-1.70	0.000	4.40	Remove prop no.3 at elev. -6.00
21	0.020	-2.20	0.000	4.40	Remove prop no.10 at elev. -10.50
22	No calculation at this stage				Install prop no.7 at elev. -2.20
23	0.021	-0.35	0.000	4.40	Remove prop no.2 at elev. -1.30
24	No calculation at this stage				Install prop no.8 at elev. 0.80
25	No calculation at this stage				Install prop no.9 at elev. 4.40
26	0.021	-0.35	0.000	4.40	Remove prop no.1 at elev. 2.50
27	0.021	-0.35	0.000	4.40	Change EI of wall to 585000kN.m2/m run
28	0.021	-0.35	0.000	4.40	Apply water pressure profile no.5
29	0.021	-0.35	0.000	4.40	Apply water pressure profile no.6
30	0.021	-0.35	0.000	4.40	Change EI of wall to 292500kN.m2/m run
31	0.021	-0.35	0.000	4.40	Apply load no.1 at elev. -13.20
32	0.021	-0.35	0.000	4.40	Apply load no.2 at elev. -10.90
33	0.021	-0.35	0.000	4.40	Apply load no.3 at elev. -8.60
34	0.021	-7.75	0.000	4.40	Apply load no.4 at elev. -6.30
35	0.021	-7.75	0.000	4.40	Apply load no.5 at elev. -4.00
36	0.021	-7.75	0.000	4.40	Apply load no.6 at elev. -1.70
37	0.022	-0.35	0.000	4.40	Apply load no.7 at elev. 0.60
38	0.022	-0.35	0.000	4.40	Apply load no.8 at elev. 2.90

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
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800mm D-Wall - Anchored | Checked :

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	Anchor no. 1 at elev. 2.50 kN/m run	kN/prop	Anchor no. 2 at elev.-1.30 kN/m run	kN/prop	Anchor no. 3 at elev.-6.00 kN/m run	kN/prop
4	51.96	129.90	---	---	---	---
6	107.09	267.72	---	---	---	---
7	92.55	231.38	69.28	173.21	---	---
9	109.13	272.84	111.66	279.15	---	---
10	104.25	260.62	98.72	246.81	187.94	375.88
12	96.38	240.94	95.08	237.70	762.69	1525.37
13	96.72	241.80	95.44	238.60	748.86	1497.72
15	92.80	231.99	90.77	226.93	895.77	1791.53
16	92.84	232.11	90.82	227.05	893.12	1786.24
20	95.84	239.59	104.96	262.41	---	---
21	93.83	234.57	102.85	257.13	---	---
23	99.15	247.86	---	---	---	---

Stage no.	Strut no. 4 at elev.-14.70		Strut no. 5 at elev.-9.80		Strut no. 6 at elev.-5.20	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
20	44.36	44.36	158.39	158.39	542.29	542.29
21	228.45	228.45	397.61	397.61	594.15	594.15
23	227.06	227.06	393.00	393.00	603.30	603.30
26	226.93	226.93	392.18	392.18	601.11	601.11
27	258.12	258.12	406.96	406.96	580.91	580.91
28	800.20	800.20	575.21	575.21	642.44	642.44
29	748.16	748.16	552.35	552.35	619.78	619.78
30	798.10	798.10	602.33	602.33	584.95	584.95
31	864.07	864.07	626.72	626.72	588.26	588.26
32	907.34	907.34	672.03	672.03	594.07	594.07
33	917.61	917.61	701.81	701.81	607.46	607.46
34	925.85	925.85	724.02	724.02	647.25	647.25
35	926.59	926.59	725.50	725.50	680.14	680.14
36	926.36	926.36	724.67	724.67	687.32	687.32
37	926.28	926.28	724.36	724.36	685.93	685.93
38	926.32	926.32	724.42	724.42	684.34	684.34

Run ID. 2_West_800DWall_anchored_gw | Sheet No.
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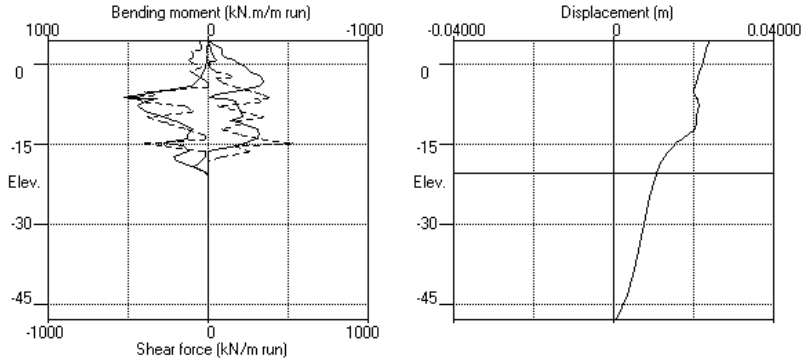
Stage no.	Strut no. 7 at elev.-2.20		Strut no. 8 at elev. 0.80		Strut no. 9 at elev. 4.40	
	kN/m run	kN/prop	kN/m run	kN/prop	kN/m run	kN/prop
23	95.70	95.70	---	---	---	---
26	105.32	105.32	47.62	47.62	45.53	45.53
27	110.68	110.68	61.87	61.87	36.27	36.27
28	128.99	128.99	73.01	73.01	37.61	37.61
29	109.69	109.69	58.58	58.58	36.45	36.45
30	118.51	118.51	79.73	79.73	24.44	24.44
31	118.13	118.13	79.63	79.63	24.50	24.50
32	117.30	117.30	79.41	79.41	24.60	24.60
33	116.04	116.04	78.72	78.72	24.74	24.74
34	118.77	118.77	76.72	76.72	24.79	24.79
35	145.24	145.24	77.00	77.00	23.64	23.64
36	185.08	185.08	95.30	95.30	21.15	21.15
37	199.40	199.40	140.59	140.59	24.87	24.87
38	199.14	199.14	171.47	171.47	57.07	57.07

Stage no.	-- Anchor no.10 --- at elev.-10.50 kN/m run	kN/prop
13	75.18	187.94
15	387.99	969.97
16	383.64	959.11
20	427.55	1068.88

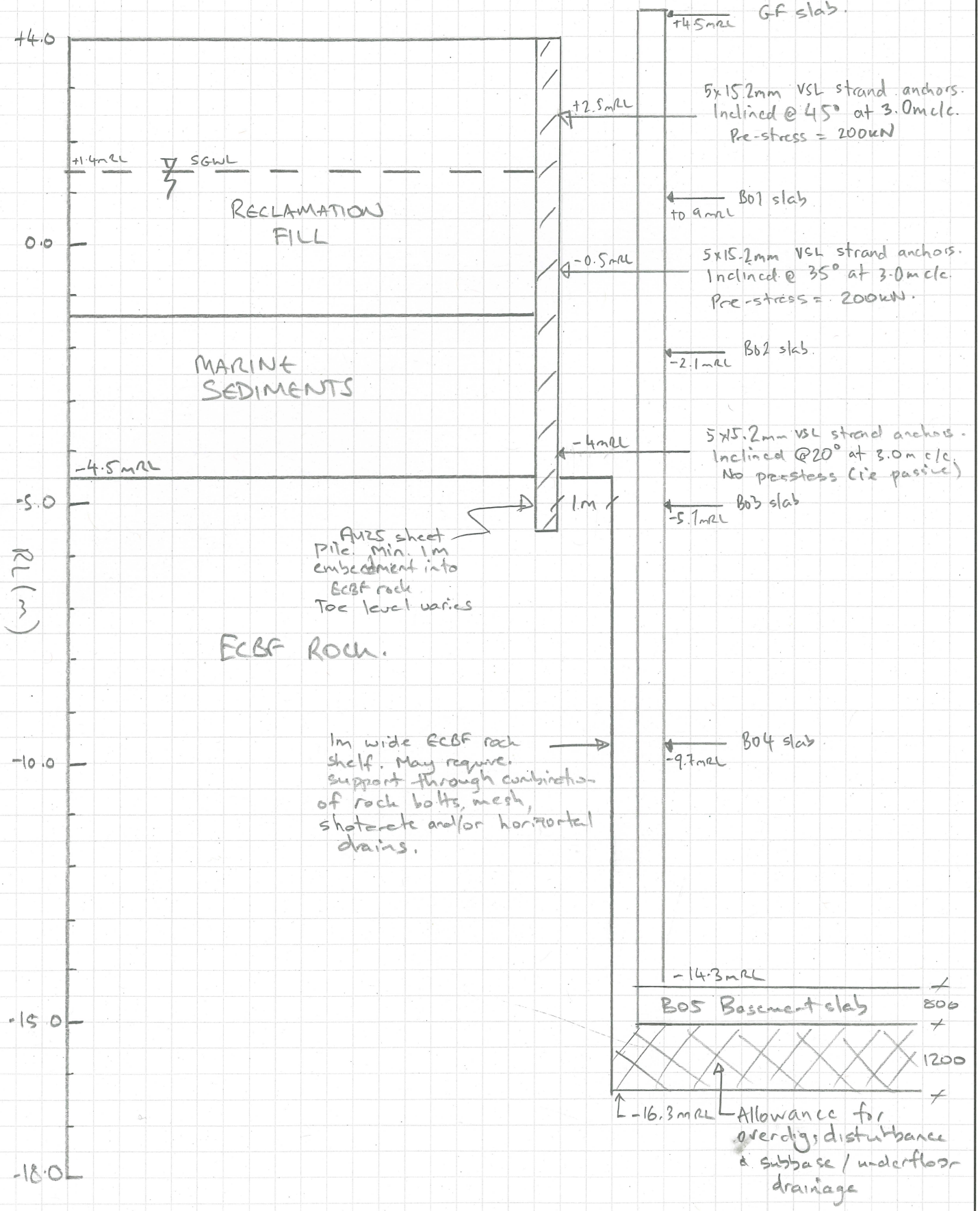
Units: kN,m

Bending moment, shear force, displacement envelopes



Tonkin+Taylor	Project: Downtown Carpark	Computed: CXSW 27/5/2024	Office: AKL
		Checked: 20	Job No: 1016043.1
Description:		Revised: 20	File:
		Checked: 20	Sheet No.

SECTION 3 – AU25 SHEETPILE ANCHORED



SCALE 1:100

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	4.00	1 Fill	1 Fill
2	-1.40	2 Marine Sediment	2 Marine Sediment
3	-4.50	4 ECBF	4 ECBF

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Fill	16.50	6000	0.530	OC (0.300)	0.318 (1.282)	3.543 (4.783)	3.000d
2	Marine Sediment	16.50	6000	0.530	OC (0.300)	0.318 (1.282)	3.960 (5.127)	3.000d
3	Tauranga Group	17.50	20000	0.500	OC (0.300)	0.292 (1.226)	3.960 (5.127)	5.000d
4	ECBF	21.00	400000	0.357	OC (0.250)	0.186 (0.970)	7.532 (7.784)	100.0d
5	Weathered ECBF	19.00	40000	0.470	OC (0.300)	0.268 (1.171)	4.448 (5.518)	7.000d

Additional soil parameters associated with Ka and Kp

No.	Soil type Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Fill	28.00	0.500	0.00	28.00	0.333	0.00
2	Marine Sediment	28.00	0.500	0.00	30.00	0.333	0.00
3	Tauranga Group	30.00	0.500	0.00	30.00	0.333	0.00
4	ECBF	40.00	0.500	0.00	40.00	0.333	0.00
5	Weathered ECBF	32.00	0.500	0.00	32.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.40	1.40

Automatic water pressure balancing at toe of wall : Yes

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	1.40	1.40	0.0	1	-1.00	-1.00	0.0
2	1	1.40	1.40	0.0	1	-4.50	-4.50	0.0
3	1	1.40	1.40	0.0	1	-5.50	-5.50	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = -5.50
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 2.1000E+08 kN/m2
Moment of inertia of wall I = 5.6240E-04 m4/m run
(Arcelor AU25) E.I = 118104 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing m	Cross-section area sq.m	Youngs modulus kN/m2	Free length m	Inclin-ation (degs)	Pre-stress /prop kN	Strut or Anchor	Allow tension ?	L/R
1	2.50	3.00	0.000717	2.100E+08	9.90	45.00	200.0	Anchor	n/a	R
2	-0.50	3.00	0.000717	2.100E+08	6.40	35.00	200.0	Anchor	n/a	R
3	-4.00	3.00	0.000717	2.100E+08	1.50	20.00	0	Anchor	n/a	R

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	4.00	2.00(L)	100.00	20.00	12.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 4.00
2	Excavate to elevation 2.00 on RIGHT side
3	Install strut or anchor no.1 at elevation 2.50
4	Apply water pressure profile no.1 No analysis at this stage
5	Excavate to elevation -1.00 on RIGHT side
6	Install strut or anchor no.2 at elevation -0.50
7	Apply water pressure profile no.2 No analysis at this stage
8	Excavate to elevation -4.50 on RIGHT side
9	Install strut or anchor no.3 at elevation -4.00
10	Apply water pressure profile no.3
11	Excavate to elevation -4.50 on RIGHT side Toe of berm at elevation -5.50 Width of top of berm = 1.00 Width of toe of berm = 1.01

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - 2-D finite element model
Open Tension Crack analysis? - No
Active limit arching modelled? - Yes
Non-linear Modulus Parameter (L) = 9.500 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation on Left side of wall = 60.00 m
Width of excavation on Right side of wall = 60.00 m

Distance to rigid boundary on Left side = 60.00 m
Distance to rigid boundary on Right side = 60.00 m
Elevation of rigid lower boundary = -15.00

Lower rigid boundary at elevation -15.00 - Rough
Rigid boundary on Left side - Rough
Rigid boundary on Right side - Rough
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 4.00	No	No	No
2	Excav. to elev. 2.00 on RIGHT side	No	No	No
3	Install prop no.1 at elev. 2.50	No	No	No
4	Apply water pressure profile no.1	No	No	No
5	Excav. to elev. -1.00 on RIGHT side	Yes	No	No
6	Install prop no.2 at elev. -0.50	No	No	No
7	Apply water pressure profile no.2	No	No	No
8	Excav. to elev. -4.50 on RIGHT side	Yes	Yes	Yes
9	Install prop no.3 at elev. -4.00	No	No	No
10	Apply water pressure profile no.3	No	No	No
11	Excav. to elev. -4.50 on RIGHT side	Yes	No	No
*	Summary output	Yes	-	Yes

Units: kN,m

Stage No. 1 Apply surcharge no.1 at elevation 4.00

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -5.50: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr -ation	Direction of failure
1	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall — Rough boundary
Right side 60.00 from wall — Rough boundary
Lower rigid boundary at elevation -15.00 — Rough boundary

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Prop forces kN/m
1	4.00	-0.42	0.001	9.51E-06	0.0	0.0	
2	3.50	-0.94	0.001	9.62E-06	-0.3	-0.1	
3	3.00	-0.90	0.001	1.04E-05	-0.8	-0.3	
4	2.50	-0.68	0.001	1.28E-05	-1.2	-0.8	
5	2.00	-0.36	0.001	1.78E-05	-1.5	-1.5	
6	1.70	-0.17	0.001	2.21E-05	-1.5	-1.9	
7	1.40	0.01	0.001	2.77E-05	-1.6	-2.4	
8	0.95	0.29	0.001	3.81E-05	-1.5	-3.1	
9	0.50	0.55	0.001	5.11E-05	-1.3	-3.7	
10	0.00	0.81	0.001	6.81E-05	-1.0	-4.3	
11	-0.50	1.07	0.001	8.71E-05	-0.5	-4.7	
12	-1.00	1.32	0.001	1.07E-04	0.1	-4.8	
13	-1.40	1.53	0.001	1.22E-04	0.7	-4.6	
14	-1.70	1.70	0.001	1.34E-04	1.2	-4.3	
15	-2.00	1.89	0.001	1.44E-04	1.7	-3.9	
16	-2.50	2.16	0.000	1.59E-04	2.7	-2.8	
17	-3.00	2.45	0.000	1.67E-04	3.9	-1.2	
18	-3.50	2.74	0.000	1.67E-04	5.2	1.1	
19	-4.00	2.98	0.000	1.57E-04	6.6	4.0	
20	-4.50	2.76	0.000	1.32E-04	8.0	7.7	
		-49.37	0.000	1.32E-04	8.0	7.7	
21	-5.00	-13.39	0.000	1.04E-04	-7.7	5.5	
22	-5.50	35.22	0.000	9.29E-05	-2.2	-0.0	
23	-5.63	-0.02	0.000	0	-0.0	0.0	
24	-6.81	0.00	0.000	0	-0.0	0.0	
25	-8.00	0.00	0.000	0	-0.0	0.0	
26	-10.00	0.01	0.000	0	-0.0	0.0	
27	-12.00	0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	
29	-15.00	-0.01	0.000	0	0.0	0.0	

(continued)

Stage No.1 Apply surcharge no.1 at elevation 4.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	0.00	0.00a	6000
2	3.50	0.00	8.32	0.00	43.84	3.92	3.92	6000
3	3.00	0.00	16.99	1.56	74.53	8.40	8.40	6000
4	2.50	0.00	26.00	4.43	106.46	13.05	13.05	6000
5	2.00	0.00	35.18	7.35	138.98	17.78	17.78	6000
6	1.70	0.00	40.69	9.11	158.53	20.61	20.61	6000
7	1.40	0.00	46.19	10.86	178.00	23.45	23.45	6000
8	0.95	4.50	49.87	12.03	191.05	25.30	29.80	6000
9	0.50	9.00	53.47	13.17	203.80	27.12	36.12	6000
10	0.00	14.00	57.37	14.41	217.62	29.12	43.12	6000
11	-0.50	19.00	61.18	15.63	231.10	31.09	50.09	6000
12	-1.00	24.00	64.90	16.81	244.29	33.04	57.04	6000
13	-1.40	28.00	67.83	17.74	254.67	34.59	62.59	6000
		28.00	67.83	17.74	284.01	34.59	62.59	6000
14	-1.70	31.00	70.00	18.43	292.61	35.75	66.75	6000
15	-2.00	34.00	72.15	19.12	301.13	36.93	70.93	6000
16	-2.50	39.00	75.70	20.25	315.17	38.85	77.85	6000
17	-3.00	44.00	79.20	21.36	329.06	40.77	84.77	6000
18	-3.50	49.00	82.67	22.47	342.80	42.68	91.68	6000
19	-4.00	54.00	86.11	23.56	356.41	44.57	98.57	6000
20	-4.50	59.00	89.52	24.65	369.92	46.22	105.22	6000
		59.00	89.52	0.00	1452.74	5.70	64.70	399998
21	-5.00	64.00	95.16	0.00	1495.20	25.68	89.68	399998
22	-5.50	69.00	100.78	0.00	1537.50	51.97	120.97	399998
23	-5.63	70.25	102.18	0.00	1548.06	34.84	105.09	399998
24	-6.81	82.13	115.44	0.00	1647.93	39.55	121.67	399998
25	-8.00	94.00	128.62	0.00	1747.21	44.23	138.23	399998
26	-10.00	114.00	150.69	0.00	1913.42	52.10	166.10	399998
27	-12.00	134.00	172.63	0.00	2078.71	59.94	193.94	399998
28	-13.50	149.00	189.03	0.00	2202.25	65.81	214.81	399998
29	-15.00	164.00	205.40	0.00	2325.51	71.67	235.67	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	0.42	0.42	6000
2	3.50	0.00	8.25	0.00	43.58	4.86	4.86	6000
3	3.00	0.00	16.50	1.41	72.81	9.30	9.30	6000
4	2.50	0.00	24.75	4.03	102.04	13.72	13.72	6000
5	2.00	0.00	33.00	6.66	131.27	18.13	18.13	6000
6	1.70	0.00	37.95	8.23	148.81	20.79	20.79	6000
7	1.40	0.00	42.90	9.81	166.35	23.44	23.44	6000
8	0.95	4.50	45.83	10.74	176.71	25.01	29.51	6000
9	0.50	9.00	48.75	11.67	187.07	26.58	35.58	6000
10	0.00	14.00	52.00	12.70	198.59	28.30	42.30	6000
11	-0.50	19.00	55.25	13.74	210.10	30.02	49.02	6000
12	-1.00	24.00	58.50	14.77	221.62	31.72	55.72	6000
13	-1.40	28.00	61.10	15.60	230.83	33.06	61.06	6000
		28.00	61.10	15.60	257.36	33.06	61.06	6000
14	-1.70	31.00	63.05	16.22	265.08	34.06	65.06	6000
15	-2.00	34.00	65.00	16.84	272.80	35.04	69.04	6000
16	-2.50	39.00	68.25	17.88	285.67	36.69	75.69	6000

Run ID. 3_AU25_Sheetpiles_Anchored | Sheet No.
Downtown Carpark Redevelopment | Date:15-10-2024
AU25_Sheetpiles_Anchored | Checked :

(continued)

Stage No.1 Apply surcharge no.1 at elevation 4.00

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
17	-3.00	44.00	71.50	18.91	298.54	38.32	82.32	6000
18	-3.50	49.00	74.75	19.95	311.42	39.95	88.95	6000
19	-4.00	54.00	78.00	20.98	324.29	41.59	95.59	6000
20	-4.50	59.00	81.25	22.01	337.16	43.45	102.45	6000
		59.00	81.25	0.00	1390.42	55.07	114.07	399998
21	-5.00	64.00	86.75	0.00	1431.85	39.07	103.07	399998
22	-5.50	69.00	92.25	0.00	1473.27	16.74	85.74	399998
23	-5.63	70.25	93.63	0.00	1483.63	34.86	105.11	399998
24	-6.81	82.13	106.69	0.00	1582.02	39.54	121.67	399998
25	-8.00	94.00	119.75	0.00	1680.40	44.23	138.23	399998
26	-10.00	114.00	141.75	0.00	1846.11	52.09	166.09	399998
27	-12.00	134.00	163.75	0.00	2011.81	59.94	193.94	399998
28	-13.50	149.00	180.25	0.00	2136.09	65.81	214.81	399998
29	-15.00	164.00	196.75	0.00	2260.36	71.69	235.69	399998

Note: 0.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 2 Excavate to elevation 2.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -5.50 Factor of Safety	FoS for toe elev. = -5.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Toe elev. for FoS = 1.000 Wall Penetr -ation	Direction of failure
2	4.00	2.00	Cant.	2.503	-5.00	1.22	0.78	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	0.00	0.017	1.91E-03	0.0	0.0	
2	3.50	0.00	0.016	1.91E-03	0.0	0.2	
3	3.00	1.56	0.015	1.91E-03	0.4	0.4	
4	2.50	4.43	0.014	1.91E-03	1.9	1.0	
5	2.00	7.87	0.013	1.90E-03	5.0	2.7	
		-6.48	0.013	1.90E-03	5.0	2.7	
6	1.70	-7.16	0.012	1.89E-03	2.9	3.9	
7	1.40	-5.34	0.012	1.88E-03	1.0	4.4	
8	0.95	-3.32	0.011	1.86E-03	-0.9	4.4	
9	0.50	-1.24	0.010	1.85E-03	-1.9	3.6	
10	0.00	0.77	0.009	1.84E-03	-2.0	2.5	
11	-0.50	2.69	0.008	1.83E-03	-1.2	1.6	
12	-1.00	4.41	0.007	1.82E-03	0.6	1.3	
13	-1.40	5.83	0.007	1.82E-03	2.6	1.9	
14	-1.70	7.00	0.006	1.81E-03	4.6	3.0	
15	-2.00	8.28	0.005	1.80E-03	6.9	4.7	
16	-2.50	9.79	0.005	1.77E-03	11.4	9.2	
17	-3.00	11.49	0.004	1.72E-03	16.7	16.1	
18	-3.50	13.10	0.003	1.63E-03	22.8	25.9	
19	-4.00	14.52	0.002	1.49E-03	29.7	38.9	
20	-4.50	10.04	0.001	1.29E-03	35.9	55.6	
		-273.42	0.001	1.29E-03	35.9	55.6	
21	-5.00	-92.59	0.001	1.09E-03	-55.6	39.4	
22	-5.50	252.04	0.000	1.01E-03	-15.8	-0.0	
23	-5.63	-0.02	0.000	0	-0.0	0.0	
24	-6.81	0.00	0.000	0	-0.0	0.0	
25	-8.00	0.00	0.000	0	-0.0	0.0	
26	-10.00	0.01	0.000	0	0.0	0.0	
27	-12.00	0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	
29	-15.00	-0.02	0.000	0	0.0	0.0	

(continued)

Stage No.2 Excavate to elevation 2.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Effective stresses Active limit	Effective stresses Passive limit	Effective stresses Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	0.00	0.00a	6000
2	3.50	0.00	8.32	0.00	43.84	0.00	0.00a	6000
3	3.00	0.00	16.99	1.56	74.53	1.56	1.56a	6000
4	2.50	0.00	26.00	4.43	106.46	4.43	4.43a	6000
5	2.00	0.00	35.18	7.35	138.98	7.87	7.87	6000
6	1.70	0.00	40.69	9.11	158.53	11.41	11.41	6000
7	1.40	0.00	46.19	10.86	178.00	14.88	14.88	6000
8	0.95	4.50	49.87	12.03	191.05	17.42	21.92	6000
9	0.50	9.00	53.47	13.17	203.80	20.00	29.00	6000
10	0.00	14.00	57.37	14.41	217.62	22.72	36.72	6000
11	-0.50	19.00	61.18	15.63	231.10	25.41	44.41	6000
12	-1.00	24.00	64.90	16.81	244.29	28.01	52.01	6000
13	-1.40	28.00	67.83	17.74	254.67	30.10	58.10	6000
		28.00	67.83	17.74	284.01	30.10	58.10	6000
14	-1.70	31.00	70.00	18.43	292.61	31.72	62.72	6000
15	-2.00	34.00	72.15	19.12	301.13	33.40	67.40	6000
16	-2.50	39.00	75.70	20.25	315.17	35.90	74.90	6000
17	-3.00	44.00	79.20	21.36	329.06	38.50	82.50	6000
18	-3.50	49.00	82.67	22.47	342.80	41.04	90.04	6000
19	-4.00	54.00	86.11	23.56	356.41	43.50	97.50	6000
20	-4.50	59.00	89.52	24.65	369.92	42.80	101.80	6000
		59.00	89.52	0.00	1452.74	0.00	59.00a	399998
21	-5.00	64.00	95.16	0.00	1495.20	0.00	64.00a	399998
22	-5.50	69.00	100.78	0.00	1537.50	252.04	321.04	399998
23	-5.63	70.25	102.18	0.00	1548.06	29.69	99.94	399998
24	-6.81	82.13	115.44	0.00	1647.93	34.33	116.45	399998
25	-8.00	94.00	128.62	0.00	1747.21	38.93	132.93	399998
26	-10.00	114.00	150.69	0.00	1913.42	46.75	160.75	399998
27	-12.00	134.00	172.63	0.00	2078.71	54.57	188.57	399998
28	-13.50	149.00	189.03	0.00	2202.25	60.46	209.46	399998
29	-15.00	164.00	205.40	0.00	2325.51	66.33	230.33	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Effective stresses Active limit	Effective stresses Passive limit	Effective stresses Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	14.35	14.35	14.35p	6000
6	1.70	0.00	4.95	0.00	31.89	18.57	18.57	6000
7	1.40	0.00	9.90	0.00	49.42	20.22	20.22	6000
8	0.95	4.50	12.83	0.24	59.79	20.75	25.25	6000
9	0.50	9.00	15.75	1.17	70.15	21.23	30.23	6000
10	0.00	14.00	19.00	2.20	81.67	21.95	35.95	6000
11	-0.50	19.00	22.25	3.24	93.18	22.72	41.72	6000
12	-1.00	24.00	25.50	4.27	104.70	23.59	47.59	6000
13	-1.40	28.00	28.10	5.10	113.92	24.27	52.27	6000
		28.00	28.10	5.10	126.68	24.27	52.27	6000
14	-1.70	31.00	30.05	5.72	134.40	24.73	55.73	6000
15	-2.00	34.00	32.00	6.34	142.13	25.12	59.12	6000

(continued)

Stage No.2 Excavate to elevation 2.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
16	-2.50	39.00	35.26	7.38	155.01	26.11	65.11	6000
17	-3.00	44.00	38.51	8.41	167.89	27.00	71.00	6000
18	-3.50	49.00	41.76	9.45	180.77	27.94	76.94	6000
19	-4.00	54.00	45.01	10.48	193.65	28.98	82.98	6000
20	-4.50	59.00	48.27	11.52	206.54	32.76	91.76	6000
		59.00	48.27	0.00	1142.00	273.42	332.42	399997
21	-5.00	64.00	53.77	0.00	1183.46	92.59	156.59	399997
22	-5.50	69.00	59.28	0.00	1224.92	0.00	69.00a	399997
23	-5.63	70.25	60.65	0.00	1235.29	29.71	99.96	399997
24	-6.81	82.13	73.73	0.00	1333.79	34.33	116.45	399997
25	-8.00	94.00	86.81	0.00	1432.32	38.93	132.93	399997
26	-10.00	114.00	108.86	0.00	1598.36	46.74	160.74	399997
27	-12.00	134.00	130.92	0.00	1764.51	54.57	188.57	399997
28	-13.50	149.00	147.47	0.00	1889.21	60.45	209.45	399997
29	-15.00	164.00	164.04	0.00	2014.00	66.35	230.35	399997

Note: 69.00 a Soil pressure at active limit
14.35 p Soil pressure at passive limit

Units: kN,m

Stage No. 3 Install strut or anchor no.1 at elevation 2.50

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -5.50: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000	Wall Penetr-ation	Direction of failure
3	4.00	2.00	2.50	7.188	n/a	1.98	0.02	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	11.71	0.005	7.72E-05	0.0	0.0	
2	3.50	10.78	0.005	7.37E-05	5.6	1.7	
3	3.00	11.11	0.005	5.75E-05	11.1	6.0	
4	2.50	12.74	0.005	1.70E-05	17.1	13.1	-47.1
		12.74	0.005	1.70E-05	-30.1	13.1	
5	2.00	15.03	0.005	-1.05E-05	-23.1	-0.1	
		11.61	0.005	-1.05E-05	-23.1	-0.1	
6	1.70	8.58	0.005	-2.06E-06	-20.1	-6.5	
7	1.40	8.00	0.005	2.16E-05	-17.6	-12.2	
8	0.95	7.60	0.005	8.16E-05	-14.1	-19.3	
9	0.50	7.29	0.005	1.65E-04	-10.8	-24.9	
10	0.00	7.19	0.005	2.80E-04	-7.1	-29.3	
11	-0.50	7.30	0.005	4.10E-04	-3.5	-32.0	
12	-1.00	7.62	0.004	5.47E-04	0.2	-32.8	
13	-1.40	8.02	0.004	6.57E-04	3.3	-32.1	
14	-1.70	8.47	0.004	7.37E-04	5.8	-30.8	
15	-2.00	9.08	0.004	8.12E-04	8.4	-28.6	
16	-2.50	9.93	0.003	9.22E-04	13.2	-23.3	
17	-3.00	11.02	0.003	1.00E-03	18.4	-15.4	
18	-3.50	12.11	0.002	1.04E-03	24.2	-4.8	
19	-4.00	13.01	0.002	1.03E-03	30.5	8.8	
20	-4.50	11.58	0.001	9.66E-04	36.6	25.7	
		-170.52	0.001	9.66E-04	36.6	25.7	
21	-5.00	-78.75	0.001	8.63E-04	-25.7	22.7	
22	-5.50	145.16	0.000	8.15E-04	-9.1	-0.0	
23	-5.63	-0.02	0.000	0	-0.0	0.0	
24	-6.81	0.00	0.000	0	-0.0	0.0	
25	-8.00	0.00	0.000	0	-0.0	0.0	
26	-10.00	0.01	0.000	0	0.0	0.0	
27	-12.00	0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	
29	-15.00	-0.02	0.000	0	0.0	0.0	

At elev. 2.50 Prop force = 47.1 kN/m run (horiz.)
= 66.7 kN/m run (inclined)

(continued)

Stage No.3 Install strut or anchor no.1 at elevation 2.50

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	11.71	11.71	6000
2	3.50	0.00	8.32	0.00	43.84	10.78	10.78	6000
3	3.00	0.00	16.99	1.56	74.53	11.11	11.11	6000
4	2.50	0.00	26.00	4.43	106.46	12.74	12.74	6000
5	2.00	0.00	35.18	7.35	138.98	15.03	15.03	6000
6	1.70	0.00	40.69	9.11	158.53	17.61	17.61	6000
7	1.40	0.00	46.19	10.86	178.00	20.20	20.20	6000
8	0.95	4.50	49.87	12.03	191.05	21.81	26.31	6000
9	0.50	9.00	53.47	13.17	203.80	23.42	32.42	6000
10	0.00	14.00	57.37	14.41	217.62	25.26	39.26	6000
11	-0.50	19.00	61.18	15.63	231.10	27.18	46.18	6000
12	-1.00	24.00	64.90	16.81	244.29	29.17	53.17	6000
13	-1.40	28.00	67.83	17.74	254.67	30.82	58.82	6000
		28.00	67.83	17.74	284.01	30.82	58.82	6000
14	-1.70	31.00	70.00	18.43	292.61	32.12	63.12	6000
15	-2.00	34.00	72.15	19.12	301.13	33.50	67.50	6000
16	-2.50	39.00	75.70	20.25	315.17	35.71	74.71	6000
17	-3.00	44.00	79.20	21.36	329.06	38.02	82.02	6000
18	-3.50	49.00	82.67	22.47	342.80	40.33	89.33	6000
19	-4.00	54.00	86.11	23.56	356.41	42.52	96.52	6000
20	-4.50	59.00	89.52	24.65	369.92	43.56	102.56	6000
		59.00	89.52	0.00	1452.74	50.80	109.80	399998
21	-5.00	64.00	95.16	0.00	1495.20	6.54	70.54	399998
22	-5.50	69.00	100.78	0.00	1537.50	198.27	267.27	399998
23	-5.63	70.25	102.18	0.00	1548.06	29.58	99.83	399998
24	-6.81	82.13	115.44	0.00	1647.93	34.24	116.37	399998
25	-8.00	94.00	128.62	0.00	1747.21	38.87	132.87	399998
26	-10.00	114.00	150.69	0.00	1913.42	46.71	160.71	399998
27	-12.00	134.00	172.63	0.00	2078.71	54.54	188.54	399998
28	-13.50	149.00	189.03	0.00	2202.25	60.42	209.42	399998
29	-15.00	164.00	205.40	0.00	2325.51	66.29	230.29	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	14.35	3.43	3.43	6000
6	1.70	0.00	4.95	0.00	31.89	9.03	9.03	6000
7	1.40	0.00	9.90	0.00	49.42	12.20	12.20	6000
8	0.95	4.50	12.83	0.24	59.79	14.21	18.71	6000
9	0.50	9.00	15.75	1.17	70.15	16.13	25.13	6000
10	0.00	14.00	19.00	2.20	81.67	18.07	32.07	6000
11	-0.50	19.00	22.25	3.24	93.18	19.88	38.88	6000
12	-1.00	24.00	25.50	4.27	104.70	21.55	45.55	6000
13	-1.40	28.00	28.10	5.10	113.92	22.80	50.80	6000
		28.00	28.10	5.10	126.68	22.80	50.80	6000
14	-1.70	31.00	30.05	5.72	134.40	23.65	54.65	6000
15	-2.00	34.00	32.00	6.34	142.13	24.42	58.42	6000

Run ID. 3_AU25_Sheetpiles_Anchored | Sheet No.
Downtown Carpark Redevelopment | Date:15-10-2024
AU25_Sheetpiles_Anchored | Checked :

(continued)

Stage No.3 Install strut or anchor no.1 at elevation 2.50

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
16	-2.50	39.00	35.26	7.38	155.01	25.78	64.78	6000
17	-3.00	44.00	38.51	8.41	167.89	27.00	71.00	6000
18	-3.50	49.00	41.76	9.45	180.77	28.22	77.22	6000
19	-4.00	54.00	45.01	10.48	193.65	29.52	83.52	6000
20	-4.50	59.00	48.27	11.52	206.54	31.98	90.98	6000
		59.00	48.27	0.00	1142.00	221.32	280.32	399997
21	-5.00	64.00	53.77	0.00	1183.46	85.29	149.29	399997
22	-5.50	69.00	59.28	0.00	1224.92	53.11	122.11	399997
23	-5.63	70.25	60.65	0.00	1235.29	29.59	99.84	399997
24	-6.81	82.13	73.73	0.00	1333.79	34.24	116.36	399997
25	-8.00	94.00	86.81	0.00	1432.32	38.87	132.87	399997
26	-10.00	114.00	108.86	0.00	1598.36	46.70	160.70	399997
27	-12.00	134.00	130.92	0.00	1764.51	54.54	188.54	399997
28	-13.50	149.00	147.47	0.00	1889.21	60.42	209.42	399997
29	-15.00	164.00	164.04	0.00	2014.00	66.31	230.31	399997

Units: kN,m

Stage No. 5 Excavate to elevation -1.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -5.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
5	4.00	-1.00	2.50	2.836	n/a	-4.08	3.08	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	9.30	0.013	-2.87E-04	0.0	0.0	
2	3.50	7.26	0.013	-2.90E-04	4.1	1.3	
3	3.00	6.41	0.014	-3.03E-04	7.6	4.5	
4	2.50	7.02	0.014	-3.32E-04	10.9	9.3	-69.7
		7.02	0.014	-3.32E-04	-58.8	9.3	
5	2.00	8.45	0.014	-3.11E-04	-54.9	-19.0	
6	1.70	10.33	0.014	-2.43E-04	-52.1	-35.0	
7	1.40	12.32	0.014	-1.34E-04	-48.7	-50.1	
8	0.95	17.31	0.014	9.50E-05	-42.0	-70.6	
9	0.50	22.34	0.014	3.96E-04	-33.1	-87.5	
10	0.00	28.29	0.014	7.95E-04	-20.4	-101.0	
11	-0.50	34.58	0.013	1.23E-03	-4.7	-107.4	
12	-1.00	41.23	0.012	1.68E-03	14.2	-105.2	
		26.88	0.012	1.68E-03	14.2	-105.2	
13	-1.40	21.41	0.012	2.02E-03	23.9	-97.4	
		19.76	0.012	2.02E-03	23.9	-97.4	
14	-1.70	20.34	0.011	2.26E-03	29.9	-89.3	
15	-2.00	21.70	0.010	2.48E-03	36.2	-79.5	
16	-2.50	23.34	0.009	2.77E-03	47.5	-58.7	
17	-3.00	25.67	0.008	2.96E-03	59.7	-32.1	
18	-3.50	27.92	0.006	3.03E-03	73.1	0.9	
19	-4.00	29.53	0.005	2.94E-03	87.5	40.9	
20	-4.50	24.56	0.003	2.66E-03	101.0	88.3	
		-562.42	0.003	2.66E-03	101.0	88.3	
21	-5.00	-194.38	0.002	2.33E-03	-88.2	68.5	
22	-5.50	437.73	0.001	2.19E-03	-27.4	0.0	
23	-5.63	-0.02	0.001	0	-0.0	0.0	
24	-6.81	0.00	0.001	0	-0.0	0.0	
25	-8.00	0.00	0.001	0	-0.0	0.0	
26	-10.00	0.01	0.000	0	0.0	0.0	
27	-12.00	-0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	
29	-15.00	-0.03	0.000	0	0.0	0.0	

At elev. 2.50 Prop force = 69.7 kN/m run (horiz.)
= 98.5 kN/m run (inclined)

(continued)

Stage No.5 Excavate to elevation -1.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	9.30	9.30	6000
2	3.50	0.00	8.32	0.00	43.84	7.26	7.26	6000
3	3.00	0.00	16.99	1.56	74.53	6.41	6.41	6000
4	2.50	0.00	26.00	4.43	106.46	7.02	7.02	6000
5	2.00	0.00	35.18	7.35	138.98	8.45	8.45	6000
6	1.70	0.00	40.69	9.11	158.53	10.33	10.33	6000
7	1.40	0.00	46.19	10.86	178.00	12.32	12.32	6000
8	0.95	3.55	50.82	12.33	194.41	13.75	17.31	6000
9	0.50	7.11	55.37	13.78	210.52	15.24	22.34	6000
10	0.00	11.05	60.32	15.35	228.06	17.24	28.29	6000
11	-0.50	15.00	65.18	16.90	245.27	19.58	34.58	6000
12	-1.00	18.95	69.95	18.42	262.20	22.28	41.23	6000
13	-1.40	22.11	73.72	19.62	275.56	24.72	46.83	6000
		22.11	73.72	19.62	307.35	24.72	46.83	6000
14	-1.70	24.47	76.53	20.51	318.45	26.77	51.25	6000
15	-2.00	26.84	79.31	21.40	329.47	29.08	55.92	6000
16	-2.50	30.79	83.91	22.86	347.69	32.58	63.37	6000
17	-3.00	34.74	88.47	24.31	365.74	36.40	71.13	6000
18	-3.50	38.68	92.99	25.75	383.65	40.16	78.84	6000
19	-4.00	42.63	97.48	27.18	401.43	43.58	86.22	6000
20	-4.50	46.58	101.94	28.60	419.11	43.58	90.16	6000
		46.58	101.94	0.00	1546.29	0.00	46.58a	399998
21	-5.00	50.53	108.63	0.00	1596.68	0.00	50.53a	399998
22	-5.50	54.47	115.30	0.00	1646.92	437.73	492.20	399998
23	-5.63	55.72	116.71	0.00	1657.47	27.02	82.74	399998
24	-6.81	67.60	129.97	0.00	1757.34	31.51	99.11	399998
25	-8.00	79.47	143.15	0.00	1856.62	35.94	115.41	399998
26	-10.00	99.47	165.21	0.00	2022.83	43.62	143.10	399998
27	-12.00	119.47	187.16	0.00	2188.12	51.37	170.84	399998
28	-13.50	134.47	203.56	0.00	2311.66	57.22	191.69	399998
29	-15.00	149.47	219.93	0.00	2434.92	63.09	212.56	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	14.35	14.35	14.35p	6000
13	-1.40	4.84	1.76	0.00	20.58	20.58	25.42p	6000
		4.84	1.76	0.00	22.34	22.22	27.06	6000
14	-1.70	8.47	3.08	0.00	27.57	22.44	30.91	6000
15	-2.00	12.11	4.39	0.00	32.79	22.11	34.22	6000

(continued)

Stage No.5 Excavate to elevation -1.00 on RIGHT side

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
16	-2.50	18.16	6.59	0.00	41.49	21.87	40.03	6000
17	-3.00	24.21	8.79	0.00	50.20	21.25	45.46	6000
18	-3.50	30.26	10.99	0.00	58.90	20.66	50.92	6000
19	-4.00	36.32	13.19	0.35	67.61	20.37	56.69	6000
20	-4.50	42.37	15.39	1.05	76.33	23.23	65.60	6000
		42.37	15.39	0.00	894.36	566.63	608.99	399999
21	-5.00	48.42	19.84	0.00	927.88	196.48	244.90	399999
22	-5.50	54.47	24.29	0.00	961.41	0.00	54.47a	399999
23	-5.63	55.72	25.67	0.00	971.77	27.03	82.76	399999
24	-6.81	67.60	38.75	0.00	1070.28	31.50	99.10	399999
25	-8.00	79.47	51.83	0.00	1168.84	35.93	115.41	399999
26	-10.00	99.47	73.89	0.00	1335.00	43.62	143.09	399999
27	-12.00	119.47	95.98	0.00	1501.40	51.37	170.84	399999
28	-13.50	134.47	112.58	0.00	1626.38	57.22	191.69	399999
29	-15.00	149.47	129.19	0.00	1751.53	63.12	212.59	399999

Note: 54.47 a Soil pressure at active limit
25.42 p Soil pressure at passive limit

Units: kN,m

Stage No. 6 Install strut or anchor no.2 at elevation -0.50

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -5.50: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000: Toe elev.	Wall Penetr-ation	Direction of failure
6	4.00	-1.00		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	10.38	0.010	-1.54E-04	0.0	0.0	
2	3.50	8.79	0.010	-1.58E-04	4.8	1.5	
3	3.00	8.43	0.010	-1.72E-04	9.1	5.2	
4	2.50	9.46	0.010	-2.06E-04	13.6	11.0	-60.6
		9.46	0.010	-2.06E-04	-47.0	11.0	
5	2.00	11.24	0.010	-2.05E-04	-41.9	-11.2	
6	1.70	13.41	0.010	-1.62E-04	-38.2	-23.1	
7	1.40	15.66	0.010	-8.99E-05	-33.8	-33.9	
8	0.95	20.91	0.010	6.49E-05	-25.6	-47.4	
9	0.50	26.20	0.010	2.62E-04	-15.0	-56.5	
10	0.00	32.30	0.010	5.10E-04	-0.4	-60.5	
11	-0.50	38.55	0.010	7.57E-04	17.4	-56.4	-54.6
		38.55	0.010	7.57E-04	-37.3	-56.4	
12	-1.00	44.85	0.009	1.02E-03	-16.4	-69.9	
		35.25	0.009	1.02E-03	-16.4	-69.9	
13	-1.40	29.17	0.009	1.26E-03	-3.5	-73.7	
		27.52	0.009	1.26E-03	-3.5	-73.7	
14	-1.70	27.18	0.009	1.45E-03	4.7	-73.5	
15	-2.00	27.45	0.008	1.63E-03	12.9	-70.9	
16	-2.50	27.84	0.007	1.91E-03	26.7	-61.1	
17	-3.00	28.86	0.006	2.14E-03	40.9	-44.3	
18	-3.50	30.03	0.005	2.27E-03	55.6	-20.3	
19	-4.00	30.82	0.004	2.29E-03	70.8	11.2	
20	-4.50	27.22	0.003	2.16E-03	85.3	50.4	
		-385.09	0.003	2.16E-03	85.3	50.4	
21	-5.00	-157.51	0.002	1.96E-03	-50.3	44.9	
22	-5.50	287.05	0.001	1.86E-03	-17.9	0.0	
23	-5.63	-0.02	0.001	0	-0.0	0.0	
24	-6.81	0.00	0.001	0	-0.0	0.0	
25	-8.00	0.00	0.001	0	-0.0	0.0	
26	-10.00	0.01	0.000	0	0.0	0.0	
27	-12.00	-0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	

(continued)

Stage No.6 Install strut or anchor no.2 at elevation -0.50

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
29	-15.00	-0.03	0.000	0	0.0	0.0	

At elev. 2.50 Prop force = 60.6 kN/m run (horiz.)
= 85.7 kN/m run (inclined)

At elev. -0.50 Prop force = 54.6 kN/m run (horiz.)
= 66.7 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	10.38	10.38	6000
2	3.50	0.00	8.32	0.00	43.84	8.79	8.79	6000
3	3.00	0.00	16.99	1.56	74.53	8.43	8.43	6000
4	2.50	0.00	26.00	4.43	106.46	9.46	9.46	6000
5	2.00	0.00	35.18	7.35	138.98	11.24	11.24	6000
6	1.70	0.00	40.69	9.11	158.53	13.41	13.41	6000
7	1.40	0.00	46.19	10.86	178.00	15.66	15.66	6000
8	0.95	3.55	50.82	12.33	194.41	17.36	20.91	6000
9	0.50	7.11	55.37	13.78	210.52	19.10	26.20	6000
10	0.00	11.05	60.32	15.35	228.06	21.25	32.30	6000
11	-0.50	15.00	65.18	16.90	245.27	23.55	38.55	6000
12	-1.00	18.95	69.95	18.42	262.20	25.90	44.85	6000
13	-1.40	22.11	73.72	19.62	275.56	27.91	50.02	6000
		22.11	73.72	19.62	307.35	27.91	50.02	6000
14	-1.70	24.47	76.53	20.51	318.45	29.56	54.04	6000
15	-2.00	26.84	79.31	21.40	329.47	31.41	58.25	6000
16	-2.50	30.79	83.91	22.86	347.69	34.39	65.18	6000
17	-3.00	34.74	88.47	24.31	365.74	37.65	72.38	6000
18	-3.50	38.68	92.99	25.75	383.65	40.95	79.64	6000
19	-4.00	42.63	97.48	27.18	401.43	44.05	86.68	6000
20	-4.50	46.58	101.94	28.60	419.11	44.90	91.48	6000
		46.58	101.94	0.00	1546.29	87.98	134.56	399998
21	-5.00	50.53	108.63	0.00	1596.68	17.93	68.46	399998
22	-5.50	54.47	115.30	0.00	1646.92	361.95	416.42	399998
23	-5.63	55.72	116.71	0.00	1657.47	26.44	82.16	399998
24	-6.81	67.60	129.97	0.00	1757.34	31.06	98.66	399998
25	-8.00	79.47	143.15	0.00	1856.62	35.64	115.11	399998
26	-10.00	99.47	165.21	0.00	2022.83	43.43	142.90	399998
27	-12.00	119.47	187.16	0.00	2188.12	51.23	170.70	399998
28	-13.50	134.47	203.56	0.00	2311.66	57.09	191.57	399998
29	-15.00	149.47	219.93	0.00	2434.92	62.96	212.43	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Run ID. 3_AU25_Sheetpiles_Anchored | Sheet No.
Downtown Carpark Redevelopment | Date:15-10-2024
AU25_Sheetpiles_Anchored | Checked :

(continued)

Stage No.6 Install strut or anchor no.2 at elevation -0.50

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
9	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	14.35	9.60	9.60	6000
13	-1.40	4.84	1.76	0.00	20.58	16.01	20.85	6000
		4.84	1.76	0.00	22.34	17.65	22.49	6000
14	-1.70	8.47	3.08	0.00	27.57	18.39	26.86	6000
15	-2.00	12.11	4.39	0.00	32.79	18.70	30.80	6000
16	-2.50	18.16	6.59	0.00	41.49	19.18	37.34	6000
17	-3.00	24.21	8.79	0.00	50.20	19.31	43.52	6000
18	-3.50	30.26	10.99	0.00	58.90	19.34	49.61	6000
19	-4.00	36.32	13.19	0.35	67.61	19.54	55.86	6000
20	-4.50	42.37	15.39	1.05	76.33	21.89	64.26	6000
		42.37	15.39	0.00	894.36	477.28	519.65	399999
21	-5.00	48.42	19.84	0.00	927.88	177.54	225.97	399999
22	-5.50	54.47	24.29	0.00	961.41	74.89	129.37	399999
23	-5.63	55.72	25.67	0.00	971.77	26.45	82.18	399999
24	-6.81	67.60	38.75	0.00	1070.28	31.05	98.65	399999
25	-8.00	79.47	51.83	0.00	1168.84	35.63	115.11	399999
26	-10.00	99.47	73.89	0.00	1335.00	43.42	142.89	399999
27	-12.00	119.47	95.98	0.00	1501.40	51.23	170.70	399999
28	-13.50	134.47	112.58	0.00	1626.38	57.09	191.56	399999
29	-15.00	149.47	129.19	0.00	1751.53	62.99	212.46	399999

Units: kN,m

Stage No. 8 Excavate to elevation -4.50 on RIGHT side

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

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = -5.50 Factor of Safety	FoS for toe elev. = -5.50 Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Toe elev. for FoS = 1.000 Wall Penetr -ation	Direction of failure
8	4.00	-4.50		More than one prop.		No FoS calc.		

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	11.49	0.010	-4.83E-04	0.0	0.0	
2	3.50	9.60	0.010	-4.86E-04	5.3	1.6	
3	3.00	8.87	0.011	-5.02E-04	9.9	5.7	
4	2.50	9.57	0.011	-5.39E-04	14.5	11.9	-62.7
		9.57	0.011	-5.39E-04	-48.2	11.9	
5	2.00	11.07	0.011	-5.41E-04	-43.0	-10.8	
6	1.70	13.01	0.011	-4.98E-04	-39.4	-23.1	
7	1.40	15.05	0.012	-4.25E-04	-35.2	-34.3	
8	0.95	18.68	0.012	-2.68E-04	-27.6	-48.4	
9	0.50	22.29	0.012	-6.38E-05	-18.4	-58.8	
10	0.00	26.54	0.012	1.98E-04	-6.2	-65.0	
11	-0.50	30.87	0.012	4.72E-04	8.2	-64.6	-64.0
		30.87	0.012	4.72E-04	-55.8	-64.6	
12	-1.00	35.26	0.011	7.96E-04	-39.3	-88.4	
13	-1.40	38.88	0.011	1.11E-03	-24.5	-101.1	
14	-1.70	41.76	0.011	1.38E-03	-12.4	-106.6	
15	-2.00	44.89	0.010	1.65E-03	0.6	-108.4	
16	-2.50	50.20	0.009	2.10E-03	24.4	-102.3	
17	-3.00	55.95	0.008	2.49E-03	50.9	-83.7	
18	-3.50	61.90	0.007	2.77E-03	80.4	-51.1	
19	-4.00	67.66	0.005	2.89E-03	112.8	-3.0	
20	-4.50	71.25	0.004	2.76E-03	147.5	62.1	
		-604.10	0.004	2.76E-03	147.5	62.1	
21	-5.00	-232.61	0.002	2.51E-03	-61.7	60.1	
22	-5.50	383.41	0.001	2.38E-03	-24.0	0.0	
23	-5.63	-0.02	0.001	0	-0.0	0.0	
24	-6.81	0.00	0.001	0	-0.0	0.0	
25	-8.00	0.00	0.001	0	-0.0	0.0	
26	-10.00	0.01	0.001	0	0.0	0.0	
27	-12.00	0.00	0.000	0	0.0	0.0	
28	-13.50	0.00	0.000	0	0.0	0.0	
29	-15.00	-0.03	0.000	0	0.0	0.0	

At elev. 2.50 Prop force = 62.7 kN/m run (horiz.)
= 88.6 kN/m run (inclined)
At elev. -0.50 Prop force = 64.0 kN/m run (horiz.)
= 78.1 kN/m run (inclined)

(continued)

Stage No.8 Excavate to elevation -4.50 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Effective stresses Active limit	Effective stresses Passive limit	Effective stresses Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	11.49	11.49	6000
2	3.50	0.00	8.32	0.00	43.84	9.60	9.60	6000
3	3.00	0.00	16.99	1.56	74.53	8.87	8.87	6000
4	2.50	0.00	26.00	4.43	106.46	9.57	9.57	6000
5	2.00	0.00	35.18	7.35	138.98	11.07	11.07	6000
6	1.70	0.00	40.69	9.11	158.53	13.01	13.01	6000
7	1.40	0.00	46.19	10.86	178.00	15.05	15.05	6000
8	0.95	1.14	53.23	13.10	202.96	17.54	18.68	6000
9	0.50	2.28	60.19	15.31	227.62	20.02	22.29	6000
10	0.00	3.54	67.83	17.74	254.66	22.99	26.54	6000
11	-0.50	4.81	75.37	20.14	281.38	26.06	30.87	6000
12	-1.00	6.08	82.82	22.52	307.80	29.19	35.26	6000
13	-1.40	7.09	88.74	24.40	328.76	31.80	38.88	6000
		7.09	88.74	24.40	366.82	31.80	38.88	6000
14	-1.70	7.85	93.15	25.80	384.29	33.91	41.76	6000
15	-2.00	8.61	97.54	27.20	401.69	36.28	44.89	6000
16	-2.50	9.87	104.83	29.52	430.52	40.33	50.20	6000
17	-3.00	11.14	112.07	31.82	459.19	44.81	55.95	6000
18	-3.50	12.41	119.27	34.12	487.72	49.49	61.90	6000
19	-4.00	13.67	126.44	36.40	516.13	53.99	67.66	6000
20	-4.50	14.94	133.59	38.67	544.43	56.32	71.25	6000
		14.94	133.59	0.00	1784.62	0.00	14.94a	399998
21	-5.00	16.20	142.96	0.00	1855.21	0.00	16.20a	399998
22	-5.50	17.47	152.31	0.00	1925.64	413.71	431.18	399998
23	-5.63	18.72	153.71	0.00	1936.19	29.74	48.46	399998
24	-6.81	30.59	166.97	0.00	2036.07	34.14	64.73	399998
25	-8.00	42.47	180.15	0.00	2135.35	38.54	81.00	399998
26	-10.00	62.47	202.22	0.00	2301.55	46.24	108.70	399998
27	-12.00	82.47	224.16	0.00	2466.84	53.99	136.46	399998
28	-13.50	97.47	240.57	0.00	2590.38	59.84	157.31	399998
29	-15.00	112.47	256.93	0.00	2713.64	65.70	178.17	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses Vertic -al	Effective stresses Active limit	Effective stresses Passive limit	Effective stresses Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.8 Excavate to elevation -4.50 on RIGHT side

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
18	-3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	778.45	619.04	619.04	400000
21	-5.00	8.73	1.77	0.00	791.75	240.07	248.81	400000
22	-5.50	17.47	3.53	0.00	805.05	30.31	47.78	400000
23	-5.63	18.72	4.91	0.00	815.41	29.76	48.48	400000
24	-6.81	30.59	17.97	0.00	913.82	34.13	64.73	400000
25	-8.00	42.47	31.04	0.00	1012.27	38.53	81.00	400000
26	-10.00	62.47	53.08	0.00	1178.22	46.23	108.69	400000
27	-12.00	82.47	75.15	0.00	1344.44	53.99	136.46	400000
28	-13.50	97.47	91.73	0.00	1469.34	59.84	157.30	400000
29	-15.00	112.47	108.34	0.00	1594.46	65.73	178.20	400000

Note: 16.20 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 10 Apply water pressure profile no.3

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

				FoS for toe elev. = -5.50		**Toe elev. for FoS = 1.000**		
Stage No.	Ground level Act.	Pass.	Prop Elev.	Factor of Safety	Moment equilib. at elev.	Toe elev.	Wall Penetr -ation	Direction of failure
10	4.00	-4.50		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	11.82	0.012	-7.13E-04	0.0	0.0	
2	3.50	9.63	0.012	-7.17E-04	5.4	1.7	
3	3.00	8.55	0.012	-7.33E-04	9.9	5.7	
4	2.50	8.94	0.013	-7.70E-04	14.3	12.0	-66.8
		8.94	0.013	-7.70E-04	-52.6	12.0	
5	2.00	10.18	0.013	-7.68E-04	-47.8	-13.0	
6	1.70	11.92	0.013	-7.17E-04	-44.5	-26.8	
7	1.40	13.77	0.013	-6.33E-04	-40.6	-39.5	
8	0.95	19.10	0.014	-4.51E-04	-33.2	-56.2	
9	0.50	24.42	0.014	-2.12E-04	-23.4	-69.0	
10	0.00	30.60	0.014	9.71E-05	-9.7	-77.3	
11	-0.50	36.90	0.014	4.26E-04	7.2	-78.1	-75.4
		36.90	0.014	4.26E-04	-68.2	-78.1	
12	-1.00	43.27	0.013	8.18E-04	-48.1	-107.3	
13	-1.40	48.52	0.013	1.20E-03	-29.8	-122.7	
14	-1.70	52.66	0.013	1.52E-03	-14.6	-129.4	
15	-2.00	57.11	0.012	1.85E-03	1.9	-131.4	
16	-2.50	64.66	0.011	2.39E-03	32.3	-123.1	
17	-3.00	72.76	0.010	2.86E-03	66.7	-98.6	
18	-3.50	81.11	0.008	3.19E-03	105.1	-55.9	
19	-4.00	89.22	0.007	3.29E-03	147.7	7.0	-39.9
		89.22	0.007	3.29E-03	107.8	7.0	
20	-4.50	94.93	0.005	3.12E-03	153.9	72.4	
		-662.96	0.005	3.12E-03	153.9	72.4	
21	-5.00	-240.93	0.003	2.83E-03	-72.1	66.7	
22	-5.50	423.50	0.002	2.69E-03	-26.5	0.0	
23	-5.63	-0.02	0.002	0	-0.0	0.0	
24	-6.81	0.00	0.002	0	-0.0	0.0	
25	-8.00	0.00	0.001	0	-0.0	0.0	
26	-10.00	0.01	0.001	0	0.0	0.0	
27	-12.00	0.00	0.001	0	0.0	0.0	
28	-13.50	0.00	0.001	0	0.0	0.0	
29	-15.00	-0.03	0.000	0	-0.0	0.0	

At elev. 2.50 Prop force = 66.8 kN/m run (horiz.)
= 94.5 kN/m run (inclined)
At elev. -0.50 Prop force = 75.4 kN/m run (horiz.)
= 92.0 kN/m run (inclined)
At elev. -4.00 Prop force = 39.9 kN/m run (horiz.)

= 42.5 kN/m run (inclined)

(continued)

Stage No.10 Apply water pressure profile no.3

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	11.82	11.82	6000
2	3.50	0.00	8.32	0.00	43.84	9.63	9.63	6000
3	3.00	0.00	16.99	1.56	74.53	8.55	8.55	6000
4	2.50	0.00	26.00	4.43	106.46	8.94	8.94	6000
5	2.00	0.00	35.18	7.35	138.98	10.18	10.18	6000
6	1.70	0.00	40.69	9.11	158.53	11.92	11.92	6000
7	1.40	0.00	46.19	10.86	178.00	13.77	13.77	6000
8	0.95	4.50	49.87	12.03	191.05	14.60	19.10	6000
9	0.50	9.00	53.47	13.17	203.80	15.42	24.42	6000
10	0.00	14.00	57.37	14.41	217.62	16.60	30.60	6000
11	-0.50	19.00	61.18	15.63	231.10	17.90	36.90	6000
12	-1.00	24.00	64.90	16.81	244.29	19.27	43.27	6000
13	-1.40	28.00	67.83	17.74	254.67	20.52	48.52	6000
		28.00	67.83	17.74	284.01	20.52	48.52	6000
14	-1.70	31.00	70.00	18.43	292.61	21.66	52.66	6000
15	-2.00	34.00	72.15	19.12	301.13	23.11	57.11	6000
16	-2.50	39.00	75.70	20.25	315.17	25.66	64.66	6000
17	-3.00	44.00	79.20	21.36	329.06	28.76	72.76	6000
18	-3.50	49.00	82.67	22.47	342.80	32.11	81.11	6000
19	-4.00	54.00	86.11	23.56	356.41	35.22	89.22	6000
20	-4.50	59.00	89.52	24.65	369.92	35.93	94.93	6000
		59.00	89.52	0.00	1452.74	0.00	59.00a	399998
21	-5.00	64.00	95.16	0.00	1495.20	0.00	64.00a	399998
22	-5.50	69.00	100.78	0.00	1537.50	394.24	463.24	399998
23	-5.63	70.25	102.18	0.00	1548.06	0.00	70.25a	399998
24	-6.81	82.13	115.44	0.00	1647.93	0.00	82.13a	399998
25	-8.00	94.00	128.62	0.00	1747.21	0.00	94.00a	399998
26	-10.00	114.00	150.69	0.00	1913.42	6.17	120.17	399998
27	-12.00	134.00	172.63	0.00	2078.71	13.88	147.88	399998
28	-13.50	149.00	189.03	0.00	2202.25	19.72	168.72	399998
29	-15.00	164.00	205.40	0.00	2325.51	25.58	189.58	399998

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.10 Apply water pressure profile no.3

		RIGHT side						
			Effective stresses				Total	Adjusted
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
18	-3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	778.45	721.96	721.96	400000
21	-5.00	0.00	10.50	0.00	857.54	304.93	304.93	400000
22	-5.50	0.00	21.00	0.00	936.62	39.74	39.74	400000
23	-5.63	1.25	22.38	0.00	946.98	69.02	70.27	400000
24	-6.81	13.13	35.44	0.00	1045.39	69.00	82.12	400000
25	-8.00	25.00	48.51	0.00	1143.84	69.00	94.00	400000
26	-10.00	45.00	70.55	0.00	1309.80	75.16	120.16	400000
27	-12.00	65.00	92.61	0.00	1476.02	82.88	147.88	400000
28	-13.50	80.00	109.20	0.00	1600.91	88.72	168.72	400000
29	-15.00	95.00	125.81	0.00	1726.03	94.61	189.61	400000

Note: 94.00 a Soil pressure at active limit
123.45 p Soil pressure at passive limit

Units: kN,m

Stage No. 11 Excavate to elevation -4.50 on RIGHT side
Toe of berm at elevation -5.50
Width of top of berm = 1.00
Width of toe of berm = 1.01

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	**FoS for toe elev. = -5.50** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.000** Toe elev.	Wall Penetr -ation	Direction of failure
11	4.00	-4.50		More than one prop. No FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
1	4.00	13.15	0.011	-1.01E-03	0.0	0.0	
2	3.50	10.73	0.012	-1.01E-03	6.0	1.8	
3	3.00	9.38	0.013	-1.03E-03	11.0	6.3	
4	2.50	9.52	0.013	-1.07E-03	15.7	13.2	-67.9
		9.52	0.013	-1.07E-03	-52.1	13.2	
5	2.00	10.56	0.014	-1.08E-03	-47.1	-11.5	
6	1.70	12.12	0.014	-1.03E-03	-43.7	-25.0	
7	1.40	13.82	0.014	-9.56E-04	-39.8	-37.6	
8	0.95	18.98	0.015	-7.82E-04	-32.5	-53.9	
9	0.50	24.08	0.015	-5.53E-04	-22.8	-66.3	
10	0.00	30.03	0.015	-2.55E-04	-9.2	-74.4	
11	-0.50	36.06	0.015	6.08E-05	7.3	-75.0	-82.7
		36.06	0.015	6.08E-05	-75.5	-75.0	
12	-1.00	42.14	0.015	4.47E-04	-55.9	-107.9	
13	-1.40	47.12	0.015	8.45E-04	-38.1	-126.6	
14	-1.70	51.02	0.014	1.17E-03	-23.3	-135.8	
15	-2.00	55.20	0.014	1.52E-03	-7.4	-140.5	
16	-2.50	62.44	0.013	2.11E-03	22.0	-137.0	
17	-3.00	70.17	0.012	2.65E-03	55.2	-118.0	
18	-3.50	78.15	0.011	3.07E-03	92.2	-81.4	
19	-4.00	85.82	0.009	3.30E-03	133.2	-25.3	-108.8
		85.82	0.009	3.30E-03	24.4	-25.3	
20	-4.50	92.37	0.007	3.36E-03	69.0	-2.0	
		-117.41	0.007	3.36E-03	69.0	-2.0	
21	-5.00	-58.04	0.006	3.36E-03	25.1	2.9	
22	-5.50	-33.85	0.004	3.35E-03	2.1	0.0	
23	-5.63	-0.02	0.004	0	-0.0	0.0	
24	-6.81	0.00	0.003	0	-0.0	0.0	
25	-8.00	0.00	0.002	0	-0.0	0.0	
26	-10.00	0.01	0.001	0	0.0	0.0	

(continued)

Stage No.11 Excavate to elevation -4.50 on RIGHT side
Toe of berm at elevation -5.50
Width of top of berm = 1.00
Width of toe of berm = 1.01

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces
		kN/m2	m	rad.	kN/m	kN.m/m	kN/m
27	-12.00	0.00	0.001	0	0.0	0.0	
28	-13.50	0.00	0.001	0	0.0	0.0	
29	-15.00	-0.03	0.000	0	-0.0	0.0	

At elev. 2.50 Prop force = 67.9 kN/m run (horiz.)
= 96.0 kN/m run (inclined)
At elev. -0.50 Prop force = 82.7 kN/m run (horiz.)
= 101.0 kN/m run (inclined)
At elev. -4.00 Prop force = 108.8 kN/m run (horiz.)
= 115.8 kN/m run (inclined)

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	14.35	13.15	13.15	6000
2	3.50	0.00	8.32	0.00	43.84	10.73	10.73	6000
3	3.00	0.00	16.99	1.56	74.53	9.38	9.38	6000
4	2.50	0.00	26.00	4.43	106.46	9.52	9.52	6000
5	2.00	0.00	35.18	7.35	138.98	10.56	10.56	6000
6	1.70	0.00	40.69	9.11	158.53	12.12	12.12	6000
7	1.40	0.00	46.19	10.86	178.00	13.82	13.82	6000
8	0.95	4.50	49.87	12.03	191.05	14.48	18.98	6000
9	0.50	9.00	53.47	13.17	203.80	15.08	24.08	6000
10	0.00	14.00	57.37	14.41	217.62	16.03	30.03	6000
11	-0.50	19.00	61.18	15.63	231.10	17.06	36.06	6000
12	-1.00	24.00	64.90	16.81	244.29	18.14	42.14	6000
13	-1.40	28.00	67.83	17.74	254.67	19.12	47.12	6000
		28.00	67.83	17.74	284.01	19.12	47.12	6000
14	-1.70	31.00	70.00	18.43	292.61	20.02	51.02	6000
15	-2.00	34.00	72.15	19.12	301.13	21.20	55.20	6000
16	-2.50	39.00	75.70	20.25	315.17	23.44	62.44	6000
17	-3.00	44.00	79.20	21.36	329.06	26.17	70.17	6000
18	-3.50	49.00	82.67	22.47	342.80	29.15	78.15	6000
19	-4.00	54.00	86.11	23.56	356.41	31.82	85.82	6000
20	-4.50	59.00	89.52	24.65	369.92	33.37	92.37	6000
		59.00	89.52	0.00	1452.74	0.00	59.00a	399998
21	-5.00	64.00	95.16	0.00	1495.20	0.00	64.00a	399998
22	-5.50	69.00	100.78	0.00	1537.50	98.35	167.35	399998
23	-5.63	70.25	102.18	0.00	1548.06	0.29	70.54	399998
24	-6.81	82.13	115.44	0.00	1647.93	0.29	82.41	399998
25	-8.00	94.00	128.62	0.00	1747.21	0.24	94.24	399998
26	-10.00	114.00	150.69	0.00	1913.42	6.33	120.33	399998
27	-12.00	134.00	172.63	0.00	2078.71	13.98	147.98	399998
28	-13.50	149.00	189.03	0.00	2202.25	19.76	168.76	399998
29	-15.00	164.00	205.40	0.00	2325.51	25.59	189.59	399998

Run ID. 3_AU25_Sheetpiles_Anchored | Sheet No.
Downtown Carpark Redevelopment | Date:15-10-2024
AU25_Sheetpiles_Anchored | Checked :

(continued)

Stage No.11 Excavate to elevation -4.50 on RIGHT side
Toe of berm at elevation -5.50
Width of top of berm = 1.00
Width of toe of berm = 1.01

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic -al	Active limit	Passive limit	Earth pressure	Total earth pressure	Adjusted soil modulus
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13	-1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16	-2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17	-3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18	-3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19	-4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20	-4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	176.41b	176.41	176.41p	400000
21	-5.00	0.00	10.50	0.00	122.04b	122.04	122.04p	400000
22	-5.50	0.00	21.00	0.00	201.20b	201.20	201.20p	400000
23	-5.63	1.25	22.38	0.00	804.74b	69.31	70.56	400000
24	-6.81	13.13	35.44	0.00	896.25b	69.28	82.41	400000
25	-8.00	25.00	48.51	0.00	998.85b	69.24	94.24	400000
26	-10.00	45.00	70.55	0.00	1160.39b	75.32	120.32	400000
27	-12.00	65.00	92.61	0.00	1324.72b	82.98	147.98	400000
28	-13.50	80.00	109.20	0.00	1451.88b	88.76	168.76	400000
29	-15.00	95.00	125.81	0.00	1571.62b	94.61	189.61	400000

Note: 64.00 a Soil pressure at active limit
201.20 p Soil pressure at passive limit
1571.62 b Passive limit reduced because of berm

Units: kN,m

Summary of results

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

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = -5.50 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	4.00	4.00	Cant.	Conditions not suitable for FoS calc.				
2	4.00	2.00	Cant.	2.503	-5.00	1.22	0.78	L to R
3	4.00	2.00	2.50	7.188	n/a	1.98	0.02	L to R
4	4.00	2.00		No analysis at this stage				
5	4.00	-1.00	2.50	2.836	n/a	-4.08	3.08	L to R
6	4.00	-1.00		More than one prop. No FoS calc.				

All remaining stages have more than one prop - FoS calculation n/a

TONKIN + TAYLOR LTD | Sheet No.
Program: WALLAP Version 6.07 Revision A55.B74.R58 | Job No. 1016043
Licensed from GEOSOLVE | Made by : rxsw
Data filename/Run ID: 3_AU25_Sheetpiles_Anchored |
Downtown Carpark Redevelopment | Date:15-10-2024
AU25_Sheetpiles_Anchored | Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00m
2-D finite element model. Active limit arching modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 60.00 from wall Rough boundary
Right side 60.00 from wall Rough boundary
Lower rigid boundary at elevation -15.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	4.00	0.017	0.000	0.0	0.0	0.0	0.0
2	3.50	0.016	0.000	1.8	-0.1	6.0	-0.3
3	3.00	0.015	0.000	6.3	-0.3	11.1	-0.8
4	2.50	0.014	0.000	13.2	-0.8	17.1	-58.8
5	2.00	0.014	0.000	2.7	-19.0	5.0	-54.9
6	1.70	0.014	0.000	3.9	-35.0	2.9	-52.1
7	1.40	0.014	0.000	4.4	-50.1	1.0	-48.7
8	0.95	0.015	0.000	4.4	-70.6	0.0	-42.0
9	0.50	0.015	0.000	3.6	-87.5	0.0	-33.1
10	0.00	0.015	0.000	2.5	-101.0	0.0	-20.4
11	-0.50	0.015	0.000	1.6	-107.4	17.4	-75.5
12	-1.00	0.015	0.000	1.3	-107.9	14.2	-55.9
13	-1.40	0.015	0.000	1.9	-126.6	23.9	-38.1
14	-1.70	0.014	0.000	3.0	-135.8	29.9	-23.3
15	-2.00	0.014	0.000	4.7	-140.5	36.2	-7.4
16	-2.50	0.013	0.000	9.2	-137.0	47.5	0.0
17	-3.00	0.012	0.000	16.1	-118.0	66.7	0.0
18	-3.50	0.011	0.000	25.9	-81.4	105.1	0.0
19	-4.00	0.009	0.000	40.9	-25.3	147.7	0.0
20	-4.50	0.007	0.000	88.3	-2.0	153.9	0.0
21	-5.00	0.006	0.000	68.5	0.0	25.1	-88.2
22	-5.50	0.004	0.000	0.0	-0.0	2.1	-27.4
23	-5.63	0.004	0.000	0.0	0.0	0.0	-0.0
24	-6.81	0.003	0.000	0.0	0.0	0.0	-0.0
25	-8.00	0.002	0.000	0.0	0.0	0.0	-0.0
26	-10.00	0.001	0.000	0.0	0.0	0.0	-0.0
27	-12.00	0.001	0.000	0.0	0.0	0.0	0.0
28	-13.50	0.001	0.000	0.0	0.0	0.0	0.0
29	-15.00	0.000	0.000	0.0	0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	7.7	-4.50	-4.8	-1.00	8.0	-4.50	-7.7	-5.00
2	55.6	-4.50	-0.0	-5.50	35.9	-4.50	-55.6	-5.00
3	25.7	-4.50	-32.8	-1.00	36.6	-4.50	-30.1	2.50
4	No calculation at this stage							
5	88.3	-4.50	-107.4	-0.50	101.0	-4.50	-88.2	-5.00
6	50.4	-4.50	-73.7	-1.40	85.3	-4.50	-50.3	-5.00
7	No calculation at this stage							
8	62.1	-4.50	-108.4	-2.00	147.5	-4.50	-61.7	-5.00
9	No calculation at this stage							
10	72.4	-4.50	-131.4	-2.00	153.9	-4.50	-72.1	-5.00
11	13.2	2.50	-140.5	-2.00	133.2	-4.00	-75.5	-0.50

Maximum and minimum displacement at each stage

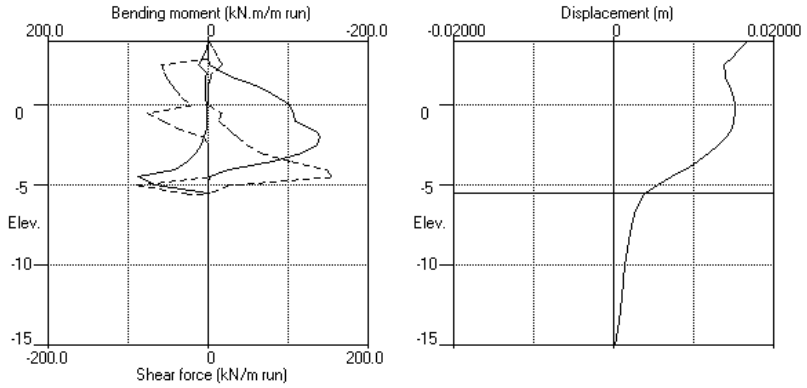
Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.001	4.00	0.000	4.00	Apply surcharge no.1 at elev. 4.00
2	0.017	4.00	0.000	4.00	Excav. to elev. 2.00 on RIGHT side
3	0.005	4.00	0.000	4.00	Install prop no.1 at elev. 2.50
4	No calculation at this stage				Apply water pressure profile no.1
5	0.014	0.95	0.000	4.00	Excav. to elev. -1.00 on RIGHT side
6	0.010	0.95	0.000	4.00	Install prop no.2 at elev. -0.50
7	No calculation at this stage				Apply water pressure profile no.2
8	0.012	0.50	0.000	4.00	Excav. to elev. -4.50 on RIGHT side
9	No calculation at this stage				Install prop no.3 at elev. -4.00
10	0.014	0.00	0.000	4.00	Apply water pressure profile no.3
11	0.015	-0.50	0.000	4.00	Excav. to elev. -4.50 on RIGHT side

Prop forces at each stage (horizontal components)

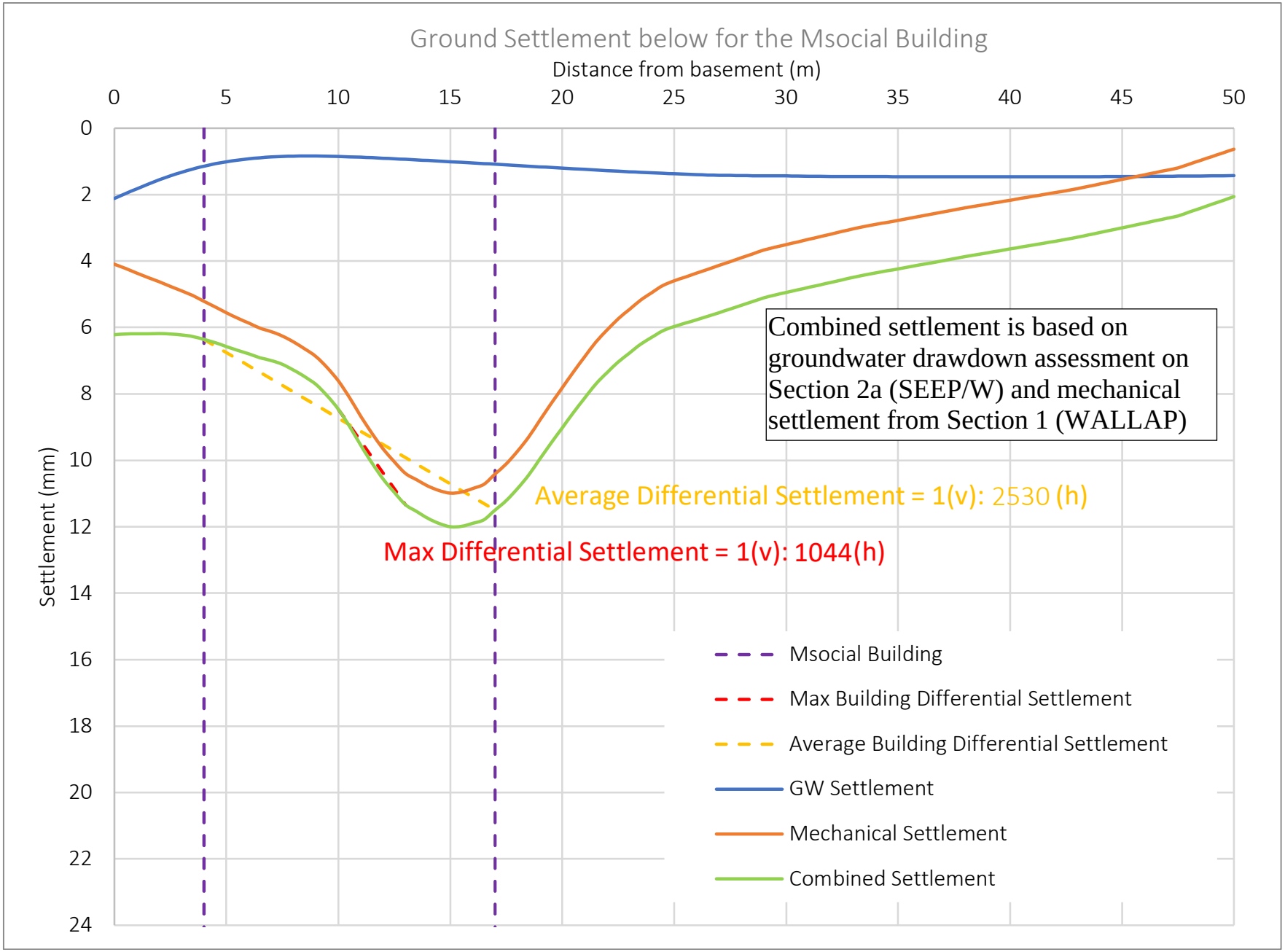
Stage no.	Anchor no. 1 at elev. 2.50 kN/m run	kN/prop	Anchor no. 2 at elev.-0.50 kN/m run	kN/prop	Anchor no. 3 at elev.-4.00 kN/m run	kN/prop
3	47.14	141.42	---	---	---	---
5	69.68	209.05	---	---	---	---
6	60.62	181.85	54.61	163.83	---	---
8	62.67	188.00	64.01	192.04	---	---
10	66.84	200.52	75.36	226.08	39.91	119.73
11	67.87	203.61	82.74	248.23	108.83	326.48

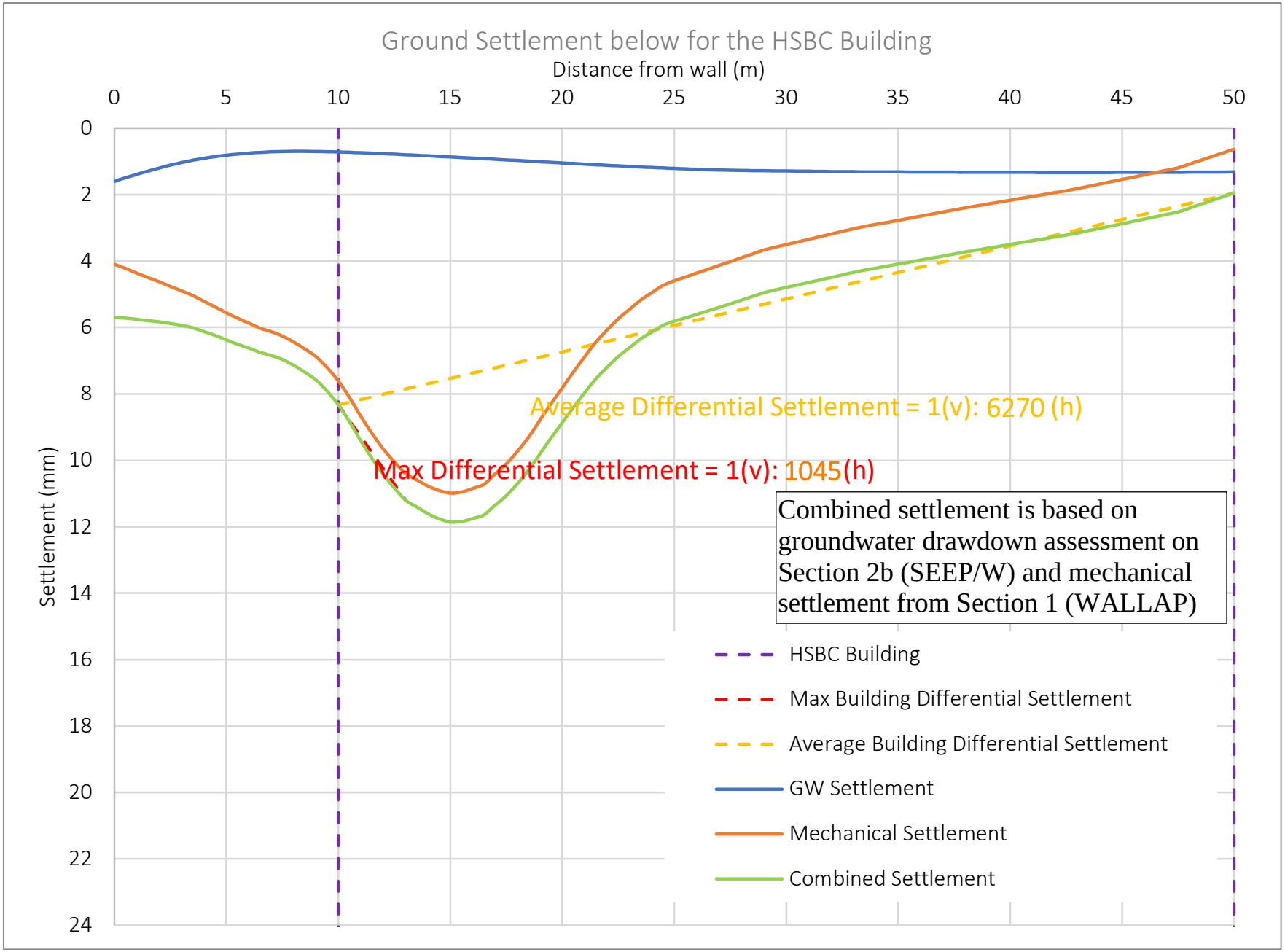
Units: kN,m

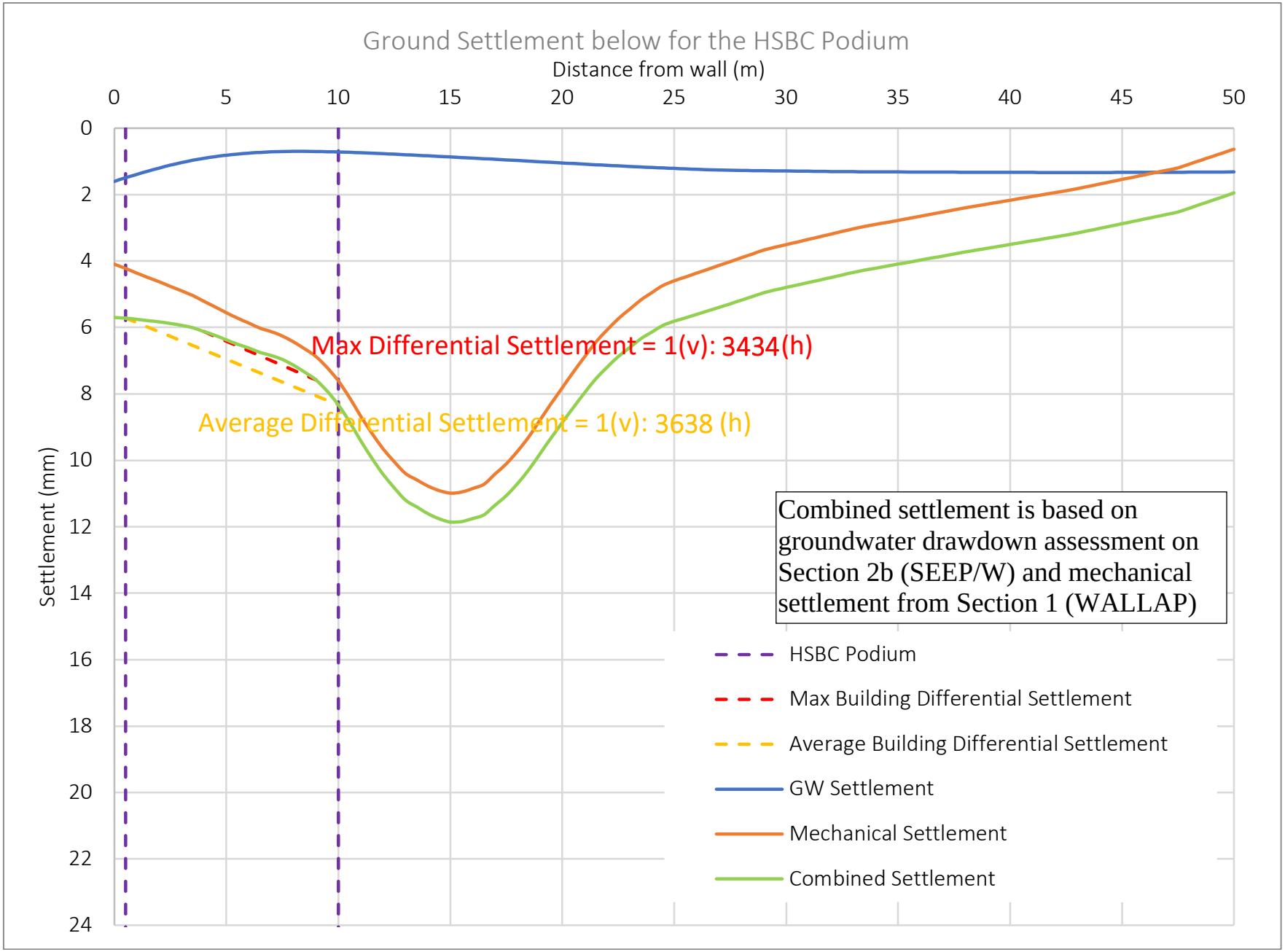
Bending moment, shear force, displacement envelopes

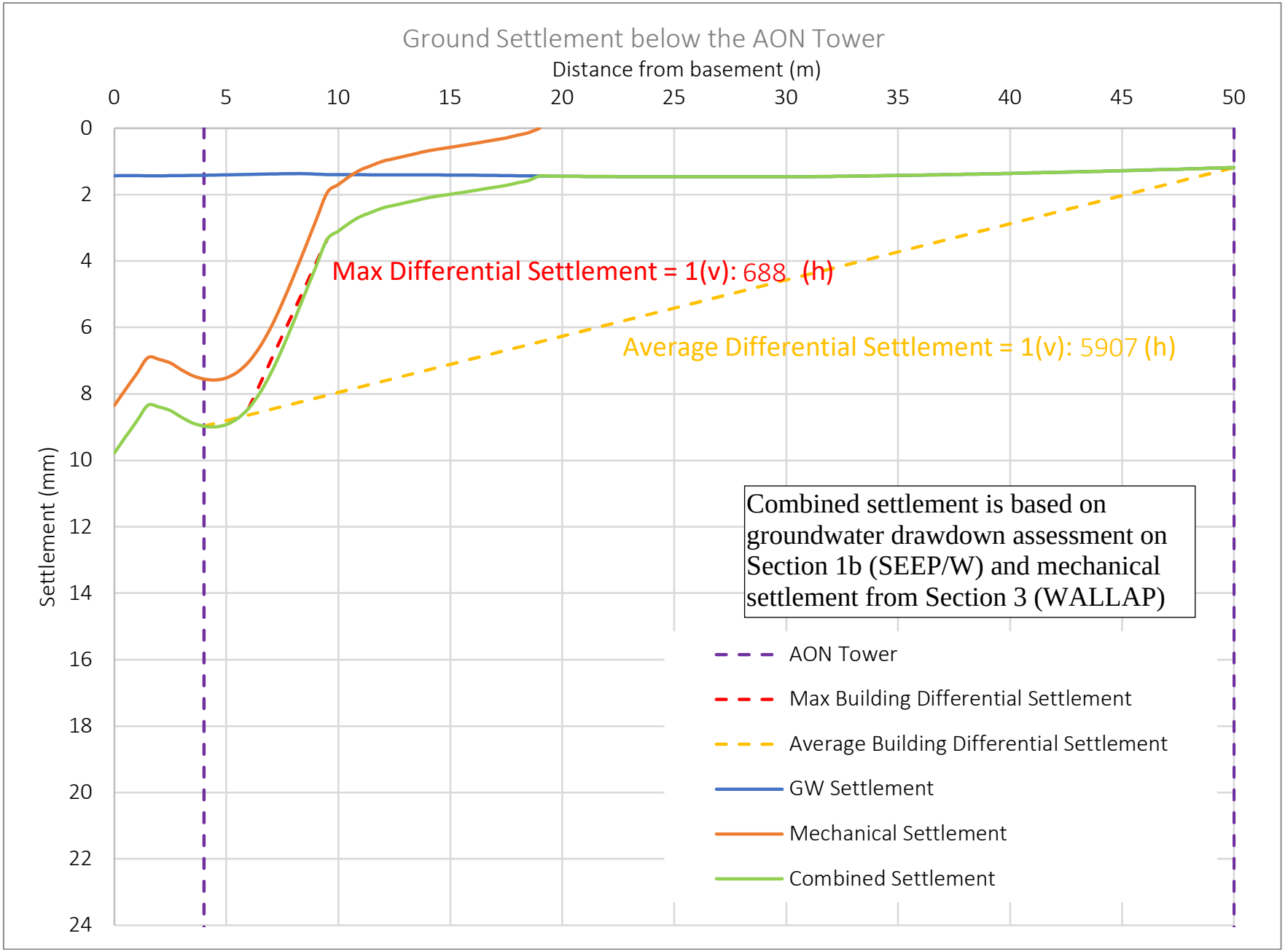


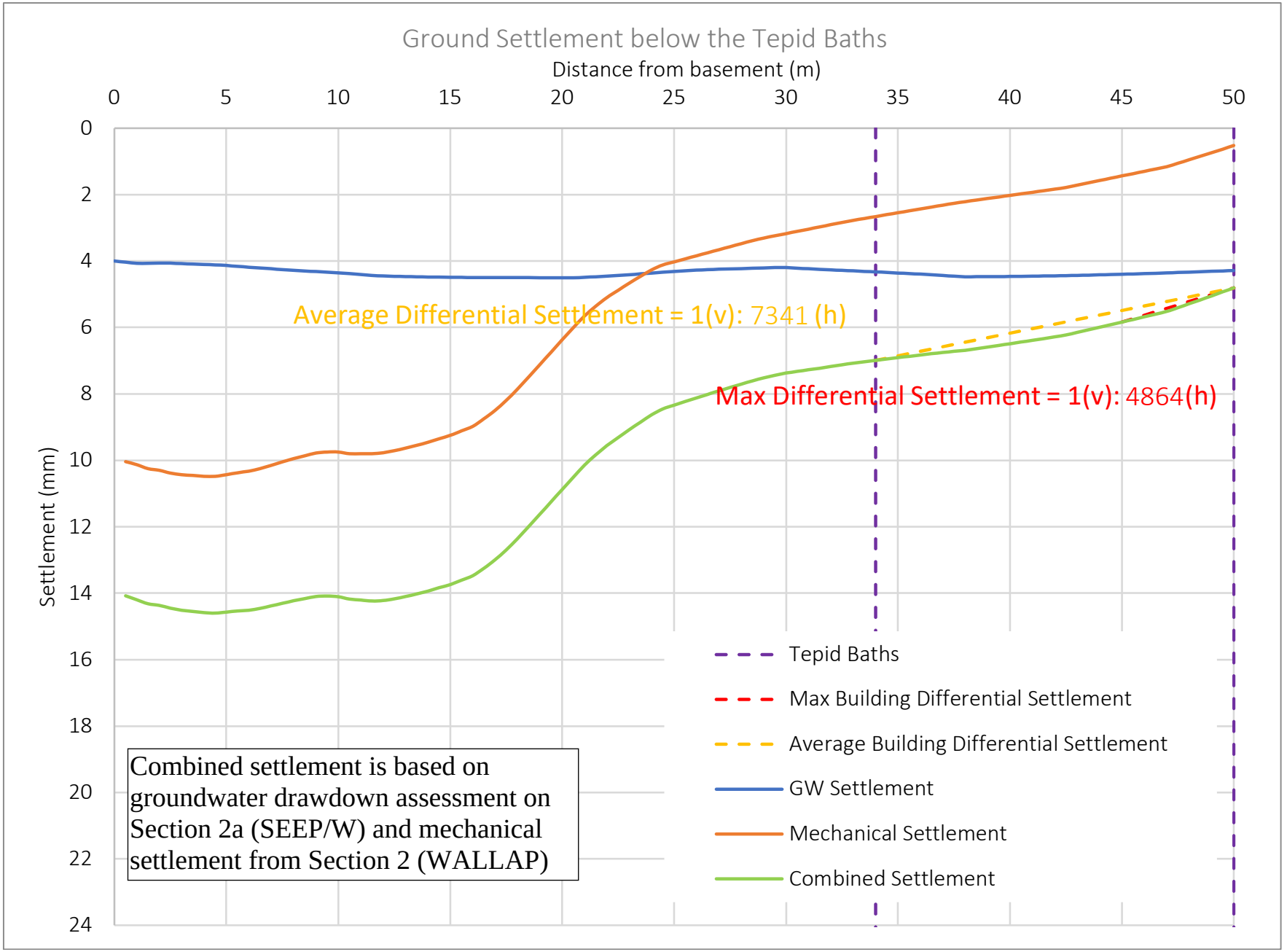
Appendix H Combined Settlement Profiles

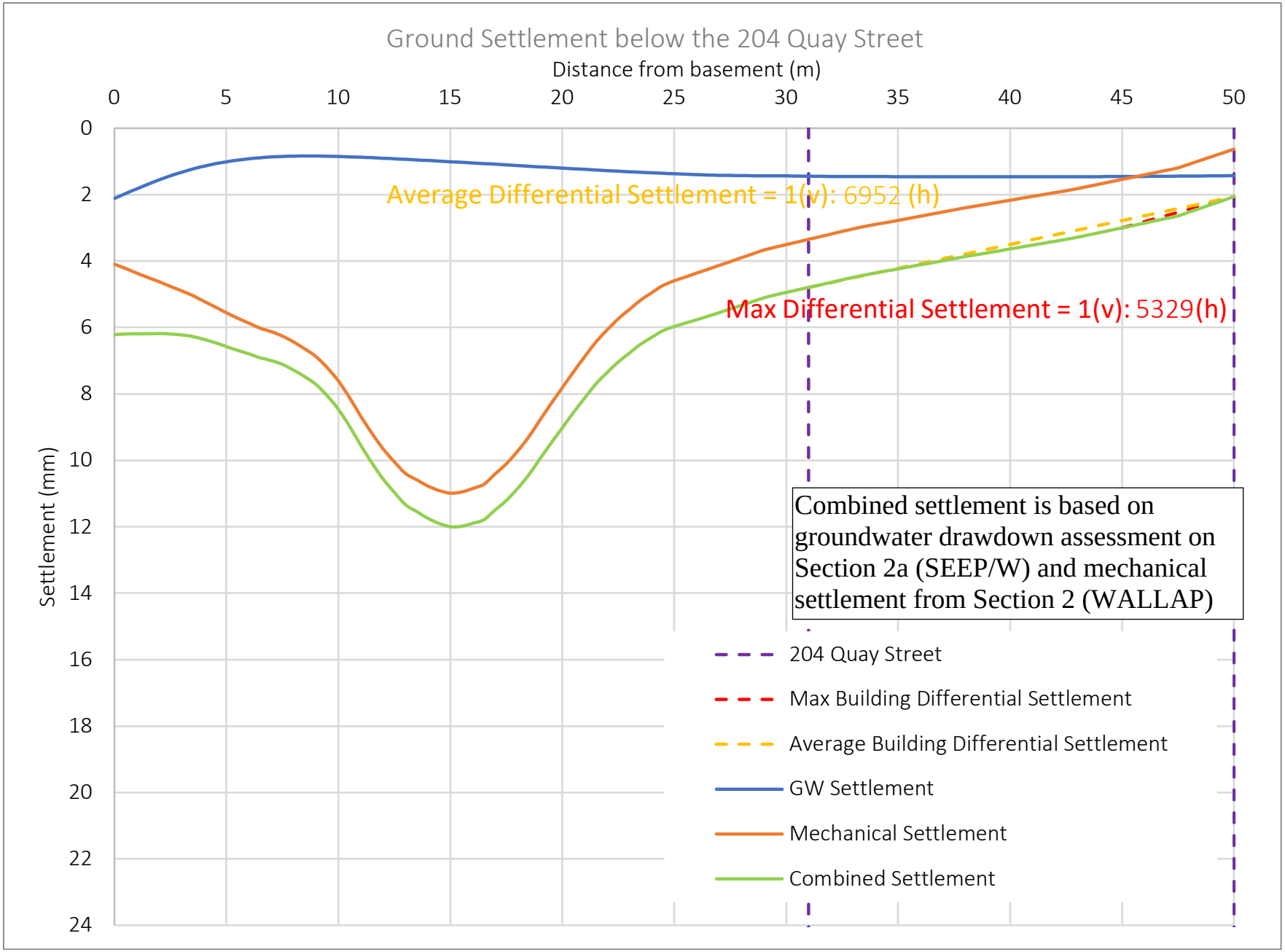

Ground Settlement below for the Msocial Building
Distance from basement (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Combined settlement is based on groundwater drawdown assessment on Section 2a (SEEP/W) and mechanical settlement from Section 1 (WALLAP)
Average Differential Settlement = 1(v): 2530 (h)
Max Differential Settlement = 1(v): 1044(h)
Msocial Building
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement

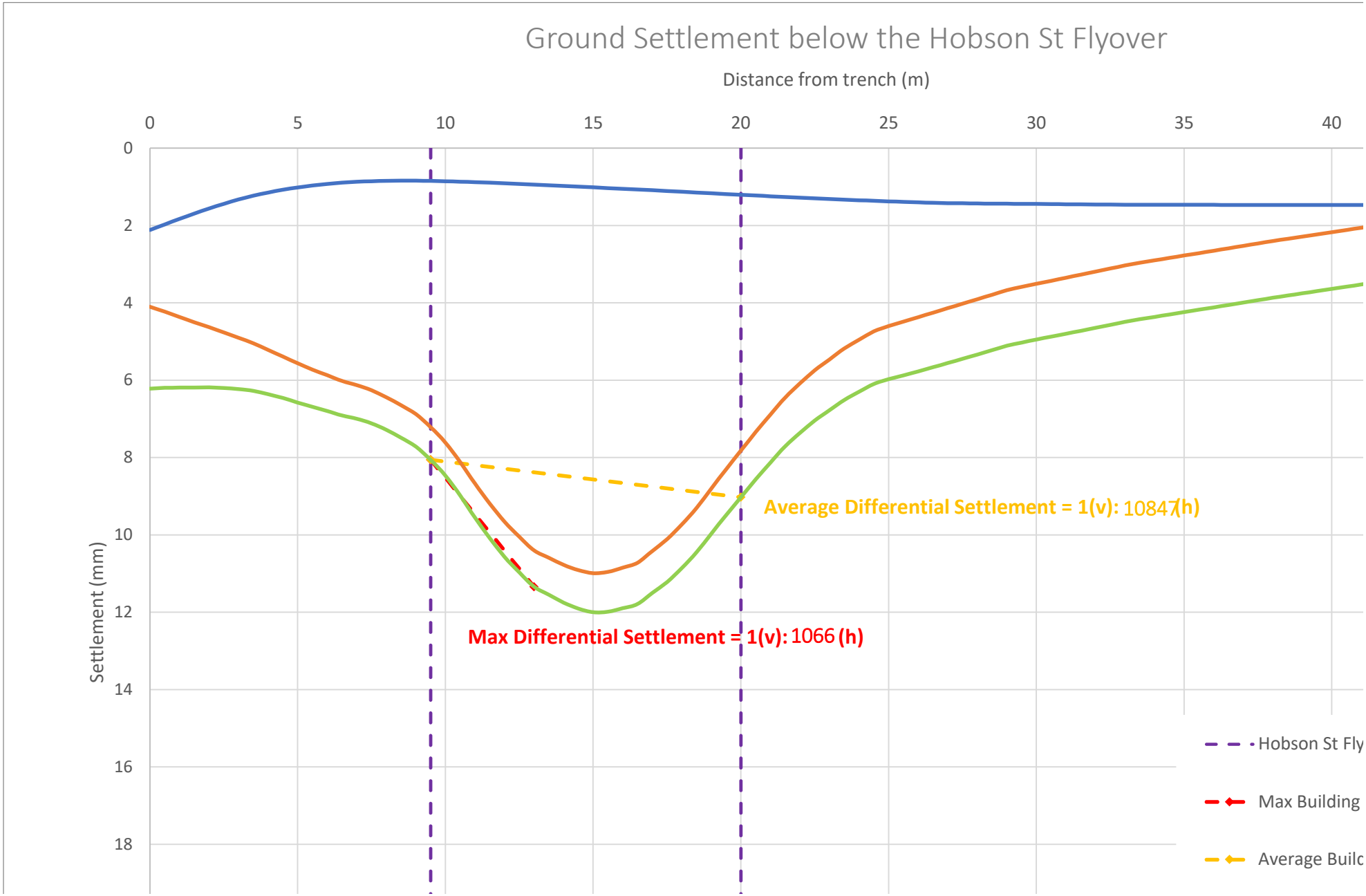

Ground Settlement below for the HSBC Building
Distance from wall (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Average Differential Settlement = 1(v): 6270 (h)
Max Differential Settlement = 1(v): 1045(h)
Combined settlement is based on groundwater drawdown assessment on Section 2b (SEEP/W) and mechanical settlement from Section 1 (WALLAP)
HSBC Building
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement


Ground Settlement below for the HSBC Podium
Distance from wall (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Max Differential Settlement = 1(v): 3434(h)
Average Differential Settlement = 1(v): 3638 (h)
Combined settlement is based on groundwater drawdown assessment on Section 2b (SEEP/W) and mechanical settlement from Section 1 (WALLAP)
HSBC Podium
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement


Ground Settlement below the AON Tower
Distance from basement (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Max Differential Settlement = 1(v): 688 (h)
Average Differential Settlement = 1(v): 5907 (h)
Combined settlement is based on groundwater drawdown assessment on Section 1b (SEEP/W) and mechanical settlement from Section 3 (WALLAP)
AON Tower
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement


Ground Settlement below the Tepid Baths
Distance from basement (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Average Differential Settlement = 1(v): 7341 (h)
Max Differential Settlement = 1(v): 4864(h)
Combined settlement is based on groundwater drawdown assessment on Section 2a (SEEP/W) and mechanical settlement from Section 2 (WALLAP)
Tepid Baths
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement


Ground Settlement below the 204 Quay Street
Distance from basement (m)
0
5
10
15
20
25
30
35
40
45
50
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
Average Differential Settlement = 1(v): 6952 (h)
Max Differential Settlement = 1(v): 5329(h)
Combined settlement is based on groundwater drawdown assessment on Section 2a (SEEP/W) and mechanical settlement from Section 2 (WALLAP)
204 Quay Street
Max Building Differential Settlement
Average Building Differential Settlement
GW Settlement
Mechanical Settlement
Combined Settlement


Ground Settlement below the Hobson St Flyover
Distance from trench (m)
0
5
10
15
20
25
30
35
40
Settlement (mm)
0
2
4
6
8
10
12
14
16
18
Average Differential Settlement = 1(v): 1084.7(h)
Max Differential Settlement = 1(v): 1066 (h)
Hobson St Fly
Max Building
Average Build

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