STRUCTURAL PEER REVIEW

14-16 Victoria St Kogarah

80820051

Prepared for
Georges River Council

21 August 2019

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1 Introduction

Cardno has been engaged by Georges River Council to carry out peer review of a structural report for 14-16 Victoria Street, Kogarah.

We understand that 14-16 Victoria Street is currently listed as a heritage building. A 12 storey residential building with three basements is proposed at the eastern adjacent site, 18-24A Victoria Street. A likely development is also proposed at the western adjacent site, 4-12 Victoria Street, involving an approximately 11 storey residential building with multiple basement levels.

The owners of 14-16 Victoria Street have submitted a structural report and heritage assessment report, which seeks to delist the heritage listed items.

A peer review has been carried out based on following documents:

- Structural report 19067-09 for 14-16 Victoria Street Kogarah prepared by JSBC Consulting;
- Geotechnical report 13779/1-A for 22-24a Victoria Street prepared by Geotechnique Pty Ltd.
- Demolition plans and proposed concept plans for 18-24A Victoria Street Kogarah by a. Basta Architects Pty Ltd;

In the site locality and the extent of the proposed development on the eastern side is shown below in Figure 1-1.

Figure 1-1 14-16 Victoria St & 18-24A Proposed Development

2 Structural Inspection

Cardno carried out an inspection on 16th of August 2019 to visit the heritage building at 14-16 Victoria Street and proposed development site. Internal access was not provided to Number 16 Victoria Street.

Refer to Appendix A for inspection photos.

3 18-24A Victoria Street Proposed Development Plans Peer Review

Cardno reviewed the proposed development plans at 18-24A Victoria Street regarding to the potential impacts of basements excavation on the 14-16 Victoria Street. The plans are architectural only.

Peer review of concept drawings of nearby proposed developments including the adjacent site (18-24a Victoria Street, Kogarah) is limited to investigations of the proposed development impacts on the adjacent building(14-16 Victoria St) and will not comprise of a full structural review of the development according to Cardno proposal No. 48980820080.

4 Structural Report Peer Review

4.1 JSBC Consulting Structural Report Key Points

The structural report by JSBC Consulting addresses the current condition of 14-16 Victoria Street in Section 4, as listed in below:

- The terraces are constructed of load bearing brickwork and timber framed floors and roof;
- Probable foundation level in accordance with the geotechnical report boreholes data and age of building. The load bearing walls could be found on the residual soil overlying rock.
- Numerous cracks on the existing load bearing walls;
- The balcony to Number 14 is sagging and appears to be structurally inadequate.
- Loose condition of the chimney;
- Evidence of multiple structural repairs throughout in the terraces;

In Section 5, the structural report discusses the structural impacts and risks of the proposed adjacent excavation on 14-16 Victoria Street, as listed in below:

- High risk of soil movement underneath of 14-16 Victoria St load bearing walls due to the proposed 9.0m deep excavation at adjacent site especially if the load bearing wall are founded on the residual soil.
- Adjacent proposed excavation including construction of the shoring wall and installing the anchors will cause vibration, which has a high risk of causing cracks in the brick walls and a high risk on the structural integrity of the terraces.
- Proposed adjacent excavation may cause lateral movement of sandstone under excavation due to stress relief. This has a high risk of damage on the brick walls and may affect the structural integrity of the terraces.

4.2 Cardno Review of JSBC Consulting Report Key Points

Cardno generally confirms the current condition of the building as outlined in Section 4 of the structural report based on site visit was carried out on 16th of August 2019. We note that further investigations will be required to confirm the level of the footings and foundation material.

In regards to Section 5 of the structural report, we provide the following comments:

- We agree that 9m deep excavation has the potential of causing lateral movement of the load bearing walls of 14-16 Victoria Street. However, we believe that with a proper designed shoring wall system, the lateral movement could be limited to be a in range tolerated by the masonry walls
- We agree that the proposed excavation and construction works will cause to vibration. However, we believe that the vibration could be controlled on site to meet allowable limits by relevant standards and guidelines for heritage building.
- Bulk excavation on the proposed development has the potential to cause lateral displacement in the sandstone underneath of 14-16 Victoria Street due to sandstone stress relief. The magnitude of the displacement and potential for damage can be determined by a geotechnical and structural engineer, and if a potential for damage exists, the shoring wall can be designed to avoid or minimise the movement.

5 Geotechnical Report Peer Review

5.1 Geotechnique Pty Geotechnical Report Key Points

Two boreholes were drilled on this site and the borehole No. 2 is closer to 14-16 Victoria Street. Borehole No.2 shows that site contains up to 1.2m of residual soil over Class V sandstone.

Page 7 of the report specifies the tolerable vibration limits (5mm/s-10mm/s) for houses and low-rise buildings and proposed the excavation methodology to minimize the ground vibration based on sandstone type.

5.2 Cardno Review Outcomes

The footing level of 14-16 Victoria load bearing walls is not clear at this stage. The load bearing wall could be on residual soil or sandstone class V. Further investigations are required to determine the level and foundation conditions of the brick wall. The investigation outcome should be used by a shoring wall designer to design a proper shoring wall system.

The acceptable vibration limit for heritage building is lower than normal house and low-rise buildings (5mm/s-10mm/s). Therefore, vibration limits should be specifically for heritage building in accordance with relevant standards or guidelines. The German DIN 4150-3 Standards is proposed which limits the vibration limit for heritage building. (Refer to Table 3-8).

6 Conclusion

The construction of the proposed building at 18-24A Victoria Street has the potential of causing damage to the heritage listed building at 14-16 Victoria Street. However, we are of the opinion, that with diligent investigations, a proper structural design and prior strengthening to sections of the heritage building the risks of damage can be minimised to acceptable limits.

We recommend the following:

1. A dilapidation report shall be prepared for 14-16 Victoria Street prior any major activity on adjacent sites for instance demolition of the existing buildings.
2. Site investigation shall be carried out to determine the detailed structural integrity, footing level and foundation conditions of the building at 14-16 Victoria Street.
3. Strengthening of the building at 14-16 Victoria Street shall be carried out if required to re-instate the structural integrity.
4. The shoring system shall be designed in accordance with the geotechnical investigation report.
5. The magnitude of lateral movement due to stress relief shall be determined by a geotechnical engineer and assessed by a structural engineer to determine the risks of damage to the heritage building. The

shoring system shall then be designed, if required, to limit the movements to an acceptable risk level to minimise the potential of damage to the heritage building.

6. Vibration trigger shall be defined by a geotechnical in accordance with the German DIN 4150-3 Standards for heritage buildings. The monitoring regime and trigger levels shall be implemented during construction to ensure that vibration limited are not exceeded.
7. All recommended investigations outcome and proposed development construction drawings shall be reviewed by third party prior to issue of construction certificate.

APPENDIX

A

Cardno Inspection Photos

Photos

Location:

Overall Photo of 14-16 Victoria Street

Comments:

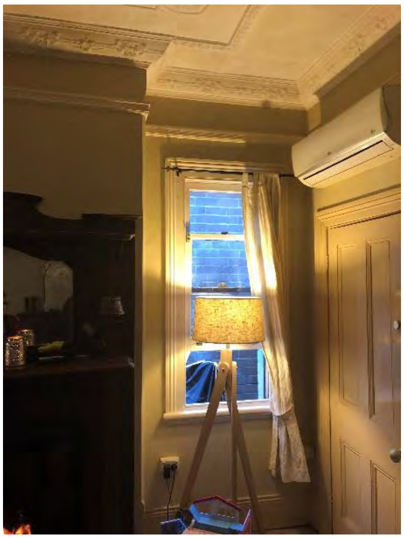
Sagging in U14 balcony

Location:

14 Victoria Street- Internal Room

Comments:

Minor crack on top of window



Location:

14 Victoria Street- Internal Room Ceiling

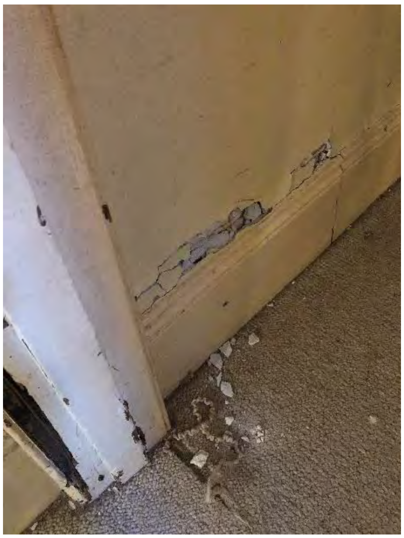
Comments:

Cracks in Ceiling

Photos

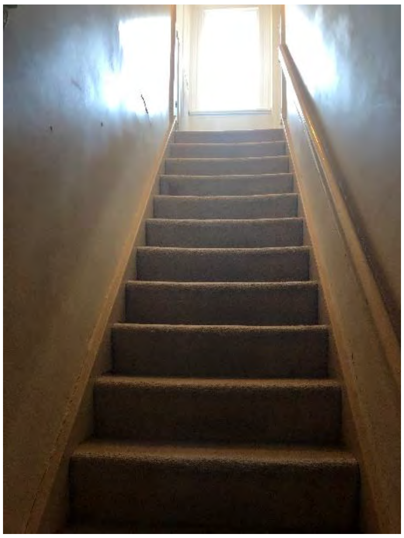
Location:
14 Victoria Street- Corridor

Comments:
Crack on the load bearing wall



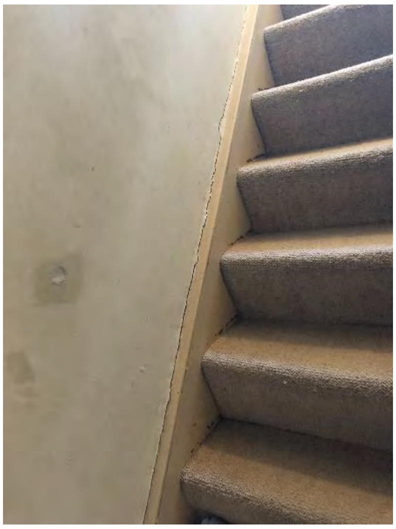
Location:
14 Victoria Street- Stair

Comments:
General Shot



Location:
14 Victoria Street- Stair

Comments:
Crack on wall next to stair stringer



Photos

Location:
14 Victoria Street- Back yard

Comments:
General shot

Location:
14-16 Victoria Street-
Chimney

Comments:
Structurally Loose Chimney

Location:
14 Victoria Street- Front
Balcony

Comments:
Structurally inadequate

Photos

Location:

14 Victoria Street- Front Balcony

Comments:

Balcony Sagging

Location:

16 Victoria Street- Side Perimeter Brick Wall

Comments:

Minor cracks

Location:

14 Victoria Street- Side Perimeter Brick Wall

Comments:

Minor cracks

Photos

Location:

18-24a Victoria Street,
Existing Buildings

Comments:

General Shot

Location:

4-12 Victoria Street, Existing
Buildings

Comments:

General Shot

APPENDIX

B

Structural Report By JSBC

STRUCTURAL REPORT

14-16 VICTORIA STREET KOGAREH

03	31/07/2019	J.Salhani	N. Morphett	B. Cheong	Issued for Information
02	30/07/2019	J.Salhani	N. Morphett	B. Cheong	Issued for Information
01	29/07/2019	J.Salhani	N. Morphett	B. Cheong	Issued for Information
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TABLE OF CONTENTS

1 INTRODUCTION

JSBC Consulting Pty Ltd has been commissioned by Sutherland and Associates Planning on behalf of the owners to carry out a structural assessment report on the current condition of 14-16 Victoria Street Kogarah.

A 12-storey residential building with 3 basements is proposed at 18-24A Victoria Street.
The likely redevelopment at 4-12 Victoria Street will involve an approximately 11 storey residential building with multiple basement levels.

The report highlights the potential structural impact on 14-16 Victoria Street Kogarah during the construction of the proposed adjacent developments.

2 SCOPE OF WORK

The scope of the review includes the following:

- A visual inspection of the current structural condition of 14-16 Victoria Street Kogarah. A representative from JSBC Consulting visited the site at 8.00AM on the 29th of July 2019. Internal access was only provided to 14 Victoria Street.
- Review of concept drawings of the proposed developments.
- Review of the geotechnical report of the adjacent site.
- Highlight potential structural impact on 14-16 Victoria Street during construction of the adjacent proposed developments.

3 DOCUMENTS REVIEWED

The following documents were referred to in the review:

- Heritage Assessment Report PM-18005 by Perumal Murphy Alessi.
- Demo plan and proposed concept plans for 18-24A Victoria Street Kogarah.
- Geotechnical report 13779/1-AA for 22-24a Victoria Street prepared by Geotechnique Pty Ltd.

4 SUMMARY OF CURRENT CONDITION

Following inspection of 14-16 Victoria Street Kogarah we note the following:

- The terraces are constructed of load bearing brickwork and timber framed floors and roof.
- The boreholes from the geotechnical report for the adjacent site show that site contains up to 1.2m of residual soil over Class V shale. Given the age of the terraces, the loading bearing elements at 14-16 Victoria Street are most likely not founded on rock.
- Numerous cracks in the load bearing brickwork around the property were observed. (Refer to photos in Appendix A).
- The front balcony at number 14 is sagging and appears to be structurally inadequate.
- The brickwork at the top of the chimney appears to be loose.
- Multiple structural repairs have been carried throughout the terraces.

5 STRUCTURAL IMPACT FROM PROPOSED DEVELOPMENTS

It is likely that the proposed developments on the East and West boundaries of 14-16 Victoria Street will have the following structural impacts on the terraces:

- Due to the 9.0m deep excavation at 18-24A Victoria St and proximity to the boundary, there is a high risk that the soil under the load bearing elements for 14-16 Victoria Street will move even if retention/shoring systems are used. Given the age of the terraces and the data presented in the geotechnical report, the load bearing elements could be founded on residual soil overlying rock, which makes it more susceptible to movement. Any slight movement in the soil will cause structural damage to the walls which has a high risk on the structural integrity of the terraces.
- Due to the deep excavations, shoring systems with temporary anchors will be adopted. Pile drilling and installation of anchors and excavation will cause vibrations during construction which has a high risk of causing cracks in the brick walls which are not founded on rock. This has a high risk on structural integrity of the terraces.
- The soil at the bulk excavation level of the adjacent site is high strength sandstone. The excavation can cause stress relief in the sandstone which will cause lateral movement in the rock underlying the residual soil at 14-16 Victoria Street. This has a high risk of damage to the brick walls at 14-16 Victoria Street which will affect the structural integrity of the terraces.

In the event of structural damage to 14-16 Victoria Street due to the construction of the adjacent proposed developments, a proper repair to maintain the structural integrity of the terraces would be extensive and would involve replacement of a lot of the original material with new building material to comply with current Australian Standards.

6 APPENDICES

The following items are appended to this report:

- Photos of Current Condition of 14-16 Victoria Street Kogarah

PHOTOS

Photo 1 - Overall Photo of 14-16 Victoria Street (Sagging Balcony)

Photo 2 - Cracks in External Brick Wall at Terrace Number 14

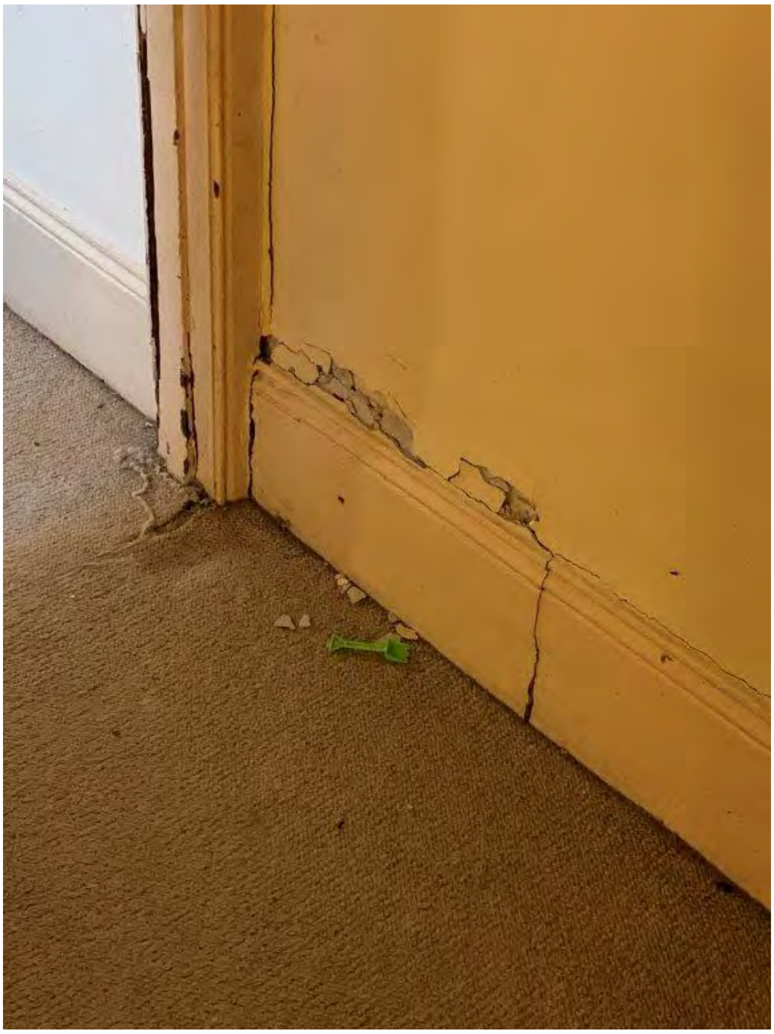

Photo 3 - Cracks in Brick Wall

Photo 4 - Cracks in Brick Wall

Photo 5 Cracks in Brick Wall

Photo 6 - Cracks in Brick Wall

Photo 7 - Cracks in Ceiling and Brick Wall

Photo 8 - Condition of Ceiling

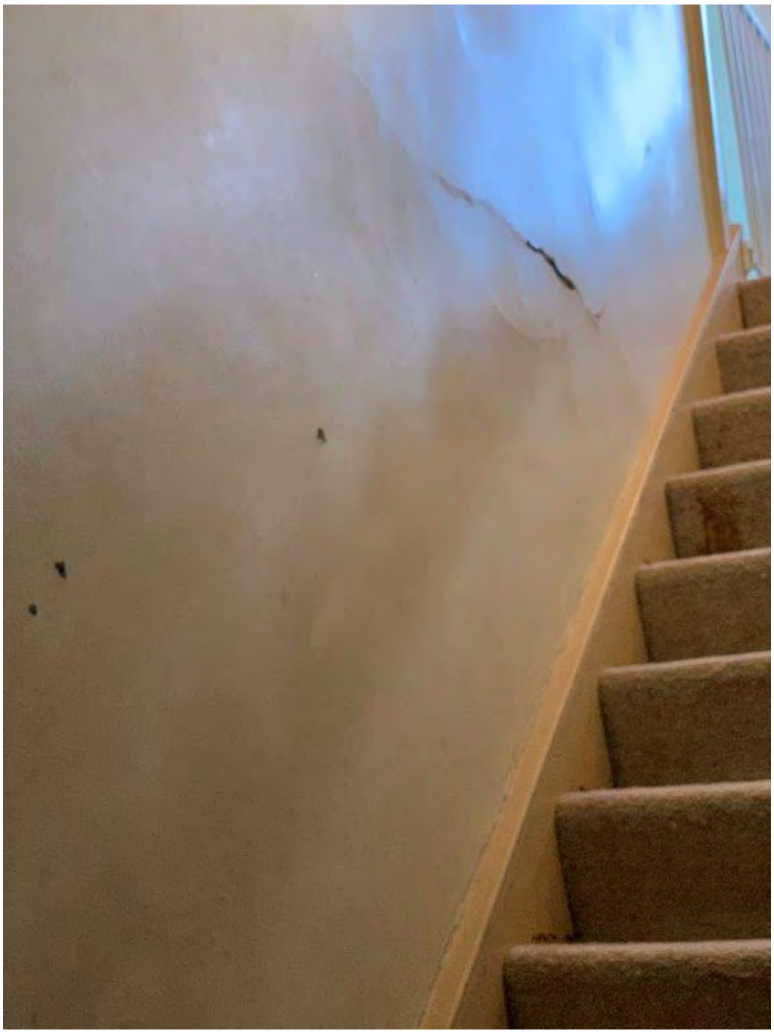

Photo 9 - Cracks in Brick Wall

Photo 10 - Cracks in Brick Wall

Photo 11 - Sagging Balcony

Photo 12 - Sagging Balcony

Photo 13 - Cracks in Brick Wall

Photo 14 - Cracks in Brick Wall

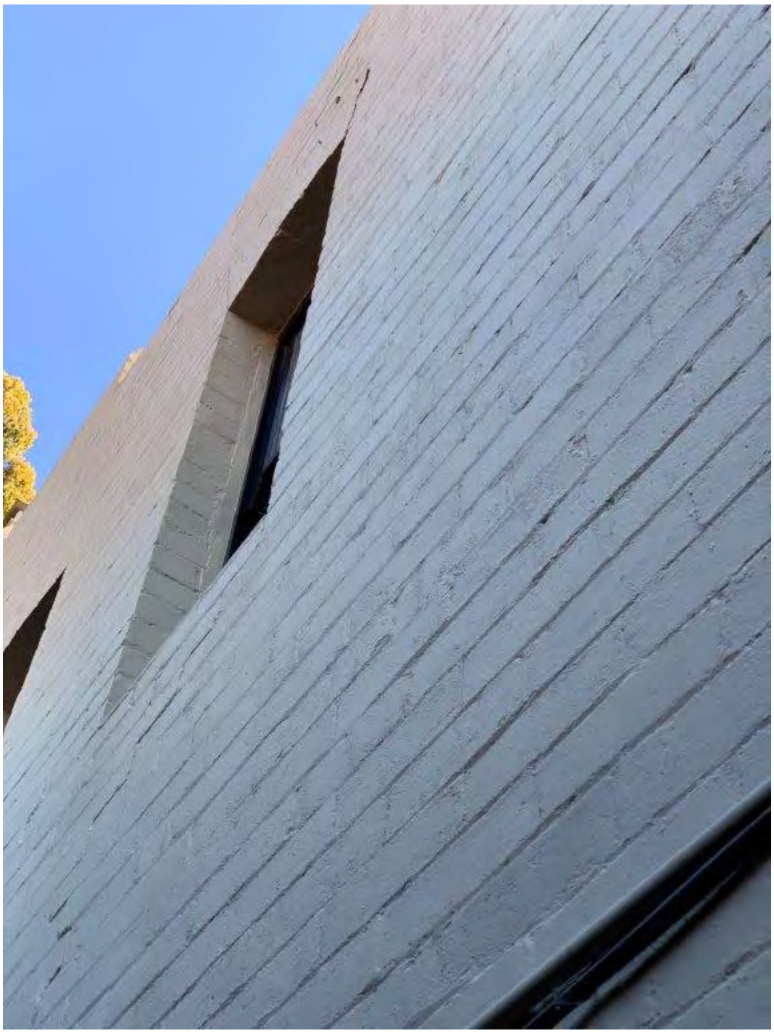

Photo 15 - Cracks in Brick Wall

Photo 16 - Sagging Balcony

Photo 17 - Cracks in Brick Parapet at Terrace Number 16

APPENDIX

C

Geotechnical Report By Geotechnique

GEOTECHNIQUE®
PTY LTD

ACLCA

ABN 64 002 841 063

Job No: 13779/1
Our Ref: 13779/1-AA
25 July 2016

Kai-Tian Group Pty Ltd
c/-a.BASTASarchitects Pty Ltd
Suite 203/349 Pacific Highway
NORTH SYDNEY NSW 2060
Email: abastas@tpg.com.au

Attention: Mr T Bastas

Dear Sir

re: **Proposed Residential Development**
22 and 24a Victoria Street, Kogarah
Geotechnical Investigation

This report details the results of a geotechnical investigation carried out for a proposed residential development at 22 and 24a Victoria Street, Kogarah, hereafter referred to as the site.

We understand that the proposed development at the above site includes demolition of existing structures and construction of a new residential building with ten storeys above the ground and three levels of basement car park. We also understand that the basement excavation will be about 9.0m deep. A site survey plan was provided for preparation of this report.

A geotechnical investigation is required to assess subsurface conditions across the site in order to provide geotechnical recommendations on the design of the basement excavation, retaining structures, floor slabs and footings.

Review of Available Information

Reference to the Geological Map of Sydney (scale 1:100,000) indicates that the bedrock at the site is Hawkesbury sandstone, comprising medium to coarse grained quartz sandstone, very minor shale and laminite lenses.

Reference to the Soil Landscape Map of Sydney (scale 1:100,000) indicates that the landscape at the site belongs to Lucas Height Group, which is characterised by gently undulating crests and ridges on plateau surfaces of Mittagong Formation (alternating bands of shale and fine grained sandstone), with local relief to 30m and ground surface slopes of less than 10%. Rock outcrop is absent. The subsurface soil is likely to be moderately deep (0.5m to 1.5m) and stony.

Reference to Acid Sulphate Soil Risk Map (Edition 2, 1:25,000) of Botany prepared by Department of Land and Water Conservation indicates that there is no known occurrence of acid sulphate soil materials within the soil profiles at the site. Acid sulfate soil materials are not expected in the site.

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Field Work
Field work for the geotechnical investigation was carried out during on 1 and 14 July 2016 and included the following:

- Reviewing available geological information relevant to the proposed development site.
- Carrying out a walk over survey to assess existing site conditions.
- Reviewing services plans obtained from "Dial Before You Dig" to determine locations of services across the site.
- Scanning proposed borehole locations for underground services to ensure that services were not damaged during field work. We engaged a specialist services locator for this purpose.
- Drilling two boreholes (BH1 and BH2) using a track mounted drilling rig fully equipped for geotechnical investigation. Boreholes were uniformly distributed in accessible portions of the site. Both boreholes were initially drilled to V-bit refusal in bedrock at depths of 1.1m to 1.5m from existing ground surface and then continued to depths of 12.1m to 12.45m using rock coring techniques. The approximate borehole locations are indicated on the attached Drawing No 13779/1-AA1. Engineering borehole logs and photographs of rock cores are also attached.
- Conducting Standard Penetration Test (SPT) in the boreholes to assess strength characteristics of sub-surface soils.
- Recovering representative soil samples and rock cores for visual assessment and laboratory tests.
- Measuring depths to groundwater level or seepage in the boreholes, where encountered.
- Backfilling the boreholes with soils recovered from boreholes after logging and sampling.

Field work was supervised by a Field Engineer from this company who was responsible for the walk over survey, nominating the borehole locations, supervision of SPT tests, sampling, and preparation of field logs.

Site Description
The proposed development site is of irregular shape measuring approximately 870.m^2 in total plan area. The following observations were made during field work:

- The site is bound by Victoria and Stanley Streets, Kogarah, to the north, Stanley Lane to the south and existing residential properties in two remaining sides.
- There are two existing residences, one each in two lots, within the site and vacant portions of the site are grass covered or paved.
- Natural ground surface across the site is almost levelled.

Sub-surface profiles encountered in the boreholes are detailed in the attached logs, and summarised below in Table 1.

Table 1 – Sub-surface Profiles encountered in Boreholes

Borehole No	Ground Surface RL* (m, AHD)	Termination Depth (m)	Depth Range for Topsoil/Fill (m)	Depth Range for Residual Soil (m)	Depth to Bedrock (m)
BH1	19.2	12.10	0.0-0.2	0.2-1.0	1.0
BH2	19.5	12.45	0.0-0.2	0.2-1.2	1.2

*Approximate

Table 1 indicates that the sub-surface profile across the site comprises a sequence of topsoil/fill and residual soil underlain by bedrock.

Topsoil is silty sand of fine to medium grained with some roots and fill includes pavement materials and silty clayey sand of fine to medium grained. Residual soils predominantly comprise silty clayey sand and silty sand of fine to medium grained. Bedrock encountered up to borehole termination depths is sandstone and the depth to bedrock across the site is likely to vary from about 1.0m to 1.2m from existing ground surface.

Groundwater level was not encountered up to V-bit refusal at depths of 1.1m to 1.5m from existing ground surface. Water used for rock coring precluded measurement of groundwater at completion of coring. However, based on observations during drilling, it is our assessment that the depth to groundwater level across the site is likely to be lower than the proposed basement level at depths of 9.0m from exiting ground surface. It should however be noted that fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors not evident during drilling.

Laboratory Testing

Rock cores obtained from boreholes were photographed and tested at regular depth intervals for determination of Point Load Strength Index (I_{s50}). The point load strength indices for the rock cores and the assessed rock strengths, in accordance with Australian Standard AS1726-1993 (Reference 1), are summarised in the following Table 3.

Table 3 – Results of Point Load Strength Index Tests

Borehole No	Depth (m)	Diametral $I_{s(50)}$ (MPa)	Axial $I_{s(50)}$ (MPa)	Assessed Diametral Strength	Assessed Axial Strength
BH1	1.80	0.88	1.46	Medium	High
BH1	2.40	0.86	1.28	Medium	High
BH1	3.60	0.96	1.47	Medium	High
BH1	4.50	0.57	1.07	Medium	High
BH1	4.50	1.49	2.27	High	High
BH1	6.60	1.10	1.92	High	High
BH1	8.00	1.19	1.84	High	High
BH1	9.50	1.19	2.28	High	High
BH1	10.50	1.53	1.99	High	High
BH1	11.60	2.04	3.41	High	Very High
BH2	1.80	1.46	1.85	High	High
BH2	2.32	0.05	0.08	Very Low	Very Low
BH2	3.25	1.11	1.36	High	High
BH2	4.05	1.64	1.46	High	High
BH2	5.30	1.41	2.22	High	High
BH2	6.30	1.46	3.10	High	Very High
BH2	7.40	1.40	1.91	High	High
BH2	8.40	1.83	1.95	High	High
BH2	9.10	1.82	2.51	High	High
BH2	10.90	1.33	1.54	High	High
BH2	11.80	1.36	2.62	High	High

It should however be noted that Point Load Strength tests could only be carried out on intact (stronger) portions of rock cores. Therefore, strength assessments presented in Table 3 indicate the upper limits of rock strengths.

Based on rock strengths (Table 3) and rock discontinuities shown in the borehole logs, bedrock from the proposed development site is classified for foundation design in accordance with Pells et al (Reference 2) in the following Table 4.

Table 4 – Rock Classification for Foundation Design

Assessed Rock Class	Depth Range in BH1* (m)	Depth Range in BH2* (m)
Sandstone - Class V	1.0-1.6	1.2-1.5
Sandstone - Class IV	1.6-3.0	1.5-3.7
Sandstone – Class III	3.0-6.0	3.7-5.5
Sandstone – Class II/I	>6.0	>5.5

* Approximate only from existing ground surface

Based on Table 4, the bedrock at the base of the basement excavation at depth of about 9.0m is anticipated to be Class II sandstone.

Representative soil samples recovered from boreholes were tested in the NATA accredited laboratory of SGS Environmental Services, in accordance with relevant Australian Standards, to determine chemical properties like Electrical Conductivity (EC), pH, chloride, sulphate and resistivity. Detailed laboratory test results are attached, and a summary is presented below in Table 2.

Table 2 – Results of Chemical Properties Tests

Borehole No	Depth (m)	EC (µS/cm)	pH	Chloride (ppm)	Sulphate (ppm)	Resistivity (ohm-cm)
BH1	0.4-0.8	120	5.4	79	88	5200
BH2	0.4-0.7	21	6.8	3.1	3.5	35000

DISCUSSION AND RECOMMENDATIONS

Soil Salinity

Salinity refers to the presence of excess salt in the environment, either in soil or water. Soil salinity is generally assessed by measuring EC of a soil sample made up of 1:5 soil water suspension. Thus, determined EC is multiplied by a factor varying from 6 to 23, based on the texture of the soil sample, to obtain Equivalent Electrical Conductivity designated as ECe (Reference 3). Alternatively, ECe may be directly measured in soil saturation extracts. Soils are classified as saline if ECe of the saturated extracts exceed 4.0dS/m. The criteria for assessment of soil salinity classes are shown in the following Table 5 (Reference 3).

Table 5 –Criteria for Soil Salinity Classification

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of very sensitive crops may be affected
Moderately saline	4 – 8	Yields of many crops affected
Very saline	8 – 16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

Subsurface soils encountered across the site were predominantly sandy for which a multiplying factor of 12 is assessed to be appropriate. Estimates of ECe values for representative soil samples presented in Table 2 vary from about 0.25dS/m to 1.44dS/m. Therefore, soils across the site are assessed to be non-saline soils. Therefore, it is our assessment that the earthworks involving excavation and disturbance of soils for the proposed development can be carried out without a Saline Soil management Plan.

Soil Aggressivity

Aqueous solution of chlorides causes corrosion of iron and steel, including steel reinforcements in concrete. Corrosion damage by chlorides is only relevant to iron and steel. The aggressivity classifications of soil and groundwater applicable to iron and steel, in accordance with Australian Standard AS2159 (Reference 4), are given below in Table 6.

Table 6 – Aggressivity Classification for Steel/Iron

Chloride		**pH**	**Resistivity (ohm cm)**	**Soil Condition A***	**Soil Condition B#**
In Soil (ppm)	**In Water (ppm)**				
<5000	<1000	>5.0	>5000	Non-aggressive	Non-aggressive
5000-20000	1000-10000	4.0-5.0	2000-5000	Mild	Non-aggressive
20000-50000	10000-20000	3.0-4.0	1000-2000	Moderate	Mild
>50000	>20000	<3.0	<1000	Severe	Moderate

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
#Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

The aggressivity classifications of soil and groundwater applicable to concrete, in accordance with Australian Standard AS2159 (Reference 4), are given below in Table 7.

Table 7 – Aggressivity Classification for Concrete

Sulphate expressed as SO_4		**pH**	**Chloride in Water (ppm)**	**Soil Condition A**	**Soil Condition B**
In Soil (ppm)	**In Groundwater (ppm)**				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10000	1000-3000	4.5-5.5	6000-12000	Moderate	Mild
10000-20000	3000-1000	4.0-4.5	12000-30000	Severe	Moderate
>20000	>10000	<4.0	>30000	Very Severe	Severe

Approximately 100ppm of SO_4 = 80ppm of SO_3

Results of aggressivity tests on representative soil samples from the site are summarised in Table 2. The soils across the site are sandy in nature. Therefore, appropriate site condition for predominant soils at the site is assessed to be "Condition A". Aggressivity tests indicated the following:

- The pH values of soil samples vary from 5.4 to 6.8, indicating that the site conditions are non-aggressive to steel/iron but mildly to moderately aggressive to concrete.
- Chloride contents in soil samples vary from 3.1 to 79.0ppm, indicating that the site conditions are non-aggressive to steel/iron and mildly aggressive to concrete.
- Sulphate contents in soil samples vary from 3.5 to 88.0ppm, indicating that the site conditions are mildly aggressive to concrete.
- Resistivity of soil samples vary from 5200.0 to 35000.0 ohm-cm indicating that the site conditions non-aggressive to steel/iron.

Therefore, it is our assessment that the construction materials, such as concrete, steel, iron etc, that are appropriate for the assessed aggressivity should be used for proposed development works.

Geotechnical Model

Based on site observation and information obtained from boreholes drilled during the investigation, a Geotechnical Model has been developed for the proposed development site. Anticipated Geotechnical Units constituting the Geotechnical Model for the site are provided in Table 8. Each Geotechnical Unit represents a specific nature of soil and/or bedrock encountered across the site.

Table 8 –Geotechnical Model

Geotechnical Unit	Material Description	Depth Range in BH1 (m)	Depth Range in BH2 (m)
Unit 1	Residual Soil	0.0-1.0	0.0-1.2
Unit 2	Class V Sandstone	1.0-1.6	1.2-1.5
Unit 3	Class IV Sandstone	1.6-3.0	1.5-3.7
Unit 4	Class III Sandstone	3.0-6.0	3.7-5.5
Unit 5	Class II/I Sandstone	>6.0	>5.5

*Depth ranges are estimates only.

If any controlled fill is placed in accordance with recommendations provided below in this report, the controlled fill may also be included in Unit 1.

In describing bedrock encountered across the site, the Geotechnical Units and rock classifications are used interchangeably in this report. Assessed strength parameters, in terms of cohesion and internal friction angle, as well as modulus for each Geotechnical Unit are presented below in Table 9.

Table 9 –Strength Parameters and Modulus

Geotechnical Units	Unit Weight (kN/m^3)	Undrained Condition			Drained Condition		
		Cohesion (kPa)	Friction Angle (deg)	Modulus (MPa)	Cohesion (kPa)	Friction Angle (deg)	Modulus (MPa)
Unit 1	19.0	100.0	0.0	20	0.0	27.0	15
Unit 2	20.0	400.0	0.0	75	10.0	28.0	50
Unit 3	21.0	1000.0	0.0	500	15.0	31.0	350
Unit 4	22.0	3000.0	0.0	1000	25.0	34.0	700
Unit 5	23.0	5000.0	0.0	2000	30.0	36.0	1400

A Poisson's Ratio value of 0.30 is recommended for Unit 1, and a value of 0.25 is considered appropriate for Units 2, 3, 4 and 5.

Excavation Conditions

The depth of the basement excavation is anticipated to be about 9.0m from existing ground surface. Therefore, materials to be excavated are expected to comprise topsoil, residual soil and bedrock. Bedrock encountered during basement excavation is anticipated to be Class V to Class II/I sandstone.

It is our assessment that the excavation of topsoils, residual soil as well as Class V bedrock can be achieved using conventional earthmoving equipment such as excavators and dozers. However, excavation into Class IV or better bedrock may require larger equipment (such as rock saw, Caterpillar D10 or equivalent). Significant excavation for proposed basement will occur in Class IV or better bedrock. However, selection of rock cutting equipment should be based on site access, desired smoothness of the excavated rock surface and acceptable ground vibration during rock excavation.

Ground vibration during rock excavation is generally represented by maximum peak particle velocity. Houses and low rise residential buildings can generally tolerate ground vibration of about 5.0mm/s to 10.0mm/s. We anticipate that excavation into Class V bedrock will result in ground vibrations that are likely to be within tolerable limits for stability of existing structures in the vicinity of the site. However, a rock saw may be preferable for excavation into Class IV or better bedrock to minimise ground vibration during rock excavation.

Observations during borehole drilling indicate that the depth to groundwater is likely to be deeper than the base of the proposed basement excavation. Therefore, we do not anticipate significant groundwater inflow during the proposed basement excavation. However, some groundwater inflow would be anticipated during excavation to depth of 9.0m. It is our assessment that such groundwater inflow, if any, could be managed by a conventional sump and pump method. We suggest a specialist dewatering contractor be contacted for advice if significant groundwater inflow is encountered during basement excavation.

Fill Placement

We consider that the proposed development works would require only minor fill placement, if any. The following procedures are recommended for placement of controlled fill, where required:

- Strip existing topsoil and fill and stockpile separately for possible future uses or disposal off site. This operation is anticipated to expose residual soil.
- Undertake proof rolling of the exposed residual soils using an 8 to 10 tonne roller, to detect potential weak spots (ground heave). Excavate areas of localised heaving to a depth of about 300mm and replace with granular fill and then compact as described below.
- Undertake proof rolling of soft spots backfilled with granular fill, as described above. If the backfilled area shows movement during proof rolling, this office should be contacted for further recommendations.
- Place suitable fill materials on proof rolled surface of soils. The fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness and compacted to a Minimum Dry Density Ratio (MDDR) of 98% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). Controlled fill should preferably comprise non-reactive fill (e.g. crushed sandstone) with a maximum particle size not exceeding 75mm, or low plasticity clay. The residual soils and bedrock obtained from excavations within the site may be used in controlled fill after removal of unsuitable materials, if any, crushing to sizes finer than 75mm, and moisture conditioning.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 2" or better supervision, in accordance with AS3798-2007 (Reference 5). It should be noted that a Geotechnical Inspection and Testing Authority will generally provide certification on the quality of the entire compacted fill only if Level 1 supervision and testing is carried out.

Batter Slopes and Retaining Structures

The proposed development will involve about 9.0m deep excavation. Some minor fill placement might also be required. Cut and fill slopes during and after development works should be battered for stability or retained by engineered retaining structures. Recommended batter slopes for stability of cut and fill slopes are presented in Table 10.

Table 10 – Recommended Batter Slopes for Excavation Faces

Material	**Temporary (Horizontal : Vertical)**		**Permanent (Horizontal : Vertical)**	
	Exposed	**Protected**	**Exposed**	**Protected**
Unit 1 - Residual Soil (and controlled fill, if any)	1.5:1.0	1.0:1.0	3.0:1.0	2.0:1.0
Units 2 and 3 - Class V and IV Sandstone	1.0:1.0	0.5:1.0	1.5:1.0	1.0:1.0
Unit 4 and 5 - Class III and II/I Sandstone	Vertical			

Surface protection of the slopes can be provided by shotcreting, which may be reinforced.

Vertical excavations in Class III or better bedrock, where required, will have very low risk of instability. However, some localised rock bolting and shotcreting might be required, depending on the relative orientations of rock discontinuities (bedding partings, fractures and joint systems) and excavation faces. Some rock discontinuities were observed in rock cores. Therefore, a Geotechnical Engineer should inspect the excavation face at depth intervals of about 1.5m to ascertain if localised rock bolting or shotcreting are required.

However, if the excavation extends to the site boundaries, or if batter slopes steeper than those recommended in Table 10 are required, excavation faces would need to be retained by engineered retaining structures. We anticipate upper 3.0m to 4.0m of basement excavation may have to be retained and appropriate retaining structures for the proposed basement excavations would comprise bored pile walls or gravity wall. Active earth pressure distribution on such retaining walls may be estimated using following equation:

$$p_h = \gamma kH$$

Where,

p_h = Horizontal active pressure (kN/m^2)
γ = Total density of materials to be retained (kN/m^3)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

For design of flexible retaining structures where some lateral movement is acceptable, an active earth pressure coefficient (k_a) is recommended. If it is critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest (k_0) is recommended. Recommended earth pressure coefficients for design of retaining structures are presented in the following Table 11.

Table 11 – Recommended Earth Pressure Parameters

Retained Material	**Unit Weight (kN/m^3)**	**Active Earth Pressure Coefficient (k_a)**	**Passive Earth Pressure (kPa)**	**At Rest Earth Pressure Coefficient (k_o)**
Unit 1 - Residual Soil (and controlled fill)	18.0	0.40	Ignore	0.60
Units 2 and 3 - Class V and IV Sandstone	21.0	0.25	250.0	0.40
Unit 4 and 5 - Class III and II/I Sandstone	22.0	None	400.0	None

The above coefficients are based on the assumptions that the ground level behind the retaining structure is horizontal and the retained material is effectively drained. Additional earth pressures resulting from surcharge loads (buildings, infrastructures, etc) on retained materials and groundwater pressure, if any, should also be allowed for in design of retaining structures. The design of any retaining structure should also be checked for bearing capacity, overturning, sliding and overall stability of the slope.

If retaining structures are anchored or strutted (by floor slabs etc), the pressure distribution on the retaining structure may be assumed to be trapezoidal in shape and estimated as follows:

p_h is linearly increasing from zero at ground surface (top of retaining wall) to $0.2\gamma H$ at depth of 0.25H, where γ = Equivalent unit weight of retained materials say $21.0kN/m^3$ and H= Depth of excavation

p_h is constant at $0.2\gamma H$ from depth of 0.25H to 0.75H

p_h is decreasing from $0.2\gamma H$ at depth of 0.75H to zero the base of excavation

Floor Slabs and Footings

The foundation material at the base of basement excavation is anticipated to comprise Class II/I sandstone bedrock (Unit 5). Therefore, floor slabs for the proposed building may be constructed as ground bearing slabs or suspended slabs supported by footings designed in accordance with recommendations provided in this report. For design of ground bearing slabs on Class II/I sandstone, we recommend a Modulus of Subgrade Reaction Value of 60.0kPa/mm.

Loading conditions from the proposed building are not known at this stage. However, we consider that the appropriate footings would comprise shallow footings (pad and strip) founded on sandstone at basement level or deep footings (bored piers) socketed into sandstone. Deep footings might be preferable if footings are required to support significant lateral and/or uplift pressures. We also anticipate footings founded at depths shallower then the base of the excavation may be required for ancillary structures. The recommended allowable bearing pressures for design of shallow and deep footings are presented in the following Table 12.

Table 12 – Recommended Allowable Bearing Pressures

Founding Material	**Allowable Bearing Pressure (kPa)**	**Allowable Shaft Adhesion (kPa)**
Unit 1 - Residual Soil	200.0	Ignore
Unit 2 - Class V Sandstone	1000.0	75.0
Unit 3 - Class IV Sandstone	2000.0	150.0
Unit 4 - Class III Sandstone	5000.0	350.0
Unit 5 - Class II/I Sandstone	8000.0	600.0

The recommended allowable shaft adhesions against uplift pressures are halves the shaft adhesions for compressive loads presented in Table 12.

If footings are founded above the 1 Horizontal to 1 Vertical line projected from the edge at the base of any excavation, the recommended allowable bearing pressures presented in Table 12 are not applicable and appropriate allowable bearing pressure will have to be determined by reassessment of materials exposed in the excavation face.

As depths of bedrock with the recommended allowable bearing pressures could vary across the site, the founding depths of footings to be constructed will also vary. Therefore, an experienced Geotechnical Engineer should confirm allowable bearing pressures at founding levels during construction, on the basis of assessment made during footing excavation or pier hole drilling.

For footings founded in residual soil and/or controlled fill (Unit 1), the total settlements under the recommended allowable bearing pressures are estimated to be about 2.0% of minimum footing dimension. For footings founded in bedrock (Units 2 to 5), total settlements under the recommended allowable bearing pressures are estimated to be about 1% of pier diameter or minimum footing dimension. Differential settlements are estimated to be about half the estimated total settlements.

Rock Anchors

It is likely that retaining walls may require anchorage or tie-back, in order to resist lateral pressure. We suggest that all anchors are socketed in bedrock (Units 2 to 5). The allowable grout to rock stress for use in rock anchorage design may be taken as 10% of the allowable bearing pressure presented in Table 12. However, the anchors should have sufficient bond length outside the 1 Vertical to 1 Horizontal line drawn from the edge of basement excavation.

General

Assessments and recommendations presented in this report are based on site observation and information from only two boreholes. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile including depth to groundwater level could differ from that encountered in the boreholes. Likewise, assessments of excavation induced ground movements are based on empirical methods are conservative but may be refined by conducting numerical analyses. We recommend that this company is contacted for further advice if soils or bedrock encountered during the construction stage differ from those presented in this report.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECHNIQUE PTY LTD

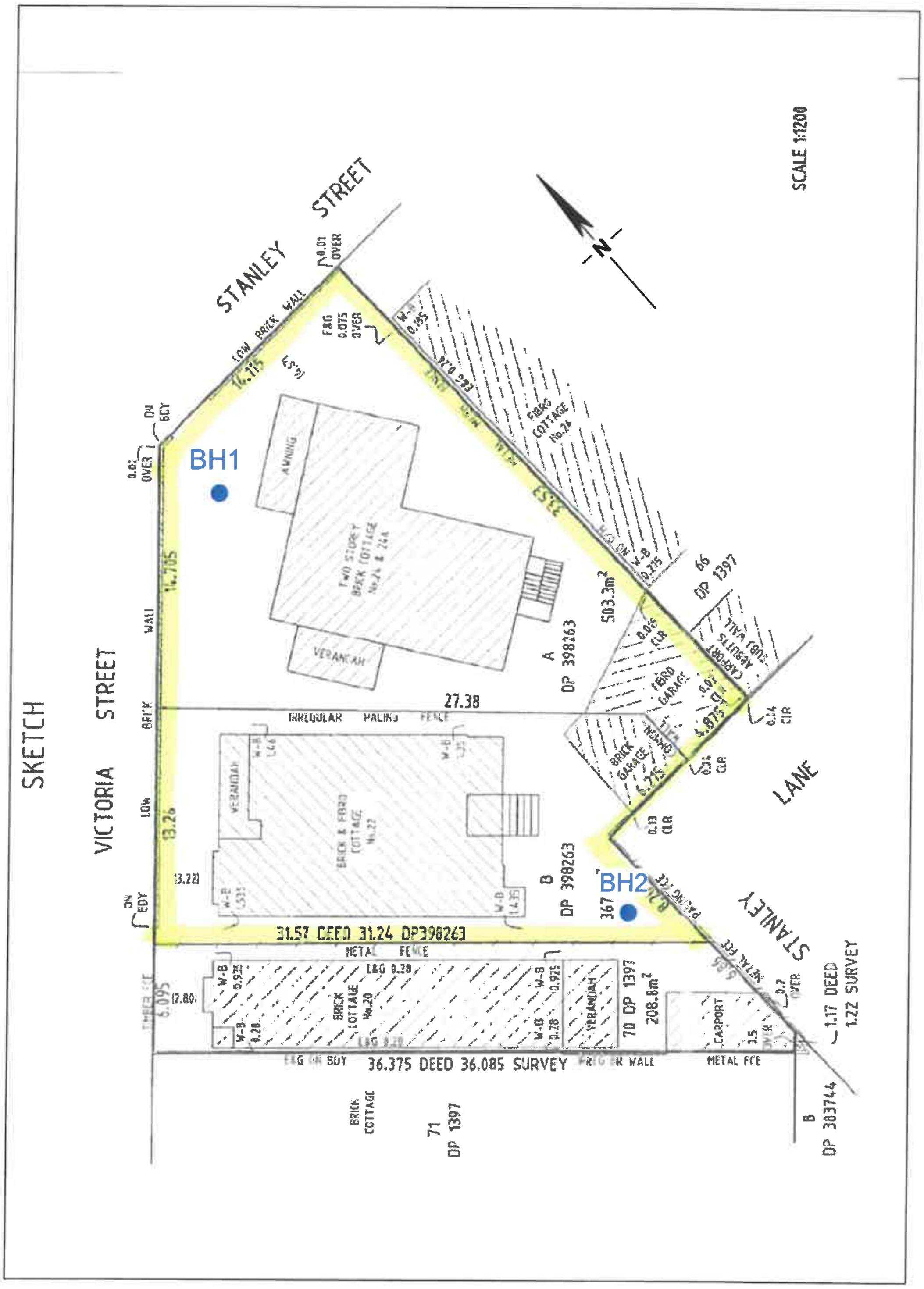
Jworcha

INDRA JWORCHAN
Principal Geotechnical Engineer

Attached	Drawing No 13779/1-AA1 Borehole Location Plan Engineering Borehole Logs, Core Photograph & Explanatory Notes Laboratory Test Results

References

1. *Australian Standard, Geotechnical Site Investigation, AS1726-1993.*
2. *Pells, P J N, Mostyn, E and Walker, B F, Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, Dec 1998.*
3. *Lillicrap, A and McGhie, S., Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.*
4. *Australian Standard AS2159-2009, Piling – Design and Installation, 2009.*
5. *Australian Standard AS3798-2007, Guidelines on Earthworks for Commercial and Residential Developments, 2007.*



LEGEND

● Borehole Location

0 10 20 30 40 50m

Scale 1:1000

PREPARED BY:

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Kai-Tian Group Pty Ltd
c/-a.BASTASarchitects Pty Ltd
Proposed Residential Apartment Development
22 and 24a Victoria Street, Kogarah

Borehole Locations

Drawing No: 13779/1-AA1
Job No: 13779/1
Drawn By: AI
Date: 21 JULY 2016
Checked By: IJ

File No: 13779-1
Layers: 0, AA1

engineering log - borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 1
Date : 01/07/2016
Logged/Checked by: MT

drill model and mounting : XC - Truck Mounted
slope : **deg.**
R.L. surface : 19.2
hole diameter : 125 **mm**
bearing : **deg.**
datum : AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			BRICK PAVEMENT, 100mm				
								SC	FILL: Silty Clayey Sand, fine to medium grained, brown	M	MD		Residual
									Silty Clayey SAND, fine to medium grained, brown-yellow				
						1			SANDSTONE, fine to medium grained, grey-yellow				Bedrock
									Refer to cored borehole				
						2							
						3							
						4							
						5							
						6							
						7							
						8							
						9							

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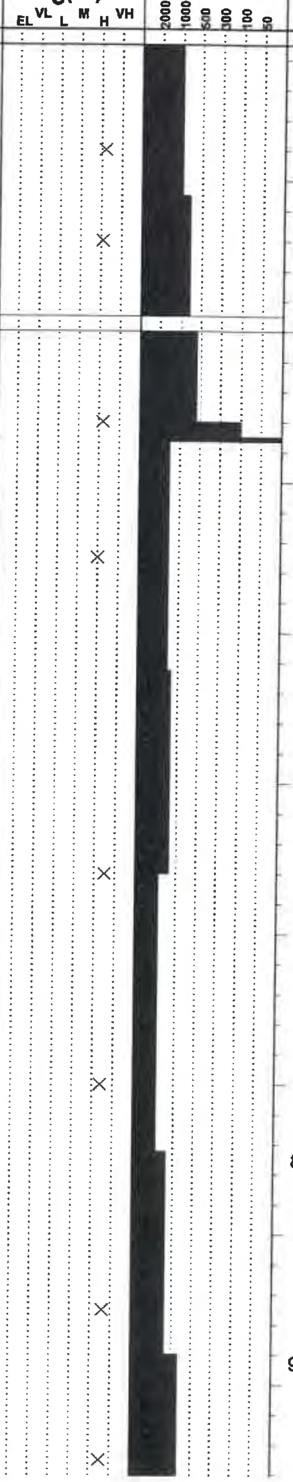
engineering log
cored borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 1
Date : 01/07/2016
Logged/Checked by : MT

drill model and mounting :
core size: NMLC
slope : **deg.**
bearing : **deg.**
R.L. surface : 19.2
datum : AHD



barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_s(50)$	defect spacing (mm)	DEFECT DETAILS DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific	General
		1		Commenced coring at 1.1m						
				SANDSTONE, fine to medium grained, brown-grey	DW-SW	M-H				
		2							2.1m: Bp=0°,Pl	
		3		CORE LOSS: 100mm						
				SANDSTONE, fine to medium grained, brown-grey	DW-SW	M-H			3.6m: Bp=0°,Pl 3.73m: Bp=0°,Pl	
				SANDSTONE, fine to medium grained, grey	F	H-M				
		4								
		5							5.25m: Is 5.5m: Bp=0°,Pl	
		6								
		7								
		8							8.45mm: Bp=0°,Pl	
		9								
		10							9.8m: Bp=0°,Pl	

engineering log
cored borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 1
Date : 01/07/2016
Logged/Checked by : MT

drill model and mounting :
slope : deg.
R.L. surface : 19.2
core size: NMLC
bearing : deg.
datum : AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength Is(50) EL VL L M H VH	defect spacing (mm) 000 1000 500 300 100 50	DEFECT DETAILS DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific	General
		11 12	▨				×	■	10.66m: Bp=0°,Pl	
		13 14 15 16 17 18 19 20		Borehole No. 1 terminated at 12.1m						

GEOTECHNIQUE
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Job No 13779/1 BH1 Started Coring at 1.1m

engineering log - borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 2
Date : 14/07/2016
Logged/Checked by: MT

drill model and mounting : XC - Truck Mounted
slope : **deg.**
R.L. surface : 19.5
hole diameter : 125 **mm**
bearing : **deg.**
datum : AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			TOPSOIL: Silty Sand, fine to medium grained, brown, with grass roots				
								SM	Silty SAND, fine to medium grained, grey	M	MD		Residual
						1		SC	Silty Clayey Sand, fine to medium grained, yellow-brown	M	MD		
									SANDSTONE, grey, low strength, extremely weathered, with some clay bands				Bedrock
									Refer to cored borehole				
						2							
						3							
						4							
						5							
						6							
						7							
						8							
						9							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 2
Date : 14/07/2016
Logged/Checked by : MT

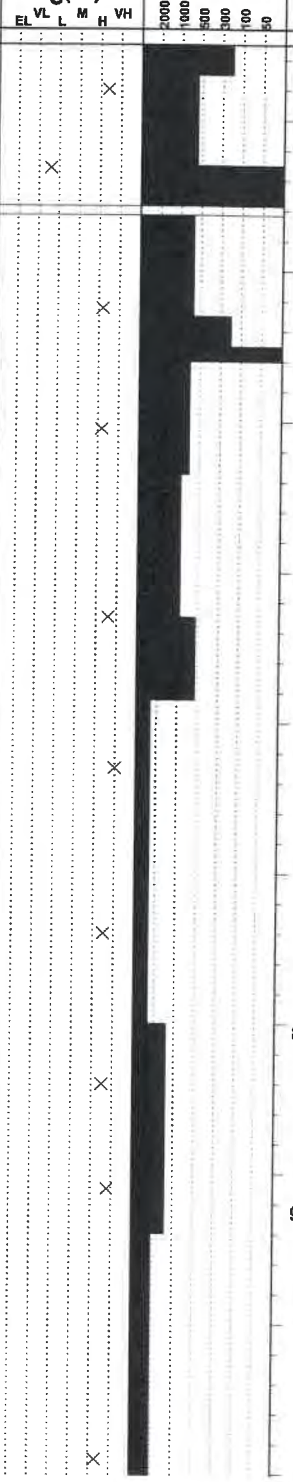
drill model and mounting :
slope : **deg.**
R.L. surface : 19.5
core size: NMLC
bearing : **deg.**
datum : AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength
				Commenced coring at 1.5m		
				SANDSTONE, fine to medium grained, brown, with some clay bands	DW-SW	M-H
		2				
				CORE LOSS: 2.57-2.63m		
				SANDSTONE, fine to medium grained, brown, with some clay bands	DW-SW	M-H
		3				
				SANDSTONE, fine to medium grained, grey	SW-FR	H-VH
		4				
		5				
		6				
		7				
		8				
		9				
		10				
		11				

point load index strength $I_S(50)$

DEFECT DETAILS

defect spacing (mm)



DESCRIPTION
type, inclination, thickness, planarity, roughness, coating.
Specific **General**

1.7m: Bp=0°,Pl
2.3m: Is
2.55m: Is
Core loss: 60mm
3.3m: Bp=0°,Pl
3.5m: Cs
3.55m: Cs
4.35m: Is
5.3m: Is
5.8m: Bp=0°,Pl
8.0m: Bp=0°,Pl
9.2m: Is

engineering log
cored borehole

Client : a.BASTASarchitects Pty Ltd
Project : Proposed Residential Development
Location : 22 and 24a Victoria Street, Kogarah

Job No. : 13779/1
Borehole No. : 2
Date : 14/07/2016
Logged/Checked by : MT

drill model and mounting :
slope : **deg.**
R.L. surface : 19.5
core size: NMLC
bearing : **deg.**
datum : AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_s(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DEFECT DETAILS DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific	General
		12					×		11.44m: Bp=0°,Pl	
		13 14 15 16 17 18 19 20		Borehole No. 2 terminated at 12.45m						

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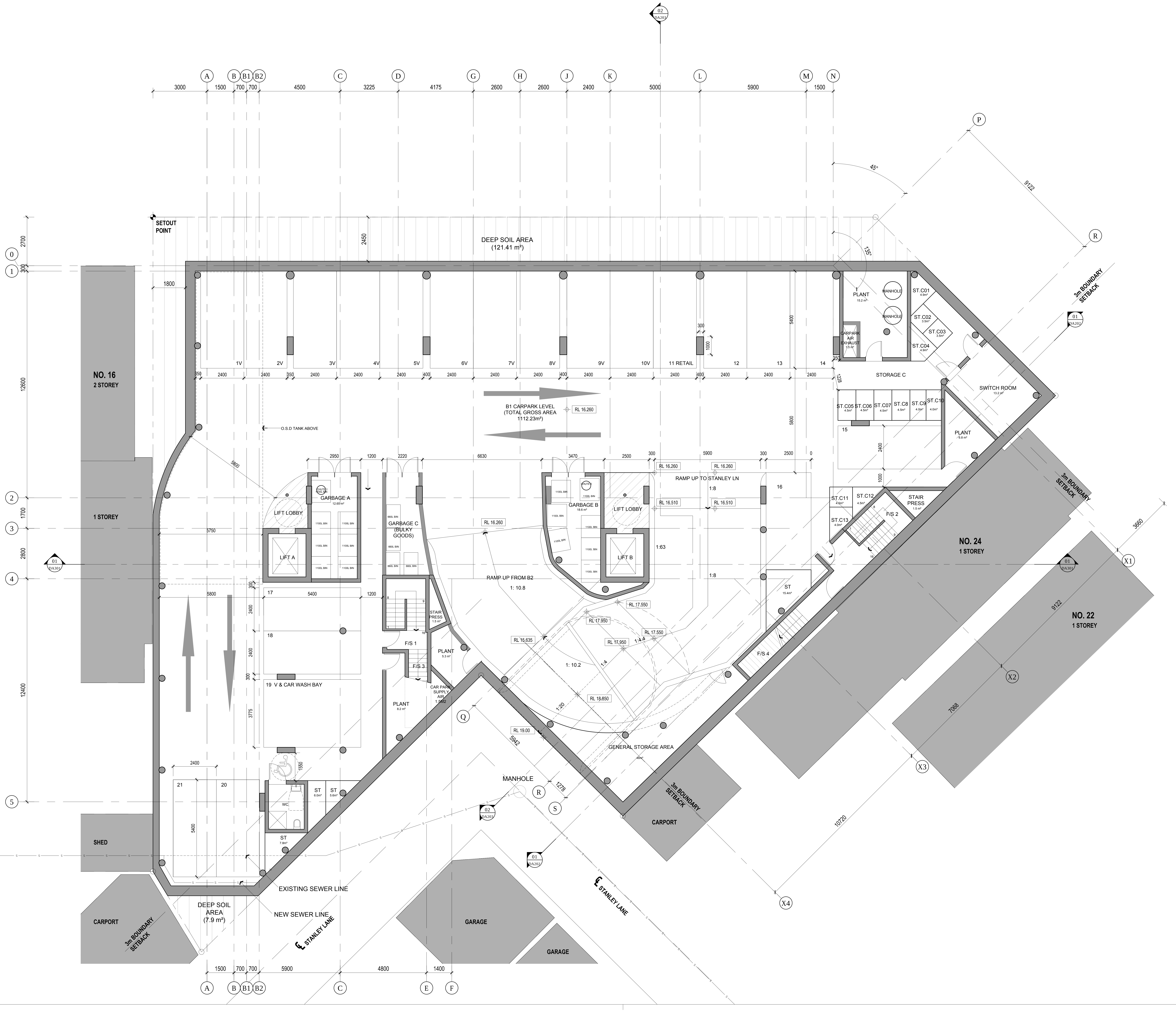
Job No 13779/1 BH2 Started Coring at 1.5m

BH2 terminated at 12.45m

APPENDIX

D

Proposed Development Plans at 18-24A Victoria St



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NOTES

LEGEND

REV	DATE	AMENDMENT	DRAWN
A	16.11.17	DA ISSUE	DD/JN

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a.BASTASarchitects pty ltd PH (02) 9922 5598
(Anastasios Bastas - NSW Reg No. 4816)

CLIENT:

KAI-TIAN GROUP KOGARAH PTY LTD

PROJECT:

PROPOSED RESIDENTIAL DEVELOPMENT AT
18, 20, 22 & 24A VICTORIA ST
KOGARAH NSW 2217

STAGE / STATUS:

DEVELOPMENT APPLICATION

TITLE:

BASEMENT FLOOR PLAN (LEVEL B1)

SCALE: 1:100 @A1

DATE: FEB 2017

TN

SHEET NORTH

SCALE BAR - 50mm ON SHEET

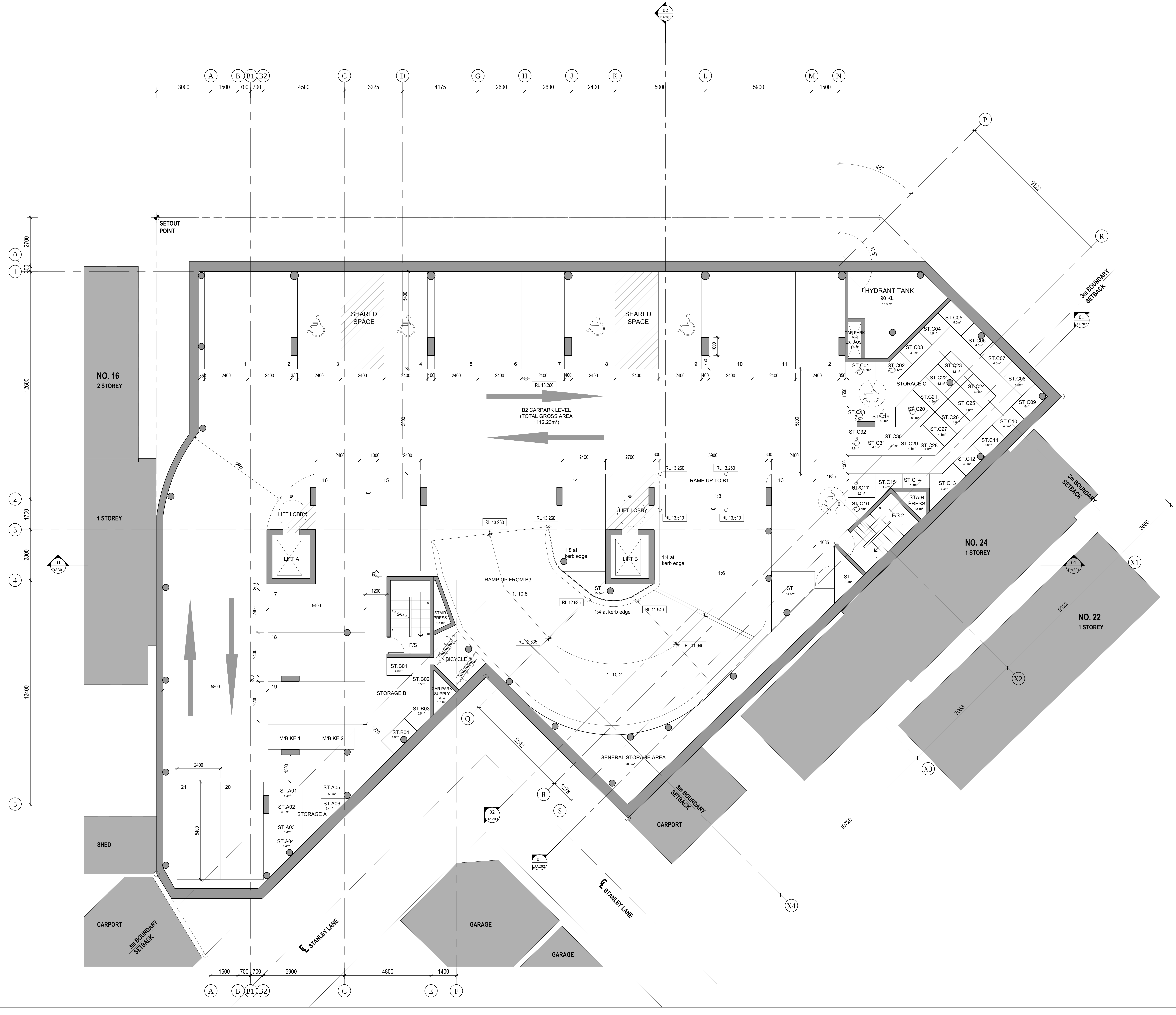
PROJECT NO.: 1559

DRAWN: JN/DD

CHECKED: TB

DRAWING NO.: DA103

REV: A



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LEGEND

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A	16.11.17	DA ISSUE	DD/JN

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(Anastasios Bastas - NSW Reg No. 4816)

CLIENT:
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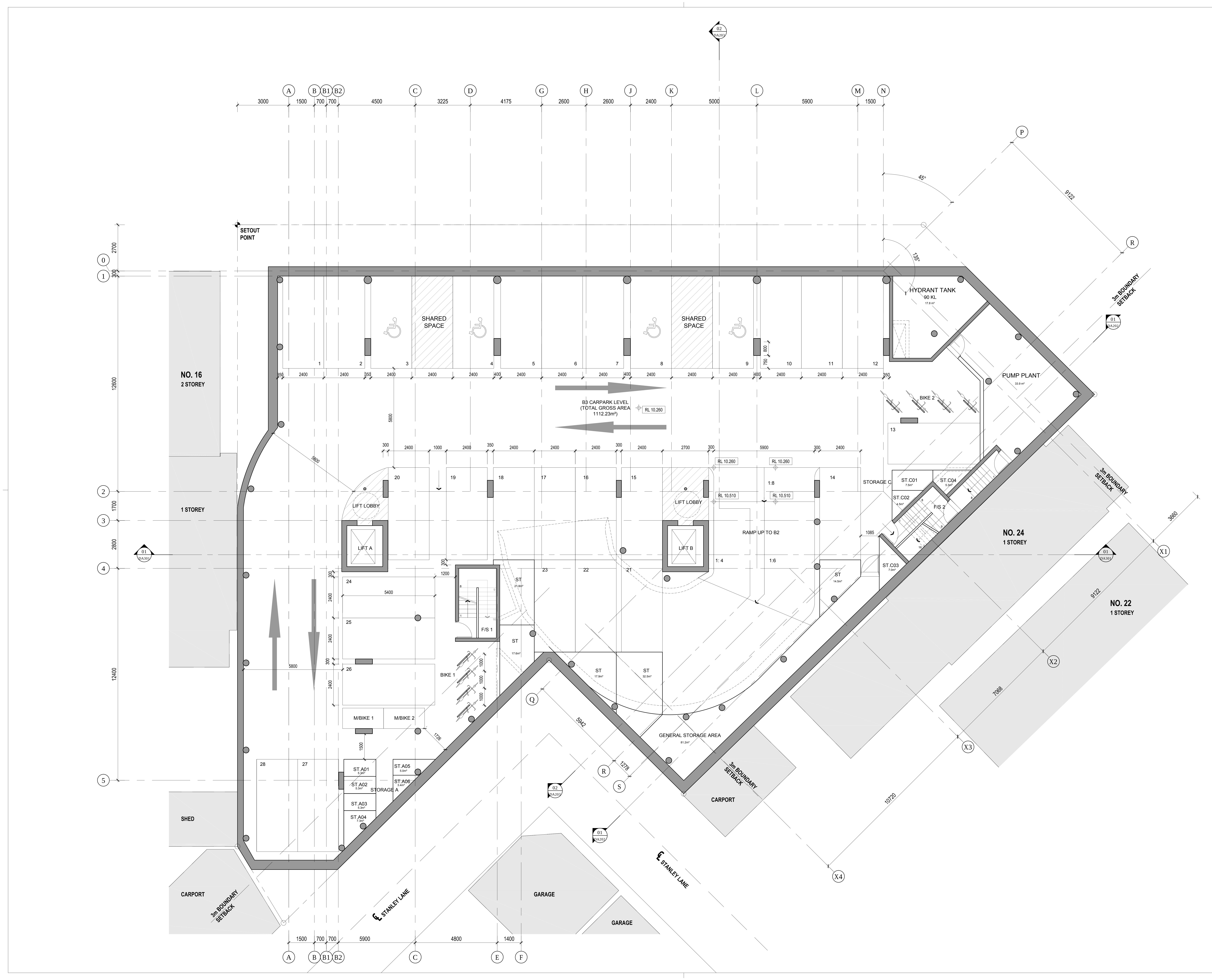
PROJECT:
PROPOSED RESIDENTIAL DEVELOPMENT AT
18, 20, 22 & 24A VICTORIA ST
KOGARAH NSW 2217

STAGE / STATUS:
DEVELOPMENT APPLICATION

TITLE:
BASEMENT FLOOR PLAN (LEVEL B2)

SCALE: **1:100** @A1
DATE: **FEB 2017**
TN
SHEET NORTH
SCALE BAR - 50mm ON SHEET
PROJECT NO.: **1559**
DRAWN: **JN/DD**
CHECKED: **TB**
DRAWING NO.: **DA102**
REV: **A**



NOTES

LEGEND

A	16.11.17	DA ISSUE	DD/JN
REV	DATE	AMENDMENT	DRAWN

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(Anastasios Bastas - NSW Reg No. 4816)

CLIENT:
KAI-TIAN GROUP KOGARAH PTY LTD

PROJECT:
PROPOSED RESIDENTIAL DEVELOPMENT AT
18, 20, 22 & 24A VICTORIA ST
KOGARAH NSW 2217

STAGE / STATUS:
DEVELOPMENT APPLICATION

TITLE:
BASEMENT FLOOR PLAN (LEVEL B3)

SCALE: **1:100** @A1
DATE: **FEB 2017**

TN
SHEET NORTH
SCALE BAR - 50mm ON SHEET

PROJECT NO.: **1559**
DRAWN: **JN/DD**
CHECKED: **TB**
DRAWING NO.: **DA101**
REV: **A**