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Our Ref: PSM3675-006L REV3

30 March 2022

JBS&G
Level 1, 50 Margaret Street
Sydney NSW 2000

Attention: Rohan Hammond

Dear Rohan

RE: SYDNEY METRO NORTH WEST (SMNW), CHERRYBROOK STATION GOVERNMENT LAND STATE SIGNIFICANT PRECINCT (SSP), GEOTECHNICAL DESKTOP STUDY

1. Overview

This study relates to a proposal to develop land called the 'Cherrybrook Station Government Land State Significant Precinct' (the State Significant Precinct) by Landcom on behalf of the landowner, Sydney Metro. The State Significant Precinct is centred around Cherrybrook Station on the Metro North West Line. The Metro North West Line delivers a direct connection with the strategic centres of Castle Hill, Norwest, Macquarie Park and Chatswood. It covers 7.7 hectares of government-owned land that comprises the Cherrybrook Station, commuter carpark and station access road (Bradfield Parade) and vacant land to the east of the station (referred to as the Developable Government Land) (DGL). It is bound by Castle Hill Road (south), Franklin Road (south east) and Robert Road (north west).

As a State Significant Precinct, the Minister for Planning and Public Spaces (the Minister) has determined that it is of State planning significance and should be investigated for rezoning. This investigation will be carried out in accordance with study requirements issued by the NSW Department of Planning, Industry and Environment (now Department of Planning and Environment (DPE)) in May 2020. These study requirements were prepared in collaboration with Hornsby Shire Council and The Hills Shire Council.

The outcome of the State Significant Precinct process will be new planning controls. This will enable the making of development applications to create a new mixed-use local centre to support Cherrybrook Station and the needs of the local community.

At the same time, DPE is also working with Hornsby Shire and The Hills Shire Councils, as well as other agencies such as Transport for NSW, to undertake a separate planning process for a broader area called the Cherrybrook Precinct. Unlike the State Significant Precinct, the outcome of this process will not be a rezoning. Instead, it will create a Place Strategy that will help set the longer term future for this broader area. Landcom will be consulted as part of this process.

Figure 1 illustrates the site boundaries of the State Significant Precinct and the Cherrybrook Precinct.

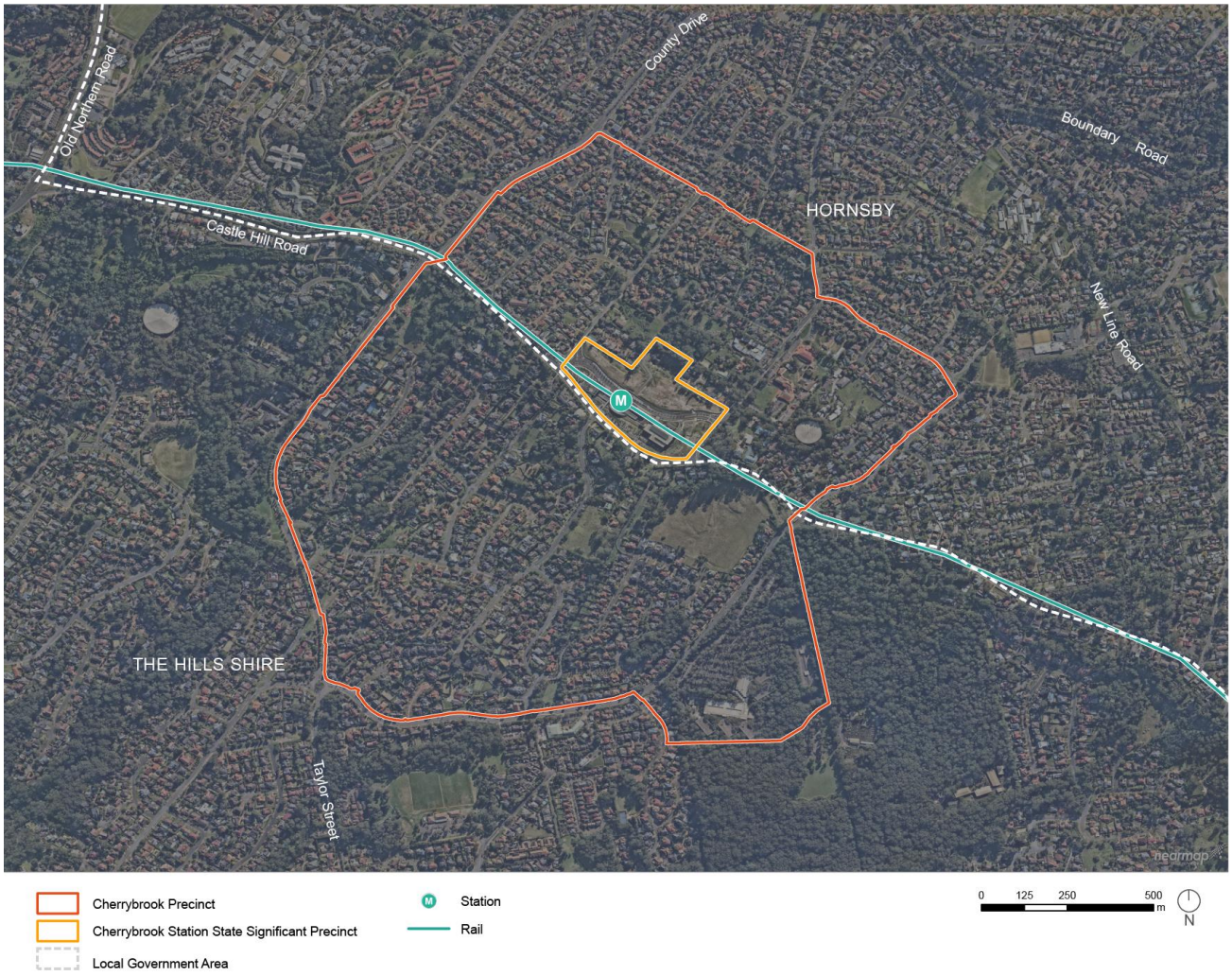

Figure 1: Cherrybrook Precinct and Cherrybrook Station State Significant Precinct (subject of this proposal). Source: NSW Department of Planning, Industry & Environment

2. Purpose

The purpose of this study is to address the relevant study requirements for the State Significant Precinct, as issued by DPE. It is part of a larger, overall State Significant Precinct Study. This State Significant Precinct Study undertakes planning investigations for the precinct in order to achieve a number of objectives that are summarised as follows (refer to the State Significant Precinct Study Planning Report for a full list of the study requirements):

- facilitate a mixed-use local centre at Cherrybrook Station that supports the function of the station and the needs of the local community
- deliver public benefit through a mixed use local centre
- deliver transport and movement initiatives and benefits
- demonstrate the suitability of the site for the proposed land uses
- prepare a new planning framework for the site to achieve the above objectives.
- prepare a new planning framework for the site to achieve the above objectives.

3. Proposal

The proposed new planning controls for the State Significant Precinct are based on the investigations undertaken as part of the State Significant Precinct Study process. A Reference Scheme has also been prepared to illustrate one way in which the State Significant Precinct may be developed in the future under the proposed new planning controls.

The proposed planning controls comprise amendments to the Hornsby LEP 2013 to accommodate:

- Rezoning of the site for a combination of R4 High Density Residential, B4 Mixed Use and RE1 Public Recreation zoned land;
- Heights of between 18.5m – 22 m;
- FSR controls of 1:1 – 1.25:1;
- Inclusion of residential flat buildings as an additional permitted use on the site in the B4 Mixed Use zone;
- Site specific LEP provisions requiring the delivery of a minimum quantity of public open space and a maximum amount of commercial floor space; and
- New site-specific Design Guide addressing matters such as open space, landscaping, land use, built form, sustainability and heritage.

The Reference Scheme (refer to **Figure 2**) seeks to create a vibrant, transit-oriented local centre, which will improve housing choice and affordability and seeks to integrate with Hornsby's bushland character. The Reference Scheme includes the following key components:

- Approximately 33,350m^2 of residential GFA, with a yield of approximately 390 dwellings across 12 buildings ranging in height from 2 to 5 storeys (when viewed from Bradfield Parade).
- A multi-purpose community hub with a GFA of approximately 1,300m^2.
- Approximately 3,200m^2 of retail GFA.
- Over 1 hectare of public open space, comprising:
  - A village square with an area of approximately 1,250m^2, flanked by active retail and community uses.
  - A community gathering space with an area of approximately 3,250m^2.
  - An environmental space around the pond and Blue Gum High Forest with an area of approximately 8,450m^2.

Green corridors and pedestrian through site links, providing opportunities for potential future precinct-wide integration and linkages to the north.

Parcel	*Area	Res GFA	Units	Non-Res GFA	Community	Portion FSR*
A	8,597	12,031	141	749		1.49
B	9,610	11,924	140	2,452	1,300	1.68
C	2,574	2,736	32			1.06
D	6,715	6,621	78			0.98
	27,272	**33,312**	**391**	**3,201**	**1,300**	

Notes:
Residential GBA > GFA : 75%
Non-residential GBA > GFA : 85%
Average unit size : 85m

Figure 2: Reference Scheme. Source: SJB

4. Geotechnical Desktop Study

This geotechnical assessment has considered information which is in the public domain including geological maps and factual and interpretive data supplied to tenderers for the SMNW project. It has also benefited from the extensive experience gained from PSM intimate involvement in the SMNW project including both the design and construction phases.

In addition, the following documents supplied by the Client were reviewed:

1. NSW Department of Planning and Environment - Study requirements for Cherrybrook Station Government Land (May 2020)
2. Douglas Partners Report "Tank Pit Inspection and Validation, Cherrybrook Station, Castle Hill Road, Cherrybrook NSW" (February 2014)
3. Douglas Partners Report "Cherrybrook Planning Proposals Cherrybrook Station Precinct" (August 2016).

Section 15 of the NSW Department of Planning and Environmental – Study requirements for Cherrybrook Station Government Land (May 2020) sets out geotechnical and contamination requirements. The geotechnical requirements are provided in this report. The relevant sections of this report are provided in Table 1 below.

Table 1 – Section 15 of NSW Department of Planning and Environmental

Requirement	Report Reference
15.1 Provide an assessment of the local soil, outlining it's suitability for the proposed uses of the SSP site with respect to erosion, salinity and acid sulphate soils.	Section 7 and Section 9 of this letter for erosion and salinity discussion. Refer to JBS&G environmental report for acid sulphate soils assessment
15.2 Provide an assessment of the proposed land uses to reflect the Section 9.1 Direction – 2.6	Refer to JBS&G environmental report

'Remediation of Contaminated Land' which requires consideration of contamination in the assessment of planning proposals and more generally in accordance with State Environmental Planning Policy No 55 – Remediation of Land (SEPP 55)	
15.3 Consider the requirements of Sydney Regional Environmental Plan 20 – Hawkesbury Nepean River in the SSP planning noting that in relation to the future development application stages, the SREP requires development consent for remediation of contaminated.	Refer to JBS&G environmental report

5. Proposed Development

Based on the supplied documents, we understand that the Site is bounded by Castle Hill Road (South-West boundary), Robert Road (North-West boundary), Oliver Way and Kayla Way (North-East Boundary) and Franklin Road (South-East boundary), refer to Figure 3, below. The project would involve development around Cherrybrook Station and the SMNW line comprising of residential, business and commercial buildings, and open and recreational spaces. In addition, the development also includes landscaping and parks.

Figure 3: Cherrybrook Station Government Land SSP Site Locality Plan (source: *"Study Requirements for Cherrybrook Station Government Land"*, Department of Planning and Environment, 2020)

The report is provided for planning purposes and not for building design. PSM should be engaged to review the recommendations contained herein should it be used in future for building design purposes.

6. Ground Conditions

6.1 Surface Conditions

The Site was historically residential land which was developed into a construction site for the SMNW project during 2013. The SMNW rail line is now completed, and the site currently comprises the SMNW Cherrybrook station, commuter carpark, road (Bradfield Parade) and open land. The surface has been modified during SMNW construction and activities however the overall landform generally slopes down to the North with an elevation change of between 15 m to 20m across the site.

Historical aerial photographs from May 2013 to June 2020 (sourced from Nearmap) are presented in Appendix A. Based on our knowledge of the Site and review of the historical aerial photographs, bulk earthworks (cut to fill) have been completed within the construction sites to provide a flat surface. As part of the earthworks for site establishment, multiple sediment basins or other water storage areas were excavated and have since been backfilled. Part of the Site has been landscaped as part of the Cherrybrook Station development.

6.2 Geological Setting

The 1:100,000 Sydney Geological Map (Ed 1 1983) indicates the Site is underlain by Ashfield Shale (Rwa) (refer Figure 4), the basal unit of the Wianamatta Group (which overlies the Mittagong Formation and Hawkesbury Sandstone units). It comprises dark grey to black claystone and siltstone grading into a distinct laminite of fine sandstone and siltstone.

Figure 4: Site location on geological map (source: 1:100,000 Sydney Geological Map 1983)

The maximum thickness of Ashfield Shale is between 60 to 70 m thick comprising four siltstone and laminate sub units (youngest to oldest) – Mulgoa Laminite, Regentville Siltstone, Kellyville Laminite, Rouse Hill Siltstone. These are described as follows:

- The laminated sub units (Mulgoa and Kellyville) tend to remain intact and can form relatively steep quarry faces, while the siltstone sub units (Regentville and Rouse Hill) tend to fret and weather more readily.
- The distinct character of the Kellyville Laminite provides a distinct marker unit. It is typically observed as regular equally spaced laminations of dark grey siltstone and fine grained grey sandstone.
- The Rouse Hill Siltstone typically contains more geological structures than the overlying Ashfield Shale subgroups such as faults, shears, clay seams and slickensided defects and is essentially free of sandstone laminations.

6.3 Subsurface Conditions

The upper two of the four sub units of the Ashfield Shale have been observed in excavations and from site investigations at the Site. The typical subsurface profile is expected to comprise:

- Topsoil and fill over most, or all, of the Site. The topsoil is expected to be of relatively shallow depth governed by the landscaping works that were undertaken as part of the SMNW Cherrybrook Station development. Fill depth is expected to be variable due to the bulk earthworks completed as part of SMNW site establishment works.
- Residual soil derived from shale bedrock, typically 2 m thick, comprising silty clay, stiff to hard, of medium to high plasticity. In areas where the SMNW bulk earthworks are in cut, some or all of the residual soil could have been removed.
- Ashfield Shale — extremely to moderately weathered Mulgoa Laminite, to 10 m depth comprising Class III to Class V Shale (rock mass classification per Pells et al. 1998)[1]
- Ashfield Shale — slightly weathered to fresh Mulgoa Laminite and Regentville Siltstone to depths between 10 m and 20 m comprising Class I to II Shale, overlying the Kellyville Laminite and Rouse Hill Siltstone.

It is noted that local deepening of the weathered rock profile (i.e. Shale Class IV/V and Shale Class III) extends up to 15m depth at the Southwest of the site due to the presence of a fault structure.

6.4 Geological Structures in Ashfield Shale

Based on a review of available information and experience with local conditions of the Site, a large fault structure is noted in the South East area of the site. The fault is shallow dipping NNW at approximately 35° below horizontal.

The sedimentary succession in the Sydney Basin is generally sub-horizontal. The regional dip of bedding is near horizontal with warping (gentle folding) producing regional dips of between 5° to 10° in places. Bedding/lamination dips in Ashfield Shale of up to 20° have been recorded near faulted areas where faulting has locally steepened bedding/laminations.

Two steeply dipping (90° ± 20°) orthogonal joint sets striking generally north-south and east-west can be expected and are considered to be ubiquitous. Joint spacing usually ranges between 0.3 to 5 m. However, random and very well defined joints also occur in shale, with dips usually in the range between 15° to 70°.

Minor faults dipping between 25° and 60° are known and are reportedly more common and closely spaced towards the base of the unit i.e. in the Rouse Hill Siltstone.

Faulting and related jointing in the Ashfield Shale is expected to cover a wide range of orientations. The origin of faulting and jointing in the Ashfield Shale is associated with dewatering during the lithification process as well as tectonic processes that have occurred post lithification.

[1] Pells PJN, Mostyn G & Walker BF. (1998), *Foundations on Sandstone and Shale in the Sydney Region,* Australian Geomechanics, Vol 33(2) 17-29.

Summary sheets presented by Bertuzzi (2014)[2] provide useful example core photographs and typical geotechnical characteristics for the various classes of Ashfield Shale that are relevant to the subsurface conditions of the Site. Example photographs of excavated faces and geological features in Ashfield Shale are presented in Appendix B.

6.5 Groundwater

The regional groundwater table is expected to be at depth within the Hawkesbury Sandstone. However some "perched" groundwater is likely to be present in the soils and siltstone in the top 10 m, especially after prolonged rainfall.

7. Excavation

7.1 Excavatability

The expected subsurface conditions are typical for many parts of Sydney and, based on our experience, excavation will be able to be undertaken using conventional approaches (e.g. large excavators with rock hammers and rock saws, and often where space permits with large bulldozers equipped with ripping tynes). It is expected that any excavation would be undertaken by contractors with suitable experience in rock excavation close to existing structures. The contractor will need satisfy itself regarding the suitability of its plant to the site conditions.

7.2 Shoring

The conventional shoring system in these conditions is to construct bored reinforced concrete soldier piles around the excavation perimeter prior to excavation commencing, down to below the bulk excavation level. Ground anchors are then installed to support the piles as excavation progresses. The number of rows of anchors will be dependent on depth of excavations and a matter of design. Shotcrete is typically applied to support the ground between the piles, although usually only the soils and weathered rock require the shotcrete to be applied prior to construction of the permanent structure.

Another approach, which allows savings on pile lengths, is to terminate some of the piles below the weathered rock but above the bulk excavation level. This design approach would need a contingency to stabilise pile toes that are underlain by rock defects, and a contingency to install rock bolts/anchors to stabilise any faulted or jointed rock faces below the pile toes. A higher level of geotechnical construction oversight would also be required for such a design. Therefore, this approach involves an increased risk of delays and extra costs during the excavation.

7.3 Permanent and Temporary Batters

The batter slope angles shown in Table 2 are recommended for the design of batters up to 3 m height; subject to the following recommendations:

1. The batters shall be protected from erosion. The following could be adopted as part of erosion protections:
   a. Vegetation / landscaping
   b. Crest drains to prevent water directly flowing over the batter face
   c. Other surface protections such as shotcrete, geofabric, etc.
2. Permanent batters shall be drained.
3. Temporary batters shall not be left unsupported for more than 3 month without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events.
4. Where loads are imposed or structures/services are located within one batter height of the crest of the batter, further advice should be sought.

[2] Bertuzzi R. (2014), *Sydney Sandstone and Shale Parameters for Tunnel Design,* Australian Geomechanics, Vol 49(1) 4-39, Vol 49(2) 95-104.

If the conditions above cannot be met, further advice should be sought.

Table 2 – Batter Slope Angles

Unit	Temporary	Permanent
SOIL UNITS eg. FILL, NATURAL SOIL	2.0H : 1V	2.5H : 1V
BEDROCK	1.0H : 1V	1.5H : 1V

Steeper batters may be possible subject to further advice, probably including inspection during construction by experienced geotechnical engineer / geologist.

7.4 Ground Movements Due to Excavation

The road and rail authorities would often require assessment of the excavation induced ground movements on the adjacent infrastructure. A predicted effects assessment (geotechnical and structural) is generally undertaken to assess effects of new developments on existing infrastructure. Pre and post construction dilapidation surveys of adjacent infrastructure should also be allowed for, as well as survey of ground movement during the works which will likely include monitoring of the development and where required, monitoring of the existing infrastructure.

8. Site Classification

Based on the available information, we have classified the site as Class “P” in accordance with Australian Standard AS 2870-2011 “Residential slabs and footings – Construction” due to the likely presence of fill on the Site. The Site may be reclassified following further investigation and assessment for specific lots.

For earthquake provisions, we have classified the site sub-soil as Class C_e in accordance with Section 4.2 of AS 1170.4-2007 “Earthquake Actions in Australia”.

9. Salinity

Reference to the Hawkesbury Nepean Salinity Hazard mapping (NSW Department of Environment and Climate Change, 2008) indicates that the Northern Zone is mapped as having a very low to moderate salinity potential as indicated in Douglas Partners 2016 report.

10. Foundations

We expect that the building foundations are likely to be shallow pad footings founded on structural fill, residual soils or bedrock. Where building loads are high, piles extending to the better quality shale could be adopted, or the foundation design could involve larger/embedded pads or strip footings to reduce the bearing pressures. All these options are conventional foundation types and the type adopted will depend on the structure and is a matter of design. These foundation types would be suitable for consideration in designing pedestrian and cycle bridges as well.

11. Civil Surface Works

Civil surface works such as pavements and low embankments should not present any unusual geotechnical challenges. Material won from any bulk excavation should be suitable to use as general compacted fill subject to development of a suitable earthworks specification. We expect that site won material will be able to be used on site or disposed of as VENM or ENM provided it is not contaminated but we defer to the environmental consultant for advice on material disposal.

12. Geotechnical Investigation

Geotechnical investigations have been completed for the SMNW comprising boreholes and test pits. These investigations were focused around the SMNW alignment but do extend outside of the alignment. Refer to Figure 5 for historical investigation locations. There is a higher concentration of investigation locations around the southern and central area of the Site (around Cherrybrook Station). We consider that the level of investigation completed to date is adequate for this rezoning application and any future development application. Further targeted geotechnical investigations are expected to be required at detailed design to supplement the existing information and fill any gaps identified by the designers. Investigation requirements will be dependent on the specific development and should be considered at the detailed design stage together with the historical data.

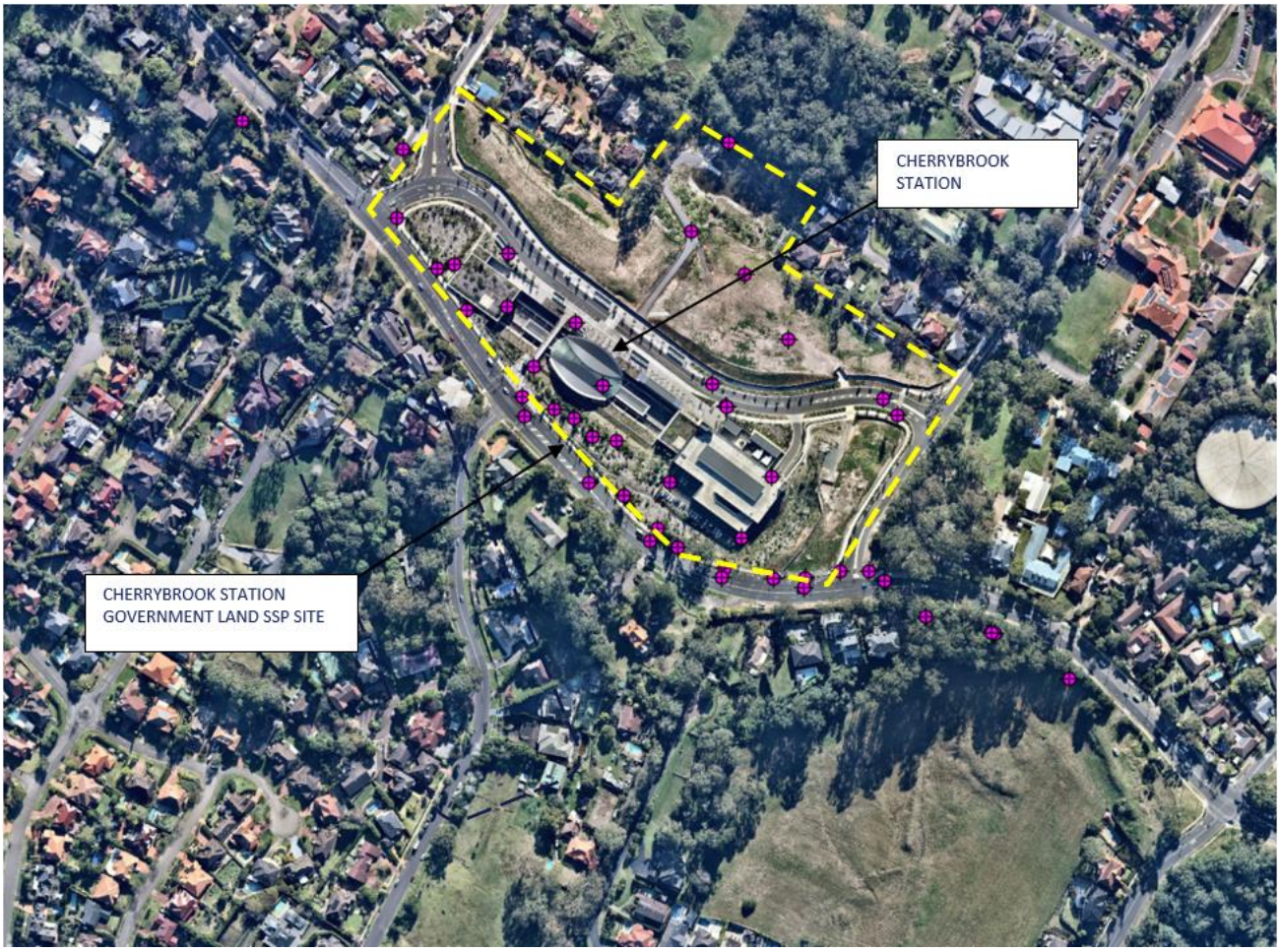

Figure 5: Historical investigation locations

13. Additional design requirements for Class 2 Buildings

We recommend that the design and construction of residential Class 2 buildings should consider the advice in this report and the relevant requirements in the Building Code of Australia (BCA). Where the BCA requirements are more stringent than the advice in this report the BCA requirements shall be adopted. Should there be any doubt further advice should be sought.

Details of the proposed residential developments are currently not known to PSM. PSM should be engaged to review the recommendations contained herein should it be used in future for building design purposes.

14. Summary and Closure

In summary, we do not expect geotechnical conditions that are unusual for north western Sydney to exist on this Site. In general, normal civil engineering and building approaches will be satisfactory for geotechnical aspects of the proposed development.

We trust that this letter meets your requirements. Should you have any queries please do not hesitate to contact the undersigned.

For and on behalf of
PELLS SULLIVAN MEYNINK

JOCK RUSSELL
SENIOR GEOTECHNICAL ENGINEER

AGUSTRIA SALIM
PRINCIPAL

Appendix A
Historical Aerial Photos

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

JBS&G

SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

18 May 2013

PSM3675-006L	**ATTACHMENT A1**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

JBS&G

SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

8 February 2014

PSM3675-006L	**ATTACHMENT A2**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

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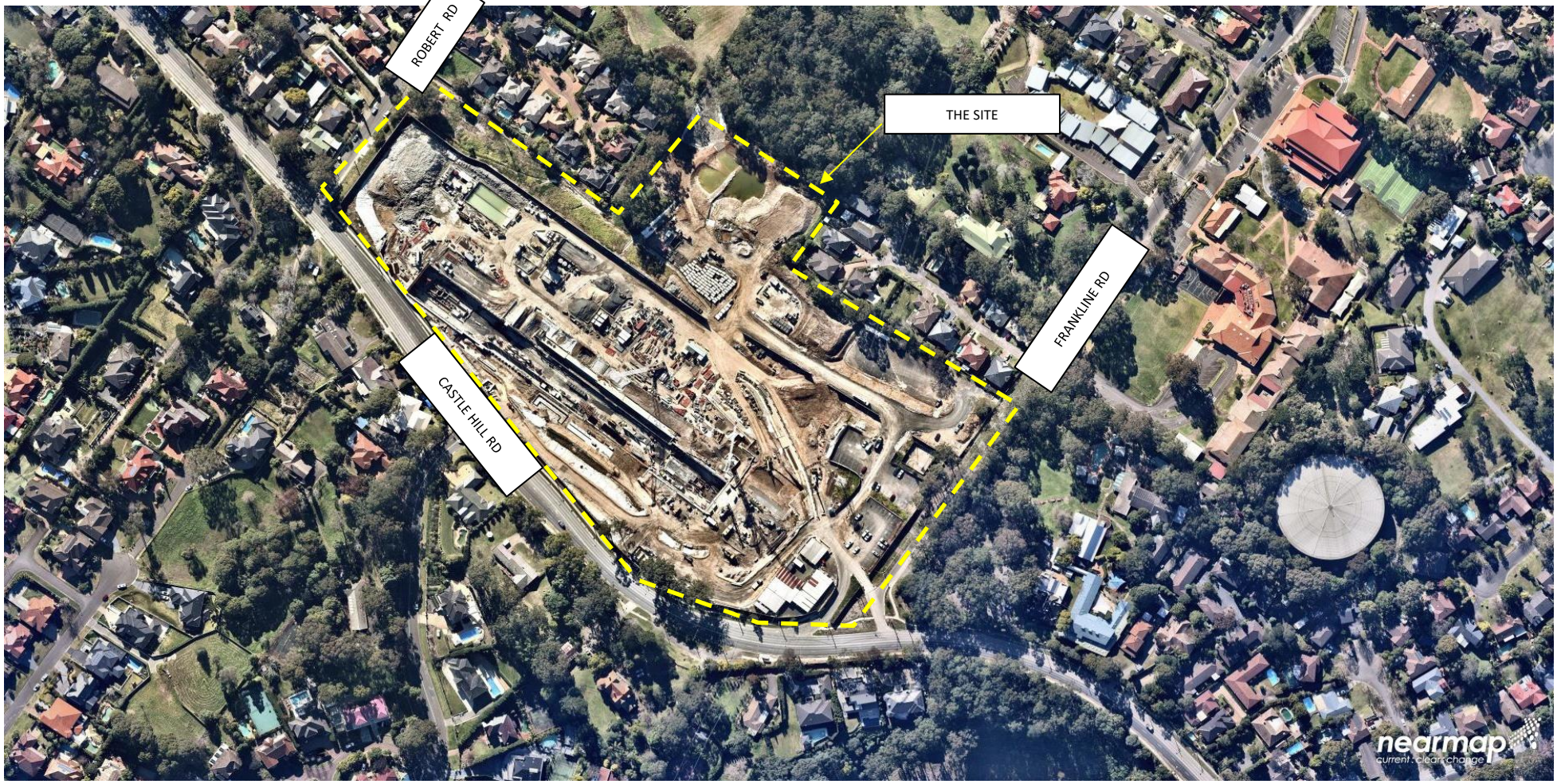
SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

26 June 2014

PSM3675-006L	**ATTACHMENT A3**



Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

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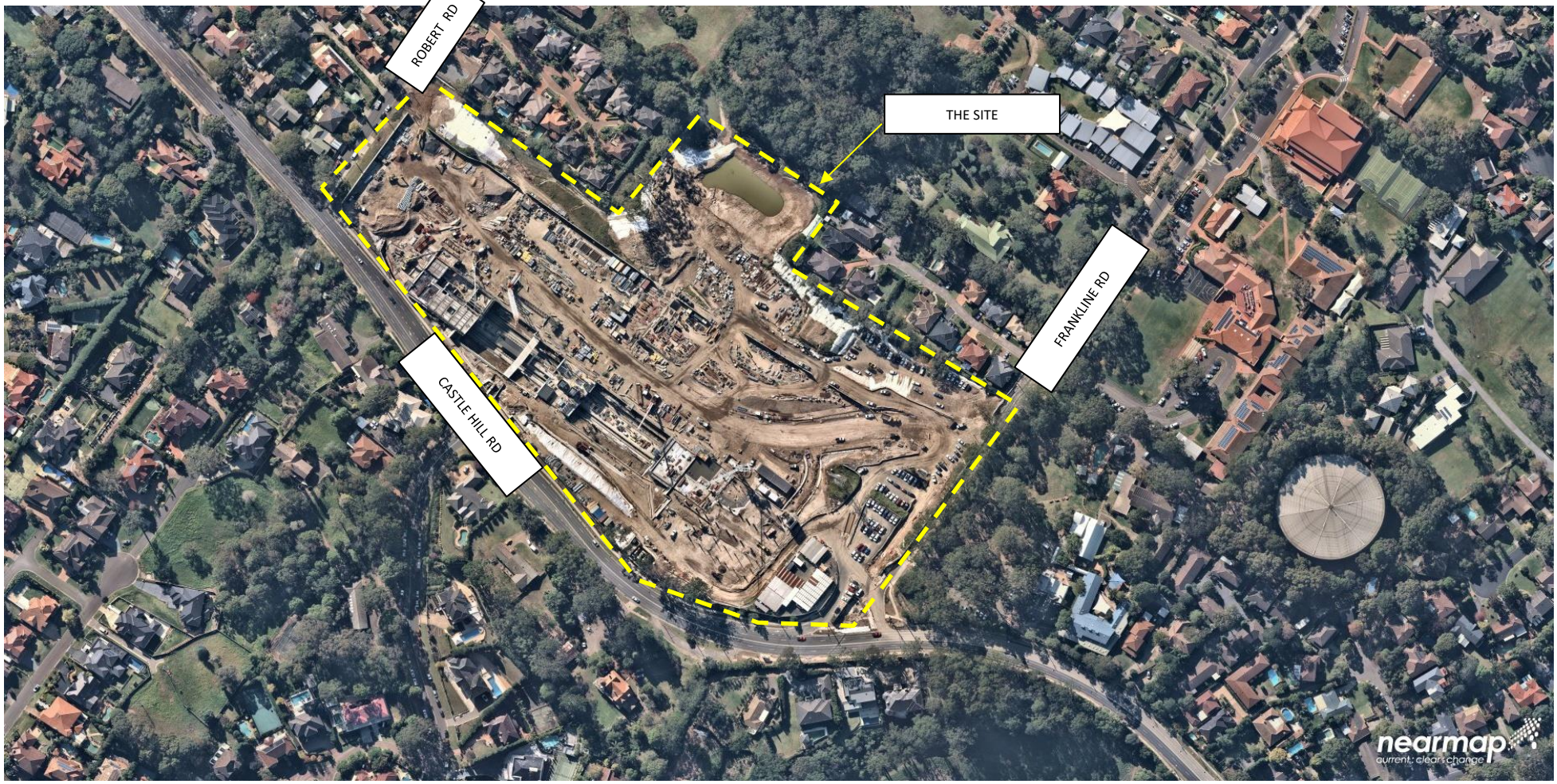
SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

22 July 2017

PSM3675-006L	**ATTACHMENT A4**



Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

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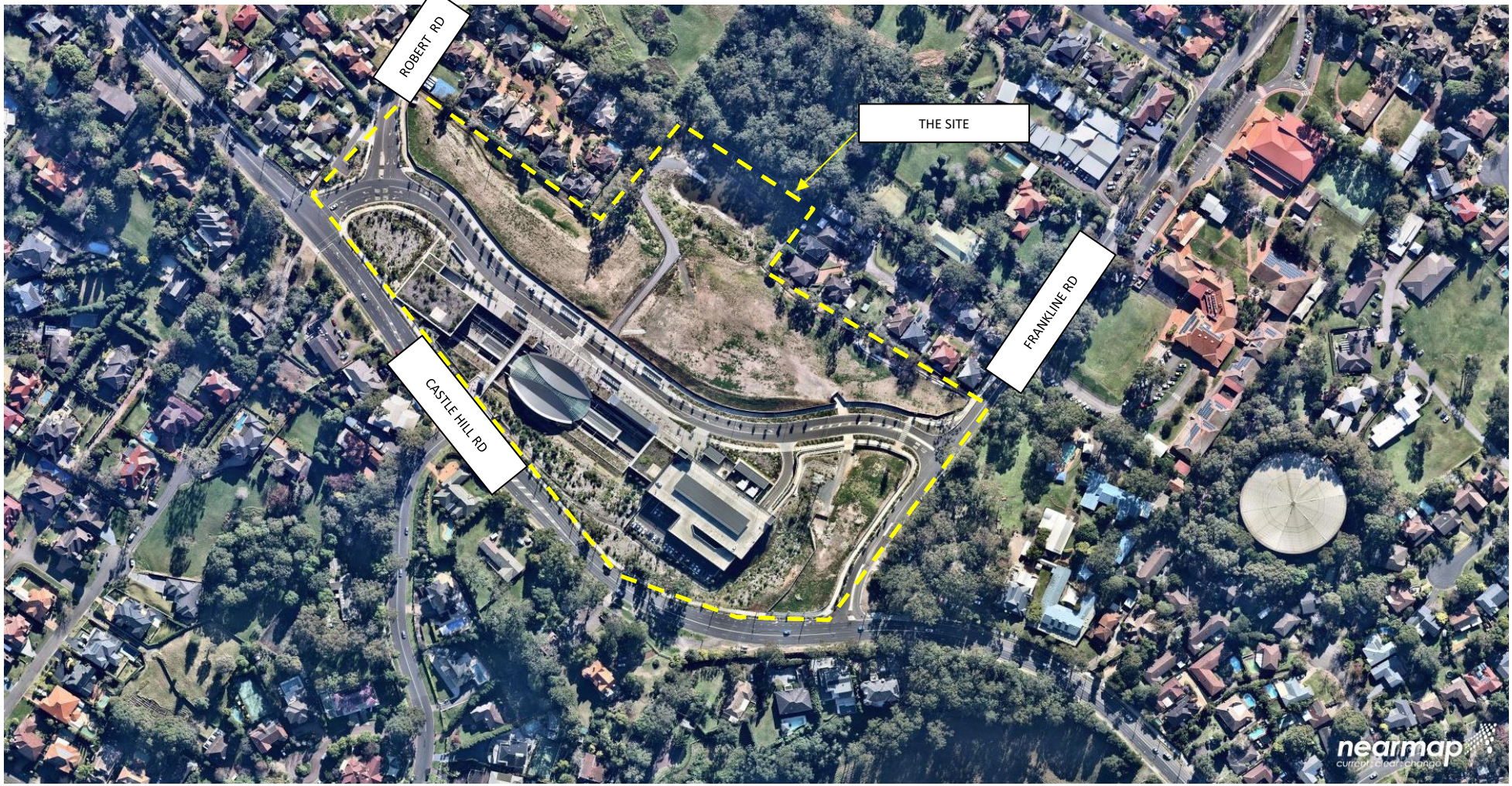
SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

5 May 2018

PSM3675-006L	**ATTACHMENT A5**



Notes:

1. Photograph source: Nearmap
2 Site boundary shown is indicative only

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SMNW Cherrybrook Station

Government Land SSP

HISTORICAL AERIAL PHOTOGRAPH

23 June 2020

PSM3675-006L	**ATTACHMENT A6**

Appendix B
Example Photos of Excavation in Ashfield Shale

Photo 1: Excavation face in weathered Ashfiled Shale

Photo 2: Excavation face in weathered Ashfiled Shale

Notes:

1.

JBS&G	
SMNW Cherrybrook Station	
Government Land SSP	
EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE	
PSM3675-006L	**ATTACHMENT B1**

Photo 3: Bulk excavation of fresh Ashfiled Shale

Photo 4: Excavation face in fresh Ashfiled Shale with jointing

Notes:

1.

JBS&G SMNW Cherrybrook Station Government Land SSP EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE	
PSM3675-006L	ATTACHMENT B2

Photo 5: Excavated floor in fresh Ashfiled Shale with typical geological structures

Photo 6: Excavated floor in fresh Ashfiled Shale with typical geological structures

Notes:

1.

JBS&G	
SMNW Cherrybrook Station	
Government Land SSP	
EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE	
PSM3675-006L	**ATTACHMENT B3**