Douglas Partners
Geotechnics / Environment / Groundwater

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Project 85696.00
10 February 2017
C.001.Rev0
JAM

Attention: Chris Ryan

Email: cryan@winten.com.au

Dear Sirs

Geotechnical Response to TfNSW Conditions
Commercial Tower
1 Denison Street, North Sydney

1. Introduction

This document presents the findings of a preliminary geotechnical assessment of potential for interaction between the proposed development of a 35 storey residential building at 1 Denison Street, North Sydney and the proposed Victoria Station excavation for the Sydney Metro Project. The preliminary assessment was completed in response to comments received from Transport for New South Wales (TfNSW) in a letter dated 20 January 2016 (Reference CD16/16369) and meeting between TfNSW, Enstruct (Structural Engineers) and Douglas Partners Pty Ltd (Geotechnical Consultants), on 6 February 2016.

The development will comprise pavement upgrade works for the streets adjacent to the development site, demolition of the existing buildings, additional excavation to increase the current basement car parking to five levels and construction of a 35 storey building. Excavation to a maximum depth of about 17 m may be required for the basement, lift core and foundations. Indicative foundation loads are in the order of 65,000 kN.

The assessment provides general information to TfNSW about the known sub-surface conditions at the site and to identify potential for interaction between the station box excavation and the basement excavation for the 1 Denison Street project.

The assessment comprised the collation and review of subsurface data available from DP's previous investigations in the area and data gathered during site inspection of exposed rock faces in the existing basement car park at the site and in the basement adjacent, and north to the site.

2. Site Description

The site is bounded by Denison, Little Spring and Spring Streets and is currently occupied by a two storey shopping village with a single level basement car park. The existing basement car park extends across the northern property boundary and the structural columns of the adjacent building are founded on pad footings within the car park.

The building located on the northern boundary of the site, the Beau Monde, has seven basement levels. A rock pillar, about 15 m in width, is intended to be left between the existing basement of the Beau Monde and the basement of the proposed development.

The site slopes gently to moderately towards the south-eastern corner, towards the corner of Spring and Little Spring Streets. Based on supplied survey information the northern end of the site is at RL 61.5 m Australian Height Datum (AHD) and the south eastern corner is at about RL 54.5 m. The transition from cut to fill in the current basement car park is about 20 m north of Spring Street.

Based on the supplied information by Sydney Metro, the proposed Victoria Cross station box is an L shaped site along the eastern side of Miller Street and the shorter, west to east oriented, southern boundary extends across to Denison Street. The south-eastern boundary of the proposed station box is about 15 m from the 1 Denison Street site boundary. The proposed development will comprise a multi-level tower over a four level basement.

The station box excavation is proposed to about RL 43 m and the five level basement on the site will be excavated to about RL 44.6 m at its nearest point to Denison Street.

3. Regional Geology

Reference to the Sydney 1:100 000 Geological Series Sheet indicates that the site is underlain by Triassic aged Hawkesbury Sandstone, which typically comprises medium to coarse grained, massive and cross-bedded sandstone with minor shale beds. The Hawkesbury Sandstone typically contains two main joint sets:

- Set 1 - NNE striking joints dipping 80° to 90° generally to the west but sometimes to the east, spaced between about 1 to 10 m and persistent over many metres.
- Set 2 - ESE striking joints dipping 80° to 90° to the north and south, generally spaced greater than 2 to 3 m and often discontinuous.

Low angle (20° to 30°) thrust faults, commonly dipping to the north and south, are present locally.

3.1 Site Conditions

The site inspection of the exposed rock faces in the existing basements confirmed the presence of sandstone, consistent with the Hawkesbury Sandstone. The encountered rock comprised highly

weathered, very low and low strength sandstone to a depth of between 1 m and 3 m, underlain by medium and high strength, essentially unbroken sandstone. Traces of north-south trending vertical joints (Set 1 joints, see Photo 1 below) were noted in the east-west trending walls, typically at more than 5 m spacing.

Photo 1: Intersection of north-south trending joints with the western basement wall.

Minor block failure was noted in the north-south oriented walls where the north-south trending sub-vertical joints intercepted the face. Accumulation of fines at the toe of the walls indicated pronounced salt weathering. The inspected faces, on basement levels four and seven were generally considered stable with the minor instabilities at the joint/face intersections and salt weathering. The rock exposed on the northern wall of the existing basement beneath the site, which is beneath the Beau Monde building was similar to the thickly bedded sandstone exposed in the Beau Monde basements.

The western wall comprised mainly medium to high strength sandstone with north-south trending sub-vertical joints intercepting the face (Photo 1 above). The slabs formed by these joints were locally fragmented and typically detached from the wall.

Based on the observations in the two basements and previous experience on adjacent sites, the subsurface conditions over both the project site and at least in the eastern portion of the station box site are likely to be similar to those observable in the existing basements. No indications for regional faults, joint swarms or intrusive dykes, all common features in the Sydney Basin, were noted.

4. Geotechnical Comments

4.1 Potential Geotechnical Hazards

Based on the geometry of the proposed station box and basement excavation and the dominant geology of the area, the following geotechnical hazards were identified:

- Transfer of vertical or horizontal stresses between the two buildings;
- Instability of the rock pillar between the two excavations; and
- Stresses acting on the excavation induced by the either of the basements (stress relief).

4.1.1 Transfer of Stresses

Vertical or horizontal stresses in the rock mass, generated by column loads transferred onto foundations, may negatively impact on an adjacent structure or cutting, where the loads are allowed to converge. Consequently, footings (pad strip or piled) are typically required to be founded below a line drawn at a 45 degree angle from the base of an adjacent structure.

Since both basements will be excavated to about RL 43 – 45 m, and the two sites are separated by about 15 m, neither of the two proposed structures will induce stresses that will be transfer onto the adjacent structure. Both buildings will be founded outside/beneath the Zone of Influence of the adjacent building.

4.1.2 Rock Pillar Instability

An existing concrete wall is used as shoring in the upper few metres of the existing excavation to support the filling, residual clay and highly weathered rock. Conceptual drawings (dated 4 October 2016) prepared by Enstruct indicate that gradual replacement of the existing concrete shoring is proposed for the site with temporary ground anchors. Permanent support to the cut faces will be provided by the floor slabs. The proposed temporary and permanent shoring system is considered feasible and practical to install.

Medium and high strength sandstone is considered self-supporting, unless affected by adversely oriented discontinuities. The existing exposed rock faces within and on the adjacent site are considered stable, except the minor salt erosion and the slab/block fall at the joint/face intersections.

The slabs/blocks formed at these intersections are typically less than 200 m thick. Once the joint surface is about 300 mm behind the rock face, the risk of slab/block detachment appears to reduce significantly. The detachment of the small slab/block has an insignificant effect on the overall stability of the rock face.

Should other adversely oriented discontinuities be encountered during the excavation, the face instabilities formed by these discontinuities will be stabilised by appropriate methods, such as rock bolts/anchors, shotcrete or similar.

The presence of the widely spaced north-south trending joints (Joint Set 1) is not likely to impact on the stability of the rock pillar between the two proposed excavations. Joint Set 2 is oriented nearly normal to the north-south trending rock faces of the two adjacent excavations and is not expected to affect the stability of the rock faces or the rock pillar as a whole.

4.1.3 In situ Stresses

High horizontal stresses are present in most Sydney bedrock. As the excavation depth increases, some of these stresses will be released, which will result in lateral movement of the rock and may cause some cracking of adjacent buildings. Experience in Sydney indicates that lateral movement due to stress relief for an excavation is generally in the range of 0.5 mm to 1 mm per metre depth of excavation in the centre of each boundary, although occasionally up to 2 mm per metre depth of excavation occurs as the size of excavation increases to the dimension of a street block. In Hawkesbury Sandstone, the movement resulting from stress relief generally occurs over a horizontal distance of up to three times the excavation depth from the excavation boundaries with an initial reduction in movement of approximately 1 mm per metre. Stress-relief movements are an unavoidable consequence of large excavations. The scale of movements can be assessed during excavation by the use of survey points or inclinometers.

In-situ virgin stress conditions have not been measured on the site and the following stresses are suggested:

$\sigma 1 = \sigma NS = 0.5$ MPa + 2.0 σV
$\sigma 2 = \sigma EW = 0.5$ MPa + 1.1$\sigma 1$
$\sigma 3 = \sigma V = 0.024$ H MPa

where H = height of excavated medium strength or stronger rock face (m)

Based on the above concepts, it is conceivable that movement induced by an excavation could cause distress in an adjacent structure. However, it is not the case at the proposed station box and the project site. Indicated timing of the developments suggests that the basement excavation for the 1 Denison Street project will occur first, followed by the construction of the building. The station box is

anticipated to be excavated during the construction of the 1 Denison Street building and finally the superstructure over the station box will be constructed.

All stress relief in the rock mass is expected to occur during the first excavation phase. In the rock mass beneath Denison Street, that will eventually form the rock pillar between the excavations, stress relief is likely to cause movement along the western excavation face towards the east. This movement will be accounted for in the design of the works.

No additional movement in the rock mass, induced by the basement excavation, are expected to occur during the excavation of the station box. Movement due to stress relief for the station box is likely to occur on the northern, western and southern side of the station box, un-related to the previously completed excavation of the basement.

4.2 Summary

Potential interaction between adjacent excavations and/or between adjacent excavation and an existing/to be built structure can adversely affect the excavation/structure involved. The geotechnical hazards identified for the proposed Victoria Cross station box and the high rise development with five basement levels at 1 Denison Street comprise potential increase in horizontal or vertical stresses, excavation face instability and movement induced by stress relief.

Due to the proposed geometry of the two projects, the risk of any of the identified geotechnical hazards occurring is considered to be insignificant. Should unforeseen adversely oriented discontinuities be encountered in the rock pillar between the two excavations, commonly used engineering solutions, such as rock bolts/anchors, shotcrete, etc. can be applied to minimise the risks.

5. Limitations

Douglas Partners (DP) has prepared this report for this project at 1 Denison Street, North Sydney in accordance with DP's email proposal dated 6 February 2017 and acceptance received from Stephen Sanlorenzo of Touchstone Partners Pty Ltd, the project managers of the project, dated 6 February 2017 The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Victoria Plaza Holdings Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific observational locations at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the observational locations. The advice may also be limited by site accessibility.

This report must be read in conjunction with all of the attachments and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Josef Major
Senior Engineering Geologist

Reviewed by

Konrad Schultz
Principal

Attachments: About this Report
Site Drawings

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

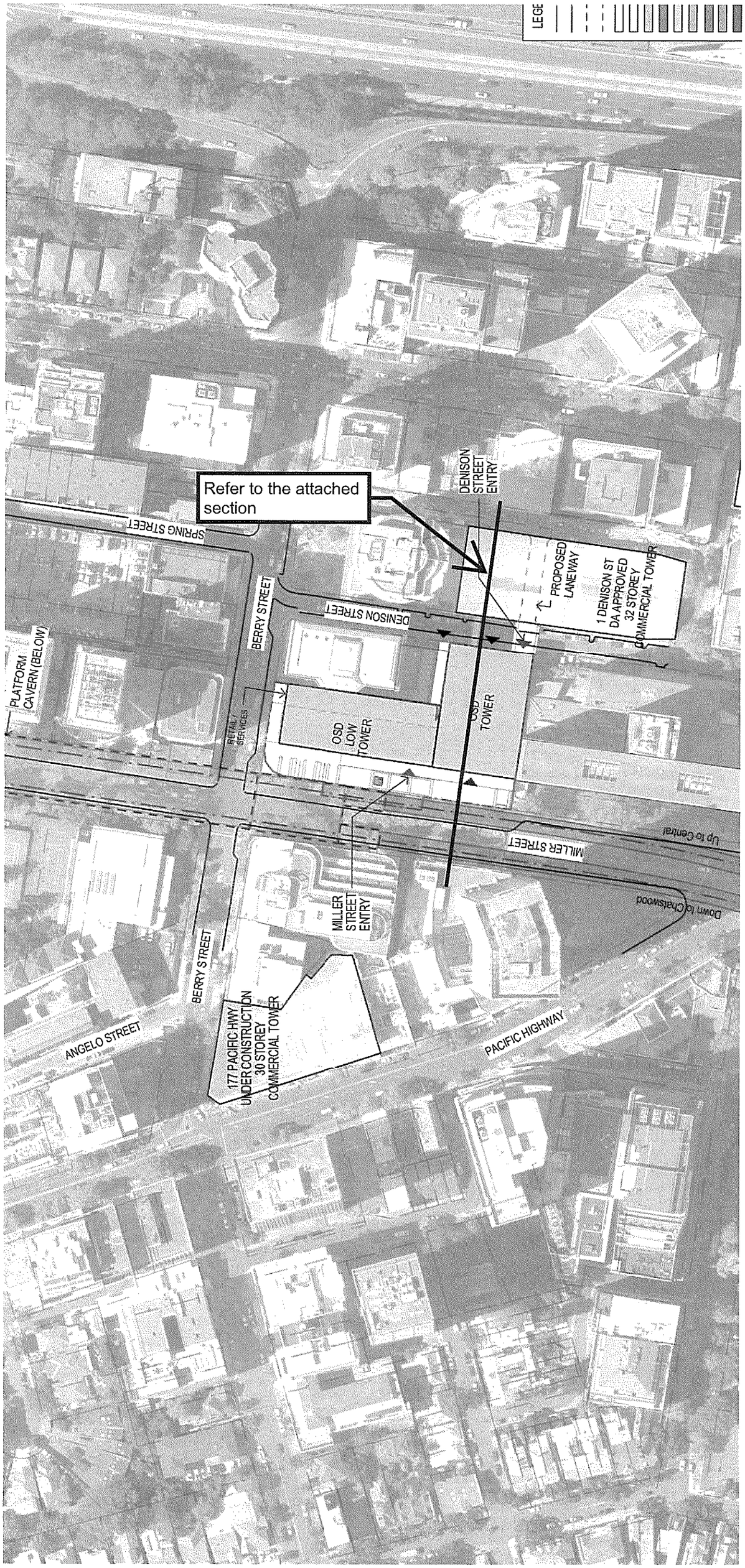
In the event that condit ions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

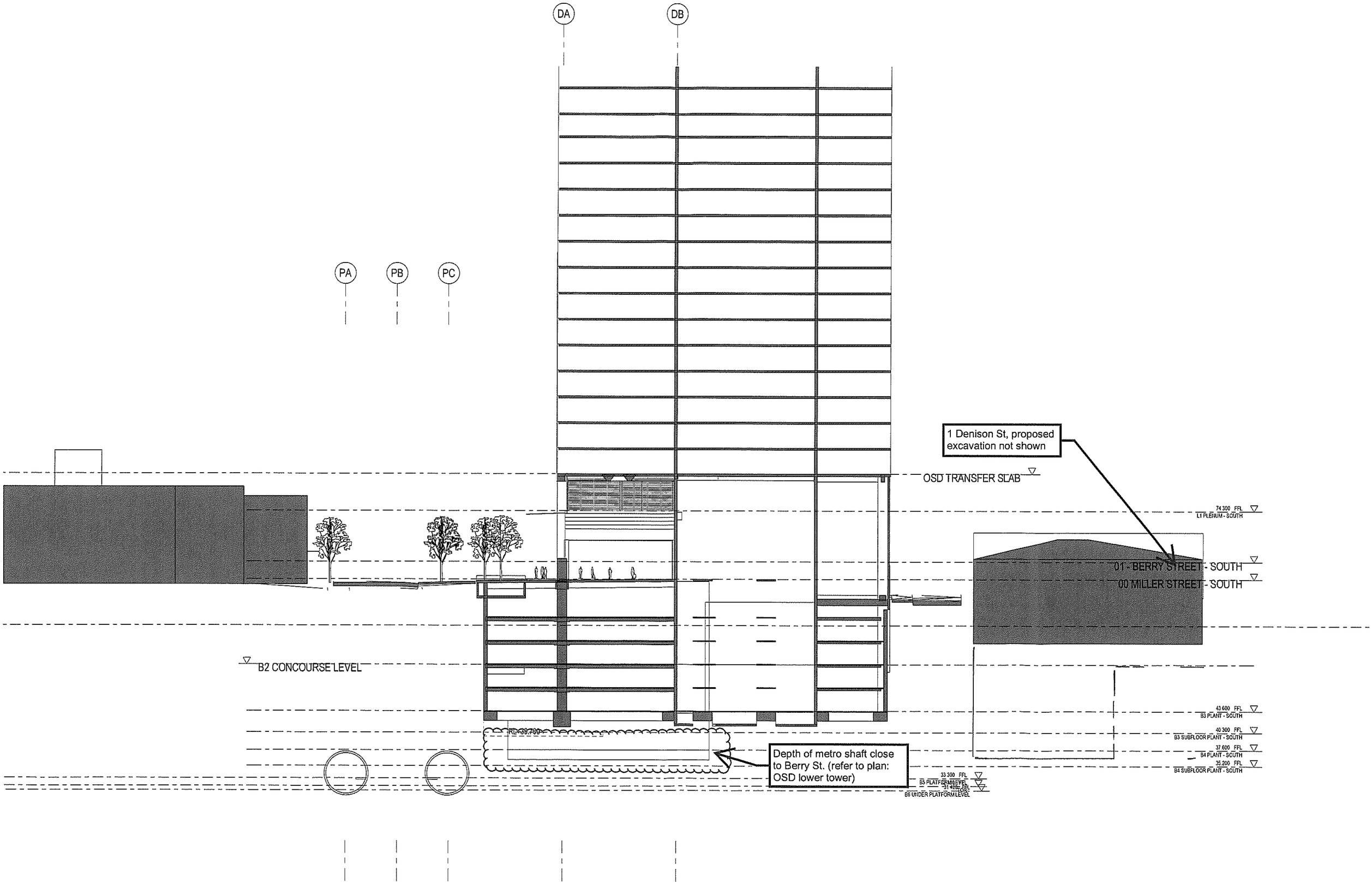
Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.


LEGE
Refer to the attached section
DENISON STREET ENTRY
SPRING STREET
BERRY STREET
DENISON STREET
PROPOSED LANEWAY
1 DENISON ST DA APPROVED 32 STOREY COMMERCIAL TOWER
PLATFORM CAVERN (BELOW)
RETAIL / SERVICES
OSD LOW TOWER
OSD TOWER
MILLER STREET
Up to Central
Down to Chatswood
MILLER STREET ENTRY
BERRY STREET
177 PACIFIC HWY UNDER CONSTRUCTION 30 STOREY COMMERCIAL TOWER
ANGELO STREET
PACIFIC HIGHWAY


DA
DB
PA
PB
PC
1 Denison St, proposed excavation not shown
OSD TRANSFER SLAB
74 300 FFL
L1 PLENUM - SOUTH
01 - BERRY STREET - SOUTH
00 MILLER STREET - SOUTH
B2 CONCOURSE LEVEL
43 600 FFL
B3 PLANT - SOUTH
40 300 FFL
B3 SUBFLOOR PLANT - SOUTH
37 600 FFL
B4 PLANT - SOUTH
35 200 FFL
B4 SUBFLOOR PLANT - SOUTH
RL -39.700
Depth of metro shaft close to Berry St. (refer to plan: OSD lower tower)
33 300 FFL
B5 PLATFORM LEVEL
31 425 FFL
B6 UNDER PLATFORM LEVEL