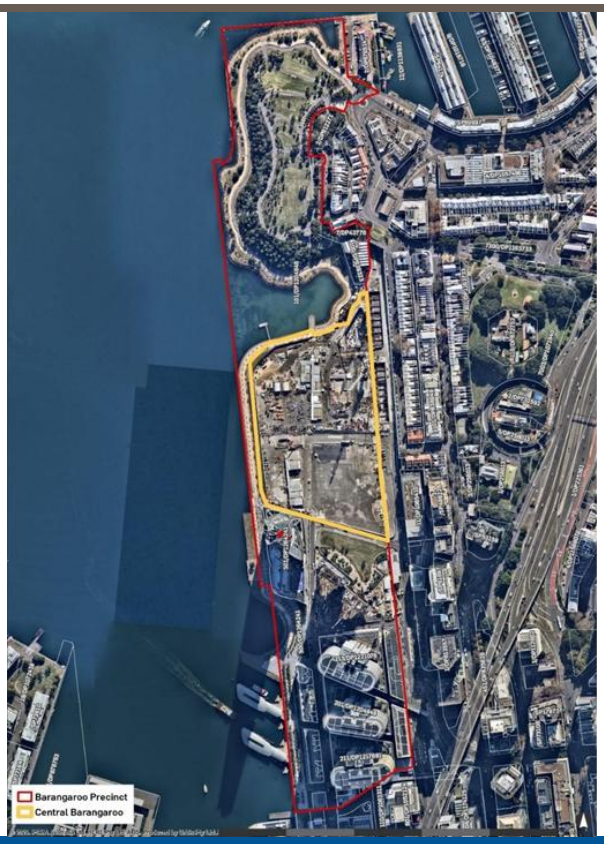
Central Barangaroo Stage 2 Early Works

Geotechnical Impact Assessment Report: State Significant Development Application: Central Barangaroo Stage 2 Early Works

Aqualand B Development Holding Pty Ltd (Aqualand)



Reference: SYDGE287887-AU Rev2

16 April 2025

CENTRAL BARANGAROO STAGE 2 EARLY WORKS

State Significant Development Application: Central Barangaroo Early Works - Hickson Road Interface

Report reference number: SYDGE287887-AU Rev2
16 April 2025

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EXECUTIVE SUMMARY[1]

This Geotechnical Impact Assessment has been prepared by Tetra Tech Coffey Pty Ltd to accompany a State Significant Development Application (SSDA) for the proposed site establishment, the installation of the Perimeter Retention Wall (PRW) and bulk excavation works for the Central Barangaroo Stage 2 Early Works project.

This report has been prepared to assess the impact of the proposed works and address the relevant conditions of the approved Barangaroo Concept Plan (MP06_0162) and the Secretary's Environmental Assessment Requirements (SEARs) issued for SSD-46922214 on 31 August 2022. The specific SEAR for which this report addresses is outlined below in Table 1 with a summary response based on the findings of this report.

Table 1: SEARs relevant to this report.

Issue and Assessment Requirement	Response
7. Ground Conditions	
The EIS must assess any geotechnical and acid sulphate soil impacts and sediment and erosion controls.	This report concludes that the proposed early works stage 2 involving the initial site establishment, installation of 339m of perimeter retaining wall and bulk excavation to RL -11.2m AHD with localised deeper excavation to -14m AHD for the Metro Interface, is not likely to have adverse impacts from a geotechnical perspective on properties and infrastructure surrounding the site. Refer to Section 6.2 of this report for further detail. The effects of any acid sulphate soil and sediment erosion controls will be addressed in a separate report.

In addition to this assessment, separate geotechnical reports are being prepared to assess the geotechnical impacts of the proposed PRW and bulk excavation works to surrounding critical infrastructure, namely:

- The adjacent Sydney Water pump station SPS1129 located to the south of the site; and
- The Sydney Metro Station Box and tunnels located to the east and north of the site.

A Special Engineering Assessment - SEA (Tetra Tech Coffey report reference SYDGE287887-AW Rev 3) is currently being prepared for the Sydney Water pump station along with a separate Geotechnical Impact Assessment (Tetra Tech Coffey report reference SYDGE287887-AV Rev 4) for the Barangaroo Sydney Metro Station Box and tunnels. The findings of these reports will address specific SEARs relevant to these works and therefore, do not form part of this document.

[1] This executive summary must be read in the context of the full report and the attached limitations.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AHD	Australian Height Datum
BEL	Bulk excavation Level
CBD	Central Business District
Council	City of Sydney Council
DPHI	Department of Planning, Housing and Infrastructure
GFA	Gross Floor Area
LGA	Local Government Area
MHWS	Mean High Waster Spring
MLWS	Mean Low Water Spring
PEHC	Precincts - Eastern Harbour City
PRW	Perimeter Retention Wall
RL	Relative Level
SEAR	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSDA	State Significant Development Application

1. PROJECT SUMMARY

The proposed SSDA will seek approval for early works associated with the future mixed-use development of Central Barangaroo (set out under **MP06_0162**). The proposal sees to undertake bulk excavation and site establishment works for the installation of the perimeter retention wall, and conduct remediation and archaeological investigations within the site.

These works will facilitate the provision of future basements, consistent with the parameters set out under the approved Concept Plan for Barangaroo under MP06_0162.

The works subject of the SSDA include the following:

- Establish the site and installation of temporary plant and machinery, including dewatering and bentonite slurry plant and ancillary services,
- Construction of perimeter retention wall, including any required excavation, associated rock anchors and PRW capping beam construction,
- Associated remediation and Archaeological investigations in the area of excavation and works;
- Provision for future services,
- Associated “tie-in” works to Metro Interface Wall and the secant pile wall proposed by the applicant under SSD-39587022,
- De-stressing and removal of existing anchors supporting Sydney Metro pile wall,
- Bulk excavation for the provision of a future basement and associated rock anchors (including anchors support the secant pile wall approved in SSD-39587022,
- Construction of foundation piling,
- Installation of waterproofing membrane
- Construction of hydrostatic slab, and
- Structure and waterproofing for the Barangaroo Metro station southern entrance interface next to the existing Sydney Metro pile wall.

The proposal does not seek approval of any buildings, or the design, construct and use of the basement. These will be subject to future detailed SSDAs for Central Barangaroo, consistent with the outcomes of MP06_0162.

2. THE SITE

The site is located in Central Barangaroo, which forms part of the wider Barangaroo Precinct comprising a total area of 22ha. It is located in the north-western edge of Sydney CBD and falls within City of Sydney Local Government Area (**LGA**). Barangaroo Precinct interfaces with Hickson Road in the east, the foreshore in the west, Walsh Bay to the north and Darling Harbour in the south.

The Precinct is divided into three distinct development areas, including:

- **Barangaroo South (approx. 7.5ha)** – Located at the southernmost end of Barangaroo Precinct. Progressively built over the last six years and includes mixed-use neighbourhood comprising commercial office buildings, mixed use buildings, shops, cafes, hotel and community uses.
- **Central Barangaroo (approx. 5.2ha and area subject of SSDA)** – Located between Barangaroo South and Barangaroo Reserve. Currently vacant and undergoing site preparation works to facilitate a mixed-use area with a focus on retail activation, residential and community uses.
- **Barangaroo Reserve (approve 6.1ha)** – Located in the northern end of the Precinct featuring Barangaroo Reserve. Featuring open space and lookout points to Sydney Harbour, Nawi Cove and Marrinawi Cove. Barangaroo Reserve features the Cutaway – a future arts and cultural entertainment space.

The above results in a total area of 18.8ha. The residual 3.2ha is represented by the reshaping of the former industrial headland into Barangaroo Reserve and the creation of Nawi Cove as a substantial water body within the Barangaroo site, forming the original 22ha.

A summary of the site is provided below in Table 2.

Table 2: Site Description

Item	Description
Site Area	5.2ha (approx.) of the 22ha Barangaroo Precinct
Ownership	Infrastructure NSW
Legal Description	Lot 52 Deposited Plan 1213772

The location of the site in the surrounding context is illustrated in Figure 1.

The area currently features a large concrete hardstand area/construction site that is occupied by temporary structures for site preparation works, machinery, materials and vehicle parking for site workers. Hoarding is currently erected around the Central Barangaroo site.

Figure 1: Site Aerial (source Urbis)

3. BACKGROUND AND RELATED APPLICATIONS

3.1 CONCEPT APPLICATION MP06_0162

The Barangaroo Concept Plan was approved on 9 February 2007 under Part 3A of the EP&A Act 1979. It has been modified several times since 2007.

The original Concept Plan was facilitated through an amendment to Schedule 3 of State Environmental Planning Policy (Major Development) 2005 now consolidated into State Environmental Planning Policy (Precincts – Eastern Harbour City) 2021 (PEHC SEPP). The SEPP establishes the land use, height, GFA and other provisions relating to the planning and development of Barangaroo.

3.1.1 The Approved Concept Plan

Following several modifications up to MOD 11, the approved Concept Plan that applies to Barangaroo currently is described in Condition A1 of the Instrument of Approval.

3.2 CENTRAL BARANGAROO EARLY WORKS PHASE 1 SSDA-39587022

SSDA-39587022 was approved by the Independent Planning Commission on 29 January 2025 and includes:

- Partial demolition of an existing shoring wall capping beam along Hickson Road,
- Construction of a new secant pile retention wall (approx. 150m long),
- Excavation of land related to construction of the secant pile retention wall,
- Localised remediation related to the secant pile retention wall,
- Associated Archaeological Investigations in the area of excavation and works,
- Sydney Metro / Hickson Road interfaces – perimeter retention wall interface works, and Hickson Road public domain interface works, and
- Relocation of stormwater and other services to enable the permanent works outlined above.

4. PROPOSED WORKS UNDER THE SUBJECT OF THIS SSDA

The proposed SSDA will seek approval for the Stage 2 early works associated with the future mixed-use development within Central Barangaroo (refer MP06_0162). The specific works associated under this SSDA are outlined in the following sections.

4.1 SITE ESTABLISHMENT

The proposal will establish a site construction establishment zone in the western portion of the site next to the proposed retention wall. The site construction establishment zone will include provision for the installation of site sheds, the water treatment plant, bentonite plant and a compound area for construction staging zones.

4.2 PERIMETER RETENTION WALL

The primary works proposed involve the construction of a reinforced concrete perimeter retention wall with supporting capping beams. The width of the wall is approximately 1000mm (subject to the detailed design) and will extend from the existing ground (approx. RL 2.5m) to a maximum depth of approximately, 17 m (RL-14.9 m) within the rock bed.

The junction of the capping beam and the wall will be constructed over the sea water line (at the ‘king’ tide level) which sits at approximately RL1.1m. The wall will extend around the northern, western, and southern perimeter boundaries of the extent of excavation.

The wall will continue below the level of bulk excavation subject to the existing rock profile to satisfy the design requirements.

The junction between the northern extent of the proposed wall and the existing Sydney Metro pile wall will be coordinated with Sydney Metro, structural engineering, geotechnical engineering and water-proofing consultants. Similarly, the junction between the southern extent of the proposed wall and the secant pile wall (proposed by the applicant, refer SSD-39587022) will be coordinated to ensure alignment.

4.3 BULK EXCAVATION

The proposed works seek consent for the bulk excavation required to accommodate the proposed perimeter wall and provision for a future basement associated with the approved Concept Plan MP06_0162.

It is estimated that approximately 277,400m^3 of material will be excavated from the site within the perimeter wall. Excavation will reach a maximum depth of approximately RL -11.2m, and approximately RL -14 m at the Sydney Metro interface, subject to design and Sydney Metro interface requirements.

Consent for the construction of the basement structure and future uses is not sought in this application and will be subject to a separate future detailed SSDA.

4.4 CONSTRUCTION STAGING

It is envisaged that the proposed early works will largely be carried out in the five following stages:

Stage 1:

- Carry out archaeological investigation works,
- Site establishment works (including installation of site sheds, Bentonite plant), and
- Installation of temporary construction pads and initial construction of approximately a 339m length of the perimeter retention wall.

Stage 2:

- Progress site establishment works as needed on site,
- Continue wall construction,
- Carry out associated remediation as required during construction of the wall,
- De-mobilise PRW plant and equipment,
- Mobilise de-watering and water treatment plant, and
- Construct capping beam.

Stage 3:

- Full extent of bulk excavation and remediation works (approximately 277,400m^3) undertaken in conjunction with dewatering and install of temporary rock anchors,
- Tie in-works, including establishing waterproof connection, with Sydney Metro interface wall and proposed Central Barangaroo secant pile wall (refer SSD-39587022),
- Removal of de-stressed Sydney Metro rock anchors.

Stage 4:

- Foundation piling.

Stage 5:

- Installation of the waterproofing membrane and construction of the hydrostatic slab (approximately 1400mm thick).

Construction and excavation are anticipated to be undertaken over an approximated 28-month program.

5. GEOTECHNICAL CONDITIONS

5.1 LOCAL GEOLOGY

The NSW Seamless Geology (Department of Planning, Industry and Environment, 2020) indicates the site is underlain by anthropogenic Fill and Quaternary sediments over Triassic age Hawkesbury Sandstone. Figure 2 displays the geology of the site and its surrounds. There is a Jurassic age dolerite dyke (Pittman LIV dyke) also located immediately to the south of Central Barangaroo site, Reference to (D.J. Och, Offler, Zwingmann, Braybrooke, & Graham, 2009) shows the Luna Park Fault near the north-western corner of the harbour foreshore area.

The Luna Park Fault Zone is interpreted by Ochs et al (refer Section 2.3) to be aligned near the north-western corner of the harbour foreshore area. Within the Luna Park Fault Zone, sub-vertical joints spaced relatively closely (typically between 0.1m to 0.5m intervals) may be encountered. The sub-vertical joints may be clean, may be open 1 to 2 mm and contain clay infilling. The rock within the upper 15 m of the bedrock surface may be more weathered and lower strength than is typical of the surrounding rock. At depth, the rock may be more weathered than is typical of the surrounding rock. The fault zone is approximately 15 m wide.

Neither the Pittman LIV dyke nor Luna Park Fault Zone are expected to directly impact the Central Barangaroo basement, although secondary jointing and fracturing of the adjacent rock could potentially lead greater seepage inflow into the north-west corner of the site.

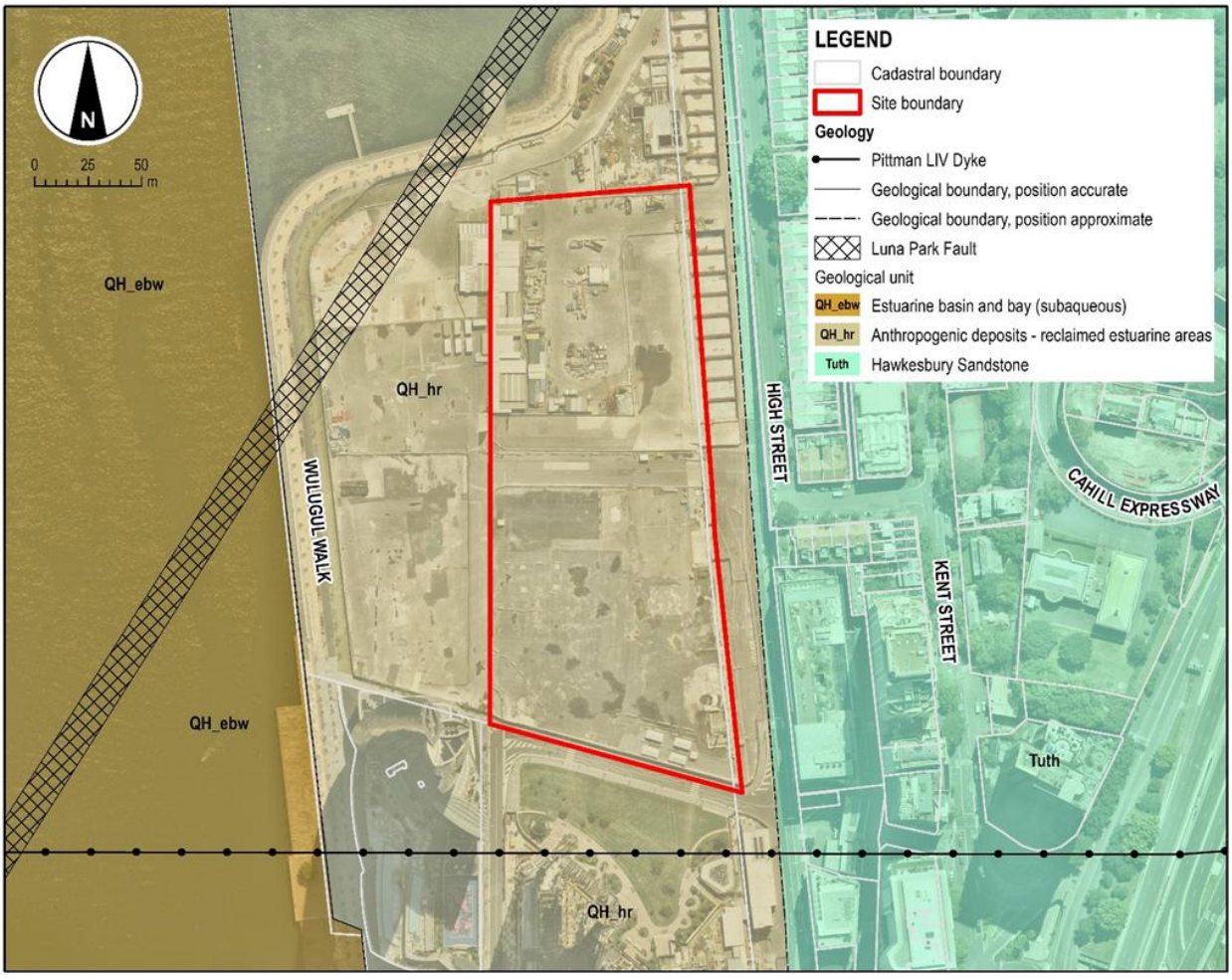

Figure 2: Site Geology from NSW Seamless Geology and Och et al.

5.2 SITE HISTORY

The following excerpt from (Godden Mackay Logan, 2012) details the site's history and usage:

"The historical development of the Barangaroo [Central] site is almost entirely related to maritime industries, including wharves, shipbuilding, and associated enterprises. The development and operation of these industries had a tremendous effect on the physical form of the site, including reclamation and major changes to the shoreline.

The historical development of the broader Barangaroo site included the following phases:

- Phase 1—Aboriginal occupation
- Phase 2—Private Ownership 1788–c1870
- Phase 3—Intensive Development and Decline c1870–1901
- Phase 4—Renewal 1902–2010.

Most of the nineteenth century development within this part of the harbour was focused around the northern and southern parts of the Barangaroo precinct. Most of the Barangaroo Central site was originally located below the water line, with the natural topography of the foreshore within the Barangaroo Central site being very steep.

The area of Barangaroo Central remained largely undeveloped throughout the nineteenth century and much of the study area now comprises reclaimed land. While the northern headland and the southern portion of the Barangaroo site was extensively developed from the early nineteenth century, the central portion remained relatively undeveloped until the 1860s, owing to the steep topography of this area. Maritime industry only extended into this part of the site after this time.

By 1865, Cuthbert's shipyard had partially extended into the area of the Barangaroo Central precinct, including construction of some wharf infrastructure in this area. Dibb's wharf was constructed in this area following Cuthbert's death in 1874.

By 1870, most of the foreshore between Dawes Point and Darling Harbour had been modified by quarrying, reclamation or the construction of seawalls, and the area was almost entirely occupied by wharves, stores and commercial properties. Between 1880 and 1900, most of the wharves and other structures were demolished as part of the government resumption of the area.

Hickson Road was constructed c1912. These works included excavation of bedrock along the road alignment and major modification of the shoreline along the Barangaroo Central precinct. The foreshore within the Barangaroo Central was partially reclaimed in the early twentieth century, and a number of finger wharves were constructed in this area c1912. By the 1950s, the finger wharves were no longer suitable for modern shipping. The areas between the wharves in the central and southern parts of the Barangaroo site were progressively infilled."

Anecdotally we understand that some of the pre-exiting timber wharves may still remain within the fill.

5.3 TYPICAL BARANGAROO GROUND CONDITIONS

This section summarises generalised ground conditions that typically have been encountered in the Barangaroo foreshore locality.

5.3.1 Fill

Reclamation fill is highly variable in nature and thickness across the site and was placed during various phases of reclamation over the past 115 years. As a result, the fill material is heterogeneous, typically uncontrolled and cannot be easily characterised. The Fill is generally continuous across the site.

The fill is known to contain deleterious materials, large hard inclusions such a boulders and rubble, and has a potential for near surface voids. As a result, excavations and piling through this material can be problematic at times.

5.3.2 Estuarine & Alluvium Deposits

Below the fill there is both alluvial and estuarine sediments occurring as pre-existing channel infills and coastal marine deposits around the pre-development Darling Harbour/Barangaroo foreshore area. The deeper Quaternary sediments are inferred to have been deposited during the last glacial period, or Pleistocene (approximately 120,000 years to 10,000 years ago) when sea level oscillation of between RL -20 m AHD and -120 m AHD occurred.

During periods of lower sea level, river systems incised into the underlying bedrock, and existing sediments became exposed and oxidised, causing Pleistocene sediments to exhibit red and orange hues. These Pleistocene sediments are typically over consolidated and of higher density/consistency that the overlying Holocene sediments (from approximately 10,000 years ago).

By nature of the periodic deposition and erosion, both the Estuarine and Alluvium Sediments tend to be thinly layered and discontinuous across the Barangaroo Precinct.

Estuarine Sediments

Clay dominated deposits represent the broad lagoon/estuarine type environments associated with elevated sea levels, while the sand units represent higher energy fluvial deposits associated with lower sea levels.

During the following Holocene Epoch to the present, sea levels rose to the current level, submerging the eroded land surface and incised river valleys. These relatively recent sediments are generally normally consolidated, typically of soft/loose consistency/relative density and are often dark grey.

Where encountered in earlier Barangaroo stages, estuarine sediments are typically dark grey to black silty/sandy clays with subordinate clayey sands. They typically contain shells and shell fragments and organic material. Organic/peaty clay horizons may be present.

Alluvial Sediments

In addition to sediments deposited from the sea, there are sediments deposited from erosion of the neighbouring sandstone ‘highland’. Where encountered in earlier Barangaroo stages, these soils are generally clayey sand with subordinate and interbedded silty clays and sandy clays, of medium dense to dense relative density and typically brown, orange brown, red brown and yellow.

5.3.3 Hawkesbury Sandstone

Due to the erosional deposition history of the overlying alluvial deposits, residual soil is generally absent and where present is typically less than 1 m thick.

The Hawkesbury Sandstone is typically a fine to coarse grained quartzose sandstone deposited in 1m to 5m thick beds and lenses that exhibit either massive or sheet facies. Shale breccia lenses and bands are common at the contacts between beds, with siltstone/shale interbeds forming a minor part of the unit. In some cases, these minor shale bands weather preferentially to form softer bands.

Structurally, there are two main joint sets within the Hawkesbury Sandstone in the Sydney CBD region: one set trending north-north-east and an orthogonal set trending west-north-west. The joints are typically sub-vertical, relatively widely spaced and may not be continuous through the sandstone beds. Vertical joints often terminate in shale bands. There are a number of sub-vertical fault zones (such as the Luna Park Fault to the north of the site) and joint swarms that have been identified trending roughly north east across the Sydney CBD that can result in more closely spaced jointing and may impact on excavation stability to a greater extent than the more widely spaced joints of the main joint sets.

The sub-horizontally bedded sandstone is inferred to step down towards Darling Harbour in a series of buried cliffs and possible overhangs paralleling the natural shoreline geometry. Quarried vertical sandstone faces also occur immediately east of Hickson Road.

5.3.4 Shale Interbeds and Breccia

During the deposition of the Hawkesbury Sandstone, areas of overbank flooding and back swamps have resulted in present day discrete siltstone and shale bands within the sandstone beds. Often these beds are non-persistent, extending over relatively short lateral distances. Break up of these beds during consolidation has resulted in zones of mixed shale and sandstone (Shale Breccia). These zones can result in areas of higher strength bedrock, but also areas of poor resistance when exposed to the atmosphere.

5.3.5 Groundwater

In 2017, groundwater levels were measured at the site at elevations between 0.6 mAHD to -0.6 mAHD. Groundwater levels are expected to vary due to tidal influence. The Mean High Water Spring (MHWS) level is about 0.62 mAHD and the Mean Low Water Spring (MLWS) level is at -0.7 mAHD.

5.4 PRELIMINARY GROUND MODEL

Based on the existing site ground information presented in the Geotechnical Interpretative Report by Tetra Tech Coffey dated 15 November 2022 reference SYDGE287887-AN, the subsurface profile for the site can be summarised into the geotechnical units as outlined in Table 2 below.

Table 3: Geotechnical Ground Model

Unit	Origin	Description	Inferred typical Thickness (m)
1	Fill	Highly variable heterogenous material, comprising gravelly sands and clayey sands with sandstone boulders and deleterious anthropogenic material including building rubble and timber	5-16m
2	Estuarine & Alluvium Deposits	Highly variable comprising interbedded soft to very stiff clays and sandy clays, together with loose to medium dense sands and clayey sands, grey to orange mottled red-brown with shells	2-18m
3	Residual Soil	Very stiff to hard clay, sandy clay and some extremely weathered sandstone, typically sparse across the site due to washing away from estuarine/alluvium depositional periods.	0.5-3m, but of limited distribution across site
4A	Class V Sandstone	Extremely to highly weathered, very low to low strength, orange brown with clay seams. Sparse	0-2m, discontinuous bands and

Unit	Origin	Description	Inferred typical Thickness (m)
		across the site due to washing away from estuarine/alluvium depositional periods.	very limited on site
4B	Class IV Sandstone	Highly to moderately weathered, low to medium strength, orange-brown to grey with closely spaced defects	0.5-2m, but of limited distribution across site
4C	Class III Sandstone	Moderately weathered to fresh, medium to high strength, orange-brown to pale grey with moderately spaced defects and/or some shale breccia	1-6m, can be discontinuous across site
4D	Class II or Better Sandstone	Slightly weathered to fresh, medium to high strength, pale grey with widely spaced defects	basal strata

6. GEOTECHNICAL ASSESSMENT

6.1 STAGE 2 WORKS LOCATION

The Stage 2 PRW is located along the northern, western and southern boundaries of the site comprising a total of approximately 339m in length and generally encompasses the site. The northern end of the Stage 2 PRW will be built adjacent to the western extent of the Barangaroo Metro Station structure and extend westward towards the shoreline before turning south along the western boundary of the site. At the southern boundary, the proposed PRW connects to the Stage 1 secant pile wall.

Following installation of the PRW, bulk excavation will be undertaken within the site area encompassed by the Barangaroo Metro Station to the north-east, The Stage 1 retaining wall to the east and south, and the Stage 2 PRW. Bulk excavation will extend to -11.2m AHD with localised deeper excavations up to -14m AHD for sump and lift pits along with the tie-in with the Barangaroo Sydney Metro station interface. Figure 3 below summarises the locality of the proposed works.

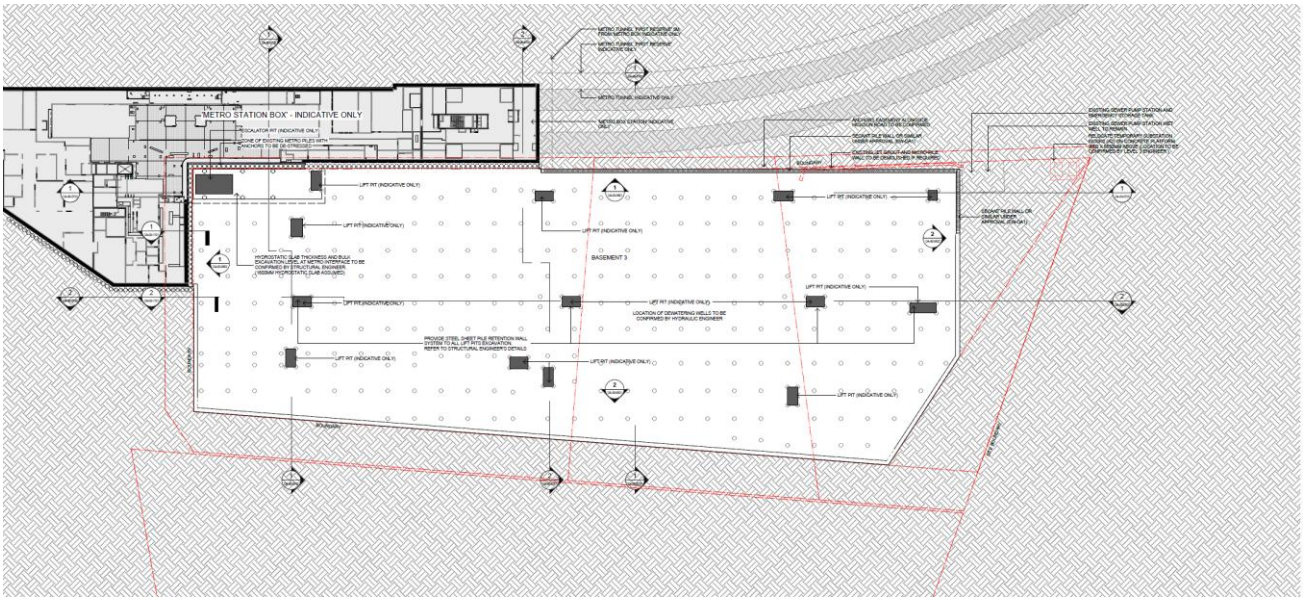

Figure 3: Early Works Stage 2 - Perimeter Retention Wall Plan.

Once bulk excavation is complete, foundation piling works will commence and then installation of the hydrostatic slab as the basement floor will be undertaken.

6.2 STAGE 2 WORKS IMPACT

The following sections outline the proposed works under this SSDA and potential geotechnical impacts they may have to surrounding properties and infrastructure. Impacts related to specific critical infrastructure are detailed further in separate documents as follows:

- A Special Engineering Assessment for the adjacent Sydney Water sewerage pump station SPS1129 located to the south of the site (Report Reference: SYDGE287887-AW Rev3)
- Geotechnical Impact Assessment for the proposed works with respect to the Barangaroo Sydney Metro Station Box and Tunnels (Report Reference: SYDGE287887-AV Rev4)

6.2.1 Site Establishment

Site establishment will generally comprise the construction of site offices and sheds along with a water treatment plant, bentonite slurry plant and construction staging zones. Minor ground improvement works for pavements and hardstands along with shallow excavation for pad or raft footings for lightweight structures and machinery would be required to be undertaken to facilitate these works. Connection of utilities and some trenching in and around the site perimeter may also be required to supply the site with services.

It is expected that excavation could be undertaken using conventional earthmoving equipment such as excavators. No rock hammering or high vibration activities are anticipated to be required for these works as the depth of excavation would generally be within fill material only using appropriate and designed shoring or battering methodologies. Where excavations extend below groundwater such as, for deeper pits and some footings, localised dewatering via sump and pump methods may be required, however these would be for short term activities and in limited quantities.

These works would generally have minimal impact to surrounding properties and infrastructure.

6.2.2 PRW Excavation and Installation

Following the site establishment, a reinforced concrete retention wall will be installed along the northern, western and southern boundaries along with supporting capping beams. Whereas the Stage 1 works proposed to use Secant piles as a retention system, given the ground conditions and greater depth to bedrock it is likely that the Stage 2 PRW will comprise a diaphragm wall. This would be consistent with the previous developments on Barangaroo precinct requiring basement construction.

The risk of this process would be instability of the excavation within the fill and / or estuarine / alluvial deposits during construction. Excavation instability has the potential to change the in-situ ground conditions immediately adjacent to the PRW and other adjacent infrastructure including the Barangaroo Metro Station. The Metro tunnels are surrounded by medium strength bedrock or better and hence there is no likely risk of PRW excavation instability considered for the tunnels. It should be noted that diaphragm walls have been successfully used on all the previous developments on this precinct.

The PRW excavation instability risk will be mitigated by the use of positive ground support mechanisms until the excavation has been backfilled with concrete. For a continuously reinforced concrete retention structure such as a diaphragm wall, this is typically achieved by keeping the excavation filled with a bentonite slurry of suitable consistency to prevent sidewall collapse. Alternative construction methodologies or shoring systems proposed by the PRW contractors should be assessed as being adequate prior to commencing the Stage 2 Early Works.

6.2.3 Bulk Earthworks

6.2.3.1 Excavation Works

Prior to any excavation works, a detailed Excavation and Monitoring Plan will need to be implemented which will outline the proposed excavation methodologies in each soil/rock unit with consideration of the proposed construction staging and material volumes. The plan will also outline a monitoring system that will be installed on site to measure excavation induced vibrations and ground movements along with any movement of the PRW during excavation. This may include the use of survey prisms, tilt sensors, vibration monitors or other instruments to quantitatively measure these changes in ground conditions both within the site and surrounding structures. This should be undertaken in conjunction with dilapidation surveys of adjacent infrastructure to further reduce the risk of excavation-inducted damages.

Where this is undertaken, excavation induced impacts to surrounding properties or infrastructure are likely to be mitigated and managed appropriately with little risk.

6.2.3.2 Temporary Support

During basement excavation, temporary lateral supports will be required for the PRW until the basement slabs are installed to provide permanent lateral support. It is anticipated that conventional temporary ground anchors (e.g. pre-stressed multi-strand steel anchors) would be utilised for wall retention, which will be de-stressed after construction of the permanent wall support. The number of anchor rows and spacing between anchors will need to be assessed during detailed design and may be used in conjunction with steel struts and walers, or props in areas where infrastructure situated behind the PRW may limit the use of temporary anchors.

The temporary ground anchors, particularly along the Hickson Road (eastern side), would be positioned (inclination angle) and designed to ensure these do not encroach into the First Reserve.

6.2.4 Foundation Piling

Following excavation to BEL, foundation piling will occur which will typically comprise piles installed to a suitable embedment depth into competent bedrock to support the future structure. From BEL at -11.2m, the eastern areas of the of the basement will be bearing on Unit 4 bedrock material, with the central and western portions of the site potentially still in Unit 2 Alluvium soils and Unit 3 Residual soils.

Pile installation will require temporary excavation and subsequent backfilling with steel reinforced concrete. The potential impact of this process would be instability or collapse of the pile excavation within the alluvium soils. However, as these will be situated within the perimeter of the PRW, the effect or risk of instability to surrounding properties be very low.

The pile excavation instability risk will be further mitigated using positive ground support mechanisms until the pile bore has been backfilled with concrete. A suitable pile shoring method within alluvium soils may involve temporary steel casings installed into the top of the sandstone bedrock.

Piles supporting compressive loads which are located in the area adjacent to the Metro Station Box (Metro Box and Shark Fin areas), may need to be sleeved to avoid reliance on the rock wedge within the second reserve as well as to avoid any loading being imposed on to the Barangaroo Station Box walls.

6.2.5 Groundwater

The use of temporary casing or other suitable ground support techniques will minimise the amount of ground water extracted during pile and PRW construction.

To prevent the occurrence of out-of-balance groundwater loads between the east and west walls of the Sydney Metro Barangaroo Station box during construction dewatering of the adjacent Central Barangaroo Development, a depressurisation system has been developed by Sydney Metro to equalise the hydrostatic water pressure across the station. The design approach of the depressurization system was described in the Appendix P of the Design Package: DP-S-240 Barangaroo Station Structure (Ref: SMCSWTSE-JAB-SBR-ST-RPT-030018 AFC(B6-B3)). Dewatering of the adjacent Sydney Metro Barangaroo Station excavation depressurisation system is assumed to be operated and managed by others.

Following the installation of the PRW, internal dewatering will be undertaken to facilitate the basement excavation. It is anticipated that the internal dewatering will remain active until the installation of the foundation piles, the hydrostatic slab and the basement structure up to and including the ground floor slab are in place. The sustained groundwater inflow into EWDA-2 excavation during construction is estimated to be up

to 2.84 L/s. The inflow includes allowance for the potential increase in groundwater intake due to the presence of the Barangaroo Station box's depressurization system operated by Sydney Metro.

The foundation piles would be designed to resist the operating tension forces until the building structure reaches the point at which there is no net tension on the hydrostatic slab.

It should be noted that drawdown in the vicinity of Sydney Metro Barangaroo Station due to the Central Barangaroo Development is unlikely to exceed that which is expected to occur due to the Sydney Metro Barangaroo Station excavation depressurisation system.

There is expected to be limited to negligible drawdown within the fill material.

7. CONCLUSION

Provided good industry practice construction techniques are employed, the site establishment, installation of the perimeter retaining wall, excavation to bulk excavation level and foundation piling is not likely to have adverse geotechnical impact on the site or adjoining properties.

APPENDIX A: LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.