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COCKLE BAY PARK

STRUCTURAL ENGINEERING REPORT

Prepared for: DPT Operator Pty Ltd &
DPPT Operator Pty Ltd
By: enstruct group pty ltd

October 2017

COCKLE BAY PARK

STRUCTURAL ENGINEERING REPORT

ISSUE AUTHORISATION

PROJECT: Cockle Bay Wharf
Project No: 4886

Rev	Date	Purpose of Issue / Nature of Revision	Prepared by	Reviewed by	Issue Authorise by
A	21/09/16	Draft Issue	RCC	ML	RCC
B	30/09/16	Final issue	RCC	ML	RCC
C	24/07/17	Draft Issue	RCC	ML	RCC
D	21/08/17	Final Issue	RCC	ML	RCC
E	16/10/17	Final Issue	RCC	ML	RCC

This Report is given for the benefit of:
DPT Operator Pty Ltd & DPPT Operator Pty Ltd

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Executive Summary

Enstruct Group has been commissioned by DPT Operator Pty Ltd & DPPT Operator Pty Ltd to assist with the preparation of the Environmental Impact Statement (EIS) in response to the Secretary's Environmental Assessment Requirements (SEARS) for the proposed Cockle Bay Park Development. The scope includes structural, civil, roads, stormwater and geotechnical engineering.

The proposed development will construct a commercial tower and podium on the site bounded to the west by Darling Harbour to the north by the Pyrmont Bridge and to the east and south by the Western Distributor, as well as bridge over the Western Distributor providing a pedestrian connection with Darling Park and the city to the east.

The site is challenged by its proximity to the harbour and a geology whose competent rock stratum falls sharply westwards to the harbour as described in the geotechnical study (Coffey).

A focus of the work has been to develop a viable construction methodology for the project in concert with Multiplex Contractors. Structural systems have been developed which address the key site construction challenges: construction traffic access, building over water, building over the western distributor, achieving a conventional and efficient Sydney CBD High rise construction sequence. This work has been supported by a rigorous review of the capacity of the existing building structure on the site as well as a detailed geometrical modelling of the western distributor layout in order to prove viable bridging methods. Roads and Maritime Services (RMS) have been consulted throughout this process.

Generally, conventional structural systems have been developed for the various elements:

Foundations: steel encased large diameter concrete piles, bearing in competent rock.

Podium: conventional cast in situ concrete frame with post tensioned slabs.

Commercial Office Tower : jump start composite steel columns, conventional jump formed reinforced concrete core working in tandem with mega braces to the north and south faces providing lateral capacity for the tower, post tensioned long span floor plates (option for a composite steel floor plate available) supported by high strength concrete columns.

Land bridge: prefabricated prestressed precast concrete beams at close centres supporting precast slab and topping layer. Dimensioned to allow transport and lifting thereby minimizing intrusion in the western distributor zone.

The proposed structural systems will deliver conventional construction techniques on this site with the final structural solution to be confirmed following design excellence process.

Contents

1 Project

This report supports the Response to Submissions and amended Concept Proposal associated with a State Significant Development Application (SSDA 7684) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

DPT Operator Pty Ltd and DPPT Operator Pty Ltd (the Proponent) are seeking approval for a Concept Proposal for the redevelopment of the Cockle Bay Wharf Building and the surrounding area to create new open space and a commercial, retail and tourist precinct in the heart of the CBD (now referred to as Cockle Bay Park). The amended Concept Proposal includes:

- a large area of publicly accessible open space;
- new retail outlets, including new food and beverage destinations;
- new cultural and entertainment destinations; and
- a new commercial office tower.

The project will add new open space to the Sydney CBD and help to reconnect the city to the Darling Harbour waterfront. Cockle Bay Park will take its place in a revitalised Sydney CBD and speaks directly to local government objectives to create a 'Green, Global and Connected City' (City of Sydney) as well as the strategic vision outlined in 'Towards Greater Sydney 2056' to grow the "developing central city". The vision for this project was developed with consideration for the NSW Government objectives to support and "grow the knowledge industry", double tourism expenditure and "strengthen our local environment and communities" as outlined in 'NSW 2021: A Plan to Make NSW Number One'.

Please note that all plans, diagrams, images and graphics within this report and the supporting documentation (excluding the amended Concept Proposal Envelope Plans prepared by Francis-Jones Morehen Thorp Pty Ltd) are indicative only and have been included to communicate the intent of the amended Concept Proposal, including representative building shapes, forms, locations, layouts and relationships. It is proposed that these representations, together with acceptance of the building envelopes and massing, and associated design principles, will then be used to inform the Design Excellence process to follow the Stage 1 SSD Determination. Design Excellence outcomes will form the basis of the Stage 2 SSDA

1.1 Background

The Proponent controls the lease of the site, and also of the adjacent Darling Park precinct. The Darling Park site is a successful premium grade office precinct located on the west of the Sydney CBD, the associated Crescent Garden, located to the west of the three existing Darling Park towers, is a key area of open space in this part of the city.

The Proponent has recognised a number key issues with the existing layout of the Darling Park and Cockle Bay precinct, these being:

- The existing Cockle Bay Wharf building is not well integrated with the city, the Western Distributor freeway currently acts as a barrier to separate this area from the CBD;
- Publicly accessible open space is limited to the existing Crescent Garden in Darling Park; and
- The existing Cockle Bay Wharf building is outdated and is not in keeping with the future of Darling Harbour area as a vibrant entertainment and tourist destination.

The Cockle Bay precinct is at risk of being left behind and undermining the significant investment being made in Darling Harbour that will see it return to the world stage as a destination for events and entertainment.

Accordingly, the Proponent is taking a carefully considered and staged approach to the complete revitalisation of the site and its surrounds. The envisaged development, which will be facilitated by the proposed building envelopes will:

- Reconnect the city with the Darling Harbour waterfront;
- Create new publicly accessible open space in the heart of the Sydney CBD;
- Create new public land above the Western Distributor;
- Provide new access routes between the city and the ICC Sydney / Darling Harbour Live precinct;
- Support the Sydney economy by providing a new premium commercial building; and
- Refresh and renew an existing entertainment and tourist destination.

1.2 Site Description

The Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

The Site is located to the immediate south of Pyrmont Bridge, within the Sydney CBD on the eastern side of the Darling Harbour precinct. The Site is also located within the City of Sydney local government area (LGA). A locational context area plan and location plan are provided at Figure 1 below.

The project Site area has been slightly amended by this Response to Submissions, a comparison of the exhibited and now-proposed Site area is provided as Figure 2, and the now proposed Site area is shown below as Figure 3.

The Darling Harbour precinct is undergoing significant redevelopment as part of the SICEEP, Darling Square, and IMAX renewal projects. The urban, built form and public transport / pedestrian context for the proposed Harbourside development will fundamentally change as these developments are progressively completed.

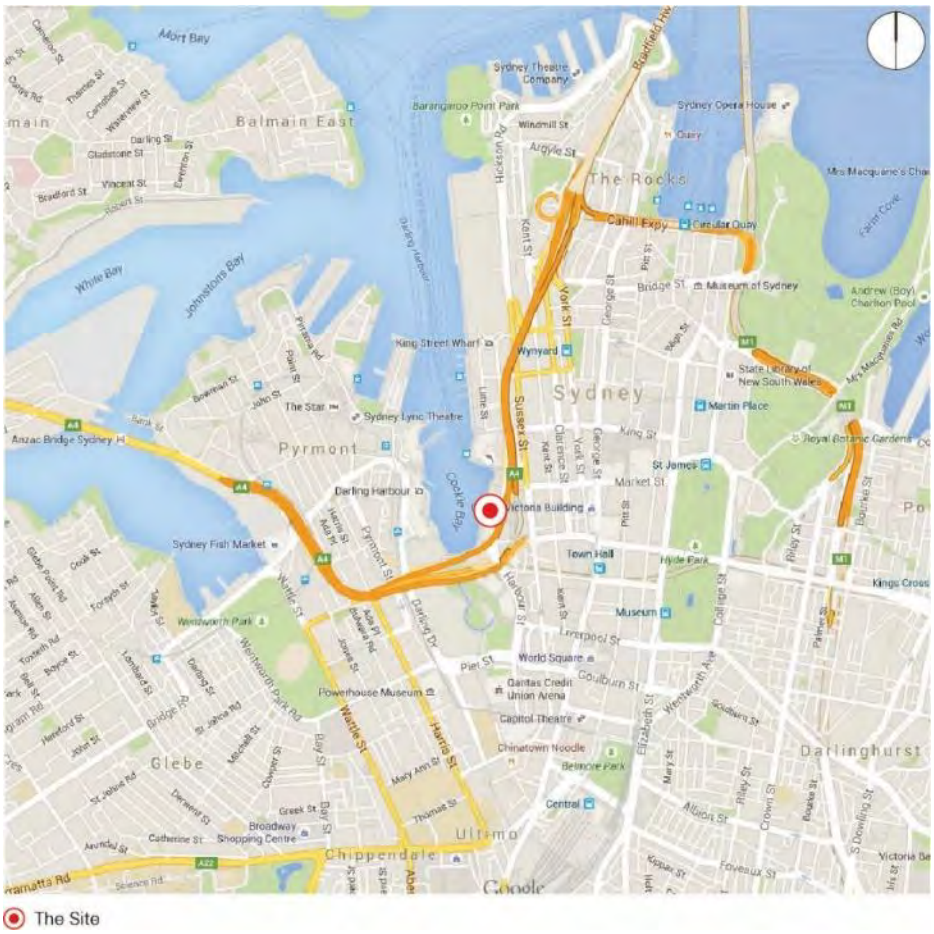


Figure 1 – Location Context Area Plan

Figure 2 – Location Plan (revisited site area in yellow)

Figure 3 – Amended Location Plan

1.3 Overview of Amended Concept Proposal

The proposal relates to a staged SSDA and seeks to establish amended concept proposal details for the renewal and re-imagining of the Cockle Bay precinct. The amended Concept Proposal establishes the vision, planning and development framework which will be the basis for the consent authority to assess future detailed development proposals. The Cockle Bay Park Site is to be developed for a mix of Retail, Cultural and Commercial (Office) uses including retail and restaurants, offices, and publicly accessible open space.

The amended Concept Proposal seeks approval for the following key components and development parameters:

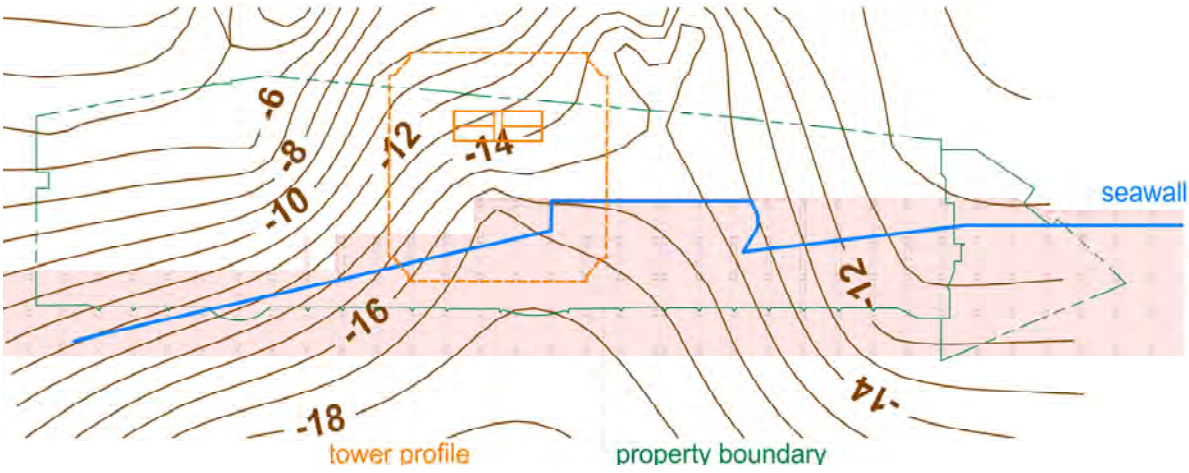
- Demolition of existing site improvements, including the existing Cockle Bay Wharf building complex, pedestrian bridge links across the Western Distributor, and obsolete monorail infrastructure;
- Building envelopes;

- Land uses across the Site;
- A maximum total Gross Floor Area (GFA) across the Cockle Bay Park of 75,000m2 for commercial development and 14,000m2 for retail (including food and beverage) development;
- Urban Design and Public Realm design principles to provide a Design Excellence framework; and
- Strategies for utilities and services provision, drainage and flooding, and ecological sustainable development.

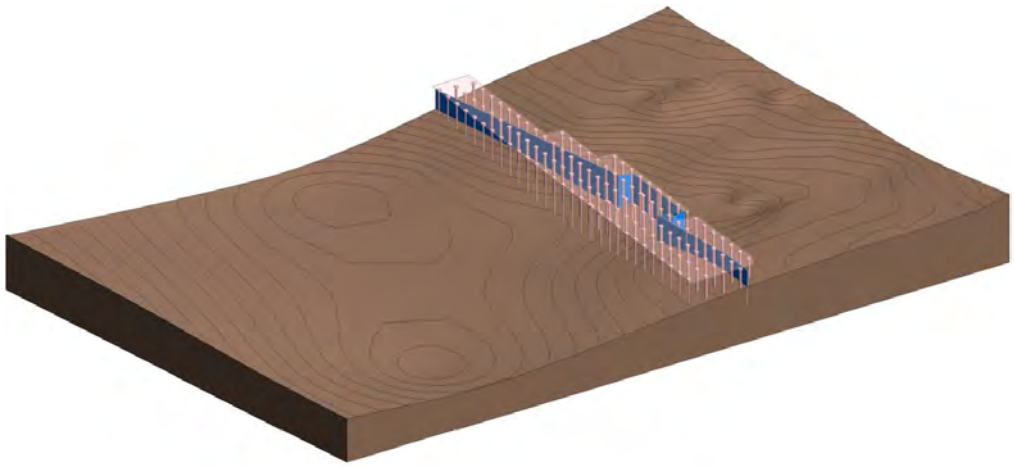
2 Site Context

2.1 Geology and contamination

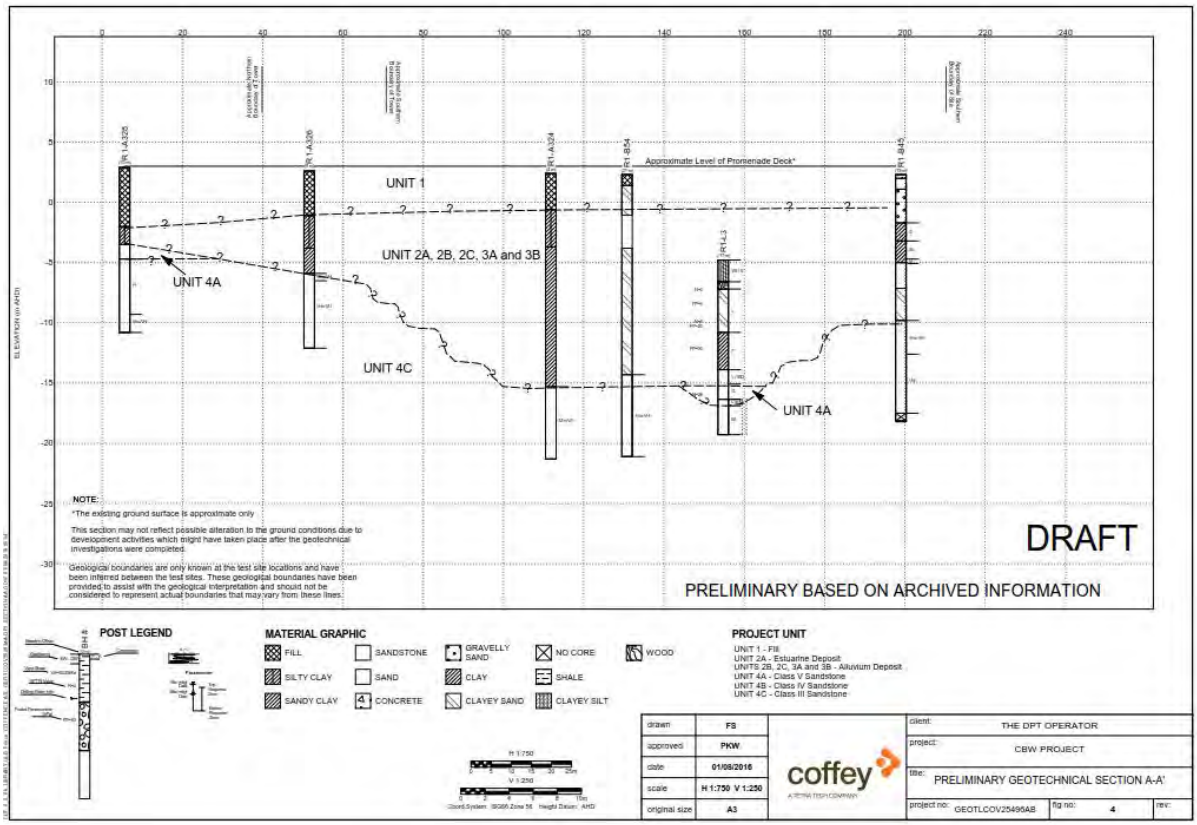
The geotechnical study (Coffey August 2016) indicates a site overlain by up to six metres of fill, over a clayey estuarine deposit, over a silty sandy clay and underlain by sandstone, gaining strength with depth. The sandstone layer, with allowable bearing pressures in the order of 8 MPa, will provide an excellent founding layer for piled foundations which will support the superstructure.



Top of Rock Contour (RL)



Top of Rock and Boardwalk Isometric



Geological Profile

The site contamination study (Coffey August 2016) , whilst recognizing the industrial history of the site and the placement of uncontrolled fill east of the sea wall, does not predict major contamination issues, given the site is currently covered by a suspended structure and this cover will be retained in the proposed development. Section 149 Certificates were obtained, nominating that the site is not classified as significantly contaminated, nor is it the subject of an investigation or maintenance order.

The study concludes the site suitable for the proposed development. Spoil material from the foundation construction may require offsite disposal, and the presence of acid sulphate soils cannot be discounted.

2.2 Previous structures

The site was used for various industrial purposes and as a working dock from the late 1800s through until 1970.

Site Prior to development of Darling Harbour 1980s

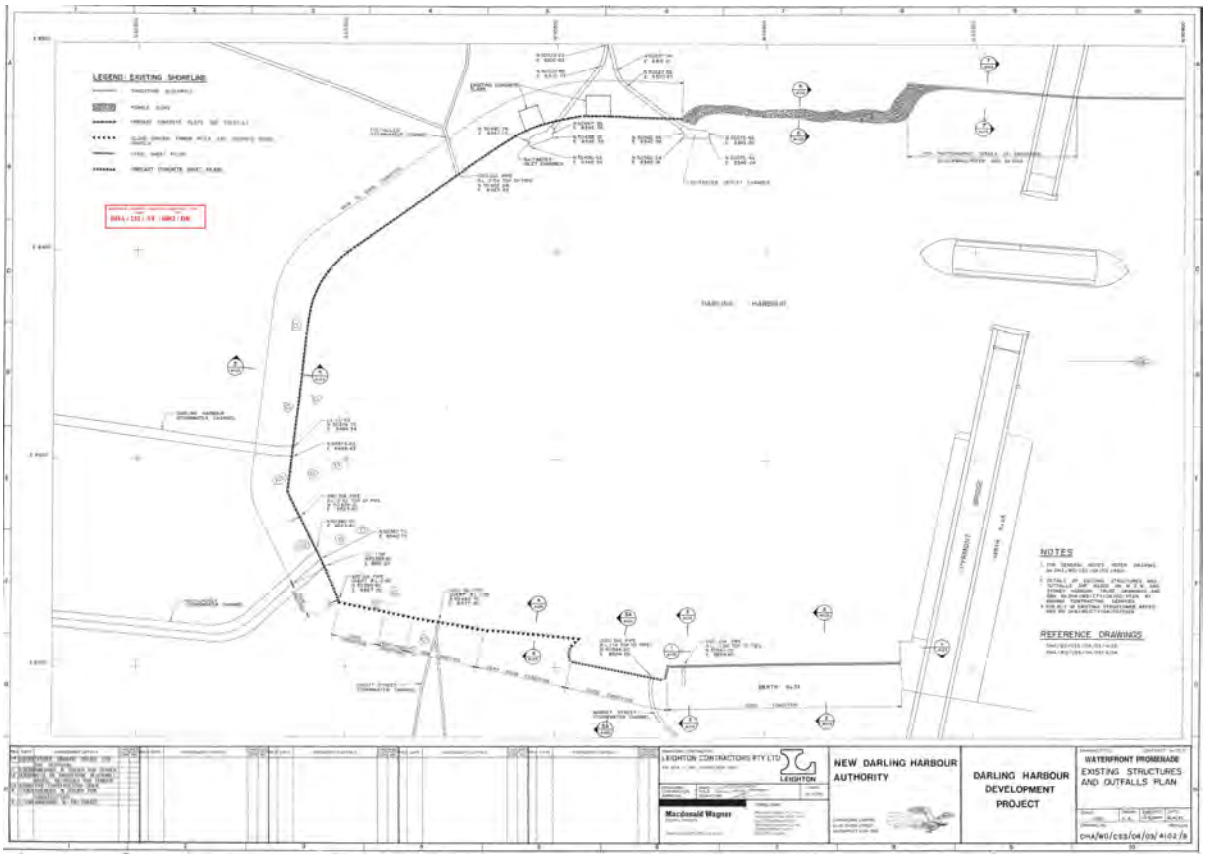
In the mid 1980's it was developed as part of the Darling Harbour Precinct and again in the 1990's as part of Stage 2 of the Darling Park Development. Through this process the eastern shoreline of Darling Harbour has been progressively reclaimed towards the west via placement of ballast, staged construction of a seawall and most recently a suspended structure.

Site during development of Darling harbour – boardwalk piles installation

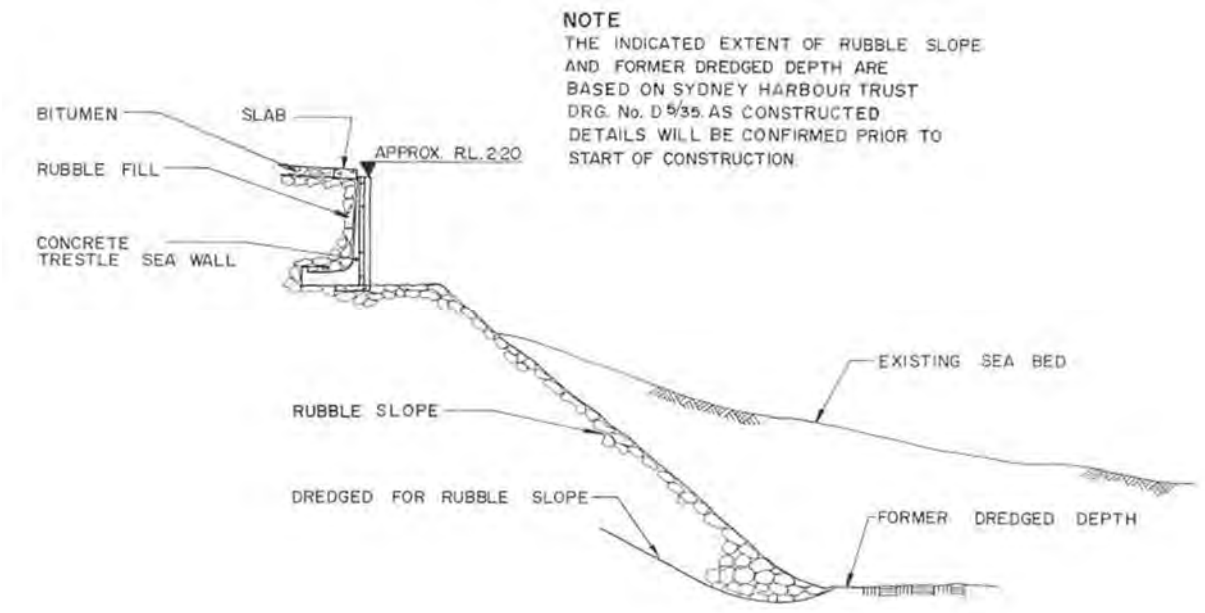
Current Site – Darling Park Stage 2 complete

2.3 Seawall

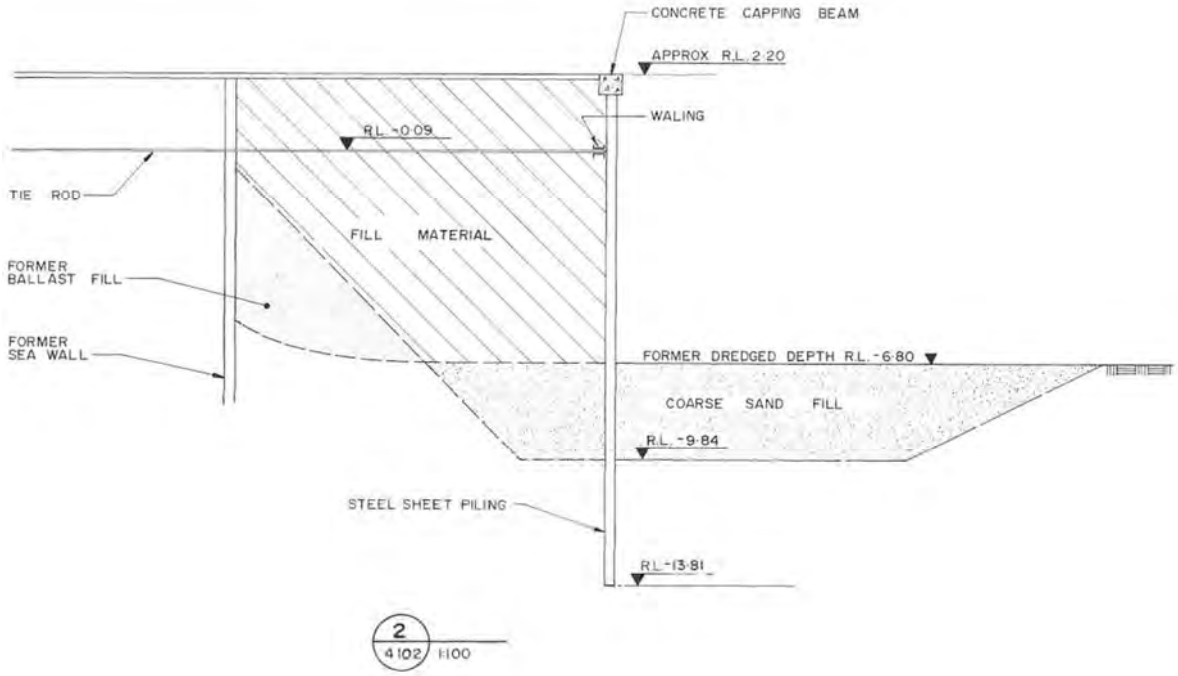
Prior to the construction of the current suspended deck and superstructure a sea wall of various forms and eras retained the western shoreline along the site. The sea wall consisted of sections of steel and concrete sheet pile, gravity retaining walls, driven timber piles with concrete panels, ballast fill. The 'Existing Structures and Outfalls Plan '– Macdonald Wagner 1985 below, describes the sea wall condition.



Seawall Plan

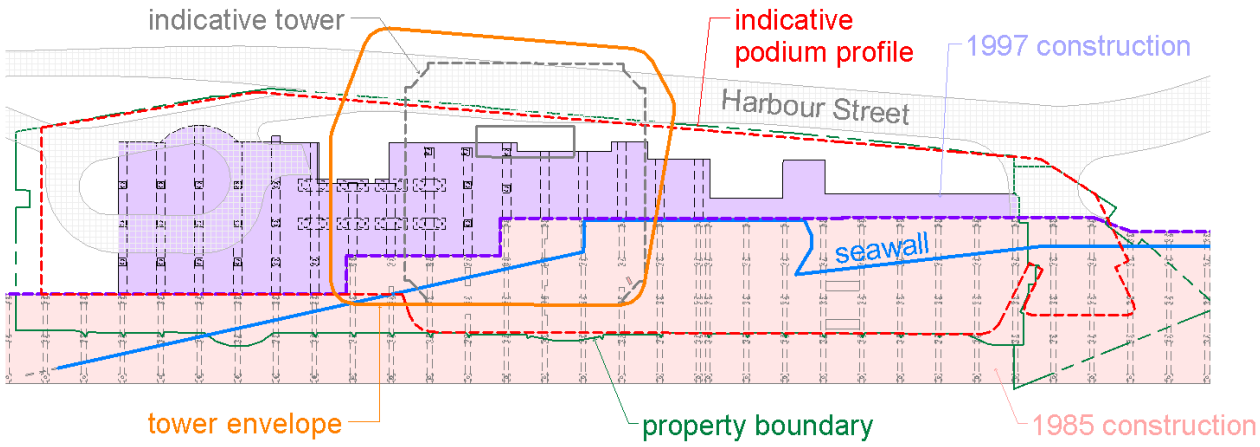


Section thru Rubble Slope Seawall



Section through Sheetpile Seawall

The section of sea wall south of the Pyrmont Bridge is a tied steel sheet pile wall with a concrete capping beam and described as being in ‘ good condition ‘ . This is the area of the site adjacent to the proposed tower plan, thereby effectively providing an ‘ on grade ‘ construction platform for the main tower building as illustrated below.

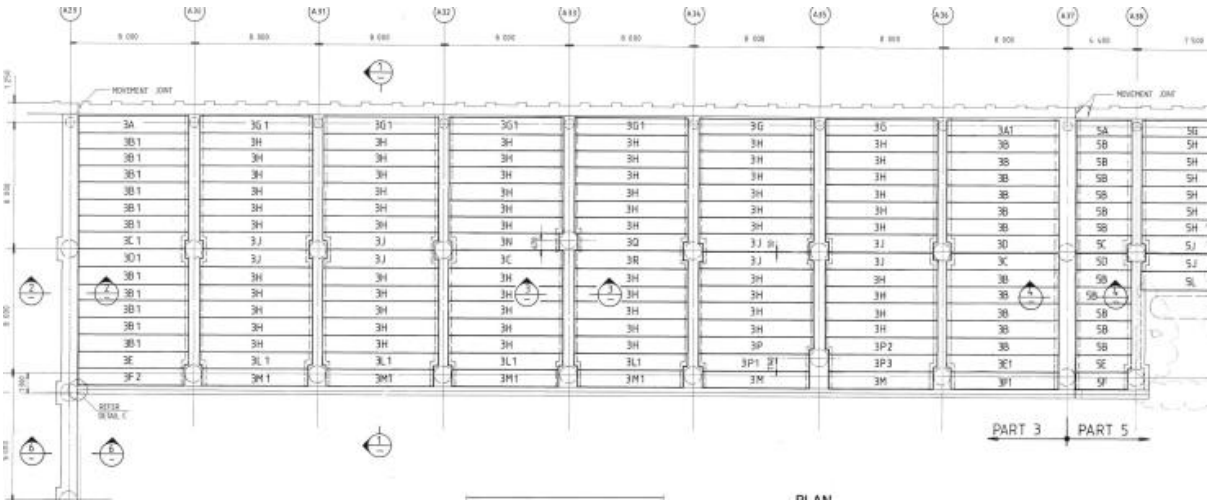


Site Plan : Rock Contour / Seawall / 1980s & 1990s suspended slabs / Proposed Development

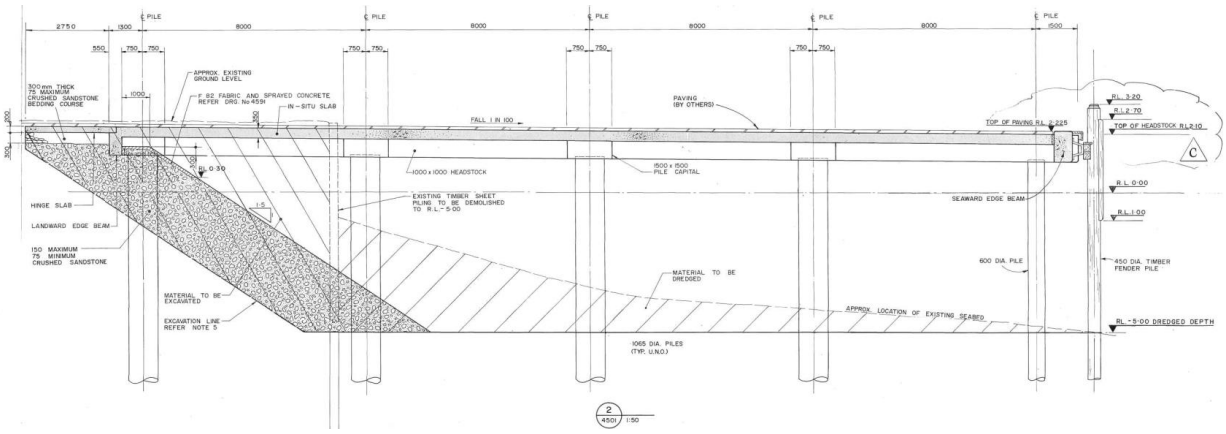
2.4 Existing Suspended Decks

There are two abutting suspended decks which cover the bulk of the site. The western deck was built in the late 1980's, the eastern deck constructed in the late 1990s as part of the Darling Park Stage 2 Waterfront Development. The current 1990's superstructure bridges these two decks and is supported by them, with the eastern deck upgraded to cater for the additional loads.

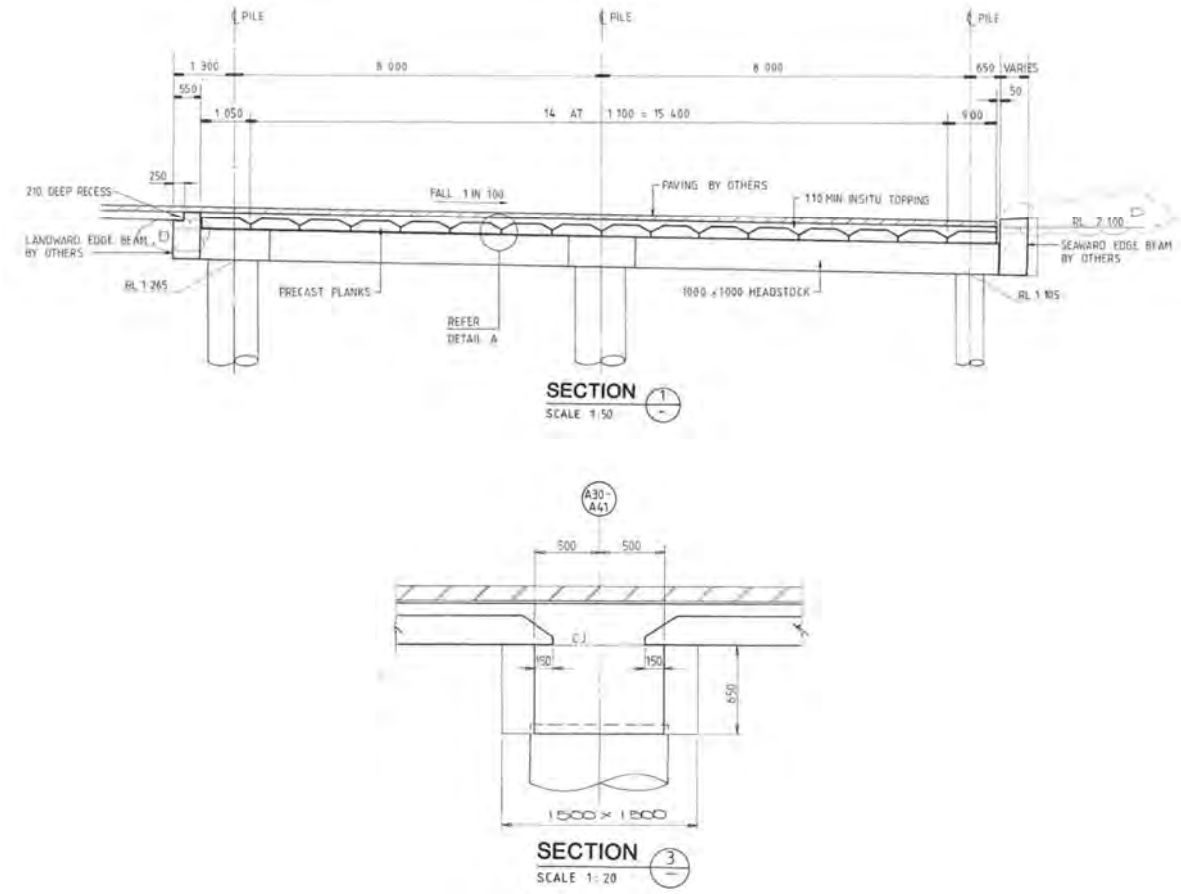
The 1980's deck structural capacity has been studied. This deck will be retained in the proposed development as part of the western boardwalk. It will also play a key role as a construction platform for the superstructure which is built to the west of the existing sea wall over the harbour. The deck is supported on a regular (8 m square) grid of steel driven piles (up to 20 m length) founded in bedrock, reinforced concrete beams span east west between the piles, and in turn support a precast concrete panel deck with a topping slab. The arrangement has a live load capacity in the order of 15 kPa. Consideration was given to utilizing the existing steel piles to support the proposed podium structure, however, in the absence of detailed driving records and with some concerns regarding durability, it was decided that new piles should be constructed to support the proposed podium and tower superstructure.



Western Suspended Deck (typical)

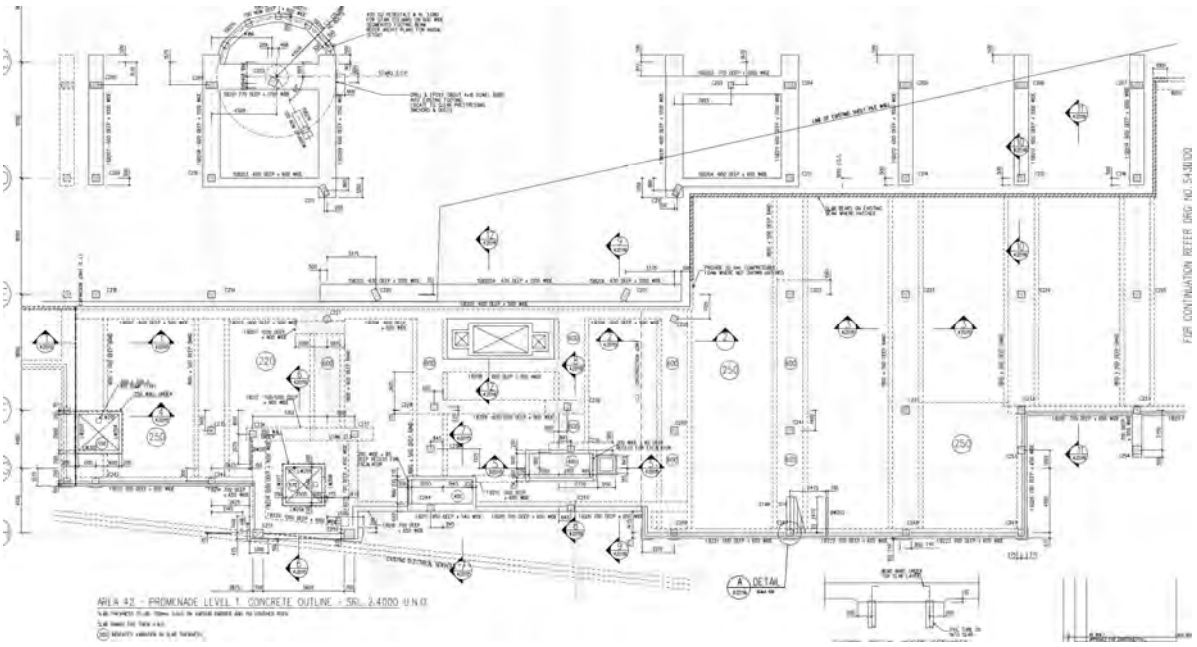


Section Through Western Suspended Deck



Western Deck Structural section : piles / insitu Beams / precast slab and topping

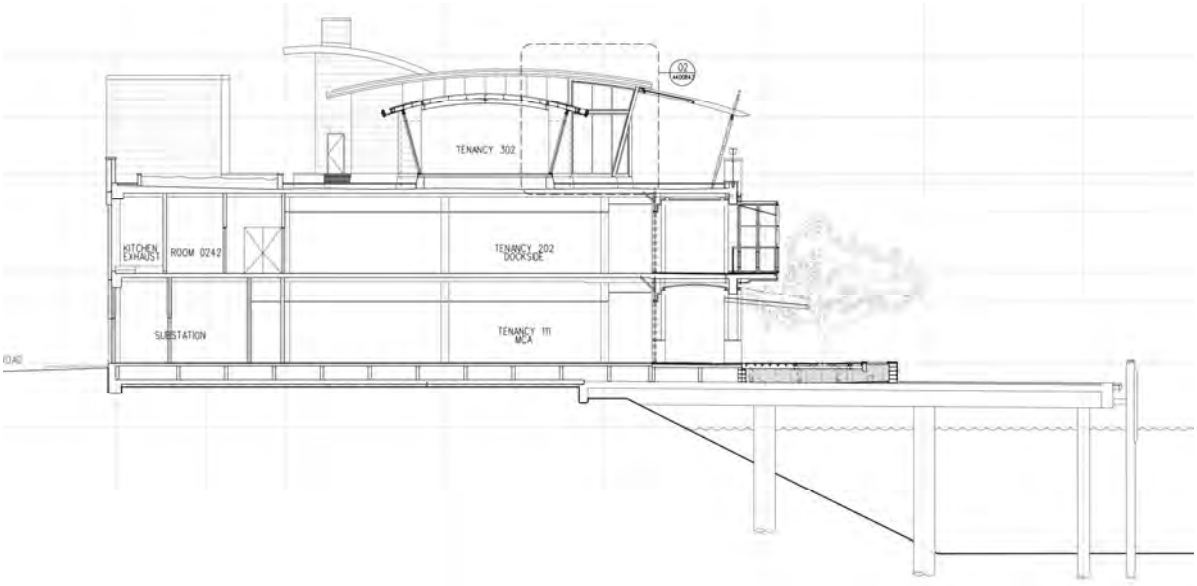
The 1990's deck is also supported on a regular (8 m square) grid of reinforced concrete piles (up to 17 m long) which in turn support reinforced concrete beams spanning east west and a reinforced concrete slab. This deck is east of the sea wall, and whilst designed as a fully suspended slab was constructed on grade. The proposed development will demolish this deck, possibly retaining it through construction as a working platform.



Eastern Deck Plan

2.5 Existing Waterfront (Darling Park Stage 2) Building

A three storey reinforced concrete structure currently is built over the two suspended decks, constructed in the late 1990s as part of Darling Harbour Stage 2. The eastern suspended deck was strengthened via the addition of new beams built over the existing deck to support the column grid of the superstructure. This building will be demolished using conventional techniques as part of the proposed development.



Section through Existing Waterfront Building

3 Proposed Structure

3.1 Existing Western Suspended Deck (1980s)

This structure will be retained supporting the western boardwalk and providing a construction platform for the podium structure. Sections of the precast slab will be removed to allow installation of a new grid of piles to support the podium superstructure. The deck, with a live load capacity of 15 kpa will then be used as a working platform to conventionally construct the ground level podium slab. This slab will contain post tensioned band beams (spanning east west) between steel cased concrete piles, and in turn supporting a post tensioned slab. These band beams (500 mm deep) will provide flexibility for a grid change between the 8 metre square pile grid and the podium column grid over.

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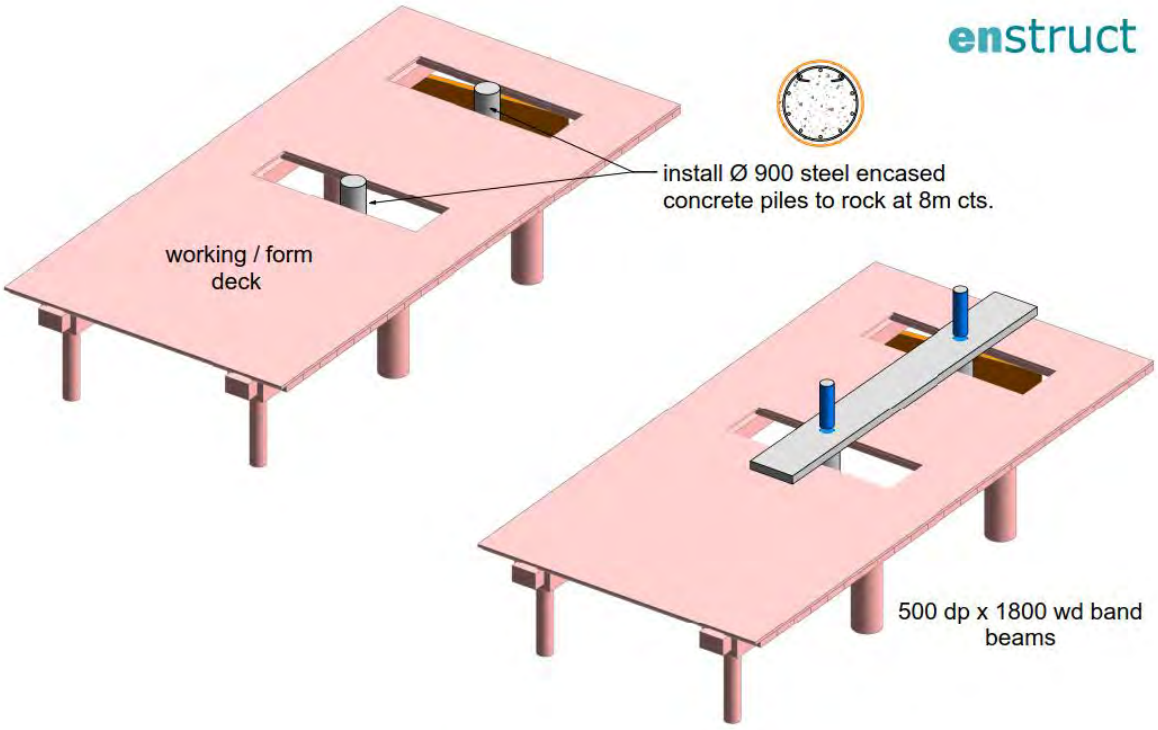

Project One Podium Foundation Sequence 03 SK-1096

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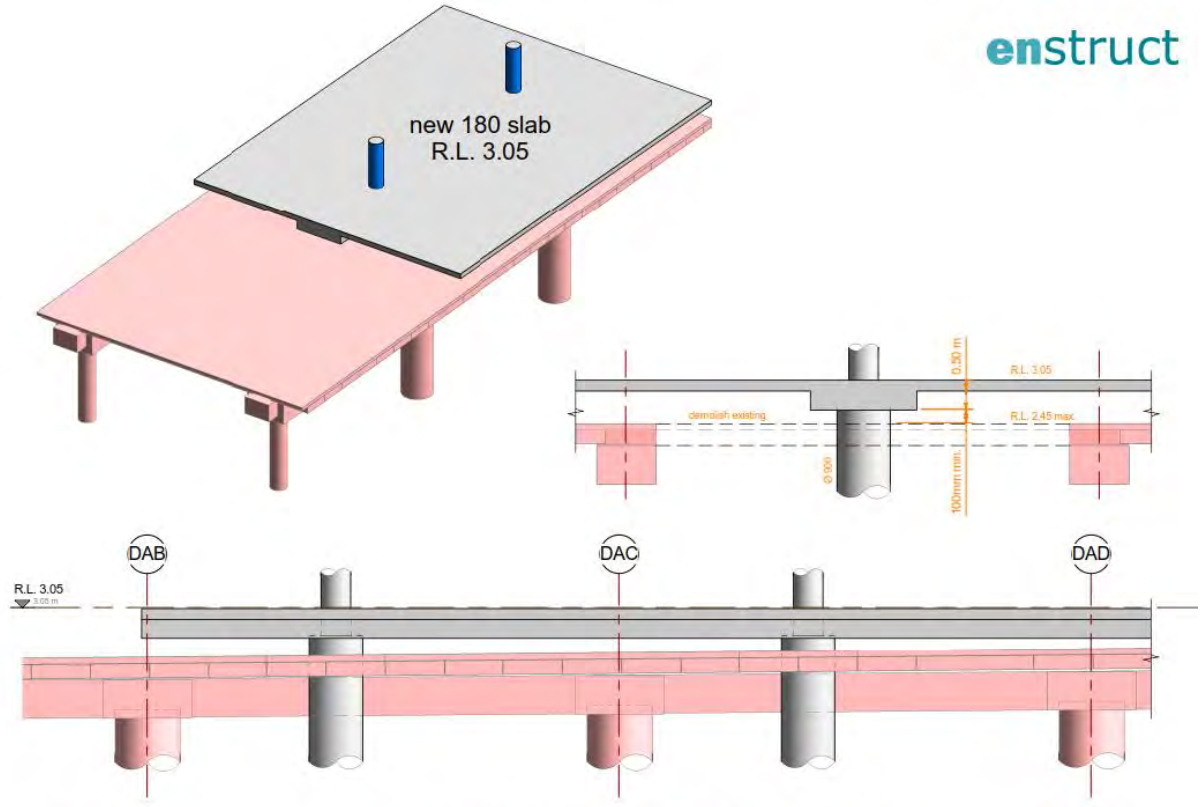
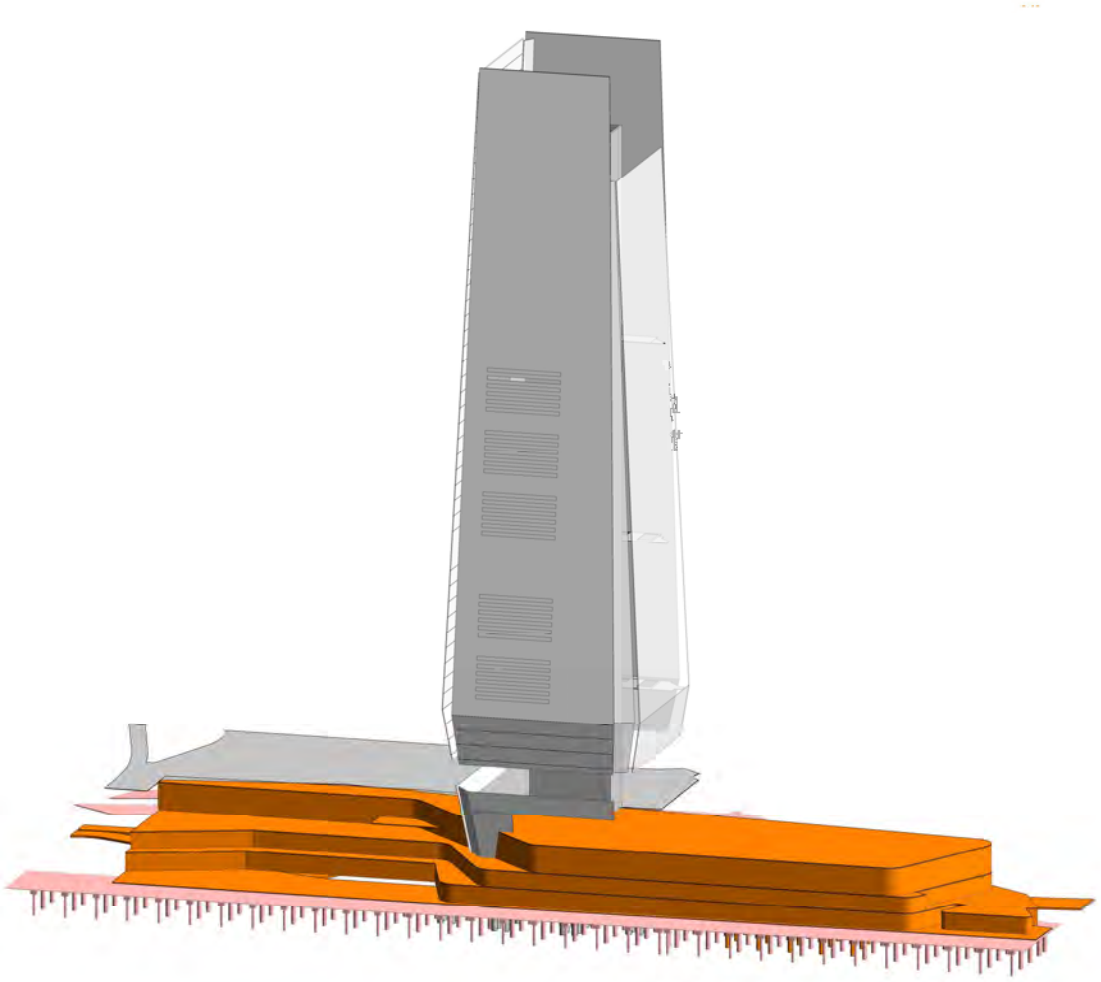


Project One Podium Foundation Sequence 04 1 : 50 SK-1097

3.2 Podium

The proposed podium contains a number of functions : vehicular access, retail, car parking and loading dock as well as extensive public spaces. The building section is bounded by the ground floor level, to be constructed over the existing western suspended slab and the land bridge which spans across the Western Distributor. The structural system will contain long span post tensioned slabs providing maximum planning flexibility. This superstructure will transfer at ground level onto a regular pile foundation grid.

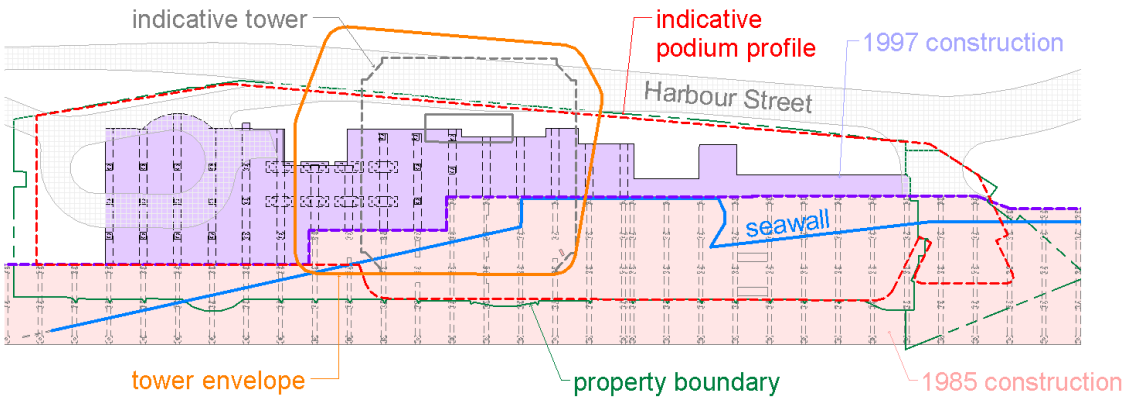


Indicative Podium Massing

3.3 Tower

3.3.1 Location on site

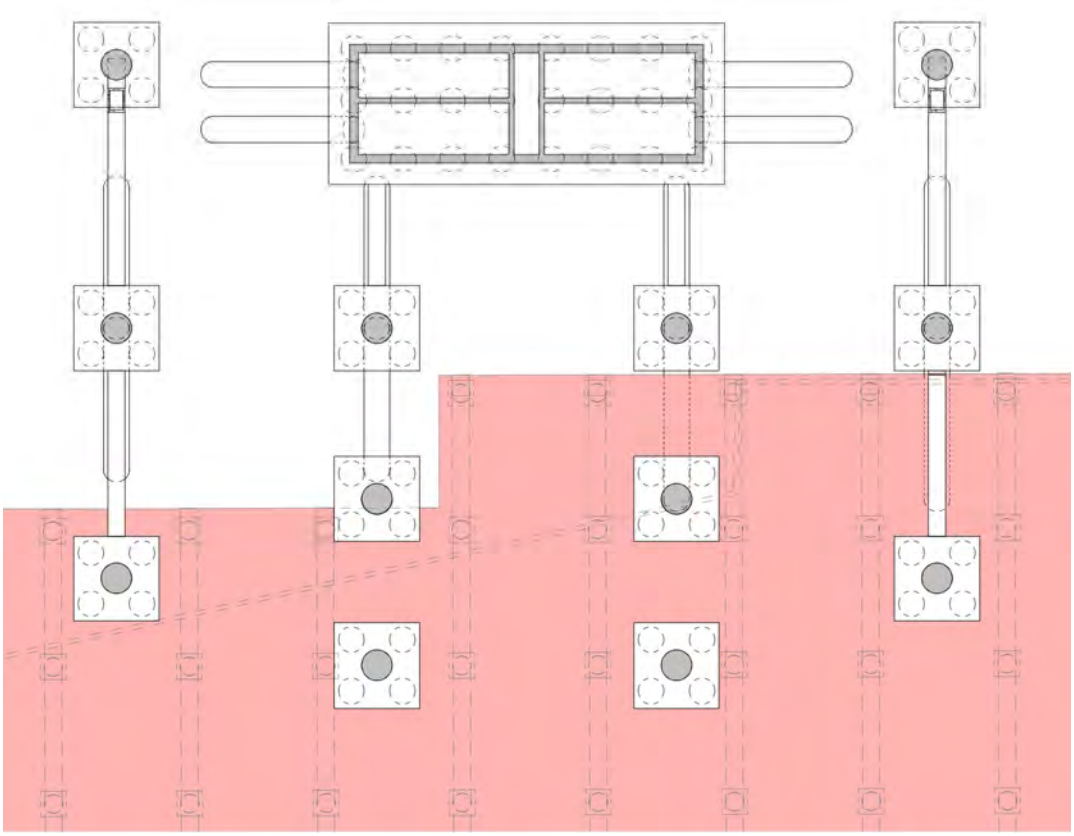
The commercial office tower is proposed to be located centrally to the east of the site. In this location the tower is constructed on the landside of the sea wall, it is also located on the site where minimum depths to rock can be achieved, thereby reducing foundation costs, and providing a preferred least depth construction location for the core raft.

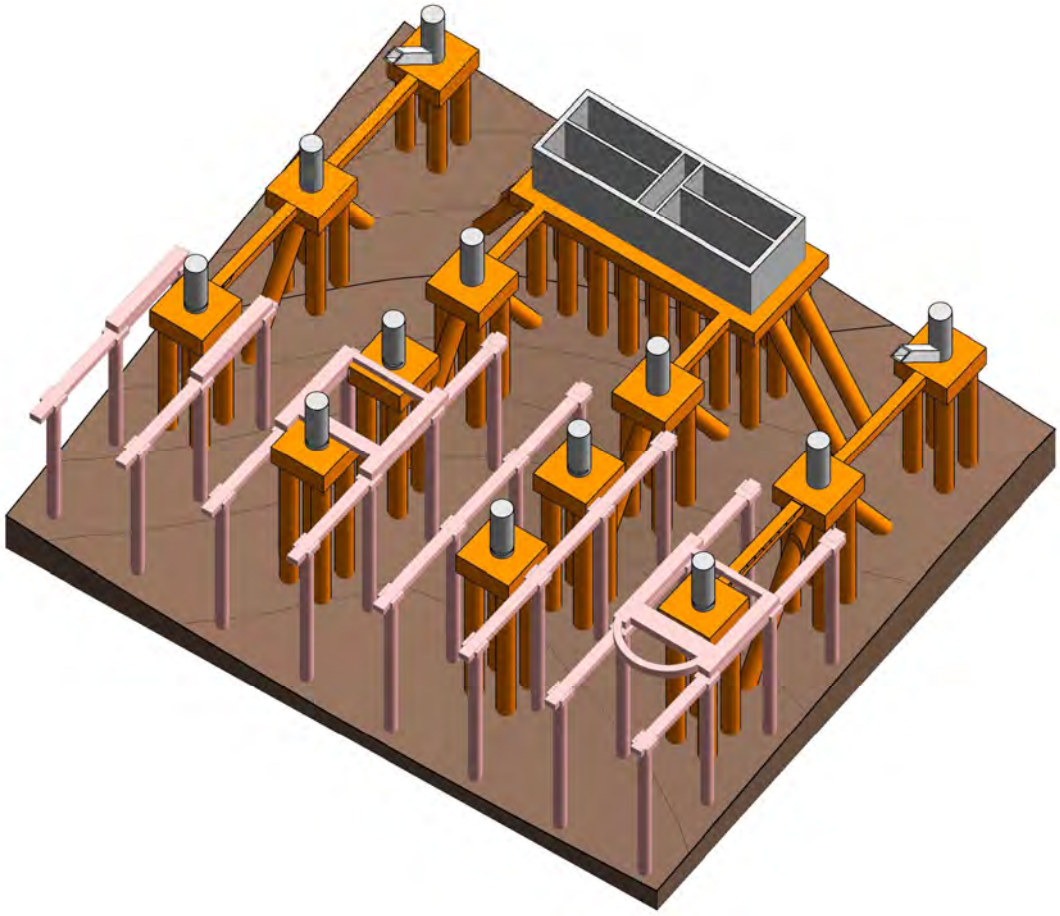


Site Plan : Rock Contour / Seawall / 1980s & 1990s suspended slabs / Proposed Development

3.3.2 Tower Column and Raft Foundations

The tower columns will be founded on pile groups of large diameter piles socketed into high strength rock. The piles will typically be installed using drilling rigs supported by the eastern suspended slab. The piles will be encased in steel tubes, with the ground water table (harbour) encountered some three metres below existing grade. The core will be founded on a piled 1.5 m deep raft. Raking piles will be used to resolve the buildings lateral forces.





Indicative Column & Piled Foundation Arrangement

3.3.3 Superstructure

The structural system for the tower is characterized by its proximity to the eastern boundary and the preference to locate the core at the eastern edge of the typical floor plate.

The indicative arrangement tested results in the eastern section of the core being suspended over the eastern boundary, above Wheat Road and the western distributor. The proposal is to construct this section of the core as a lightweight steel frame and cantilever this section back to a conventional reinforced concrete core to the west. This reinforced concrete core is supported on a piled raft, and can be constructed using jump forms. This arrangement results in a reduced structural core with limited east / west lateral capacity, and the proposal is to introduce mega braces on the southern and northern faces of the building to supplement this capacity. The final structural system will be dependent upon the future tower design.

The tower's typical floor plate is proposed as either a long span post tensioned concrete system, or alternatively a composite steel arrangement, supported on high strength reinforced concrete columns.

The proposed arrangement adopts conventional Sydney CBD high rise structural systems and construction techniques.

3.4 Land bridge over Western Distributor

3.4.1 Consultation

The evolution of a structural scheme for the land bridge has been developed by the project consultants with input from a number of external parties.

Several meetings (ongoing) and discussions have taken place with the Roads and Maritime Services. These meetings which have included various RMS disciplines – engineering, planning, operations etc. have highlighted key constraints – clearances, potential future network reconfiguration.

A key consideration has been constructability of this longspan structure spanning a key road infrastructure. Multiplex have assisted with the development of the structural system so as to prove up viable construction methods. The system adopted is similar to that arrangement recently deployed by Multiplex at the 4 Points Project north of the site. Enstruct were commissioned by RMS as proof engineer for that project.

3.4.2 Set out

The land bridge spans a complex multi-level roadway system. Site survey and also extensive site inspections have been used to develop a 3D (Revit) model of the full extent of the site. This model provides key location and clearance data to facilitate

the development of structural systems and identify potential land bridge support locations.

3.4.3 Structural System

The proposed structural system is similar to that deployed at the neighbouring 4 Points project. The land bridge does not carry conventional traffic load and has been designed to carry landscape, single level lightweight superstructures and pedestrian loading.

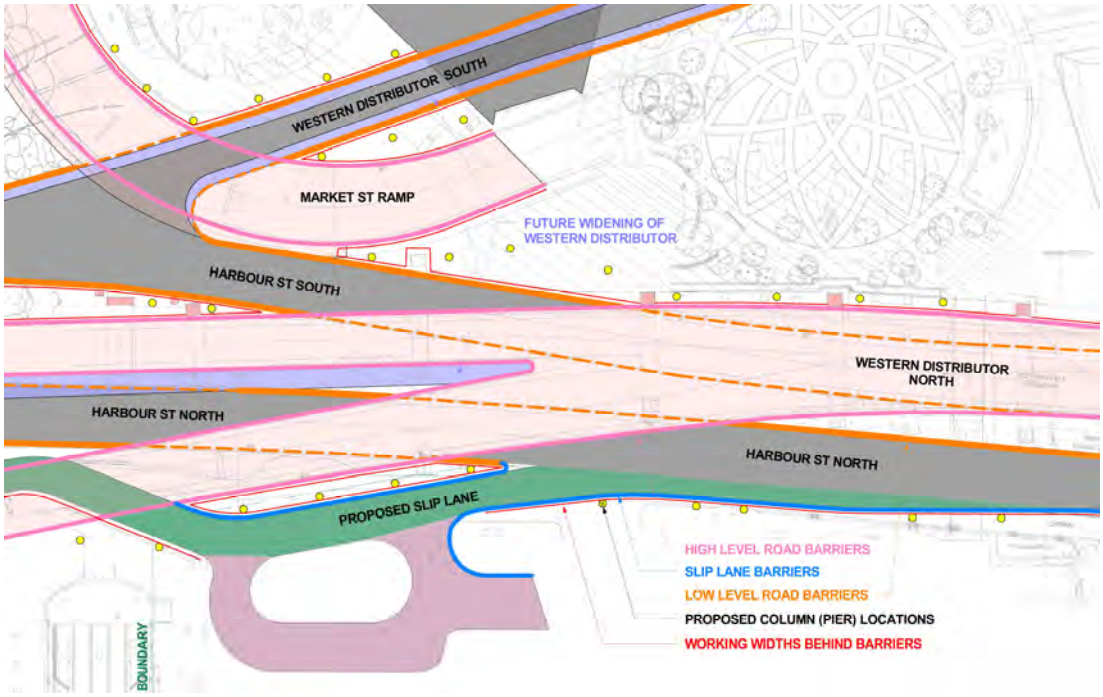
Long span precast (prestressed) concrete beams will be fabricated off site and transported by road to site. These beams will have lengths in the order of 35 m, weighing some 65 tonnes with a depth of 1.5 m and a spacing of 1.75 m, supporting precast slab planks and a reinforced concrete topping slab.

They will typically span the full width of the western distributor supported by the new building to the west and an upgraded existing Darling Park structure to the east. They will be lifted in place via a high capacity crane located on the western side of the western distributor.

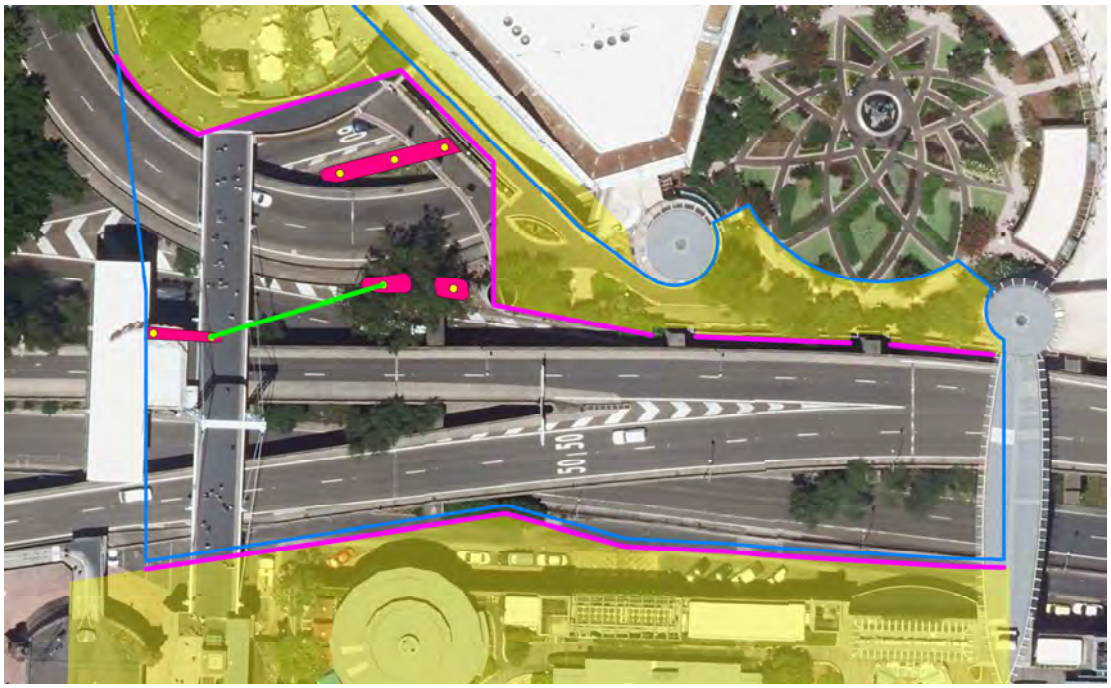
To the north of the site the typical span increases to some 70 metres, challenging both structural depth and construction methodology. A number of locations for support in the form of concrete columns carrying headstocks have been proposed based on available space within the Western Distributor corridor. These locations have been developed in consultation with RMS and consider:

- Working widths behind barriers for rollover of high vehicles to road design standards.
- Preservation of current road corridors within existing barriers and kerbs.
- Preservation of current carriageway and barriers of the Western Distributor.
- Preservation of access for maintenance and repair of the Western Distributor.
- Allowance for future widening of Western Distributor between Harris Street and King Street diverge to 4 lanes.
- Allowance for future widening of Western Distributor between King Street diverge and Four Points to 3 lanes.
- Allowance for future shared path from Harris Street to King Street ramp.

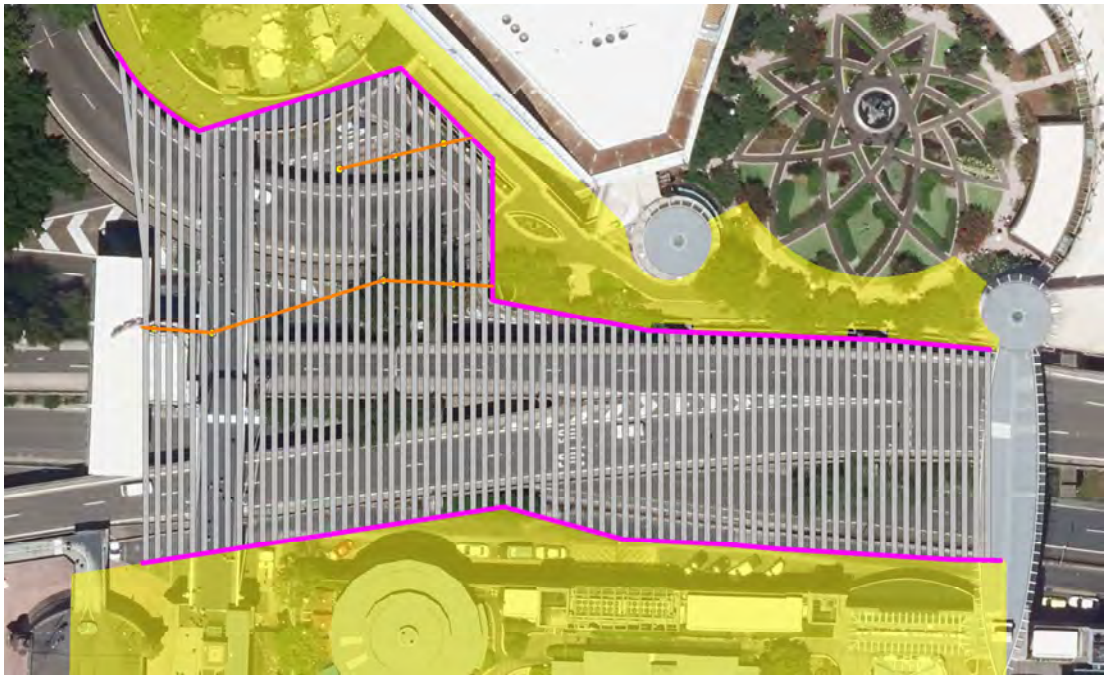
The proposed Land bridge structure will be supported on piled foundations or pad footings that will be placed to not adversely affect the structural integrity of the existing Western Distributor.



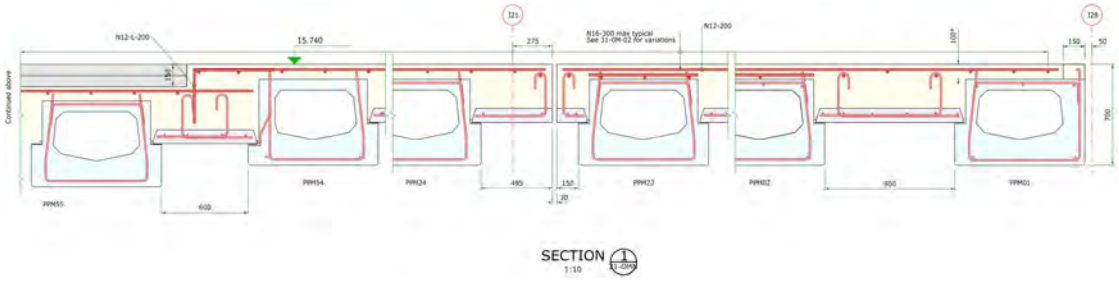
Western Distributor Corridor



Land bridge Available Support Locations



Land bridge Precast Beam Layout



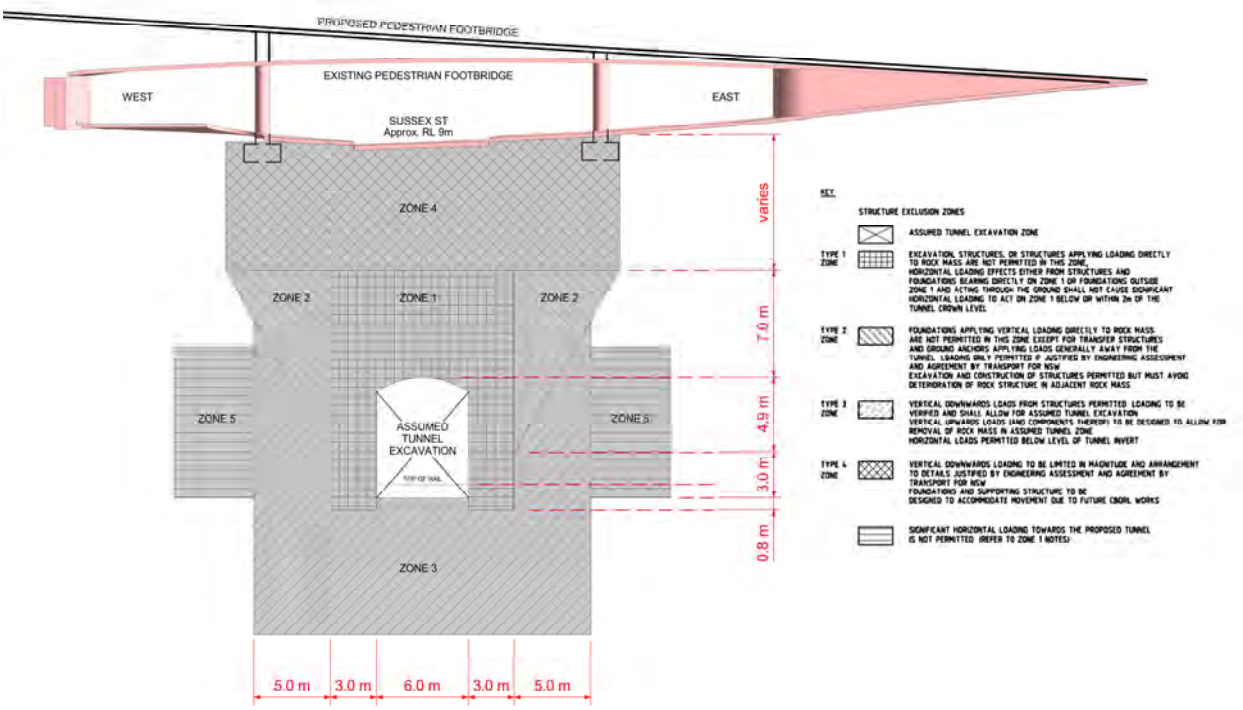
Land bridge Structural Section – precast beams and infills.

3.4.4 Market Street Pedestrian Footbridge

The proposed development will include an upgrade to the existing pedestrian footbridge at the intersection of Market and Sussex Streets. This structure currently crosses the future CBDRL Sussex Street corridor.

It is assumed that the existing columns and foundations would be utilised. Vertical downwards loading will be limited in magnitude and arrangement to details justified by final engineering assessment and agreement by Transport for NSW. Structure to be designed to accommodate movement due to future CBDRL works.

Considering the nature of this structure the loading impact would be incidental compared to the existing building loads already imposed on the easement.



Pedestrian Footbridge over CBDRL Sussex Street corridor.