Utilities Report

Draft St Leonards and Crows Nest 2036 Plan

28 March 2018

NSW Department and Planning and Environment

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Executive Summary

The area nominated as the St. Leonard's and Crows Nest Station Precinct currently has approximately 10,000 dwellings and 1,767,000m^2 of employment Gross Floor Area (GFA). The Department of Planning and Environment (DPE) have nominated significant growth in this Precinct due in part to the Sydney Metro Station at Crows Nest. This study assesses the utility services implications of growing the number of dwellings and employment GFA to the maximum growth scenarios of about 23,250 dwellings and 1,986,000m^2 GFA respectively to support the Draft 2036 Plan being prepared by the Department. Consideration has also been given to lower growth scenarios. Services assessed in this report include water, sewer, electricity, gas and telecommunications. The findings are summarised as follows.

Water Servicing

The Precinct is currently supplied potable water from three reservoirs to the north west in Chatswood. Four trunk mains transfer water to the Precinct and surrounding areas. Sydney Water were unable to confirm if the reservoirs or trunk mains have sufficient capacity or require upgrade for the increased population expected. At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study. In a worst-case scenario which assumes there is no capacity within the existing network to meet the maximum growth scenario, the equivalent of an additional 600mm main would need to be constructed from the Chatswood Reservoir to the Precinct.

Sewer Servicing

A crest passes through much of the Precinct and a large portion of it drains via gravity to the south-east with the remainder draining to the north-east. Ultimately all sewers drain east via the North Head Ocean Outfall Sewer. Sydney Water were unable to confirm if the existing trunk mains have sufficient capacity or require upgrade for the increased dwellings and employment space. At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study. An estimate for the required equivalent increases in size for the key trunk mains which service the Precinct in Section 3.2.4 was made.

Electricity Servicing

The Willoughby Transmission Substation (TS) is within the Precinct and supplies Ausgrid's bulk power via three zone substations (ZS) within the Precinct (at Gore Hill, Crows Nest and Royal North Shore Hospital (RNSH)) and one to the south-east of the Precinct at North Sydney.

Ausgrid have recently upgraded all four of these zone substations and several high voltage feeders. As a result, there is sufficient zone substation capacity in the region to service the

Precinct for the maximum growth scenarios. Ausgrid noted that there could be a localised shortfall in supply from the Crows Nest ZS for the medium and high growth scenarios that were tested. However an alternative strategy that reduces reliance on Crows Nest ZS and routes unused capacity at RNSH ZS and North Sydney ZS can service the Precinct without the need to construct a costly new zone substation and reserve expensive land to accommodate one. Therefore even in the high growth scenario, the only upgrade required to trunk electricity supply is approximately 550m of new 33kV or 132kV feeders to cater for an additional 28.0MVa to the RNSH ZS from Willoughby TS. Upgrades to minor electricity infrastructure such as 11kV feeders and distribution / padmount substations will be required as development progresses.

Gas Servicing

Jemena currently supply gas to households throughout the Precinct via a 1050kPa secondary gas main feeding a network of reticulation gas mains.

Jemena have flagged two minor upgrades to their network around Crows Nest and RNSH.

Telecommunications Servicing

The Precinct is currently well serviced by telecommunications with assets owned by Telstra, Optus and NBN Co.

NBN Co have confirmed that they would be the service provider for any re-development in the Precinct. They have identified standard fees as $400 per unit or $600 per lot. Furthermore, they have indicated that there will be no backhaul charges applicable.

1 Introduction

Mott MacDonald has been engaged by the NSW Department of Planning and Environment (DPE) to assist with the preparation of a draft land use and infrastructure plan to guide the development of the St Leonards and Crows Nest Precinct.

1.1 Scope of Works

The NSW Department of Planning and Environment (DPE) is preparing a draft 2036 Plan to guide the future land uses, built form proposals and growth projections of the St Leonards and Crows Nest Station Precinct (the Precinct). Mott MacDonald has been engaged to undertake a utilities services study to assist in planning for the Precinct. The study aims to identify existing opportunities, constraints and risks associated with civil engineering and services infrastructure to support the delivery of the draft 2036 Plan.

Mott MacDonald has undertaken the following tasks:

- An initial Precinct review via Dial Before You Dig (DBYD) to understand services present;
- Collected existing utility asset information from service providers and undertaken associated desktop review of their services;
- Mapped the extent of existing services and infrastructure in ArcGIS;
- Estimated the capacity of existing trunk utility services to determine capacity limitations to future growth where not provided by the service authorities; and
- Developed an initial conceptual infrastructure servicing strategy to meet demand from the predicted population and employment changes in the Precinct (where possible these strategies are endorsed by the utility authorities).

1.2 Purpose of Report

The purpose of this report is to identify existing servicing infrastructure and outline additional requirements for new infrastructure to service the Precinct. This report will explore the following:

- Existing/proposed servicing strategies (including sewer, water, electrical, telecommunications and gas);
- Review of current supply;
- Available capacity;
- Key constraints and opportunities;
- Demand generated by the Precinct; and
- Adjustments/augmentations required to existing infrastructure to enable development.

1.3 Limitations

The advice provided by service authorities is indicative only and does not form a committed strategy or replace the need for the authorities to prepare a long-term management plan. Service authorities generally plan for network upgrades as development applications are received in accordance with their funding business model. As existing spare capacity is

exhausted larger network augmentations will need to be planned and commissioned to meet market demand.

The following study provides a strategy for potential trunk servicing requirements to meet the increase in demand based on available information.

1.4 Regional Context

The Precinct is located approximately five kilometres north to north west of the Sydney CBD, and situated within the local government boundaries of Willoughby, Lane Cove and North Sydney LGA. The suburb is generally bordered by the Gore Hill Freeway to the north, partly by the Pacific Highway to the west, River Road to the south and West Street to the east.

Figure 1: St Leonards to Crows Nest Precinct Study Area

Source: Department of Planning and Environment

The NSW Government's *Greater Sydney Region Plan* considers St Leonards as a "Health and Education Precinct". It also considers the rail corridor linking St Leonards with the CBD to the south and other Health and Education Precincts and Strategic Centres such as Chatswood, Macquarie Park, Castle Hill and Hornsby to the north-west an "Economic Corridor". These are illustrated in Figure 2.

Figure 2: Greater Sydney Region Plan – St Leonards Context

Source: https://www.greater.sydney/greater-sydney-region-plan

1.5 The Precinct

The Precinct covers an area of approximately 276 hectares and has a ridge line which generally passing through the centre as shown in Figure 3. Consequently from the topography shown in Figure 3 the Precinct drains generally either to the south west (directly into Sydney Harbour via Berry's Creek through the suburb of Greenwich) or to the east (into Flat Rock Creek through the suburb of Naremburn).

Figure 3: Precinct Topography

Source: LIDAR

There are approximately 10,036 existing dwellings. The majority are located in the south and east regions of the Precinct. The Precinct contains a health and education sub precinct centred around the Royal North Shore Hospital the Artarmon employment area, a commercial core focused on the existing St Leonards Railway station and the Crows Nest village and surrounding heritage conservation areas. The metro station at Crows Nest will be located adjacent to the Pacific Highway and to the west of Willoughby Road. A smaller health precinct is located on the southern side of the precinct associated with the Mater Hospital and associated allied health services.

Construction of the new Sydney Metro station includes two new stations, one within the Precinct and the other (Victoria Cross) to its south as illustrated in Figure 4 below. Another metro station will be located at Chatswood to the north of the Precinct. The works include:

- Upgrading the existing Chatswood train station located approximately 1.7km north of the Precinct;

- Construction of a new Crows Nest Station (between the Pacific Highway and Clarke Lane (on the eastern side of the Pacific Highway) and between Oxley Street and south of Hume Street) within the Precinct; and
- Construction of a new Victoria Cross Station (beneath Miller Street between McLaren Street and south of Berry Street, North Sydney). This is approximately 750m south of the Precinct boundary.

Figure 4: New Sydney Metro Alignment

Source: https://www.sydneymetro.info/map/interactive-map

1.6 Precinct Character Areas

1.6.1 Basis of Report

The Precinct has been separated into nine character areas shown in Figure 5.

Figure 5: St Leonards & Crows Nest Precinct Existing Character Areas

Source: Department of Planning & Environment

Details of the existing and proposed land use for each character area are detailed in Table 1. Three growth options have been explored for the Precinct as detailed in Table 2. Option 1 is a low growth scenario, option 2 is a high growth scenario and option 3 is a moderate growth scenario. Option 2 has been adopted for this assessment to provide an upper limit of the assumed growth to 2036 and therefore provides a worst case approximation of demand on utilities infrastructure. The rates used in the utility assessment are shown in Table 1, and include some additional allowance for variations in yield.

Given these changes in land use and the associated increase in utility demand, it is anticipated that lead-in/out works and potential trunk upgrades will be required to support growth. Lead-in works are likely to be provided incrementally over time as demand grows in such a way to initially leverage off existing spare service capacity and then to make efficient use of lead-in works as they are required. Once existing supply is exhausted larger trunk upgrades are required to service the remaining growth. As the lead-in works and trunk network upgrades are often significant with respect to cost, time, and construction difficulty, the efficient forward planning of these items is important to ensure development does not stagnate.

Table 1: Character Areas Existing and Option 2 (High Growth Scenario) 2036

Area	Character Area	Existing Commercial GFA (sqm)	Proposed GFA Allowance (sqm)	Existing Dwellings	Proposed Dwelling Allowance
1	Artarmon Employment Area	578,000	605,000	NA	NA
2	Health & Education Precinct	452,000	509,200	-	150
3	Residential (St Leonards South)	43,000	53,000	594	3,500
4	Mixed Use Centre	479,000	608,000	4,877	10,400
5	Residential (Naremburn)	19,000	19,000	1,250	2,200
6	Crows Nest Village	94,000	77,000	669	2,200
7	Residential (Wollstonecraft)	1,000	12,000	889	1,500
8	Residential (Crows Nest)	45,000	28,000	1,241	2,200
9	Pacific Highway Corridor (East)	56,000	75,000	516	1,100
	TOTAL	**1,767,000**	**1,986,200**	**10,036**	**23,250**

Source: Department of Planning & Environment

Table 2 shows the differences in dwellings between the options including a 2% allowance for optioneering:

Table 2: Comparison of dwellings for each option (2036)

Area	Character Area	Existing Dwellings	Option 1 Proposed Dwellings	Option 2 Proposed Dwellings	Option 3 Proposed Dwellings
1	Artarmon Employment Area	0	0	0	0
2	Health & Education Precinct	0	150	150	150
3	Residential (St Leonards South)	594	1,400	3,500	2,700
4	Mixed Use Centre	4,877	5,600	10,400	10,000
5	Residential (Naremburn)	1,250	1,600	2,200	1,800
6	Crows Nest Village	669	1,100	2,200	1,600
7	Residential (Wollstonecraft)	889	1,000	1,500	1,500
8	Residential (Crows Nest)	1,241	1,500	2,200	1,700
9	Pacific Highway Corridor (East)	516	600	1,100	1,200
	TOTAL	**10,036**	**12,950**	**23,250**	**20,650**

Source: SJB (Options 3-9), DPE (Options 1-2)

1.6.2 Revised Yields for Exhibition

At the time of drafting consultant reports, a preferred built form outcome had not been determined. Accordingly, it was necessary to make assumptions on a range of potential growth scenarios in order to inform how thresholds of development impact services infrastructure.

It is understood the built form recommendations that are to be placed on exhibition would result in an additional dwelling yield of approximately 6,800 additional dwellings to the year 2036, excluding 2,058 are already in the pipeline for a total of approximately 9,270 dwellings not currently serviced by utilities. This change in yield for the Precinct is lower than the 13,214 total

yield increase from existing assumed in the High Growth Scenario (as presented in Table 1). Therefore this report generally recommends upgrades to infrastructure which would likely be greater than the exhibition yield would require. Mott MacDonald assume that the yield in no individual character area and/or sewer drainage catchment has is greater that what was assessed in the High Growth Scenario. In the event of an increase in the allowance in a specific character area or sewer catchment, further assessment would be required.

It should also be noted that as at January 2018, DPE sourced data from Sydney Water about existing dwellings. This identified an approximate existing dwelling number of 7,200 dwellings for the Precinct. The total number of existing dwellings is lower than the 10,036 provided as a base case for this report based on urban design analysis (as per Table 2). This discrepancy does not impact the findings of the report as the basis of the recommendations is related to additional yield generated.

2 Existing Services Infrastructure

The existing utilities assessment is primarily based on information received as a result of a DBYD search. This information was supplemented by a site inspection and subsequent liaison with key personnel at the respective service authorities. Digital GIS files were provided by Sydney Water, Ausgrid and NBN Co to supplement the DBYD information.

The services information has been consolidated and displayed on a number of plans which can be found in Appendix A. The details shown on the plans should be considered as indicative only as the original DBYD information is not based on detailed survey data.

The following sections provide a commentary on the existing services within and adjacent to the Precinct.

2.1 Water

2.1.1 Reservoirs

The Precinct receives potable water supply from the Chatswood Reservoirs (WS0024, WS0025 and WS0239), approximately 1km north west of the Precinct boundary as illustrated in Figure 7.

The northern two Reservoirs (WS0024 and WS0025) were built in 1888 and have an interconnecting walkway at roof level. They each have 7ML capacity and depths of 9.5m. They are State Heritage Register (SHR) listed and are unlikely to be augmented should additional capacity be required.

The southern reservoir (WS0239) is a 54ML welded steel reservoir which was constructed in 1972.

Also located on the Chatswood Reservoir site is a decommissioned brick pumping station which was built in 1895 and closed in 1918. It serviced the northern two reservoirs and is an item of local heritage significance.

Figure 6: Chatswood Reservoirs

Source: ArcGIS Basmaps

2.1.2 Trunk Water Mains

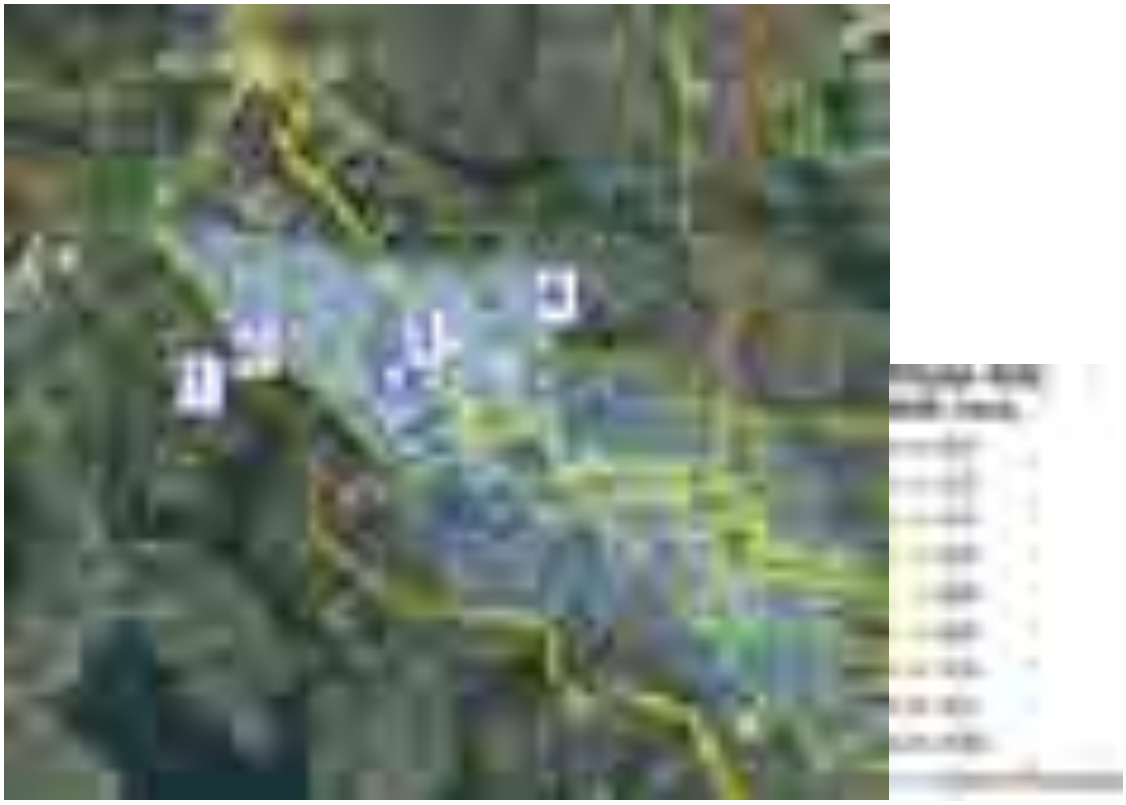
Four water mains supply the Precinct from the Chatswood Reservoir which are also illustrated in Figure 7 and described below:

1. A 750mm cast iron cement lined (CICL) pipe runs southward along River Road, west of the Precinct. It reduces in size to 600mm and then 500mm diameter CICIL pipe - it services Character Area 5 (Residential - Naremburn) and part of Character Area 6 (Crows Nest Village);
2. A 500mm CICL pipe runs south east along the Pacific Highway and then east into the southern portion of Character Area 1 (Artarmon Employment Area). It then disperses into several 500mm and 250mm trunk pipes to the south east of the Precinct. It is likely to service Character Areas 1, 2, 3, 7, 8, 9, 10 and 4;
3. A 500mm CICL pipe which runs south east along Reserve Road then east out of the southern portion of Character Area 2 (Health & Education Precinct) and then south east along the Pacific Highway. It is likely to service Character Areas 1, 2, 3, 4, 5, 6, 7 and possibly 8; and

4. A 600mm CICL pipe which runs south and east along Francis Street and Dalleys Road on the Precinct's eastern boundary. It then enters the Precinct Boundary near the border of Character Areas 9 and 10 before feeding into several 500mm trunks that service the south east portion of the Precinct. It is likely to service Character Areas 1, 7, 8, 9, 10, 4 and 6.

Each of the four major trunk pipes listed above connect to minor existing reticulation lines, typically located within the standard trench allocation of the road reserve and 100-200mm in size.

Figure 7: Existing water infrastructure



Source: Sydney Water Hydra

2.1.3 Review and Commentary on Existing Capacity

The trunk mains provide convenient access and reliable supply coverage to the Precinct, particularly should new or upgraded connections be required from these trunk mains.

2.1.3.1 Sydney Water Current Planned Growth in the Local Area

It is noted that Sydney Water's 2014-2019 Growth Servicing Plan (GSP) confirmed that eight major sites (as listed in Table 3) in the Willoughby and Lane Cove LGA's with a combined 4,541 potential dwellings growth from 2011 to 2025 can all be serviced by connection into existing infrastructure.

As shown in Table 3, if Sydney Water's expected "short term" dwellings were all assumed to be built, there is a further 2,754 dwellings that Sydney Water have allowed to be accommodated before 2025 in the broad Lane Cove and Willoughby LGA area.

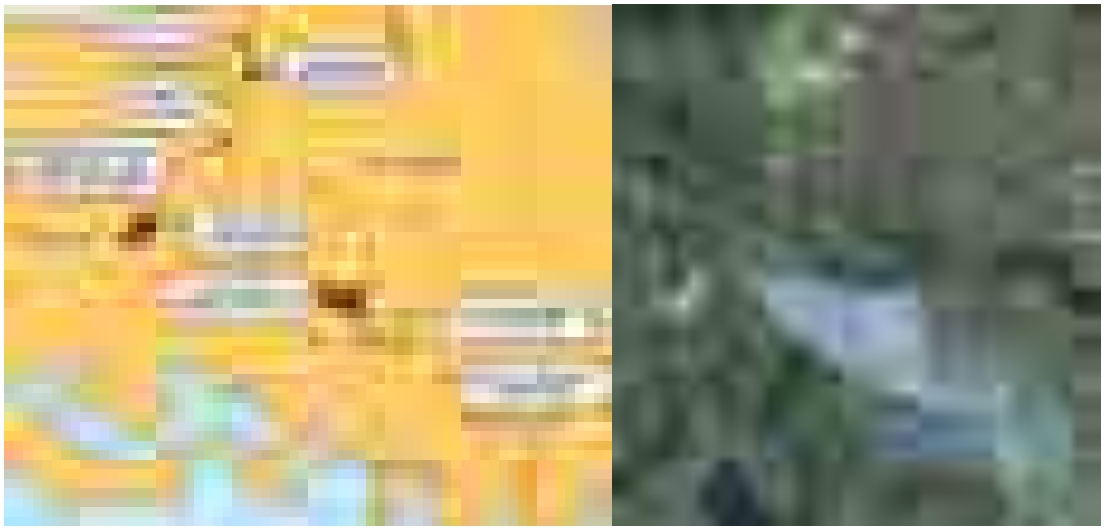
However, given only three of the eight development sites appear to be located in the Precinct, there are only 1,374 additional dwellings that Sydney Water have allowed to be accommodated before 2025. As such the GSP does not provide sufficient allowance for the forecasted growth in the Precinct.

Table 3: Sydney Water 2014-2019 Growth Servicing Plan - Lane Cove & Willoughby LGA's

	LGA	Major Site (>200 dwellings)	Total Potential Dwellings to 2025	Short term	(Total Potential Dwellings to 2025) - (Short term)	Dwellings within Precinct
1	Lane Cove	Lane Cove Town Centre	350	150	200	0
2	Lane Cove	Mowbray Road and Centennial Avenue, Lane Cove North	1,580	400	1,180	0
3	Lane Cove	Pacific Highway/Mowbray Road, Lane Cove	320	0	320	320
4	Lane Cove	St Leonards	406	152	254	254
5	Willoughby	Chatswood interchange	584	584	0	0
6	Willoughby	Pacific Place	300	300	0	0
7	Willoughby	Thomas St Car Park	201	201	0	0
8	Willoughby	Royal North Shore Hospital	800	0	800	800
		TOTAL	**4,541**	**1,787**	**2,754**	**1,374**

Source: Sydney Water 2014-2019 Growth Servicing Plan

Figure 8: Inner North Subregion from Sydney Water Growth Servicing Plan and approximate locations in relation to the Precinct



Source: Sydney Water 2014-2019 Growth Servicing Plan

2.1.3.2 Forecast Growth

Due to the presence of large trunk water mains inside and surrounding the Precinct, it is likely that there is some residual capacity in the existing system to service the Precinct in isolation. However, given downstream areas (typically to the south and east) are also serviced by these trunk pipes, upgrades are likely to be required to service the combination of existing and proposed development.

Mott MacDonald have undertaken a high level assessment to determine the increase in demand for the Precinct. Mott MacDonald undertook a high level assessment to determine the increase in demand for the Precinct. The results of this assessment can be found in Section 3.1. Should there be no spare capacity in the Precinct a new trunk main would be required with an equivalent 600mm diameter.

2.1.4 Sydney Water Planning Investigation

Sydney Water are unable to provide any information further to the publicly available information relating to remaining capacity in the system for inclusion in this study. At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study. Correspondence regarding this information has been provided in the appendices. It is therefore recommended that the draft 2036 Plan consider that there is limited spare capacity in the network as an upper limiting scenario.

2.1.5 Key Constraints and Opportunities

- Upgrade to one or more trunk pipes is likely to be required as there is limited capacity in the existing water mains to service the increased density in the Precinct and existing developments to the south east;
- Upgrading the 500-600mm water mains underneath the rail corridor or under the M1 could incur significant cost. The extent of required works will be determined once a feasibility application is submitted. Upgrades under the M1 could be in the soffit of a bridge structure or underneath the road surface and if required (in the form of upgrades to existing pipes or provision of new crossings), there is a risk that that such works would be major and costly;
- Risk there may be a need to upgrade the reservoirs, two of which are heritage listed. There may be difficulties in increasing supply without building an extra reservoir given the Chatswood Reservoir site appears constrained in vacant area;
- Sydney Water is currently undertaking a study for the North Shore Area. This study will include an assessment of the proposed yields of the Precinct.
- Existing minor reticulation within the Precinct may require removal/relocation to suit new development.

2.2 Sewer

2.2.1 North Head Ocean Outfall Sewer

The Precinct is serviced primarily via a 3251mm wide x 2426mm high sandstone concrete box culvert trunk sewer main which was installed in 1930. The location of this main is shown as a red dashed line in Figure 10 and denoted P1 in Figure 11. It runs west to east transferring sewer from the North Head Ocean Outfall Sewer (NSOOS) to the North Head Sewerage Treatment Plant. It is located within a small portion of the Precinct's southern boundary.

All sewer mains within the Precinct boundary and in the surrounding area ultimately discharge to this trunk main. NSOOS passes through approximately 750m in the south of the Precinct. It is noted that :

1. The cadastral survey from NSW Six Maps does not appear to show an easement along the length of NSOOS within the Precinct
2. NSOOS appears to be located under existing houses as illustrated in Figure 9

Therefore it is likely to be at sufficient depth to avoid standard easement set backs. Its depth would need to be considered if buildings requiring medium to deep foundations along its alignment.

Figure 9: Location of NSOOS within Precinct Boundary

Source: Sydney Water Hydra

It is highly unlikely the NSOOS will be amplified or realigned and generally does not form a constraint to development.

Figure 10: Trunk sewer main location

Source: Sydney Water Hydra

2.2.2 Trunk Sewer Mains

The north west and central areas of the Precinct generally slope from south to north (see Catchments C1 and C2 in Figure 11). The remainder of the Precinct generally slops north to south (see Catchments C3-C7 in Figure 11).

Catchment C5 drains directly into P1 via reticulation and makes up approximately 18% of the Precinct. The remainder of the Precinct drains via gravity into four trunk mains (denoted as P2-P5 in Figure 11) as follows:

1. P2 is a 400mm pipe in the western portion (laid in 1929), which increases to a 406mm wide x 533mm high box culvert and then a 533mm wide x 736mm high box culvert as it descends to the east which were laid in 1910 and 1898 respectively. It drains Catchments C1 and C2 shown in Figure 11 which make up approximately 50% of the Precinct by area. Note that this pipe passes under the M1 in two separate locations
2. P3 is a 375mm concrete pipe to the north which increases to a 450mm concrete pipe as it drains southwards to P1 and was laid in 1994. It drains catchments C3 and C4 as illustrated in Figure 11 which make up approximately 26% of the Precinct by area. Note that this pipe appears to pass under the rail corridor
3. P4 is a 375mm pipe to the west of unknown type which increases to a 450mm brick pipe as it drains north east to P1 and was laid in 1890-1893. It drains catchment C7 as illustrated in Figure 11 which make up approximately 3% of the Precinct by area
4. P5 is a 990mm wide x 660mm high concrete box culvert to the south east which reduces to a 457mm wide x 635 high concrete box culverts as it drains north west to P1. It was laid in 1914. Catchment C6 drains to P5 via reticulation and makes up approximately 3% of the Precinct by area. It is noted that this pipe drains a large area not included in the Precinct. Note that the reticulation pipes that drain C6 to P5 appears to pass under the rail corridor.

Figure 11: Existing Sewer Trunk Layout and Catchment Topography

Source: Sydney Water Hydra

2.2.3 Northside Storage Tunnel (NST)

The 3.8m x 3.8m unlined rock Northside Storage Tunnel (NST) passes through a large portion of the Precinct (see pink dashed line in Figure 10). According to Sydney Water's website, the NST stores approximately 500,000 cubic metres of effluent from four overflow sites before transferring to the North Head Wastewater Treatment Plant. The NST is approximately 118m below the surface within the Precinct area.

This study has assumed that increased density in the Precinct will have negligible impact on load to the NST. Due to its significant depth, the location of this tunnel would not be expected to constrain the layout and staging plans for the Precinct.

2.2.4 Existing Trunk Infrastructure Capacity

As discussed in Section 2.1.3, Sydney Water allowed for 1,374 extra dwellings without upgrades to existing infrastructure in the Precinct as a result of three development sites by 2025.

Sydney Water were unable to provide any further information relating to remaining capacity in the system prior to completion of their Lower North Sydney Planning investigation, but will require internal approvals before public release. Correspondence regarding this information has been provided in the appendices. It is therefore recommended that the draft 2036 Plan consider that there is limited spare capacity in the network as an upper limiting scenario.

2.2.5 Key Constraints and Opportunities

- It appears that the NSOOS sewer main does not require an easement. However assessment of its relative depth to the surface level would be required if buildings requiring deep foundations are intended along its alignment;
- As the Precinctis generally along a ridge line no sewer pumping stations are required to drain the site;
- Should there be no spare capacity in the three sewer mains draining under the Gore Hill Freeway and rail corridor, upgrading these pipes may generate significant cost in under boring;
- Existing minor sewer reticulation that passes through private properties may require removal/relocation to suit new building footprints should sites be consolidated;
- At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study.

2.3 Electricity

2.3.1 Regional Network

The Precinct and surrounding area receives electricity from Ausgrid. The locations of substations and 33kV and 132kV lines in the vicinity of the Precinct are illustrated in Figure 12.

Figure 12: Approximate Surrounding Substation Locations

Source: Ausgrid – Supply and Demand 2012-2013 Update, http://data.environment.nsw.gov.au/dataset/state-heritage-register-centroids9b5f6

The region is well serviced by distribution substations (minor padmount substations/chamber substations, etc) to service the existing population as illustrated in Figure 13. Developers would relocate and install these units as development occurs which is not expected to prohibit roll out of development.

Figure 13: Ausgrid Distribution Substation Locations

Source: Ausgrid Feasibility Letter 9th October 2017

To gain an understanding of the existing capacity in the trunk electricity network the following was undertaken:

- a review of Ausgrid's publicly available information and;
- requested Ausgrid to provide capacity information in their feasibility assessment.

These are detailed in Sections 2.3.1.1 and 2.3.1.2 respectively.

2.3.1.1 Ausgrid Capacity from Publicly Available Information

In 2012, Ausgrid released information regarding the planned upgrades and capacity and predicted demand for substations in the North Sydney region. The information relevant to the substations in the vicinity of the Precinct have been summarised in Table 4. It is noted that peak loads have been taken as the maximum of winter and summer peak loads.

Table 4: Substations surrounding the Precinct

Substation	Voltage (kV)	Recent Upgrades	Capacity (MVa)	Projected 2018 Peak Load (MVa)
Willoughby STS	132kV/33kV	Refurbished with 132kV compact gas insulated switchgear in 2012 Connection points to Crows Nest, North Sydney & Royal North Shore Hospital ZS's upgraded in 2012 Some capacity may have been diverted to Mosman ZS in 2015 by installation of two new 132kV feeders to Mosman ZS	Total: 350 Secure: 304	149.2 (49% of Secure Capacity)
Crows Nest ZS	132kV/11kV	Converted from 33/11kV to 132kV in 2012 with feeders from Willoughby STS 11kV switchgear replaced in 2010	Total: 114.3 Secure: 65.5	45.7 (70% of Secure Capacity)
North Sydney ZS	132kV/11kV	Upgraded from 33/11kV to 132kV substation in 2014	Total: 171.5	83.6

Substation	Voltage (kV)	Recent Upgrades	Capacity (MVa)	Projected 2018 Peak Load (MVa)
		New feeders from Crows Nest ZS installed in 2014	Secure: 114.3	(73% of Secure Capacity)
Royal North Shore Hospital (RNSH) ZS	132/11kV	Constructed in 2012 132kV feeders installed in 2012	Total: 97.3 Secure: 53.5	13 (24% of Secure Capacity)
Gore Hill ZS	33/11kV	Appears to have been constructed in 2011	Total: 149.2 Secure: 95.9	67.8 (71% of Secure Capacity)

Source: Ausgrid – Supply and Demand 2012-2013 Update. Ausgrid Electricity System Development Review (ESDR) 2012/2013

A rail substation is located in the north east corner of the Precinct as shown in Figure 12. This substation services the rail line only and is unlikely to be used for any additional electrical requirements.

Ausgrid also assessed feeders connecting zone substations to confirm available spare capacity. As indicated in Table 5, generally these bulk distribution feeders are operating at approximately 50-70% capacity and indicates additional supply could be diverted to the zone substations if required.

Table 5: Feeders surrounding the Precinct

Feeder Name	ZS's linking	Rating (MVa)	Projected 2018 Peak Load (MVa)	Estimated percent utilised
9H3	Willoughby STS to Crows Nest ZS	272	154.5	57%
9H5	Willoughby STS to Crows Nest ZS	272	156.7	58%
9H1	Willoughby STS to RNSH ZS	166	13.1	8%
9H2	Willoughby STS to RNSH ZS	166	13.1	8%
9P3	Crows Nest ZS to North Sydney ZS	272	126.5	47%
9P5	Crows Nest ZS to North Sydney ZS	272	127.3	47%
571	Willoughby STS to Gore Hill ZS	40.2	28.7	71%
572	Willoughby STS to Gore Hill ZS	40.2	29.1	72%
573	Willoughby STS to Gore Hill ZS	40.2	28.9	72%
574	Willoughby STS to Gore Hill ZS	40.2	29.1	72%

Source: Ausgrid – Supply and Demand 2012-2013 Update. Ausgrid Electricity System Development Review (ESDR) 2012/2013

2.3.1.2 Existing Capacity as per site specific Ausgrid Study

Ausgrid confirmed in their feasibility assessment that the estimated spare capacity in the region is as per Table 6. We note however that transmission lines lose voltage over long distances therefore, these capacities should be treated as applicable only for the immediate surrounding area of the respective zone substations.

Table 6: Spare Ausgrid Capacity (as of October 2017)

Zone Substation	Spare Zone Capacity (MVa)	Spare Feeder Capacity (MVa)
Gore Hill	23	21
Royal North Shore	40	12
Crows Nest	28	33
North Sydney	37	39
TOTAL	128	105

Source: Ausgrid Feasibility Letter 9th October 2017

2.3.2 Existing Zone Substation Considerations

Crows Nest Zone Substation

The Crows Nest Zone Substation is listed on the State Heritage Register and comprises a heritage listed brick building to the west and recent upgrades to the east. The heritage building is still operational and integral to the site functionality. Ausgrid are expecting to maintain operation of the heritage building. As the site is heritage listed it is unlikely to have development potential and therefore would be ideal to maintain the zone substation in its present location as opposed to potential relocation.

Figure 14: Ausgrid Zone Substation

Source: Google Earth

Royal North Shore Hospital (RNSH) Zone Substation

It is understood that the RNSH ZS was recently updated for the hospital and is therefore not expected to be upgraded in the near future. Spare transformer bays are available at this site however it is understood that these bays will be required for long term upgrades of RNSH.

Figure 15: RNSH Zone Substation

Source: Google Earth

Willoughby Transmission Station and Gore Hill Zone Substation

As shown in Figure 16, the Willoughby TS and Gore Hill ZS are located on a highly constrained site and have a large number of transmission cables passing through the substations. This site is not flagged for development.

Figure 16: Willoughby Transmission Station and Gore Hill Zone Substation

Source: Ausgrid

2.3.3 Key Constraints and Opportunities

- Based on Ausgrid's data regarding spare capacity, the substations and feeders in the Precinct are likely to have some spare capacity to service the increased population;
- The existing substations will have limited space for upgrades. Once the upgrade potential of these substations is exhausted a new zone substation site would be required. Given the proximity to transmission lines, creation of a new zone substation is not expected to be a key constraint, however the acquisition of a site may raise challenges;
- Initial data indicates there is significant capacity available in the Royal North Shore Hospital ZS. However, it is understood that this spare capacity is required for the hospital precinct.

2.4 Gas

Gas is supplied to the Precinct and surrounding area by Jemena. Jemena indicated that the existing network in the area does not have sufficient capacity to supply the additional load, and a network reinforcement will be required.

As gas is a non-essential service, extending mains to areas of the Precinct without sufficient capacity will be dependent on demand and will be the responsibility of individual developers. A feasibility application was lodged with Jemena to determine the available network capacity.

2.4.1 Existing Network

A 1050kPa secondary gas main runs through the Precinct along Reserve Road, Berry Road, the Pacific Highway and Atchison Street which would service a large portion of the Precinct including the Royal North Shore Hospital. This is shown in Figure 17.

Figure 17: Jemena Existing Secondary Gas Main Approximate Location

Source: Dial Before You Dig

2.4.2 Key Constraints and Opportunities

- The Precinct is serviced by Jemena and some supply may be available for initial developments without network augmentation; and
- It is not expected that provision of gas to the Precinct will pose a constraint to future development, however gas provision may not be feasible for isolated sites, particularly where neighbouring properties choose not to service their development with gas and lengthy lead in works would therefore need to be provided by individual developers.

2.5 Telecommunications

Telstra provide telecommunications services throughout the Precinct. NBN Co also service parts of the Precinct. Figure 18 shows the locations of Telstra mobile sites within the region.

Figure 18: Telstra mobile site location

Source: Telstra Correspondence 16/06/2017

Figure 19 shows properties that are impacted by existing trunk telecommunications services. Whilst this does not pose a constraint to land use planning, any future development within these sites would need to consider the implications on these assets. Further studies will need to be undertaken as designs are progressed for these sites as they may limit development potential or require relocation/deviation.

Figure 19: Properties Impacted by Existing Trunk Telecommunications Infrastructure

Source: NBN: CW3967 - GIS DATA - ST LEONARDS

2.5.1 Key Constraints and Opportunities

- The region is well serviced by phone, mobile and high speed fibre. It is expected that NBN Co. will service the area in the future. The provision of telecommunications services is not expected to limit or constrain development;
- If development is proposed on sites with existing mobile towers these will need to be relocated to ensure network coverage is maintained. Additional towers may be required to ensure that there is no loss in coverage due to the increase in high density towers; and
- Sites impacted by trunk telecommunications infrastructure may require further studies before development can occur.

3 Proposed Services Infrastructure

3.1 Water

3.1.1 Water servicing options

The two main options for water servicing of the Precinct are:

1. Option 1: Continue to source water from the Chatswood reservoirs via the existing trunk pipe routes and construct new reservoirs on a site adjacent the existing Chatswood reservoirs if necessary. Provide a 600mm main supply (or equivalent in capacity) to the area. This sizing is based on assuming there is no spare capacity available in the system.
2. Option 2: Acquire land within the Priority Precinct and construct a new reservoir to limit the required lead in works.

Option 1 is considered to be the most practical and cost efficient course of action for the following reasons:

- Holistically Option 2 would require a larger amount of infrastructure, trenching and acquisition cost. Option 2 would require transfer mains to be constructed to connect between the reservoirs however, this would not need to be as large as the 600mm main in option 1. Whist it is noted that the pipes are smaller a large cost associated with the upgrade works is associated with trenching in a densely populated area.
- Acquisition of land for a new reservoir may be prohibitive closer to the economic core. Additional trunk mains would be required to connect the new reservoir to development, however, the length of mains are expected to be shorter than in Option 1 where significant extra trunk mains would be required to link the new reservoir with the existing potable water network;
- Historically water demand is reducing on a per dwelling basis over time and the need for large upgrades or additional reservoirs may not be required.

Sydney Water were unable to provide details regarding existing spare capacity or upgrade requirements. At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study.

This study assumed has that there is limited spare water supply available. This approach is seen as an upper limiting scenario for the purpose of testing development feasibility. It is expected that Sydney Water will ultimately provide the rollout of these services and as such sequence upgrade works to match demand.

3.1.2 Introduction and Capacity Assessment

Potable water is currently supplied to much of the Precinct primarily from the Chatswood Reservoirs.

To determine the water supply requirements to service the additional demand for the Precinct, a high level assessment was undertaken using the Water Supply Code of Australia (WSA). This involved calculating the additional peak hourly demand for the Precinct by the proposed increase in dwelling and employment area density to determine the approximate trunk pipe size.

The maximum water demand rates for each land use was extracted from Table 2.1 of the WSA. For hospitals, the WSA code rate is based on a hospital size of 350 beds. Therefore the increase in demand for the health precinct was determined assuming that Royal North Shore Hospital currently includes 600 beds. The increase in demand was then scaled accordingly.

The demand rate for each land use was then multiplied by the approximate number of proposed dwellings or the total GFA to determine the average daily demand. The average demand was then multiplied by the peak day factor of 1.5 to determine the peak daily demand.

The peak hourly demand was then calculated using the average hour demand for the peak day and a peak hour factor of two. Assuming a design velocity of 1.4m/s for the pipe, the minimum pipe size required to meet the total demand is 600mm. The results of this assessment are shown in Table 7.

Table 7: Water Main Calculations

	Assumed increase (GFA or dwellings)	Max Day Demand Rate	Average Daily Demand (L/s)	Peak Daily Demand (L/s)	Peak Hourly Demand (L/s)
Residential	13,214	0.8kL/dwelling	122	184	367
Hospital	57,200	270kL/350 beds	0.68	1.02	2.04
Commercial	193,446	41kL/Ha	9.18	13.8	27.54
Light Industrial	2,700	66kL/Ha	0.21	0.31	0.62
		Total	**132**	**199**	**397**

Sydney Water are unable to provide guidance on remaining capacity. Therefore a “worst-case” assessment is provided below which would occur in the event that there is no remaining capacity.

Assuming there is no capacity within the existing network to meet this additional demand, the equivalent of a 600mm main in capacity would need to be constructed from the Chatswood Reservoir to the Precinct. This could be achieved through a series of smaller, reticulation mains or through a single 600mm main. Given the number of trunk mains within the Precinct boundary, there may be some residual capacity available to service development.

Larger development sites could consider the use of onsite packaged water treatment and reuse systems to reduce consumption of potable water.

As the Precinct is expected to be developed incrementally over a 20 year period, it is understood that there is sufficient lead time for Sydney Water to stage any trunk infrastructure upgrades.

Negotiations will be required between individual proponents and Sydney Water to confirm funding arrangements and reimbursement schemes should major network augmentations be required to service development.

3.1.3 Recommended Amplification and Staging Works

In lieu of further advice from Sydney Water, Figure 20 provides a visual representation of the possible trunk pipe network upgrades that may be required if the scenarios described in Section

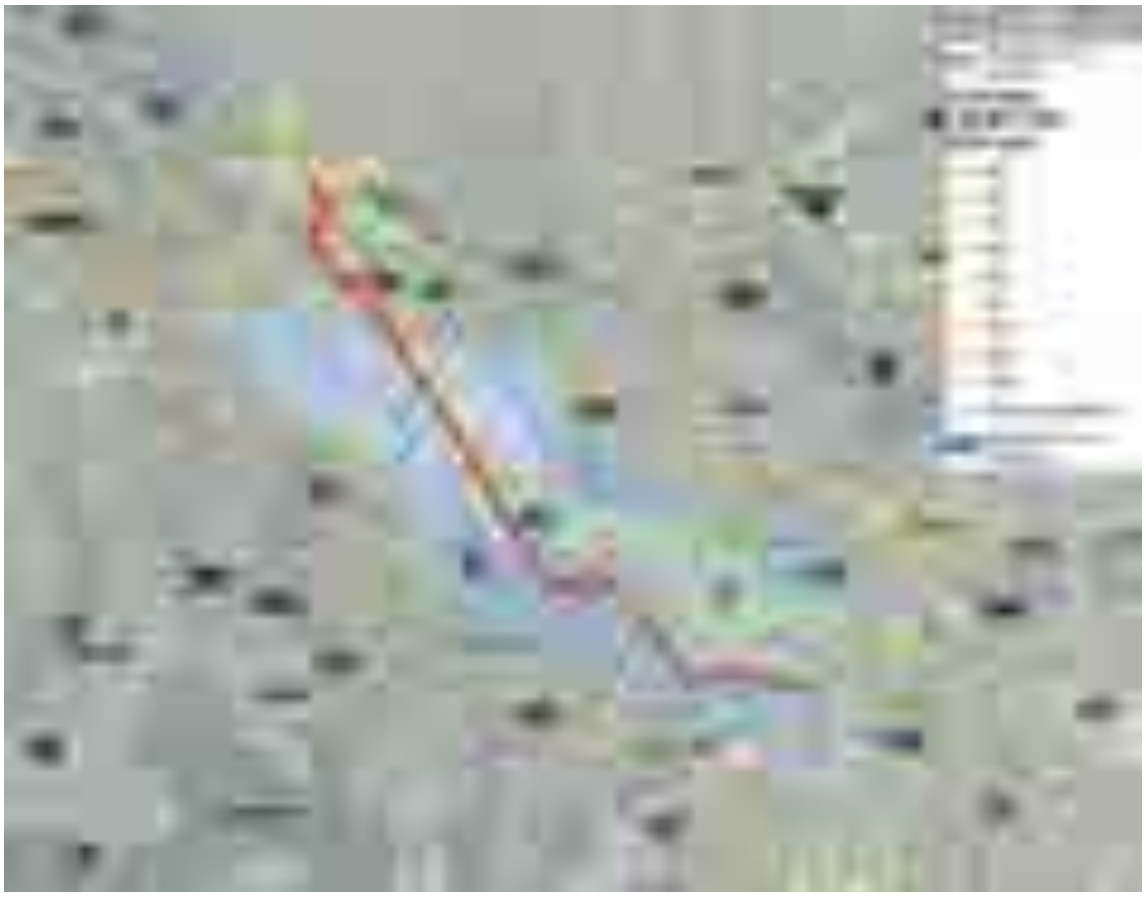
3.1.2 eventuate. The existing alignment of the trunk main servicing large portions of the Precinct has been used for the route of the possible new 600mm pipe.

For such an arrangement, there would be the following costly items:

- A crossing under the Warringah/Gore Hill Freeway. The 500mm pipe along the same alignment has been chosen for the new pipe crossing with a locally increased 600mm pipe section. This means in a lower growth scenario or if there is remaining capacity in the existing pipe, it is possible that the section crossing the freeway corridor would not need to be upgraded but instead the 500mm regions outside the freeway corridor would be increased;
- A crossing of the existing rail corridor and a crossing of the future rail corridor;
- A crossing of the Pacific Highway.

Sydney Water would need to consider if the Chatswood reservoirs could be upgraded if further capacity is needed.

Figure 20: Possible Trunk Water Upgrades



Source: Sydney Water Hydra

3.2 Sewer

3.2.1 Introduction

Any future sewer network strategy will be delivered in the same manner as the water supply. This means as development progresses and existing mains reach capacity, the existing mains would be upgraded or duplicated along existing routes to account for the increased load.

At the time of writing this study, Sydney Water were undertaking a separate investigation for their Lower North Shore (LNS) water and sewer networks. Sydney Water were provided with the potential Precinct growth yields which are referenced in this study and consequently are incorporating the expected growth in their LNS study. Once released their findings will supersede the recommendations of this study.

The advice provided by Mott Macdonald in this study is based on the assumption that there is limited spare sewer capacity available. This approach is seen as an upper limiting scenario for the purpose of testing development feasibility. It is expected that Sydney Water will ultimately provide the rollout of these services and as such sequence upgrade works to match demand.

Option 2 has been used to determine the proposed ultimate Precinct sewer network.

3.2.2 Proposed Sewer Loads

3.2.2.1 Sewer Loads per Land Use

The Sewerage Code of Australia's *WSA 02-2002-2.2 Table A1* has been used to estimate sewage loads for the Precinct. This has been undertaken by classifying the existing Character Areas into comparable classifications for sewage loads per Equivalent Persons (EP) which is used as a measure of loading on the system.

Table 8: Equivalent persons per Character Area residential and employment spaces

Precinct Character Area	Assumed WSA02 Table A1 Classification	No of people/ units	Employment Space Classification	EP / Employment Ha
1	N/A	0	Warehousing	50
2	High density	3	Hospital	800
3	High density	2.5	Local Commercial	75
4	High density	2.5	High Density Commercial	300
5	Medium density	3	Local Commercial	75
6	High density	2.5	Local Commercial	75
7	High density	2.5	Local Commercial	75
8	Medium density	3	Local Commercial	75
9	High density	2.5	Local Commercial	75

Source: Sewerage Code of Australia's *WSA 02-2002-2.2 Table A1*

3.2.2.2 Sewer Loads Per Catchment

The proposed sewer loads for Option 2 are shown in Table 9 based on their relative catchments. These have been provided to assess the maximum trunk upgrades that would be required if the existing system is at full capacity.

Table 9: Sewer Demand

Catchment	Character Area	Area (Ha)	Assumed Proposed WSA Classification	% of Character area within Catchment	EP per Character Area	Increase in EP
Catchment 1						
	Area 1	72.3	Warehousing	93%	135	126
	Area 2	11.7	Hospital	27%	5026	1352
Total		**83.9**		**100%**		**1,479**
Catchment 2						
	Area 1	5.0	Warehousing	7%	135	9
	Area 2	4.2	Hospital	10%	5026	488
	Area 4	16.3	High Density Commercial	51%	17664	8923
	Area 5	22.7	Local Commercial	85%	2852	2416
	Area 6	5.3	Local Commercial	34%	3828	1320
	Area 7	1.1	Local Commercial	7%	1610	115
Total		**54.6**		**100%**		**13,272**
Catchment 3						
	Area 2	27.0	Hospital	62%	5026	3137
	Area 3	0.2	Local Commercial	1%	7340	57
	Area 4	2.6	High Density Commercial	8%	17664	1420
	Area 5	0.0	Local Commercial	0%	2852	0
Total		**29.8**		**100%**		**4,614**
Catchment 4						
	Area 2	0.4	Hospital	1%	5026	48
	Area 3	22.3	Local Commercial	99%	7340	7283
	Area 4	13.0	High Density Commercial	40%	17664	7108
	Area 7	7.6	Local Commercial	51%	1610	819
Total		**43.2**		**100%**		**15,259**
Catchment 5						
	Area 4	0.0	High Density Commercial	0%	17664	0
	Area 5	4.1	Local Commercial	15%	2852	434
	Area 6	10.0	Local Commercial	65%	3828	2499
	Area 7	0.0	Local Commercial	0%	1610	0
	Area 8	32.8	Local Commercial	83%	2877	2401
	Area 9	2.3	Local Commercial	36%	1605	573
Total		**49.3**		**100%**		**5,909**
Catchment 6						
	Area 4	0.4	High Density Commercial	1%	17664	212
	Area 6	0.0	Local Commercial	0%	3828	0
	Area 7	6.2	Local Commercial	42%	1610	672
	Area 9	1.6	Local Commercial	25%	1605	406
Total		**8.3**		**100%**		**1,291**
Catchment 7						

Catchment	Character Area	Area (Ha)	Assumed Proposed WSA Classification	% of Character area within Catchment	EP per Character Area	Increase in EP
	Area 8	6.5	Local Commercial	17%	2877	476
	Area 9	2.5	Local Commercial	39%	1605	625
Total		9.0		**100%**		**1,101**
Grand Total		**278.1**		**100%**		**42,918**

Source: WSA 02-2002-2.2 Table A1 & Master Plan Option 2

3.2.3 Capacity of Existing Trunk Services

Sydney Water were unable to provide information on remaining capacity in the existing trunk pipes. As there is no information available on remaining pipe capacity, Mott MacDonald cannot assess whether existing infrastructure can cope with any additional loads. Therefore we have assessed upgrades that would be necessary if the existing network is at capacity.

3.2.4 Proposed Sewer Upgrades

Upgrades have been assessed according to the maximum development case (Option 2). The grades for each proposed trunk pipe has been determined by averaging the grades of the existing Sydney Water pipes along the same route as the proposed pipe. The upgrades proposed below are on the assumption that the existing pipes are at full capacity however, should Sydney Water's assessment indicate that there is additional spare capacity in the network these upgrades may be reduced or eliminated.

The NHOOS (P1) is sufficiently designed to cater for large sewage loads and will not require upgrading. The increased load on it due to increased development in the Precinct is considered a negligible fraction of its current load. Any upgrade to this pipe would be state significant on a much broader scale than the Precinct and therefore is outside the scope of this report.

Table 10 estimates the required upgrades for each trunk pipe as a result of a proposed increase in sewer load. If the existing corresponding pipe along each route has remaining capacity, magnitudes of upgrades will likely be reduced. Upgrades suggested are in the form of constructing an additional main adjacent the existing main but alternatively the existing main could be upsized by a comparable cross sectional area to support the expected growth. This assessment could be undertaken at a later stage to evaluate the impacts of cost and network downtime. These upgrades cater for the ultimate development build out and would need to be incrementally provided as development occurs.

Table 10: Trunk Sewer Mains

Trunk Pipe	Existing Size	Catchment Serviced	Grade	Proposed Increased Load (EP)	Approx Length (m)	Equivalent Required Upgrade
P1	3251x2426mm box culvert	All	-	-	NA	NA
P2	400mm pipe	C1	2.4%	1,480	1070	225mm pipe
P2A	406x533mm box culvert	C1, C2	0.029%	14,755	1190	1200mm pipe
P2B	533x736mm box culvert	C1, C2, C5	0.19%	20,665	970	900mm pipe
P3	375mm pipe	C3, C4	5.8%	19,875	1070	600mm pipe
P4	375mm pipe	C7	1.4%	1,105	730	225mm pipe
P5	990x660mm box culvert	C6	0.25%	1,300	1650	300mm pipe
P6	225mm pipe	C6	0.25%	1,300	600	300mm pipe

Source: Sydney Water Hydra

The pipes referenced for upgrade in Table 10 are identified in Figure 21.

Figure 21: Possible Sewer Network Upgrades

3.3 Electricity

3.3.1 Anticipated Demand

The assumed electrical loads generated by the development are outlined in Table 11.

Table 11: Electricity Load Assumptions

Type	Assumed VA per sqm/dwelling	Source
Knowledge Intensive	100	AS/NZS3000-2007 Table C3 Office: Light and Power + Zonal reheat cooling
Population Serving	100	AS/NZS3000-2007 Table C3 Office: Light and Power + Zonal reheat cooling
Health & Education	120	AS/NZS3000-2007 Table C3 Retail: Light and Power + Office Zonal reheat cooling
Industrial	70	AS/NZS3000-2007 Table C3 Light industrial: Light and Power + Ventilation + Air-conditioning
Residential	4,000	Endeavour Energy Technical Bulletin 12/09/2016

The associated increase in demand for each character area is summarised in Table 12 for the three development scenarios from Table 2. The areas referred to in Table 12 were previously defined in Figure 5.

Table 12: Increases in electrical loads

Area	Character Area	Low (Option 1) Increase in (MVa) -	Medium (Option 3) Increase in (MVa)	High (Option 2) Increase in (MVa)
1	Artarmon	3.3	3.3	3.3
2	Health & Education Precinct	7.9	7.9	8.5
3	Residential (St Leonards South)	4.2	9.3	12.9
4	Mixed Use Centre	18.1	35.4	38.0
5	Residential (Naremburn)	1.2	1.9	3.9
6	Crows Nest Village	1.4	3.3	6.1
7	Residential (Wollstonecraft)	1.6	3.4	3.8
8	Residential (Crows Nest)	0.8	1.6	3.8
9	Pacific Highway Corridor (East)	2.6	4.9	4.7
	TOTAL	**41.1**	**70.9**	**85.2**

The above calculated demands in Table 12 are indicative only and will be further refined as more information becomes available regarding final built forms. AS/NZS3000-2007 has been used and is considered appropriate for this assessment.

However, these standards have not been modified to account for recent advances in lower energy technologies that reduce power usage in comparison with historical technologies and appliances.

Therefore it is likely that the total increase in MVa shown in Table 12 would be a conservative or “upper limiting” estimate of the full increase in load.

3.3.2 Ausgrid Capacity Assessment

Ausgrid assessed the adequacy of each zone substation and associated feeders under the three proposed future option electricity demand scenarios presented in Table 12. They have assumed the electricity is sourced for each Character Area as shown in Table 13.

Table 13: Assumed ZS servicing arrangement for each Character Area

Area	Character Area	Ausgrid's assumed ZS to service Character Area
1	Artarmon	Gore Hill
2	Health & Education Precinct	Royal North Shore
3	Residential (St Leonards South)	Royal North Shore
4	Mixed Use Centre	Crows Nest
5	Residential (Naremburn)	Crows Nest
6	Crows Nest Village	Crows Nest
7	Residential (Wollstonecraf)	Crows Nest
8	Residential (Crows Nest)	North Sydney
9	Pacific Highway Corridor (East)	North Sydney

Source: Ausgrid Feasibility Letter 9th October 2017

This servicing arrangement is illustrated in Figure 22 to visualise how Ausgrid have assumed each Character Area will be serviced.

Figure 22: Illustration of assumed servicing arrangement

Source: Ausgrid Feasibility Letter 9th October 2017

Using the assumed arrangement, Ausgrid determined the adequacy of zone substations and feeders respectively as discussed in the following sections.

3.3.2.1 Zone Substation Analysis

Table 14 compares the zone substation capacities provided by Ausgrid with the anticipated demand from the scenarios if dwellings are to be delivered by 2036. Note this does not include demands from any new developments outside the Precinct. Values in green indicate the demand generated by the option is within the spare capacity. Values in red indicate the demand generated by the option is above the spare capacity.

Table 14: Zone Substation capacities and anticipated demands

Zone Substation	Spare Zone Capacity (MVa)	Low Yield Demand (Option 1) (MVa)	Medium Yield Demand (Option 3) (MVa)	High Growth Scenario (Option 2) (MVa)
Gore Hill	**23**	3.3	3.3	3.3
Royal North Shore	**40**	12.1	17.2	21.4
Crows Nest	**28**	22.3	43.9	51.9
North Sydney	**37**	3.4	6.5	8.6
TOTAL	**128**	**41.1**	**70.9**	**85.2**

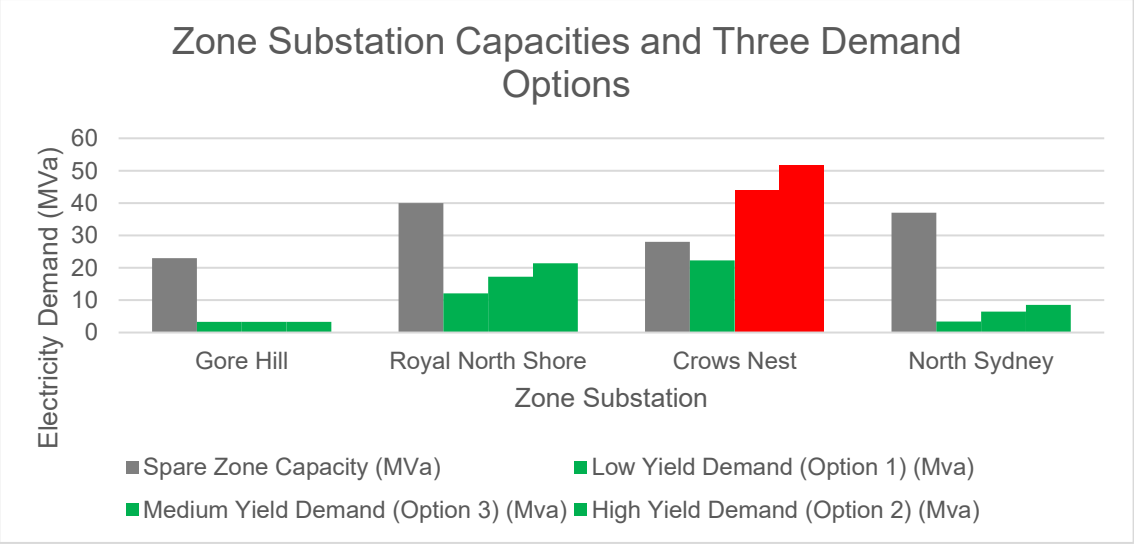
Source: Ausgrid Feasibility Letter 9th October 2017

Table 14 shows that there appears to be sufficient total supply in the surrounding network to cater for the proposed development without the need to upgrade zone substation capacity.

A local shortfall in supply would occur for the medium and high yield scenarios at the Crows Nest ZS. As a guide; if dwelling uptake is assumed to occur at a linear rate over time and energy demands were to remain at 2017 levels this shortfall would occur around 2030 and 2028 for the high and medium options respectively.

Figure 23 represents the comparisons presented in Table 14 graphically.

Figure 23: Zone Substation capacities and anticipated demand options



Source: Ausgrid Feasibility Letter 9th October 2017

3.3.2.2 Feeder Analysis

Table 15 compares the feeder capacities provided by Ausgrid with the anticipated demand from the three options if dwellings are to be delivered by 2036. This does not include demands from any new developments outside the Precinct. Values in green indicate the demand generated by the option is within the spare capacity. Values in red indicate the demand generated by the option is above the spare capacity.

Table 15: Feeder capacities and anticipated demands

Zone Substation	Spare Feeder Capacity (MVa)	Low Yield Demand (Option 1) (MVa)	Medium Yield Demand (Option 3) (MVa)	High Growth Scenario (Option 2) (MVa)
Gore Hill	**21**	3.3	3.3	3.3
Royal North Shore	**12**	12.1	17.2	21.4
Crows Nest	**33**	22.3	43.9	51.9
North Sydney	**39**	3.4	6.5	8.6
TOTAL	**105**	**41.1**	**70.9**	**85.2**

Source: Ausgrid Feasibility Letter 9th October 2017

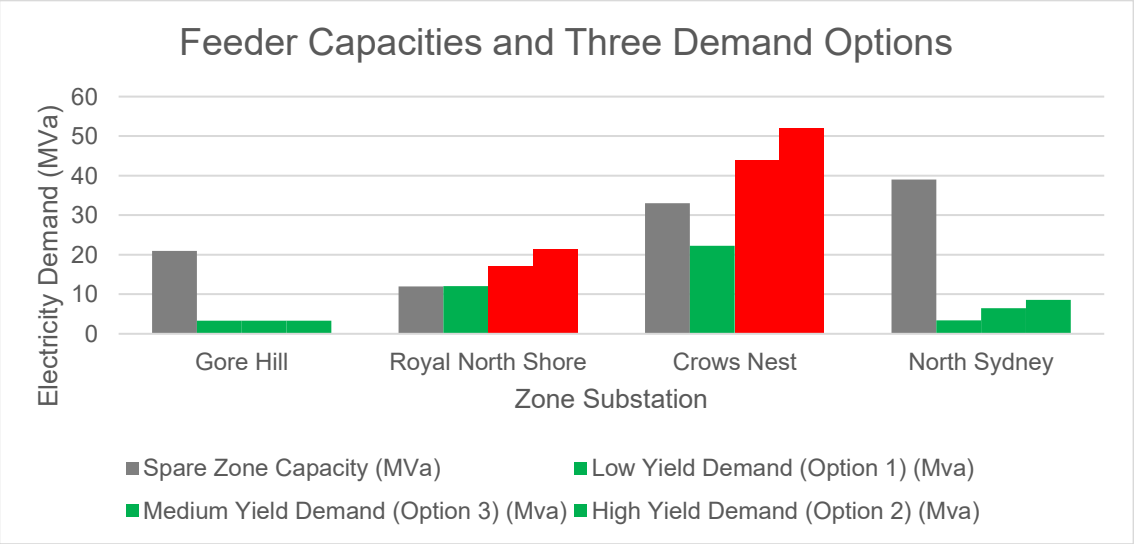
Table 15 shows that there appears to be sufficient total supply in the surrounding network to cater for the proposed development.

However a local shortfall in distribution capacity is expected for the medium and high yield scenarios at the Royal North Shore Hospital and Crows Nest zone substations. As a guide; if dwelling uptake is assumed to occur at a linear rate over time and energy demands were to remain at 2017 levels this shortfall would occur around:

- 2031 and 2029 from RNSH for the high and medium options respectively;
- 2032 and 2030 from Crows Nest for the high and medium options respectively.

Figure 24 represents the comparisons presented in Table 15 graphically.

Figure 24: Feeder capacities and anticipated demand options



Source: Ausgrid Feasibility Letter 9th October 2017

3.3.3 Recommended Strategy

3.3.3.1 Zone Substations

From the analysis in Section 3.3.2, it appears that electricity supply particularly around the Crows Nest ZS will be exhausted for the medium and high growth scenarios by the early 2030s. Steps could be taken to safeguard future electricity provision as part of the planning process. Such action would primarily include securing land in the vicinity of the Crows Nest ZS and existing transmission lines for a further zone substation however, this is not considered to economic or practical and an alternative servicing option has been developed. Should the High Growth Scenario case eventuate an alternative to constructing a new zone substation could involve the following three key changes:

1. Change 1: RNSH ZS is within a 2km radius of Area 4 and only operates at 54% of capacity even in the High Growth Scenario (leaving around 18.6MVa of spare capacity). Feeders could be constructed to connect this to service 18.6MVa of Area 4's 38.0MVa demand. This change is visualised by Area 4a in Figure 25 being serviced by RNSH ZS instead of Crows Nest ZS;
2. Change 2: North Sydney ZS is within a 2km radius of Area 7 and only operates at 23% of capacity even in the High Growth Scenario (leaving around 28.4MVa of spare capacity). Feeders could be constructed to connect this to service Area 7's 3.8MVa demand. This change is visualised by Area 7 in Figure 25 being serviced by North Sydney ZS instead of Crows Nest ZS;
3. Change 3: North Sydney ZS is within a 2.5km radius of Area 4 and only operates at 33% of capacity even in the High Growth Scenario and including Change 2 (leaving around 24.6MVa of spare capacity). Feeders could be constructed to connect this to service the remaining 1.5MVa of demand not accounted for by the Crows Nest ZS from Area 4. This change is visualised by Area 4c in Figure 25 being serviced by North Sydney ZS instead of Crows Nest ZS

The three changes listed above are shown in Figure 25. The portion of Area 4 from Ausgrid's servicing arrangement that is still serviced by Crows Nest ZS is denoted as Area 4b.

As development occurs, there are other servicing options and configurations that could also adequately supply the Precinct. This option has been provided to demonstrate that an option to redistribute loads from the zone substations can be achieved to service the Precinct High Growth Scenario.

Figure 25: Proposed High Demand Servicing Strategy

Source: Ausgrid Feasibility Letter 9th October 2017

The analysis of Ausgrid's assessment shows that there is likely to be a solution to accommodate the High Yield Density case by 2036 without the need for further zone substations to be constructed. To summarise these loads, Table 14 has been altered for the High Growth Scenario to show that the loads on each ZS under the preferred option as Table 16:

Table 16: Zone Substation capacities and High Growth Scenario under Preferred Option

Zone Substation	Spare Feeder Capacity (MVa)	High Growth Scenario (Option 2) (MVa)
Gore Hill	**23**	3.3
Royal North Shore	**40**	40.0
Crows Nest	**28**	28.0
North Sydney	**37**	13.9
TOTAL	**128**	**85.2**

Source: Ausgrid Feasibility Letter 9th October 2017

Actual electricity demand for the Precinct is likely to be less than calculated in Section 3.3.1. This is because electricity demand calculations were undertaken in accordance with the assumptions presented in Table 11. Future more energy efficient developments are likely to reduce energy demand per dwelling as time progresses. Some of the initiatives to achieve this are presented in Section 5.

This assessment does not include increases in electrical demand from developments in surrounding areas that are not in the Precinct. There is zone substation capacity to the north and south of the Precinct. Specifically, even in the High Density Yield scenario and with the three changes mentioned above:

1. North Sydney ZS still has 23.1MVa of capacity;
2. Gore Hill ZS still has 19.7MVa of capacity;
3. Chatswood ZS is not needed to service any upgrades in the Precinct.

3.3.3.2 33/132kV Electrical Feeders

As identified in Section 3.3.2.2, Ausgrid's zone substation strategy showed insufficient feeder capacity from the Crows Nest ZS and RNSH ZS would be reached for the medium and high load scenarios.

However the strategy explained in Section 3.3.3.1 would reduce the total additional demand on the Crows Nest ZS to 28MVa to meet its remaining capacity. Therefore given its available feeder capacity is 33MVa, the strategy would likely avoid the need to upgrade feeders from Crows Nest ZS.

The strategy to relieve Crows Nest ZS of electrical demand would increase load on the RNSH from the Ausgrid strategy by 18.6MVa. Therefore new feeders would need to be constructed to service RNSH ZS to cater for a total of 28.0MVa of extra load.

If this upgrade becomes necessary, it would involve routing new HV underground cables in the existing route that connected the RNSH ZS with the Willoughby TS. This is illustrated in Figure 26 and would require around 550m of new HV feeders.

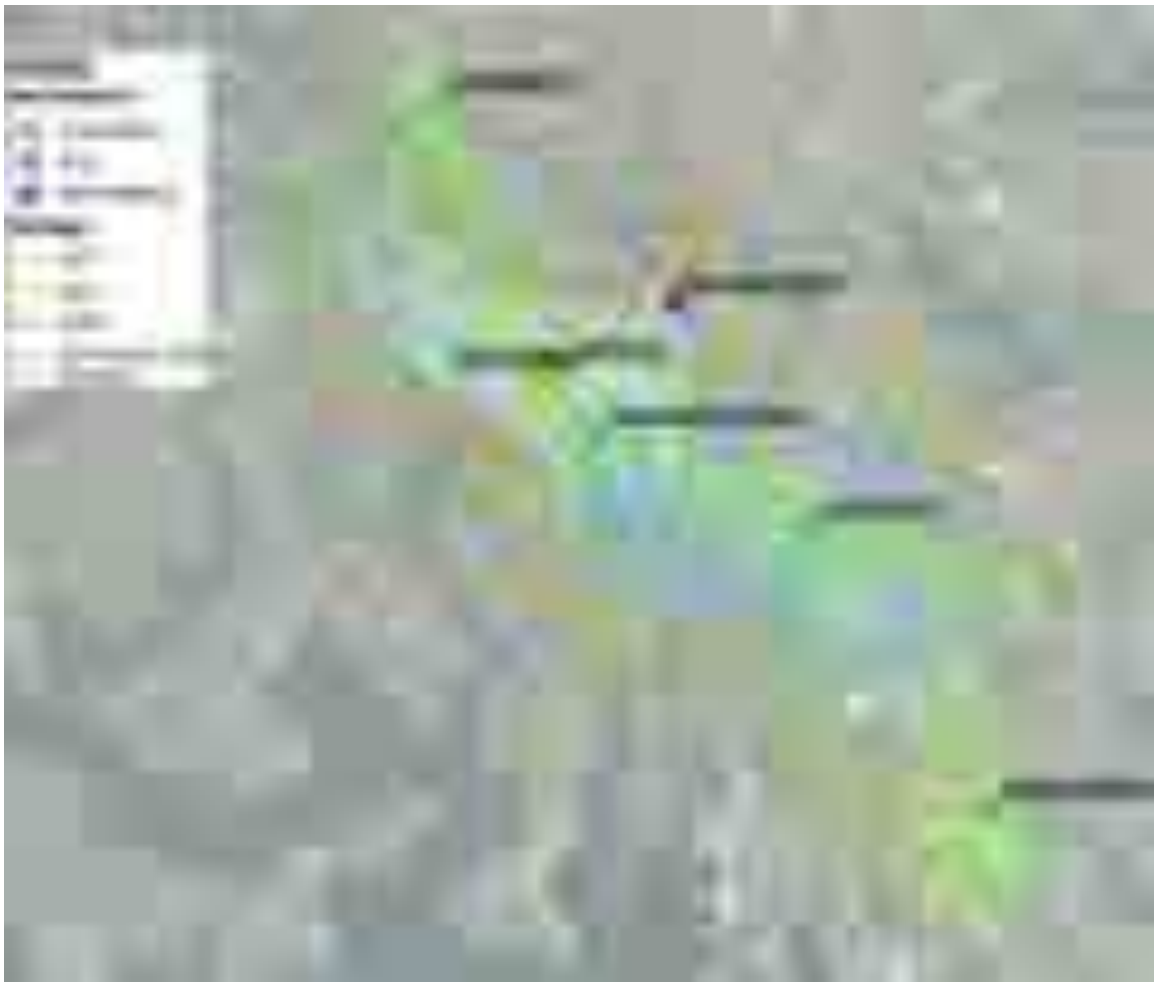
Figure 26: Possible Feeder Upgrades

Source: Ausgrid Feasibility Letter 9th October 2017

3.3.3.3 11kV Electrical Feeders

As a guide, one new 11kV feeder is usually needed for every additional 1000 dwellings. Therefore it would be reasonable to assume in the High Growth Scenario that around 13 new 11kV feeders will be needed throughout the Precinct. These would likely typically match the existing 11kV routes which are provided in Figure 27 for information. These would be routed from the relevant nearby substation as required by developers.

Figure 27: Existing 11kV Network



Source: Ausgrid Feasibility Letter 9th October 2017

3.4 Gas

Under NSW regulation, Jemena is required to ensure that any connection to the natural gas distribution system is commercially viable and therefore must assess each request for supply on an individual basis (as gas supply is a non-essential service). Jemena indicated that they would be able to assess the individual lots once the final building configurations are prepared and a connection application is made.

They have indicated that at the time of this report there is insufficient gas supply within the vicinity and a network reinforcement will be required. A contribution may be required for this works. Specifically, areas of Artarmon and St Leonards have adequate pressure to cope with an increased demand until 2036, however there are two areas which will require new infrastructure by 2036.

Firstly, there will need to be new connections around the RNSH. This is primarily through a small interconnection across the Pacific Highway to boost pressure following the rail crossing. At present, the railway divides the networks of Crows Nest and Artarmon as shown in Figure 28.

Figure 28: New connections around RNSH

Source: Jemena Correspondence Letter

Secondly, provision for reinforcements around Crows Nest would be required. A tentative investigation indicates a possible upgrade of the SRS box in Crows Nest and approximately 1km of 110mm PE main will require an upgrade, as indicated on Figure 29.

Figure 29: Reinforcements around Crows Nest

Source: Jemena Correspondence Letter

The information provided by Jemena is unlikely to be the full extent of upgrades for the Precinct. As development progresses, Jemena will work with individual developers to determine whether gas supply and upgrades are economically viable.

3.5 Telecommunications

3.5.1 NBN Co

NBN Co confirmed that they are the service provider for the Precinct. They have identified standard fees as $400 per unit or $600 per lot. Furthermore, they have indicated that there will be no backhaul charges applicable.

3.5.2 Telstra

Telstra have confirmed that NBN Co will be the major Service Provider for any new development in the Precinct. Telstra's focus will be on maintaining their existing assets in the area .

Figure 19 highlights key areas of major Telstra trenching which intersect existing blocks. These, and any changes to road alignments would likely affect Telstra's interests .

4 Sites of Interest

DPE are interested in understanding existing utilities for two areas within the Precinct:

1. Immediately west of the new Crows Nest Metro Station. This will be located between the Pacific Highway and Clarke Lane (eastern side of the Pacific Highway) and between Oxley Street and south of Hume Street;
2. The Pacific Highway corridor south of the existing St Leonards Railway Station.

Potential services conflicts for these areas are shown in Figure 30 and Figure 31 and indicate the following for information purposes:

1. Sydney Water's water mains as provided by Sydney Water's Hydra file;
2. Sydney Water's sewer mains as provided by Sydney Water's Hydra file;
3. Ausgrid's underground HV cables as provided by Ausgrid's digital GIS file;
4. Telstra trenches with at least 10 conduits as provided by NBN Co to highlight major cable runs;
5. Approximate locations of Jemena gas mains as traced from their DBYD PDF files.

It should be noted that this information is indicative and must not be relied on for construction purposes.

Figure 30: New Crows Nest Metro Station Site

Figure 31: Pacific Highway section south of St. Leonards Railway Station

5 Sustainability Considerations

Strategies identified in this study have generally been based on traditional servicing principles. At DPE's request, potential sustainability initiatives that could be included in the Precinct have been considered in relation to water, sewer, electrical, gas and telecommunications utilities as technologies change.

There are relatively limited sustainability opportunities on a Precinct wide scale given its fragmented nature and that it is already developed and serviced by all major utilities. Consequently initiatives such as recycled water harvesting re-use schemes are less commercially viable than they are for large, single private developer owned greenfield developments.

Instead the greater opportunities for sustainability gains will tend to be driven by modern apartment building design replacing older residential dwellings as opposed to Precinct wide initiatives. Some such sustainability improvements include:

- Building designs that maximise natural light intake, reducing electrical demand in comparison to older buildings;
- Building designs that optimise natural ventilation for thermal comfort to reduce electricity demand for heating and air-conditioning;
- Building designs that optimise façade designs and material choices for thermal comfort to reduce electricity demand for heating and air-conditioning;
- Modern tap fixtures, washing machines, toilets and other household appliances that operate more water efficiently reducing potable water demands.

However opportunities exist for Government Leadership to enforce better than industry standard practice and some of the following measures could be undertaken :

- Encourage councils to modify their Development Control Plan (DCP) to force developers to provide "green roofs" (gardens, lawn, etc spaces) on building roofs. These have several sustainability and climate change adaptation benefits including reducing stormwater runoff and reducing solar heat absorption in comparison with concrete roofs;
- Encourage councils to modify their DCP to force developers to provide rainwater tanks in new buildings for re-use of water. This is a common method for developers to achieve BASIX compliance in Sydney;
- Encourage developers to provide solar panels on the roofs of new developments. Over time however, the National Electricity Market (NEM) grid will increase its portion of renewable energy use and reduce the advantage of isolated solar panel systems.
- Precinct wide Climate Change Adaptation (CCA) and Ecologically Sustainable Development (ESD) studies could be undertaken to identify further opportunities with regard to climate resilience sustainable best practice.

Appendices

A. Existing Services Plans 59
B. Proposed Services Plans 60
C. Authority Correspondence 61

A. Existing Services Plans

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Client: Department of Planning and Environment

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	13/09/17	Ta	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest Sewer

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number: 386047-MMD-00-CI-GIS-C-0001

Security	Status	Rev
STD	PRE	P1

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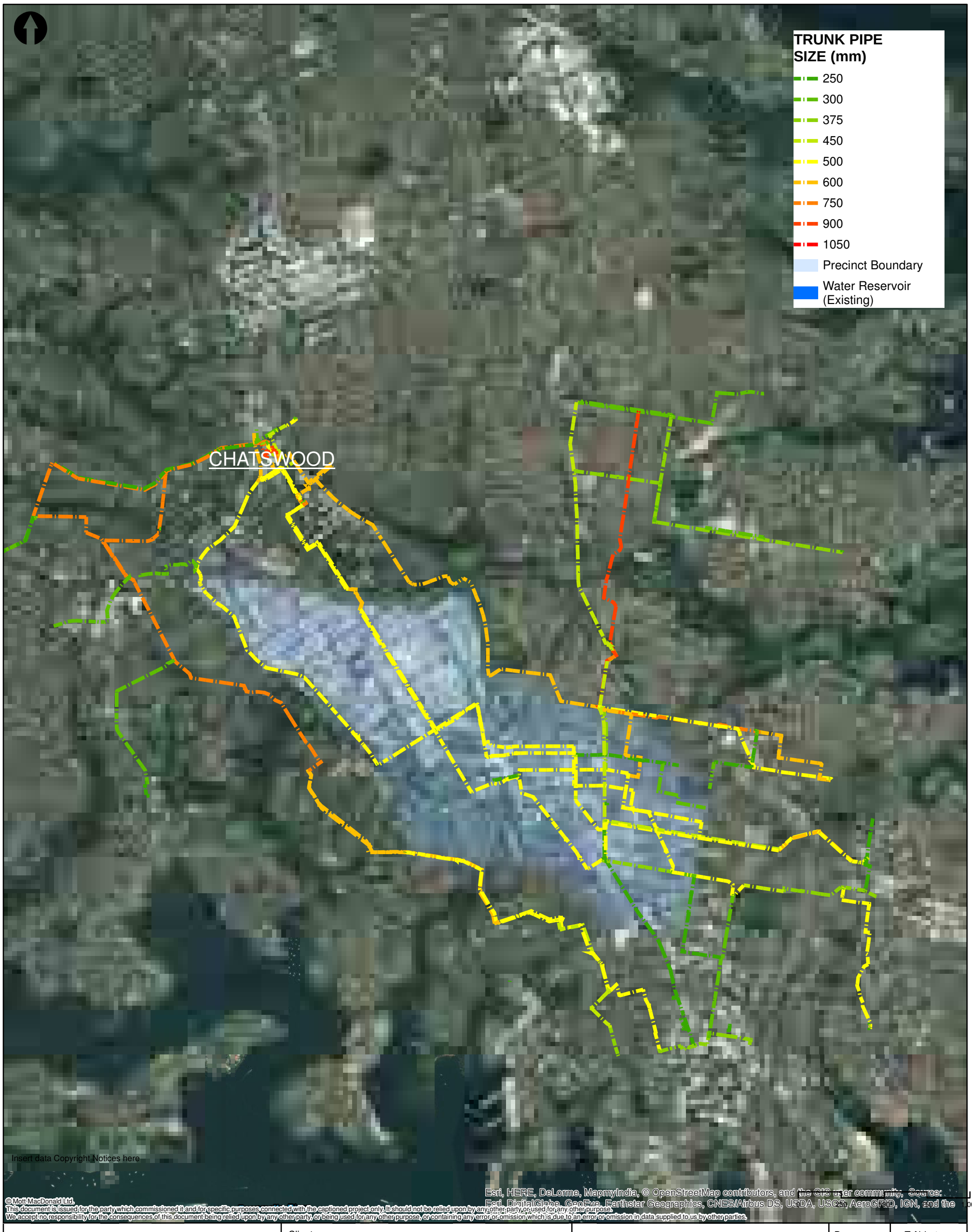

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	13/09/17	TA	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest Water

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number	Security	Status	Rev
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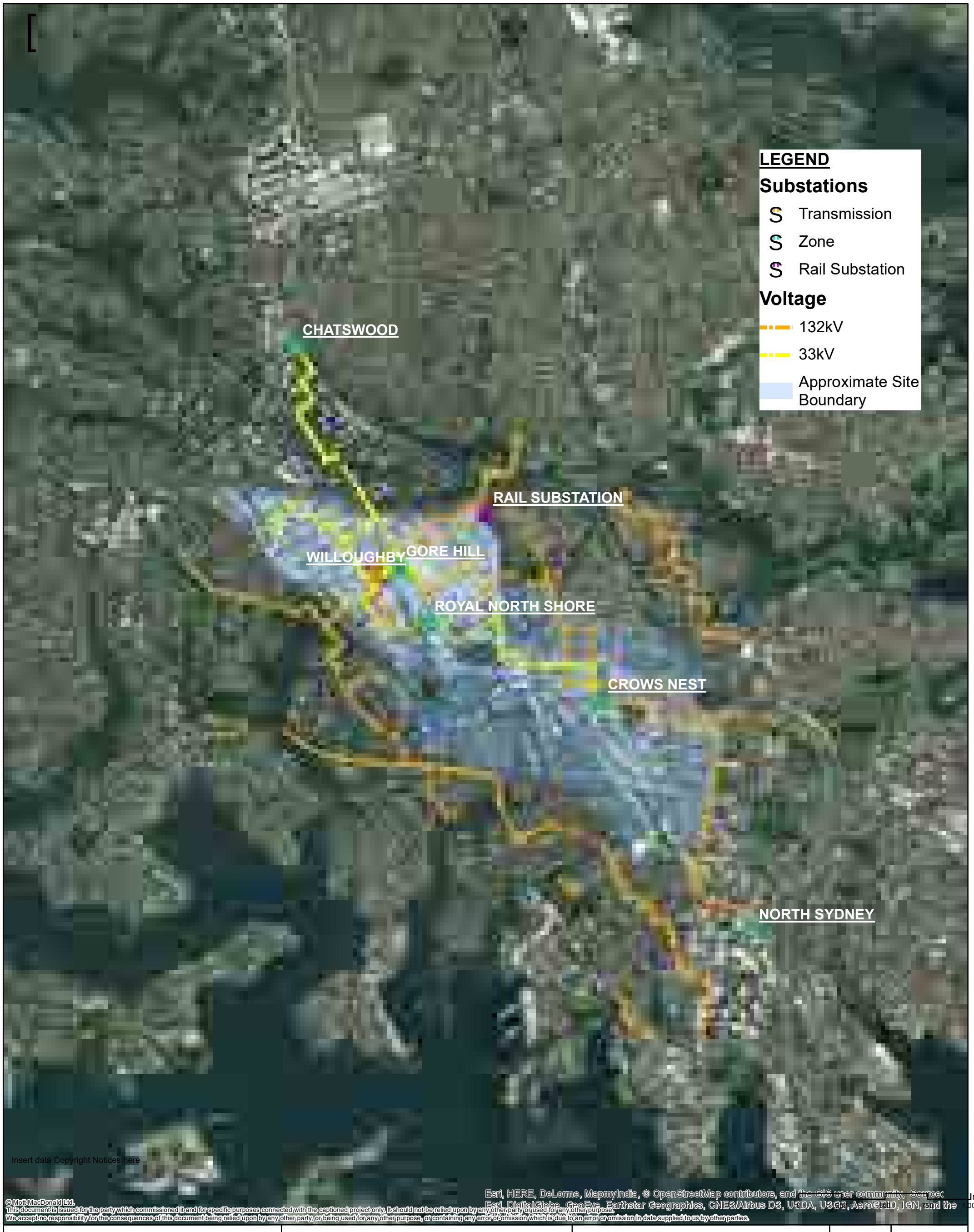

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Client: Department of Planning and Environment

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	18/05/2017	TA	For Information	GL	CA

Title: St. Leonards to Crows Nest Electricity

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number: 386047-MMD-00-CI-GIS-C-0003

Security	Status	Rev
STD	PRE	P1

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Client: Department of Planning and Environment

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	13/09/17	TA	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest Gas

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:11,068

Drawing Number	Security	Status	Rev
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LEGEND

- Sydney Trains Stations
- Sydney Trains Network
- Telstra Trenches with >10 Conduits
- No Clash with >10 trenches

Properties Intersecting

- Properties Intersecting
- Approximate Site Boundary

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	13/09/17	TA	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest
Telstra - Trenches >10 Conduits

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis

Scale at A3: 1:14,037

Drawing Number: 386047-MMD-00-CI-GIS-C-0006

Security	Status	Rev
STD	PRE	P1

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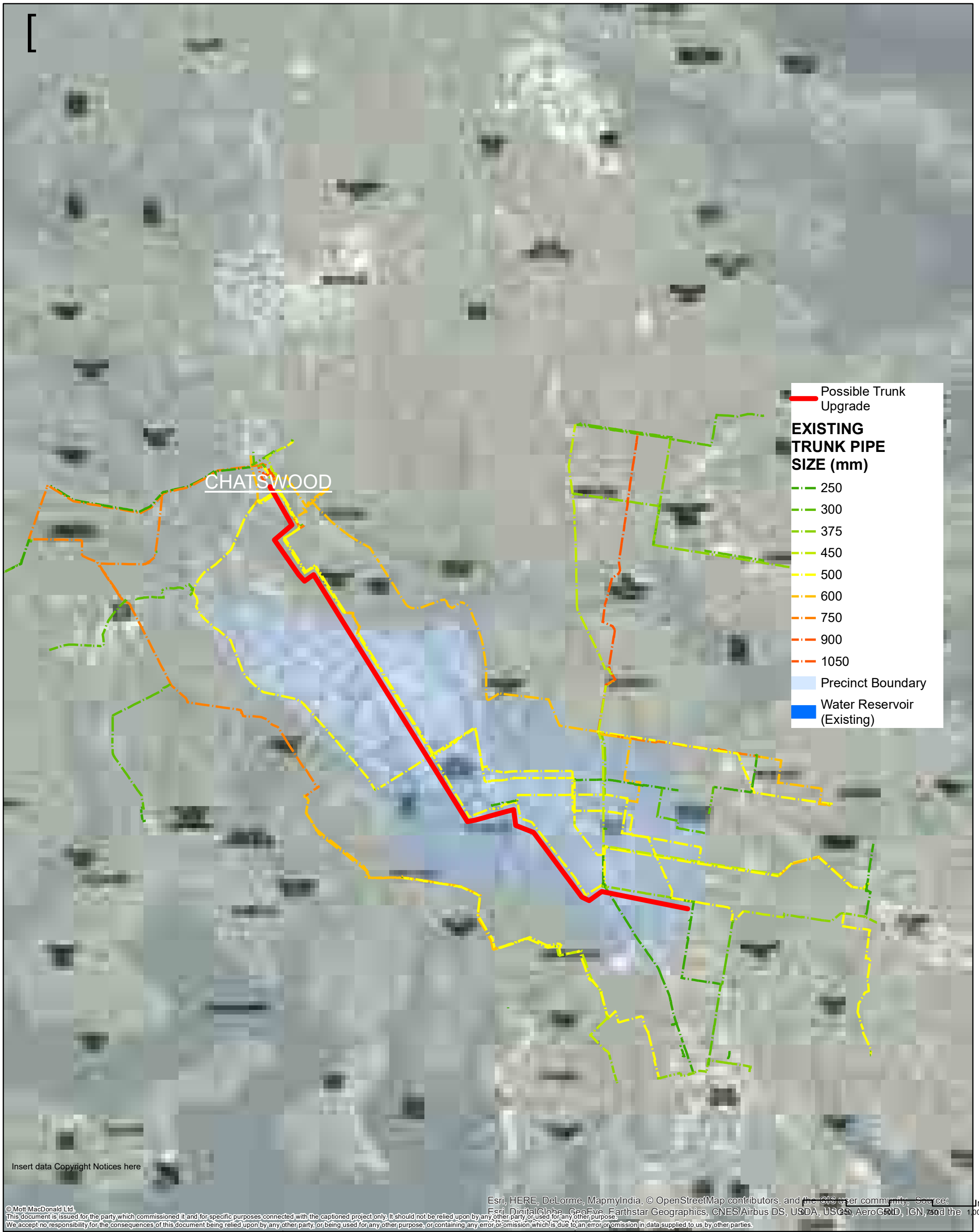
B. Proposed Services Plans



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Rev	Date	Drawn	Description	Ch'k'd	App'd
TA	25/10/17	TA	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest Possible Water Upgrades

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number	Security	Status	Rev
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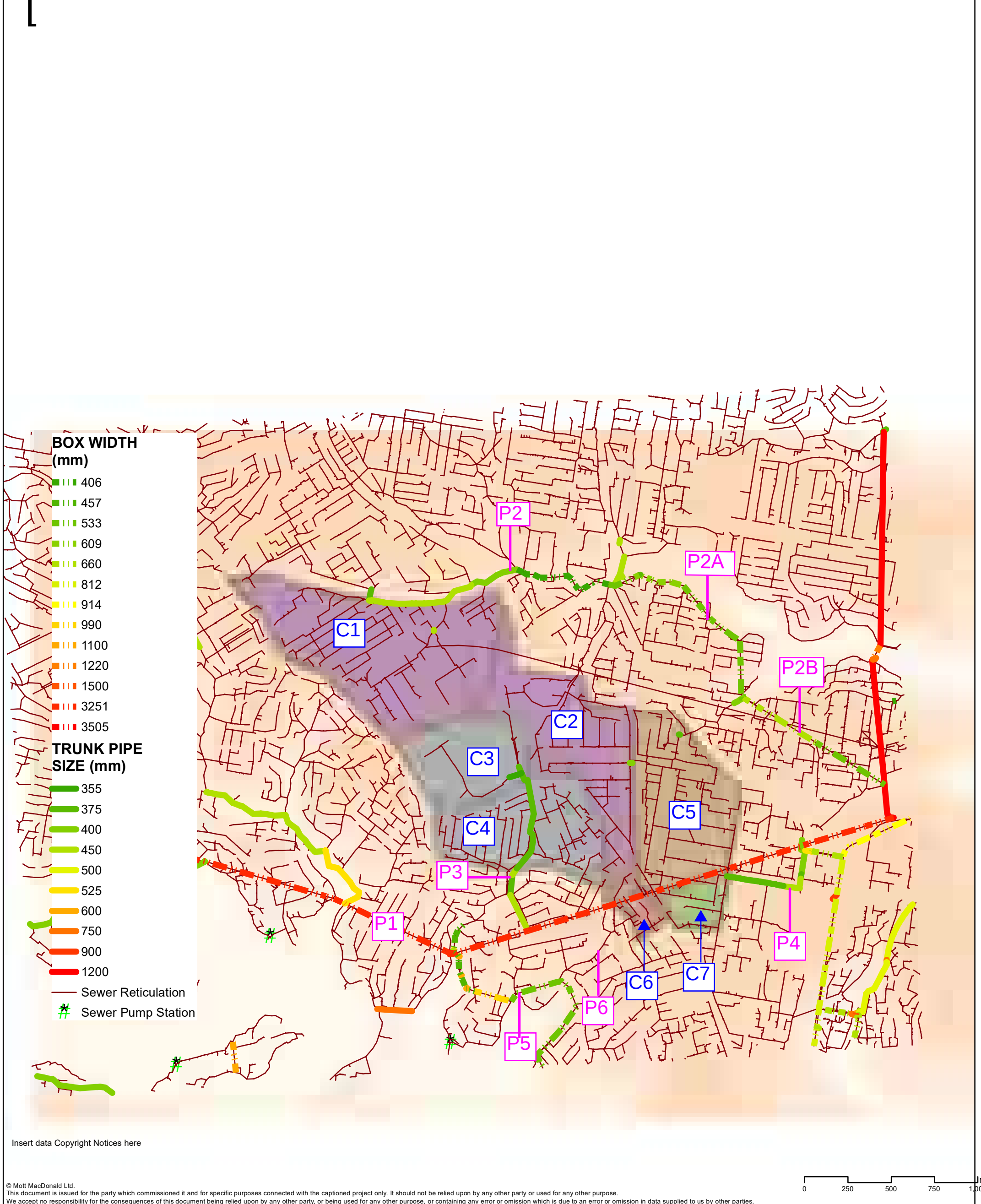

0 250 500 750 1,000 Metres

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	19/09/17	TA	FOR INFORMATION	GL	CA

Title: St. Leonards to Crows Nest Existing Sewer

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number	Security	Status	Rev
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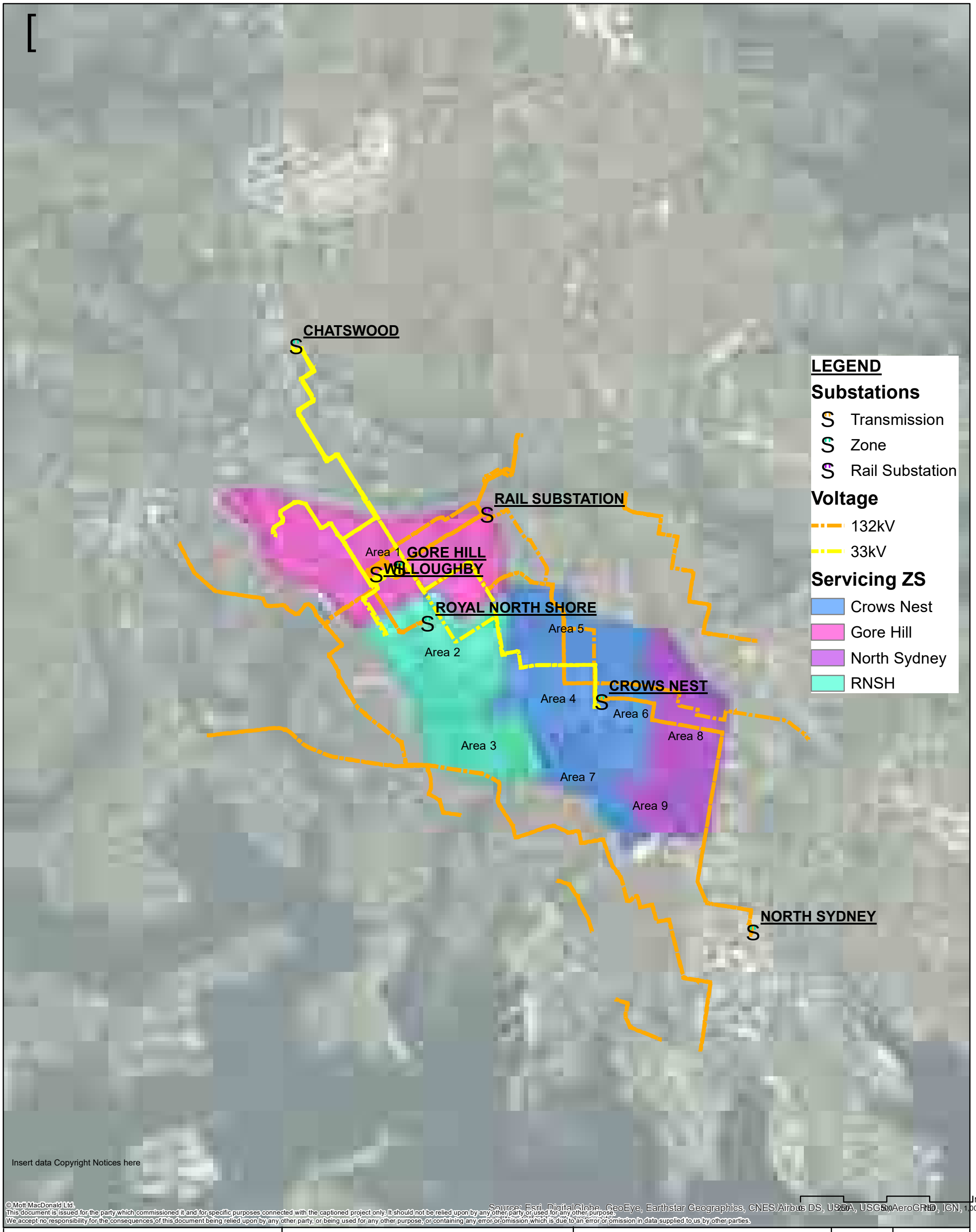

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Client: Department of Planning and Environment

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	11/07/2017	TA	For Information	GL	CA

Title: St. Leonards to Crows Nest Electricity - Ausgrid Proposed

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number	Security	Status	Rev
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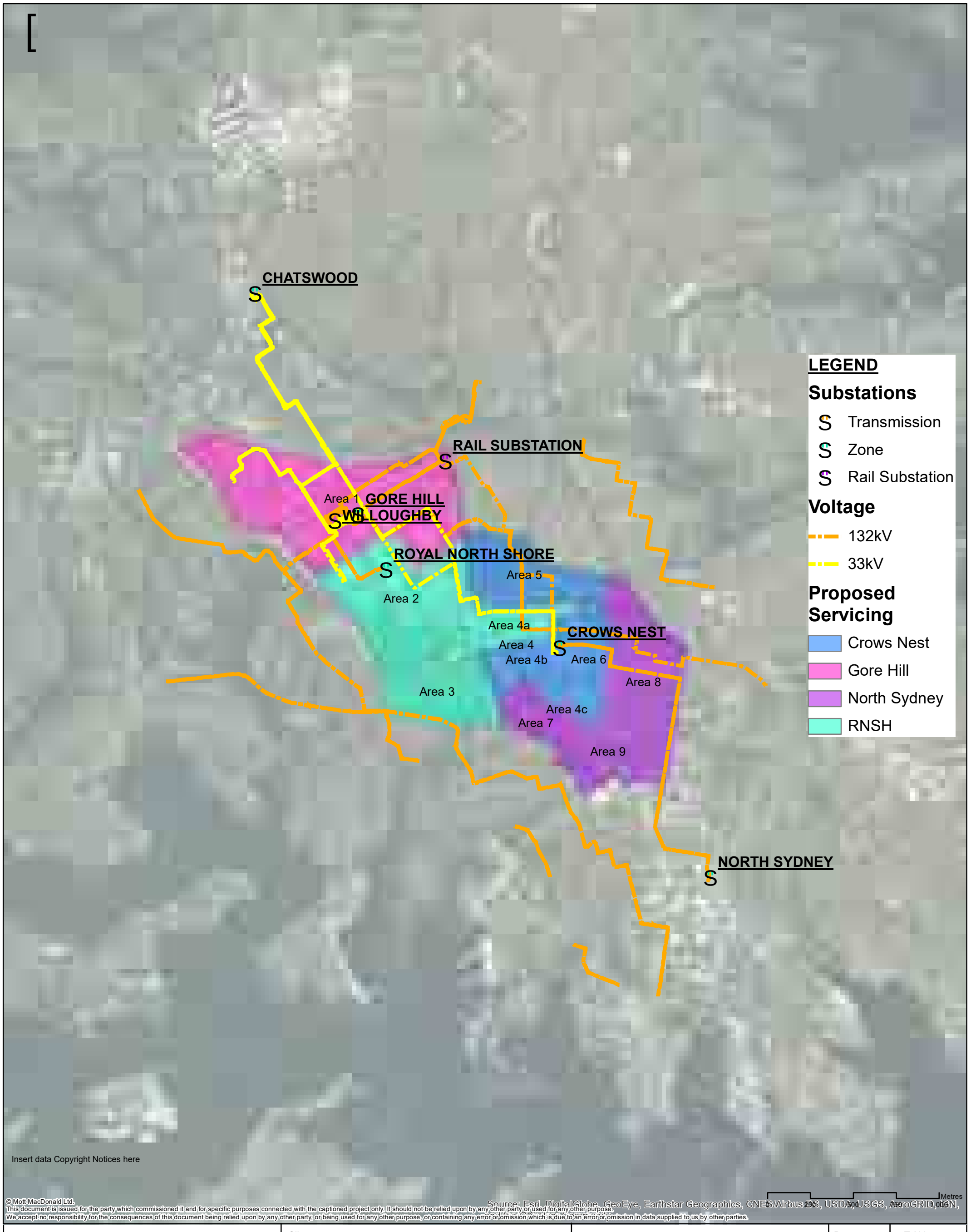

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	11/07/2017	TA	For Information	GL	CA

Title: St. Leonards to Crows Nest Electricity - Proposed High Density Strategy

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number: 386047-MMD-00-CI-GIS-C-0221

Security	Status	Rev
STD	PRE	P1

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	11/07/2017	TA	For Information	GL	CA

Title: St. Leonards to Crows Nest Electricity - Proposed High Density Feeder Upgrades

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:5,000

Drawing Number: 386047-MMD-00-CI-GIS-C-0222

Security	Status	Rev
STD	PRE	P1

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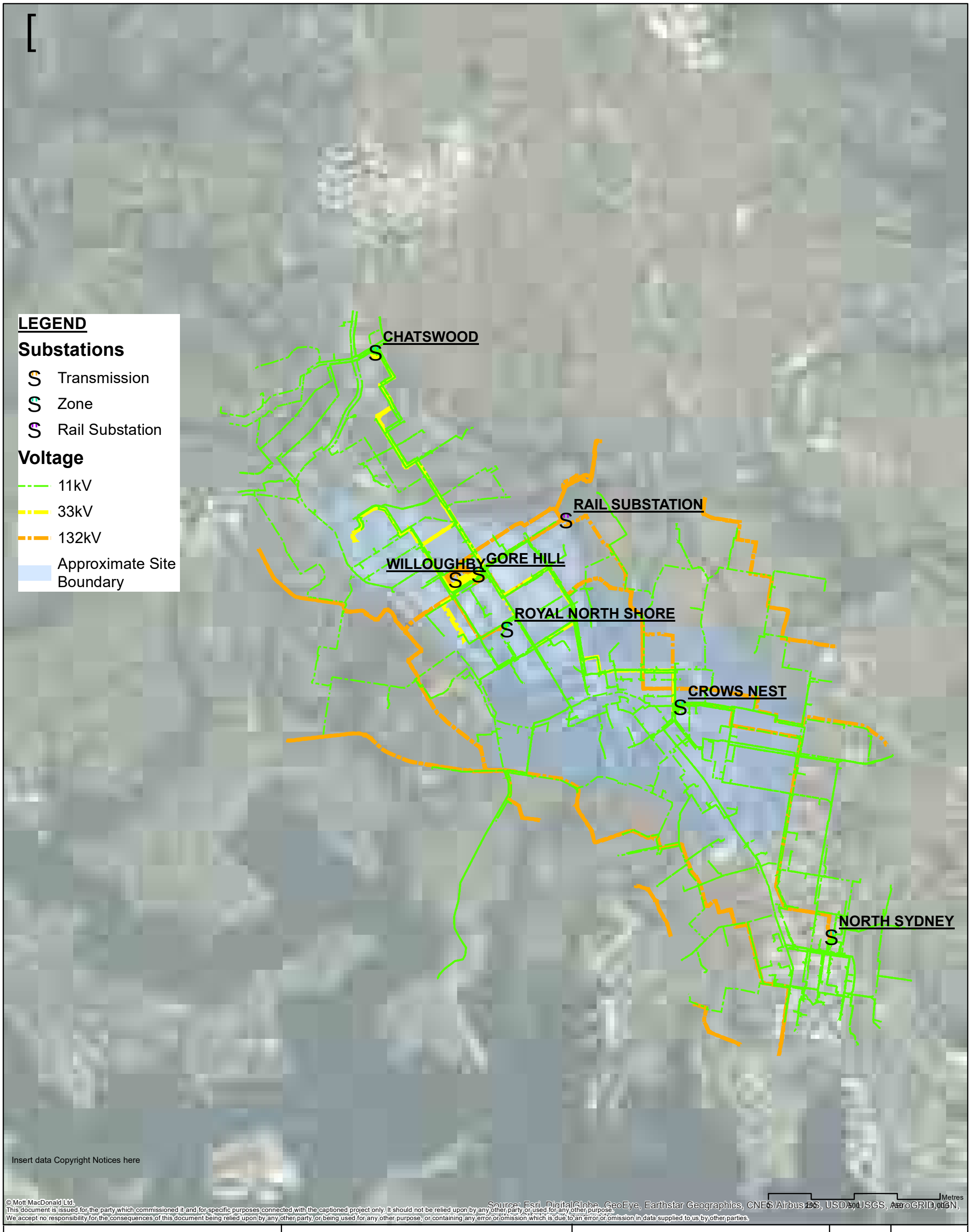

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Client: Department of Planning and Environment

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	11/10/2017	TA	For Information	GL	CA

Title: St. Leonards to Crows Nest Electricity - Existing 11kV Feeders

Drawn	T Abbot
Checked	G. Lee
Approved	C. Avis
Scale at A3	1:20,000

Drawing Number: 386047-MMD-00-CI-GIS-C-0123

Security	Status	Rev
STD	PRE	P1

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C. Authority Correspondence

Table 17 summarises the correspondence we received from the relevant authorities. Copies of this correspondence can be provided upon request.

Table 17: Summary of authority correspondence

Authority	Date Received	Case Number	Summary of Authority Advice
Sydney Water	4th September 2017 & 27th March 2018	165865	• Sydney Water confirmed the development is within the Chatswood, Killara and Pymble water supply zones; • Sydney Water are currently undertaking a planning investigation which they expect to be completed by June 2018. Thy were unable to provide any preliminary findings or provide any commentary on the unutilised capacity of any of their trunk assets.
Ausgrid	9th October 2017	700004132	• Ausgrid confirmed the area is serviced by Willoighby STS, Gore Hill ZS, RNSH ZS, Crows Nest ZS & North Sydney ZS; • See Section 3.3.2 for detailed summary of their assessment.
Jemena	6th September 2017 & 22nd August 2017	N/A	• Jemena confirmed they supply gas to the region; • See Section 3.4 for a detailed summary of their assessment.
NBN Co	4th September 2017	N/A	• NBN Co confirmed that they are the service provider for the Precinct; • Identified standard fees as $400 per unit or $600 per lot and indicated that there will be no backhaul charges applicable.
Telstra	8th August 2017	N/A	Confirmed NBN Co are the service provider for the Precinct.
Transgrid	5th May 2017	N/A	Confirmed Transgrid do not have any assets in the Precinct.