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M4-M5 Link

Environmental Impact Statement

August 2017

Appendices U to X



Volume 2J

Since finalisation of the Environmental Impact Statement, the project has been declared by Ministerial Order to be State significant infrastructure and critical State significant infrastructure under sections 115U (4) and 115V of the *Environmental Planning and Assessment Act 1979*. The Ministerial Order also amended Schedule 5 of *State Environmental Planning Policy (State and Regional Development) 2011*. The project remains subject to assessment under Part 5.1 of the *Environmental Planning and Assessment Act 1979* and requires the approval of the Minister for Planning.

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Appendices

U ..... Technical working paper: Non-Aboriginal heritage
V ..... Technical working paper: Aboriginal heritage
W ..... Detailed greenhouse gas calculations
X ..... Climate change risk assessment framework

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Appendix U

Technical working paper: Non-Aboriginal heritage

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Roads and Maritime Services

WestConnex – M4-M5 Link

Technical working paper: Non-Aboriginal heritage

August 2017

Prepared for

Roads and Maritime Services

Prepared by

GML Heritage Pty Ltd

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Glossary of terms and abbreviations

Term	Definition
AA	Archaeological assessment
AECOM	AECOM Australia Pty Ltd
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical).
CBD	Central business district
CHL	Commonwealth Heritage List
CMP	Conservation management plan
Campbell Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at St Peters
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility and provide basis for estimating and to determine further investigations needed for detailed design
Construction	Includes all physical work required to construct the project
Construction ancillary facilities	Temporary facilities during construction such as construction sites (civil and tunnel), sediment basins, temporary water treatment plants, precast yards and material stockpiles, laydown areas, parking, maintenance workshops and offices
Contributory item	Place within a Heritage Conservation Area that contributes to its heritage significance
CoS	City of Sydney
Cumulative impact	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessed on its own
Cut-and-cover	A method of tunnel construction whereby the structure is built in an open excavation and subsequently covered
Darley Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Leichhardt
DCP	Development control plan
Detailed design	The phase of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction
DP&E	NSW Department of Planning and Environment
EIS	Environmental impact statement
Enabling works	Works which are required to enable the commencement of the main construction works
EP&A Act	*Environmental Protection and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
GML	GML Heritage Pty Ltd
Haberfield civil and tunnel site/Haberfield civil site	Construction ancillary facilities for the M4-M5 Link project located at Haberfield
HAMU	Historical archaeological management units
HARD	Historical archaeological research design
HCA	Heritage Conservation Area
Heritage Act	*Heritage Act 1977* (NSW)
Heritage Council	Heritage Council of NSW
Heritage Division	NSW Heritage Division of the NSW Office of Environment and Heritage
Heritage item	Any place, building or object listed on a statutory heritage register
HIA/HIS	Heritage Impact Assessment/Heritage Impact Statement
Inner West subsurface interchange	A subsurface interchange at Leichhardt and Annandale that would link the mainline tunnels with the Rozelle interchange and the Iron Cove Link

Term	Definition
Intrusive item	Place within a Heritage Conservation Area that detracts from its heritage significance
Iron Cove Link	Around one kilometre of twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge
Iron Cove Link civil site	A construction ancillary facility for the M4-M5 Link project located at Rozelle
LEP	Local environmental plan
LGA	Local government area
LPI	NSW Land and Property Information Office
M4 East	M4 East Motorway
Mainline tunnels	The M4-M5 Link mainline tunnels connecting with the M4 East at Haberfield and the New M5 at St Peters
National Trust Register	Register of the National Trust of Australia (NSW)
Neutral item	Place within a Heritage Conservation Area that does not contribute to or detract from its heritage significance
New M5	A component of the WestConnex program of works. Located from Kingsgrove to St Peters (under construction)
NHL	National Heritage List
NLA	National Library of Australia
Northcote Street civil site	A construction ancillary facility for the M4-M5 Link project located at Haberfield
NPWS Act	*National Parks and Wildlife Act 1974* (NSW)
NSW	*New South Wales*
OEH	NSW Office of Environment and Heritage
Parramatta Road East civil site	A construction ancillary facility for the M4-M5 Link project at Haberfield
Parramatta Road ventilation facility	A ventilation facility located on the south-eastern corner of the Parramatta Road / Wattle Street intersection (referred to as the Eastern ventilation facility in the M4 East project EIS). The facility is being built as part of the M4 East project. As part of the M4-M5 Link project, fitout works would be carried out on a section of this facility
Parramatta Road West civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at Ashfield
Potential heritage item	Place identified in this report as potentially having heritage significance, which is not recognised on a heritage registe
POM	Plan of Management
Project	A new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange
Project footprint	The land required to construct and operate the project. This includes permanent operational infrastructure (including the tunnels), and land required temporarily for construction
Pyrmont Bridge Road tunnel site	A construction ancillary facility for the M4-M5 Link project at Annandale
REF	Review of Environmental Factors
Roads and Maritime	NSW Roads and Maritime Services
Rozelle civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Lilyfield and Rozelle
Rozelle interchange	A new interchange at Lilyfield and Rozelle that would connect the M4-M5 Link mainline tunnels with City West Link, Anzac Bridge, the Iron Cove Link and the proposed future Western Harbour Tunnel and Beaches Link

Term	Definition
Rozelle Rail Yards	The Rozelle Rail Yards is bound by City West Link to the south, Lilyfield Road to the north, Balmain Road to the west, and White Bay to the east. Note that the project only occupies part of the Rozelle Rail Yards site
RTA	Former NSW Roads and Traffic Authority (now NSW Roads and Maritime Services)
S170	State Agency Section 170 Heritage and Conservation Register. Section 170 of the *Heritage Act 1977* (NSW) requires NSW Government agencies to keep a register of heritage items/assets owned, occupied or managed by that government agency
SEARs	Secretary's Environmental Assessment Requirements. Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 115Y of the *Environmental Planning and Assessment Act 1979* (NSW)
SHI	NSW State Heritage Inventory database
SHR	State Heritage Register
SLNSW	State Library of NSW
SMC	Sydney Motorway Corporation
SREP	Sydney Regional Environmental Plan
SREP SHC	Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005
SREP 26	Sydney Regional Environmental Plan No. 26 – City West
SSI	State significant infrastructure
St Peters interchange	A component of the New M5 project, located at the former Alexandria Landfill site at St Peters. Approved and under construction as part of the New M5 project. Additional construction works proposed as part of the M4-M5 Link project
The Crescent civil site	A construction ancillary facility for the M4-M5 Link project located at Annandale
Ventilation facility	Facility for the mechanical removal of air from the mainline tunnels, or mechanical introduction of air into the tunnels. May comprise one or more ventilation outlets
Ventilation outlet	The location and structure from which air within a tunnel is expelled
Victoria Road civil site	A construction ancillary facility for the M4-M5 Link project located at Rozelle
Wattle Street civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located above and below ground along Wattle Street at Haberfield, between Parramatta Road and Ramsay Street
Wattle Street interchange	An interchange to connect Wattle Street (City West Link) with the M4 East and the M4-M5 Link tunnels. Approved and under construction as part of the M4 East project. Additional construction works proposed as part of the M4-M5 Link project
WestConnex program of works	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, New M5 and M4-M5 Link projects

Executive summary

Background

GML Heritage Pty Ltd (GML) has been commissioned by NSW Roads and Maritime Services (Roads and Maritime) to prepare a non-Aboriginal heritage impact assessment (HIA) for the M4-M5 Link project (the project). This non-Aboriginal HIA has been prepared to inform the environmental impact statement (EIS) for the project.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. Revised Secretary's Environmental Assessment Requirements (SEARs) for the EIS were issued by the NSW Department of Planning and Environment (DP&E) on 3 May 2017. This HIA addresses the SEARs specific to non-Aboriginal heritage, including historical archaeology, as well as relevant agency comments received during the preparation of the SEARs.

Summary of findings

The report makes the following findings in relation to impacts of the project on the built and landscape heritage:

The project directly affects five listed heritage items across the study areas, which are:

- Demolition of three statutory heritage items of local heritage significance, being:
  - Stormwater canal at Rozelle
  - 'Cadden Le Messurier' at Rozelle
  - Former hotel at Rozelle
- Partial demolition of one statutory heritage item of local heritage significance, being the Whites Creek Stormwater Channel No. 95
- The project temporarily encroaches into the south western boundary of the curtilage of the White Bay Power Station which is a State Heritage Register (SHR) listed item. The minor encroachment occurs during the construction phase of the project as a result of the alignment of the temporary Victoria Road bridge. However, the works would be some distance from the Power Station building itself and the building would not be physically impacted by the project.

Twenty-one other statutory heritage items of State or local heritage significance and heritage conservation areas (HCAs) would be subject to indirect impacts through potential vibration, settlement and visual setting. The project also directly affects nine individual buildings/structures assessed as being potential local heritage items which would be fully demolished. One landscape feature assessed as being a potential local heritage item would be partially demolished, being the sandstone cutting at Rozelle Rail Yards.

One structure assessed as being a potential heritage item of State significance would be indirectly impacted through vibration which is the southern penstock associated with the White Bay Power Station. Six other individual buildings/structures assessed as being potential local heritage items would be subject to indirect impacts through potential vibration, settlement and visual setting.

Project context

The project is located within the Inner West (amalgamation of former Ashfield, Leichhardt and Marrickville local government areas (LGAs)) and City of Sydney LGAs. The HIA is structured around the following six areas that would be subject to surface impacts along the project corridor:

- Area 1 – Haberfield/Ashfield (Option A around Wattle Street and Option B around Alt Street and Bland Street)
- Area 2 – Leichhardt

- Area 3 – Rozelle and Lilyfield (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road, excluding Iron Cove which comprises Area 4)
- Area 4 – Iron Cove (around Victoria Road)
- Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)
- Area 6 – St Peters.

The built heritage and landscape assessment has focused on a broader study area applied to each of these six areas, comprising an appropriate buffer surrounding the project footprint (the heritage study area). This is to ensure indirect impacts are appropriately assessed (ie visual impacts). This assessment has also included consideration of potential vibration and settlement impacts on heritage items and HCAs above underground works (ie mainline tunnel alignment).

The archaeological assessment has focused on the six areas outlined above to identify where key archaeological resources may exist and may be impacted by the project, including by tunnel entry and exit portals and associated infrastructure. As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further.

Built heritage and landscape

This HIA report makes findings regarding impacts of the project on built and landscape heritage within the study area. The following summaries include for each area:

- A description of the proposed works within the area
- An overview of identified heritage items including HCAs
- An overview of any potential heritage items identified
- A summary of the heritage impacts (direct or indirect) that arise from the project.

Area 1 – Haberfield/Ashfield (Option A around Wattle Street and Option B around Alt Street and Bland Street)

As identified in the WestConnex M4 East Non-Aboriginal Heritage Impact Assessment (GML 2015), Haberfield contains a high number of heritage items and an HCA listed on the Ashfield Local Environmental Plan 2013 (Ashfield LEP). Almost the entire suburb of Haberfield, from Dobroyd Canal (Iron Cove Creek) to Hawthorne Canal and northwest to Iron Cove, but excluding properties along Parramatta Road, is listed as a HCA of local significance on the Ashfield LEP and potential State significance.

Impacts associated with the demolition of heritage and contributory items within the Haberfield HCA, and construction of new motorway infrastructure (including the Parramatta Road ventilation facility) at Haberfield have already been assessed in the M4 East Non-Aboriginal Heritage Impact Assessment (GML 2015) for the M4 East project.

Within Area 1 – Haberfield/Ashfield, the M4-M5 Link project works are limited to connecting to the underground M4 East mainline tunnels, fitout of the dive structures and cut and cover tunnels at the Wattle Street interchange; and fitout of the Parramatta Road ventilation facility, which are all being constructed as part of the M4 East project, and some minor amendments to the surface road network.

The concept design considers two possible combinations for construction ancillary facilities around Haberfield and Ashfield. These are described and assessed in this EIS as Option A and Option B. The construction ancillary facilities that comprise these options have been grouped together and are denoted by the suffix *a* (for Option A) or *b* (for Option B) eg Wattle Street civil and tunnel site (C1a).

Option A at Haberfield for the M4-M5 Link project would use the Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a) and Northcote Street civil site (C3a), currently being used by the M4 East project for construction of that project.

There are no additional property acquisitions or demolition of buildings in Haberfield as a result of Option A, nor were any new heritage assessments undertaken to identify potential items, as all items were previously identified and assessed as part of the M4 East project. The indirect and cumulative

impact on the Haberfield HCA from Option A of the M4-M5 Link project would primarily result from the extension of time associated with using the existing M4 East construction ancillary facilities for the M4-M5 Link project.

Option B at Haberfield/Ashfield for the M4-M5 Link project would require new construction ancillary facilities on the east and west sides of Parramatta Road, around the intersections of Alt Street and Bland Street. These would comprise the Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b) in addition to the Haberfield civil site (C2b) which is subject to the assessment undertaken in the M4 East project as explained above. The Parramatta Road sites are outside of the Haberfield HCA and were not specifically assessed as part of the M4 East project.

Construction work associated with the M4-M5 Link project at these sites would involve the demolition of existing commercial premises. Owing to the location, scale, type and temporary nature of construction activity at these new construction sites, no new statutory heritage items or conservation areas were identified as needing further impact assessment (additional to the assessment undertaken for the M4 East project and as part of Option A). However, additional heritage assessments were undertaken to identify potential heritage items within and in the vicinity of these new construction ancillary facilities (C1b and C3b).

The indirect and cumulative impact on the Haberfield HCA from Option B of the M4-M5 Link project would result from the expansion of the construction areas further east along Parramatta Road. This option would allow most of the M4 East construction ancillary facilities (aside from C2a/b) to be rehabilitated and delivery of the M4 East Urban Design Landscape Plan and Residual Land Management Plan to be delivered earlier.

There are also a number of potential heritage items of local significance which would be subject to indirect impacts through potential vibration, settlement and visual setting. The assessment identifies a neutral impact on these potential heritage items.

Area 2 – Leichhardt

Within Area 2 – Leichhardt, the project would use a site at Darley Road as a civil and tunnel site (C4). This site is adjacent to the Leichhardt (Charles Street) Underbridge which is a heritage item listed under RailCorp's State Agency Section 170 Heritage and Conservation Register (S170 Register) under the *Heritage Act 1977*. The bridge would be subject to minor and temporary indirect (setting and vibration) impacts as a result of the adjacent site being demolished and used for tunnelling.

No buildings within the study area were identified as potential heritage items therefore no heritage assessments were required.

Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road)

Within Area 3 – Rozelle and Lilyfield, the project would comprise the establishment of the Rozelle civil and tunnel site, The Crescent civil site, Victoria Road civil site and the construction of the Rozelle interchange, and local street upgrades/works. Heritage items in the Rozelle, Lilyfield and Annandale study area are listed under the Leichhardt LEP, the Sydney Regional Environmental Plan No. 26 – City West (SREP 26), State heritage register and S170 registers.

The Rozelle interchange would be constructed within and around the Rozelle Rail Yards with underground connections from the Rozelle interchange north to the Iron Cove Link and the proposed future Western Harbour Tunnel and Beaches Link, east to Victoria Road and Anzac Bridge, south to the connecting tunnels towards Haberfield/Ashfield and surface connections which link to City West Link and Johnston Street in Annandale. Some tunnel portals and dive structures would be visible from within the Rozelle Rail Yards, as well as a ventilation facility and outlets, and other associated motorway infrastructure. The project includes the construction of connections into the proposed future Western Harbour Tunnel and Beaches Link project, which is subject to separate planning, assessment and approval.

The project also includes modifications to The Crescent and City West Link (including widening, re-alignment and creation of a new left turn lane onto the City West Link) which would necessitate the encroachment into Buruwan Park, removal of existing vegetation and a new/extended bridge over the Whites Creek Stormwater Channel No. 95, and the reshaping of the land immediately to the south of

Whites Creek to increase capacity of the channel and mitigate flood impacts. The project also includes modifications to The Crescent and Johnston Street (for the creation of an additional right turn lane onto Johnston Street) which would necessitate the widening of Johnson Street, realignment of footpath, kerb/guttering, drainage and utilities, and relocation of traffic lights and signage, closer to the piers of the Annandale (Johnston Street) underbridge.

Within the Rozelle and Lilyfield area, the project would result in the full or partial demolition of four statutory heritage items for the construction of the Rozelle interchange and associated works. Direct physical impacts would result from new motorway infrastructure, including ventilation and motorway facilities and the loss or reduction of significant streetscapes. Temporary visual impacts would also result from the establishment of the construction ancillary facilities (Rozelle civil and tunnel site (C5), The Crescent civil site (C6) and Victoria Road civil site (C7).

The project temporarily encroaches into the south western boundary of the curtilage of the White Bay Power Station which is a State Heritage Register (SHR) listed item. The minor encroachment occurs during the construction phase of the project as a result of the alignment of the temporary Victoria Road bridge. However, the works would be some distance from the Power Station building itself and the building would not be physically impacted by the project.

There are also a number of potential heritage items of local significance which would be subject to direct (full or partial demolition) or indirect impacts (potential vibration).

Rozelle Rail Yards site management works

Roads and Maritime has undertaken an assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for a suite of site management works on part of the Rozelle Rail Yards. These works would remove rail and rail related infrastructure from the site and allow existing issues at the site such as waste and noxious weeds to be appropriately managed. Key features of the works relevant to this HIA include removal of existing above ground rail infrastructure including gantries, railway lines, ballast, sleeps and buildings (excluding the southern penstock, switching station, transformer and rail infrastructure to the east of the Victoria Road bridge) generally to a depth of 500 millimetres below ground level, except where drainage channels and sediment basins are required. The site management works were assessed in a review of environmental factors (REF) which was approved by Roads and Maritime under Part 5 of the EP&A Act on 10 April 2017.

As part of the REF, a HIA was prepared for the site management works (Rozelle Rail Yards Heritage Impact Assessment (GML 2016), which noted:

The assessment concluded that the most notable impact is to the role that the rail yards has within a broader network of Sydney industrial and freight sites, known as the 'goods lines'. Although successively fragmented, the network still offers a contribution to the local historic landscape, industrial and maritime history and working class character of the area. With regard to heritage impacts on individual items the proposal has been found to have neutral/no impact in the majority of cases. What little impact has been identified is able to be mitigated through a few simple measures.

No listed heritage items are being demolished as part of the site management works. However, the REF HIA identified a number of items of potential local heritage significance in and around the Rozelle Rail Yards site. Some of these items are being demolished as part of the site management works, being a lighting tower and Port Authority building. Mitigation measures including archival recordings of these items and salvage and storage of the lighting tower and rail gantries for potential reuse in future development of the Rozelle Rail Yards were recommended in the REF. These works have commenced. The works do not form part of the M4-M5 Link project and are therefore not assessed as part of this HIA.

Additional items of potential local heritage significance, including the Victoria Road bridge and sandstone cuttings on the northern side of the Rozelle Rail Yards were also identified in the REF HIA and are not directly impacted during the site management works. However, the M4-M5 Link project proposes to demolish the Victoria Road bridge and parts of the sandstone cuttings. This is discussed in **section 6.7.5** of this report.

Area 4 – Iron Cove (around Victoria Road)

Within Area 4 – Iron Cove, the M4-M5 Link project would comprise construction of a connection between the new Rozelle interchange and Victoria Road at the eastern abutment of Iron Cove Bridge (the Iron Cove Link). This necessitates the realignment, widening and resurfacing of Victoria Road. A bioretention facility and car park improvement works are also proposed within King George Park at Rozelle (adjacent to Manning Street).

In this location, construction of the project would result in the demolition of six potential heritage items. No listed heritage items are proposed to be demolished, however two listed heritage items would be indirectly impacted (setting, vibration) from construction activities.

There are also a number of potential heritage items of local significance which would be subject to direct (full demolition) or indirect impacts (potential vibration, setting).

Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)

Within Area 5 – Annandale, the M4-M5 Link project comprises the Pyrmont Bridge Road tunnel site (C9) and associated tunnelling for the Inner West subsurface interchange. In this location, the project would result in the demolition of a potential heritage item (former Bank of NSW). No listed heritage items are proposed to be demolished, however four listed heritage items will be indirectly impacted (setting, vibration) from construction activities.

Area 6 – St Peters

As identified in the New M5 Non-Aboriginal Heritage Impact Assessment (AECOM 2015), St Peters contains a number of heritage items listed on the Sydney Local Environmental Plan 2012 (Sydney LEP) and Marrickville Local Environmental Plan 2011 (Marrickville LEP). Impacts associated with the demolition of heritage and contributory items, resulting from construction of new motorway infrastructure have already been assessed in the New M5 Non-Aboriginal Heritage Impact Assessment (AECOM 2015).

Within Area 6 – St Peters, the project links the St Peters interchange to the M4-M5 Link mainline tunnel entries, and construction of aboveground links to Euston Road, Gardeners Road, Sydney Airport and Port Botany. The project footprint for M4-M5 Link coincides directly with that of the New M5 project.

There would be negligible additional heritage impacts as the result of the construction of a new ventilation facility and construction works at the St Peters interchange. No buildings within Area 6 were identified as potential heritage items therefore no heritage assessments were required.

Ground movement

Heritage items, potential heritage items and HCAs along the tunnel alignment and in the vicinity of construction works may be subject to ground movement (predominantly settlement and vibration caused by the works) during construction. Areas most likely to be affected by settlement are usually where tunnelling is closest to the ground surface (shallowest), around the tunnel portals and on and off-ramps. Settlement impacts vary based on the type of construction activity, ground conditions and the condition of property.

The alignment of the tunnels and the locations of tunnel portals have given regard to maximising the use of the best possible geotechnical conditions. As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further.

Potential vibration impacts to heritage items have been assessed, with 11 listed heritage items located within safe working distances of the project that may experience vibration impacts. These items would be managed in accordance with the recommendations of the noise and vibration assessment undertaken for the project (**Appendix J** (Technical working paper: Noise and vibration) of the EIS). Appropriate monitoring and protection of the physical fabric of heritage items to be retained would be undertaken during construction of the project.

Ground movement caused by groundwater drawdown and tunnel-induced movement could also have impacts on heritage items. The groundwater impact assessment undertaken for the project (refer to

Appendix T (Technical working paper: Groundwater) of the EIS determined that small scale dewatering of the alluvium and Hawkesbury Sandstone may be required during construction. This could result in an increase in effective stress, leading to ground settlement. Movement in clay soils between hydrogeological units would cause settlement, which may continue over a long period of time.

Although the groundwater assessment has predicted groundwater drawdown within the alluvium and Botany Sands, it is not considered appropriate to use these regional results to calculate localised ground settlement. The model is a regional groundwater model and is not considered appropriate for use in estimating groundwater induced settlement at a more localised level. A geotechnical model of representative geological and groundwater conditions would be prepared by the construction contractor prior to excavation and tunnelling for the project.

Potential ground movement impacts should be managed in accordance with the relevant mitigation measures for vibration impacts detailed in the EIS, such as undertaking condition surveys prior to construction works commencing and settlement monitoring.

Historical archaeology

This HIA has assessed historical archaeology across the project footprint, allocating Historic Archaeology Management Units (HAMU) to each heritage area according to historical phases, archaeological potential, past construction activities, proposed impacts and management requirements. There are 11 HAMUs located across four of the heritage study areas – one in Area 1 (Haberfield/Ashfield), one in in Area 2 (Leichhardt), five in Area 3 (Rozelle), two in Area 4 (Iron Cove) and two in Area 5 (Annandale). The archaeological potential and significance of the study area at Haberfield/Ashfield (within Area 1) and St Peters (within Area 6) have been previously assessed under the M4 East project and New M5 project, respectively, and have therefore not been considered further in this HIA.

The significance of HAMUs which retain archaeological potential are rated as being of local significance only, with the exception of the White Bay Power Station, where the archaeology is of state significance as a contributory element. The identified level of significance for areas of archaeological potential will influence the degree of impact that may be acceptable or the level of investigation and recording that may be required. Consequently, the management guidelines and recommendations have been formulated in accordance with the heritage significance of the potential archaeological resources.

Two HAMUs in Rozelle (HAMU 3 and HAMU 6), one in Iron Cove (HAMU 9) and two in Annandale (HAMU 10 and 11) with locally significant remains will be impacted by the project. The project is likely to have minor to major adverse impacts on the potential historical archaeological resource, dependent upon the nature and integrity of the archaeological remains, and the location and nature of the proposed works in each area.

Based on the detailed design and construction planning, a Historical Archaeological Research Design (HARD) will be prepared before the start of proposed works within identified HAMUs where potential for locally or State significant archaeology has been identified. The HARD would define the methodology and scope for any archaeological investigation required, and be prepared in consultation with NSW Heritage Council.

For this project, archaeological test excavation is considered unlikely to alter the outcome of the assessment in terms of identifying previously unknown and unassessed archaeological relics, and is not recommended at this stage.

Cumulative heritage impacts

The design intent of M4-M5 Link was to place as much infrastructure below ground to avoid and minimise impacts across the project. However, the project would contribute to the overall heritage impacts from the preceding components of WestConnex including the M4 Widening and King Georges Road Interchange Upgrade (both completed construction and open to traffic) and the M4 East and New M5 (both under construction). These projects have collectively resulted in widespread change to the urban fabric of greater metropolitan Sydney, including to items and areas of heritage significance.

Table E-1-1 Overall heritage impacts of WestConnex projects

WestConnex project	Overall heritage impact ranking
New M5	Moderate adverse
King Georges Road Interchange Upgrade	Nil
M4 Widening	Nil
M4 East	Major adverse
M4-M5 Link	Moderate adverse

The overall cumulative impacts of the WestConnex program of works to date on heritage items can be described as major and irreversible given the scale of the construction project. It has had a substantial impact by severing and eroding the legibility of a large part of the Haberfield HCA (which was identified as being of potential State significance); it has removed evidence of subdivision layouts, modest Federation domestic architecture and estate landscaping (gardens, fences and tree lined streets). Elsewhere, the demolition of locally significant heritage items (including the Rudders Bond Store) incrementally diminishes the early and mid-twentieth century industrial building stock from the southern and inner west suburbs of Sydney. However, it should also be recognised that the cumulative impact to heritage has been dramatically reduced by tunnelling and through the site selection process for construction areas.

Further impacts to heritage from the M4-M5 Link project have also been avoided through:

- Design and refinement of the Rozelle interchange
- Avoiding heritage items such as Easton Park, the Sewage Pumping Station No.6, the former State Rail Authority (SRA) cable store and traffic office at Leichhardt
- Retaining important elements of the White Bay Power Station site
- Avoiding impacts to heritage items and HCAs at Camperdown.

The site management works and M4–M5 Link works in the Rozelle Rail Yards would permanently remove evidence of a significant period of rail infrastructure within a broader network of Sydney industrial and freight sites, known as the goods lines, as well as the distinct industrial landscape. However, the M4-M5 Link project will reuse and incorporate heritage elements from some of the items removed during the site management works in the urban design and landscape plan for Rozelle, acknowledging heritage themes and interpretation of impacted sites.

Management of impacts

The detailed design and construction of the project would be managed to ensure, as far as possible, that the identified potential heritage and archaeological impacts are minimised and/or avoided by implementation of a range of general and specific measures. **Chapter 8** of this HIA proposes a range of mitigation measures to avoid, reduce and manage identified potential impacts to non-Aboriginal heritage. These measures would be further developed on a case by case basis during detailed design. The final management measures would be documented in the Construction Heritage Management Plan.

The mitigation measures would include, but is not limited to:

- Preparation of a Construction Heritage Management Plan which would include a HARD
- Preparation and implementation of an interpretation plan
- Undertaking of photographic archival recordings
- Salvaging of historic fabric and features from properties to be demolished
- Managing of potential vibration and settlement impacts
- Implementation of an unexpected finds procedure.

Chapter 8 of the HIA also proposes a range of mitigation measures to avoid and/or minimise impacts on specific heritage items including White Bay Power Station, Hornsey Street HCA and the Whites Creek Stormwater Channel No. 95. The detailed design and construction of the project would need to be managed to ensure that, as far as possible, the identified potential heritage and archaeological impacts are minimised and/or avoided.

1 Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Together with the other components of the WestConnex program of works and the proposed future Sydney Gateway, the project would facilitate improved connections between western Sydney, Sydney Airport and Port Botany and south and south-western Sydney, as well as better connectivity between the important economic centres along Sydney's Global Economic Corridor and local communities.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

1.1 Overview of WestConnex and related projects

The M4-M5 Link is part of the WestConnex program of works. Separate planning applications and assessments have been completed for each of the approved WestConnex projects. Roads and Maritime has commissioned Sydney Motorway Corporation (SMC) to deliver WestConnex, on behalf of the NSW Government. However, Roads and Maritime is the proponent for the project.

In addition to linking to other WestConnex projects, the M4-M5 Link would provide connections to the proposed future Western Harbour Tunnel and Beaches Link, the Sydney Gateway (via the St Peters interchange) and the F6 Extension (via the New M5).

The WestConnex program of works, as well as related projects, are shown in **Figure 1-1** and described in **Table 1-1**.

Table 1-1 WestConnex and related projects

Project	Description	Status
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the EP&A Act granted on 21 December 2014. Open to traffic.
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
King Georges Road Interchange Upgrade	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.

Project	Description	Status
New M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.
M4-M5 Link (the project)	Tunnels connecting to the M4 East at Haberfield (via the Wattle Street interchange) and the New M5 at St Peters (via the St Peters interchange), a new interchange at Rozelle and a link to Victoria Road (the Iron Cove Link). The Rozelle interchange also includes ramps and tunnels for connections to the proposed future Western Harbour Tunnel and Beaches Link project.	The subject of this EIS.
Related projects		
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
Western Harbour Tunnel and Beaches Link	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
F6 Extension	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.

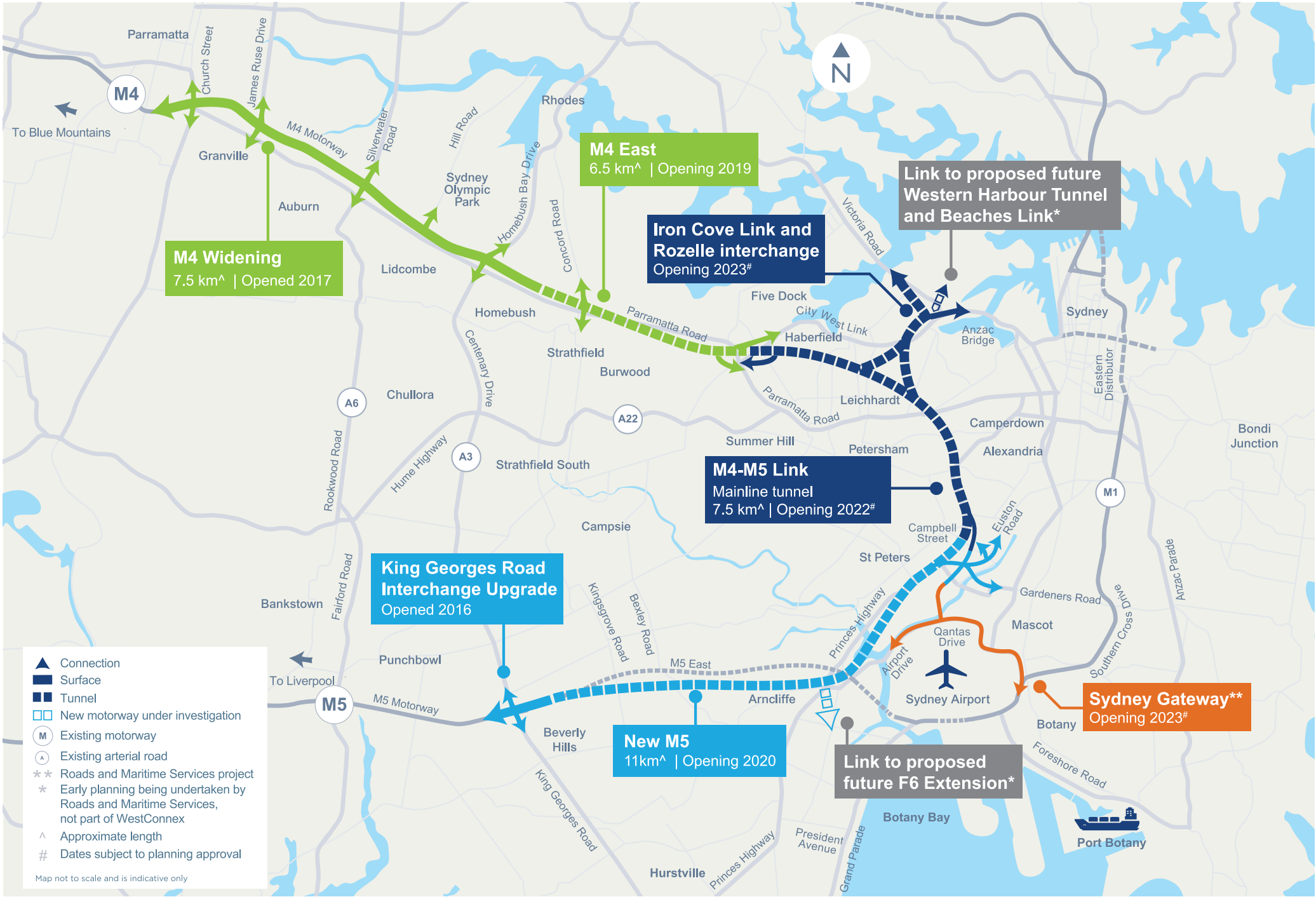


Figure 1-1 Overview of WestConnex and related projects

1.2 Purpose of this report

The NSW Department of Planning and Environment (DP&E) has issued revised Secretary's Environmental Assessment Requirements (SEARs) for the project on 3 May 2017 that inform the EIS. The purpose of this non-Aboriginal heritage impact assessment (HIA) report is to assess the non-Aboriginal heritage impacts of the M4-M5 Link project in response to the revised SEARs.

In particular, the report addresses the heritage impacts of the project on listed heritage items, potential heritage items, and areas of State and local heritage significance and outlines the proposed mitigation and management measures, including an evaluation of the effectiveness of the mitigation measures. There are no heritage items listed on the National or World heritage items in the immediate vicinity of the project footprint. In addition, this report provides an overview of the historical archaeological potential in areas where ground disturbance is proposed and establishes a set of mitigation measures for the management of any impacts on potential or known significant archaeological resources.

1.3 SEARs and Agency comments

Table 1-2 displays the SEARs that are specific to heritage, and also provides a cross reference to the relevant section(s) of this report that address these requirements. Agency comments that are specific to heritage are referenced in **Table 1-3**.

Table 1-2 Relevant SEARs addressed in this report

SEARs (issued 3 May 2017)		
14. Heritage		
Key Issue and Desired Performance Outcome		
The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.		
Requirement	**Section where Addressed in EIS**	**Current Guidelines**
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of listed heritage items inclusive of: (a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	Refer to **Chapter 21** (Aboriginal heritage) and **Appendix V** (Technical working paper: Aboriginal heritage) of the EIS.	*Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (NSW Office of Environment and Heritage (OEH) 2011) *Aboriginal Cultural Heritage Consultation requirements for proponents* (Department of Environment Climate Change and Water (DECCW) 2010) *Code of practice for archaeological investigation of Aboriginal objects in NSW* (DECCW 2010) *NSW Skeletal Remains: Guidelines for*
(b) Aboriginal places of heritage significance, as defined in the Standard Instrument–Principal Local Environmental Plan;	Refer to **Chapter 21** (Aboriginal heritage) and **Appendix V** (Technical working paper: Aboriginal heritage) of the EIS.	
(c) environmental heritage, as defined under the *Heritage Act 1977* (including potential items of heritage value, conservation areas, built heritage landscapes and archaeology);	**Chapter 5** and **6** of this report	

SEARs (issued 3 May 2017)		
14. Heritage		
(d) items listed on the National and World Heritage lists; and	There are no heritage items listed on the National or World heritage items in the immediate vicinity of the study area. **Chapter 6** of this report	*Management of Human Remains* (Heritage Office 1998) Aboriginal site recording form Aboriginal site impact recording form Aboriginal Heritage Information Management System site registration form Care agreement application form Criteria for the assessment of excavation directors (NSW Heritage Council 2011) *NSW Heritage Manual* (Heritage Office and Department of Urban Affairs and Planning 1994) *Assessing Heritage Significance* (NSW Heritage Office 2001) *The Australia ICOMOS Burra Charter* (2013 edition)
(e) heritage items and conservation areas identified in local and regional planning environmental instruments covering the project footprint.	**Chapter 6** of this report	
2. Where impacts to State or locally significant heritage items are identified, the assessment must: (a) include a significance assessment and statement of heritage impact for all heritage items (including any unlisted places that are assessed of heritage value);	**Chapter 6** of this report	
(b) provide a discussion of alternative locations and design options that have been considered to reduce heritage impacts;	**Chapter 3** of this report	
(c) in areas identified as having potential archaeological significance, undertake a comprehensive archaeological assessment in line with Heritage Council guidelines which includes a methodology and research design to assess the impact of the works on the potential archaeological resource and to guide physical archaeological test excavations and include the results of these excavations;	**Chapter 5** of this report	
(d) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, increased traffic, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant);	**Chapter 6** of this report	
(e) provide a comparative analysis to inform the rarity and representative value of any heritage places proposed for demolition;	**Chapter 6** of this report	
(f) outline measures to avoid and minimise those impacts in accordance with the current guidelines; and	**Chapter 8** of this report	

SEARs (issued 3 May 2017)		
14. Heritage		
(g) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	This Non-Aboriginal HIA has been prepared by suitable qualified heritage consultants; GML Heritage Pty Ltd. Authors are listed in **section 3.11**.	
3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (DECCW 2010).	Refer to **Chapter 21** (Aboriginal heritage) and **Appendix V** (Technical working paper: Aboriginal heritage) of this EIS.	
4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	Refer to **Chapter 21** (Aboriginal Heritage) and **Appendix V** (Technical working paper: Aboriginal heritage) of this EIS.	

Table 1-3 Relevant agency comments addressed in this report

Agency letters	
Heritage Council	
Requirement	**Section where addressed in report**
· It is noted that the Iron Cove Link involves surface works in the location of White Bay Power Station, which is listed on the State Heritage Register, and also contains various local heritage items, landscape items and conservation areas. It is understood and methods to reduce any impacts to these places will be addressed throughout the detailed design and in the Environmental Impact Statement.	**Section 6.7.4** of this report
· The amended design provides further detail on the project, however does not trigger the need for any SEARs in addition to those previously requested by the Heritage Council on 19 February 2016. It is therefore requested that the recommended SEARs provided by the Heritage Council on 19 February 2016 are considered relevant to this amended design.	Noted
Sydney Water	
Requirement	**Section where addressed in report**
· The proponent must assess the impact of the proposed development on existing Sydney Water infrastructure. If the proposed development impacts on Sydney Water infrastructure the proponent may need to complete an options assessment to determine the optimal solution for relocation or deviation of Sydney Water's infrastructure.	**Section 6.7.4** of this report

Agency letters	
Ashfield Council	
Requirement	**Section where addressed in report**
· The SEARs should also specify a requirement for the EIS to address cumulative impacts of the proposal across all major issues – traffic, noise, vibration, social, health, visual, heritage, biodiversity, environmental, climate change, flooding, water quality, etc.	**Chapter 7** of this report
City of Sydney	
Requirement	**Section where addressed in report**
· The heritage impact assessment should be undertaken for all State and locally listed heritage items and heritage conservation areas identified in Schedule 5 of Sydney Local Environmental Plan 2012 that may be impacted by the project. These items and conservation areas include (but not limited to): - a) heritage items within the Royal Prince Alfred Hospital site(s); - b) heritage items within the Sydney University site(s) including Victoria Park; - c) University of Sydney Heritage Conservation Area (C5), Chippendale Heritage Conservation Area (C9), Bishopthorpe Heritage Conservation Area (C27), Glebe Point Road Heritage Conservation Area (C29), Hereford and Forest Lodge Heritage Conservation Area (C33) and Mountain Street Heritage Conservation Area (C68).	**Section 6.9** of this report, though the specified heritage items and HCAs are no longer being impacted by the project
· The Proponent must consult directly with the City of Sydney for any proposed works to Parramatta Road and Broadway (including the intersection of Broadway and City Road) that may impact adjacent heritage items.	Work is no longer proposed at the intersection of Broadway and City Road. Works at Pyrmont Bridge Road/Parramatta Road are addressed at **section 6.9** of this report
· The Proponent must consult directly with the City of Sydney to determine any items identified for potential future heritage listing that may be impacted by the project.	**Section 6.9.2** of this report
· The Proponent must assess the visual impact of the project and any ancillary infrastructure on: - a) views and vistas; - b) streetscapes, key sites and buildings; - c) heritage items including Aboriginal places and environmental heritage; - d) heritage conservation areas; and - e) the local community.	**Sections 6.9.3** and **6.9.4** of this report

2 The project

2.1 Project location

The project would be generally located within the City of Sydney and Inner West local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters. The local context of the project is shown in **Figure 2-1**.

2.2 Project features

Key components of the project are shown in **Figure 2-1** and would include:

- Twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction
- Connections of the mainline tunnels to the M4 East project, comprising:
  - A tunnel-to-tunnel connection to the M4 East mainline stub tunnels east of Parramatta Road near Alt Street at Haberfield
  - Entry and exit ramp connections between the mainline tunnels and the Wattle Street interchange at Haberfield (which is currently being constructed as part of the M4 East project)
  - Minor physical integration works with the surface road network at the Wattle Street interchange including road pavement and line marking
- Connections of the mainline tunnels to the New M5 project, comprising:
  - A tunnel-to-tunnel connection to the New M5 mainline stub tunnels north of the Princes Highway near the intersection of Mary Street and Bakers Lane at St Peters
  - Entry and exit ramp connections between the mainline tunnels and the St Peters interchange at St Peters (which is currently being constructed as part of the New M5 project)
  - Minor physical integration works with the surface road network at the St Peters interchange including road pavement and line marking
- An underground interchange at Leichhardt and Annandale (the Inner West subsurface interchange) that would link the mainline tunnels with the Rozelle interchange and the Iron Cove Link (see below)
- A new interchange at Lilyfield and Rozelle (the Rozelle interchange) that would connect the M4-M5 Link mainline tunnels with:
  - City West Link
  - Anzac Bridge
  - The Iron Cove Link (see below)
  - The proposed future Western Harbour Tunnel and Beaches Link
- Construction of connections to the proposed future Western Harbour Tunnel and Beaches Link project as part of the Rozelle interchange, including:
  - Tunnels that would allow for underground mainline connections between the M4 East and New M5 motorways and the proposed future Western Harbour Tunnel and Beaches Link (via the M4-M5 Link mainline tunnels)
  - A dive structure and tunnel portals within the Rozelle Rail Yards, north of the City West Link / The Crescent intersection
  - Entry and exit ramps that would extend north underground from the tunnel portals in the

Rozelle Rail Yards to join the mainline connections to the proposed future Western Harbour Tunnel and Beaches Link

- A ventilation outlet and ancillary facilities as part of the Rozelle ventilation facility (see below)

· Twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge (the Iron Cove Link). Underground entry and exit ramps would also provide a tunnel connection between the Iron Cove Link and the New M5 / St Peters interchange (via the M4-M5 Link mainline tunnels)

· The Rozelle surface works, including:

- Realigning The Crescent at Annandale, including a new bridge over Whites Creek and modifications to the intersection with City West Link

- A new intersection on City West Link around 300 metres west of the realigned position of The Crescent, which would provide a connection to and from the New M5/St Peters interchange (via the M4-M5 Link mainline tunnels)

- Widening and improvement works to the channel and bank of Whites Creek between the light rail bridge and Rozelle Bay at Annandale, to manage flooding and drainage for the surface road network

- Reconstructing the intersection of The Crescent and Victoria Road at Rozelle, including construction of a new bridge at Victoria Road

- New and upgraded pedestrian and cyclist infrastructure

- Landscaping, including the provision of new open space within the Rozelle Rail Yards

· The Iron Cove Link surface works, including:

- Dive structures and tunnel portals between the westbound and eastbound Victoria Road carriageways, to connect Victoria Road east of Iron Cove Bridge with the Iron Cove Link

- Realignment of the westbound (southern) carriageway of Victoria Road between Springside Street and the eastern abutment of Iron Cove Bridge

- Modifications to the existing intersections between Victoria Road and Terry, Clubb, Toelle and Callan streets

- Landscaping and the establishment of pedestrian and cycle infrastructure

· Five motorway operations complexes; one at Leichhardt (MOC1), three at Rozelle (Rozelle West (MOC2), Rozelle East (MOC3) and Iron Cove Link (MOC4)), and one at St Peters (MOC5). The types of facilities that would be contained within the motorway operations complexes would include substations, water treatment plants, ventilation facilities and outlets, offices, on-site storage and parking for employees

· Tunnel ventilation systems, including ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels

· Three new ventilation facilities, including:

- The Rozelle ventilation facility at Rozelle

- The Iron Cove Link ventilation facility at Rozelle

- The Campbell Road ventilation facility at St Peters

· Fitout (mechanical and electrical) of part of the Parramatta Road ventilation facility at Haberfield (which is currently being constructed as part of M4 East project) for use by the M4-M5 Link project

· Drainage infrastructure to collect surface and groundwater for treatment at dedicated facilities. Water treatment would occur at

- Two operational water treatment facilities (at Leichhardt and Rozelle)

- The constructed wetland within the Rozelle Rail Yards

- A bioretention facility for stormwater runoff within the informal car park at King George Park at

Rozelle (adjacent to Manning Street). A section of the existing informal car park would also be upgraded, including sealing the car park surface and landscaping

- Treated water would flow back to existing watercourses via new, upgraded and existing infrastructure
- Ancillary infrastructure and operational facilities for electronic tolling and traffic control and signage (including electronic signage)
- Emergency access and evacuation facilities, including pedestrian and vehicular cross and long passages and fire and life safety systems
- Utility works, including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities. A Utilities Management Strategy has been prepared for the project that identifies management options for utilities, including relocation or adjustment. Refer to **Appendix F** (Utilities Management Strategy) of the EIS.

The project does not include:

- Site management works at the Rozelle Rail Yards. These works were separately assessed and determined by Roads and Maritime through a Review of Environmental Factors under Part 5 of the EP&A Act (refer to **Chapter 2** (Assessment process) of the EIS)
- Ongoing motorway maintenance activities during operation
- Operation of the components of the Rozelle interchange which are the tunnels, ramps and associated infrastructure being constructed to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project.

Temporary construction ancillary facilities and temporary works to facilitate the construction of the project would also be required.

2.2.1 Staged construction and opening of the project

It is anticipated the project would be constructed and opened to traffic in two stages:

Stage 1 would include:

- Construction of the mainline tunnels between the M4 East at Haberfield and the New M5 at St Peters, stub tunnels to the Rozelle interchange (at the Inner West subsurface interchange) and ancillary infrastructure at the Darley Road motorway operations complex (MOC1) and Campbell Road motorway operations complex (MOC5)
- These works are anticipated to commence in 2018 with the mainline tunnels open to traffic in 2022. At the completion of Stage 1, the mainline tunnels would operate with two traffic lanes in each direction. This would increase to generally four lanes at the completion of Stage 2, when the full project is operational.

Stage 2 would include:

- Construction of the Rozelle interchange and Iron Cove Link including:
  - Connections to the stub tunnels at the Inner West subsurface interchange (built during Stage 1)
  - Ancillary infrastructure at the Rozelle West motorway operations complex (MOC2), Rozelle East motorway operations complex (MOC3) and Iron Cove Link motorway operations complex (MOC4)
  - Connections to the surface road network at Lilyfield and Rozelle
  - Construction of tunnels, ramps and associated infrastructure as part of the Rozelle interchange to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project
- Stage 2 works are expected to commence in 2019 with these components of the project open to traffic in 2023.

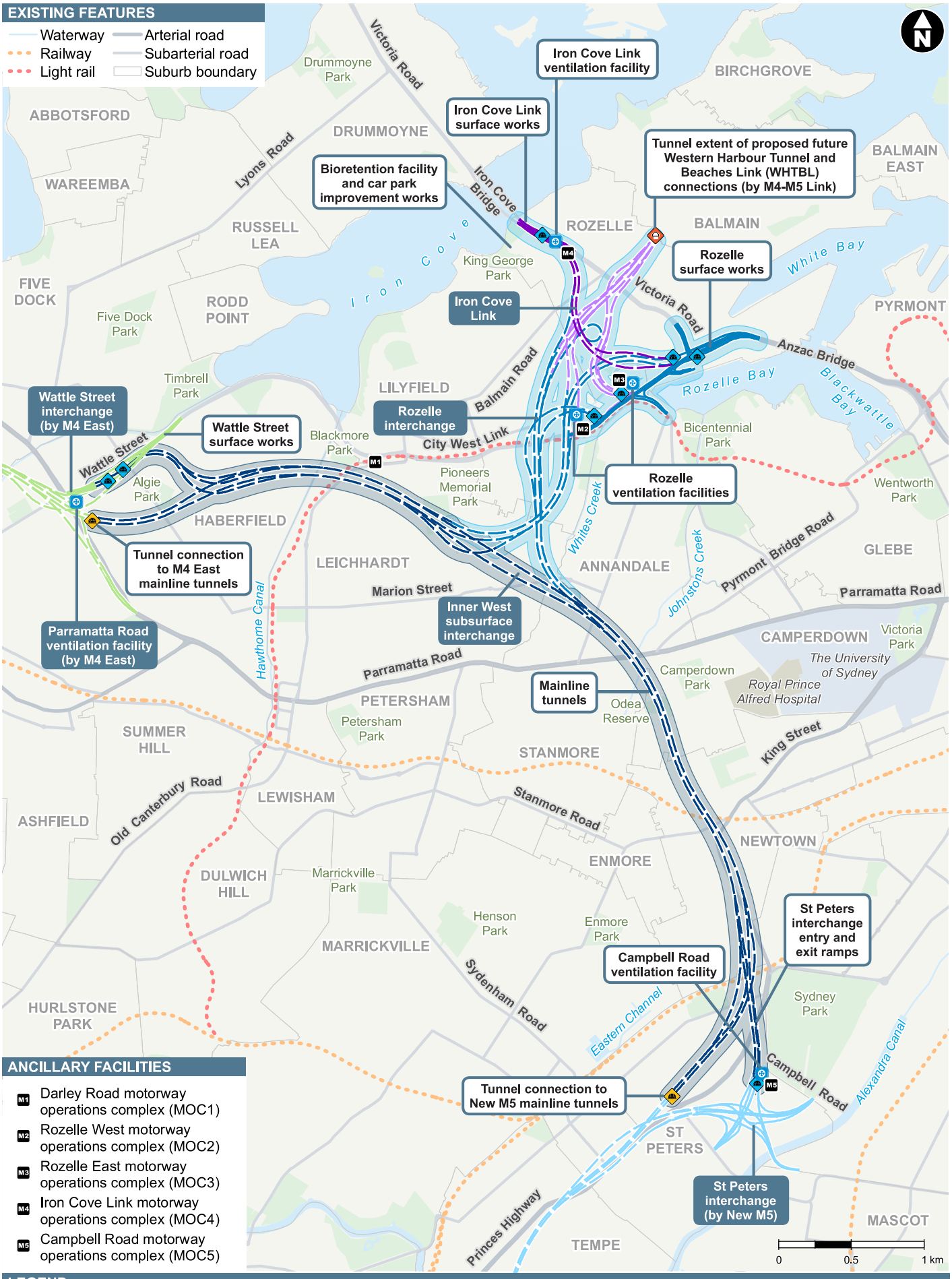


Figure 2-1 Overview of the project

2.3 Construction activities

An overview of the key construction features of the project is shown in **Table 2-1** and would generally include:

- Enabling and temporary works, including provision of construction power and water supply, ancillary site establishment including establishment of acoustic sheds and construction hoarding, demolition works, property adjustments and public and active transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway operations complexes and other ancillary operations buildings
- Realignment, modification or replacement of surface roads, bridges and underpasses
- Implementation of environmental management and pollution control facilities for the project.

A more detailed overview of construction activities is provided in **Table 2-1**.

Table 2-1 Overview of construction activities

Component	Typical activities
Site establishment and enabling works	· Vegetation clearing and removal · Utility works · Traffic management measures · Install safety and environmental controls · Install site fencing and hoarding · Establish temporary noise attenuation measures · Demolish buildings and structures · Carry out site clearing · Heritage salvage or conservation works (if required) · Establish construction ancillary facilities and access · Establish acoustic sheds · Supply utilities (including construction power) to construction facilities · Establish temporary pedestrian and cyclist diversions
Tunnelling	· Construct temporary access tunnels · Excavation of mainline tunnels, entry and exit ramps and associated tunnelled infrastructure and install ground support · Spoil management and haulage · Finishing works in tunnel and provision of permanent tunnel services · Test plant and equipment
Surface earthworks and structures	· Vegetation clearing and removal · Topsoil stripping · Excavate new cut and fill areas

Component	Typical activities
	· Construct dive and cut-and-cover tunnel structures · Install stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls and secant pile walls (where required) · Construct required retaining structures · Excavate new road levels
Bridge works	· Construct piers and abutments · Construct headstock · Construct bridge deck, slabs and girders · Demolish and remove redundant bridges
Drainage	· Construct new pits and pipes · Construct new groundwater drainage system · Connect drainage to existing network · Construct sumps in tunnels as required · Construct water quality basins, constructed wetland and bioretention facility and basin · Construct drainage channels · Construct spill containment basin · Construct onsite detention tanks · Adjustments to existing drainage infrastructure where impacted · Carry out widening and naturalisation of a section of Whites Creek · Demolish and remove redundant drainage
Pavement	· Lay select layers and base · Lay road pavement surfacing · Construct pavement drainage
Operational ancillary facilities	· Install ventilation systems and facilities · Construct water treatment facilities · Construct fire pump rooms and install water tanks · Test and commission plant and equipment · Construct electrical substations to supply permanent power to the project
Finishing works	· Line mark to new road surfaces · Erect directional and other signage and other roadside furniture such as street lighting · Erect toll gantries and other control systems · Construct pedestrian and cycle paths · Carry out earthworks at disturbed areas to establish the finished landform · Carry out landscaping · Closure and backfill of temporary access tunnels (except where these are to be used for inspection and/or maintenance purposes)

Component	Typical activities
	· Site demobilisation and preparation of the site for a future use

Twelve construction ancillary facilities are described in this EIS (as listed below).To assist in informing the development of a construction methodology that would manage constructability constraints and the need for construction to occur in a safe and efficient manner, while minimising impacts on local communities, the environment, and users of the surrounding road and other transport networks, two possible combinations of construction ancillary facilities at Haberfield and Ashfield have been assessed in this EIS. The construction ancillary facilities that comprise these options have been grouped together in this EIS and are denoted by the suffix a (for Option A) or b (for Option B).

The construction ancillary facilities required to support construction of the project include:

- Construction ancillary facilities at Haberfield (Option A), comprising:
  - Wattle Street civil and tunnel site (C1a)
  - Haberfield civil and tunnel site (C2a)
  - Northcote Street civil site (C3a)
- Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b)
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- The Crescent civil site (C6)
- Victoria Road civil site (C7)
- Iron Cove Link civil site (C8)
- Pyrmont Bridge Road tunnel site (C9)
- Campbell Road civil and tunnel site (C10).

The number, location and layout of construction ancillary facilities would be finalised as part of detailed construction planning during detailed design and would meet the environmental performance outcomes stated in the EIS and the Submissions and Preferred Infrastructure Report and satisfy criteria identified in any relevant conditions of approval.

The construction ancillary facilities would be used for a mix of civil surface works, tunnelling support, construction workforce parking and administrative purposes. Wherever possible, construction sites would be co-located with the operational footprint to minimise property acquisition and temporary disruption. The layout and access arrangements for the construction ancillary facilities are based on the concept design only and would be confirmed and refined in response to submissions received during the exhibition of this EIS and during detailed design.

2.3.1 Construction program

The total period of construction works for the project is expected to be around five years, with commissioning occurring concurrently with the final stages of construction. An indicative construction program is shown in **Table 2-2**.

Table 2-2 Indicative construction program

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mainline tunnels																								
Site establishment and establishment of construction ancillary facilities			■	■	■	■	■	■	■	■														
Utility works and connections			■	■	■	■	■																	
Tunnel construction				■	■	■	■	■	■	■	■	■	■											
Portal construction				■	■	■	■	■																
Construction of permanent operational facilities												■	■	■	■	■								
Mechanical and electrical fitout works													■	■	■	■								
Establishment of tolling facilities														■	■	■								
Site rehabilitation and landscaping																■	■	■	■					
Surface road works																	■	■	■					
Demobilisation and rehabilitation																			■					
Testing and commissioning																■	■	■	■					
Rozelle interchange and Iron Cove Link																								
Site establishment and establishment of construction ancillary facilities				■	■	■	■	■																
Utility works and connections and site remediation				■	■	■	■																	
Tunnel construction									■	■	■	■	■	■	■	■	■							
Portal construction						■	■	■																
Construction of surface road works						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Construction of permanent operational facilities						■	■	■	■	■	■	■	■	■	■	■								
Mechanical and electrical fitout works													■	■	■	■	■	■	■	■				
Establishment of tolling facilities																		■						

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022					2023		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site rehabilitation and landscaping																								
Demobilisation and rehabilitation																								
Testing and commissioning																								

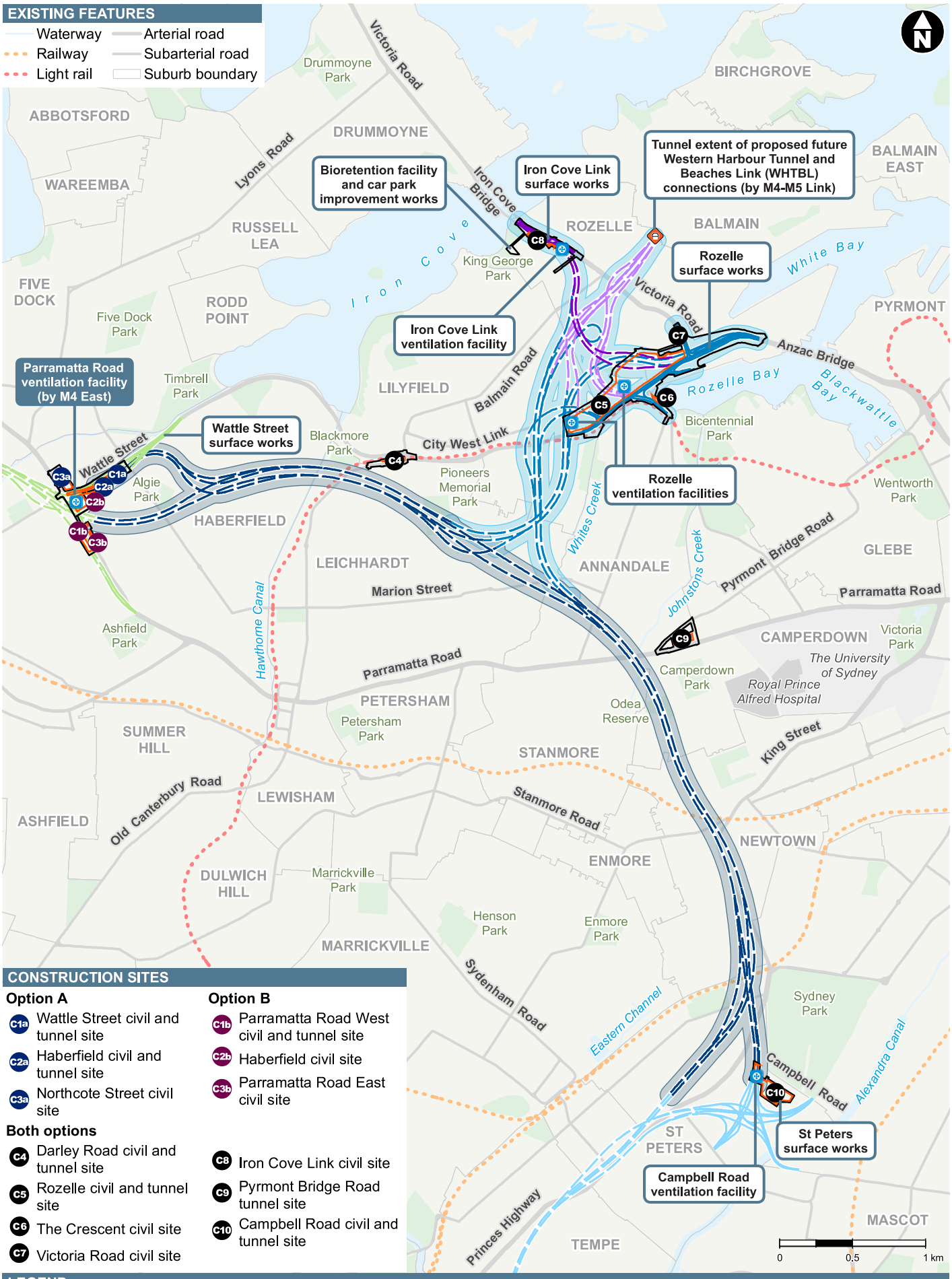


Figure 2-2 Overview of project footprint and ancillary facilities

2.4 Heritage study areas

The study area for the HIA comprises the project footprint and a surrounding buffer determined by the character and visual corridors surrounding the project footprint to ensure indirect impacts are appropriately assessed (ie visual impacts). The study area is separated into six areas that would be subject to surface disturbance as part of the project and the area above the mainline tunnel alignment. The six areas of surface disturbance comprise:

- Area 1 – Haberfield/Ashfield (Option A around Wattle Street, and Option B around Alt Street and Bland Street)
- Area 2 – Leichhardt
- Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road, excluding Iron Cove which comprises Area 4)
- Area 4 – Iron Cove (around Victoria Road)
- Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)
- Area 6 – St Peters.

The six heritage study areas that were the focus of this assessment are shown in **Figure 2-3**.

The historical archaeological assessment in **Chapter 5** has focused on the project footprint in six areas and where tunnel entry and exit portals from the mainline tunnels reach the surface (at Haberfield, Ashfield, Rozelle and St Peters), to identify where key archaeological resources may exist and may be impacted by the project, ie those areas that will be subject to surface works only (ie cut and cover, dive structures, portals, ancillary structures). As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further.

The built heritage and landscape assessment has focused on a broader study area applied to each of these six areas, comprising an appropriate buffer surrounding the project footprint (the study area). This is determined by the character and visual corridors surrounding each area. This is to ensure that the assessment includes heritage items, potential heritage items and HCAs adjacent to the project footprint that may be subject to visual or vibration impacts, and has been determined on a case by case basis when undertaking site inspections of the areas. This broader study area is referred to as the heritage study area in this report. A description of these areas and the works proposed are set out in this section.

Section 6.14 of the HIA also addresses potential vibration and settlement impacts on heritage items and HCAs located above the tunnels but which are not included within the six areas subject to surface impacts as listed above.

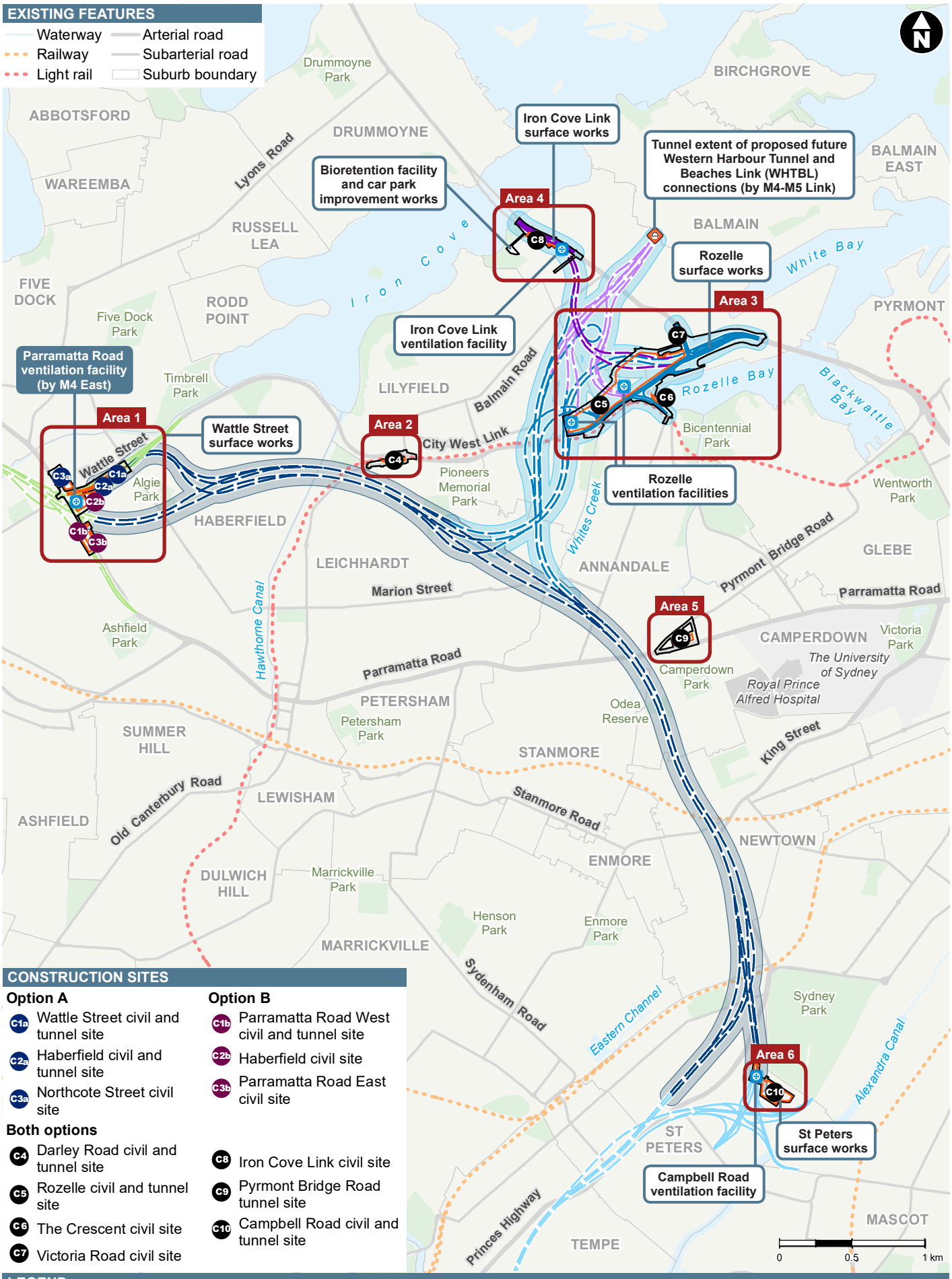


Figure 2-3 Overview of heritage study areas

2.4.1 Area 1 – Haberfield/Ashfield



Figure 2-4 Construction ancillary facility layout at Haberfield (Option A)



Figure 2-5 Construction ancillary facility layout at Haberfield/Ashfield (Option B)

Haberfield is located around seven kilometres west of Sydney's CBD, with historic character which retains a largely intact subdivision layout dating from the Federation-era and a high number of heritage listed items. This area extends from the corner of Wattle and Ramsay streets in the east to the corner of Parramatta Road in the west. Almost the entire suburb of Haberfield, from Dobroyd Canal (Iron Cove Creek) to Hawthorne Canal and northwest to Iron Cove, but excluding the properties along Parramatta Road, is listed as a HCA of local significance under Ashfield Local Environmental Plan 2013 (Ashfield LEP) and potential State significance.

Haberfield is Australia's first fully planned and developed 'garden suburb', with the form, materials, scale and setbacks of the predominantly brick Federation and interwar period houses and their landscaped gardens. The suburb's tree-lined streets provide consistent and aesthetically significant streetscapes.

The M4 East project included the demolition of 53 properties within the Haberfield HCA. The heritage impacts of these works have been assessed as part of the M4 East HIA and were found to be major adverse and unable to be fully mitigated. The M4-M5 Link project would utilise some of the construction compounds currently being utilised by the M4 East project, however some for different uses.

Within Area 1 – Haberfield, Option A for the M4-M5 Link project works are limited to connecting to the underground M4 East mainline tunnels, connections to and fitout of the dive structures and cut and cover tunnels at the Wattle Street interchange; and fitout of the Parramatta Road ventilation facility on the corner of Parramatta Road and Walker Avenue, which are all being constructed, and were assessed and approved, as part of the M4 East project.

For Option B at Haberfield/Ashfield, the M4-M5 Link project will require new construction ancillary facilities on the east and west sides of Parramatta Road, around the intersections of Alt Street and Bland Street. These would comprise the Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b) in addition to the Haberfield civil site (C2b) which is subject to the assessment undertaken in the M4 East project as explained above. The Parramatta Road sites are outside of the Haberfield HCA and were not assessed as part of the M4 East project.

2.4.2 Area 2 – Leichhardt

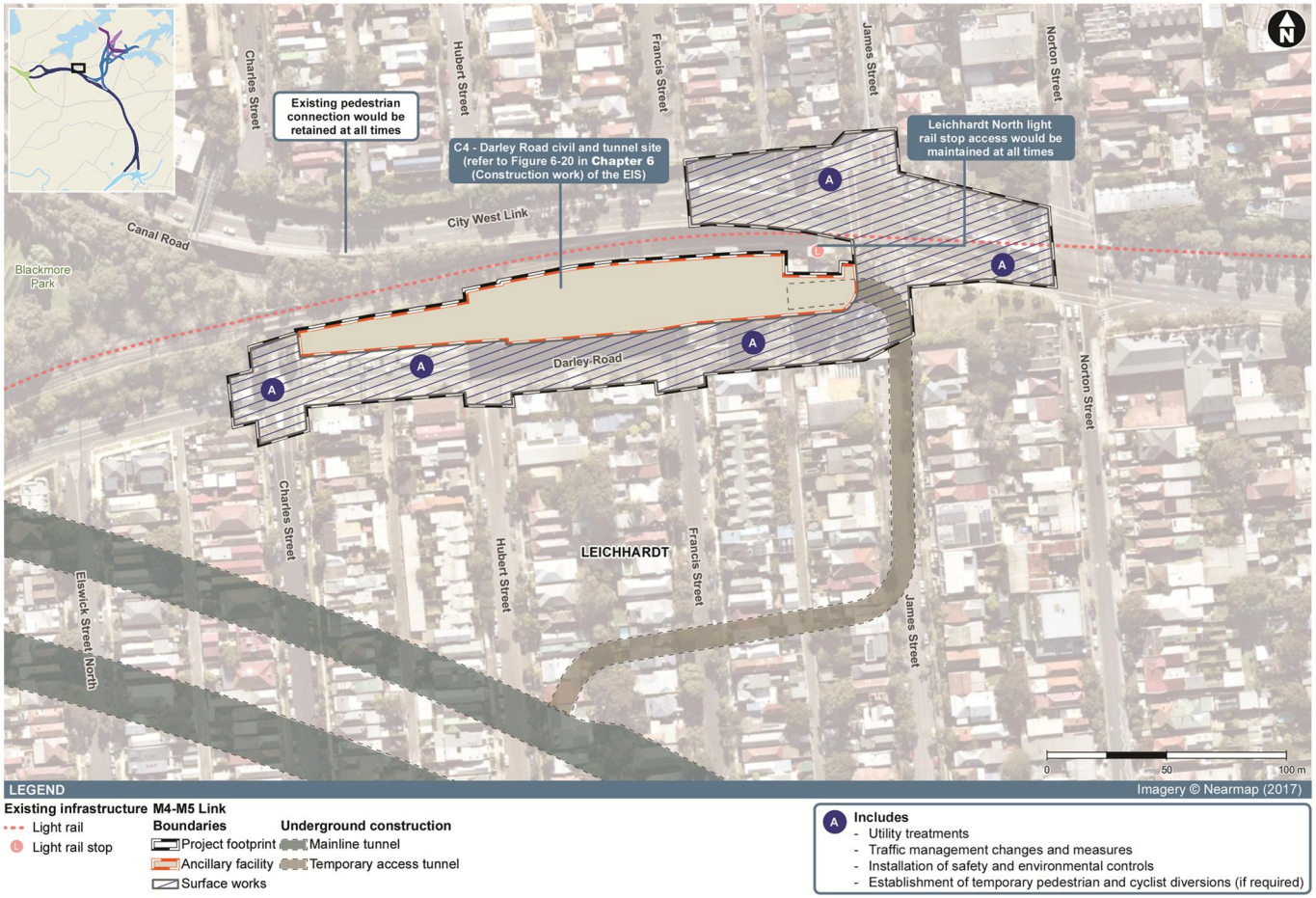


Figure 2-6 Construction ancillary facility layout at Leichhardt

Leichhardt is a suburb around six kilometres west of Sydney's CBD. The mid-point civil and tunnel site at Darley Road (C4) is shown on **Figure 2-6**.

The Darley Road civil and tunnel site (C4) is bounded by the Light Rail Line to the north and Darley Road to the south. Further to the north is the City West Link and the suburb of Rozelle. The residential development along Darley Road and cross streets is characterised by a broad range of architectural styles and typologies dating from the Victorian-era to the present day, with a high degree of alterations and modifications to most properties. The Leichhardt heritage study area (Area 2) is oriented around the alignment of the former Rozelle-Darling Harbour Goods Line, which has resulted in significant modifications to the landscape. Views of Darley Road civil and tunnel site (and its local context) are shown in **Figure 2-7** to **Figure 2-18**. The photos in **Figure 2-7** to **Figure 2-18** were taken in 2016, prior to the refurbishment of the commercial building.



Figure 2-7 Looking west along Darley Road from the intersection with James Street.
The study area is visible in the background (Source: GML 2016)



Figure 2-8 Looking northwest at the c.1960s brick warehouse facing onto Darley Road (Source: GML 2016)



Figure 2-9 Looking northeast at the western half of the c1960s brick warehouse facing onto Darley Road (Source: GML 2016)



Figure 2-10 Looking northeast at the western half of the c1960s brick warehouse facing onto Darley Road (Source: GML 2016)



Figure 2-11 Looking northeast towards the yard/car park within the study area from the intersection of Charles Street and Darley Road (Source: GML 2016)



Figure 2-12 Looking southeast at the late twentieth century warehouse in the northern half of the study area.
The light rail tracks are visible in the foreground (Source: GML 2016)



Figure 2-13 Looking southeast at the eastern half of the late twentieth century warehouse on Darley Road

(Source: GML 2016)



Figure 2-14 Looking east across the Leichhardt North tram stop.

The cutting for the rail line is visible on the left side of the image (Source: GML 2016)



Figure 2-15 Looking southeast at the steps into the Leichhardt North tram stop.

The cutting into the sandstone is visible behind the fence (Source: GML 2016)



Figure 2-16 Looking southeast across the car park at the eastern end of the Darley Road study area

(Source: GML 2016)



Figure 2-17 Looking west across the eastern car park of the Darley Road study area

(Source: GML 2016)



Figure 2-18 Looking west along the stormwater culvert visible in the southeast corner of the Darley Road study area

(Source: GML 2016)

2.4.3 Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road)

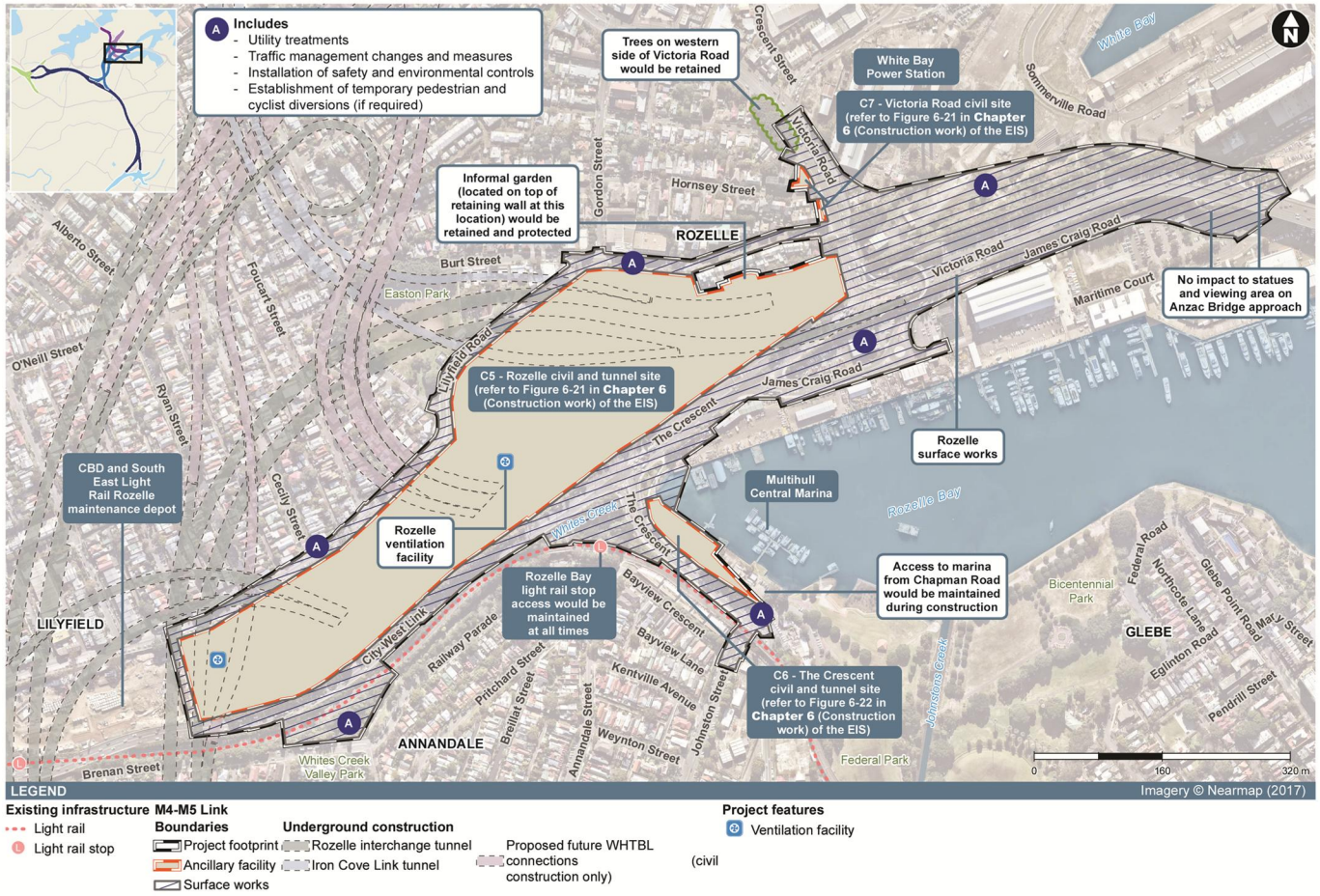


Figure 2-19 Construction ancillary facility layout at Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road)

The Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) (Area 3) heritage study area is located around four kilometres west of Sydney's CBD and contains a number of linking roadways which connect the suburbs of Rozelle, Pyrmont, Annandale and Lilyfield. The project footprint in this area comprises the eastern end of the City West Link, the southern section of Victoria Road, The Crescent, an area around White Creek's eastern extent towards Rozelle Bay, and a portion of the White Bay Power Station. Anzac Bridge lies outside the eastern end of the project footprint. An overview of the project footprint is shown in **Figure 2-19**.

The area is characterised by light industrial development interspersed with parkland constructed above areas of nineteenth century reclamation and bisected by the network of modern roadways. Late nineteenth century residential developments surround the northern boundary of the project footprint. Views and features of the Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) heritage study area are shown in **Figure 2-20** to **Figure 2-33**.



Figure 2-20 Looking southwest across Easton Park

The Sewage Pumping Station is visible in the background at left (Source: GML 2016)



Figure 2-21 Looking east along Lilyfield Road on the southern side of Easton Park

(Source: GML 2016)



Figure 2-22 Looking east along Lilyfield Road towards Easton Park in background

(Source: GML 2016)



Figure 2-23 An area of exposed sandstone bedrock observed along Lilyfield Road

(Source: GML 2016)



Figure 2-24 Looking southeast at the warehouses within the light industrial area in the northern part of the project footprint

(Source: GML 2016)



Figure 2-25 The stormwater canal which runs through the light industrial area

(Source: GML 2016)



Figure 2-26 Looking west along Lilyfield Road from the intersection with Gordon Street

(Source: GML 2016)



Figure 2-27 Looking northeast across an open grassed area within the White Bay Power Station site

The Power Station is visible in the background at left. Disused railway tracks are visible in the image foreground (Source: GML 2016)



Figure 2-28 Grassed and tarmac surfaces at White Bay Power Station which characterises much of the Rozelle project footprint

(Source: GML 2016)



Figure 2-29 Evidence of quarrying of the sandstone bedrock within the White Bay Power Station site

(Source: GML 2016)



Figure 2-30 Southern penstock with safety fence enclosure

(Source: GML 2016)



Figure 2-31 Remaining foundations of the former White Bay Hotel, with the White Bay Power Station in the background

(Source: GML 2016)



Figure 2-32 White Bay Power Station showing proposed location of construction

(Source; GML 2016)



Figure 2-33 View southeast across the parkland on the northern side of the City West Link which characterises the western part of the project footprint

(Source: GML 2016)

2.4.4 Area 4 – Iron Cove



Figure 2-34 Construction ancillary facility layout at Ion Cove

Iron Cove Bridge links the suburb of Rozelle to the suburb of Drummoyne to its northwest. Area 4 is oriented along Victoria Road, a major thoroughfare located around four kilometres to the west of Sydney's CBD. The residential development, which fronts on to Victoria Road and occupies the adjacent cross streets, is predominantly late nineteenth century workers housing. The area is a small scale, irregular subdivision which demonstrates a variety of building types and construction methods including single-fronted cottages, two-storey terraces, free-standing timber and stone single storey cottages most with small front gardens.

The project footprint at Iron Cove is shown on **Figure 2-34**. This includes the proposed bioretention facility and car park improvement works at King George Park, adjacent to Manning Street, in the block between the southern end of Byrnes and Clubb streets. This area is currently grassed with a few bollards, and used as an informal parking area. There is a slope across the site from the north (Manning Street) to the south (King George Park).

Views within Area 4 are shown in **Figure 2-35** to **Figure 2-52**.



Figure 2-35 Looking north along Springside Street towards the rear of 212-218 Victoria Road (at left)

(Source: GML 2016)



Figure 2-36 Looking west along Victoria Road; the car park at 212-218 Victoria Road is visible at left

(Source: GML 2016)



Figure 2-37 Looking east at the side of 224 Victoria Road on Callan Street showing the stepping down of the building floor level

(Source: GML 2016)



Figure 2-38 Looking north at the southwest corner of 224 Victoria Street

The rear wall of the building has been constructed directly above bedrock (visible beneath the red brick section) (Source: GML 2016)



Figure 2-39 Looking north along Toelle Street towards Victoria Road and at the rear of 238 Victoria Road

(Source: GML 2016)



Figure 2-40 Looking west along the unnamed lane behind 242–248 Victoria Road showing the variation in ground level

(Source: GML 2016)



Figure 2-41 Looking south towards the raised garden behind 242 Victoria Road

(Source: GML 2016)



Figure 2-42 Shop on the corner of Toelle Street and Victoria Road

(Source: GML 2016)



Figure 2-43 Looking west along Victoria Road outside the car yard 258 Victoria Road

(Source: GML 2016)



Figure 2-44 View of the eastern side of 260 Victoria Road showing the concrete slab on which the house is built

(Source: GML 2016)



Figure 2-45 View of the front steps leading up to 264 Victoria Road

(Source: GML 2016)



Figure 2-46 View of the western wall of 264 Victoria Road showing the underlying bedrock on which the house has been constructed

(Source: GML 2016)



Figure 2-47 View of the bedrock foundations beneath 270 Victoria Road

(Source: GML 2016)



Figure 2-48 Looking north across the park towards the westbound section of Iron Cove Bridge

(Source: GML 2016)



Figure 2-49 Looking northeast across the park on the southern side of Victoria Road.

The house on the corner of Victoria Road and Byrnes Street is visible in the background (Source: GML 2016)



Figure 2-50 Looking northwest from the edge of King George Park towards the site of the proposed bioretention facility

(Source: GML 2016)



Figure 2-51 Looking south from the intersection of Byrnes Street and Manning Street towards the site of the proposed bioretention facility

(Source: GML 2016)



Figure 2-52 Looking east from the continuation of Byrnes Street towards the site of the proposed bioretention facility

(Source: GML 2016)

2.4.5 Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)

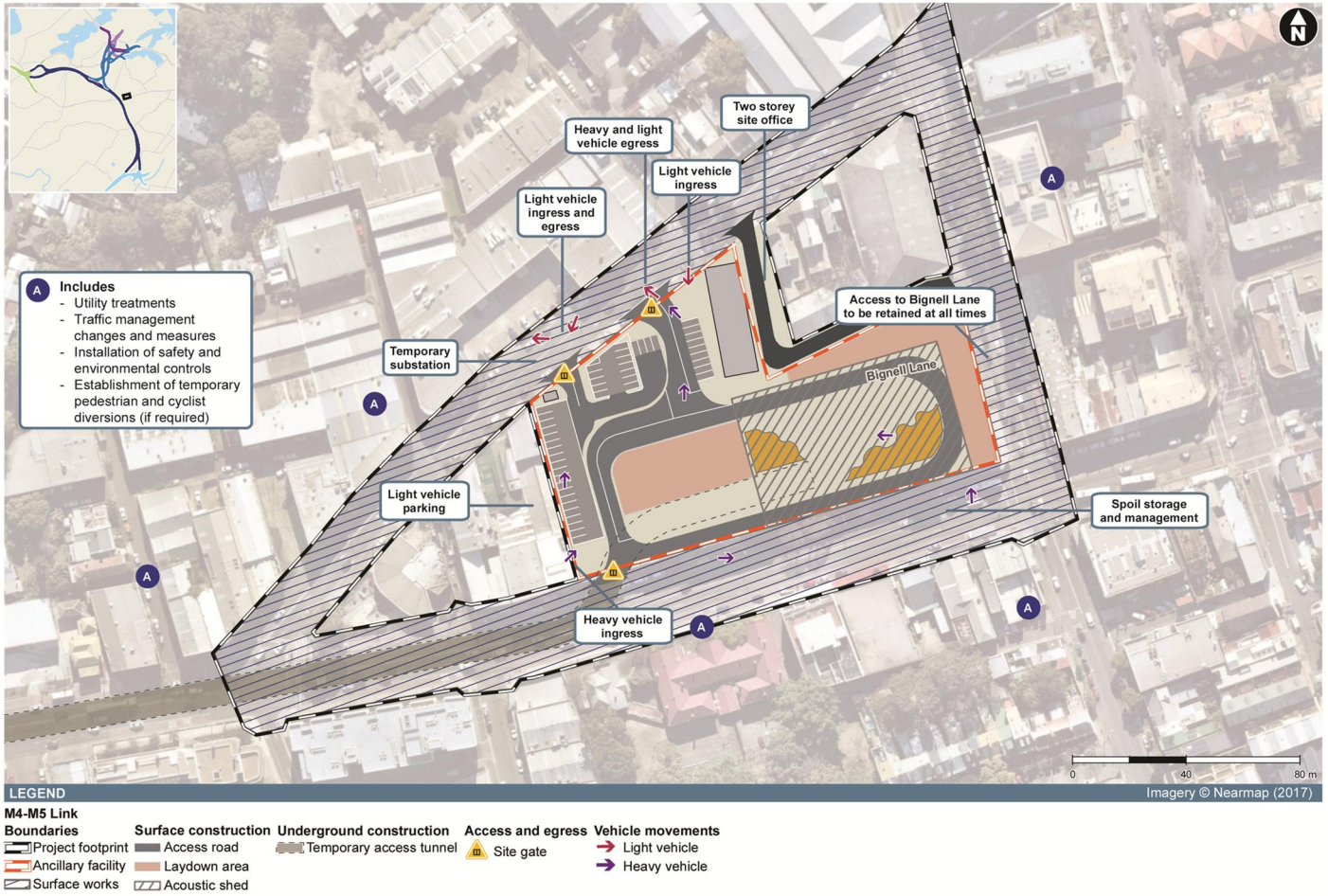


Figure 2-53 Construction ancillary facility layout at Annandale (around Pyrmont Bridge Road and Parramatta Road)

Within Area 5 – Annandale, the project comprises the Pyrmont Bridge Road tunnel site (C9) (a construction ancillary facility, shown in **Figure 2-53**) and associated tunnelling for the Inner West subsurface interchange.

Annandale is located around three kilometres from Sydney's CBD and is characterised as a mixed use commercial/residential area oriented around Parramatta Road and Pyrmont Bridge Road. The area is generally occupied by medium density development of predominantly industrial character. Buildings date primarily from the early to mid-twentieth century punctuated by contemporary apartment development. Views showing the local context within Area 5 are provided in **Figure 2-54** to **Figure 2-65**.

The project footprint is bound by Parramatta Road to the south, Pyrmont Bridge Road to the north and Bignell Lane and Mallett Street to the east.



Figure 2-54 Looking northwest towards 160 Parramatta Road on southeast corner of Study Area C8

(Source: GML 2016)



Figure 2-55 Looking northwest at 164–172 Parramatta Road forming the southern boundary of Study Area C8

(Source: GML 2016)



Figure 2-56 Looking north towards 174–180 Parramatta Road on the southern boundary of Study Area C8

(Source: GML 2016)



Figure 2-57 Looking north towards 182–186 Parramatta Road forming the southwest corner of Study Area C8

(Source: GML 2016)



Figure 2-58 Looking south at 93–95 Pyrmont Bridge Road and the entrance to Bignell Lane in the northwest of the Study Area C10

(Source: GML 2016)



Figure 2-59 Looking south at the western end of 79 Pyrmont Bridge Road

The entrance to Bignell Lane is visible on the right (Source: GML 2016)



Figure 2-60 Looking along façade of 79 Pyrmont Bridge Road, situated in the northern third of Study Area C8

(Source: GML 2016)



Figure 2-61 View west taken approximately halfway along Bignell Lane

(Source: GML 2016)

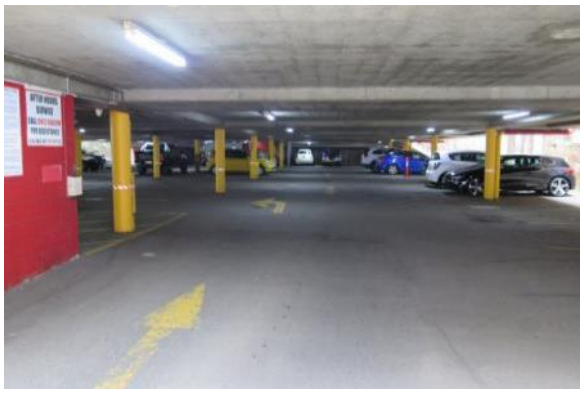


Figure 2-62 Looking across the basement level car park beneath 166–172 Parramatta Road (Camperdown Fitness)

(Source: GML 2016)



Figure 2-63 The street level car park accessed from Bignell Lane at the rear of 164 Parramatta Road

(Source: GML 2016)



Figure 2-64 Looking down into the car park beneath 166–172 Parramatta Road (Camperdown Fitness) from Parramatta Road showing the depth below street level

(Source: GML 2016)



Figure 2-65 Looking east along Bignell Lane at the rear of 182–186 Parramatta Road

(Source: GML 2016)

2.4.6 Area 6 – St Peters

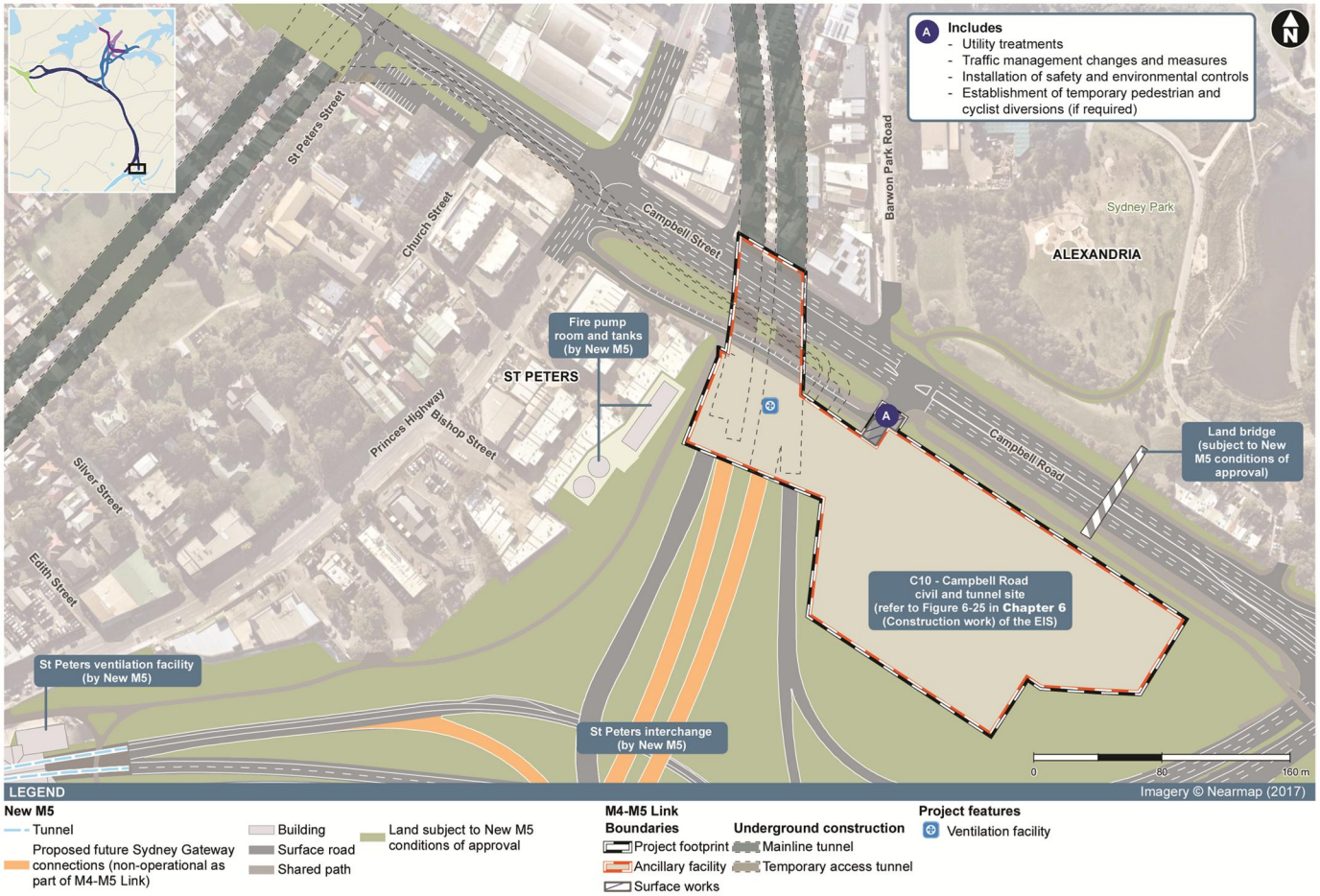


Figure 2-66 Construction ancillary facility layout at St Peters

The Campbell Road civil and tunnel site (C10) at St Peters (shown on **Figure 2-66**) is located around six kilometres south of Sydney's CBD and comprises a cleared construction compound (being used currently for the New M5 project) bounded by Campbell Road in the north, Holland Street in the south and Albert Street in the northwest.

Within Area 6, the project comprises linking the St Peters interchange to the M4-M5 Link mainline tunnel entries, construction of St Peters motorway operations complex (MOC5) and ventilation facility, and construction of above ground links to Euston Road, Gardeners Road, Sydney Airport and Port Botany. This area has previously been assessed for heritage impacts as part of the New M5 project (at the St Peters interchange). Current work on the construction of the New M5 has already resulted in the demolition of buildings within the M4-M5 Link project footprint.

3 Assessment methodology

3.1 Relevant legislation

This HIA has referred to the following statutory planning instruments/legislation relevant to heritage management in NSW:

- *Heritage Act 1977* (NSW) (Heritage Act)
- *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Commonwealth)
- Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (SREP Sydney Harbour Catchment)
- Sydney Local Environmental Plan (LEP) 2012 (Sydney LEP)
- Ashfield Local Environmental Plan (LEP) 2013 (Ashfield LEP)
- Leichhardt Local Environmental Plan (LEP) 2013 (Leichhardt LEP)
- Marrickville Local Environmental Plan (LEP) 2011 (Marrickville LEP)
- Sydney Regional Environmental Plan 26 (SREP 26) – City West (SREP 26).

3.2 Relevant guidelines and policies

This HIA has referred to the following key guidelines and policies relevant to heritage management in NSW:

- Heritage Branch of the NSW Department of Planning *Assessing Heritage Significance for Historical Archaeological Sites and 'Relics'* (2009)
- NSW Heritage Office *Historical Archaeology Code of Practice* (2006)
- NSW Heritage Office *Skeletal Remains: Guidelines for Management of Human Remains* (1998)
- NSW Heritage Council *Criteria for the assessment of excavation directors* (2011)
- Heritage Office and Department of Urban Affairs and Planning, *NSW Heritage Manual* (1994)
- NSW Heritage Office *How to Prepare Archival Records of Heritage Items* (2003)
- Heritage Council of NSW *Assessing Heritage Significance* (2002)
- Heritage Council of NSW *Statements of Heritage Impact* (2002)
- NSW Heritage Office *Archaeological Assessments: Archaeological Assessment Guidelines* (1996)
- Heritage Council of NSW *Historical Archaeological Sites: Investigation and Conservation Guidelines* (1993)
- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 2013* (the Burra Charter).

3.3 Overview

The following methodology has been adopted in preparing this report:

- Review of statutory heritage lists, including the State Heritage Register (SHR), heritage schedules on LEPs, heritage schedules on Sydney Regional Environmental Plans, State Agency Section 170 Heritage and Conservation Registers (S170 Registers), the National Heritage List (NHL) and Commonwealth Heritage List (CHL)
- Review of relevant heritage reports, archaeological zoning plans and archaeological assessments previously prepared for relevant items and areas within the project footprint and the heritage study area, as available

- Field survey of the study area defined in **section 2.4** to inspect listed heritage items, HCAs and potential archaeological sites and to identify potential heritage items that may be affected by the project
- Desktop research and historical research to inform the impact assessment, including review of relevant conservation management plans (CMPs) and other plans of management.

3.4 Field survey

Known non-Aboriginal heritage items and areas identified as having the potential to be impacted (either directly or indirectly) by the project were subjected to a targeted inspection to determine their current condition. Items of potential heritage significance were also identified during these inspections. Results from these inspections were used to inform an assessment of potential impacts on non-Aboriginal heritage values. This process comprised:

- Review of mapped non-Aboriginal heritage listings to identify those properties with the potential to be directly or indirectly impacted during the construction or operation of the project
- Compilation of available information of potentially impacted non-Aboriginal heritage listings, including past inspection photographs, as a point of comparison
- Field inspections of the identified listings, which involved recording the current condition of each site. Each listed item was photographed and compared to past descriptions/photos. Interior features or the condition of the interior of each site, if relevant to the listing, were based on the details provided within the database
- Field investigation of other potential items of non-Aboriginal heritage, additional to those recorded listing locations that may be impacted by the project
- Updates to existing background information with results of the field inspections.

Field inspections were undertaken and included a pedestrian and vehicle survey from the public domain with the project footprint. Sites marked on parish plans or identified as part of the survey were inspected and:

- The structure and/or features identified at each site were recorded
- The structures/features were then assessed for historical significance
- Photographs were taken of the structures/features with details maintained in a photo log.

3.5 Assessment of heritage significance

The statements of significance for the assessed heritage items have been drawn from the following local, state and federal statutory and non-statutory heritage registers:

- State Heritage Register
- NSW State Heritage Inventory database
- Ashfield LEP
- Leichhardt LEP
- Marrickville LEP
- Sydney LEP
- S170 Registers for Sydney Water, Roads and Maritime, Sydney Ports, RailCorp and Ausgrid
- SREP 26.

Additional information on significance, including heritage curtilages, has been drawn from conservation reports, such as CMPs, conservation plans and heritage impact statements, where available. These documents are cited in the footnotes to this report.

The methodology for assessments of heritage significance is based on the NSW heritage criteria as set out in the NSW Heritage Manual guideline, *Assessing Heritage Significance*, prepared by the

NSW Heritage Office in 2001. Assessments of potential heritage significance for items identified during field survey were undertaken in accordance with NSW Heritage Manual guidelines.

3.6 Archaeological assessment

The evaluation of the historical archaeological potential associated with various phases of history within the project footprint is based on consideration of the physical evidence observed at the sites, identified areas of previous disturbance, historical information about the development and occupation of the sites and previous archaeological assessments and excavations. Consequently, a broad approach to the identification of the potential archaeological resource has been adopted and is based on a predictive model that assumes that historical archaeological remains are generally located close to occupation and activity areas.

The historical background and significance assessment of individual sites within the project footprint has been primarily based on previous historical archaeological assessment and excavations, as well as historical information gathered for this HIA from a range of primary and secondary sources, presented in **Chapter 4**. A field survey of the project footprint has been undertaken to assess the general condition and locations of known and potential historical archaeological sites. Further detail in provided in **Chapter 5**.

3.7 Assessment of heritage impact

This HIA has been prepared with reference to the guideline document *Statements of Heritage Impact* (2002), prepared by the NSW Heritage Office and contained within the NSW Heritage Manual. It is also consistent with the relevant principles and guidelines of the Burra Charter, which defines the principles and procedures to be followed in the conservation of Australian heritage places.

In order to clarify the potential impacts of the proposed works, GML has developed a ranking for measuring the level of potential impacts on heritage values (see **Table 3-1**). This methodology was developed for the CBD and South East Light Rail Heritage Impact Assessment prepared by GML in 2013, and the M4 East Non-Aboriginal Heritage Impact Assessment prepared by GML in 2015, and is applied consistently in this report. The methodology used to rate the impact level is explained below.

These rankings are applied throughout this report using an item by item approach. The impact ranking is not related to the significance of the heritage item. The impact ranking relates to the effect of the proposed actions/works on the identified heritage values of the individual item/area rather than indexed against the overall impacts of the project.

Table 3-1 Ranking of heritage impact

Ranking	Definition
Major adverse	Actions that would have a severe, long-term and possibly irreversible impact on a heritage item. Actions in this category would include partial or complete demolition of a heritage item or addition of new structures in its vicinity that destroy the visual setting of the item. These actions cannot be fully mitigated.
Moderate adverse	Actions that would have an adverse impact on a heritage item. Actions in this category would include removal of an important part of a heritage item's setting or temporary removal of significant elements or fabric. The impact of these actions could be reduced through appropriate mitigation measures.
Minor adverse	Actions that would have a minor adverse impact on a heritage item. This may be the result of the action affecting only a small part of the place or a distant/small part of the setting of a heritage place. The action may also be temporary and/or reversible.
Neutral	Actions that would have no heritage impact.
Minor positive	Actions that would bring a minor benefit to a heritage item, such as an improvement in the item's visual setting.

Ranking	Definition
Moderate positive	Actions that would bring a moderate benefit to a heritage item, such as removal of intrusive elements or fabric or a substantial improvement to the item's visual setting.
Major positive	Actions that would bring a major benefit to a heritage item, such as reconstruction of significant fabric, removal of substantial intrusive elements/fabric or reinstatement of an item's visual setting or curtilage.

3.8 Alternative locations and design options

Chapter 4 (Project development and alternatives) of the EIS details the alternatives for the M4-M5 Link project (eg improvements to existing arterial road networks, investment in alternative transport modes, demand management, and the 'do nothing'/'do minimum' case), as well options that were considered as part of the design development process for the M4-M5 Link project.

Specific components of the M4-M5 Link project which were removed, which avoided or minimised heritage impacts include:

- Removal of the Camperdown interchange at Camperdown which avoided direct and indirect impacts on HCAs and heritage items such as the University of Sydney and Victoria Park (both subject to an application for State significance) and on the locally listed sandstone retaining wall on the northern side of Parramatta Road
- Removal of Easton Park as a compound site which avoided direct impact to the locally listed park, reduced impacts on the Easton Park HCA, as well as allowing the retention of the locally listed Sewage Pumping Station No.6
- Removal of the proposed Angel Street/Railway Lane, Newtown site from the construction footprint which avoided direct impact (demolition) on the former Newtown Tram Sheds (of State significance)
- Removal of Derbyshire Road as a mid-point tunnel and civil site and as a workforce parking site which avoided direct impact (demolition) of one local heritage item which consisted of two buildings; former State Rail Authority (SRA) cable store and traffic office at Leichhardt.

Other aspects of the project which could have potentially impacted heritage items or HCAs, which have had alternatives considered included:

- The location of the ventilation facilities and outlets for the project, and in particular for the Iron Cove Link
- The location of bioretention facilities in Leichhardt.

3.9 Previous reports

GML has reviewed the following reports in the preparation of this HIA:

- GML Heritage Pty Ltd, 2016, Rozelle Rail Yards Heritage Impact Assessment, prepared for Roads and Maritime Services
- GML Heritage Pty Ltd, 2015, WestConnex M4 East Non-Aboriginal Heritage Impact Assessment, prepared for WestConnex Delivery Authority
- AECOM Australia Pty Ltd and GHD Pty Ltd, 2015, WestConnex M4 East Environmental Impact Statement, prepared for WestConnex Delivery Authority
- AECOM Australia Pty Ltd, WestConnex 2015, New M5 Non-Aboriginal Heritage Impact Assessment, prepared for Roads and Maritime Services
- AECOM Australia Pty Ltd, WestConnex 2015, New M5 Environmental Impact Statement, prepared for Roads and Maritime Services.

Heritage reports, such as CMPs and archaeological assessments, referred to in the preparation of this HIA, are acknowledged in the endnotes for each section.

3.10 Limitations

Only those areas subject to surface works/infrastructure and their immediate vicinities were surveyed in the preparation of this HIA. As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further. Where tunnels are closer to the surface – ie following on from or leading to cut-and-cover tunnels and construction of tunnel portals and ramps – there may be potential for possible damage from the effects of construction vibration. These have been assessed and there are management measures for potential vibration impacts to properties in the vicinity of the works and above the tunnel alignment.

Properties of potential heritage values that are proposed to be demolished for the project, which are not listed as heritage items or within HCAs, were subject to heritage significance assessments to identify whether they have potential heritage values.

3.11 Authors

This HIA has been prepared by the GML consultants listed in the following table. Unless otherwise noted, all photographs were taken by GML on various site inspections as part of the preparation of this HIA.

Table 3-2 Consultant qualifications and experience

Consultant	Qualification	Experience
Julian Siu, Associate; project manager, was the primary author of the built heritage impact assessment	Master of Heritage Conservation, University of Sydney (currently undertaking) Master of Architecture, University of Sydney Bachelor of Design (Architecture/Urban Design and Planning), University of Sydney	Julian is a built heritage expert with extensive experience in providing heritage conservation advice, undertaking heritage assessments and preparing various heritage management reports. He has also developed strategic heritage management frameworks for key development and industrial sites.
Emma McGirr, Consultant; assisted with the built heritage impact assessment	Master of Urban Planning, University of NSW Bachelor of Arts (Art History), University of Sydney	Emma is a heritage specialist with a background in historical, curatorial and cultural studies as well as experience in urban planning.
Jane McMahon, Senior Consultant; prepared the historical archaeological assessment	Bachelor of Arts (Honours), University of Sydney	Jane has five years of experience in historical archaeology and heritage interpretation.
Sophie Jennings, Consultant; assisted with the historical archaeological assessment	Bachelor of Arts (Archaeology, Heritage Studies), University of Sydney Bachelor of Arts (Honours) (Archaeology), University of Western Australia	Sophie has eight years' experience as a professional archaeologist working in the heritage sector, and has undertaken archaeological projects in both Australia and England.
Angela So, Consultant; prepared the historical overview	Master of Arts (Research), University of Sydney Bachelor of Arts (Honours), University of Sydney	Angela has over 10 years' experience in archaeology, historical research and interpretation planning.

Consultant	Qualification	Experience
Claire Nunez, Associate; project director and provided overall guidance and input to the project and reviewed the report	Diploma of Project Management, University of New England Partnerships Bachelor of Cultural Heritage Studies, University of Canberra	Claire has extensive experience working on heritage assessments, management planning documents and liaising with a wide variety of stakeholders including Australian federal and state government agencies, as well as international organisations, community groups and industry representatives.
Peter Romey, Special Adviser; provided input to the project and reviewed the report	Elected Associate by the Royal Australian Institute of Architects Bachelor of Architecture, NSW Institute of Technology	Special Adviser and former Partner of GML Heritage, Peter has more than 30 years' experience in heritage conservation. He has worked in consultancy firms, government organisations and in private practice.

4 Historical overview

4.1 Introduction

This section provides an overview of historical development of the land within the project footprint and provides further detail on the heritage study areas:

- Area 1 – Haberfield/Ashfield (Option A around Wattle Street and Option B around Alt Street and Bland Street) (around Wattle Street)
- Area 2 – Leichhardt
- Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road, excluding Iron Cove which comprises Area 4)
- Area 4 – Iron Cove (around Victoria Road)
- Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)
- Area 6 – St Peters.

4.1.1 Historical resources

Historical research was undertaken for the heritage study areas Leichhardt, Rozelle Rail Yards, Iron Cove and Annandale. The histories are based on primary and secondary sources. Research and archival material was retrieved from the following institutions:

- Australian Railway Historical Society (NSW)
- City of Sydney Archives
- Inner West Council Local Studies Library
- Land, Property and Information Office (LPI)
- National Library of Australia (NLA)
- State Library of NSW (SLNSW)
- Sydney Water/Water NSW Historical Research and Archives Facility
- Transport Heritage NSW
- Westpac Banking Group Archives.

The historical information for the Haberfield and St Peters study areas has been provided in the M4 East Non-Aboriginal Heritage Impact Assessment (GML 2015) and New M5 Non-Aboriginal Heritage Impact Assessment (AECOM 2015) respectively.

4.2 Area 1 – Haberfield/Ashfield heritage study area

Land on the northern side of Parramatta Road between Dobroyd Parade and O'Connor Street, Haberfield, was originally part of the 480-acre Dobroyd Estate granted to Nicholas Bayley in 1803. Land opposite this on the southern side of Parramatta Road from Page Avenue to Ashfield Park was originally part of 280 acres granted to Augustus Alt (see **Figure 4.1**).

4.2.1 Dobroyd Estate

A grant of 480 acres to Ensign Nicholas Bayley in 1803 comprised all land north of Parramatta Road from the shores of Iron Cove to Long Cove (**Figure 4.1**). The property was known as Sunning Hill Farm; however, there is no evidence that Bayley farmed or built a dwelling there during his tenure. The boundaries of this land form the present day suburb of Haberfield.

Simeon Lord, emancipist and successful Sydney businessman, purchased Sunning Hill in 1805 and renamed it 'Dobroyd'. His daughter Sarah Anne married Dr David Ramsay in 1825, and the couple were given the Dobroyd Estate as a component of Sarah's dowry.[i]

The Ramsay's built a timber cottage and garden on the property in 1826, named Dobroyd House. It was outside the study area on the western side of Dalhousie Street near Parramatta Road. During this phase of development, the property was used for grazing and agricultural activities, with associated outbuildings situated closer to the Dobroyd residence and farm complex. An additional house was constructed on the Dobroyd Estate west of Dobroyd House in 1855 following the marriage of Mary Louisa Ramsay (David and Sarah Anne's daughter) to Alexander Learmonth. Mary and Alexander called their house Yasmar.[ii]

4.2.2 Subdivision of the Dobroyd Estate

While most of the Dobroyd Estate remained undeveloped until 1901, the land east of Wattle Street between Parramatta Road and Ramsay Street was subdivided in 1885. Owned by Isabella Ramsay, this subdivision included Walker and Alt Street (then named The Avenue) and Tenandra Street (now Alt Street) (**Figure 4-2**). A sale notice from October 1885 had some of the lots shaded indicating they had already been sold however the Sands Directory records only one occupant within this subdivision, on Tenandra (Alt) Street until 1910. Between 1910 and 1915 a few more occupants appeared in Wattle Street, The Avenue (Walker Avenue) and Alt Street plus one occupant along the Parramatta Road frontage, but by 1915 most of this subdivision had been developed including the properties fronting Parramatta Road which were all residential at this time.

From 1901 the other Ramsay siblings began selling their land. Local real estate entrepreneur and early town planning advocate Richard Stanton had a vision for this as yet undeveloped land and initially the Ramsay children sold their land directly to Stanton. Haberfield is the tangible evidence of his vision. The suburb's name arose from Mrs Stanton (nee Nicholls) family's connection with Lord Haberfield, Mayor of Bristol in the early nineteenth century.[iii]

Stanton was inspired by an early town planning movement which sought to regulate uses and building types, an example he had seen in England and the USA. From the first subdivision in 1901, Haberfield was marketed as the 'Model Suburb' and, being based upon the City Beautiful Movement, was also known as the 'Garden Suburb'. This model suburb included sewerage, (thereby no longer needing rear lanes) and provided public infrastructure of nature strips, public trees, stone curbs and gutters. Houses were to have cavity brick walls to rid the salt damp. Stanton controlled all aspects from subdivision-providing finance and buyer terms and building materials through to designing the gardens and houses. His first architect was Wormal, while J Spencer Stansfield is accredited with designing the bulk of all the Stanton estate houses.[iv]

The land from eastern side of Alt Street to eastern side of Bland Street was inherited by Mary Louisa Ramsay and contained Yasmar House. She sold the portion containing the study area to Joseph and Albert Grace who subdivided it in 1905, as the Haberfield No.3 Subdivision (**Figure 4-3**). This subdivision was developed between 1910 and 1915.

By the 1930s Haberfield had been completed with house types from the earlier Queen Ann and Arts and Crafts styles, followed by early Inter-war Bungalow style (**Figure 4-4**).

4.2.3 The Underwood Estate

Baron August Alt, first surveyor general of the new colony, was granted 100 acres at Ashfield on the western side of Iron Cove Creek (**Figure 4-1**). He named this land Hermitage Farm and built for himself a house with orchard where Croydon Station now lies. Robert Campbell jnr purchased Alts 280 acres in 1813 and named this property Ashfield Park. The Ashfield Park Estate was then sold to Joseph Underwood in 1817 and in 1818 he added to his land holdings Alt's original 100-acre Hermitage Farm.[v] When Joseph died in 1833 his widow Elizabeth took over the management of the Ashfield Park Estate, including the completion of a large family home. Joseph had in 1833 begun the construction of a house on his Estate but had only laid the foundation stones. He had however built a magnificent stables block and Elizabeth stopped all work on the house and converted the stables into a large family home. This house was located outside the study area.

4.2.4 Subdivision of the Ashfield Park Estate

Elizabeth began to subdivide her land in 1838 forming the beginnings of the Village of Ashfield. The study area formed part of Block 5 (**Figure 4-5**). The remaining lands were kept by Elizabeth until her death in 1858, when they were also subdivided. In 1859 these heavily timbered 500 acres of Ashfield

Park Estate, extending from Parramatta Road to Liverpool Road, were subdivided and sold. The blocks of land in this subdivision were large' one to five acres, attracting wealthier clientele and with the arrival of the railway in 1855 with a station at Ashfield, this area prospered. [vi] Mansions for some wealthy merchants and professional men were constructed and the dense with the iron bark forest began to disappear. These well to do residents also bought up extra land in this area waiting for further subdivision in the next building boom.

The block of land bound by Frederick, Henry, Alt Streets and Parramatta Road was purchased in 1859 by Thomas Wild from the Ashfield Estate subdivision. Wild purchased Lots 33, 34, 35, 36, 37 and 42, 43, 44 of Section 2. In the 1860s Wild built a house on his land which he called 'Gordon'. There were also several out-buildings, a three storey stable, a double coach house with hayloft above, grooms rooms, storeroom, harnesses and saddle room.[vii] The buildings were all located at the rear of the site near Henry Street (**Figure 4-7**).

In 1876 the entire site was purchased by Thomas Walker for the establishment of the Ashfield Infants Home. The Home's aim was for the shelter and care of foundling and orphaned children. This home remains on the site and the complex has, over the years, been enlarged with the construction of additional structures. No significant development was undertaken on the northern portion of the block fronting Parramatta Road. Plans from the 1890s indicate a small creek ran through the middle of the site, with a dam in the centre of the block, and bridges at Frederick Street and Alt Street. Two gates provided entry to the property from Parramatta Road (**Figure 4-7**).

In 1920 the eastern portion of the site was sold and then subdivided for residential development (**Figure 4-8**). The blocks within the current study area are marked as unoccupied at this time. Development within this subdivision was completed by 1930 (**Figure 4-5**). The remaining land fronting Parramatta Road was sold in 1935 to Peak Freans (Australia) Ltd Biscuit Manufacturers for the construction of their biscuit factory.[viii]

On the eastern side of Alt Street lay the Underwood Nursery (Camellia Grove) originally established by Joseph Underwood with John Treseder as the nursery man. In 1882 land surrounding the nursery along Parramatta Road and Bland Street was offered for sale (**Figure 4-9**). The portion within the study area is marked as forming part of the orchard. By 1890 a Sydney Water plan shows that no development had occurred on the Parramatta Road lots but four houses (outside the study area) are shown fronting Bland Street (**Figure 4-10**).

The Parramatta Road frontage was developed in the early 1920s and was an early commercial strip. Businesses along this strip in 1924 included two grocers, a hairdresser, a motor garage (one of the earliest of many that would occupy parts of Parramatta Road), a timber yard, an electrician and a draper (**Figure 4-5**). [ix]

Post–1980s development along Parramatta Road

With the increasing ownership of cars in Sydney and the spreading suburbs, dealerships and garages began to spread along Parramatta Road. Much of the land along Parramatta Road at Haberfield was redeveloped from the 1980s as industrial sites including several car dealerships which remain the main business in this area. Within the study area, most residential buildings have been demolished and replaced with open car parking, or dealership showrooms. On the west side of Parramatta Road, this has included deep excavation into the slope of the site to the southwest. A row of early twentieth century buildings remain on the corner of Parramatta Road and Bland Street.

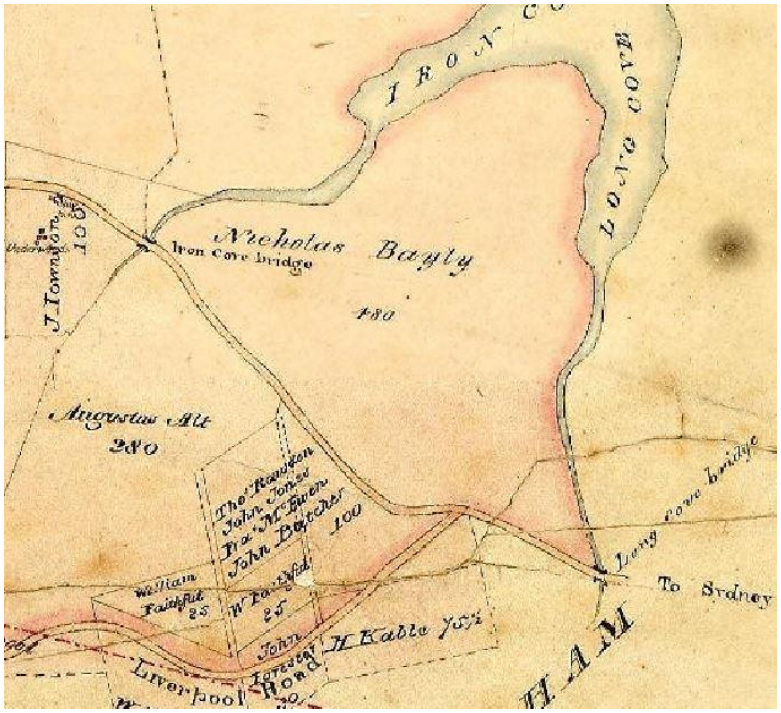


Figure 4-1 Parish Map showing on the early land grants on both sides of Parramatta Road

To the south, the land granted Augustus Alt. Land on the northern side of Parramatta Road formed the Dobroyd Estate and is now the suburb of Haberfield. (Source: Department of Lands)

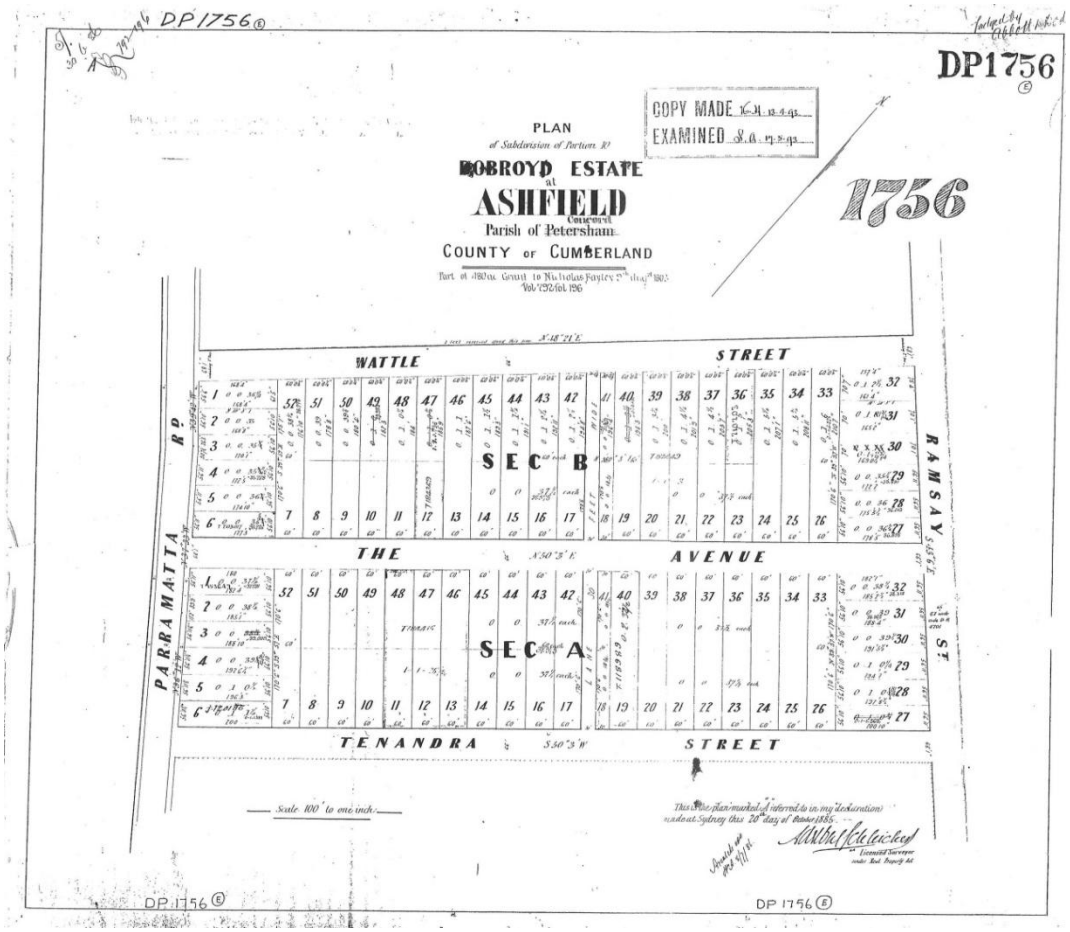


Figure 4-2 1885 subdivision of the land east of Wattle Street, including Walker Street (formerly The Avenue) and Alt Street (formerly Tenandra Street)

(Source: DP1756 Department of Lands)

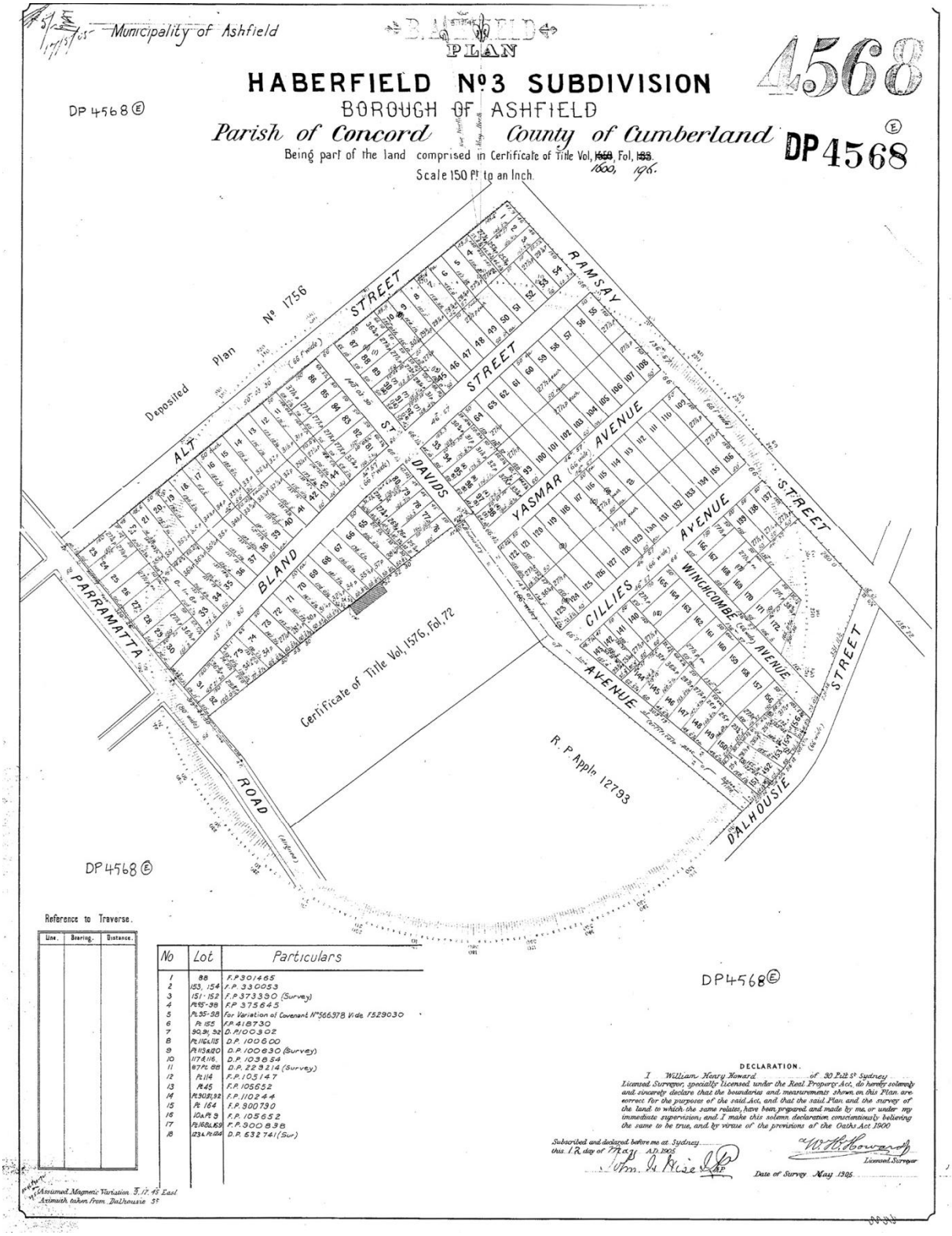


Figure 4-3 1905 plan of the Haberfield No. 3 Subdivision dated May 1905

This was the subdivision of Mary Louisa Ramsay's land around Yasmar. (Source: DP4568 Department of Lands)

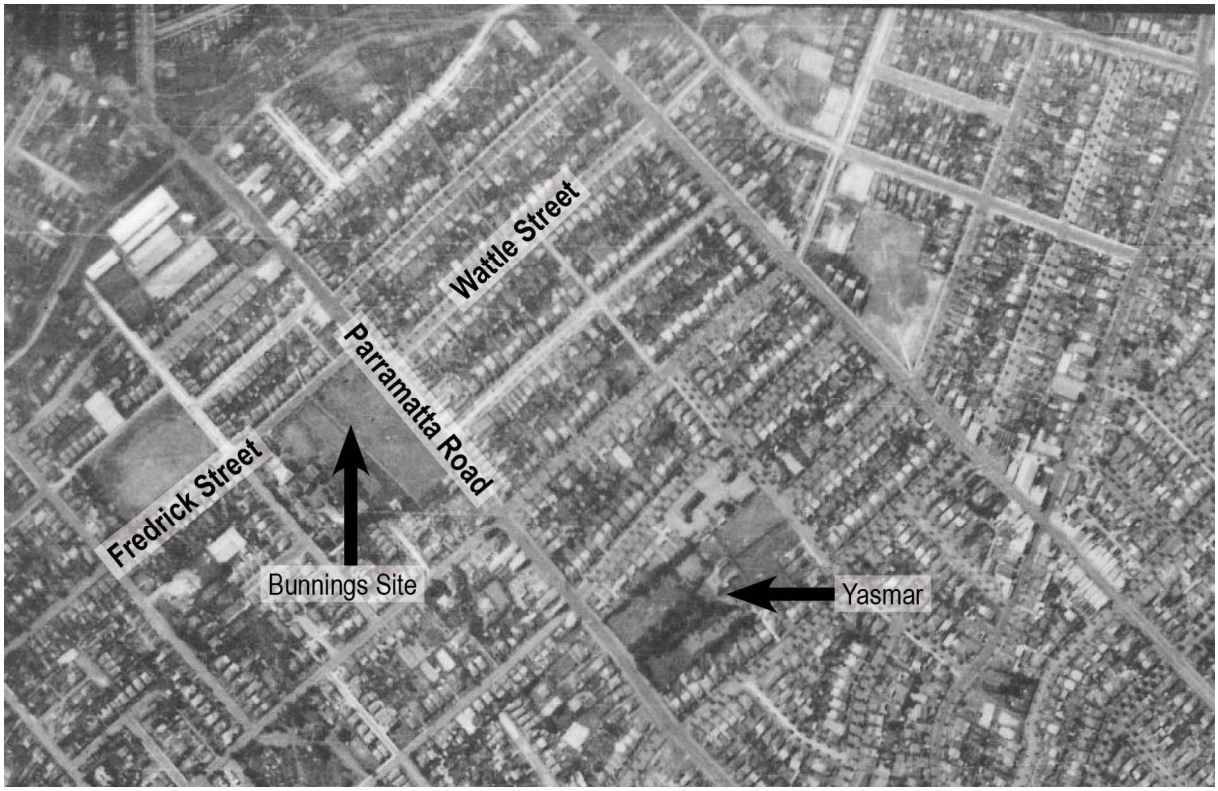


Figure 4-4 1930 aerial showing development along Parramatta Road around the study area

Note the Bunnings site is still shown as vacant land. Almost all the subdivisions discussed in this study have been fully developed. (Source: Department of Lands)



Figure 4-5 1943 aerial showing development along Parramatta Road around the study area

Almost all the lots within the study area have been developed. (Source: Department of Lands)

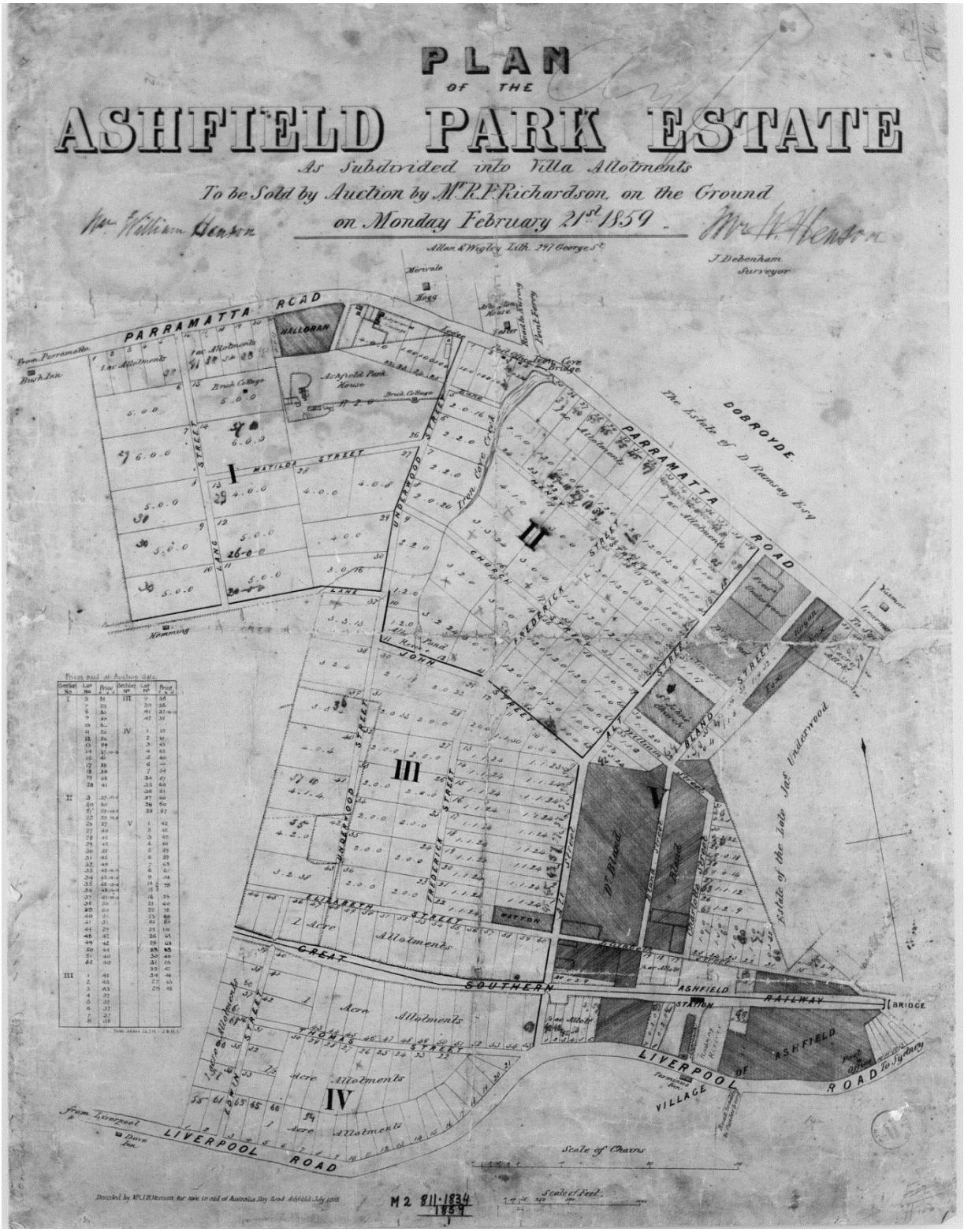


Figure 4-6 1859 subdivision of the Ashfield Park Estate

(Source: SLNSW ZM2 811.1834/1859/1)

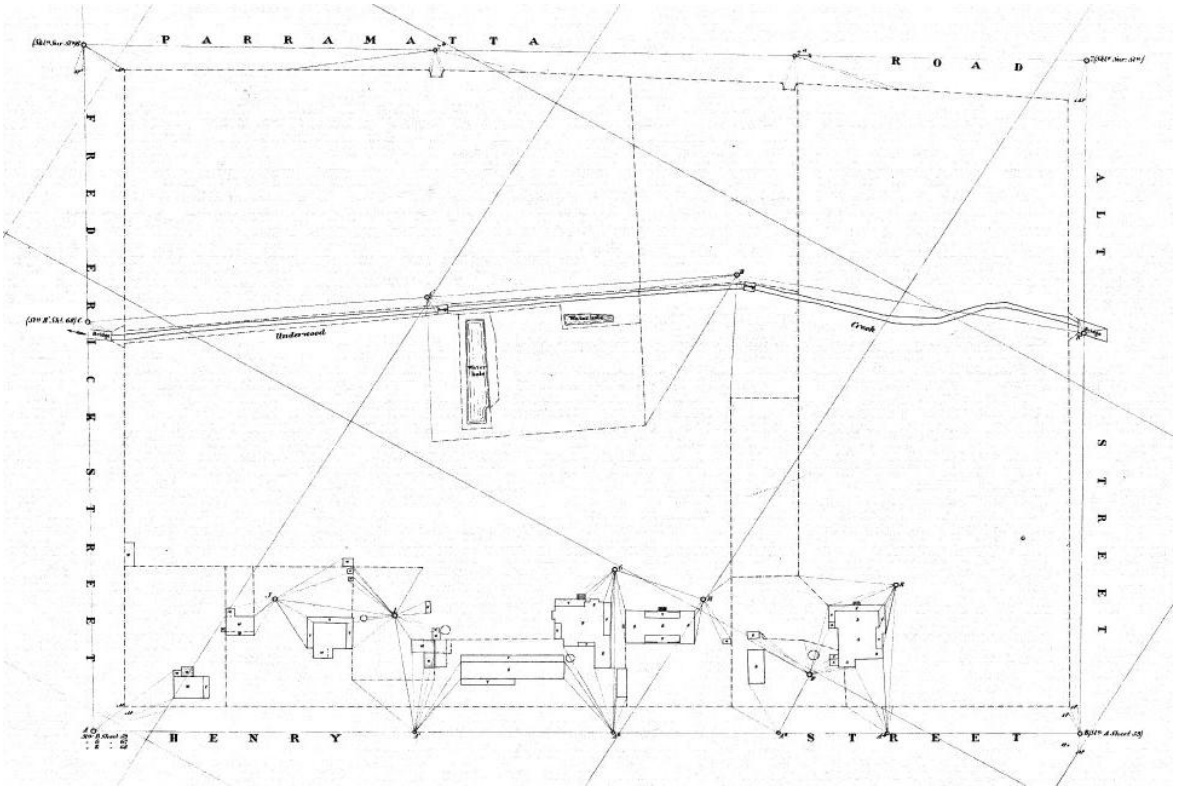


Figure 4-7 Site of the Ashfield Infants Home, c1890

The land on the corner of Parramatta Road and Frederick Street would later be occupied by the Peak Frean Biscuit Factory , now Bunnings. (Source: Sydney Water Plan Room)

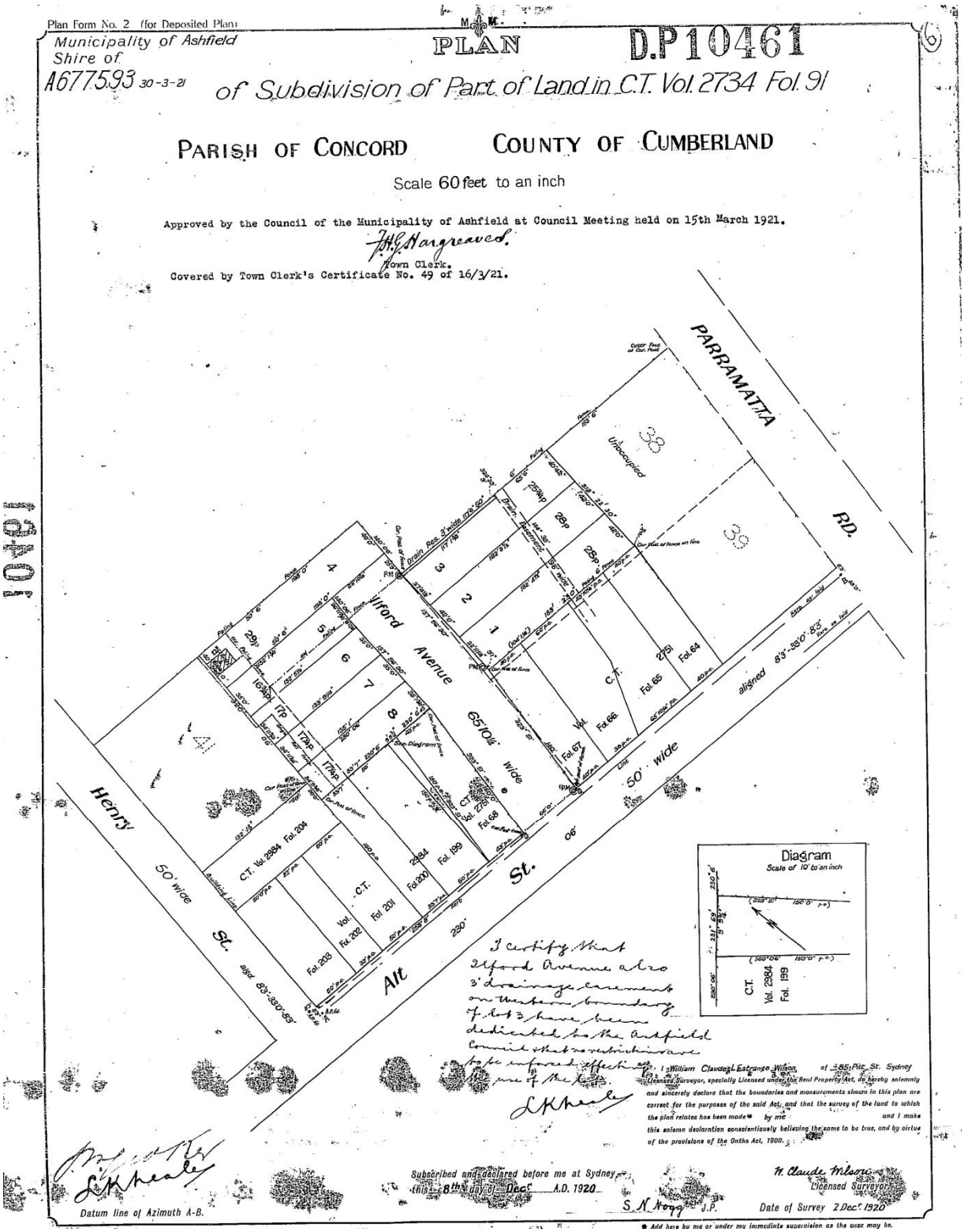


Figure 4-8 1920 subdivision of the eastern portion of the Ashfield Infants Home site, including the study area at the intersection of Alt Street and Parramatta Road

(Source: DP 10461, Department of Lands)

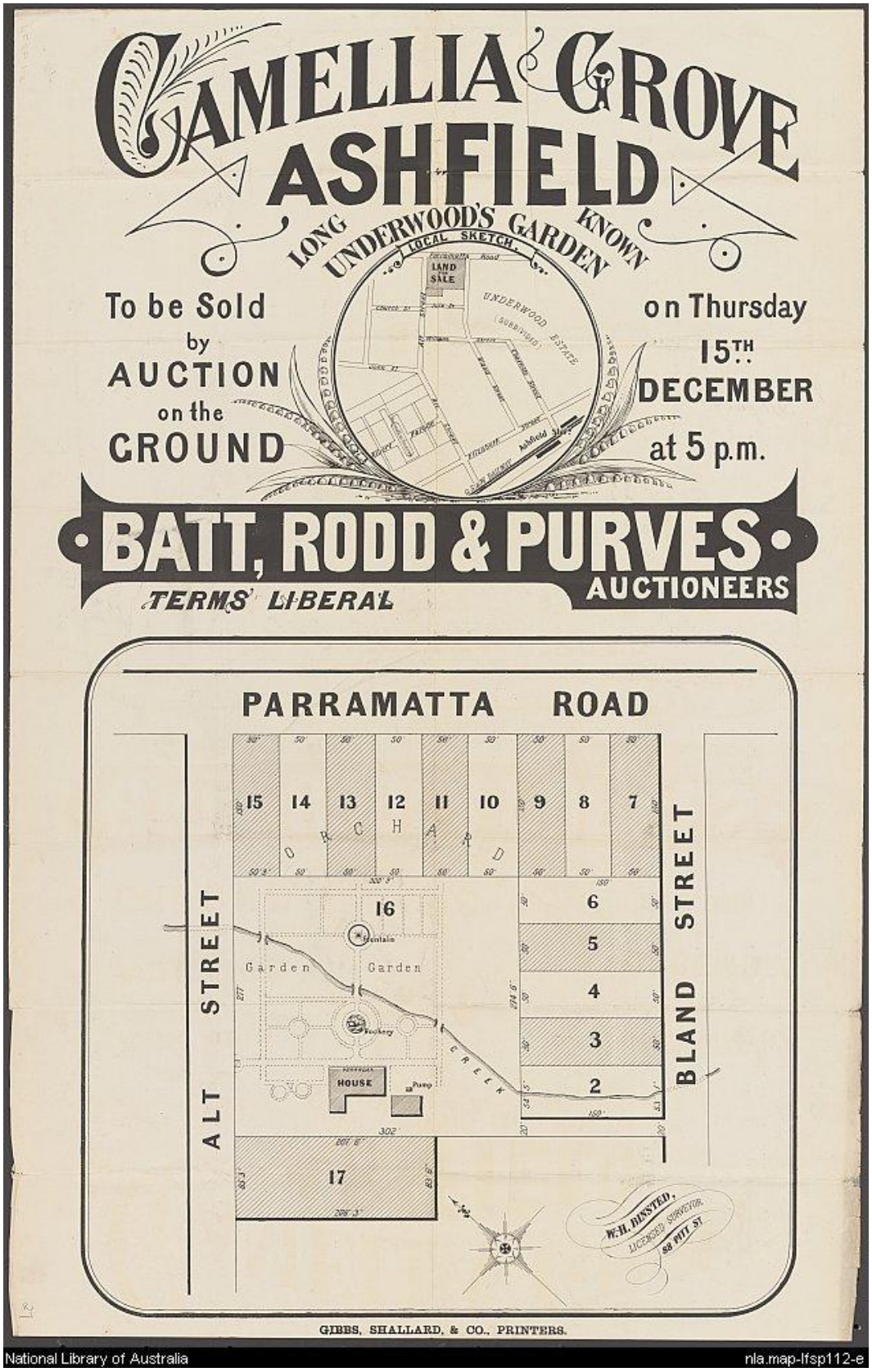


Figure 4-9 1882 Subdivision of the Camellia Grove (Underwood's Nursery) Ashfield

(Source: NLA)

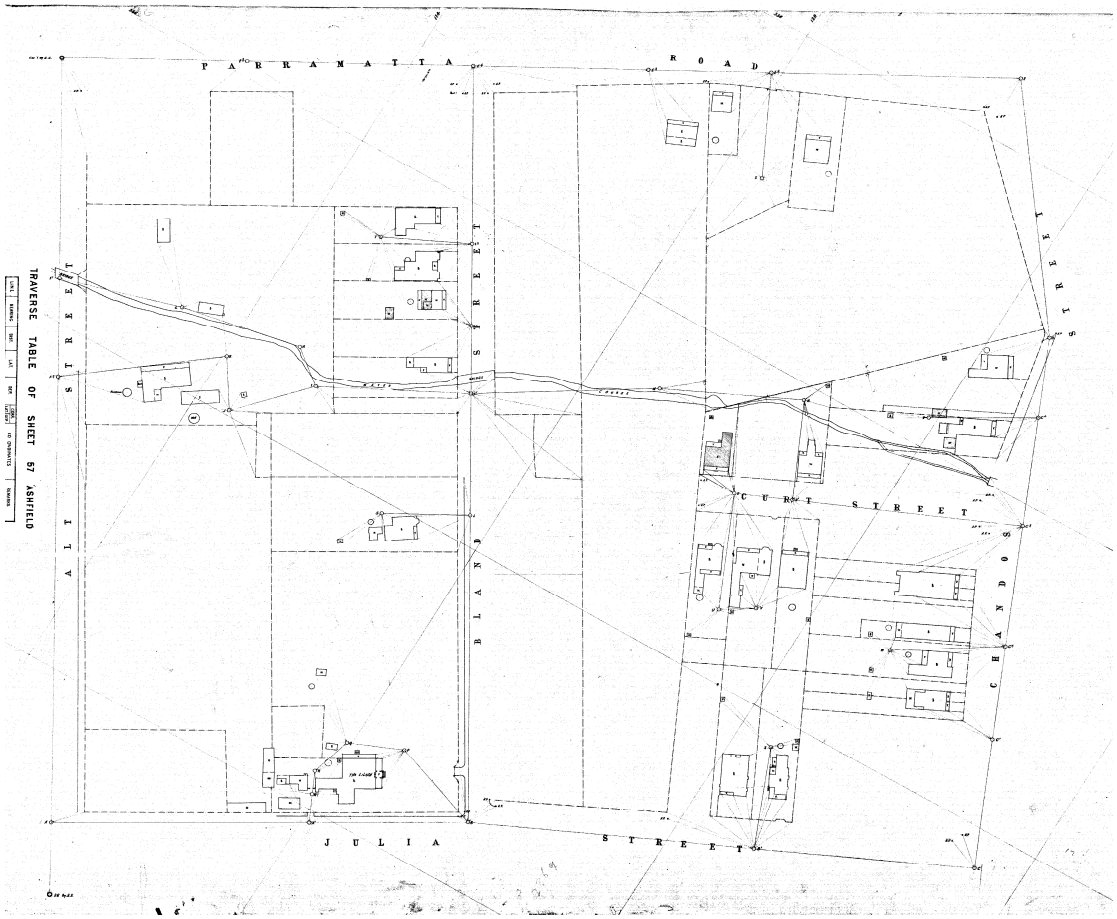


Figure 4-10 Development on southern side of Parramatta Road between Alt Street and Chandos Street, 1892

(Source: Sydney Water Plan Room)

4.3 Area 2 – Leichhardt heritage study area

4.3.1 Early land grant: 1811–1832

The Darley Road construction sites originally formed part of a 270-acre grant to Ensign Hugh Piper in 1811, which he named 'Macquarie Gift'.[10] Ensign Piper arrived in NSW after 1799 as an officer of the NSW Corps. His older brother Captain John Piper, also of the NSW Corps, had been in NSW since 1792. Captain Piper was also granted in 1811 the 165 acres adjacent to Ensign Piper's grant which he named 'Piperston'.[11]

Ensign Piper left NSW with his regiment in 1812 and never returned to Australia. Captain Piper remained in the colony and retired from the army. In 1814, he was appointed to the position of Naval Officer and continued to acquire land across NSW and Van Diemen's Land, including at Vaucluse, Woollahra, Point Piper and Bathurst. In 1820 Captain Piper purchased James Darbyshire's 30 acres adjoining 'Macquarie Gift' to the north and in 1822, he purchased John Prentice's 100 acres 'Hampton Farm' to the south and completed building his official residence 'Henrietta Villa', at Point Piper.[12] By 1832, Captain Piper had assumed ownership of 'Macquarie Gift' and also owned Thomas Bigger's 30-acre 'Biggers Farm', located between 'Macquarie Gift' and 'Piperston'. By now, Captain Piper owned over 595 acres–the majority of the current suburb of Leichhardt.[13] However, during this time a government inquiry was undertaken into his administration as Naval Officer, a position responsible for collecting customs duties, and it was found that Captain Piper had embezzled £12,000. He was required to sell most of his properties in order to pay back the government. Once the debt was settled, Captain Piper retreated with his family to Bathurst and died at his property 'Westbourne' in 1851.[14]

4.3.2 The Helsarmel estate–phase 1: 1832–1844

Captain Piper's land in Leichhardt was sold off in four separation portions. The Darley Road and Blackmore Park sites are located within the 92 acres purchased by Jean Charles Prosper de Mestre in 1832 (**Figure 4-11**). The 92 acres comprised Darbyshire's 30 acres and 62 acres of 'Macquarie Gift', which de Mestre named 'Helsarmel'. This name was derived from the first three letters of the names of his three eldest daughters – Helen, Sarah and Melanie.[15]

De Mestre was an American-French merchant who arrived in NSW in 1818. He began working in Sydney as an importer and was active in the commercial affairs of the colony. He eventually became a director of the Bank of NSW, serving from 1826 to 1842. He was also director at several other companies including the Marine Assurance Co in the 1830s and a founder of the Mutual Fire Insurance Co of Sydney in 1840. Prior to purchasing in Leichhardt, de Mestre already owned a small farm, 'Terara' at Bargo, and was granted 1300 acres on the Shoalhaven River in 1829. He also owned several houses in Sydney, including his residence in George Street and later in Liverpool Street. De Mestre became insolvent in 1843 and died later that year at 'Terara'.[16]

4.3.3 The Helsarmel Estate–phase 2: 1844–1883

There is currently no historical evidence that shows what de Mestre did with 'Helsarmel' while it was in his ownership. It is possible that he occasionally resided there but his main residence was in Sydney. After his death, 'Helsarmel' was purchased by Henry Alfred Hindson.[17]

Hindson kept the property for 11 years and sold it to James Henderson in February 1856, who six months later sold it to George William Lord, son of wealthy emancipist Simeon Lord (**Figure 4-12**). In October 1856, there was an advertisement by George William Lord for the lease of Helsarmel, which stated:

> *TO BE LET, Helsarmel, the present residence of the undersigned [George William Lord]. It is situated on the Balmain-road, adjoining Messers. Norton and Beames, and consists of dwelling-house, coach-house, stables, and all necessary appurtenances, large garden and orchard together with ninety acres of land divided into paddocks, with large frontage to the salt water.*

George William Lord died in 1880 and 'Helsarmel' was inherited by his son, Herbert Edward Lord. In 1882, Herbert Edward Lord, TA Dibbs and George Lee Lord were listed as joint owners of 'Helsarmel'.[18] In 1883, 'Helsarmel' was sold to Anglo-Australian Investment Finance and Land Company Ltd and separated into two parts–Helsarmel East and Helsarmel West.

4.3.4 Development of Leichhardt: 1871–1890

In 1871, the suburbs of Leichhardt, Lilyfield and Annandale were incorporated in the Municipality of Leichhardt. The municipality covered an area of 1300 acres and a population of 614 people. Leichhardt was already well serviced by horse-drawn buses but there was mounting public pressure for steam trams. The tram network, which extended from the city into Leichhardt along Norton Street to Short Street, was completed in 1884 (**Figure 4-13**). It was further extended north along Norton Street in 1889. The Abbotsford line was opened in 1890 and started at Norton Street and went along Marion Street. The trams were electrified by 1905.[19]

Subdivision – Helsarmel East: 1884

Over 61 acres of the eastern part of the Helsarmel Estate were subdivided into eight sections with 564 lots. Nine new streets were created to provide access to the lots. They were Charles, Hubert, Francis, James, Henry, William and Augustus Streets and Park Road, with Norton Street extending northwards. Sale of the lots began in 1884 and were mainly purchased by the future occupants, establishing their homes, with some houses built by speculators. Streets and allotments were laid out regardless of topography resulting in some lots not being able to be built upon without extensive draining and filling.[20] Many of the unusable allotments were later resumed between 1910 and 1912 for construction of the goods railway.

The Darley Road construction site lies within the Helsarmel East subdivision running perpendicular to the primary street layout as shown in the 1891–1893 Sydney Metropolitan plans (**Figure 4-14**). These show three properties built along Francis Street. The line of a creek which originally drained into Long

Cove Creek (now Hawthorne Canal) runs through the heritage study area. The culvert beneath James Street lies between the two parts of the heritage study area. By 1917 two additional houses were constructed: a third house on the western side of Francis Street and a second on James Street (**Figure 4-15**).

Subdivision – Helsarmel West: 1884

The remaining 31 acres located in the western part of the Helsarmel Estate were not offered for sale until 1888. This part was subdivided into five sections with 318 lots, and extensions were made to Elswick, Piper, Augustus, Charles and William Streets and Park Road. Allotments closer to the swampy grounds along the Long Cove shoreline were more difficult to sell (**Figure 4-16**).

4.3.5 The Goods Railway Line and Leichhardt Goods Yard: 1910–1916

By the turn of the century, increasing traffic of both freight and passengers was causing congestion on suburban railway lines. A scheme to develop separate railways for goods trains was implemented. The goods line would run from Darling Harbour–Glebe Island to Dulwich Hill, via Leichhardt. The new line was laid parallel to the Hawthorne Canal and diverted eastward to Glebe Island, and was constructed along land reclaimed as part of the canal construction, in addition to a number of private properties acquired between 1910 and 1912 by the Commissioner of Railways. The majority of the land purchased formed part of the original Helsarmel subdivisions.[21] A plan dated to December 1917 shows the extent of the land resumed for construction of the rail line along the eastern side of the Hawthorne Canal and cutting across the Helsarmel subdivision (shaded red on **Figure 4-16**). The houses within the larger heritage study area were demolished to accommodate the railway.

The goods line officially opened in 1916. Adjacent to the goods line, the Charles Street Goods Siding was opened in 1918 within the larger heritage study area.[22] A detailed plan dated to August 1916 shows the layout of the adjacent Charles Street railway siding and goods yard situated on the southern side of the goods railway line (**Figure 4-17**). A small shed is shown on the southern side of the railway towards the eastern end of the yard–this is identified as a goods shed on a plan dated to 1922 (

Figure 4-18); the separate goods siding line is also identified.

4.3.6 Construction of Darley Road: 1919–1923

The original section of Darley Road was initially named Park Road and ran along the eastern side of the Hawthorne Canal turning eastwards as far as Charles Street, to the west of the heritage study area. Between 1919 and 1920, the government acquired land on the southern side of the goods line for an extension to Darley Road.[23] The first extension ran parallel to the railway from Loftus Street to Hubert Street, and was extended to James Street in 1923. These later extensions to Darley Road required additional reclamation along the creek bed which drained the area as late as 1923 to facilitate construction.[24]

4.3.7 Operation of the Leichhardt Goods Yard: 1916–present

The Charles Street Goods Siding and Yard continued in operation throughout most of the twentieth century. An aerial photograph of the heritage study area in 1943 shows the goods line, siding and yard within the heritage study area. Piles of timber visible in the western half of the goods yard likely indicates the continued private use of this area. The Charles Street signal box was decommissioned on 23 June 1966, and an agreement was made with Geoff Penny in 1968 for the use of the siding.[25] A photo of the heritage study area taken in 1964 shows that the goods yard remained in use for timber storage at this time. It is probable that the existing warehouses situated within the heritage study area were constructed after Geoff Penny leased the site in 1968. The Charles Street Goods Siding was renamed after Geoff Penny in 1970, and then changed shortly afterwards to Fielder's Siding, after George Fielder, in 1972.[26] The siding went out of use in 1994; the railway line outside the northern edge of the heritage study area was acquired for the Inner West Light Rail Extension and the Leichhardt North tram stop (situated outside the heritage study area) was opened in March 2014.[27] The goods yard remains extant containing two large warehouses which are currently leased to private tenants.

4.3.8 City West Link: 2000–present

Construction of the railway goods line had limited impact on the eastern portion of the heritage study area. The 1943 aerial photograph **(Figure 4-19**) shows three buildings within the heritage study area. Based on the size and outline of the western buildings on James Street it is likely that these are the late nineteenth century buildings. The pair of buildings on Norton Street are both two storeys high and an extension has been added to the rear of the southern building. It is not clear from the aerial if the late nineteenth century houses remain extant at this time. Along the northern edge of the smaller heritage study area a fence demarcates the edge of the railway land sloping northwards down to the rail line which was cut into the landscape. This section of the railway line now lies below the City West Link roadway.

A study by the Leichhardt Historical Society in 1988 shows that the four properties were still standing at this time.[28] The buildings at 350 and 352 Norton Street were in use as shops, while the properties at 109 and 111 James Street consisted of single storey brick houses.

Construction of the City West Link roadway commenced in 1991 with construction of an underpass beneath Victoria Road. The stretch of the new roadway running parallel to the northern side of the heritage study areas forms the last section of the new roadway and was opened in December 2000. It is probable that the late nineteenth century buildings on James and Norton Street were demolished to facilitate construction of the new road. A title search on Lot 1 DP 919865 indicates that it was purchased by Roads and Maritime in July 1993; Lot 17 DP 653807 is also owned by Roads and Maritime although the date of purchase is not known.[29] The eastern heritage study area remains undeveloped land and is currently grassed over.

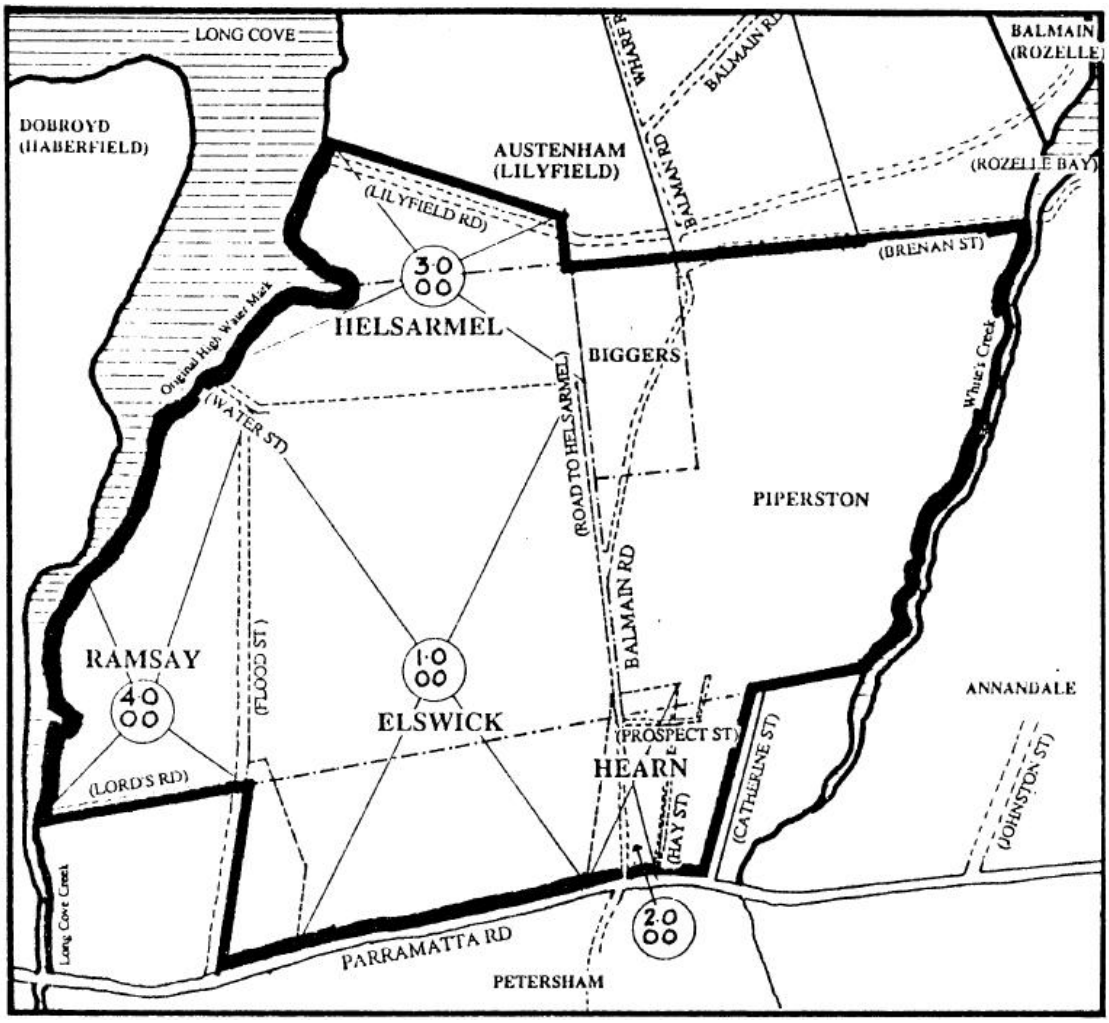


Figure 4-11 Captain John Piper's landholdings in Leichhardt

From 1831–1832, Captain Piper was forced to sell most of his properties to settle a debt. His Leichhardt landholdings were sold in four separation portions. The Darley Street site is located within the portion that became known as the Helsarmel Estate (northwestern portion) (Source: Cusick, A 1989, 'Leichhardt West: Original Land Grants and Subdivisions', *Leichhardt Historical Journal* June 1889, vol 16, figure 4)

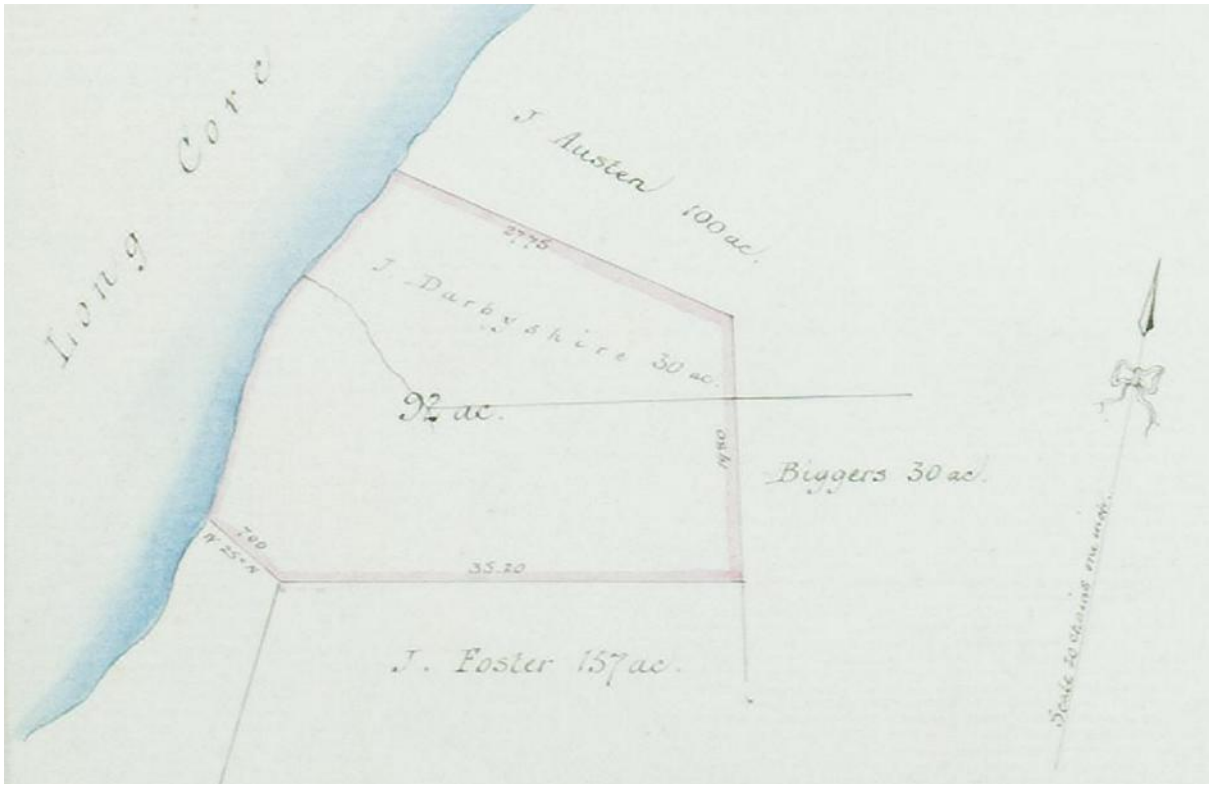


Figure 4-12 'Helsarmel' Estate, as purchased by George William Lord

(Source: CT 1–109, LPI NSW)

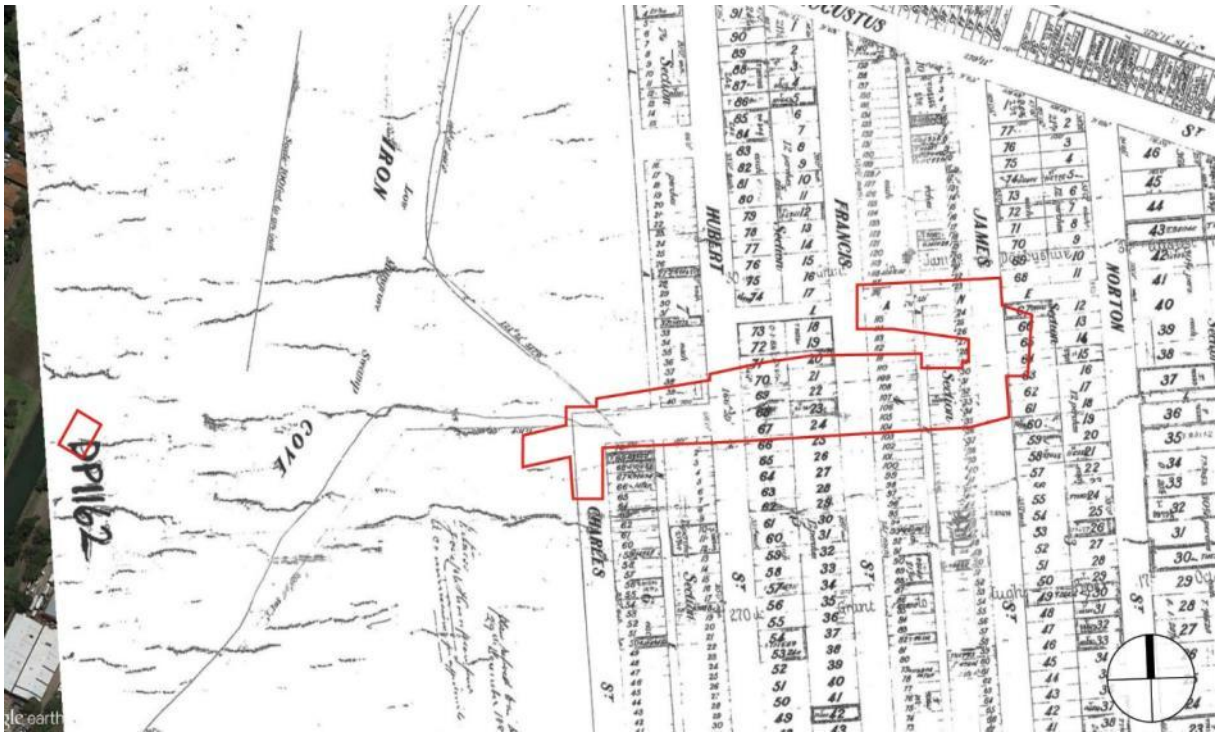


Figure 4-13 Subdivision plan of Helsarmel Estate, Leichhardt, 1886

(Source: DP1162, LPI NSW, with GML overlay 2016)

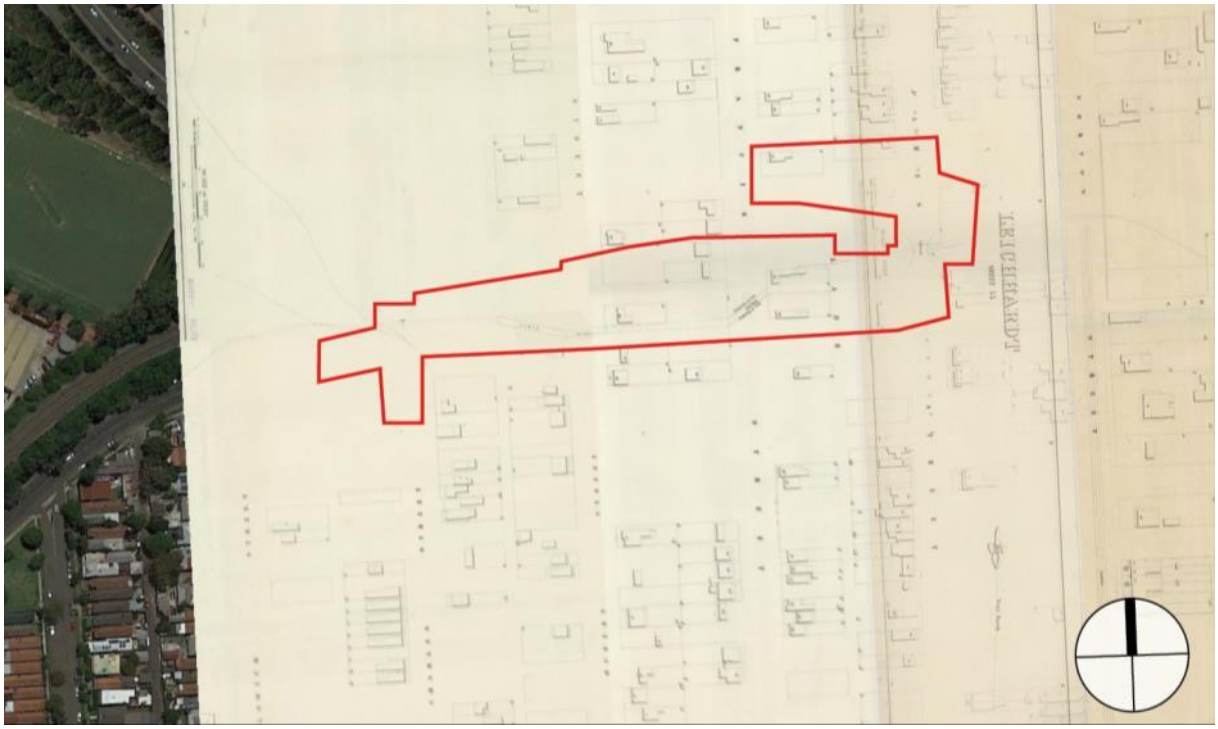


Figure 4-14 Sydney Metropolitan plans, 1891–1893

(Source: SLNSW with GML overlay 2016)

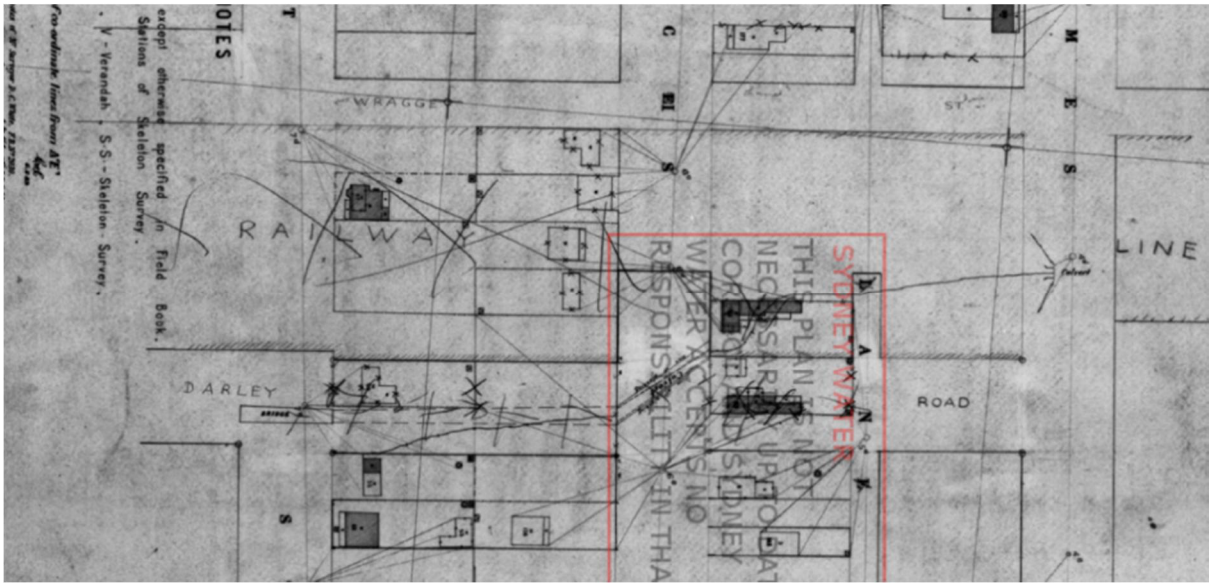


Figure 4-15 Detail from 'Leichhardt, Sheet 53', dated March 1889

(Source: Sydney Water Archives with GML overlay)



Figure 4-16 Detail from 'N.S.W.R. Wardell Road to Glebe Island & Darling Harbour Land Plan', 1917
(Source: Crown Plan 4389-3000, LPI NSW with GML overlay 2016)



Figure 4-17 Plan of the Leichhardt Goods Yard, dated 1917
(Source: Transport Heritage NSW with GML overlay 2016)

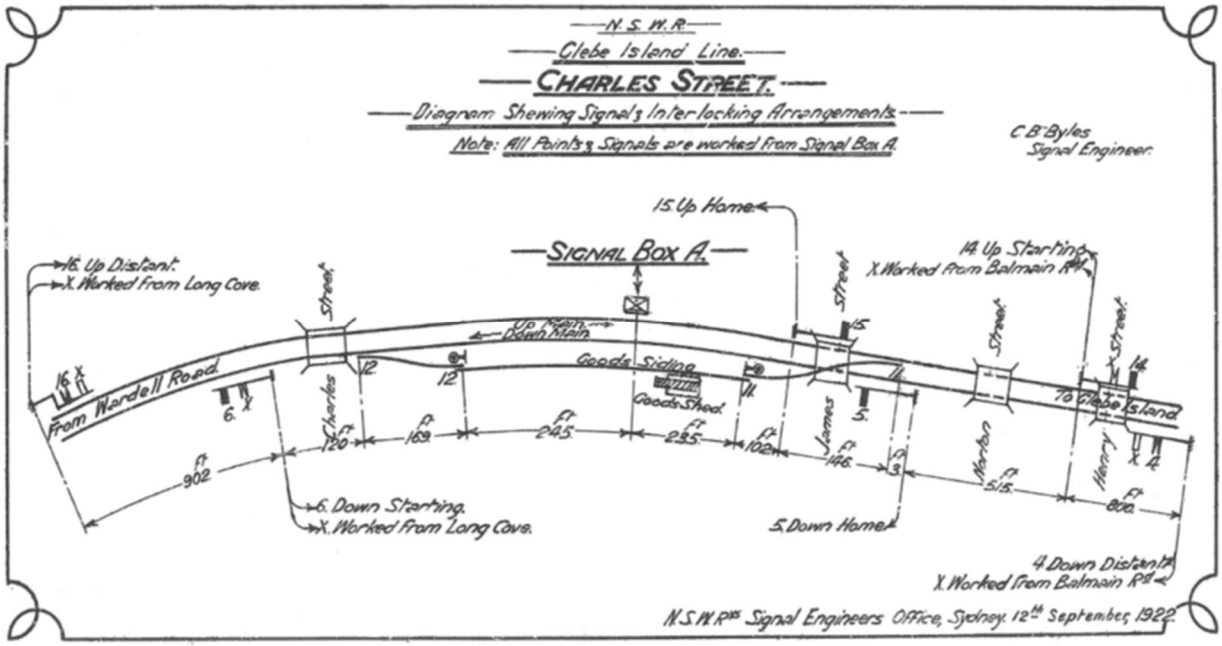


Figure 4-18 Plan of the Leichhardt Goods Yard, dated September 1922

(Source: ARHS [NSW] Track and Signals Diagram 11506 with GML overlay, 2016)

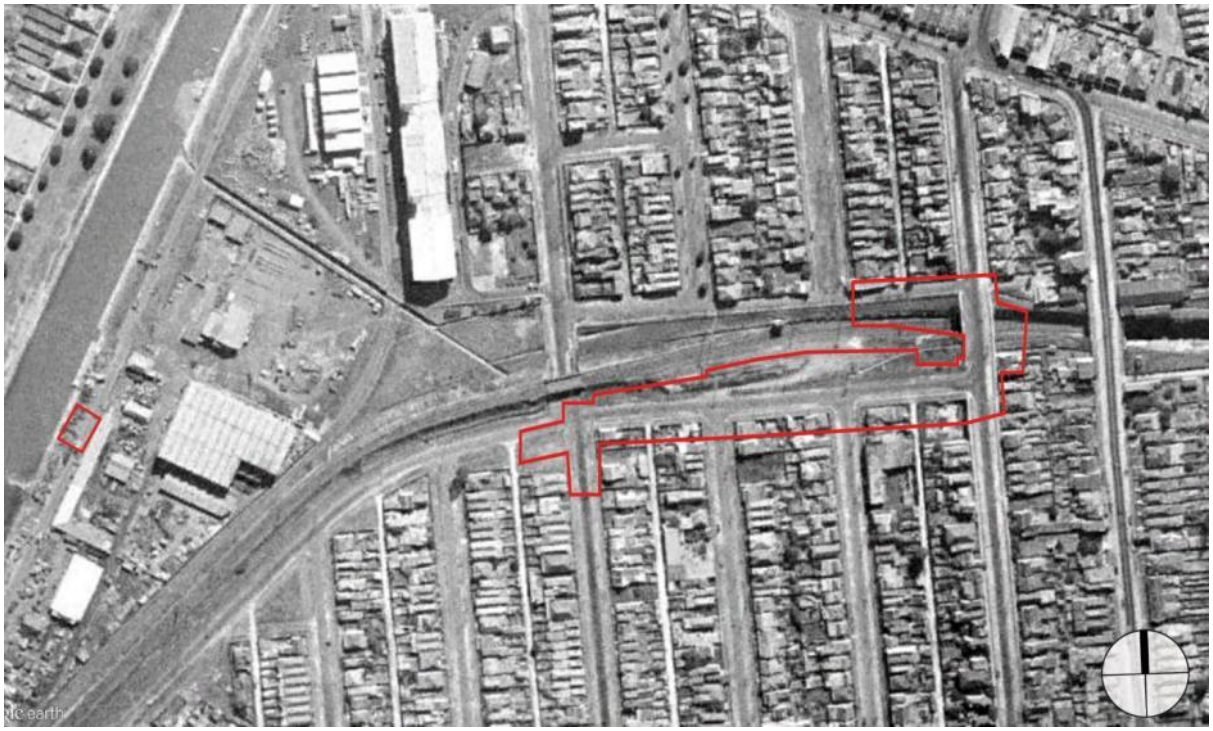


Figure 4-19 1943 aerial photograph showing the project footprint in Leichhardt

(Source: LPI NSW)

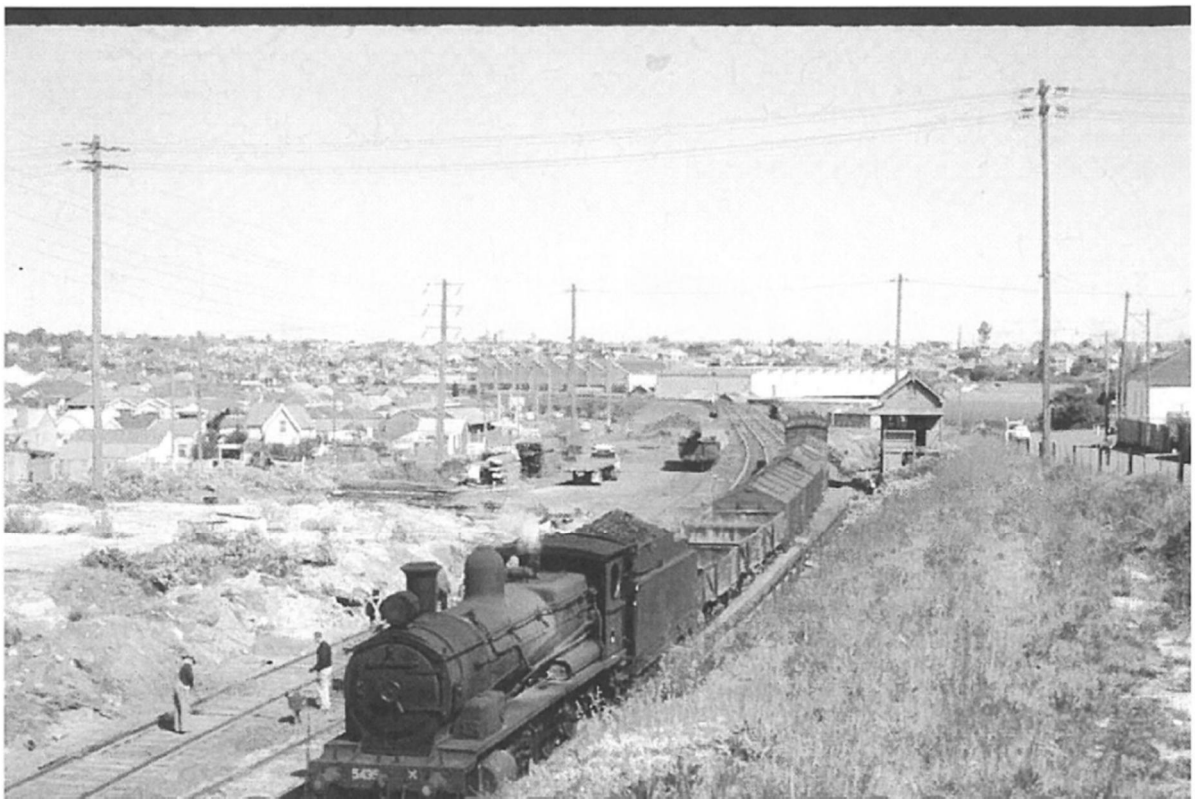


Figure 4-20 Looking west towards the Leichhardt Goods Yard, dated 1964

(Source: ARHS [NSW] image No. 00868)

4.4 Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) heritage study area

4.4.1 European land grant

The Rozelle heritage study area was originally part of the 550-acre Balmain Estate granted to the colony's principal surgeon, William Balmain, in 1800 (see **section 4.4.1**).[30] The southern portion of the heritage study area occupies reclaimed land which was once part of the estuary of Rozelle Bay.[31] **Figure 4-21** shows the original shoreline, and the multiple creeks which flowed through the heritage study area. This area, known as West Balmain, was relatively undeveloped until the 1880s when Alfred Hitchcock subdivided large portions of the land, and sold small, modestly priced plots to working class families (**Figure 4-22** and **section 4.5.3**).[32]

4.4.2 Industrialisation of Rozelle

In the early nineteenth century the waterfronts around White Bay and Blackwattle Bay proved attractive to industries that had been forced to relocate from inner Sydney. The first of these was the abattoir set up on Glebe Island in 1860, followed by other noxious industries. By the mid-late 1800s, the shoreline was well developed with a range of industries utilising the ready access to ships (**Figure 4-23**).

Plans from 1890 show a number of industries located within the heritage study area (the area currently occupied by 68–76 Lilyfield Road), including a meat preserving works, preparing a variety of products using the meat and offal coming from the abattoirs, while Alston Hutchinson's soap works (established in 1876) used the tallow and gelatine extracted from the carcases (**Figure 4-25** to **Figure 4-28**). In addition to these, other industries included glassworks, a saw mill and later, a box making works. Comparison of the shoreline suggests some areas of the foreshore were reclaimed to

create even working surfaces, and to manage the disease believed to be caused by the swampy mangroves of the various creek estuaries in this area (**Figure 4-27**). Odour and pollution caused by the discharge of industrial waste products into Rozelle and White Bay no doubt contributed to this, and the generally unhealthy reputation of the area.[33]

The properties along Lilyfield Road to the west of Gordon Street were largely part of Rozelle Bay until the heritage study area was reclaimed in the late 1800s and the small creek running through what is now Easton Park was enclosed. It appears that there were two small cottages located facing Abattoir Road in 1890 (**Figure 4-29**).

4.4.3 Early residential development

With the spread of industry, there was pressure to develop the land with housing for workers. Prior to this, only a small number of structures are noted on the 1852 plan of the Balmain Estate (**Figure 4-21**) in the area of Easton Park. By the 1880s the basic street layout of the peninsula was established, with Catherine, Burt, Brennan and Gordon Streets shown in **Figure 4-22**.[34] The street along the northern edge of Rozelle Bay is referred to first as Storey Street, and later Abattoir Road.

Easton Park was partially reclaimed from 'five acres of low-lying probably flood liable land'.[35] It was resumed for recreation ground in 1889 and proclaimed as Easton Park in 1890. Located close to the foreshore, it was the sole public space for recreation in Rozelle until additional lands were reclaimed at Rozelle Bay, White Bay and Iron Cove, and parkland created in the early 1900s (**Figure 4-30**).

Plans from the 1890s show terraces and freestanding houses built along Lilyfield Road (previously Abattoir and Storey Street); and along a portion of Gordon Street (**Figure 4-25** to **Figure 4-27**). A number of these mid-nineteenth century buildings remain today, including Floods Hotel, located on the corner of Gordon Street and Lilyfield Road. A series of terraces were constructed along Lilyfield Street, including 10–20, 56–66, and 61–65 Lilyfield Street and the cottage at 6 Lilyfield Road.

4.4.4 The White Bay Power Station

The closure of the abattoir in 1912 led to the larger-scale industrialisation of the neighbourhood. The waterfront was levelled for the construction of wharves, including what became the Glebe Island Container terminal, and the Rozelle Bay wharves. The waterfront became dominated by various cargo handling enterprises including rail.[36] The White Bay Power Station was built by the NSW Rail Commissioners on a number of amalgamated residential lots and the reclaimed mudflats of White Bay (**Figure 4-31**).[37] These properties were progressively resumed from 1911 and all previous structures and vegetation cleared from the site.[38] The cutting and railway siding from goods line to Glebe Island was constructed to assist with coal and plant delivery and ash disposal.[39] The power station was originally built to power the rapidly expanding tramway network; but after becoming fully operational in 1917, it gradually produced more and more power for the electrified rail network, and then general use.[40] It underwent multiple phases of modification and expansion after World War II and between 1950 and 1958, with additional structures added until a reduction in demand saw its closure in 1983 (**Figure 4-32**).

Although it was used as a substation for some time, it was decommissioned and later stripped of all elements except a representative sample of the power generation operational systems identified for heritage conservation.[41]However, through its location, massing, design, machinery and associated archives the complex is still able to demonstrate the early power-generating technology in Sydney.[42] The closure of the power station also resulted in the decline of the White Bay Hotel, an establishment regularly frequented by workers from the power station and nearby waterfront industries. It was built in 1916 by Tooth and Co,[43] fronting the newly configured Victoria Road on the site of earlier residential buildings. It was well known in the area as the neighbourhood's only venue with a licence. It closed in 1992 and was left unused until it was destroyed by fire in 2008. The site was purchased by Sydney Harbour Foreshore Authority (SHFA) and cleared of all structural remains.

4.4.5 Establishment and use of the Rozelle Rail Yards: 1916–1996

In June 1916, the Rozelle Rail Yards (then known as the Rozelle Marshalling Yard) was created as part of the Goods Railway Line.[44] The Rozelle Marshalling Yard was designed as a holding yard for traffic proceeding to Darling Harbour, which was Sydney's main goods yard at this time. Following the

closure of the Glebe Island Abattoir, grain and coal handling facilities and wharves were developed at White Bay near the Rozelle Marshalling Yard facility.[45]

The Rozelle Rail Yards were created by filling in much of the White Creek estuary, and through the quarrying of the rugged sandstone outcrops which are shown along the foreshore in **Figure 4-23**. This also removed what previous structures there were along the shoreline (**Figure 4-29**). The Crescent was built as a bridge, over the open channel of the Whites Creek Storm Water Channel.

Two large brick overbridges, the Catherine Street overbridge and the Victoria Road overbridge, were constructed in the 1920s as part of a larger rollout of overbridges across the goods rail network. They functioned to carry vehicular traffic across the newly opened goods yard and likely used bricks from the State Brickworks in Homebush.[46]

By 1928, a plan of the Rozelle Rail Yards shows the huge number of lines operating from there (**Figure 4-33**), and this is confirmed by photographs (**Figure 4-34** and **Figure 4-35**). The Rozelle Rail Yards were a locomotive depot until World War II with an engine shed, 75-foot (23m) turntable, water columns and coal storage facilities. The Rozelle signal box, erected to control the rail connection from the eastern end of the yard, was removed in July 1931.

During World War II, the Rozelle Rail Yards became a storage area for the American Army and the locomotive depot was removed. Trains would sometimes turn up at the yard during the war years loaded with soldiers bound for active service overseas.[47] **Figure 4-41** shows the Rozelle Rail Yards in 1943.

Since World War II the goods yard has held a variety of freight. Trainloads of wheat, barley, and other grains came in from numerous country branch lines and were transferred to silos for storage before being loaded onto the ships.[48]

Coal exports from the 1960s saw many trains loaded with coal move through an unloader and then move along to the departure road once emptied.[49] During 1967, the railway from Dulwich Hill to Rozelle was electrified. This allowed the movement of electrically-hauled freight trains from the Blue Mountains and Gosford to Rozelle (**Figure 4-37**).

Very few members of the public were allowed access to the Rozelle Rail Yards, because electric passenger trains were incompatible with the tracks, which were wired specifically for the use of electric locomotives. The Australian Railway Historical Society ran a Metropolitan Goods Line mystery tour in 1986 and another in 1987. In June 1988, the 'last' train of export grain arrived from Parkes in the Rozelle Rail Yards.[50] In 1996 the goods line from Pyrmont to Rozelle closed, bringing an end to 80 years of use at the yards, for marshalling trains and goods on their way into and out of the city. In 2000, the light rail to Lilyfield opened using the tracks from the Rozelle Rail Yards near Brennan Road. For a few years, the yard was used irregularly, including for the unloading of wheat and storage of concrete, but was completely closed around 2007.[51]

4.4.6 Changes throughout the twentieth century

As part of the construction of the Rozelle Rail Yards in 1915, areas of the 1880s' residential subdivision were resumed and streets realigned (**Figure 4-38**). This included straightening Catherine Street across the new rail bridge, and sections of both White Street and Abattoir Road were removed, including the residential properties at the western end of Rozelle Bay (**Figure 4-39**). The remaining portion of Abattoir Road was renamed Lilyfield Road, and connected to a new road running west towards Haberfield. The 1800s houses located along both Weston Street and Barnes Street were demolished for the realignment of Weston Road to what is now Victoria Road.

By 1915, the residential development of the area had increased dramatically.[52] More allotments within the heritage study area began to be occupied from early twentieth century onwards. The southern side of Abattoir Road was developed with the one and two storey terraces, now 6–66 Lilyfield Street. The two shops (present day at 78 Lilyfield Street) were also constructed at this time. A 1926 plan (**Figure 4-40**) shows the land south of Easton Park was for a short time known as Cohen Park, while the remainder of this area was developed.

By 1943, Rozelle was fully developed (**Figure 4-41**), with the mixed industrial and residential character that the heritage study area demonstrates today. Some of the industrial sites have undergone changes, with new structures added and removed over time. For instance, in 1930, the

1880s houses located at 68–76 Lilyfield Road were cleared. By 1943 this land was also occupied by large warehouse buildings which were replaced with the present day industrial park in the late twentieth century. The warehouse at 90 Lilyfield Road now occupied by Ironwood Australia was constructed in the mid-twentieth century, on what was originally part of the rail yards and was operating as a rail siding (**Figure 4-42**). In 1914, the land at 92–94 Lilyfield Road was owned by Arthur William Swadling, where he operated a timber yard. The family continue to operate the business from Rozelle, where a range of warehouses have been built and modified during 100 years of business, and other locations across Sydney (**Figure 4-43**).

During the early twentieth century, much of the infrastructure in Rozelle was also established. The open portion of Lilyfield Street Canal was constructed c1915, to channelise the creek running through Easton Park, after this land was resumed (**Figure 4-42**). Substation 1435 on Burt Street was constructed in 1934. The Interwar Stripped Classical style building was purpose designed and built by the private Electric Light and Power Supply Corporation (ELPSC) as a distribution substation. It was supplied with power from the now demolished Balmain Power Station.[53]

As discussed in **section 4.4.5**, the character of the area changed in the late twentieth century through gentrification. These changes in the area, and across Sydney, also required large scale modifications to the road systems in this area. A key element of this was the construction of the new Anzac (formerly Glebe Island) Bridge which opened in 1995.[54] It bypassed the old Glebe Island Bridge to connect the western distributor with Victoria Road, and the City West Link, which was completed in stages during the 1990s. While they caused wide scale impacts at the time, these projects created a highly important interchange between the local network of smaller roads in the surrounding area, and the large arterial roads which connected the inner west with the city, and beyond.

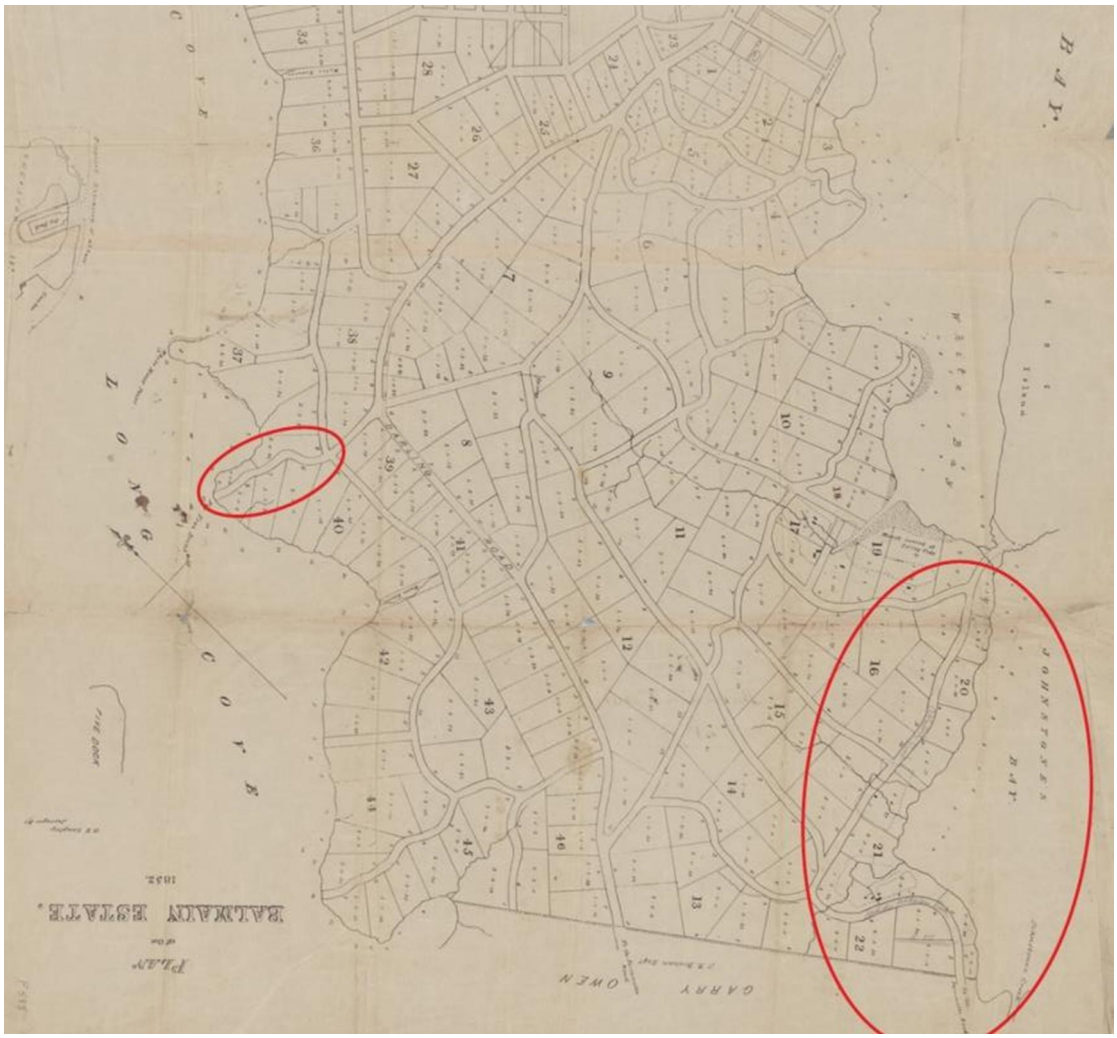


Figure 4-21 Detail of the 1852 Balmain Estate subdivision lots in the Rozelle area, with proposed street alignments that were not realised

(Source: CE Langley Surveyor, NLA)

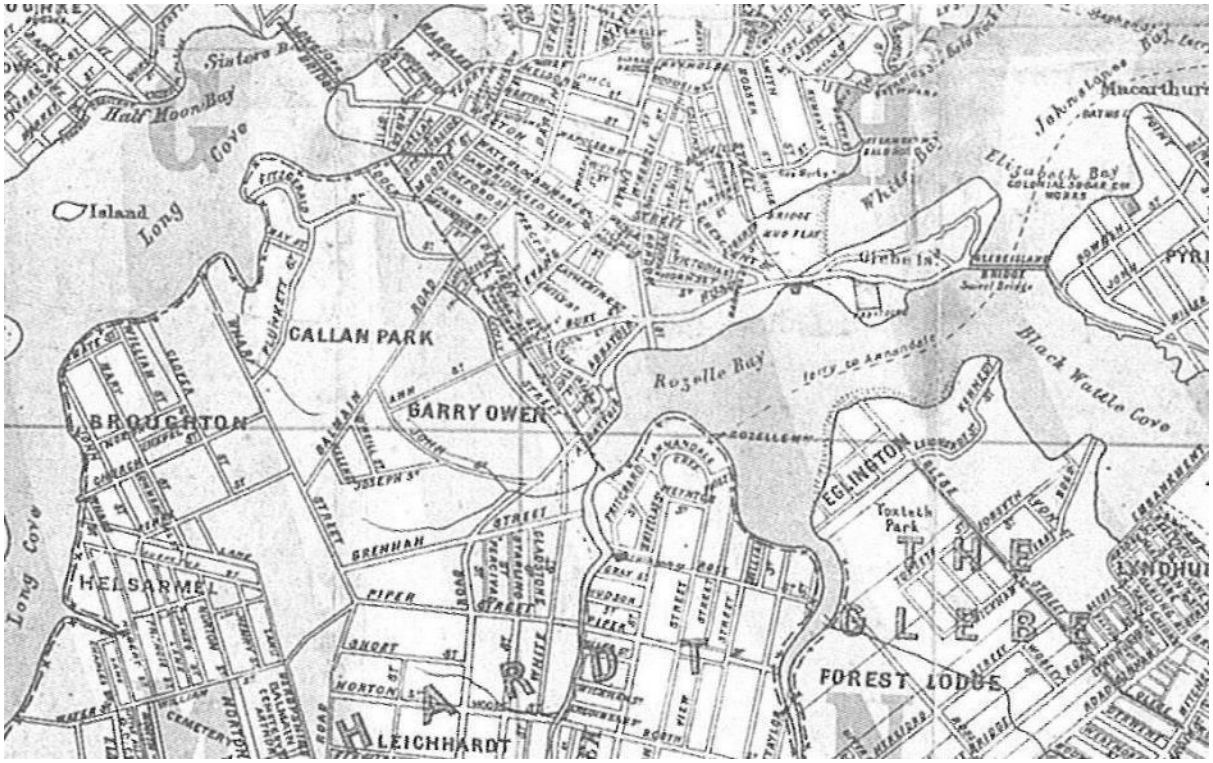


Figure 4-22 1885 Gibbs and Shallard Map of the City of Sydney & Suburbs showing streams from Rozelle Bay

The streams flow across the western extremity of the heritage study area, and the original shoreline along Abattoir Road (now Lilyfield Road). White Street and Catherine Street have been constructed (Source: Ashton, P and Waterson, D 2000, *Sydney Takes Shape*, p 36)



Figure 4-23 Photograph of Rozelle Bay in the late 1800s, showing industrial and maritime development along the foreshore.

The natural foreshore topography can be seen at the right of the image (Source: Powerhouse Museum)

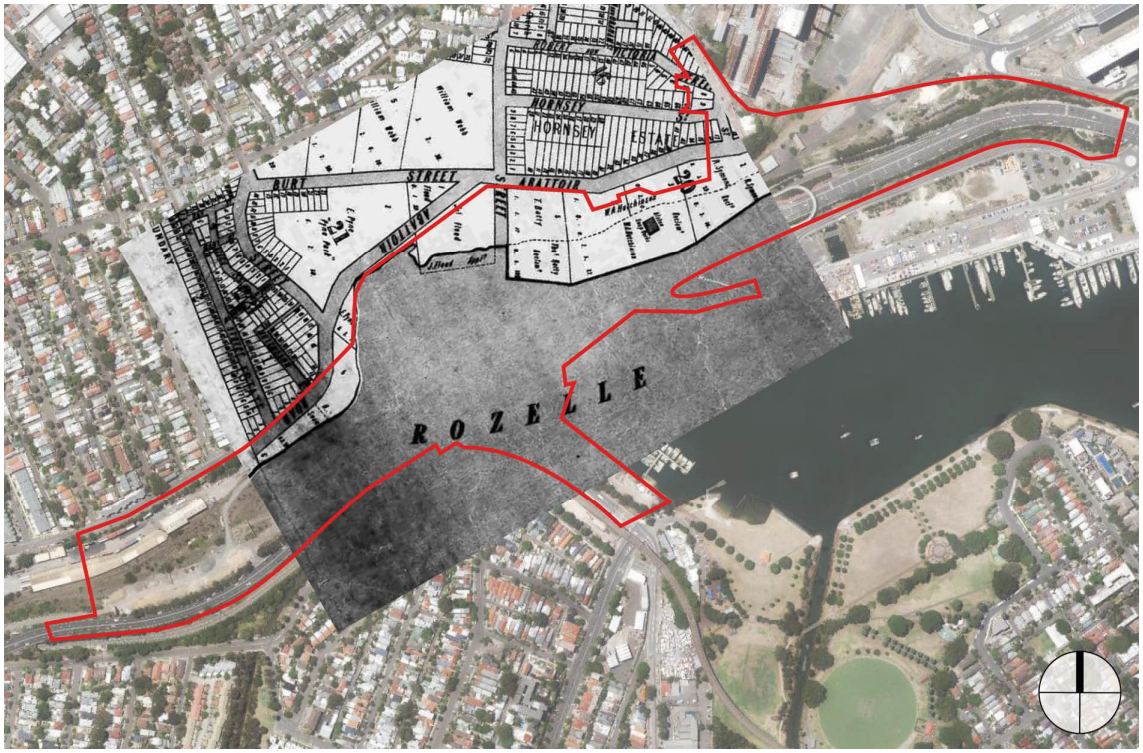


Figure 4-24 Detail from the Plan of the Municipality of Balmain in 1882, showing the original shoreline (dotted) and the mixture of Hitchcock's subdivision lots, and small residential lots

(Source: Inner West Council Local Studies Library with GML overlay)



Figure 4-25 An 1890 plan showing development on the project footprint prior to the construction of the Rozelle Goods Line, and the Rozelle Marshalling Yard in 1916.

Abattoir Road is now called Lilyfield Road, and some of the terraces shown still remain today (Source: Sydney Water, Metropolitan Detail, Balmain Sheet 70, SLNSW)



Figure 4-26 Plan of Lilyfield Road (then Storey Street) between Gordon Street and Victoria Road, in the early twentieth century

(Source: Sydney Water Archives)

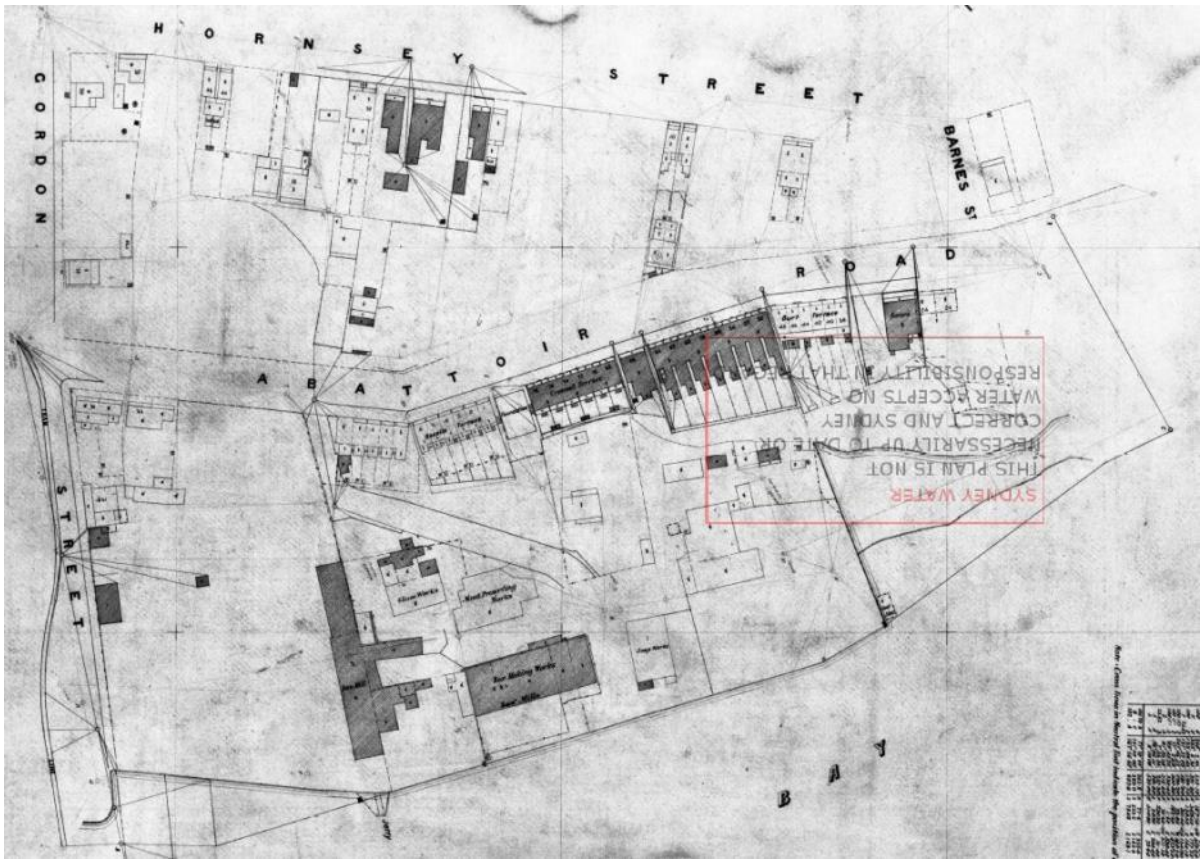


Figure 4-27 Plan of properties on Lilyfield Road and Gordon Street in the early twentieth century

(Source: Sydney Water Archives)



Figure 4-28 Alston Soap and Candle Co on Abattoir Road (now Lilyfield Road) in 1890

(Source: Inner West Council Local Studies Library)



Figure 4-29 The central portion of the project footprint in part of Rozelle Bay in 1888, to the south of Abattoir Road

(Source: Sydney Water, Metropolitan Detail, Balmain Sheet 70-72, SLNSW)



Figure 4-30 View of Easton Park, looking east towards Lilyfield Road in the early twentieth century

(Source: Inner West Council Archives)



Figure 4-31 Eastern portion of the project footprint in part of Rozelle Bay in 1888 and residential development, prior to demolition for the construction of White Bay Power Station

(Source: Sydney Water, Metropolitan Detail, Balmain Sheet 51, SLNSW)



Figure 4-32 View of the White Bay Power Station, across Victoria Road, showing the White Bay Hotel in the foreground, and the railway siding

(Source: City of Sydney Archives)

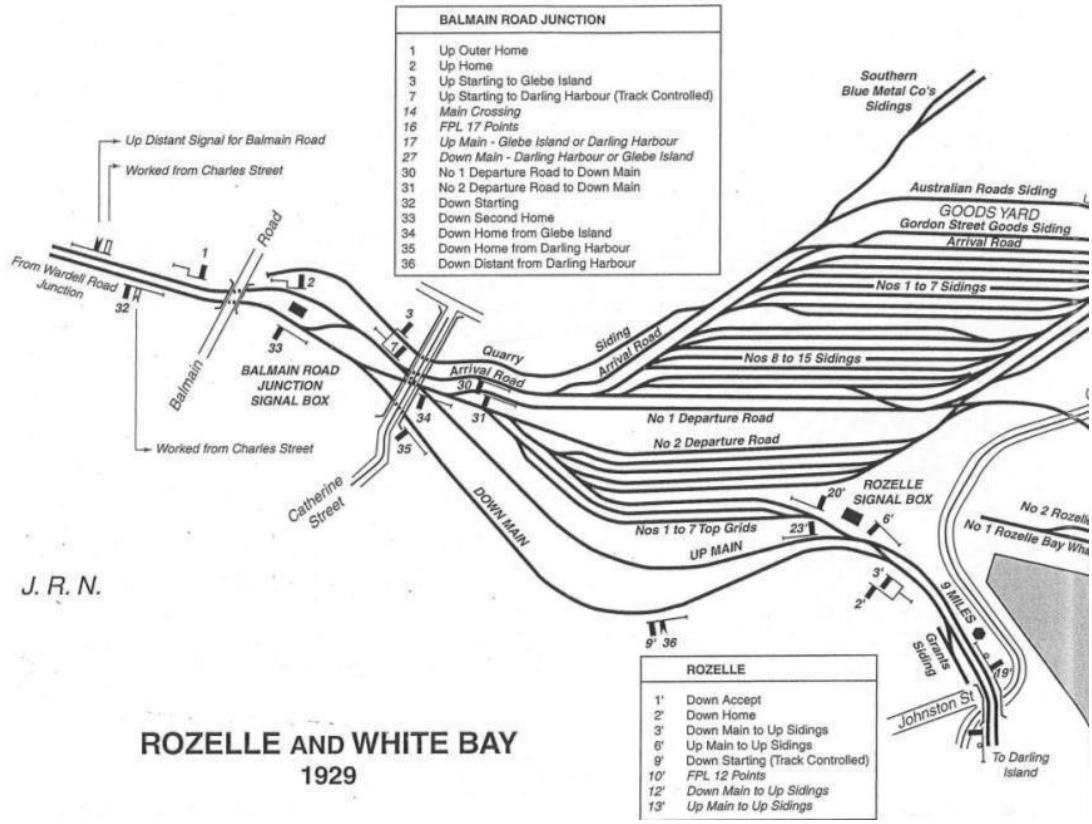


Figure 4-33 1929 plan showing the usage of the Rozelle Rail Yards at this time

(Source: Oakes J 2002, *Sydney's Forgotten Goods Railways*, Australian Railway Historical Society, p 46)



Figure 4-34 Rozelle Rail Yards viewed from Lilyfield Road near the Catherine Street overbridge in 1951

(Source: Oakes J, 2002, *Sydney's Forgotten Goods Railways*, Australian Railway Historical Society, p 49)



Figure 4-35 An early image of the Rozelle Rail Yards looking west towards Catherine Street Bridge (undated)

Brennan Street, now the City West Link, is to the left of the image (Source: Oakes J, 2002, *Sydney's Forgotten Goods Railways*, Australian Railway Historical Society, p 43)



Figure 4-36 A 1960s view of the Rozelle Rail Yards depot looking west toward Catherine Street overbridge.

Brennan Street (now City West Link) is to the top left of the image and Lilyfield Road is in the foreground. The Up and Down lines to Darling Harbour (now the tracks for the Sydney Light Rail) are located at the far boundary of the yard just below Brennan Street and the arrival and departure roads are located between the two lines of sheds (Source: Oakes J 2002, *Sydney's Forgotten Goods Railways*, Australian Railway Historical Society, p 48)



Figure 4-37 Rozelle Rail Yards in March 1968, showing infrastructure and condition of the heritage study area during its use

(Source: Oakes J 2002, Sydney's Forgotten Goods Railways, Australian Railway Historical Society, p 102)

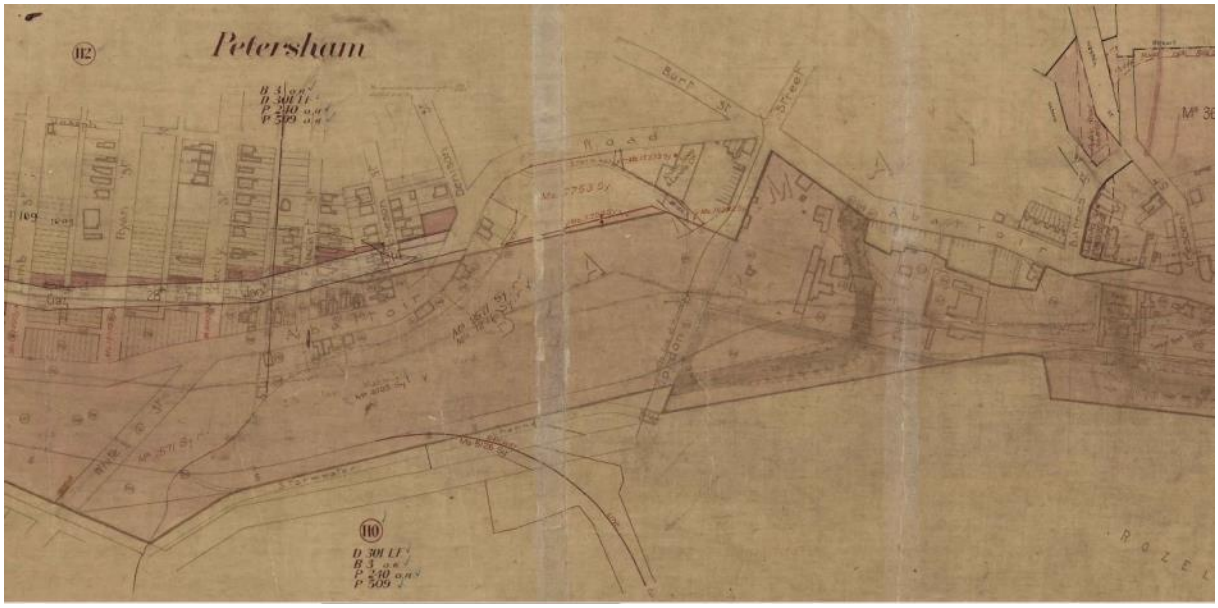


Figure 4-38 Detail from the 1917 plan showing the areas of land resumed for the construction of the goods line, a dedicated freight rail network between Wardell Road and Glebe Island

(Source: Crown Plan 4389-3000, LPI NSW)

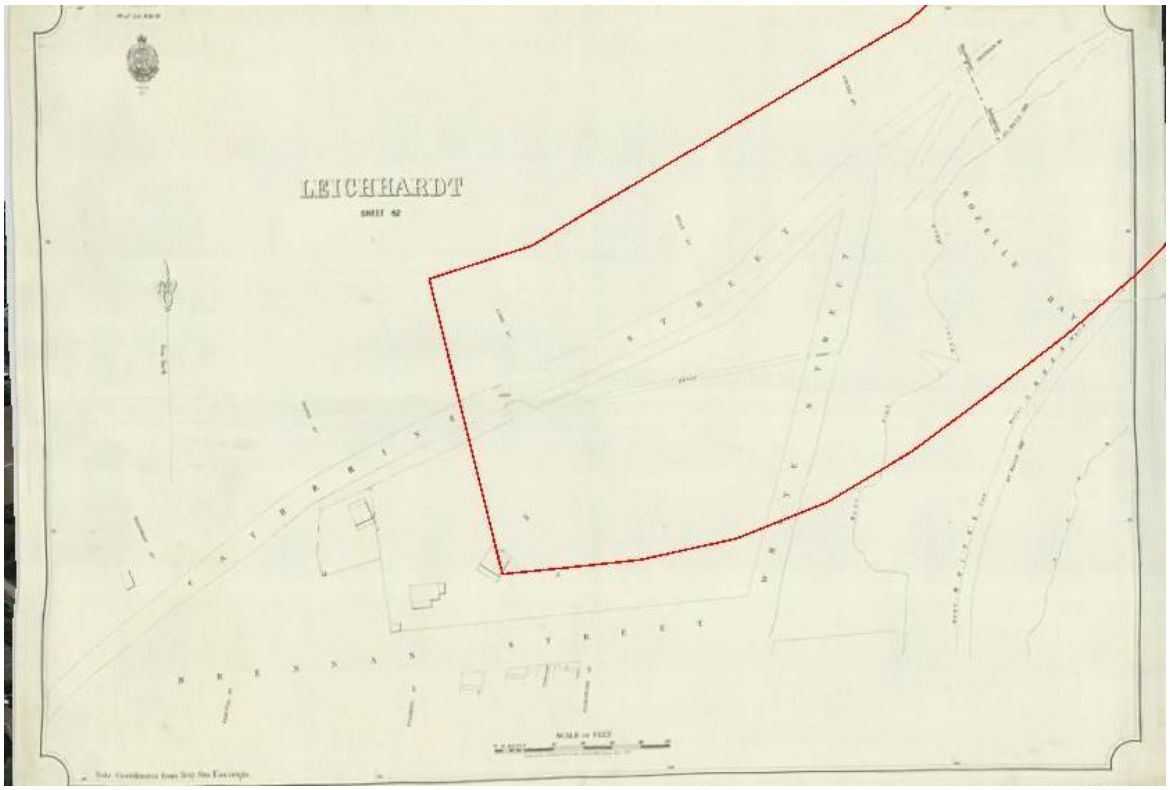


Figure 4-39 The westernmost end of the project footprint in 1888, showing Whites Creek, and three small buildings (outside the heritage study area)

(Source: Sydney Water, Metropolitan Detail, Leichhardt Sheet 62, SLNSW)



Figure 4-40 Plan showing Cohen Park and the industrial development in the central portion of the heritage study area

(Source: Crown Plan R479290, LPI NSW)

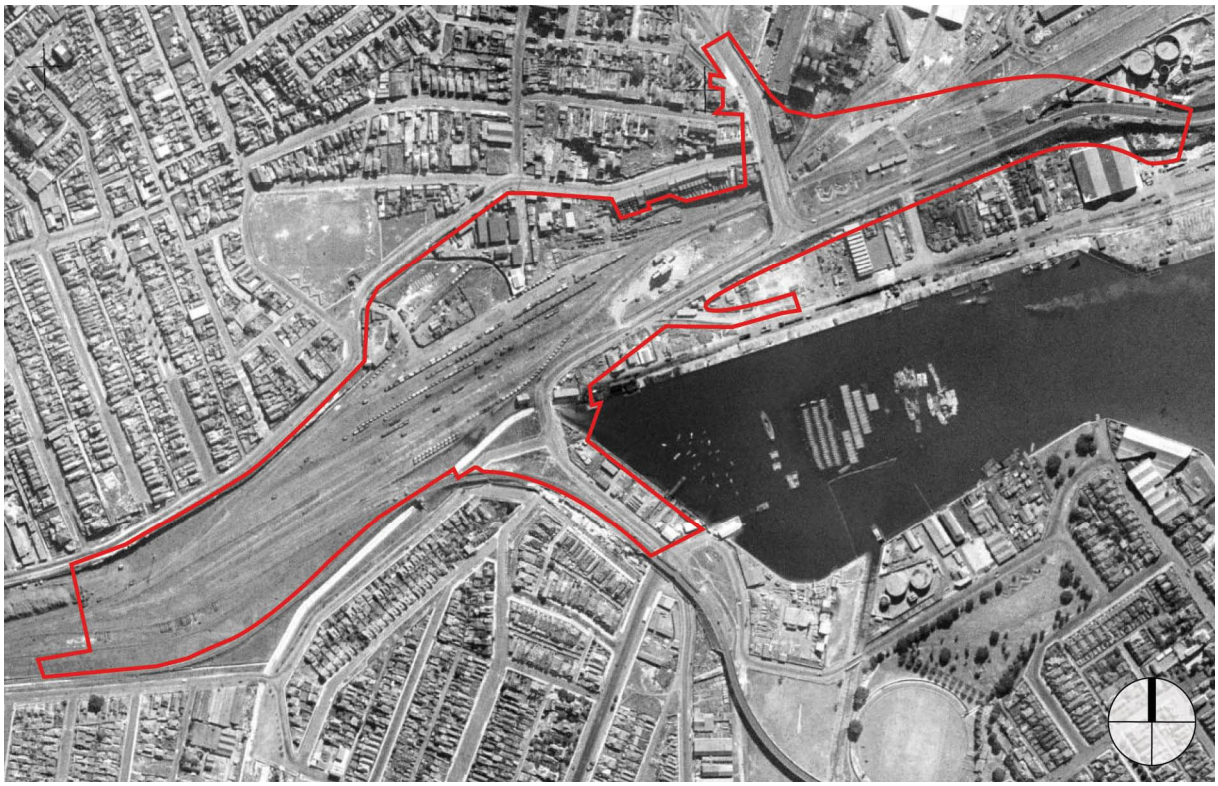


Figure 4-41 A **1943 aerial photograph of the Rozelle heritage study area showing the project footprint**

(Source: LPI NSW)

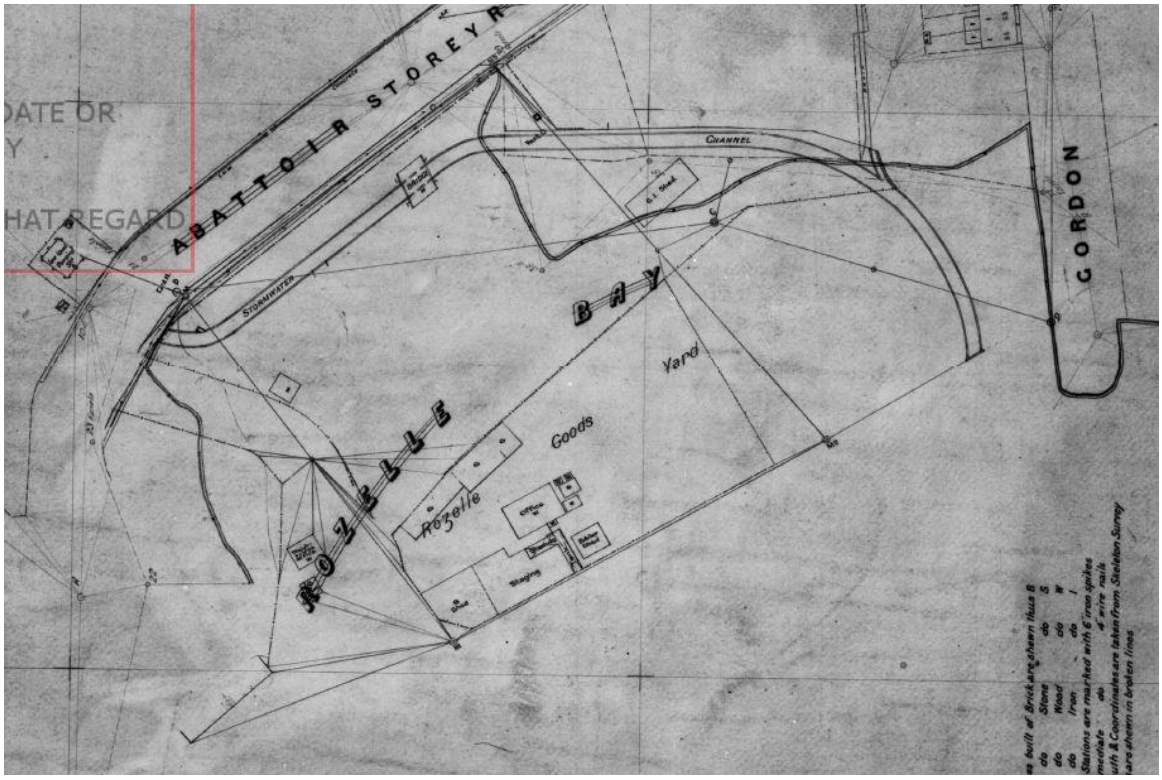


Figure 4-42 Plan showing the area of Cohen Park in the central portion of the heritage study area, now occupied by the Rozelle Goods Yard in c1913

(Source: Sydney Water Archives)



Figure 4-43 Photograph looking east along Lilyfield Street, showing the Swadling and Sons Timber Yards, c1952

(Source: Leon Manny, photographs of the Tramways of Leichhardt Municipality, Tramway Museum and Leichhardt Library)

4.5 Area 4 – Iron Cove heritage study area

4.5.1 European land grant

The Iron Cove heritage study area is located in the southwestern corner of a 550-acre grant to colonial surgeon Dr William Balmain (1762–1803) made in 1800 (**Figure 4-21**). A year after the grant was made, Balmain sold his entire holding for five shillings to John Bothwick Gilchrist in order to settle a debt. Balmain returned to England and this transaction remained unknown to Balmain's family until after his death. The legality of the land transfer from Balmain to Gilchrist was challenged by Balmain's descendants and further development of the area was initially blocked. The area subsequently became known as 'Gilchrist's place', although court documents refer to the area as the 'Balmain Estate'. In 1823 Gilchrist tried to sell the land but failed to attract a buyer. Eventually Gilchrist appointed Frederick Parbury in 1833 to act as his attorney and to subdivide and sell the 'Balmain Estate'. The first land was sold in 1835.[55]

4.5.2 Early development of Balmain West

From the 1830s to 1850s, Balmain developed as a suburb with a strong maritime industry. Along its coastline were boat yards, slipways, ships and wharves. Balmain also became connected to the city via regular ferry connections and horse drawn omnibuses.[56] In 1857, Blackbutt Bridge, which linked Pyrmont to Glebe Island across Johnston Bay, was opened and provided quick connection via a road to the city. Blackbutt Bridge was replaced by Glebe Island Bridge in 1903.

While Balmain, particularly around Darling Street, was quickly being developed, Balmain West (now known as Rozelle) remained relatively unpopulated. Balmain Council was incorporated in 1860.[57] During the early 1860s, Dr George Robinson Elliot, a chemist, with his brothers Frederick and James

opened Australia's first chemicals, pharmaceuticals and later glassworks factory along the Iron Cove foreshore. Off the opposite coast of the Balmain peninsula, abattoir works began in 1860 at Glebe Island. The abattoir remained there until 1912 when it was moved to Homebush.[58]

In 1873, the Government purchased Callan Park, located on the west of the Balmain boundary line, for the purpose of constructing a mental health hospital. (Callan Park is identified as 'Garry Owen' in **Figure 4-30**.) The Callan Park Hospital was to provide relief of overcrowding and additional resources for the Gladesville Hospital for the Insane (operating since 1838 and later known as Gladesville Mental Hospital).

The first patients from Gladesville were transferred to Callan Park in 1877 and housed in the Garry Owen House (constructed in c1840). From 1880 to 1885, 33 new buildings were constructed across the asylum grounds. The Callan Park for the Insane was officially opened in 1885.[59]

At the same time as the construction of the Callan Park Mental Hospital, Iron Cove Bridge was also being built in order to connect Drummoyne and Rozelle. The original bridge was constructed of wrought-iron lattice girders and opened in 1882.[60] Iron Cove Bridge was connected to Weston Road (now Victoria Road) on the Rozelle side.

4.5.3 'Homes for the People'

Alfred Hancock, a real estate agent and Balmain alderman (serving 1873–1882 and 1884–1886), recognised the need for housing for the people who was working on the construction of the hospital and Iron Cove Bridge. Hancock acquired large land portions for subdivision in the vicinity of these developments and encouraged others, including WH and RJ Paling and Dr L Foucart, to do the same (**Figure 4-44**).

Hancock's real estate advertising slogan was 'Homes for the People'.[61] The allotments were sold at modest prices and easy terms, which encouraged a high turnover of small residential lots. From 1880 to 1882, the overall population of the Balmain peninsula doubled from 8000 to over 16,000. An 1890 plan of the Iron Cove heritage study area shows a quarry between Iron Cove and Byrne Street and only a handful of houses between Byrnes and Callan Streets along Victoria Road, including today's 232 Victoria Road. Another house at the end of Byrnes Street is also shown facing south into the bay. (**Figure 4-45**). Between Callan and Springside Streets nearly all the allotments were occupied (**Figure 4-46**). Some of the allotments in the area south of the heritage study area, between Victoria Road and Callan Park, are also occupied, including 6, 8, 10 Toelle Street and 8 Callan Street (**Figure 4-45**).

After years of petitioning, a post office to service Balmain West was opened in 1894. It was officially named Rozelle Post Office and the suburb adopted the name.

4.5.4 Industrialisation of Rozelle

In 1892, the first steam tramline to run through Rozelle was opened. It was an extension of the Forest Lodge line to the city and ran from Bridge Road, Glebe, to Darling Street and Merton Streets, via Victoria Road.[62]

An 1895 plan of the Rozelle shows only one house was constructed within the heritage study area– between Clubb Street (then known as Cove Street) and Toelle Street at today's 256 Victoria Road (**Figure 4-47** and **Figure 4-48**). While development was slow along Victoria Road, more of the allotments to the south, near Callan Park, were occupied by 1895.

Heavy industries continued to be established in Rozelle. In 1897, the Lever Brothers Limited established a factory at White Bay that extracted oil from copra. They also manufactured glycerine and Sunlight Soap. Balmain Power Station, located on the eastern side of Iron Cove Bridge, was opened in 1909 and White Bay Power Station opened in 1917.

The tramline was electrified in 1902.[63] More allotments began to be occupied along Victoria Road from the early twentieth century onwards. Based on the 1909 survey field book of the Rozelle heritage study area, two more dwellings (now numbered as 264 and 266 Victoria Road) were constructed between Byrnes Street and Clubb Street (**Figure 4-49**). These two allotments and the adjacent allotments (now 260 and 262 Victoria Road) were all owned by Johan Alfred Anderson in 1909.[64] Two more cottages were constructed on 260 and 262 Victoria Road soon after and all four cottages were

occupied by 1911.[65] Also in the 1909 field book were five more dwellings between Clubb Street and Toelle Street, including 244 to 250 Victoria Road (**Figure 4-50** and **Figure 4-51**); and two more between Toelle Street and Callan Street – 232 Victoria Road and 234 Victoria Road[66] (**Figure 4-52** and **Figure 4-53**). Away from Victoria Road, 8 Byrnes Street had also been constructed (**Figure 4-54**).

Land reclamation around the Balmain Peninsula began to occur from the 1890s onward. At Iron Cove, the mud flats were reclaimed and in 1910 extended out to the currently existing sea wall. The progress of these works is shown in **Figure 4-47** with reclamation around the boatshed and house on the southern shore. Later, the house located within the bioretention facility study area was demolished, and this reclaimed land was proclaimed as King George Park in 1912 (**Figure 4-55**).

The foreshore of Rozelle Bay was also reclaimed and by the 1920s the bay had become one of the largest timber handling wharves in Sydney.[67] In c1915, G Folster and H Bourne established a timber yard on the corner of Clubb Street and Victoria Road.[68] In 1922, Glebe Island Grain Silo began operations and railways sidings were completed. Dotted throughout Rozelle were also broom and brush makers.

Hancock claimed the growing industries and tram networks made Rozelle a worthwhile investment. However, the increasing pollution brought down the value and desirability of the area and Rozelle was known as a working class area and slum.[69]

4.5.5 Changes throughout the twentieth century

By the 1940s, all the allotments within the Iron Cove heritage study area were occupied, including 8 Callan Street (constructed in c1922) and 236 Victoria Road (constructed in 1930s) (**Figure 4-56** and **Figure 4-57**). Located on the corner of Clubb Street and Victoria Road at the G Folster and H Bourne timberyard, there appears to be large sheds – possibly for housing cut timber **(Figure 4-58**).

While predominantly used as recreational field and parklands, King George Park was the site of United States service men encampment during World War II.[70] Possibly related to the encampment at King George Park, there appears to be air raid trenches, visible as a zig zag to the south of Victoria Road dug into the headlands by Iron Cove (**Figure 4-59** and **Figure 4-60**). The bioretention facility study area remained empty in this period.

Since the 1920s, there had been discussion to widen Victoria Road to accommodate its rapidly increasing population. This did not occur until the 1888 Iron Cove Bridge was replaced in 1955 with the existing Art Deco steel truss bridge.[71] In 1959, Ampol Petroleum Limited purchased 222 to 206 Victoria Road (between Callan Street and Springside Street).[72] The buildings within these allotments were demolished and a petrol station and car park was constructed in this location. This site has been leased by Liquorland since 1994. In 1964, the Gladesville Bridge was opened and, to cope with increased traffic, Victoria Road was widened again to a six lane carriage way from Gladesville to White Bay[73] (**Figure 4-61**).

Rozelle's reputation as a slum began to change during the 1970s and in the 1980s. There was a local movement to gentrify the area, noticeably through improvement of homes. In the early 1990s, maritime and heavy industries relocated to other areas which left open a number of prime vacant waterfront sites. In 1992, the State Planning Minister approved a regional development plan that allowed for high rise high density development at the adjoining Balmain Power Station and Monsanto Chemical sites at Iron Cove.

This decision was opposed by the community as the new plan allowed for large scale development without proportionate provision of public open space. Leichhardt Council (which amalgamated with Balmain, Annandale and Glebe Councils in 1949[74]) challenged this decision in the NSW Land and Environment Court and lost, but later won on appeal. The Balmain Power Station site has been redeveloped as Bridgewater Park and is connected via a footpath to Callan Park via King George Park. Callan Park Hospital had become Rozelle Hospital in 1975 and was closed in 1994. From 1996 to 2016, Rozelle Hospital was home to University of Sydney's Sydney College of the Arts.[75]

In 2009, works began on constructing a second bridge over Iron Cove. The headland to the west of Iron Cove Bridge appears to have been used as a construction compound for these works

(**Figure 4-62**). The duplicate bridge was completed and opened in 2011 (**Figure 4-63**). The parkland was restored at the same time.

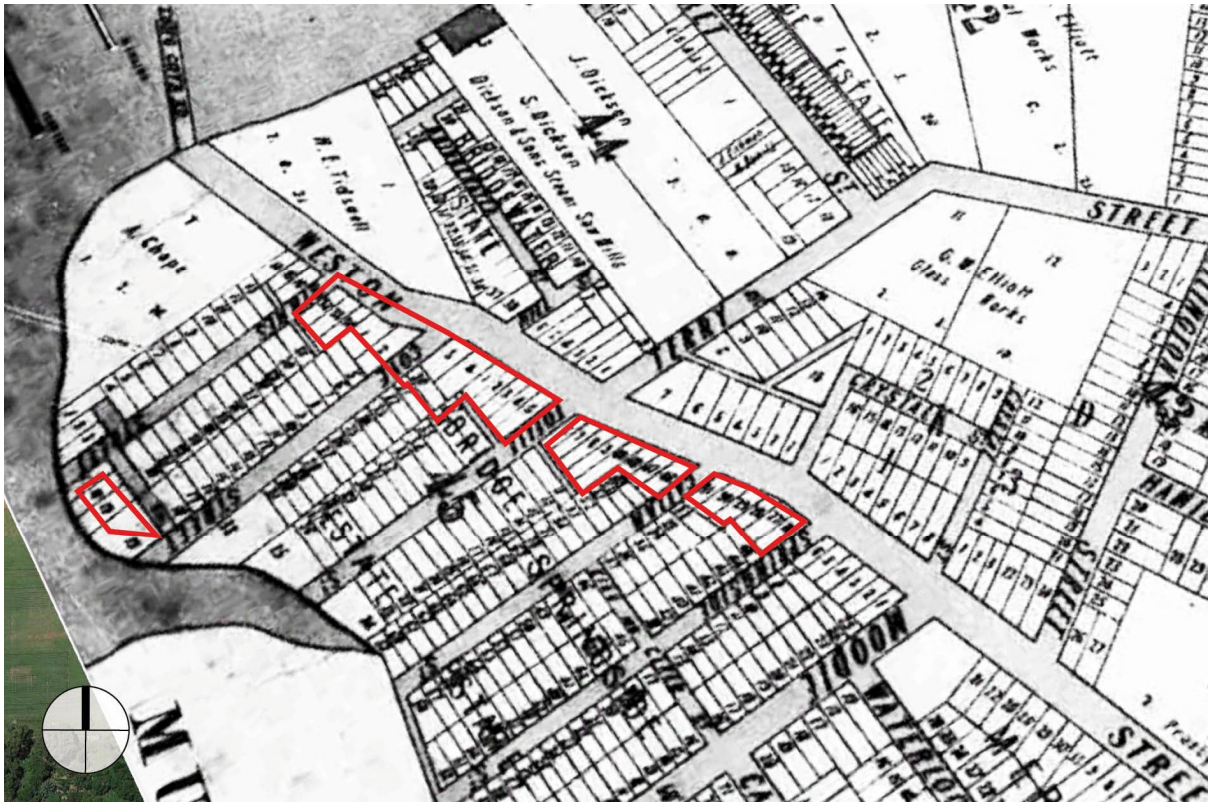


Figure 4-44 1882 plan showing the later subdivision of the Iron Cove project footprint

(Source: Inner West Council Local Studies Library with GML overlay)



Figure 4-45 An 1890 Metropolitan plan showing early development along Weston Road (now Victoria Road) from Iron Cove to Callan Street

(Source: Metropolitan Detail, Balmain Sheet 62, SLNSW with GML overlay)

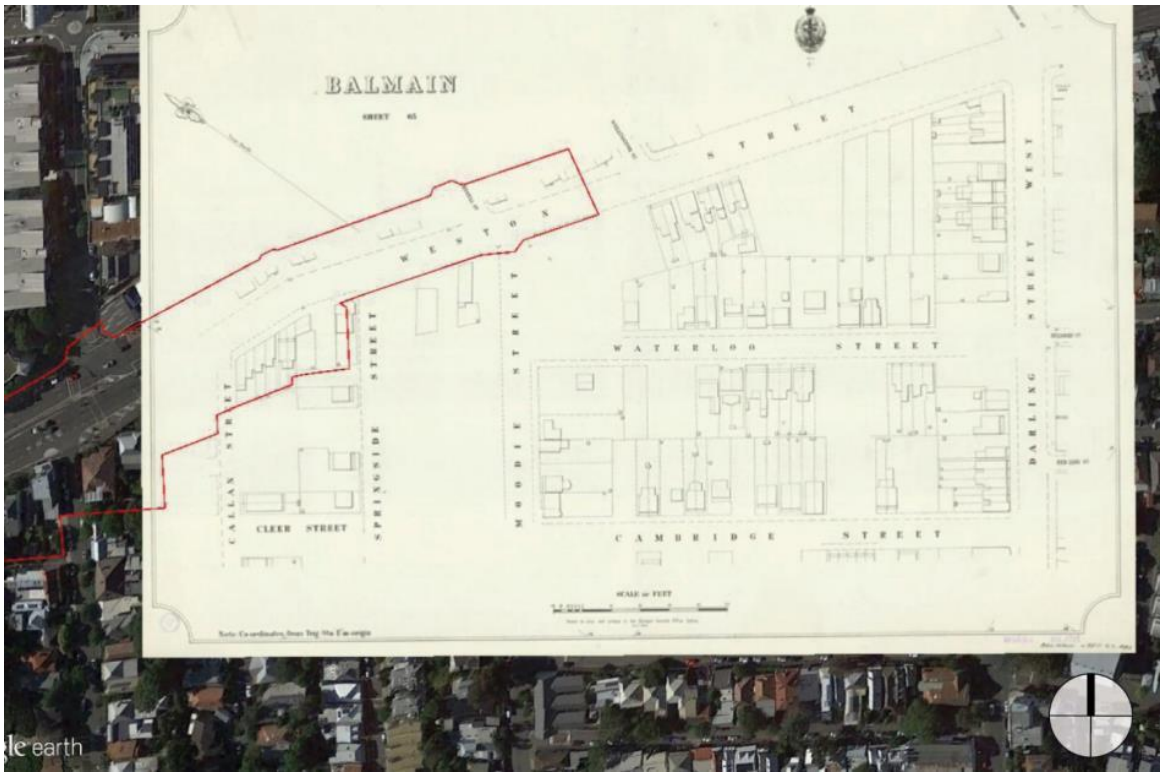


Figure 4-46 An 1890 Metropolitan Plan showing development along Weston Road (now Victoria Road). Compared to Figure 3, nearly all the allotments between Callan and Springside Street are occupied

(Source: Metropolitan Detail, Balmain Sheet 63, SLNSW)

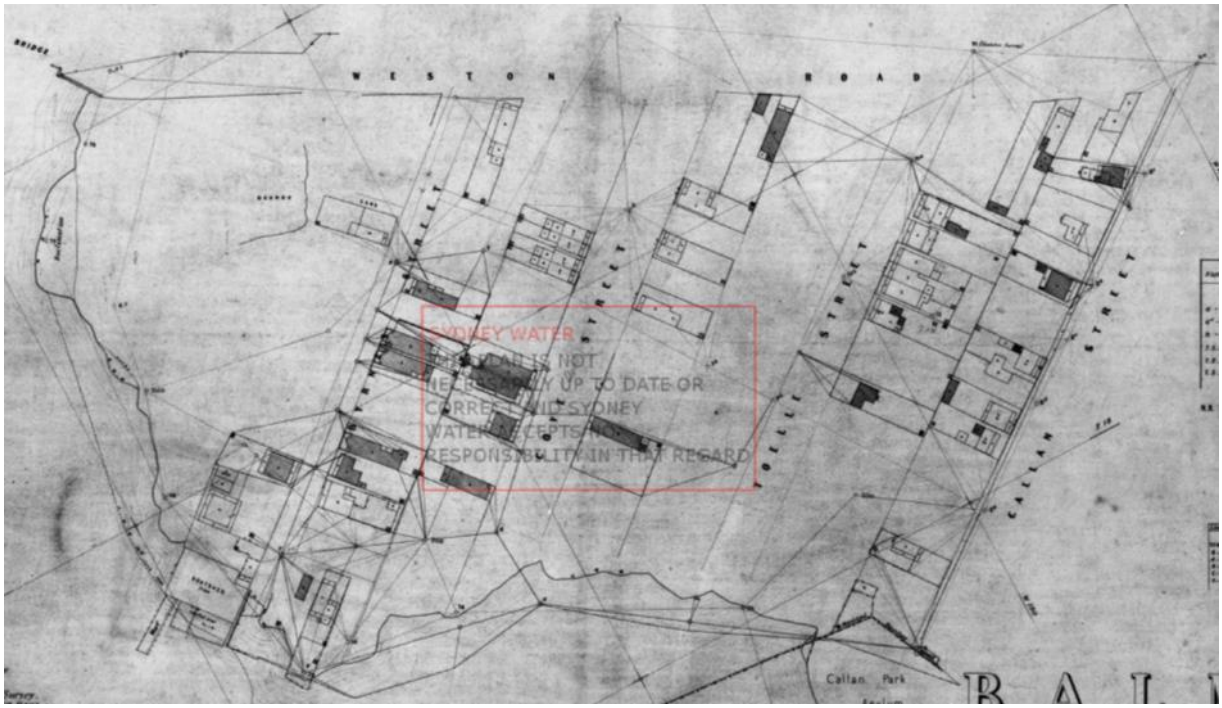


Figure 4-47 1895 plan of the Iron Cove Heritage study area, from Iron Cove to Callan Street.

Only one more house was constructed in five years along Victoria Road between Cove Street (now Clubb Street) and Toelle Street, at today's 256 Victoria Road. There were also more allotments occupied between the project footprint and Callan Park (Source: Sydney Water Archives)

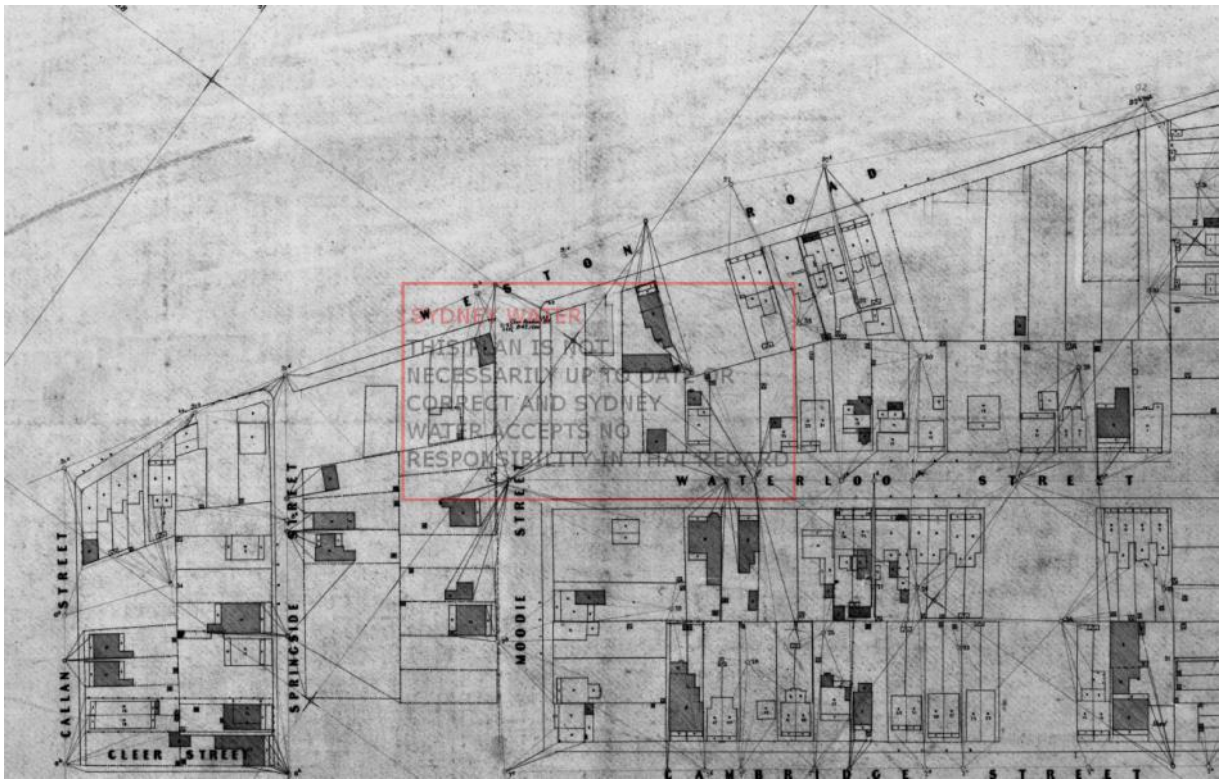


Figure 4-48 1895 plan showing the project footprint between Callan Street and Springside Street, and further to east along Victoria Road (then Weston Road)

(Source: Sydney Water Archives)

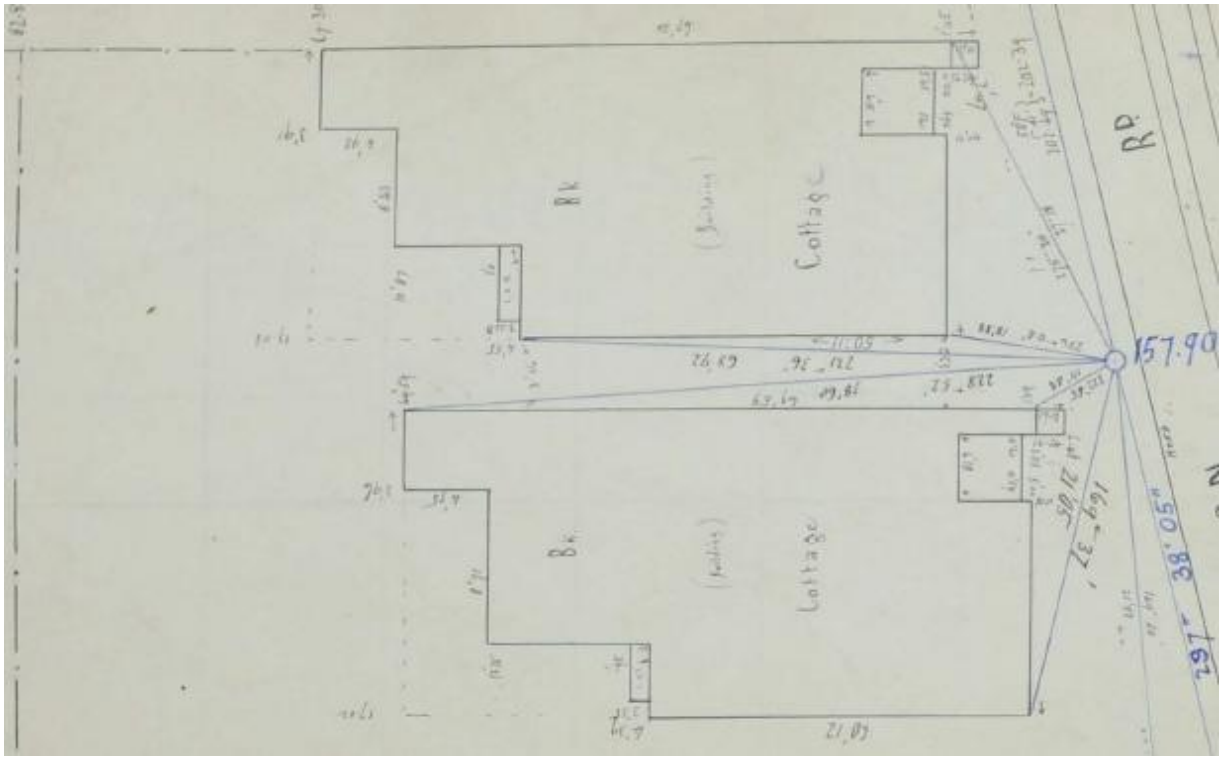


Figure 4-49 Page 35 of 1909 Field Survey Book No. 355, showing 264 (bottom) and 266 (top) Victoria Road, Rozelle

(Source: Sydney Water Archives)

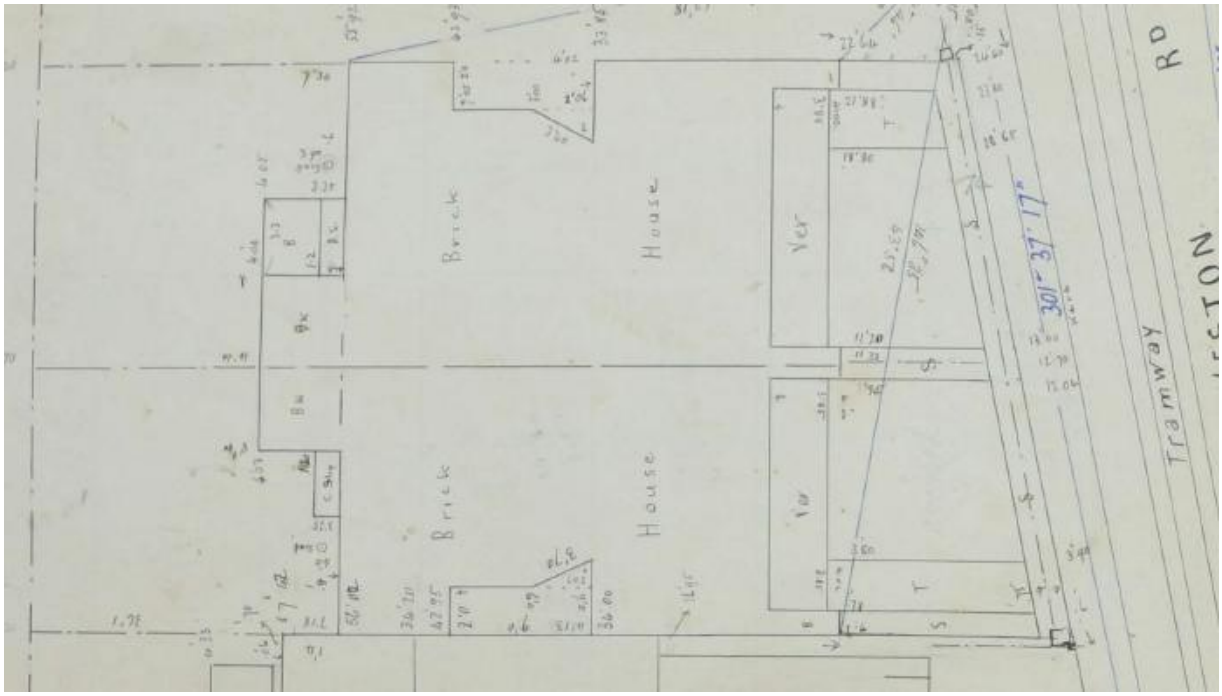


Figure 4-50 Page 23 of 1909 Field Survey Book No. 355, showing 250 (top) and 248 (bottom) Victoria Road, Rozelle

(Source: Sydney Water Archives)

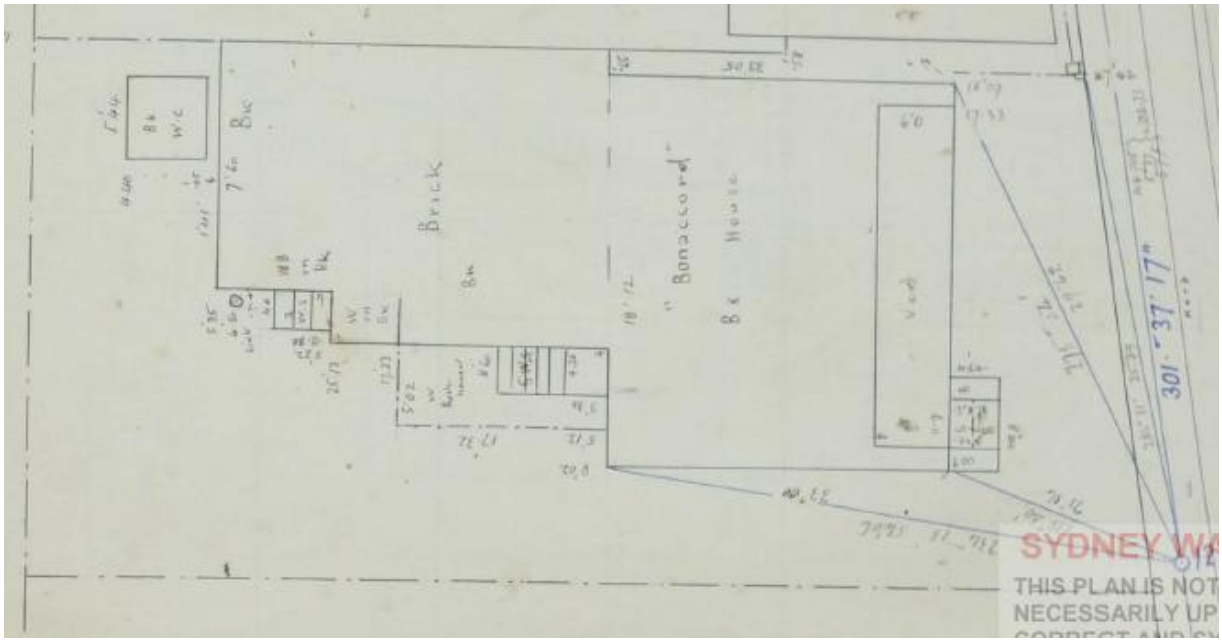


Figure 4-51 Page 22 of 1909 Field Survey Book No. 355, showing 246 Victoria Road, Rozelle

(Source: Sydney Water Archives)

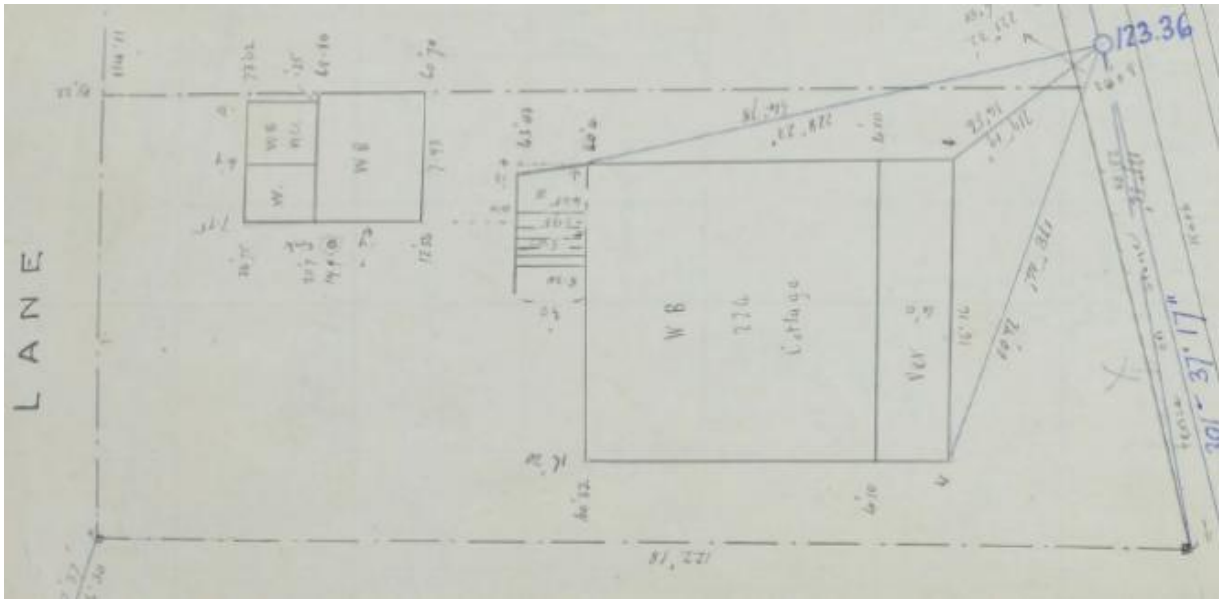


Figure 4-52 Page 21 of 1909 Field Survey Book No. 355, showing 244 Victoria Road, Rozelle

(Source: Sydney Water Archives)

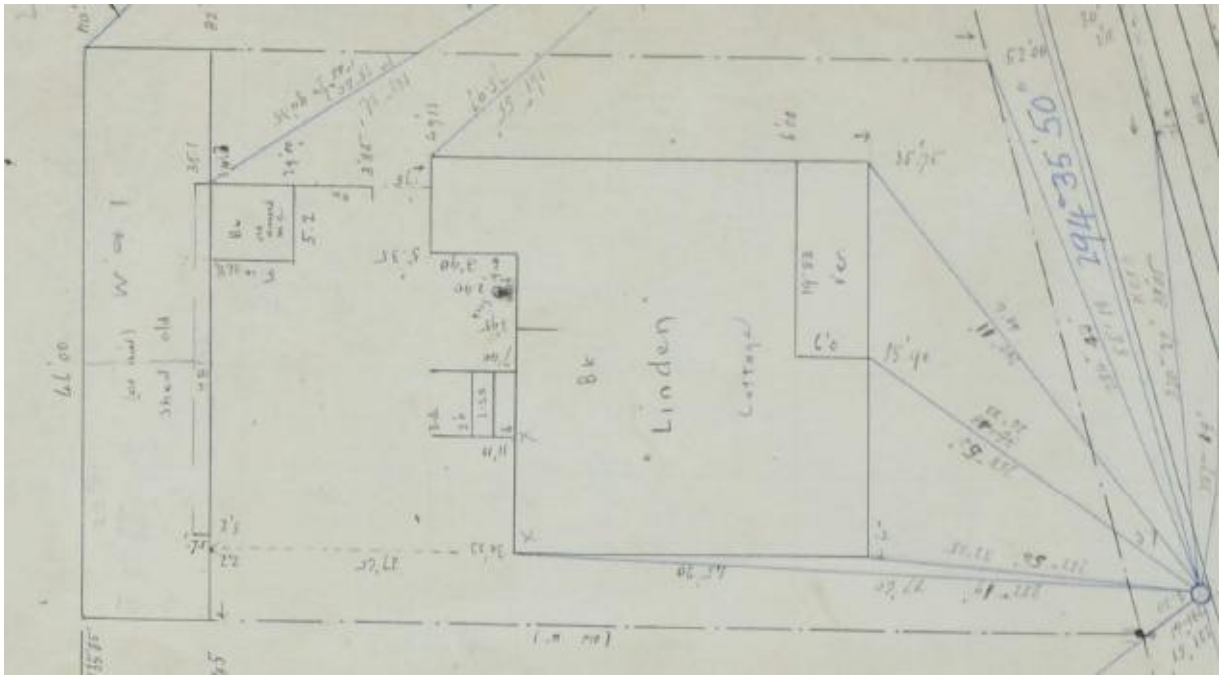


Figure 4-53 Page 6 of 1909 Field Survey Book No. 355, showing 234 Victoria Road, Rozelle
(Source: Sydney Water Archives)

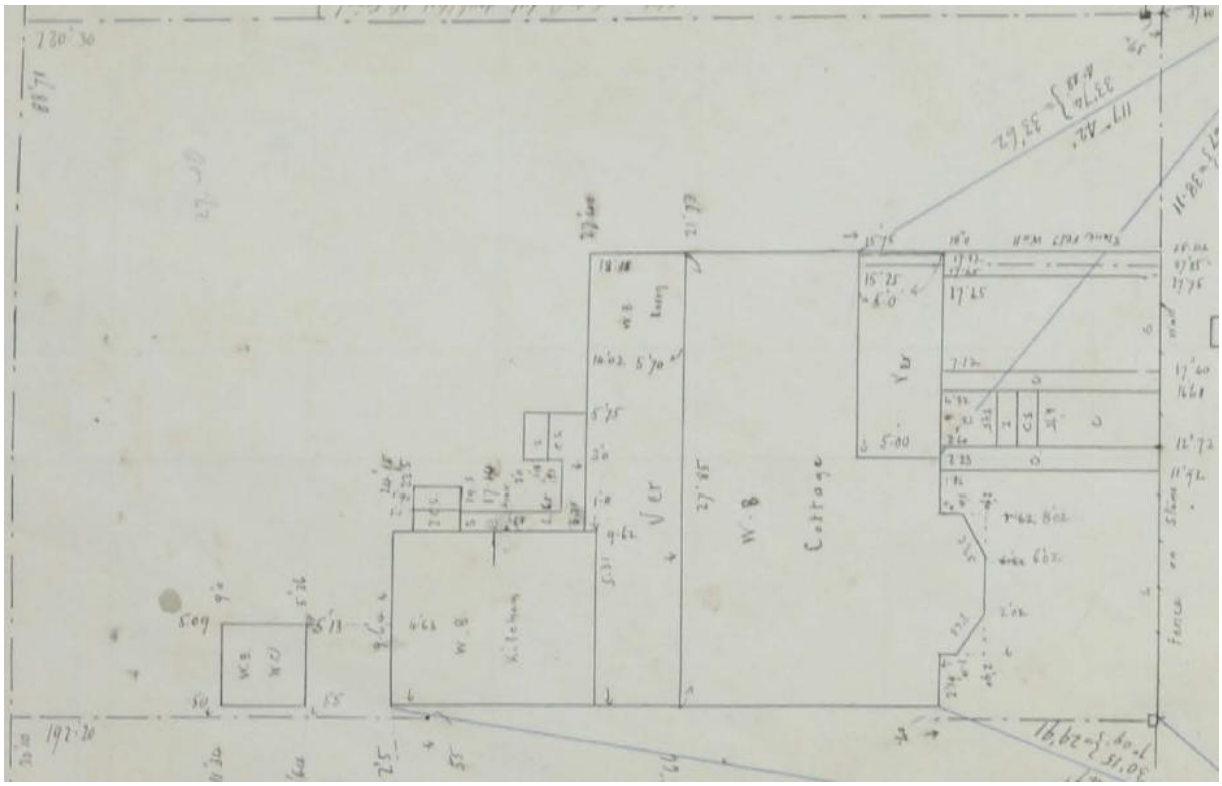


Figure 4-54 Page 39 of 1909 Field Survey Book No. 355, showing 6 Byrne Street, Rozelle
(Source: Sydney Water Archives)

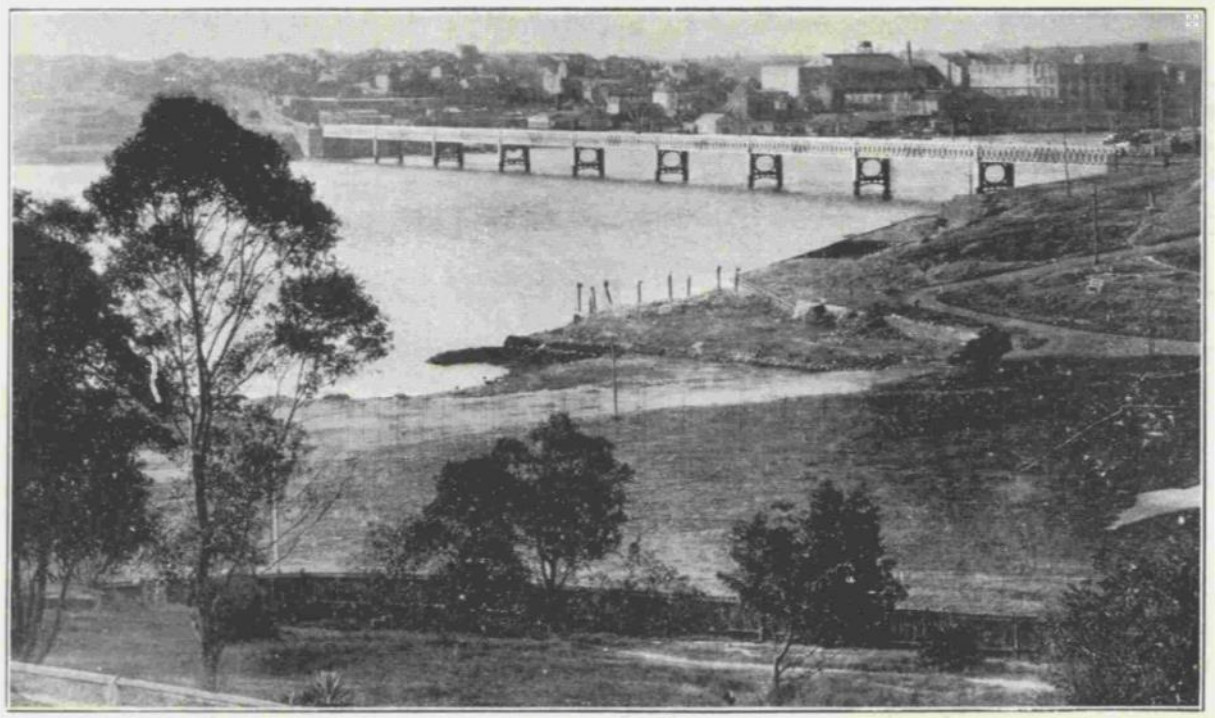


Figure 4-55 c1910 photograph of King George Park with Iron Cove Bridge in the background
(Source: Inner West Council Local Studies Library)



Figure 4-56 c1933 plan showing the allotments from Iron Cove to Callan Street are now occupied
(Source: Sydney Water Archives)

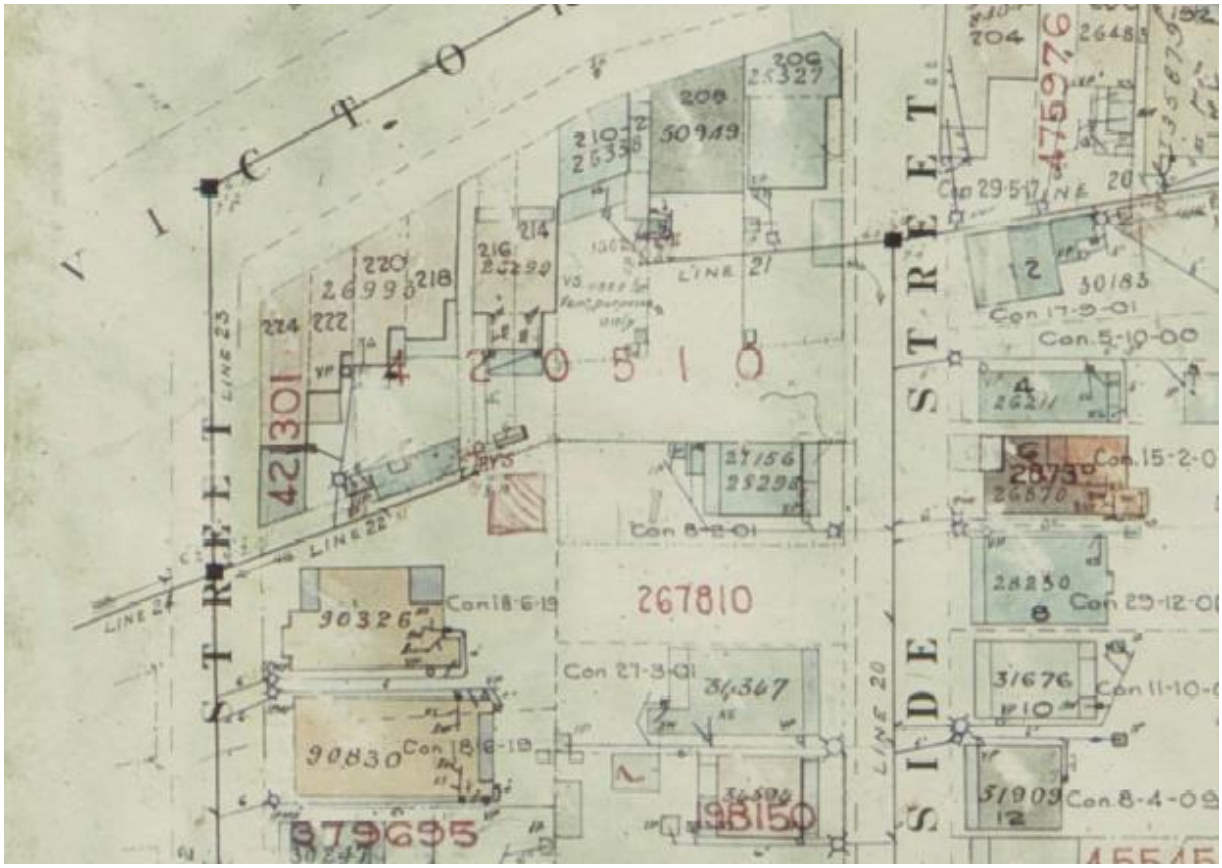


Figure 4-57 Undated plan (ranging from c1922–1961) of Iron Cove heritage study area between Callan Street and Springside Street

(Source: Sydney Water)

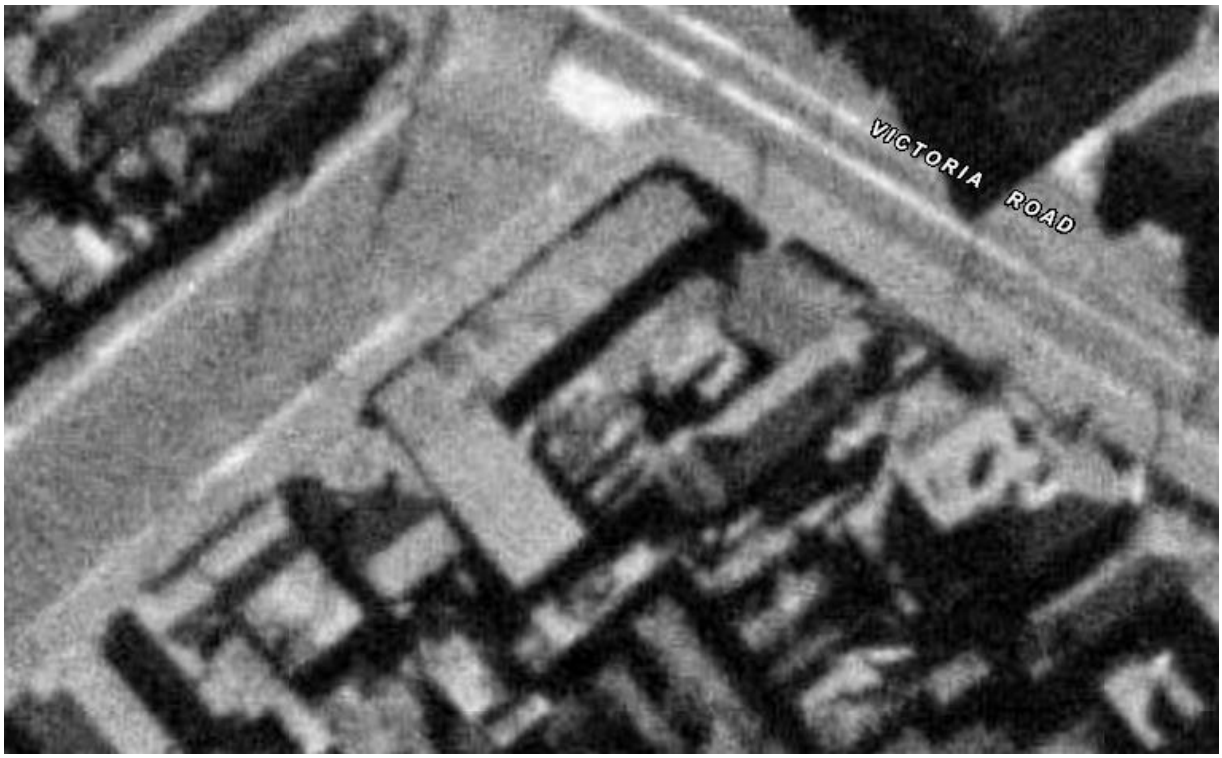


Figure 4-58 1943 aerial showing the corner of Victoria Road and Clubb Street, where there appears to be large sheds on the corner with log piles in the centre of the site
(Source: LPI NSW)



Figure 4-59 1943 aerial of the project footprint and King George Park.

The United States service men encampment can be seen on this photograph (Source: LPI NSW)



Figure 4-60 1943 aerial, showing possibly trenches at the headlands by Iron Cove Bridge

(Source: LPI NSW)



Figure 4-61 1965 aerial showing the expansion of Victoria Road, following the construction of Gladesville Bridge in 1964

(Source: LPI NSW)



Figure 4-62 2009 aerial photograph of the headlands between Iron Cove Bridge and Byrnes Street.

This area appears to be used as a work compound during Iron Cove Bridge duplication works (Source: Google Earth)



Figure 4-63 2011 aerial photograph of the headlands between Iron Cove Bridge and Byrnes Street.

This area has been restored as parkland following completion of Iron Cove Bridge duplication works (Source: Google Earth)

4.6 Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road) heritage study area

4.6.1 Early land grant

The Annandale heritage study area is part of Governor William Bligh's 240-acre grant, made to him by Governor Philip Gidley King in 1806 (**Figure 4-64**). Bligh named the estate after a naval battle site he fought in off the coast of Holland. In 1808, Bligh was overthrown as governor by a military coup, which marked the beginning of the 'Rum Rebellion'. The military remained in power until the arrival of Lachlan Macquarie, who assumed the position of governor in 1810. Bligh returned to England that year for the court martial of Major George Johnston, one of the rebellion leaders. Johnston was convicted for his role in the coup but given a light sentence.

After the trial, Bligh remained in England. He was promoted to Rear Admiral and as Vice-Admiral in 1814. Bligh's wife died in 1813 and he died in 1817. His landholdings were passed on to his six surviving daughters.[76]

By the 1840s, the Camperdown Estate was in the ownership of Sir Maurice O'Connell. Maurice was a Lieutenant Colonel in the 73rd Regiment and had married Bligh's widowed daughter, Mary Putland, in 1810. Mary was a headstrong woman who was openly hostile towards her father's opponents. To avoid any further discomfort, Macquarie arranged for the 73rd Regiment, thereby the O'Connells, to leave NSW in 1814.

The O'Connells returned to NSW in 1838. Maurice was now in charge of the colony's military forces. Soon after their arrival, Mary served ejection notices to residents and institutions of Parramatta claiming the land was part of her inheritance. A settlement was eventually reached whereby she would forfeit her claim in Parramatta in exchange for the confirmation of her ownership of other estates within NSW. This included the Camperdown Estate.

In 1842, the Camperdown Estate was subdivided and sold. Most of the blocks were villa allotments, up to two hectares in size but there were also smaller residential lots. The heritage study area is located within lots 34–37, purchased by E Phillips (34), L Gordon (35), and JB Jones (36–37) (**Figure 4-65**).

New streets were also laid out, including a new alignment of George Street – the present day Parramatta Road[77] (**Figure 4.61**). Parramatta Road was constructed in the first years of the colony to link the two European settlements, Sydney and Rose Hill (later renamed Parramatta). It is highly probable, although no written account confirms it, that the first European-made track between the two settlements followed an Aboriginal pathway. The creation date of the first European made track also remains unknown, but was likely to have been sometime in 1790 or 1791 as it was first mentioned in 1792 by David Collins.[78] Lieutenant Governor Francis Grose formalised the early track into a road in 1794.[79] However, Parramatta River continued to be used by wealthier citizens who could afford to pay for passage on private boats which operated between the settlements.[80]

4.6.2 Mid-nineteenth century subdivision

While there was the occasional sale on Parramatta Road, it was not until the 1840s that large-scale subdivisions began to appear along the road and the suburbs developed. The initial impetus for subdividing the estates came from an economic downturn that hit Sydney in 1842, resulting in the declaration of over 600 insolvencies that year.[81] Between 1840 and 1850, major subdivision sales along Parramatta Road occurred at Annandale (Fitzroy Terrace Estate, c1840); on both sides of Parramatta Road at Camperdown (Camperdown Estate, 1841); around Missenden Road (O'Connell Town, 1843); at Concord (Village of Longbottom and Concord, 1843); Burwood (Village of Burwood, 1843); and at Ashfield (Ashfield Village, 1838–1849).

Like the Camperdown Estate, the other newly subdivided estates along Parramatta Road were divided into large and small allotments, purchased for residential and commercial uses. Enoch Fowler, who established a pottery and brickyard on Parramatta Road, opposite the Kent Brewery at Abercrombie Street, expanded his business and moved to Glebe in 1848 and then c1854 to Camperdown. Fowler's Camperdown site was bounded by Parramatta Road, Australia, Denison and Derby Streets. Making tiles, bricks, chimney pots and laundry tubs, Fowlers remained on Parramatta Road until 1919 when the works were relocated to Marrickville and the Parramatta Road site was demolished and replaced by Garratt's motor works and garage – an industrial type that would come to dominate sections of the road in the twentieth century.[82]

On the opposite side of Parramatta Road, within the Annandale heritage study area, the land appears to have been used for residential occupation. Two houses that can be identified from the mid–late nineteenth century are 'Chester Lodge' and 'Didliston' (**Figure 4-66**).

'Chester Lodge' was constructed in c1857. In October of that year, it was advertised for let:

> *To LET at Camperdown, Chester Lodge, a new house, containing eight rooms and kitchen; veranda at back, grates in rooms, and fireplaces in bedrooms. Near Mr J. B. Jones garden.*[83]

'Didliston' is also mentioned in the newspapers from 1868, as the home of John Booth Jones, most likely the same man mentioned as the neighbour of 'Chester Lodge'.[84]

4.6.3 Opening up of the suburbs

The first omnibuses to head west from the city ran to Glebe from 1846, running between the lower end of George and Bay Streets, Glebe. Despite the often appalling state of the road, sometimes making it impassable to vehicles, the number of omnibuses rose rapidly, with 45 operators recorded in 1867 running buses to Glebe, Forest Lodge and Balmain.[85] As well as services to Glebe and Balmain, horse buses operated between the city and Leichhardt and to Belmore via Parramatta Road.[86]

In August 1882, the Glebe horse buses were joined by the government operated tramways. The first line ran along Broadway/Parramatta Road to Glebe Point Road, with a continuation heading west down Parramatta Road to Derwent Street where it turned off to Forest Lodge. In 1892, this line was extended on to Johnstone Street, Annandale, and Merton Street in Rozelle. In June 1883, the tram was connected to Trafalgar Street, Annandale, via Parramatta Road, with a double track extension

added in May 1884 to Norton Street. All of these services started as steam trams, with the lines electrified from 1901.[87]

The construction and then extension of the tramways encouraged further subdivision in the estates along Parramatta Road.

4.6.4 Late nineteenth century suburban development

The land surrounding 'Chestor Lodge' and 'Didliston' was subdivided for sale in c1885 and the grounds of 'Didliston' was subdivided and sold in c1886[88] (**Figure 4-67**). By 1890, 'Chester Lodge' was demolished and Booth Street South (now Mallett Street) was laid out (**Figure 4-68**). Along Pyrmont Bridge Road, the allotments appear to be dominantly residential. In the northern portion of the former 'Chester Lodge' grounds are seven terrace houses facing Pyrmont Bridge Road, six of which are extant – 67 to 77 Pyrmont Bridge Road.

'Didliston' is still standing. Along Parramatta Road, between Mallett Street and Gordon Street is a mix of residential and industries including Bignell and Clark's Camperdown steam joinery works (Didliston's neighbour on the east). Bignell and Clark were responsible for building the Sydney Town Hall and Strand Arcade in Pitt Street, Sydney.[89] They also managed the rebuilding of the Bondi Aquarium after it burnt down in 1891.[90] Alfred Bignell, son of the establishing partner, served for a year as Alderman in the Camperdown Council in 1899.[91] Bignell Lane is named after the Bignell family.

'Florenceville' was located to the east of Bignell and Clark's Camperdown steam joinery works and occupied by the Pritchard family since at least 1880.[92] There were also candlestick and soap manufacturers and carpenters along Parramatta Road. At the corner of Pyrmont Bridge Road and Parramatta Road is John Cahill and Co Australian Soap and Candle works[93] (**Figure 4-68**).

4.6.5 Early twentieth century

The trend of mixed residential and commercial use of the Annandale area continued into the early twentieth century. 'Didliston' was converted into two four bedroom residences in c1895.[94] Bignell and Clark's Camperdown steam joinery works was demolished and the land was referred to as 'Camperdown Stadium' in the 1813 Sands Sydney Directory.[95] The allotment along Mallett Street, spanning from Pyrmont Bridge Road to Parramatta Road, was owned by Charles B Vintner since the early 1900s.[96] Vintner also owned the terraces at 67 to 77 Pyrmont Bridge Road (**Figure 4-69**).

Vintner established a store along Mallett Street and on the corner of Mallett Street and Parramatta Road was the Government Savings Bank of NSW (**Figure 4-69**). The Government Savings Bank of NSW was incorporated in 1907 to absorb banks established through the Post Office since 1871. It was eventually merged into Commonwealth Bank in 1931.[97] To the west of Government Savings Bank of NSW was a shop and residential houses with outbuildings, including 'Florenceville'.

To the west of 'Didliston' was Charles Ashdown's coach building workshop and warehouse. At this point in time, Ashdown also occupied the workshop behind that faced on to Pyrmont Bridge Road.[98] The Pyrmont Bridge Road coach workshop was demolished by 1914.[99] From Ashdown's workshop to Gordon Street are several smaller factories, cottages and blacksmiths facing Parramatta Road.[100] The block on the corner of Pyrmont Bridge Road and Gordon Street is empty.

By 1921, Vintner had sold his landholdings within the Annandale heritage study area. The buildings along Mallett Street and on Parramatta Road, including the Government Savings Bank of NSW, were sold to Grace Bros. The bank was converted into an office and store. The terraces near the corner of Pyrmont Bridge Road and Mallett Street were purchased by Patrick Casey. Ashdown had purchased the land on the corner of Pyrmont Bridge Road and Gordon Street and built a two-storey workshop on the corner lot. Ashdown also leased out his Parramatta Road coach workshop.[101]

4.6.6 New buildings in the early to mid-twentieth century

By 1924, the residential cottages along Parramatta Road, within the Annandale heritage study area, were being replaced with factories, stores, and shops. Florenceville and its two neighbours to the east were still standing but all the other buildings from Mallett Street to George Road were for commercial use. Didliston had been demolished and the double allotment was now occupied with two shops.[102]

Ashdown's landholdings at the corner of Pyrmont Bridge Road and George Road were now owned by Crane & Watson, who had owned and occupied the adjacent corner block since 1914.[103]

In c1930, Morris (NSW) Limited set up a garage and motor works on corner of Pyrmont Bridge Road and Bignell Lane. On the western side of Bignell Lane, the land was still unoccupied, however, between Pyrmont Bridge Road, George Road and Parramatta Road, the workshops, blacksmith and cottages had been replaced by a series of small warehouses (**Figure 4-70**).

In 1937, Bank of NSW purchased 164 Parramatta Road.[104] Bank of NSW was established by Governor Macquarie in 1817 and was Australia's oldest financial institution. Bank of NSW merged with Commercial Bank of Australia Ltd in 1982 and changed its name to Westpac Banking Corporation.[105]

The early buildings on the site, including a c1890 cottage, were demolished and replaced with a purpose built bank and car park (**Figure 4-71**). The building was designed by Spain & Cos Architects and built by Welch Bros (**Figure 4-72** and **Figure 4-73**). Minor alterations of the building were undertaken in 1955 and 1964, with major internal works undertaken by RS Hamilton in 1974. The branch was open until at least 1994.[106]

4.6.7 Towards the twenty-first century and beyond

From the 1940s onwards, there has been minimal physical changes to the Annandale heritage study area. A garage was constructed to the rear of the Pyrmont Bridge terraces (**Figure 4-74**). This garage was used by Grace Bros, who still occupied the store located on the corner of Pyrmont Bridge Road and Mallett Street up until the 1960s (**Figure 4-74** to **Figure 4-77**).

By 1975, the Grace Bros-owned store, garage and terrace on the corner of Pyrmont Bridge Road and Mallett Street had been demolished and replaced by a warehouse/store (**Figure 4-78**).

In 1988, Hahn Brewing Company purchased the warehouse on the corner of Pyrmont Bridge Road and George Road.[107] It received financial support from Lion Nathan in 1993 and in 1998, Hahn Brewery was relaunched as Malt Shovel Brewery, after the James Squire original brewery tavern– 'The Malting Shovel'.[108] In 2010, Hahn Brewing Company purchased 188 Parramatta Road and 95 Pyrmont Bridge Road, back to back properties, in order to expand their business[109] (**Figure 4-79**). By 1994, the stores and warehouses adjacent to the former Bank of NSW were replaced by one large building, which is presently Camperdown Fitness (**Figure 4-80**). The buildings from 1994 remain externally unchanged today.



Figure 4-64 1835 plan of environs of Sydney by PL Bemi showing Bligh's land holdings on the north side of Parramatta Road, Camperdown

(Source: SLNSW)



Figure 4-65 1841 subdivision plan of Bligh's Camperdown Estate

(Source: SLNSW with GML overlay)

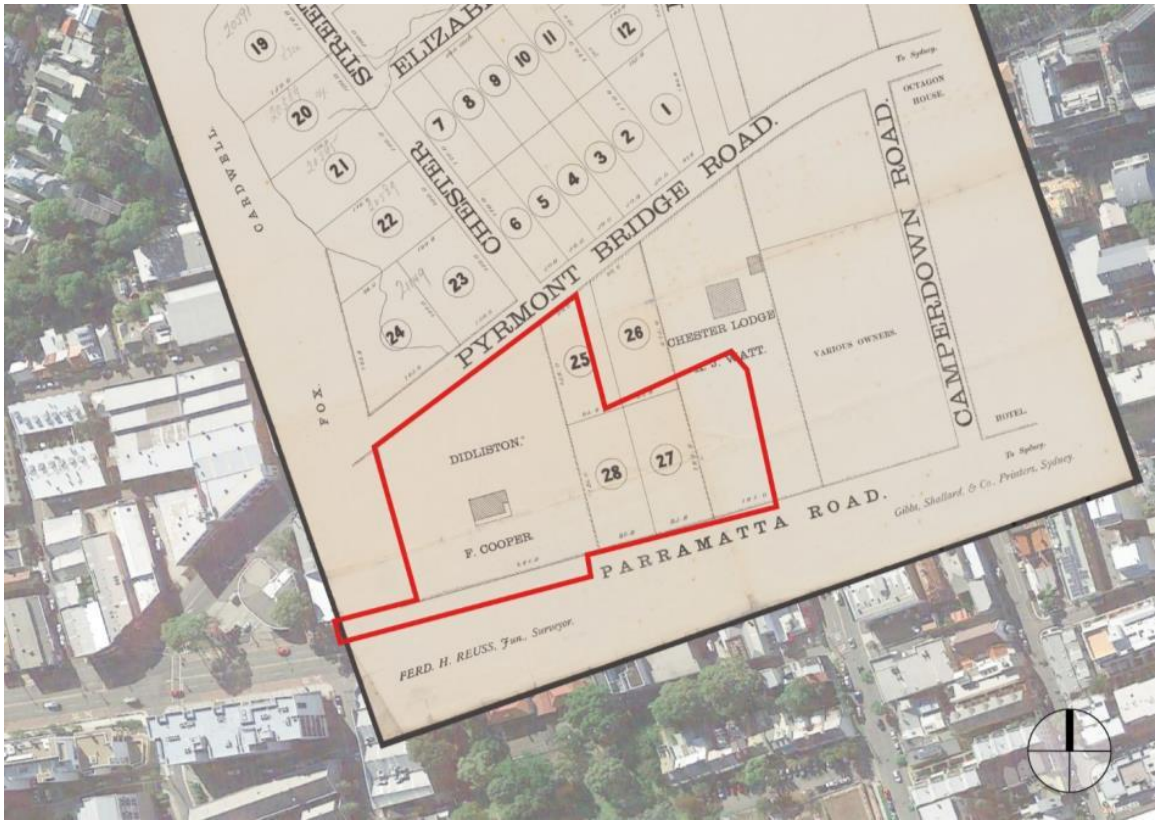


Figure 4-66 Detail of c1885 sale of villa allotment subdivisions in Camperdown and Annandale (Source: NLA with GML overlay)



Figure 4-67 Detail of a c1890 parish map showing the subdivision of the project footprint (Source: SLNSW with GML overlay)

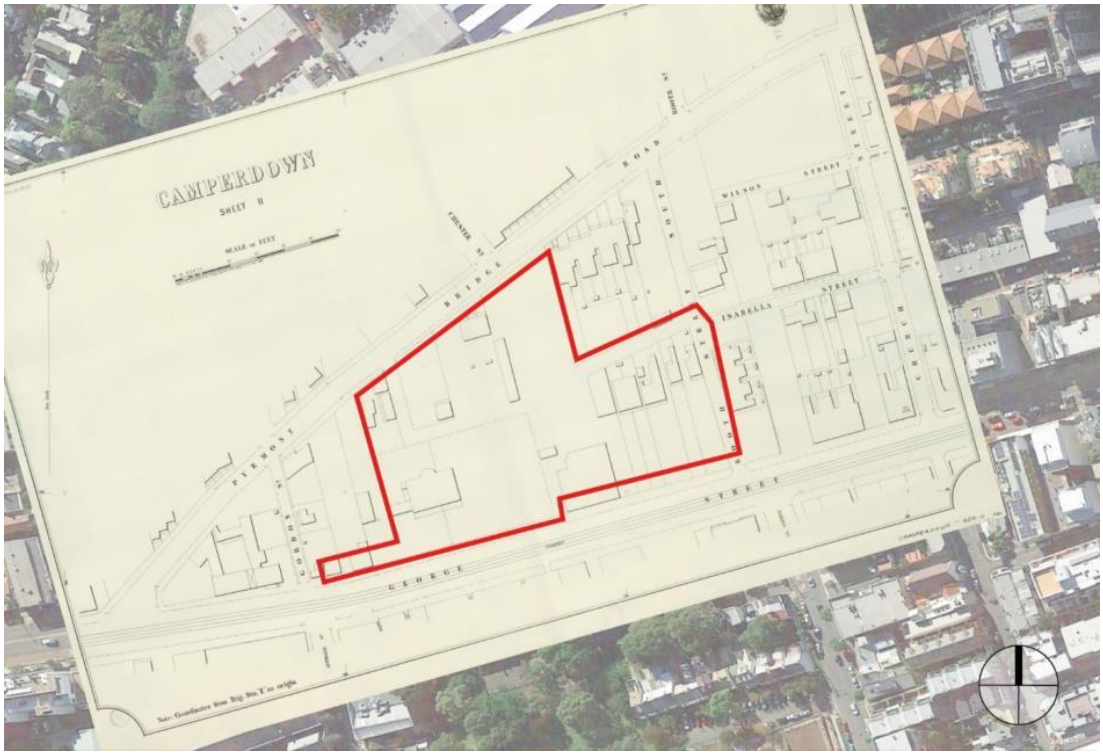


Figure 4-68 c1890 Metropolitan plan for Camperdown, sheet 11. Didliston can be seen in the centre of the block, facing Parramatta Road (identified as George Street on the plan).

To the east of Didliston is Bignell and Clark's Camperdown steam joinery works. The third house from Mallett Street (Booth Street South) is Florenceville (Source: SLNSW with GML overlay)



Figure 4-69 1912 Metropolitan Board of Water Supply & Sewerage Field Book No. 656, showing the Annandale project footprint

(Source: Sydney Water Archives – field book has been digitally stitched together by GML, 2016)



Figure 4-70 1930 aerial of the Camperdown aerial

Morris (NSW) Limited has set up a garage on corner of Pyrmont Bridge Road and Bignell Lane (Source: LPI NSW with GML overlay)



Figure 4-71 Blueprint of the lot to be purchased by Bank of NSW

(Source: Westpac Group Archives)



Figure 4-72 1936 plan of Bank of NSW, building elevations

Plans by Spain & Cos, Architects (Source: Westpac Group Archives)

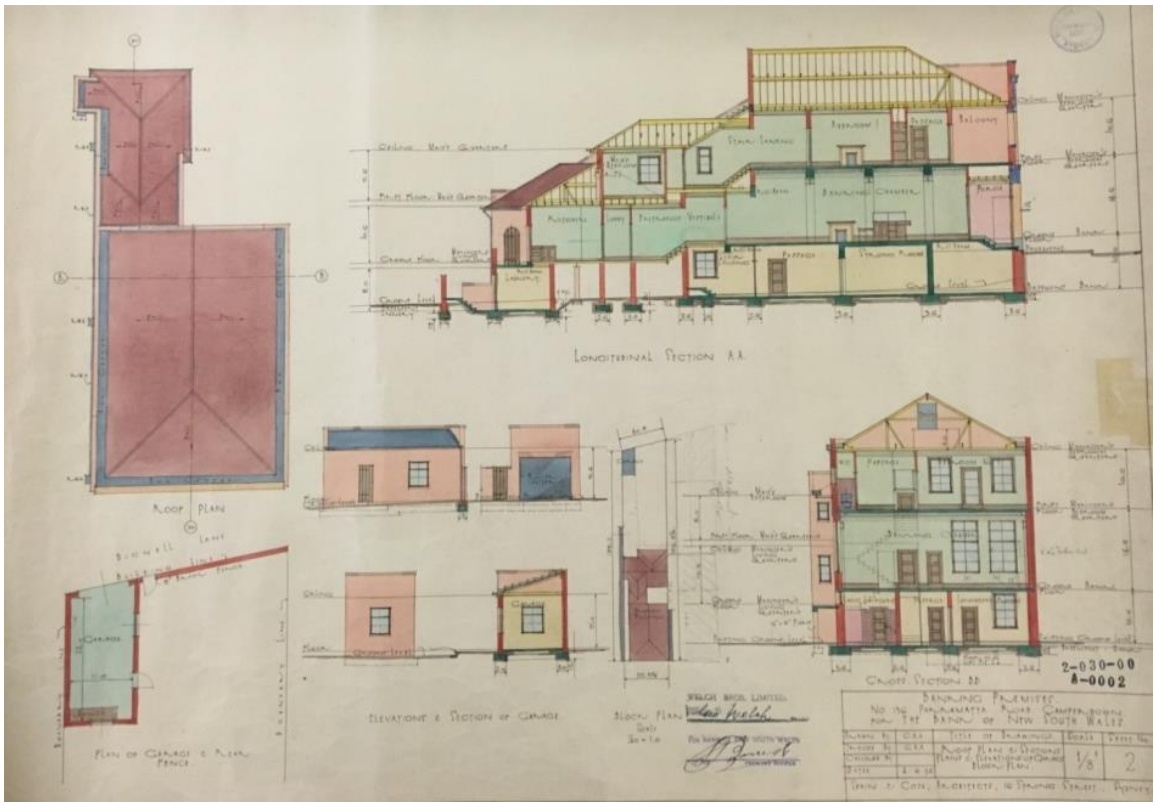


Figure 4-73 1936 plan of Bank of NSW, cross-section plan

Plans by Spain & Cos, Architects (Source: Westpac Group Archives)

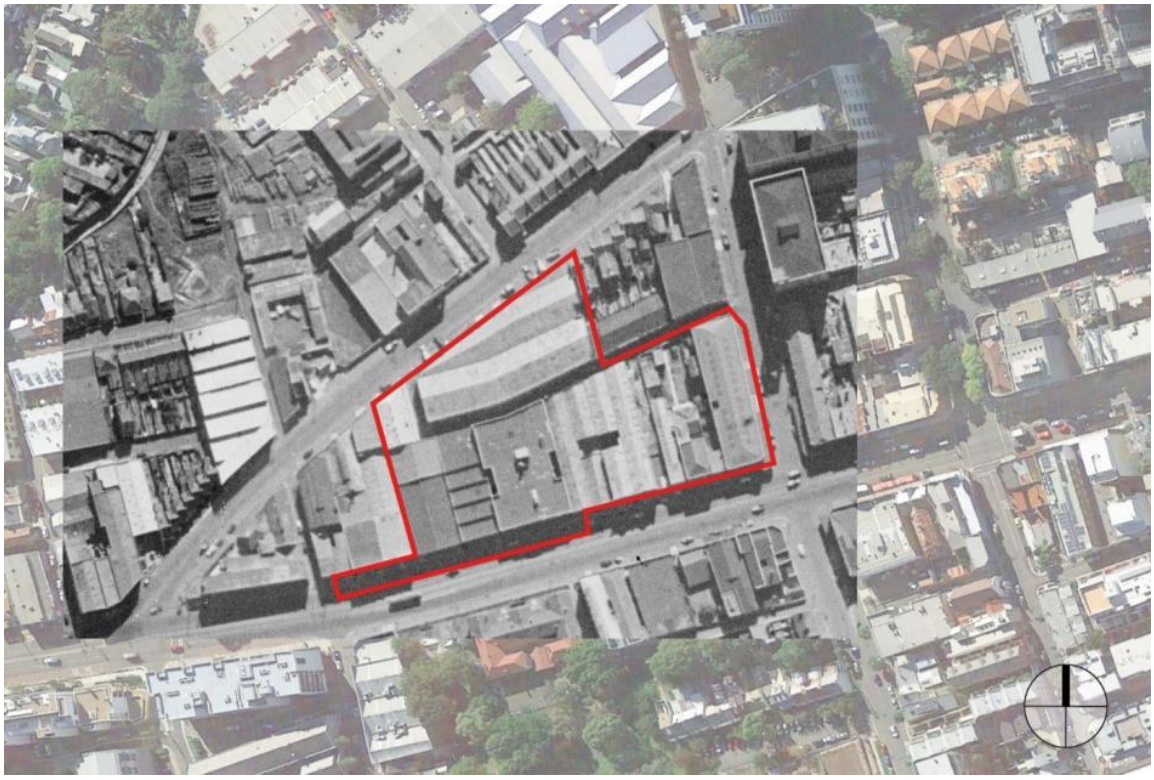


Figure 4-74 1943 aerial showing corner of Parramatta Road, Pyrmont Bridge Road and Mallett Street

(Source: LPI NSW with GML overlay)



Figure 4-75 1948 Civic Survey of the Annandale heritage study area, showing most of the allotments have been built upon and are dominantly commercial

(Source: CoS with GML overlay)

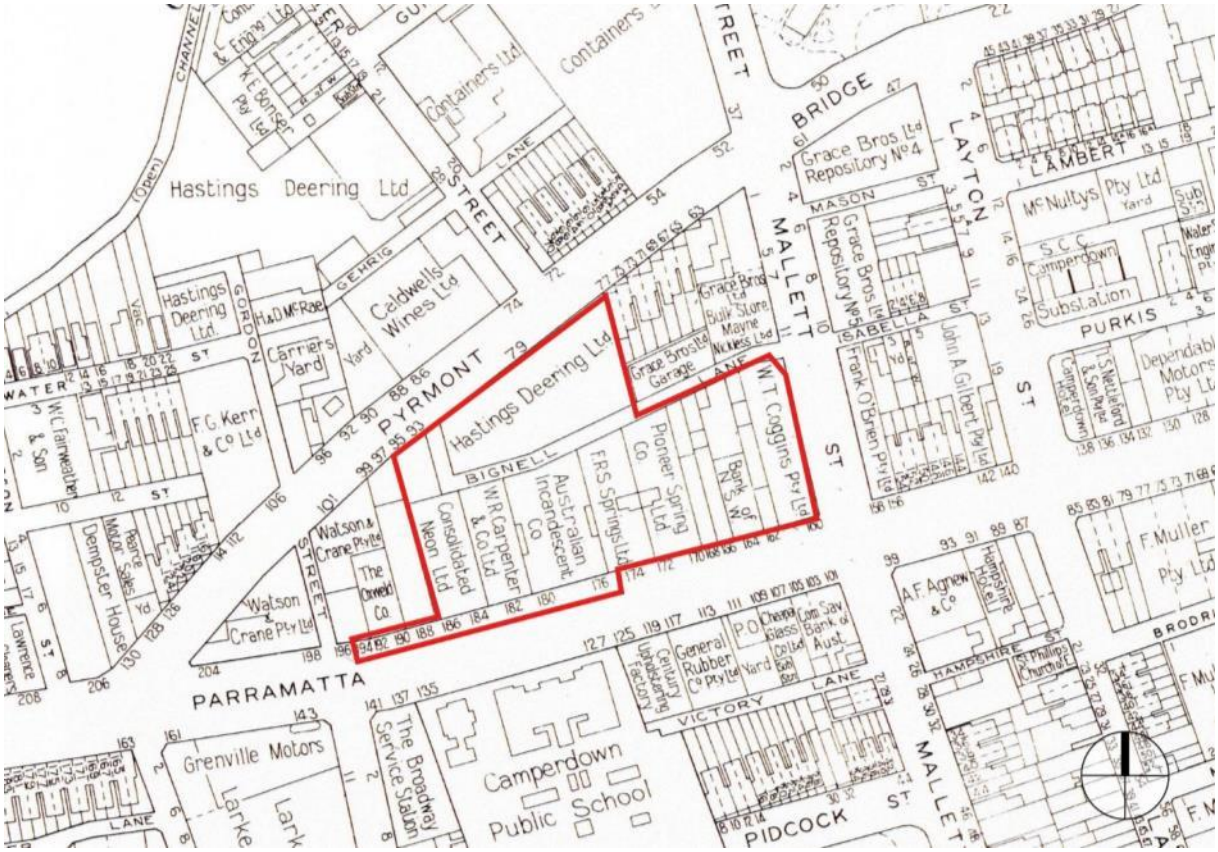


Figure 4-76 1956 City Building Surveyor's Detail Sheets showing the commercial occupants and little change in the project footprint

(Source: CoS with GML overlay)

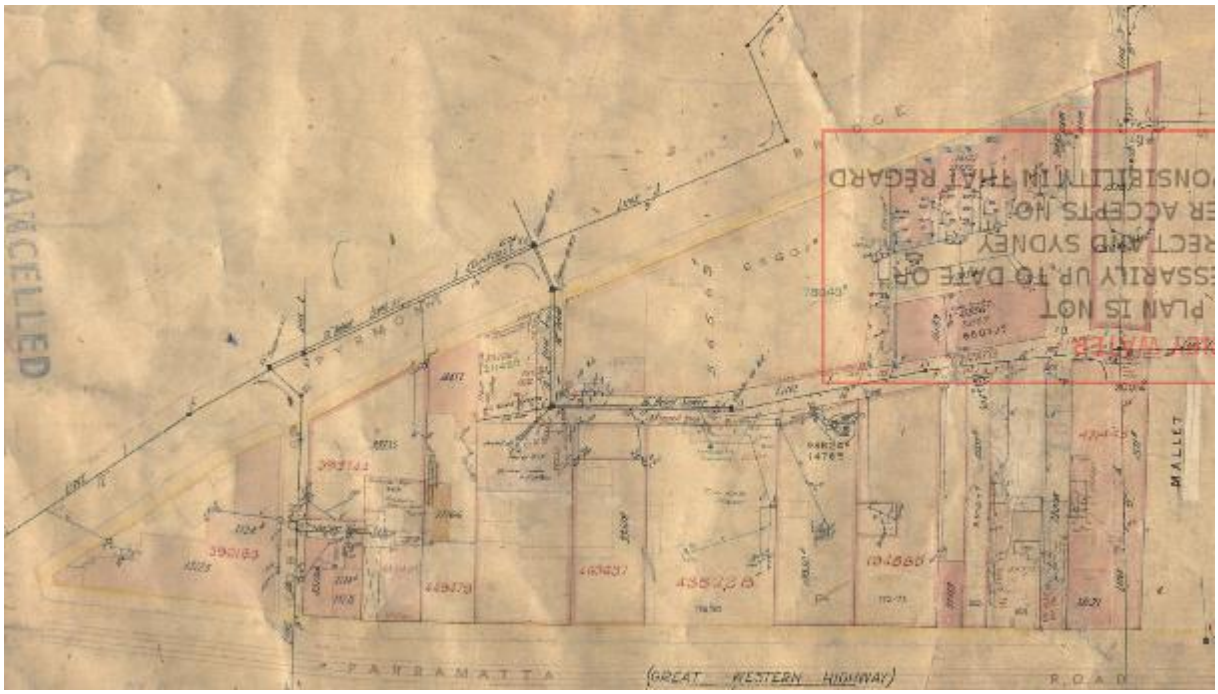


Figure 4-77 1912–1962 Blackwattle plan of project footprint

(Source: Sydney Water Archives)



Figure 4-78 1975 aerial showing a new warehouse/showroom on the corner of Pyrmont Bridge Road and Mallett Street

(Source: LPI NSW with GML overlay)

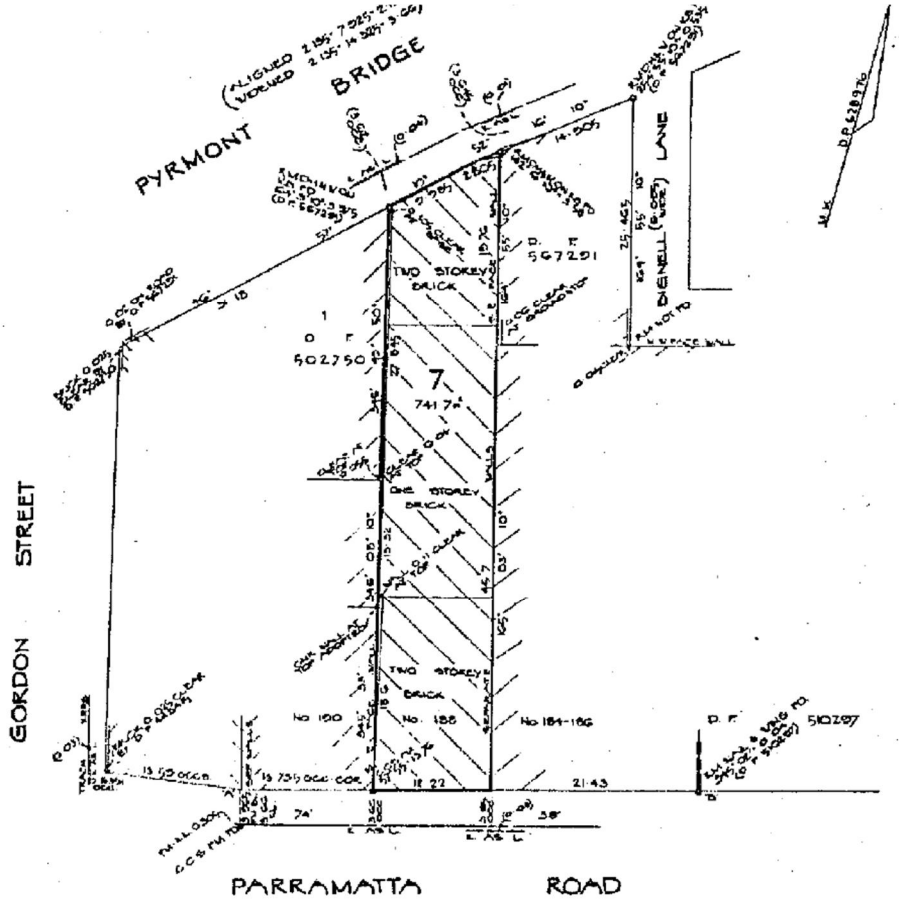


Figure 4-79 1984 plan of 188 Parramatta Road and 95 Pyrmont Bridge Road, which was purchased by Hahn Brewery by 2010 in order to expand its operations
(Source: LPI NSW)



Figure 4-80 1994 aerial showing Camperdown Fitness which has moved in next door to former Bank of NSW building along Parramatta Road

(Source: LPI NSW)

4.7 Area 6 – St Peters heritage study area

The study area formed part of a large parcel of land granted to William Hutchinson who gave the area the name 'Waterloo'. Subsequently, during the twentieth century was used as a brickwork, and later as a landfill site.

The historical information for the St Peters heritage study area is detailed in the New M5 Non-Aboriginal Heritage Impact Assessment (AECOM 2015).

5 Historical archaeology

5.1 Preamble

This section describes the historical archaeological potential of the six study areas. The heritage significance of each archaeological site has been determined at the state or local level. This section also assesses the potential impact to archaeological resources resulting from construction of the project described in **section 2.3**.

5.2 Overview of approach

The focus of this historical archaeological assessment has been to identify key areas within the project footprint likely to contain significant historical archaeological resources that may be impacted by the project. The historical archaeological assessment has been prepared on the basis of:

- A site inspection of the six areas defined in **section 2.4** which would be subject to surface works
- A review of the SHR, S170 Register, SREP and LEPs for known state and locally listed sites
- The historical overview prepared for the project (**Chapter 4** of this report)
- A review of relevant historical archaeological background documentation, where readily available
- Identification of previous major works that would have impacted on historical archaeological resources within the six areas.

The assessment does not provide a detailed review of all potential archaeological resources across the entire corridor, but rather uses the information extrapolated from the above-mentioned sources in order to initially determine where the key archaeological resources may exist. It also only assesses those areas that would be subject to surface works including tunnel entry and exit portals and infrastructure. As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further.

The nature of archaeology is that it is sometimes unpredictable; as such, this assessment is based on currently available knowledge. The level of significance associated with heritage items (State or local) is based on extant values assessments, and comparable sites. Unexpected archaeological finds could hold high value depending upon their nature and extent. The historical research and assessment is considered to be sufficiently robust that testing to confirm the extent location of potential archaeological remains is not required at this stage.

Further, where known and potentially significant archaeological sites have been identified through desktop assessment within the footprint, a program of archaeological test excavation within the project footprint could unnecessarily disturb historical archaeological relics which may not be otherwise impacted as an outcome of the final design. Consequently, archaeological test excavation during the EIS stage of the project could result in a higher level of heritage impact than targeted test excavation undertaken during the early works phase when the final design has been adopted.

A comprehensive historical archaeological research design should be prepared before the start of proposed works within identified Historical Archaeological Management Units (HAMUs) where potential for locally or State significant archaeology has been identified. This way, archaeological monitoring and test excavation activities would only be undertaken in advance of the early works and construction program where archaeological remains are likely to be extant and cannot be conserved in situ for the projects. This approach would facilitate better heritage outcomes.

In summary, the archaeological assessment methodology for the project is commensurate with the level of design and planning that has been undertaken to date. It has followed the assessment and reporting standards on previous recently approved SSI projects including previous stages of the WestConnex program of works. It proposes an appropriate methodology for the management of non-Aboriginal archaeology for the M4-M5 Link project.

5.2.1 Assessment of historical archaeological potential

'Archaeological potential' refers to the level of possibility that physical evidence of past historical phases will survive on a site. It is an assessment made by interpreting the results of historical analysis and the extent of previous physical disturbance at a site to determine the likelihood of historical archaeological remains to survive.

For the purpose of this assessment low, moderate and high levels of disturbance are defined as follows:

- Low disturbance – minimal and/or superficial impact to the landscape which has resulted in little or no disturbance to subsurface remains, characterised by such activities as capping of areas with introduced fill, or construction of roads and pathways
- Moderate disturbance – shallow or localised impacts to the landscape, characterised by excavations for shallow building footings or service trenches
- High disturbance – largely disturbed landscape, characterised by such land use impacts as deep building footings (piled foundations, deep slab foundations), basements, or quarrying.

Correlating the levels of disturbance with the types of archaeological evidence that may remain through analysis of the historical development, determines the level of archaeological potential. This is usually described as low, moderate or high, and is assessed as follows:

- Low – it is unlikely that archaeological evidence associated with this historical phase or feature survives
- Moderate – it is possible that some archaeological evidence associated with this historical phase or feature survive. If archaeological remains survive they may have been subject to some disturbance
- High – it is likely that archaeological evidence associated with this historical phase or feature survives intact.

5.2.2 Assessment of historical archaeological significance

The assessment of significance of historical archaeological relics requires a specialised framework for consideration of their research potential. Generally, relics with a greater research potential will be of higher heritage significance. The most widely used framework for assessing archaeological research potential is three key questions developed by Bickford and Sullivan in 1984[110] :

- Can the site contribute knowledge that no other resource can?
- Can the site contribute knowledge that no other site can?
- Is this knowledge relevant to general questions about human history or other substantive questions relating to Australian history, or does it contribute to other major research questions?

Use of the Bickford and Sullivan questions provide basic but essential information. In addition to the current NSW Heritage Criteria, the Heritage Branch has prepared a set of guidelines to allow consideration of how an individual archaeological site or relic may be assessed in its own right.

The significance assessment of the identified archaeological resource is carried out by applying criteria expressed in the publication *Assessing Significance for Historical Archaeological Sites and 'Relics'*, prepared by the Heritage Branch, formerly NSW Department of Planning (now the Heritage Division, OEH, NSW Department of Premier and Cabinet) in December 2009.[111] The criteria as adapted for archaeological remains are:

- Archaeological research potential (Current NSW Heritage Criterion E)
- Associations with individuals, events or groups of historical importance (NSW Heritage Criteria A, B & D)
- Aesthetic or technical significance (NSW Heritage Criterion C)
- Ability to demonstrate the past through archaeological remains (NSW Heritage Criteria A, C, F & G).

5.2.3 Historical archaeological management units

In order to facilitate the management of archaeology the individual project footprints have been subdivided into discrete parcels of land referred to as HAMUs. The division of HAMUs takes into consideration factors such as the nature of the archaeological profile, the assessed level of archaeological potential, and existing geographic factors that create discrete parcels such as existing roads which impact on management recommendations. The Leichhardt, Rozelle, Iron Cove and Annandale project footprints have been divided into 11 separate HAMUs and each is described separately below in **section 5.3** to **section 5.8**. As the Haberfield and St Peters project footprints have been previously assessed, no further recommendations for archaeological management have been developed as part of this assessment.

An assessment of archaeological survival within each HAMU has been undertaken which compares past activities and events which may have resulted in the creation of archaeological remains against previous developments which are likely to have impacted or removed these remains. Based on this assessment the potential for archaeological remains to survive within each HAMU has been designated as either nil, low, moderate or high.

Following the assessment of potential archaeology for the individual HAMUs, a preliminary heritage significance assessment for each one has been undertaken. Each HAMU has been ascribed either local or state heritage value in relation to their archaeological resources. Archaeological resources should be managed in accordance with their heritage significance. Each HAMU and its archaeological potential has been mapped, as shown in **Figure 5-2** to **Figure 5-9**.

5.3 Area 1 – Haberfield/Ashfield (C1–C3)

The archaeological potential and significance of the area that would comprise construction ancillary facilities for Option A has been previously assessed under the M4 East project (GML September 2015[112]) and all archaeological remains were managed during these works. As outlined in **section 2.4.1**, for the purpose of this assessment it has been assumed that the proposed construction works associated with M4 East within this study area have been completed and any mitigation measures relating to impacts on archaeological remains have been implemented.

As the proposed works assessed under this report comprise the internal fitout of the ventilation facility, continued use of existing construction compounds and tie ins with the underground stub tunnels constructed as part of the M4 East project only, it is considered that these works would not result in any impacts to archaeological remains within the study area and no further assessment for the Haberfield under Option A has been undertaken.

The project footprint for Option B contains construction ancillary facilities at Haberfield and Ashfield which have not previously been subject to assessment. These are the Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b). The two sites are separated by Parramatta Road, which runs approximately north-south. The land slopes gently to the southwest, with most construction stepped to this slope. The Haberfield civil site (C2b) has been previously assessed by the M4 East project and is therefore not reported on below.

The following observations were made in regard to the physical conditions within the Haberfield/Ashfield Option B project footprint which informs the assessment of potential for archaeological deposits:

- Generally, the study area has been cleared of any previous development for the construction of the commercial development that comprises most of the sites
- New buildings along the western boundary of the project footprint have been cut into the original slope, to create a second storey at the rear of the blocks fronting Parramatta Road
- One section of the early twentieth century development remains, with two storey shopfronts remaining at 244-250 Parramatta Road, on the corner of Bland Street
- The original house at 266 Parramatta Road is extant, behind a modern shopfront building.

5.3.1 Site land use history

In addition to the site investigation, a desktop analysis of historical aerial photographs and plans has been undertaken to identify historic developments within the project footprint which may have had an impact on the survival of archaeological remains, but which may no longer be visible in the current landscape. The impact of the recent and historic developments is set out in **Table 5-1**. Collectively, these developments have resulted in disturbance across the project footprint. HAMUs within this project footprint are shown in **Figure 5-1**.

Table 5-1 Summary of past disturbance

Past developments	Nature of past disturbance	Level of disturbance
Late nineteenth/early twentieth century buildings – basement excavation	Disturbance of agricultural landscape features, fencelines	Moderate to high – Construction activities are likely to have caused significant disturbance to the ephemeral remains of early land clearing and agricultural land use.
Late twentieth century buildings – building foundations, cutting and levelling	Surface clearing and localised impacts resulting from excavation for building foundations.	Moderate to high – localised areas of complete disturbance where the slope from Parramatta Road means that excavation for two storey buildings has completely removed archaeological remains towards the western edge of the project footprint. There is potential for deposits to survive below concrete slabs or between deeper building footings.
Services	Excavation for services (water, gas, sewage) will have completely removed any remains within the trench footprint.	Moderate – localised areas of complete disturbance in particular along Parramatta Road.
Construction of roads – Parramatta Road	Construction and maintenance of road way.	Low to moderate – resurfacing and upgrades to the road surface is likely to have impacted on earlier road surfaces.



Figure 5-1 Historical Archaeological Management Unit within the Haberfield/Ashfield (Option B) project footprint (showing HAMU 1)

(Source: GML Heritage)

5.3.2 Archaeological potential and significance

The Haberfield/Ashfield project footprint consists of one HAMU which has potential for archaeological remains which do not meet the threshold for local significance.

HAMU 1 – Haberfield/Ashfield

HAMU 1	Haberfield/Ashfield
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within Haberfield/Ashfield HAMU 1.

HAMU 1	Haberfield/Ashfield
Archaeological potential	There is moderate or high potential for archaeological evidence to be present associated with the following: · Late 19th to early 20th century building footings · Early 20th century services beneath road surfaces and footpaths. There is low potential for archaeological evidence to be present associated with the following: · Early to mid-19th century property boundaries and garden/agricultural remains.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for *Assessing Significance for Historical Archaeological Sites and 'Relics'* (2009). Archaeological research potential: · Archaeological remains relating to the residential occupation of the study area are unlikely to provide information that is not available from other sites and sources due to the limited potential for artefact bearing deposits · Remains associated with the early 20th century early land clearance and farming of the site would have limited research value for their ability to supplement our knowledge of land uses prior to residential subdivision. Association with individuals, events, or groups of historical importance: · No historical associations have been identified at this stage. Aesthetic or technical significance: · The archaeological remains would not demonstrate aesthetic or technical significance. Ability to demonstrate the past through archaeological remains: · Archaeological remains have limited ability to demonstrate aspects of the past, including daily life of residents, or early settlement and farming practices.
Significance level	Nil – does not meet the threshold for significance.
Heritage impact assessment	Proposed works within the Haberfield/Ashfield HAMU include: · Site establishment and enabling works · Tunnelling and tunnelling/construction support activities · Surface earthworks and structures · Finishing works. The proposed works are likely to entail deep excavations associated with tunnelling activities. However, as there are unlikely to be significant archaeological remains in this HAMU, the proposed works are considered to have no heritage impact.
Mitigation measures	No further archaeological investigation required. An unexpected finds procedure should be implemented if archaeological remains are identified.

5.4 Area 2 – Leichhardt (C4)

The Darley Street project footprint is oriented around the alignment of the former Goods Line, which has resulted in significant modifications to the landscape. The topography of this area slopes steadily downwards from east to west across the project footprint towards Hawthorne Canal. The gradient of the slope is visible looking west along Darley Road.

The following observations were made in regard to the physical conditions within the Darley Road project footprint which informs the assessment of potential for archaeological deposits:

- In the eastern half of the project footprint the rail corridor has been cut into the original landform (sandstone bedrock) to create a level surface along which to lay the rail line. The edges of the cutting are visible beneath the staircase providing access to the Leichhardt North light rail stop outside the northeast boundary of the project footprint and on the northern side of the rail line. Within the project footprint itself, evidence of the reduction of the former ground surface is visible along the southern edge of the eastern car park
- Along the northwest boundary of the project footprint the rail line has been raised up on an earthen embankment to convey the rail line across the Charles Street Bridge. The southern edge of the embankment extends into the project footprint and is supported by a concrete retaining wall
- The open yard/car park in the western third of the project footprint appears to have undergone limited modification resulting from development impacts. The natural slope is still evident in this area and there is no visible evidence of cutting and/or levelling works. A stormwater grate visible on the southern edge of the yard/car park is likely to feed into the stormwater drain which runs along the southern boundary of the project footprint
- The existing c1960s brick warehouse contains a basement level occupying about 40 per cent of the building footprint. The line of windows visible along the lower edge of the building shows the approximate extent of the basement. Construction of the basement will have cut into the existing slope of the site in the eastern half of the building footprint
- The corrugated steel warehouse in the centre of the project footprint is founded on a concrete slab which extends the entire building length
- A stormwater culvert is visible in the southeast corner of the project footprint. The project footprint for the culvert was not visible within the existing landscape. However, excavation for the culvert will have disturbed any remains within the service trench footprint.

The site investigation for this assessment was undertaken in 2016, prior to the refurbishment of the commercial building.

5.4.1 Site land use history

In addition to the site investigation, a desktop analysis of historical aerial photographs and plans has been undertaken to identify historic developments within the project footprint which may have had an impact on the survival of archaeological remains, but which may no longer be visible in the current landscape. The impact of the recent and historic developments is set out in **Table 5-2**. Collectively, these developments have resulted in a moderate to high degree of impact across the project footprint indicating that much of the area has been heavily disturbed. HAMUs within this project footprint are shown in **Figure 5-2**.

Table 5-2 Summary of past disturbance

Past developments	Nature of past disturbance	Level of disturbance
Railway Goods Line	Excavation of sandstone bedrock, and levelling of ground surface for construction of the railway goods line.	High – the eastern half of the Darley Road project footprint lies below the surrounding street levels with areas of exposed bedrock visible indicating the high level of impact resulting from this work.
Early twentieth century reclamation	Filling and levelling within waterfront and estuary areas.	Low to moderate – the filling process may have caused some disturbance, such as the demolition of earlier structures, but their subsurface remains are likely to be present.
Twentieth century warehouses	Excavation and levelling to create a level surface for construction of the existing building.	High – the lower floor of the warehouse has been cut into the natural slope of the site and will have completely removed any earlier remains within the building footprint.

Past developments	Nature of past disturbance	Level of disturbance
Stormwater drainage system	Excavation for the stormwater culvert and pipe trenches.	High – construction of the culvert and excavation for the pipes, visible in the eastern half of the Darley Road project footprint, will have completely removed any deposits within the individual trench footprint/s.
Construction of Hawthorne Canal	Reclamation for the construction of the Hawthorne Canal	High – filling and levelling of the natural creek bed
Services– excavation for service trenches	Excavation for services (water, gas, sewage) will have completely removed any remains within the trench footprint.	Moderate – localised areas of complete disturbance.



Figure 5-2 Historical Archaeological Management Unit within the Leichhardt (Darley Road) project footprint (showing HAMU 2)

(Source: GML Heritage)

5.4.2 Archaeological potential and significance

The Darley Road project footprint consists of one HAMU. HAMU 2 is assessed as having no potential to contain archaeological remains.

HAMU 2 – Darley Road

HAMU 2	Darley Road
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within Darley Road HAMU 2.
Archaeological potential	There is nil potential for archaeological evidence to be present in the project footprint. Archaeological evidence associated with remains of 1890s houses will have been completely removed by more recent developments within the site as outlined in **Table 5-2**.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Archaeological remains are not expected to survive in this HAMU and there is no research potential. Association with individuals, events, or groups of historical importance: · No historical associations have been identified at this stage. Aesthetic or technical significance: · The archaeological remains would not demonstrate aesthetic or technical significance. Ability to demonstrate the past through archaeological remains: · Archaeological remains are not expected to survive in this HAMU.
Significance level	Nil – does not meet the threshold for significance.
Heritage impact assessment	Proposed works within the Darley Road HAMU include: · Site establishment and enabling works · Tunnelling · Drainage · Finishing works · Construction of a motorway operations complex including a permanent water treatment plant. The proposed works are likely to entail deep excavations associated with tunnelling activities. However, as previous developments within this HAMU are anticipated to have completely removed any archaeological remains, the proposed works are considered to have no impact on significant archaeological remains
Mitigation measures	No further archaeological investigation required. An unexpected finds procedure should be implemented if archaeological remains are identified.

5.5 Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) project footprint (C5, C6 and C7)

The following observations were made in regard to the physical conditions within the Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) project footprint which informs the assessment of potential for archaeological deposits:

- Most of the project footprint has been artificially modified by historic development which is evident in the current layout of the area
- Sections of exposed sandstone bedrock along the northern boundary of the Rozelle Rail Yards, and within the White Bay Power Station site indicate that these sections of the project footprint have been quarried to facilitate historic developments which will have had an impact on the survival of archaeological remains
- Easton Park is relatively level, although there is a gradual slope towards Lilyfield Road on the southern edge of the park. The park dips downwards around the edges towards the playing field which occupies the centre of the park
- The light industrial area on the southern side of Lilyfield Road is occupied by single and two storey warehouses that will be demolished as part of the project. A canalised stormwater channel runs west to east bisecting the area. Exposed sandstone bedrock was observed within this area suggesting that construction of the existing buildings is likely to have resulted in a certain amount of cutting and/or filling which will have impacted on the survival of archaeological remains
- The parkland areas situated on the northern side of City West Link and the eastern part of Victoria Road leading to Anzac Bridge makes up a small per cent of the project footprint. This portion of the project footprint is low-lying in relation to the surrounding areas and relatively level. The parkland comprises grassed areas, extensive bitumen surfaces, and sections of disused rail track, in particular within the White Bay Power Station site
- The Rozelle foreshore area is generally covered by concrete hardstands, with timber wharves south of James Craig Road, and a stone seawall and concrete slips along The Crescent
- The project footprint contains a number of multi lane roads including the City West Link, The Crescent, Anzac Bridge and Victoria Road. Construction of these intersections have required cutting and filling of the natural topography. The roadways consist of bitumen road surfaces, concrete kerbing and islands, and infrastructure including signage, lighting, footpaths and footbridges, and street plantings
- Whites Creek has been enclosed in a concrete channel with grassed public parklands along the southern boundary, and mature trees along the northern edge.

5.5.1 Site land use history

Evidence from the site investigation and a desktop analysis of historical aerial photographs and plans have been combined in order to identify the main developments within the project footprint that are likely to have impacted on earlier archaeological remains. The cumulative impacts of the recent and historic developments are set out in **Table 5-3**. The impacts of previous developments within the Rozelle project footprint has resulted in localised areas with a moderate or high potential for archaeological survival. Across most of the central and eastern sections of the Rozelle project footprint previous impacts such as quarrying, or cutting and levelling for the construction of roads and buildings has resulted in the removal of any archaeological remains. HAMUs within this project footprint are shown in **Figure 5-3**.

Table 5-3 Summary of past disturbance

Past development	Nature of past disturbance	Level of disturbance
Progressive reclamation	Multiple phases of filling and levelling within waterfront and estuary areas.	Moderate – the filling process may have caused some disturbance, such as the demolition of earlier structures, but their subsurface remains are likely to be present.
Quarrying and cutting sandstone	Excavation of sandstone bedrock, and levelling of ground surface.	High – the difference in ground levels between Lilyfield Road and the original shoreline means that excavation for the rail yards and industrial buildings is likely to have had a higher degree of impact towards the northern edge of the project footprint.
Construction of modern roads, Victoria Road, City West Link, Western Distributor	Demolition of previous structures and any earlier deposits, and earlier street alignments for new, upgraded or wider roads.	High – the construction of the modern road network within the project footprint has required varying levels of excavation for the creation of underpasses and stable road base.
Eighteenth and nineteenth-century buildings	Surface clearing and some excavation for footings.	Low – generally they were the first substantial structures built on the site and did not impact evidence of prior European settlement.
Twentieth century buildings–cutting and levelling	Demolition of pre-existing buildings and complete removal of any earlier deposits.	Moderate to High – the changing ground levels within the project footprint means that most modern buildings have been cut in to the bedrock, removing evidence of earlier occupation.
Infrastructure and services–excavation for service trenches	Excavation for services (water, gas, sewage) and infrastructure (trams on Lilyfield Road) will have completely removed any remains within the trench footprint.	Moderate – localised areas of complete disturbance.



Figure 5-3 Historical Archaeological Management Units within the Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) project footprint (showing HAMUs 3 to 7)

(Source: GML Heritage)

5.5.2 Archaeological potential and significance

Based on the level of archaeological potential and management requirements, five separate HAMUs have been delineated within the Rozelle project footprint (HAMUs 3 to 7). HAMUs 3 and 6 are considered to have a high degree of archaeological potential. HAMUs 4 and 5 are considered to have some potential for archaeological remains which do not meet the threshold for significance, and do not require ongoing management. HAMU 7 has known archaeological remains associated with the state significant White Bay Power Station. Areas of archaeological potential within HAMUs are shown in **Figure 5-3** to **Figure 5-6**.

This assessment has not included any impacts on archaeological remains which may arise during the site management works at the Rozelle Rail Yards. The impacts of these works have been previously assessed and are not considered further in this report.

HAMU 3 – Lilyfield Road and Gordon Street

HAMU 3	Lilyfield Road and Gordon Street
Listed archaeological items	No heritage register listings specifically reference the significance of the potential historical archaeological resource within the Lilyfield Road and Gordon Street HAMU.
Archaeological potential	There is moderate potential for archaeological evidence to be present associated with the following: · Early residential occupation on Gordon Street (circa 1860–1915) such as structural remains and artefact deposits

HAMU 3	Lilyfield Road and Gordon Street
	· Previous phases of industrial activity at the site, including associated artefact deposits or structural remains. There is high potential for archaeological evidence to be present associated with the following: · Reclamation activities of the Rozelle foreshore prior to 1890. Most sites or features in this HAMU are likely to have been disturbed by the quarrying of the sandstone bedrock along the property boundary with Lilyfield Road, with the exception of the driveway areas of the industrial developments at 92–94 Lilyfield Road and 80–84 Lilyfield Road.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Archaeological remains in this HAMU relating to early residential development may have low research potential depending on the nature and extent of the remains. · Archaeological remains in this HAMU relating to the establishment and development of industrial activities, including reclamation, may have moderate to high research potential depending on the nature and extent of the remains. Association with individuals, events, or groups of historical importance: · May have historical associations, particularly with former residents, but specific associations have not been identified at this stage. Aesthetic or technical significance: · There is no clear indication in historical records examined to date to establish whether or not archaeological remains would have aesthetic/technical significance. Ability to demonstrate the past through archaeological remains: · Structural and artefact deposits relating to the early residential development on Gordon Street have the potential to provide information relating to the lives of residents in the first phases of industrialisation in Rozelle. · Remains of industrial activities, including the reclamation of the foreshore have the potential to provide information about the earliest phases of industrialisation in the Rozelle area, prior to the construction of the Rozelle Rail Yards.
Significance level	Local
Heritage impact assessment	Proposed works within the Lilyfield Road and Gordon Street HAMU include: · Site establishment and enabling works · Tunnelling · Surface earthworks and structures · Drainage · Pavement · Operational Ancillary facilities · Finishing works. Much of the works in this HAMU may require deep excavation in areas where archaeological deposits are likely to be present, and in the location of the known

HAMU 3	Lilyfield Road and Gordon Street
	stormwater drain. Extensive ground disturbance of this kind will have a major adverse impact on any archaeological remains which may be present. Activities associated with surface earthworks, drainage, and finishing works (such as service installation, installation of bridge foundations and landscaping) would have more localised impacts on the historical archaeological resource. These works are likely to have a minor to moderate adverse impact on the potential historical archaeological resource, depending on the location, extent and nature of the proposed works.
Mitigation measures	Mitigation measures as outlined in **Chapter 8** for locally significant historical archaeology would apply including: · Further developing mitigation methodologies for the management of impacts on known and potential locally significant historical archaeological resources · Preparing a Historical Archaeological Research Design (HARD) · Developing a methodology and scope for a program of test excavation · Undertaking an archaeological excavation program including salvage.



Figure 5-4 Areas of archaeological potential within HAMU 3

(Source: GML Heritage)

HAMU 4 – Victoria Road, City West Link, The Crescent and vicinity

HAMU 4	Victoria Road, City West Link
Listed archaeological items	No heritage register listings specifically reference the significance of the potential historical archaeological resource within the Victoria Road, City West Link HAMU.
Archaeological potential	There is low potential for archaeological evidence to be present associated with the following: · Early residential occupation on Weston Road and Abattoir Road (c1860–1915) such as structural remains and associated artefact scatters · Early road alignments of Weston Road and Barnes Street predating the 1960s upgrades to Victoria Road, and alignment of Abattoir Road prior to construction of Rozelle Rail Yards and White Bay Power Station · Evidence of reclamation and modifications of the Rozelle Bay foreshore, including. There is moderate potential for archaeological evidence to be present associated with the following: · Subsurface structural remains, and basement of the former White Bay Hotel site foundations · Reclamation activities of the Rozelle foreshore prior to 1890, including early stages of bridging Glebe Island, and channelization of Whites Creek, reclamation fills, and structures such as revetments or slips. Most sites or features in this HAMU are likely to have been disturbed or destroyed by the sandstone quarrying for the construction of the Rozelle Rail Yards and White Bay Power Station, and late twentieth century developments, or by the construction of major roadways and the installation of associated services. Remains of the White Bay Hotel may have been extensively disturbed by the fire which destroyed the hotel, and subsequent demolition.

HAMU 4	Victoria Road, City West Link
Significance assessment	Preliminary assessment against the NSW Heritage Criteria *for Assessing Significance for Historical Archaeological Sites and 'Relics'* (2009). Archaeological research potential: · Archaeological remains in this HAMU have low research potential due to the level of anticipated disturbance · Archaeological remains relating to the former White Bay Hotel are of low research potential as they are unlikely to provide any information that is not available from existing sources · There is some research potential for the evidence relating to the reclamation of foreshore areas, for comparative analysis with the body of research resulting from large scale developments along much of the Sydney foreshore. Association with individuals, events, or groups of historical importance: · May have historical associations, particularly with former residents, but specific associations have not been identified at this stage · Archaeological remains in this HAMU relating to the former White Bay Hotel are associated with the former power station workers who frequently patronised the hotel. Aesthetic or technical significance: · The archaeological remains likely to be present would not have aesthetic/technical significance. Ability to demonstrate the past through archaeological remains: · The anticipated archaeological resource's potential to demonstrate the past through archaeological remains is limited.
Significance level	Nil – does not meet the threshold for significance.
Heritage impact assessment	Proposed works within the Victoria Road, City West Link HAMU include: · Site establishment and enabling works · Surface earthworks and structures · Bridge works · Drainage · Pavement · Finishing works. However, this HAMU is considered to have a low potential for archaeological remains, and any surviving remains are likely to have been highly disturbed and would not meet the threshold for local significance, or would not provide information that is not available from existing sources. Therefore, the works proposed in this HAMU are considered to have no impact on significant archaeological remains.
Mitigation measures	No further archaeological investigation required. An unexpected finds procedure should be implemented.

HAMU 5 – Former Rozelle Rail Yards (West)

HAMU 5	Former Rozelle Rail Yards (West)
Listed archaeological items	No heritage register listings specifically reference the significance of the potential historical archaeological resource within the Former Rozelle Rail Yards (West) HAMU. The Lilyfield Road Stormwater Canal extant within HAMU 3 (listed under SREP 26, see **Chapter 6**) continues underground in this HAMU, however the listing does not specifically address this portion of the canal.
Archaeological potential	There is low potential for archaeological evidence to be present associated with the following: · Early road alignments of Abattoir Road prior to construction of the Rozelle Rail Yards. There is high potential for archaeological evidence to be present associated with the following: · Reclamation activities of the Rozelle foreshore during the nineteenth and twentieth centuries · Nineteenth-century drainage infrastructure associated with channelising the creek, and early twentieth century drainage infrastructure associated with the stormwater canal · Elements and infrastructure related to the operation of the Rozelle Rail Yards including rail tracks, sleepers and infrastructure. Some sites or features in this HAMU are likely to have been disturbed by the quarrying of the sandstone bedrock along the northern boundary. Further disturbance may have been caused by the levelling of the area for the Rozelle Rail Yards, subsequent modifications to the yards for operational upgrades, and installation of services and utilities.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for *Assessing Significance for Historical Archaeological Sites and 'Relics'* (2009). Archaeological research potential: · Archaeological remains in this HAMU are of low research potential as they are unlikely to provide any information that is not available from existing sources. Association with individuals, events, or groups of historical importance: · May have historical associations, particularly with former residents, but specific associations have not been identified at this stage. Aesthetic or technical significance: · Archaeological remains may demonstrate some technical achievement but are unlikely to be sufficiently intact or sufficiently rare so as to be considered significant under this criterion · The underground portions of the Lilyfield Street stormwater canal may be of significance, dependent on the fabric and integrity. Ability to demonstrate the past through archaeological remains: · The anticipated archaeological resource's potential to demonstrate the past through archaeological remains is limited.
Significance level	Nil – does not meet the threshold for significance.

HAMU 5	Former Rozelle Rail Yards (West)
Heritage impact assessment	Proposed works within the Former Rozelle Rail Yards (West) HAMU include: · Site establishment and enabling works · Tunnelling · Surface earthworks and structures · Drainage · Pavement · Operational ancillary facilities · Finishing works. This HAMU is considered to have a low potential for archaeological remains, and any surviving remains are likely to have been highly disturbed and would not meet the threshold for local significance. Therefore, the works proposed in this HAMU are considered to have no impact on significant archaeological remains.
Mitigation measures	No further archaeological investigation required. Uncovering infrastructure such as railway infrastructure and twentieth century services and utilities would not trigger the unexpected finds procedure as they are unlikely to be of archaeological significance. Evidence of early drainage and stormwater systems may warrant archaeological investigation and recording depending on the extent of modifications. An unexpected finds procedure should be implemented where these are identified.

HAMU 6 – Former Rozelle Rail Yards (East)

HAMU 6	Former Rozelle Rail Yards (East)
Listed archaeological items	No heritage register listings specifically reference the significance of the potential historical archaeological resource within the Former Rozelle Rail Yards (East) HAMU.
Archaeological potential	There is low potential for archaeological evidence to be present associated with the following: · Early industrial occupation on Lilyfield Road (c1860–1915), such as structural remains and associated artefact deposits in areas which have been quarried for the construction of the rail yards. There is moderate potential for archaeological evidence to be present associated with the following: · Early industrial occupation on Lilyfield Road (c1860–1915), such as structural remains and associated artefact deposits in areas which have been filled for the construction of the rail yards. There is high potential for archaeological evidence to be present associated with the following: · Reclamation activities of the Rozelle foreshore during the nineteenth and twentieth centuries · Elements and infrastructure related to the operation of the Rozelle Rail Yards including rail tracks, sleepers and infrastructure. Some sites or features in this HAMU are likely to have been disturbed by the quarrying of the sandstone bedrock along the northern boundary. Further disturbance may have been caused by the levelling of the area for the Rozelle Rail Yards, and subsequent modifications to the yards for operational upgrades, and installation of services and utilities.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Archaeological remains in this HAMU relating to early industrial development may have moderate research potential depending on the nature and extent of the remains. Association with individuals, events, or groups of historical importance: · May have historical associations, particularly with former residents, but specific associations have not been identified at this stage. Aesthetic or technical significance: · Archaeological remains in this HAMU relating to early industrial development may have moderate technical significance for their ability to demonstrate early manufacturing and trade processes associated with the waterfront industries originally located here. Ability to demonstrate the past through archaeological remains: · The anticipated archaeological resource has the potential to demonstrate the nineteenth-century industrialisation of the Rozelle waterfront.
Significance level	Local

HAMU 6	Former Rozelle Rail Yards (East)
Heritage impact assessment	Proposed works within the Former Rozelle Rail Yards (East) HAMU are likely to include: · Site establishment and enabling works · Tunnelling · Earthworks and associated structures · Drainage · Pavement · Finishing works. Parts of these works will require deep excavation in areas where archaeological deposits may be present. Extensive ground disturbance of this kind will have a major adverse impact on any significant archaeological remains which may be present. Activities requiring minor excavation or levelling may not impact the zone where potential archaeological deposits are located and are therefore likely to have a minor adverse impact on the potential historical resource. Service installation works, installation of bridge foundations and landscaping would have more localised impacts on the historical archaeological resource. These works are likely to have a moderate adverse impact on the potential historical archaeological resource, depending on the location, extent and nature of the proposed works.
Mitigation measures	Mitigation measures as outlined in **Chapter 8** for locally significant historical archaeology would apply including: · Further developing mitigation methodologies for the management of impacts on known and potential locally significant historical archaeological resources · Preparing a HARD · Developing a methodology and scope for a program of test excavation · Undertaking an archaeological excavation program including salvage.



Figure 5-5 Areas of archaeological potential within HAMU 6

(Source: GML Heritage)

HAMU 7 – White Bay Power Station

HAMU 7	White Bay Power Station
Listed archaeological items	White Bay Power Station is a listed heritage item of State significance, with significant archaeological components of the system known to exist both within and outside the SHR curtilage. Impacts to this item and its contributory elements are also discussed in **section 6.5.5**.
Archaeological potential	There are extant archaeological elements associated with the White Bay Power Station including: · Water channels associated with the southern penstock · The specific location of the channels is unknown.
Significance assessment	The water channels are excluded from the SHR curtilage for White Bay Power Station, and, are not identified in the 2013 CMP. They are closely associated with the southern penstock, which is graded 'high significance' in the White Bay Power Station CMP as an element of the substantially intact cooling water system, which was integral to the operation of the complex.[113] The channels play an important role in strengthening and supporting the significance of the place and are therefore considered an element of high significance.
Significance level	State

HAMU 7	White Bay Power Station
Heritage impact assessment	Proposed works within the White Bay Power Station HAMU includes a minor encroachment during the construction phase of the project as a result of the alignment of the temporary Victoria Road bridge which would cross over the southern penstock of the power station complex. The extent of excavation in this area is unknown at this stage; however, physical and indirect impacts to this heritage element should be avoided.
Mitigation measures	Mitigation measures as outlined in **section 8** for elements of the White Bay Power Station. This should include: · Preparing a HARD to guide archaeological investigation of the HAMU · Developing a methodology and scope for a program of test excavation to identify the location and integrity of the White Bay Power Station water channels if excavation in this HAMU is required · A cover and bridging structure would need to be designed to protect the water channels and the southern penstock, and to distribute the loads away from the heritage asset. This cover and bridging structure must not be supported on the penstock or channels themselves.

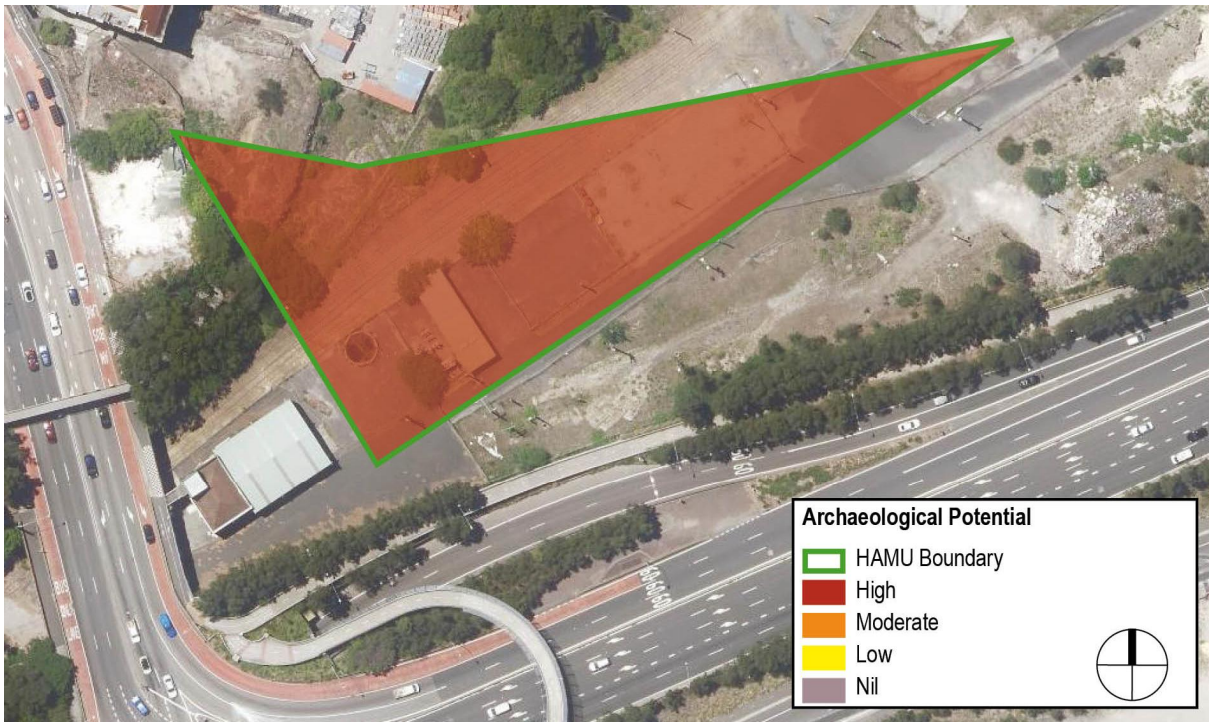


Figure 5-6 Areas of archaeological potential within HAMU 7

(Source: GML Heritage)

5.6 Area 4 – Iron Cove (C8) and bioretention facility

The following observations were made in regard to the physical conditions within the Iron Cove project footprint which informs the assessment of potential for archaeological deposits:

· The ground level within the project footprint slopes steeply downwards from Victoria Road along the side roads which branch off to the southwest (Byrne, Clubb, Toelle, Callan and Springside streets). To a lesser degree, the project footprint slopes down to the west along Victoria Road towards Iron Cove Bridge

- Construction of the existing late nineteenth and twentieth century properties has required varying degrees of cutting and filling to provide level surfaces on which to construct the buildings
- Several properties on Victoria Road between Byrnes Street and Toelle Street have been constructed directly onto the sandstone bedrock which appears to have been quarried in places to accommodate these buildings
- Other properties have been constructed on areas of fill where the ground level has been raised up. This is evident at 212-218 Victoria Road where the rear of the site has been raised by up to 1.5 metres. The concrete retaining wall along the rear boundary of the property. Similarly, the rear yard at 242 Victoria Road has also been built up with a brick retaining wall supporting the filled-in area
- As access inside the buildings was not possible at the time of the site visit the extent of any basements and/or lower ground floors was not able to be determined. However, observations of external features indicate some properties are likely to have lower ground floors which cut into the slope of the site (possibly down to bedrock), as at 224 Victoria Road; while others have been raised up on supporting foundations such as at 224 and 260 Victoria Road
- Comparison of the project footprint as it currently exists with aerial images taken during building of Iron Cove Bridge abutment between 2009 and 2011 shows that the section of King George Park within the project footprint was completely cleared to facilitate construction. The current landscaping is likely to be made up of imported fill deposited across the area to rehabilitate the park.

The following observations were made in regard to the physical conditions within the Manning Street project footprint which informs the assessment of potential for archaeological deposits:

- The ground level within the project footprint slopes down to the oval to the southwest
- The surface is generally grassed, with some areas of eroded soil along the road edge, showing gravels and scatters of broken ceramic and glass.

5.6.1 Site land use history

The combined evidence from the site investigation and desktop analysis of historical aerial photographs and plans has been analysed to identify the main historic developments within the Iron Cove project footprint and the proposed bioretention facility that are likely to have impacted on earlier archaeological remains. This assessment has indicated that around 80 per cent of the Iron Cove project footprint has been heavily disturbed by historic developments. The cumulative impact of the recent and historic developments is set out in **Table 5-4**. HAMUs within this project footprint are shown in **Figure 5-7**.

Table 5-4 Summary of past disturbance

Past developments	Nature of past disturbance	Level of disturbance
Construction of Iron Cove Bridge abutment	Excavation for the bridge head and adjacent construction compound.	High – construction works west of Byrne Street and south of Victoria Road within the current King George Park will have completely removed any earlier remains in the western part of the project footprint.
Former petrol station underground tanks at 212–218 Victoria Road	Complete removal of earlier remains within the tank/s footprint.	High (localised)
Cutting and levelling for late nineteenth/early twentieth century buildings	Excavation of bedrock to create level surfaces; areas of fill may have potentially buried remains.	Low to moderate – generally the structures were the first built structures and so would not have impacted evidence of prior European settlement.

Past developments	Nature of past disturbance	Level of disturbance
Construction of modern Victoria Road	Demolition of previous structures and any earlier deposits, and earlier street alignments for new, upgraded or wider roads.	High – construction of the modern roadway is likely to have involved grading of the roadway and removal of earlier surfaces.
Services–excavation for service trenches	Excavation for services (water, gas, sewage) will have completely removed any remains within the trench footprint.	Moderate – localised areas of complete disturbance.
Establishment of King George Park	Demolition of earlier buildings, and modification of the landscape including construction of new roads; areas of fill may have potentially buried remains.	Low to moderate



Figure 5-7 Historical Archaeological Management Units within the Iron Cove project footprint (showing HAMUs 8 to 9)

(Source: GML Heritage)

5.6.2 Archaeological potential and significance

The potential for archaeological remains within the Iron Cove project footprint (C8) and Manning Street bioretention facility (which comprises two HAMUs) has been assessed and is outlined in this section. The assessment has considered past activities that have occurred which may have left evidence in the archaeological record, as well as physical processes and developments that may

have impacted their survival. Overall, the project footprint is considered to have a low to moderate potential for archaeological remains along the southern side of Victoria Road (HAMU 8). HAMU 9 has moderate potential for locally significant archaeological remains. Areas of archaeological potential within HAMU 9 are shown in **Figure 5-8**.

HAMU 8 – Iron Cove

HAMU 8	Iron Cove
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within the Iron Cove HAMU.
Archaeological potential	There is low potential for archaeological evidence to be present associated with the following: · Remains of a quarry may have extended into the project footprint within King George Park adjacent to Byrne Street · Remains of zigzag air raid trenches visible on the 1943 aerial · Truncated footings and artefact scatters from 1890s houses at 212–218 and 224 Victoria Road · Earlier road surfaces, drainage features and services within Victoria Road and side streets including Byrnes, Clubb, Toelle, and Callan Street. Sites or features in this HAMU are likely to have been heavily disturbed or completely removed by modern developments, in particular from works associated with the construction of Iron Cove Bridge abutment and the ongoing maintenance and upgrading of Victoria Road and intersections.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for *Assessing Significance for Historical Archaeological Sites and 'Relics'* (2009). Archaeological research potential: · Any surviving archaeological remains are likely to be highly fragmentary and have limited research potential. Association with individuals, events, or groups of historical importance: · No historical associations have been identified at this stage. Aesthetic or technical significance: · Remains of the quarry, if present within the project footprint, are unlikely to demonstrate aesthetic or technical significance. Ability to demonstrate the past through archaeological remains: · Any archaeological remains are likely to be heavily truncated and fragmentary and as such would be of limited value in demonstrating the past.
Significance level	Nil – does not meet the threshold for significance.

HAMU 8	Iron Cove
Heritage impact assessment	Proposed works within the Iron Cove HAMU would likely include: · Site establishment and enabling works · Tunnelling · Earthworks and associated structures · Pavement · Operational ancillary facilities · Finishing works. These works are predominantly located within the footprint of Victoria Road and would likely require localised areas of deep excavations associated with the proposed earthworks, tunnelling and bridge works resulting in a major adverse impact. Along the southern edge of the HAMU ancillary works (such as utility relocation, road works, and finishing works) would likely result in minor to moderate adverse impacts. However, this HAMU is considered to have a low potential for archaeological remains, and any surviving remains are likely to have been highly disturbed and would not meet the threshold for local significance. Therefore, the works proposed in this HAMU are not considered likely to impact on significant archaeological remains.
Mitigation measures	No further archaeological investigation required. An unexpected finds procedure should be implemented if archaeological remains are identified.

HAMU 9 – Manning Street bioretention facility

HAMU 9	Manning Street bioretention facility
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within the Manning Street bioretention facility HAMU.
Archaeological potential	There is moderate potential for archaeological evidence to be present associated with the following: · Truncated footings and deposits associated with c1890s houses. Although localised service excavation will have resulted in areas of disturbance, the introduction of fill to create the parkland may have buried earlier remains which potentially survive intact beneath the modern ground surface.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Truncated footings and artefact deposits may have research potential depending on the nature and extent of the remains. Association with individuals, events, or groups of historical importance: · No historical associations have been identified at this stage. Aesthetic or technical significance: · There is no clear indication in historical records examined to date to establish whether or not archaeological remains would have aesthetic/technical significance. Ability to demonstrate the past through archaeological remains: · Structural and artefact deposits associated with the c1890s houses have the potential to provide information relating to the lives of local residents in the early phases of subdivision in this area.
Significance level	Local
Heritage impact assessment	Proposed works within the Manning Street bioretention facility HAMU would likely include: · A new bioretention facility and upgrades to the existing car park at Manning Street at Rozelle, next to King George Park, to treat stormwater runoff generated by the surface road works associated with the Iron Cove Link · These works will require excavation in the area of archaeological potential, and a likely to result in a major adverse impact to archaeological remains of local significance.
Mitigation measures	Mitigation measures as outlined in **Chapter 8** for locally significant historical archaeology would apply including: · Further developing mitigation methodologies for the management of impacts on known and potential locally significant historical archaeological resources · Preparing a HARD · Developing a methodology and scope for a program of test excavation · Undertaking an archaeological excavation program including salvage.



Figure 5-8 Areas of archaeological potential within HAMU 9

(Source: GML Heritage)

5.7 Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road) project footprint (C9)

The following observations were made in regard to the physical conditions within the Annandale (around Pyrmont Bridge Road and Parramatta Road) project footprint which informs the assessment of potential for archaeological deposits:

- The modern ground level surrounding the project footprint slopes down from east to west; the slope in ground level is more pronounced along Pyrmont Bridge Road bordering the northern edge of the project footprint (**Figure 5-9**). There is also a lesser slope in the ground level from Parramatta Road towards Bignell Lane
- The site is currently occupied by a range of two storey early to mid-twentieth century commercial buildings and warehouses. Access inside the buildings was not available at the time of the site visit
- The buildings at 164, 166–172, 174 and 176 Parramatta Road were all observed to contain basements. Based on the difference in ground levels between Parramatta Road and Bignell Lane, excavation for the basements is likely to have had a higher degree of impact towards the southern edge of the project footprint (Parramatta Road)
- The warehouse at 79 Pyrmont Bridge Road features a ground floor level which appears to have been cut into the existing slope of the site. As noted above, excavation for in the eastern half of the building will have likely removed any earlier remains within the building footprint
- The buildings at 93–95 Pyrmont Bridge Road, and at 162 and 182–186 Parramatta Road do not contain basements and earlier remains may survive beneath these buildings. Likewise, the street level car park at the rear of 164 Parramatta Road also has potential for earlier remains.

5.7.1 Site land use history

The combined evidence from the site investigation and a desktop analysis of historical aerial photographs and plans has been analysed to identify the main historic developments within the project footprint that are likely to have impacted on earlier archaeological remains. The cumulative impact of the recent and historic developments is set out in **Table 5-5**. HAMUs within this project footprint are shown in **Figure 5-9**.

Table 5-5 Summary of past disturbance

Past developments	Nature of past disturbance	Level of disturbance
Twentieth century buildings – basement excavation	Demolition of late nineteenth century buildings and excavation for basement levels.	Moderate to high – the difference in ground levels between Parramatta Road and Bignell Lane means that excavation for the basements is likely to have had a higher degree of impact towards the southern edge of the project footprint.
Twentieth century buildings – building foundations, cutting and levelling	Surface clearing and localised impacts resulting from excavation for building foundations.	Moderate – localised areas of complete disturbance although there is potential for deposits to survive below shallow floor slabs or between deeper building footings.
Services	Excavation for services (water, gas, sewage) will have completely removed any remains within the trench footprint.	Moderate – localised areas of complete disturbance in particular along Bignell Lane.
Construction of roads – Bignell Lane	Construction and maintenance of road way.	Low – resurfacing of the laneway is likely to have had limited impact on earlier remains which potentially survive below.



Figure 5-9 Historical Archaeological Management Units within the Annandale (around Pyrmont Bridge Road and Parramatta Road) project footprint

(Source: GML Heritage)

5.7.2 Archaeological potential and significance

Based on the level of archaeological potential, two separate HAMUs have been delineated within the Annandale study area. HAMU 10 encompasses those areas within the project footprint that are considered to have a moderate or high degree of archaeological potential for locally significant remains. HAMU 11 contains areas that have a low potential for archaeological remains. Areas of archaeological potential within HAMU 10 and 11 are shown in **Figure 5-10** and **Figure 5-11**.

HAMU 10 – Bignell Lane

HAMU 10	Bignell Lane
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within the Bignell Lane HAMU 10.
Archaeological potential	There is a moderate or high potential for archaeological evidence to be present associated with the following: · Western half of the c1860s Didliston House (building footings and deposits) · Footings and deposits associated with c1890s houses · Early twentieth century services beneath Bignell Lane · Early to mid-nineteenth-century property boundaries and garden/agricultural remains · External structures and features associated with the Bignell and Clarke steam joinery works (the main building is outside of this HAMU). Given the size of the twentieth century buildings and the absence of basements within this HAMU there is potential for archaeological remains to survive beneath the existing floor slabs and between building footings.
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Archaeological remains of Didliston House may have moderate research potential to contribute to our understanding of residential development along Parramatta Road in the mid-nineteenth century. · If present, remains associated with the Bignell and Clark steam joinery could contribute knowledge on the industrial development of this area. Association with individuals, events, or groups of historical importance: · Remains of the steam joinery would be of significance for its association with Bignell and Clark Company which was involved in the construction of the major local buildings such as the Sydney Town Hall, Strand Arcade, and Bondi Aquarium. Aesthetic or technical significance: · It is not currently known if significant structural remains of the steam joinery were located to the rear of the main building, and therefore it is not possible to determine if the archaeological remains may hold aesthetic or technical significance. Ability to demonstrate the past through archaeological remains: · Structural remains and artefact bearing deposits of Didliston House and, if present, the steam joinery have the potential to demonstrate earlier uses of the site.

HAMU 10	Bignell Lane
Significance level	Local
Heritage impact assessment	Proposed works within the Bignell Lane HAMU are likely to include: · Site establishment and enabling works · Earthworks and associated structures · Realignment of Bignell Lane · Tunnelling · Pavement · Finishing works. These works may require deep excavation in areas where archaeological deposits may be present. Extensive ground disturbance of this kind will have a major adverse impact on any archaeological relics which may be present. Activities requiring minor excavation or levelling may not impact the zone where potential archaeological deposits are located. Thus, the works are likely to have a minor to moderate adverse impact on the potential historical resource. Service installation works and landscaping would have more localised impacts on the historical archaeological resource. These works are likely to have a minor to moderate adverse impact on the potential historical archaeological resource, depending on the location, extent and nature of the proposed works.
Mitigation measures	Mitigation measures as outlined in **Chapter 8** for locally significant historical archaeology would apply including: · Further developing mitigation methodologies for the management of impacts on known and potential locally significant historical archaeological resources · Preparing a HARD · Developing a methodology and scope for a program of test excavation · Undertaking an archaeological excavation program including salvage.



Figure 5-10 Areas of archaeological potential within HAMU 10

(Source: GML Heritage)

HAMU 11 – Parramatta Road, Pyrmont Bridge Road

HAMU 12	Parramatta Road, Pyrmont Bridge Road
Listed archaeological items	There are no heritage register listings for potential historical archaeological resources within the Parramatta Road, Pyrmont Bridge Road HAMU 11.
Archaeological potential	There is a low potential for archaeological evidence to be present associated with the following: · Eastern half of the c1860s Didliston House (building footings and deposits) · Footings and deposits associated with c1890s buildings · Remains of the Bignell and Clarke Steam joinery works (main building) · Early to mid-nineteenth century property boundaries and garden/agricultural remains.

HAMU 12	Parramatta Road, Pyrmont Bridge Road
Significance assessment	Preliminary assessment against the NSW Heritage Criteria for Assessing Significance for Historical Archaeological Sites and 'Relics' (2009). Archaeological research potential: · Surviving structural remains are likely to be highly fragmentary and would have limited research value. Association with individuals, events, or groups of historical importance: · Remains of the steam joinery would be of local significance for its association with the Bignell and Clark Company which was involved in the construction of major landmark buildings such as the Sydney Town Hall, Strand Arcade, and Bondi Aquarium. Aesthetic or technical significance: · Remains of the Bignell and Clark steam joinery are likely to be highly fragmented and unlikely to contain evidence of technological processes and/or innovations. Ability to demonstrate the past through archaeological remains: · Any surviving archaeological remains are likely to have been heavily disturbed by later developments and would not meet this criterion.
Significance level	Local
Heritage impact assessment	Proposed works within the Parramatta Road, Pyrmont Bridge Road HAMU are likely include: · Site establishment and enabling works · Earthworks and associated structures · Tunnelling · Pavement · Finishing works. These works may require deep excavation in areas where archaeological deposits may be present. Extensive ground disturbance of this kind will have a major adverse impact on any archaeological relics which may be present. Activities requiring minor excavation or levelling may not impact the zone where potential archaeological deposits are located. Thus, the works are likely to have a minor to moderate adverse impact on the potential historical resource. Service installation works and landscaping would have more localised impacts on the historical archaeological resource. These works are likely to have a minor to moderate adverse impact on the potential historical archaeological resource, depending on the location, extent and nature of the proposed works.
Mitigation measures	Mitigation measures as outlined in **Chapter 8** for locally significant historical archaeology would apply including: · Further developing mitigation methodologies for the management of impacts on known and potential locally significant historical archaeological resources · Preparing a HARD · Developing a methodology and scope for a program of archaeological monitoring during site establishment works · Undertaking an archaeological excavation program including salvage.



Figure 5-11 Areas of archaeological potential within HAMU 11

(Source: GML Heritage)

5.8 Area 6 – St Peters project footprint (C10)

The archaeological potential and significance of this project footprint have been previously assessed under the New M5 project.[114] The study concluded that the St Peters interchange (within which this project footprint is located):

> *…retains the potential to encounter late nineteenth and early twentieth century refuse deposits and brick wasters (bricks that did not fire properly or were faulty in some way) from the surrounding bricks works. Within road reserves there is potential to encounter earlier road surfaces beneath the current asphalt or evidence of the dismantled tram network in the vicinity of the Princes Highway and Campbell Street intersection. Should such deposits or relics be encountered they are unlikely to be of archaeological significance due to their ubiquitous nature and lack of provenance, making their ability to contribute to archaeological research minimal. Uncovering such finds would not trigger the unexpected finds procedure as they are anticipated and are unlikely to be of archaeological significance.*

The current project footprint is located within this area of low archaeological significance, and therefore will not result in an adverse impact to archaeological remains.

6 Built and landscape heritage

6.1 Introduction

This section of the report comprises identification of the listed heritage items, potential heritage items and HCAs within or adjacent to the project footprint. It also assesses potential impacts from the construction or operation of the project on identified heritage items. Identified heritage items include heritage-listed buildings, structures, bridges, tunnels, parks, trees and HCAs. The section also includes a summary of the assessment of impacts on potential heritage items identified by this HIA (the full assessment is included as **Annexure A**).

The built and landscape heritage assessment adopts a broader survey area (referred to throughout this report as the heritage study area), which includes the proposed project footprint plus an appropriate buffer around the footprint in the cases of Haberfield/Ashfield (Option B), Iron Cove, Rozelle, Leichhardt and Annandale. This is to ensure that the assessment includes heritage items and HCAs adjacent to the project footprint that may be subject to indirect (visual, vibration or settlement) impacts, and each one has been determined on a case by case basis when undertaking site inspections of the areas. In the case of Haberfield (Option A), the Haberfield civil site (C2b) from Haberfield/Ashfield (Option B) and St Peters, the heritage study area coincides with the project footprint and refers to the assessment previously undertaken as part of the M4 East and New M5 projects, respectively. The total area surveyed by GML for this assessment is referred to in the singular as the heritage assessment area.

6.2 Overview of approach

The impact assessments have been set out on the basis of the identified heritage study area, illustrated collectively in **Figure 6-1**, **Figure 6-3**, **Figure 6-5**, **Figure 6-7**, **Figure 6-9** and **Figure 6-11** in accordance with the requirements of the SEARs, for each heritage study area, the report:

- Provides an overview of the heritage study area's heritage context
- Identifies the heritage items and HCAs within the area with the potential to be affected by the project, either through direct impacts and/or impacts on visual setting
- Identifies heritage items and HCAs that are likely to be physically impacted, or those that have a direct frontage to substantial project infrastructure (eg tunnel portals and noise walls). For these items and areas, the following structure has been employed:
- A description and statements of significance (drawn from existing heritage listings)
- An assessment of the heritage impact of the proposed works on the heritage significance of each of the affected heritage items and HCAs
- An overall ranking of the severity of the impact
- Identifies potential heritage items in the heritage study area, assesses their significance and assesses the impact of the project on those potential items
- Assesses the indirect impact of the tunnelling during construction on heritage items above the tunnel corridor.

The assessment also assigns an impact type to each item and HCA – above tunnel, setting, partial demolition and demolition. Impacts on 'setting' include visual impacts. The majority of the project footprint would be underground. However, surface works would be required to support tunnelling activities as well as construction compounds and to construct surface infrastructure such as interchanges, tunnel portals, ventilation facilities, ancillary operations buildings and facilities.

It is acknowledged that associated motorway infrastructure, including electronic toll gantries, traffic lights, signage, etc, would be required. However, the impact of these on the visual setting of heritage items and character of HCAs has not been comprehensively assessed in this HIA because there is no design/information at present about this associated infrastructure. Further assessment will be required as the design is developed.

6.3 General impacts

As a consequence of the identified construction aspects above, the potential direct heritage impacts could include:

- Complete or partial demolition of heritage items
- Complete demolition of non-listed buildings assessed as having heritage values (ie potential heritage items)
- Complete demolition of contributory buildings within a HCA
- Modifications to heritage items/structures
- Removal of heritage vegetation
- Inadvertent damage to heritage trees/roots.

Potential indirect impacts could include:

- Impacts to heritage curtilage or visual setting of heritage items or HCAs
- Continued use of existing construction compounds at Haberfield and St Peters
- Vibration impacts from earthworks, piling and tunnelling activities
- Settlement and groundwater drawdown from tunnelling activities.

6.4 Summary heritage impacts – all heritage study areas

6.4.1 Listed heritage items

Table 6-1 summarises all the listed heritage items and HCAs (ie 25 items in total) located within the six study areas, and includes their level of significance (local or State), the statutory register(s) on which they are listed, and their impact type and ranking (if impacted), as identified in the detailed heritage impact assessments in the following chapters.

Table 6-1 uses:

- Orange shading to identify heritage items which would be subject to direct impacts from the M4-M5 Link project through full demolition (three items)
- Yellow shading to identify heritage items which would be subject to direct impacts from the M4-M5 Link project through partial demolition (one item)
- Green shading to identify heritage items and HCAs which would be subject to indirect impacts from the M4-M5 Link project through vibration, settlement and visual setting (21 items).

Table 6-1 Summary of potential impacts (type and ranking) on listed heritage items and HCAs within the study areas

Register listing	Item name	Address	Significance	Impact type	Impact ranking
Area 1 – Haberfield and Ashfield					
Ashfield LEP 2013 (Item no. C42)	Haberfield HCA	Haberfield	Local	Setting, vibration and settlement	Neutral
Ashfield LEP 2013 (Item no. 273)	Commercial building	476 Parramatta Road, Ashfield	Local	Setting, vibration and settlement	Neutral
Area 2 – Leichhardt					
RailCorp S170 Register (#4805738)	Leichhardt (Charles Street) Underbridge	Charles Street, Leichhardt	Local	Setting, vibration	Minor adverse
Area 3 – Rozelle and Lilyfield					
Leichhardt LEP 2013 (Item no. C16)	Brennan's Estate Heritage Conservation Area	Rozelle	Local	Setting, vibration and settlement	Minor adverse
Leichhardt LEP 2013 (Item no. C18)	Easton Park Heritage Conservation Area	Rozelle	Local	Setting, vibration and settlement	Minor adverse
Leichhardt LEP 2013 (Item no. I752)	Easton Park	Denison Street, Rozelle	Local	Vibration and settlement, temporary visual, potential tree root impacts	Minor adverse
Sydney Water S170 Register (#4571704)	Sewage Pumping Station No.6	168 Lilyfield Road, Rozelle	Local	Vibration and settlement, temporary visual	Minor adverse
Leichhardt LEP 2013 (Item no. C19)	Hornsey Street Heritage Conservation Area	Rozelle	Local	Demolition of a non-contributory building, setting, vibration and settlement	Neutral

Register listing	Item name	Address	Significance	Impact type	Impact ranking
SHR (#01015) SREP 26 (Schedule 4, Part 3, #11) Ausgrid S170 Register (#74)	White Bay Power Station	Victoria Road and Robert Street, Rozelle	State	Minor encroachment on curtilage and setting	Minor adverse
Sydney Water S170 (#4570343)	Whites Creek Stormwater Channel No 95	Railway Parade to Parramatta Road, Annandale	Local	Partial demolition resulting from 'naturalisation' and reshaping of the channel. Setting, vibration	Moderate adverse
Leichhardt LEP 2013 (Item no. I78)	Street trees – row of Palms on Railway Parade	Railway Parade, Annandale	Local	Setting, vibration	Neutral
Leichhardt LEP 2013 (Item no. I79)	Avenue of Phoenix canariensis on Railway Parade	Railway Parade, Annandale	Local	Setting, vibration	Neutral
SREP 26 (Schedule 4, Part 3, #7) RailCorp S170 (#4803231)	Annandale (Railway Parade) Railway Bridge	Railway Parade, Annandale	Local	Setting, vibration	Minor adverse
SREP 26 (Schedule 4, Part 3, #8)	Arched Bridge (at Whites Creek)	Whites Creek, Annandale	Local	Nil	Neutral
SREP 26 (Schedule 4, Part 3, #9) RailCorp S170 (#4803229)	Annandale (Johnston Street) Underbridge	Johnston Street, Annandale	Local	Setting, vibration	Neutral
SREP 26 (Schedule 4, Part 3, #6)	Stormwater Canal	Lilyfield Road, Rozelle	Local	Full demolition	Major adverse
SREP 26 (Schedule 4, Part 3, #3)	'Cadden Le Messurier'	84 Lilyfield Road, Rozelle	Local	Full demolition	Major adverse

Register listing	Item name	Address	Significance	Impact type	Impact ranking
SREP 26 (Schedule 4, Part 3, #2)	Former Hotel	78 Lilyfield Road, Rozelle	Local	Full demolition	Major adverse
Area 4 – Iron Cove					
SREP SHC (#17) RTA S170 (#65)	Iron Cove Bridge	Rozelle	State	Setting, vibration	Minor adverse
Leichhardt LEP 2013 (Item no. C6)	Iron Cove HCA	Rozelle	Local	Setting, vibration	Neutral
Area 5 – Annandale					
Leichhardt LEP 2013 (Item no. I613)	Kerb and gutter	Chester Street, Annandale	Local	Setting, vibration	Neutral
Leichhardt LEP 2013 (Item no. I616)	Warehouse including interiors	52–54 Pyrmont Bridge Road, Annandale	Local	Setting, vibration	Minor adverse
Sydney LEP 2012 (Item no. I2242)	Former Grace Bros Repository including interiors	6-10 Mallett Street, Annandale	Local	Setting, vibration	Minor adverse
Marrickville LEP 2011 (Item no. I5)	Bridge Road School (former Camperdown Public School), including interiors	127 Parramatta Road, Annandale	Local	Setting, vibration	Minor adverse
Area 6 – St Peters					
Marrickville LEP 2011 (Item no. I12)	Terrace group including interiors	2–34 Campbell Road, St Peters	Local	Setting	Neutral

6.4.2 Potential heritage items

The following table summarises all buildings assessed as having potential heritage significance (17 items in total) across the six study areas, and includes their assessed significance, impact type (if impacted) and ranking, as identified in **Annexure A**. **Table 6-2** uses:

- Orange shading to identify items with assessed potential heritage value which would be subject to direct impacts from the M4-M5 Link project through full demolition (nine items) and results in major adverse impacts
- Yellow shading to identify items with assessed potential heritage value which would be subject to direct impacts from the M4-M5 Link project through partial demolition (one item) and results in moderate adverse impacts.
- Green shading to identify items with assessed potential heritage value which would be subject some indirect impacts from the M4-M5 Link project, or which would not be impacted (seven items).

Table 6-2 Summary of potential impacts on potential heritage items within the study area

Item name	Assessed Significance	Impact type	Impact ranking
Area 1 – Haberfield			
135 Bland Street, Haberfield	Local	Setting	Neutral
136 Bland Street, Haberfield	Local	Setting	Neutral
138 Bland Street, Haberfield	Local	Setting	Neutral
139 Alt Street, Ashfield	Local	Nil	Neutral
144 Alt Street, Ashfield	Local	Nil	Neutral
Area 3 – Rozelle and Lilyfield			
Victoria Road Bridge, Rozelle	Local	Full demolition	Major adverse
Sandstone cutting, Rozelle	Local	Partial demolition	Moderate adverse
Former White Bay Hotel site foundations (plinth and archaeology)	Local	Full Demolition	Major Adverse
Southern Penstock (associated with the White Bay Power Station)	State	Vibration	Neutral
Area 4 – Iron Cove			
260 Victoria Road, Rozelle	Local	Full demolition	Major adverse
262 Victoria Road, Rozelle	Local	Full demolition	Major adverse
264 Victoria Road, Rozelle	Local	Full demolition	Major adverse
266 Victoria Road, Rozelle	Local	Full demolition	Major adverse
248 Victoria Road, Rozelle	Local	Full demolition	Major adverse
250 Victoria Road, Rozelle	Local	Full demolition	Major adverse
8 Callan Street, Rozelle	Local	Vibration, setting	Neutral

Item name	Assessed Significance	Impact type	Impact ranking
Area 5 – Annandale			
164 Parramatta Road, Annandale (former Bank of NSW)	Local	Full demolition	Major adverse

6.5 Area 1 – Haberfield/Ashfield heritage study areas (Option A: C1a, C2a and C3a) and (Option B: C1b, C2b and C3b)

6.5.1 Overview

As identified in the M4 East Non-Aboriginal Heritage Impact Assessment (GML 2015), Haberfield contains a large number of heritage items and a HCA listed on the Ashfield LEP and the Roads and Maritime S170 Register. Almost the entire suburb of Haberfield, from Dobroyd Canal (Iron Cove Creek) to Hawthorne Canal and north west to Iron Cove, but excluding properties along Parramatta Road, is listed as a HCA of local significance on the Ashfield LEP. Impacts associated with the demolition of heritage and contributory items within the Haberfield HCA were assessed within the M4 East project.

For Option A, and the Haberfield civil site (C2b) of Option B, the project footprint for the M4-M5 Link interface within Haberfield falls within the bounds of the previously assessed M4 East project footprint. Within Area 1, the M4-M5 Link project works are limited to connecting to the underground M4 East mainline tunnels, fitout of the dive structures and cut and cover tunnels at the Wattle Street interchange and fitout of the ventilation facility on the corner of Parramatta Road and Walker Avenue, which are all being constructed as part of the M4 East project.

Additional external construction work associated with the M4-M5 Link project at this location is not proposed. Some finishing works would be undertaken (re-establishment works for compounds), but would not have substantial heritage impacts. Under Option A, the M4-M5 Link project will utilise the Northcote Street civil site (C3a), Wattle Street civil and tunnel site (C1a) and the Haberfield civil and tunnel site (C2a) construction ancillary facilities currently being utilised by the M4 East project during construction of that project. There are no additional property acquisitions in Haberfield (Option A) as a result of the M4-M5 Link project, nor were any new heritage assessments undertaken to identify potential items, as all items were previously identified and assessed as part of the M4 East project.

For Option A, and the Haberfield civil site (C2b) of Option B, the findings of the M4 East Non-Aboriginal heritage impact assessment (GML 2015) remain valid. However, indirect and cumulative impact on the Haberfield HCA would primarily result from the extension of time associated with using the existing M4 East construction ancillary facilities for the M4-M5 Link project.

For Option B, the project footprint includes commercial development on the east and west sides of Parramatta Road, around the intersections of Alt Street and Bland Street. These sites are outside of the Haberfield HCA and were not assessed as part of the M4 East project. The M4-M5 Link project works at these sites would involve a civil and tunnel site and laydown area at C1b, and construction workforce parking and a site office at C3b. This option would also include the site C2b which is the same as C2a from Option A, however, without the tunnelling activities from that site.

Construction work associated with the M4-M5 Link project at these sites would involve the demolition of the existing buildings, adapting the sites as car parks and laydown areas (where possible), and constructing an acoustic tunnel shed over the tunnel site at C1b. Owing to the location, scale, type and temporary nature of construction activity at these new construction sites, no new statutory heritage items or HCAs were identified as needing further impact assessment (additional to the assessment undertaken for the M4 East project and as part of Option A). However, additional heritage assessments were undertaken to identify potential heritage items within and in the vicinity of these new construction sites (C1b and C3b).



Figure 6-1 Haberfield/Ashfield project footprint (Option A and Option B) with heritage study area shown (Source: Google Maps with GML overlay)

6.5.2 Heritage items and conservation areas

Table 6-3 and **Figure 6-2** set out the listed heritage items and HCAs in the Haberfield/Ashfield heritage study areas that have the potential to be impacted by the M4-M5 Link project. These items have been described in detail previously for the M4 East HIA. Refer to the M4 East Non-Aboriginal heritage impact assessment (GML 2015) for further information on these items.

Table 6-3 Statutory heritage listings for heritage items in the Haberfield/Ashfield heritage study area. Items with no shading may be subject to indirect impacts.

Item name	Address	Suburb	Significance	Listing	Impact Type
Haberfield HCA		Haberfield	Local	Ashfield LEP 2013 (Item no. C42)	Setting, vibration and settlement

Item name	Address	Suburb	Significance	Listing	Impact Type
Commercial building	476 Parramatta Road	Ashfield	Local	Ashfield LEP 2013 (Item no. 273)	Setting, vibration and settlement



Figure 6-2 Haberfield/Ashfield project footprint (Option A and Option B) with heritage study area shown

(Source: Google Maps with GML overlay) (Source: Ashfield LEP 2013 Heritage Map (001), overlay by GML)

6.5.3 General heritage impact assessment

The construction of the M4 East project will require the demolition of houses, gardens and street trees in Haberfield around Wattle Street, including 53 heritage and contributory items in the Haberfield HCA which would have been located in the M4-M5 Link project footprint.

These direct and visual heritage impacts from construction of the new motorway infrastructure has already been assessed in the M4 East Non-Aboriginal Heritage Impact Assessment, prepared by GML in September 2015. The general heritage impact assessment is provided below:

> *The potential for heritage impacts resulting from the project in the Haberfield area would arise from the demolition of heritage items and contributory items within the Haberfield HCA and the construction of new motorway infrastructure, including dive structures, cut-and-cover tunnels, tunnels, noise barriers, ventilation facilities and ancillary motorway buildings and services. Direct physical impacts would result from the demolition of buildings and gardens. Visual impacts would arise from new motorway infrastructure and the loss or reduction of significant streetscapes. Temporary visual impacts would also result from the establishment of work sites (C7, C8 and C9) during construction.*
>
> *Although localised in the section of the HCA around Wattle Street, Northcote Street and Wolseley Street, the impact of the project on the heritage significance of the Haberfield HCA and individual heritage items within it would be major and unable to be effectively mitigated.*
>
> *In Ashfield, the potential for heritage impacts would arise from the demolition of heritage items and construction of new motorway infrastructure, including dive structures, cut-and-cover tunnels, driven tunnels, noise barriers and a civil construction site (C10) in the vicinity of heritage items, and possible damage from the effects of construction vibration. The M4 East alignment has been modified to avoid direct impacts on Ashfield Park.*

Previous mitigation measures including relocating and making the ventilation facilities and motorway infrastructure less intrusive, urban design and landscaping treatments and photographic archival recording have been incorporated into conditions of approval for the M4 East project. However, all the previously identified mitigation measures, conclusion of construction works and revegetation would not totally offset the substantial heritage impacts on the Haberfield HCA as a whole. Recognised as a suburb of heritage significance to NSW and Australia, the historic garden suburb will be impacted by a new motorway and its associated motorway facilities. The M4 East EIS (September 2015) was prepared by AECOM Australia Pty Ltd and GHD Pty Ltd. Approval for this SSI project (SSI 6307) was granted on 11 February 2016. Construction works commenced in March 2016 and are ongoing.

As noted in the M4 East HIA, all ramps, interchanges, ventilation and ancillary facilities for the western end of the M4-M5 Link project are being constructed as part of the M4 East project to avoid the need to undertake further substantial surface works in the Haberfield HCA in association with key M4-M5 Link infrastructure. While the M4 East HIA did note that further impacts to the Haberfield HCA might be required for construction compounds for the M4-M5 Link project, it noted that further works for permanent infrastructure in the Haberfield HCA should be avoided.

The M4-M5 Link project has sought to minimise further impacts to the Haberfield HCA through the design and construction planning for the project, in accordance with the recommendations made in the M4 East HIA. The M4-M5 Link project proposes to reuse but also reduce the size of some of the construction compounds, being only to support the construction of the mainline tunnel component of the project. Heritage items which were retained as part of the M4 East project (ie 146-148 Ramsay Street and 150-152 Ramsay Street) would be retained and indirect impacts minimised. Dwellings located at 18, 20 and 22 Walker Avenue were retained in accordance with the approval conditions for the M4 East project. These sites would continue to be protected and indirect impacts minimised by the M4-M5 Link project.

6.5.4 Detailed heritage impact assessments

Overall assessment of the impact of the M4 East project on the Haberfield HCA has previously been assessed in the M4 East Non-Aboriginal HIA.

Within Area 1 – Haberfield, for Option A, the M4-M5 Link project works are limited to connecting to the underground M4 East mainline tunnels, fitout of the dive structures and cut and cover tunnels at the Wattle Street interchange; and fitout of the Parramatta Road ventilation facility, which are all being constructed as part of the M4 East project, and some minor amendments to the surface road network.

It is not anticipated that the internal fitout of the Parramatta Road ventilation facility would have any further adverse heritage impacts on any of the listed items within the Haberfield study area or on the Haberfield HCA. The construction of the underground tie-ins to the stub tunnels would not have any direct impacts to the retained heritage items or the Haberfield HCA.

Option A at Haberfield for the M4-M5 Link project will utilise the Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a) and Northcote Street civil site (C3a), currently being used by the M4 East project for construction of that project. Additional external construction work associated with the M4-M5 Link project at this location is not proposed. Finishing works (eg re-establishment works for compounds, line marking, signage) are unlikely to have substantial additional heritage impacts within the M4-M5 Link project footprint.

There are no additional property acquisitions or demolition of buildings in Haberfield as a result of Option A, nor were any new heritage assessments undertaken to identify potential items, as all items were previously identified and assessed as part of the M4 East project.

The indirect and cumulative impact on the Haberfield HCA from Option A of the M4-M5 Link project would primarily result from the extension of time associated with using the existing M4 East construction ancillary facilities for the M4-M5 Link project.

Option B at Haberfield/Ashfield for the M4-M5 Link project would require new construction ancillary facilities on the east and west sides of Parramatta Road, around the intersections of Alt Street and Bland Street. These would comprise the Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b) in addition to the Haberfield civil site (C2b) which is subject to the assessment undertaken in the M4 East project as explained above. The Parramatta Road sites are outside of the Haberfield HCA and were not specifically assessed as part of the M4 East project. The M4-M5 Link project works at these sites would involve a civil and tunnel site and laydown area at C1b and construction workforce parking and a site office at C3b. C2b in Option B is the same as C2a from Option A, however, without the tunnelling activities from that site.

Construction work associated with the M4-M5 Link project at these sites would involve the demolition of existing commercial premises. Owing to the location, scale, type and temporary nature of construction activity at these new construction sites, aside from the adjacent Haberfield HCA, no new statutory heritage items or conservation areas were identified as needing further impact assessment (additional to the assessment undertaken for the M4 East project).

The indirect and cumulative impact on the Haberfield HCA from Option B of the M4-M5 Link project would result from the expansion of the construction areas further east along Parramatta Road. This option would allow most of the M4 East construction ancillary facilities (aside from C2a/b) to be rehabilitated and delivery of the M4 East Urban Design Landscape Plan and Residual Land Management Plan to be delivered earlier.

6.5.5 Potential heritage items

For Option A, no new heritage assessments have been undertaken for Haberfield for the M4-M5 Link as the project footprint falls within the bounds of the previously assessed M4 East project footprint and works proposed as part of the M4-M5 Link project within that footprint and not substantially different than previously assessed. Refer to the M4 East HIA report for the full inventory of buildings, which were subject to heritage assessments as part of the M4 East project.

For Option B, during the surveys the additional areas at Haberfield/Ashfield were surveyed to identify items with potential heritage value that are not listed and may be impacted by the project, both within

and in the vicinity of these new construction sites (C1b and C3b). This was achieved via a pedestrian survey of the project footprint.

The following buildings (in **Table 6-4** to **Table 6-8**) were identified on the site inspection to be of potential heritage significance, were subject to a heritage values assessment and an impact assessment.

Table 6-4 Heritage significance assessment and impact assessment for potential heritage item

Address	**135 Bland Street, Haberfield**	
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield HCA.	
Assessed level of significance	Local – contributory to the Haberfield HCA	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, there would be no physical impact. However, with the construction of the site office (opposite) would change in the setting of this property. However, the existing setting (car dealership) was not contributory to the property or to the significance of the Haberfield HCA, so it would be a neutral impact.	
Impact type	Setting	
Impact ranking	Neutral	

Table 6-5 Heritage significance assessment and impact assessment for potential heritage item

Address	**136 Bland Street, Haberfield**	
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield HCA.	
Assessed level of significance	Local – contributory to the Haberfield HCA	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, there would be no physical impact. However, the construction of the site office (adjacent) would change in the setting of this property. However, the existing setting (commercial) was not contributory to the property or to the significance of the Haberfield HCA, so it would be a neutral impact.	
Impact type	Setting	
Impact ranking	Neutral	

Table 6-6 Heritage significance assessment and impact assessment for potential heritage item

Address	138 Bland Street, Haberfield	
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield HCA.	
Assessed level of significance	Local – contributory to the Haberfield HCA	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, there would be no physical impact. However, the construction of the site office (to the south separated by 135 Bland Street) would change in the setting of this property. However, the existing setting (commercial) was not contributory to the property or to the significance of the Haberfield HCA, so it would be a neutral impact.	
Impact type	Setting	
Impact ranking	Neutral	

Table 6-7 Heritage significance assessment and impact assessment for potential heritage item

Address	139 Alt Street, Ashfield	
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield HCA.	
Assessed level of significance	Local – contributory to the Haberfield HCA	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, the existence of an intermediate building (137 Alt Street), and the proposed use of the closest civil site for construction workforce parking, there would be no physical or visual impact.	
Impact type	Nil	
Impact ranking	Neutral	

Table 6-8 Heritage significance assessment and impact assessment for potential heritage item

Address	144 Alt Street, Ashfield	
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield HCA.	
Assessed level of significance	Local – contributory to the Haberfield HCA	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, the existence of an intermediate building (142 Alt Street), and the proposed use of the closest civil site for construction workforce parking, there would be no physical or visual impact.	
Impact type	Nil	
Impact ranking	Neutral	

6.6 Area 2 – Leichhardt heritage study area (C4)

6.6.1 Overview

The study area for Leichhardt is shown on **Figure 6-3**. Directly to the north of the project footprint is the Leichhardt North Light Rail Stop. It is a mainly residential area in Leichhardt interspersed with commercial properties concentrated along Norton Street and Marion Street, and some light industrial areas.

Settlement of the area dates from the 1790s, with land used mainly for grazing and farming. Rapid development took place from the late 1800s into the 1920s. Some expansion occurred from the post-war years into the 1970s. The population increased during the late 1990s as new dwellings were added to the area.

Today, the Leichhardt heritage study area mainly consists of detached and semi-detached, single storey residences on narrow lots. Some later two storey dwellings and amalgamated developments also characterise the area. There are no notable heritage buildings, however, there is rail infrastructure including the Charles Street underbridge, historically a part of the Goods Line, and now functioning as part of the light rail.



Figure 6-3 Leichhardt project footprint with heritage study area shown

(Source: Google Maps with GML overlay)

6.6.2 Heritage items and conservation areas

Table 6-9 below sets out the listed heritage items and conservation areas in Area 2 – Leichhardt, and are also shown on **Figure 6-4**.

Table 6-9 Statutory heritage listings for heritage items in the Leichhardt heritage study area. Items with no shading may be subject to indirect impacts.

Item name	Address	Suburb	Significance	Listing	Impact Type
Leichhardt (Charles Street) Underbridge	Dulwich Hill to Rozelle Goods Line 12.405km Charles Street	Leichhardt	Local	RailCorp S170 Register (#4805738)	Setting, vibration



Figure 6-4 Statutory heritage listings for heritage items in the vicinity of the Leichhardt study area

(Source: Google Earth with GML overlays 2016)

6.6.3 General heritage impact assessment

The works in Leichhardt study area comprise the use of the site at Darley Road as a civil and tunnel site. A motorway operations complex, comprising a permanent water treatment plant and associated substation to service to mainline tunnel for the project would be constructed at the Darley Road civil and tunnel site.

Generally, the potential for adverse heritage impacts resulting from the project in the Leichhardt heritage study area is neutral to minor. The Darley Road civil and tunnel site is in the vicinity of the Leichhardt (Charles Street) Underbridge (which is located adjacent to the project footprint) but is not in the vicinity of any HCAs. Therefore, the use of the site for construction would not directly physically impact on any identified heritage values, however some indirect setting and vibration impacts may occur to the Charles Street Underbridge.

6.6.4 Detailed heritage impact assessment

Table 6-10 provides an impact assessment for the statutory heritage item within the area with the potential to be directly or indirectly affected by the project. For this item, a description and statement of significance (drawn from existing heritage citations) is provided, an assessment of the heritage impact of the proposed works on the heritage significance of the affected heritage item is undertaken, and an overall ranking of the severity of the impact is identified.

Table 6-10 Heritage significance assessment and impact assessment for Leichhardt (Charles Street) Underbridge

Name	Leichhardt (Charles Street) Underbridge	
Address	Dulwich Hill to Rozelle Goods Line 12.405km Charles Street, Leichhardt	
Significance	Local – RailCorp S170 (#4805738)	
Description	Single span, double track, steel half-through plate web girder bridge, with a 22.86m span between brick abutments, with perpendicular wing walls.	
Statement of Significance	The Charles Street Underbridge is significant as part of the original infrastructure for the Metropolitan Goods Line, one of the most significant and effective railway projects in NSW during the twentieth century, which separated freight and passenger rail traffic within the metropolitan network. The bridge is a good representative example of riveted plate girder rail bridges, with a span towards the maximum length for plate web girders, and is a highly visible landmark structure over Charles Street.	
Heritage Impact Assessment	The Darley Road civil and tunnel site would have a minor and temporary impact on the Leichhardt (Charles Street) Underbridge, as it would result in the site adjacent to the heritage item (currently commercial) being demolished and used for construction. Owing to the narrowness at the western extent of the civil and tunnel site (ie the area closest to the underbridge), this area would be used for a substation and vehicle parking area during construction. The civil and tunnel construction works would not directly impact on the underbridge as it would be retained and continue to function during construction (for the Sydney light rail). However, some indirect impacts from vibrations or changes to visual setting could be experienced. However, these would also be minor and temporary. At the conclusion of tunnelling works, a motorway operations complex would be constructed on a portion of the site. The remainder of the site would be rehabilitated and would become remaining project land. The exact location of the motorway operations complex would be determined as part of the detailed design. However, for the purposes of this assessment has been assumed to be located closest to the underbridge. Landscaping, following the construction of the substation, should consider screening the substation and water treatment plant, from the Leichhardt (Charles Street) Underbridge. The design and location of the landscaping would be informed by a heritage specialist and should seek to create a visual separation between the new structure and the heritage item.	
Impact Type	Setting, vibration	
Impact Ranking	Minor adverse	

6.6.5 Potential heritage items

During the surveys, areas of potential heritage value were investigated to identify items with heritage value that are not listed and may be impacted by the project. This was achieved via a pedestrian and vehicle survey of the project footprint in order to assess the external condition and nature of properties in the vicinity.

No buildings within the study area were identified as potential heritage items therefore no heritage assessments were required.

6.7 Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) heritage study area (C5, C6 and C7)

6.7.1 Overview

The study area for Rozelle and Lilyfield (C5, C6 and C7) is shown on **Figure 6-5**.

The Rozelle Rail Yards are the dominant element within the Rozelle heritage study area. They are bounded by the multi-laned City West Link to the south and the CBD and South East Light Rail Rozelle maintenance depot to the west. To the east, the Rozelle Rail Yards extend under the Victoria Road bridge for about 80 metres. A quarried sandstone cutting rises up to demarcate the Rozelle Rail Yards' northern boundary in the western portion and directly beyond lies Lilyfield Road. In the vicinity of Gordon Street, the northern boundary abuts industrial and commercial buildings. To the east of Gordon Street, the northern boundary is marked by a quarried sandstone cutting, with residential properties above this.



Figure 6-5 Rozelle project footprint with Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) heritage study area shown

(Source: Googles maps with GML overlay)

The Rozelle study area is of a linear character, oriented along the Goods Line. The ground slopes gently to the southeast corner where a concrete slab has been laid, and is currently occupied by temporary structures and crane parts. The southern boundary of the study area is raised, approximately three metres to the surface level of the adjacent roadway.

The Rozelle Rail Yards are located on what was a filled and reclaimed estuary and are set down into an early cutting through the sandstone of the ridgeline. There are a number of other landscape modifications that have occurred at the rail yards, which are consistent with their use as an industrial site, including road paving and gravel landscaping. Based on historical imagery, it appears the Rozelle Rail Yards have been cleared of a large portion of infrastructure that related to its use as a rail yard.

The Rozelle Rail Yards site management works are being undertaken to remove rail and rail related infrastructure from the site and allow existing issues at the site such as waste and noxious weeds to be appropriately managed. Key features of the works relevant to the REF HIA include removal of existing above ground rail infrastructure including gantries, railway lines, ballast, sleeps and buildings (excluding the southern penstock, switching station, transformer and rail infrastructure to the east of the Victoria Road bridge) generally to a depth of 500 millimetres below ground level, except where drainage channels and sediment basins are required. No listed heritage items are being demolished as part of the site management works. However, the REF HIA identified a number of items of potential local heritage significance in and around the Rozelle Rail Yards site. Some of these items are being demolished as part of the site management works, being a lighting tower and Port Authority building. Mitigation measures including archival recordings of these items and salvage and storage of the lighting tower and rail gantries for potential reuse in future development of the Rozelle Rail Yards were recommended in the REF.

The character of the surrounding suburbs of Lilyfield and Rozelle is predominantly residential, with much of the housing built to serve workers employed by rail and maritime reliant industries over the first half of the twentieth century. There are many vestiges of the area's industrial and port focused past around the waterfronts of Rozelle Bay and White Bay.

6.7.2 Heritage items and conservation areas

Table 6-11 and **Figure 6-6** sets out the listed heritage items and conservation areas in Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road).

Table 6-11 Statutory heritage listings for heritage items in the Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road) heritage study area.

Items with the potential to be directly affected by the M4-M5 Link project are shaded. Items with no shading may be subject to indirect impacts.

Item name	Address	Suburb	Significance	Listing	Impact Type
Brennan's Estate HCA		Rozelle	Local	Leichhardt LEP 2013 (Item no. C16)	Setting, vibration, settlement
Easton Park HCA		Rozelle	Local	Leichhardt LEP 2013 (Item no. C18)	Setting, vibration, settlement
Easton Park	Denison Street	Rozelle	Local	Leichhardt LEP 2013 (Item no. I752)	Vibration, settlement, temporary visual, potential tree root impacts
Sewage Pumping Station No.6	168 Lilyfield Road	Rozelle	Local	Sydney Water S170 Register (#4571704)	Vibration, settlement
Hornsey Street HCA		Rozelle	Local	Leichhardt LEP 2013 (Item no. C19)	Demolition of non-contributory building, setting, vibration, settlement

Item name	Address	Suburb	Significance	Listing	Impact Type
White Bay Power Station	Victoria Road and Robert Street	Rozelle	State	State Heritage Register (#01015) Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#11) AusGrid S170 (#74)	Setting, minor curtilage encroachment
Whites Creek Stormwater Channel No 95	Railway Parade to Parramatta Road	Annandale	Local	Sydney Water S170 (#4570343)	Partial demolition, reshaping, setting, vibrations
Street trees – row of Palms	Railway Parade	Annandale	Local	Leichhardt LEP 2013 (Item no. I78)	Setting, vibration
Avenue of Phoenix canariensis	Railway Parade	Annandale	Local	Leichhardt LEP 2013 (Item no. I79)	Setting, vibration
Annandale (Railway Parade) Railway Bridge	Railway Parade	Annandale	Local	Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#7) RailCorp S170 (4803231)	Setting, vibration
Arched Bridge	Whites Creek	Annandale	Local	Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#8)	Nil
Annandale (Johnston Street) Underbridge	Johnston Street	Annandale	Local	Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#9) RailCorp S170 (4803229)	Setting, vibration

Item name	Address	Suburb	Significance	Listing	Impact Type
Stormwater Canal	Lilyfield Road	Rozelle	Local	Sydney Regional Environmental Plan – City West REP No. 26 – Sch. 4, Part 3 (#6)	Full demolition
'Cadden Le Messurier'	84 Lilyfield Road	Rozelle	Local	Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#3)	Full demolition
Former Hotel	78 Lilyfield Road	Rozelle	Local	Sydney Regional Environmental Plan - City West REP No. 26 - Sch. 4, Part 3 (#2)	Full demolition

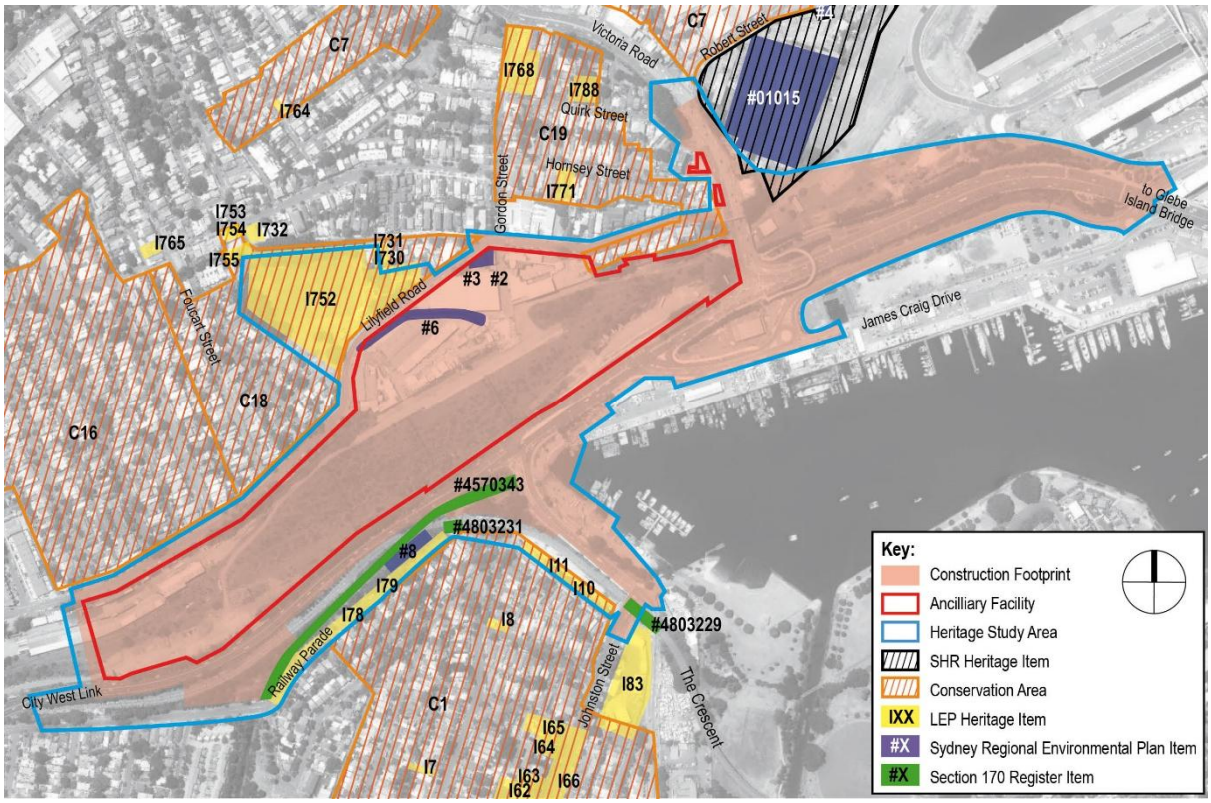


Figure 6-6 Rozelle project footprint with heritage items and HCAs shown

(Source: Leichhardt LEP 2013 Heritage maps 004 and 008, overlay by GML)

6.7.3 General heritage impact assessment

In relation to the Rozelle civil and tunnel site (within the Rozelle Rail Yards), the site management works (including site clearing, removal of redundant rail infrastructure and service investigations) have been previously assessed in the Rozelle Rail Yards HIA (GML 2016). In summary:

> *The assessment concluded that the most notable impact is to the role that the Rail Yards has within a broader network of Sydney industrial and freight sites, known as the 'goods lines'. Although successively fragmented, the network still offers a contribution to the local historic landscape, industrial and maritime history and working class character of the area. With regard to heritage impacts on individual items the proposal has been found to have neutral/no impact in the majority of cases. What little impact has been identified is able to be mitigated through a few simple measures.*

The Rozelle interchange would be constructed mostly underground around the Rozelle Rail Yards with connections north to the Iron Cove Link and the proposed future Western Harbour Tunnel and Beaches Link project, east to Victoria Road and Anzac Bridge, and south to the connecting tunnels south towards Haberfield.

Visible surface structures in and around Rozelle Rail Yards would consist of:

- Tunnel portals connecting into the New M5 at the western end of the site
- Tunnel portals and structures for the Iron Cove Link / M4 East to Anzac Bridge connections at the eastern end of the site
- Tunnel portals connecting to the proposed future Western Harbour Tunnel and Beaches Link at the centre of the site.

While the design of the open space and landscaping to be provided at the Rozelle Rail Yards is yet to be finalised, generally it would change the character of the area and impact surrounding HCAs (with additional infrastructure, landscaping, changing the topography).

The potential for heritage impacts resulting from the project in the Rozelle area would arise from the demolition of SREP listed heritage items (Stormwater Canal, 'Cadden Le Messurier' and Former Hotel) and contributory items within the Hornsey Street HCA to facilitate the dive portals, cut-and-cover tunnels, and ancillary infrastructure. There is also potential for setting, vibration and settlement impacts to a number of other listed heritage items.

The permanent infrastructure within the motorway operations complex (ie water treatment plant, ventilation facility and outlets) have been sited towards the centre of the Rozelle civil and tunnel site and as far as possible to the south, near the City West Link, away from the HCAs to the north. This is to maximise physical and visual separation in an effort to minimise intrusion/impacts on the curtilage and setting of the HCAs to some extent. Where feasible, the size, form, design and materiality of the proposed ventilation facility, outlets and water treatment plant would be as recessive as possible to reduce permanent visual impacts on the HCAs. Urban design and landscaping would also be designed to reduce the prominence of the infrastructure within the overall design of remaining project land.

The ventilation supply facility and substation is contained in the motorway operations complex and is sited at the southwestern extent of the Rozelle civil and tunnel site, adjacent to facilities constructed for the CBD and South East Light Rail project. Similar principles to that described above have been employed to reduce the visual prominence of this infrastructure.

6.7.4 Detailed heritage impact assessment

The following tables (**Table 6-12** to **Table 6-26**) provide an impact assessment for each statutory heritage item and HCA within the area with the potential to be directly or indirectly affected by the project. For these items and areas, a description and statements of significance (drawn from existing heritage citations) is provided, an assessment of the heritage impact of the proposed works on the heritage significance of each of the affected heritage items or HCAs is undertaken, and an overall ranking of the severity of the impact is identified.

Table 6-12 Heritage significance assessment and impact assessment for Brennan's Estate HCA

Name	Brennan's Estate HCA	
Address	Rozelle	
Significance	Local - Leichhardt LEP 2013 (#C16)	
Description	Brennan's Estate HCA comprises all of JR Brennan's estate, excepting the southwestern allotments recently redeveloped from industrial purposes to multi-unit residential uses. It also includes on its northern boundary, the allotments facing O'Neill Street, created from the last subdivision of the Maida Estate in 1915.	
Statement of Significance	One of a number of conservation areas that collectively illustrate the nature of Sydney's early suburbs and Leichhardt's suburban growth particularly between 1871 and 1891, with pockets of infill up to the end of the 1930s (ie prior to World War II). This area was intensely developed 1880s–1890s, and this forms the major element of its identity. It is significant for its surviving development from this period and the pockets of later infill development prior to World War II (ie up to 1939). Through its pattern of subdivision and the scale, shape, siting and materials of its buildings it provides a very intact example of a late nineteenth, early twentieth century suburb built for working men and tradesmen. The density and regularity of its development across the landform, the views so created out of the area, together with the small-scale detail of its modest architectural decoration result in a place of aesthetic value. It demonstrates through its remaining factories and the town houses that have replaced others, the mixed industrial/residential/retail nature of suburban development of that period, before the rise of cheap public transport, and before the urban reform movement sought to separate land uses into zones. Through its small scale regular housing and the narrowed width of Joseph Street, it demonstrates a continuing theme in residential development throughout suburban Australia – the owner's determination to gain as much as possible from his land. The concentration of free-standing houses in an area of narrow allotments demonstrates possibly both early fire regulations and the social status attached to a free-standing house. It demonstrates the role of timber as a building material in nineteenth century Sydney especially for the most modest end of the housing market, and the proximity of the timber yards in Whites Bay. It demonstrates, through its groupings of three to five identical houses, the work of small-scale building contractors who constructed the suburb. It illustrates through the existence of back lanes the reliance on the night soil cart before the reticulation of sewerage systems throughout suburban Sydney. Source: Inner West Council, 2013, 'Conservation Area 9 – Brennan's Estate', viewed 1 November 2016 < http://www.leichhardt.nsw.gov.au/Planning---Development/Planning-Controls--DCPs--LEPs--VPAs-/Heritage/Conservation-Area-9-Brennan-s-Estate>	

Name	Brennan's Estate HCA
Heritage Impact Assessment	Generally, the potential for adverse heritage impacts resulting from the project in this area arises from visual impacts on the setting of the conservation area from the temporary construction buildings and hoardings, and from permanent above ground infrastructure. The siting of the ventilation facility, outlets and water treatment plant a fair distance to the northeast of the HCA, and the efforts to minimise their prominence through design and landscaping, helps to reduce its visual impact on the HCA. Owing to the topography of the Rozelle Rail Yards site (ie lower than the conservation area) the closest infrastructure (ie the air intake facility and substation located at the southwestern extent of the project footprint) would be below the road level of Lilyfield Road and therefore slightly obscured from views from the conservation area. The retention of street trees along Lilyfield Road would also help to screen the proposed buildings/structures. These factors would help to minimise the visual impact on the HCA. Their location in the same area as the infrastructure of the CBD and South East Light Rail project minimises but does not ameliorate the intrusion in the curtilage of the Brennan's Estate HCA.
Impact Type	Setting, vibration and settlement
Impact Ranking	Minor adverse

Table 6-13 Heritage significance assessment and impact assessment for Easton Park HCA

Name	Easton Park HCA	
Address	Rozelle	
Significance	Local - Leichhardt LEP 2013 (#C18)	
Description	The Easton Park HCA occupies a small knoll of land above Whites Creek, and the small valley to its north, now largely occupied by Easton Park (reclaimed from Rozelle Bay).	

Name	Easton Park HCA
Statement of Significance	One of a number of conservation areas which collectively illustrate the nature of Sydney's early suburbs and Leichhardt's suburban growth particularly between 1871 and 1891, with pockets of infill up to the end of the 1930s (ie prior to World War II). This area illustrates development of workers' and tradesmen's housing from the 1880s-1930s in response to nearby industry. It is significant for its surviving development from the pre-World War II period (ie pre-1939). In its now rare weatherboard buildings it can continue to demonstrate the nature of an important/major construction material in the fabric of early Sydney suburbs, and the proximity of the timber yards in Whites Bay. Through the mixture of shops, and nearby industrial buildings it demonstrates the nature of a Victorian suburb, and the close physical relationship between industry and housing in nineteenth century cities before the advent of the urban reform movement and the separation of land uses. Of aesthetic value for the valley siting and mature plantings of Easton Park, and the relationship of adjoining and enclosing anchor buildings with verandas. It demonstrates the nature of some private subdivisions before the introduction of the Width of Streets and Lanes Act of 1881 required roads to be at least one chain wide. Source: Inner West Council, 2013, 'Conservation Area 10 – Easton Park', viewed 1 November 2016 <http://www.leichhardt.nsw.gov.au/Planning---Development/Planning-Controls--DCPs--LEPs--VPAs-/Heritage/Conservation-Area-10-Easton-Park>
Heritage Impact Assessment	Easton Park which is at the 'centre' of this HCA would not be physically affected by the project. The historic contribution and aesthetic significance of Easton Park to the conservation area would not be compromised by the project. The historic and aesthetic values embodied in the surrounding subdivision, houses and gardens would also not be compromised by the project. Generally, the potential for adverse heritage impacts resulting from the project in this area arises from visual impacts on its setting from the temporary construction buildings and hoardings, and from permanent above ground infrastructure. For the proposed infrastructure in the centre of the Rozelle Rail Yards, the siting of the ventilation facility, outlets and water treatment plant to the south of this HCA would have a moderate adverse impact on the visual setting of the HCA despite efforts to minimise their prominence through design and landscaping. For the proposed infrastructure in the southwestern extent of the Rozelle Rail Yards, there would not be a noticeable impact on the Easton Park HCA, due to the substantial physical separation between the air intake facility and substation.
Impact Type	Setting, vibration and settlement
Impact Ranking	Minor adverse

Table 6-14 Heritage significance assessment and impact assessment for Easton Park

Name	Easton Park	
Address	Denison Street, Rozelle	
Significance	Local - Leichhardt LEP 2013 (Item no. I752)	
Description	Easton Park is located within the suburb of Rozelle and is bounded by Lilyfield Road, Denison Street and Burt Street. The main entry to the park is from Lilyfield Road. The site comprises passive open space areas and a local sports field utilised for soccer in the winter months and junior cricket in the summer. It also contains an enclosed children's playground a hip-roofed, brick and corrugated iron amenities building incorporating a public toilet and a heritage listed sewer pumping station owned by Sydney Water. The parkland is defined by the curvilinear street edges to the south and west, a reflection of the site's historical topography and settlement pattern, near the edge of Rozelle Bay. It contains 15 mature *Ficus microcarpa var. hillii* (Hills Weeping fig) and one *Ficus macrophylla* (Moreton Bay Fig) which are protected by a Tree Preservation Order. These significant Hills Fig trees at the northern and western border create much of the character of the park. The park is used for passive public recreation, including walking, dog walking, and playing in addition to the active use of the playing field. There are concrete footpaths of varying widths with an existing footpath along the southern edge of the park to Lilyfield Road. An asphalt footpath runs along the Burt Street alignment. The playing field and playground are enclosed. The playground has a grassed, rectangular shaped playing area with timber slatted seating and table, children's play equipment comprising swing, climbing structure and slide, and overhead shade structure. The central open space area is utilised for off-leash dog exercise. There is an area to the east of the amenities (containing public toilet and change facilities) which is used for the storage of play equipment and nets.	
Statement of Significance	Easton Park was established in the early 1890's and significantly retains original features and early formal layout such as the sewer pumping station owned by Sydney Water, the Morton Bay fig trees, low fences, paths, open grassed area, and various native trees and shrubs. This is overlayed by modern features such as the playground which overall make a positive contribution to the local area. Source: OEH, 2012, 'Easton Park', viewed 17 July 2017 <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=1940802>	

Name	Easton Park
Heritage Impact Assessment	Easton Park itself is not physically affected by the proposed construction works. Its significant features of the park, including the Sewage Pumping Station and the Moreton Bay fig trees, would not be directly impacted. However, owing to the tunnelling under the park from Rozelle Rail Yards, there is the potential for indirect vibration and settlement impacts on the park. The visual setting of the park would be temporarily impacted by the proposed construction works owing to the hoardings which will be required to secure the site. Overall, the heritage values of Easton Park would be retained and interpretable throughout the construction, and its primary (significant) use as a public park would be maintained. There would be no operational impacts on Easton Park.
Impact Type	Potential vibration and settlement, temporary visual and potential tree root impacts
Impact Ranking	Minor adverse

Table 6-15 Heritage significance assessment and impact assessment for Sewage Pumping Station No.6 (SP0006)

Name	Sewage Pumping Station No.6 (SP0006)	
Address	168 Lilyfield Road, Rozelle	
Significance	Local – Sydney Water S170 Heritage and Conservation Register (#4571704)	
Description	SP0006, Rozelle is a low level sewage pumping station prominently located in Easton Park. It consists of two distinct parts: a superstructure comprising a small rectangular single storey loadbearing brick building; and a substructure constructed of concrete which houses a machinery and sewage chambers. Architecturally, the building was designed in a utilitarian version of the Federation Queen Anne style. Externally there is a corrugated iron gambrel roof with timber louvered gable vents and exposed eaves with timber sarking boards; double casement windows with multi paned fanlights; dark red-brown tuck pointed brickwork laid in English bond with a splayed brick plinth and engaged brick piers capped with rubbed sandstone; rock faced sandstone sills and lintels; quadrant gutters and cast iron rainwater heads and downpipe. Internally, the ceiling is lined with tongue and grooved boarding and walls are rendered and lined out to simulate ashlar coursing. The substructure is divided into a machinery well comprising two vertical spindle centrifugal pumps, each direct coupled to electric motors. Adjacent are two sewage wells and an inlet well.	

Name	Sewage Pumping Station No.6 (SP0006)
Statement of Significance	SP0006 is of historic, aesthetic and technical/research significance. Historically it was part of an original network of twenty low level sewage pumping stations constructed at the end of the nineteenth century to serve Sydney. The station along with the construction of the Bondi Ocean Outfall Sewer (10 years earlier) formed a part of the major advance in the protection of the public health of Sydney by ending the discharge of sewage into the Harbour. They were built as a direct response to the outbreaks of enteric fever (typhoid) which plagued Sydney from the 1870s to 1890s, and the recommendations of the Sydney City and Suburban Health Board (established by the NSW Government in 1875 to report on the best means of sewage disposal) which proposed the establishment of outfall sewers. Aesthetically it is a good example of a small-scale industrial building designed in the Federation Queen Anne style. Due to its prominent location in the public reserve, the station contributes to the local cultural landscape. In its surviving fabric, SP0006 reflects the importance of Federation Period public utilities, which is evident in the overall design, technical excellence of the traditional construction techniques and craftsmanship such as the stone dressing and tuckpointed brickwork. The station is also technically significant for its continuous use nearly a century after its introduction as a low level sewage pumping station as originally designed and constructed, apart from mechanical and electrical modifications. It has educational and interpretation potential to reveal information about sewage pumping engineering and in architectural taste in a period when utilitarian buildings were given as much careful attention as public buildings. The station occupies a prominent location along Lilyfield Road within Easton Park and by virtue of its design, scale, colour and texture it makes a valuable contribution to the townscape and cultural landscape of Rozelle. Source: Sydney Water, 2014, 'Sewage Pumping Station No 6 (SP0006)', viewed 17 July 2017 <https://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/heritage-detail/index.htm?heritageid=4571704&FromPage=searchresults>
Heritage Impact Assessment	The Sewage Pumping Station would not be physically impacted by the proposed construction works. However, owing to the tunnelling under this item from Rozelle Rail Yards, there is the potential for indirect vibration and settlement impacts on the item depending on the depth at which the tunnel is when it is under this southern extent of the park (which is currently a minimum of 10m below ground level). This would be managed in accordance with the recommendations of noise and vibration assessment in **Appendix J** (Technical working paper: Noise and vibration) of the EIS and with the recommendations of **Chapter 12** (Land use and property) of the EIS. The visual setting of the item would be temporarily impacted by the proposed construction works owing to the hoardings which will be required to secure the site. Overall, the historic, aesthetic and technical/research heritage values of the Sewage Pumping Station and its operation would be retained.
Impact Type	Potential vibration and settlement, temporary visual
Impact Ranking	Minor adverse

Table 6-16 Heritage significance assessment and impact assessment for Hornsey Street HCA

Name	Hornsey Street HCA	
Address	Rozelle	
Significance	Local – Leichhardt LEP 2013 (#C19)	
Description	This HCA is situated around a small knoll of land above Victoria Road, and just above the Whites Creek estuary and the industrial areas of Rozelle Bay. There are views across to Rozelle Bay and the city skyline.	
Statement of Significance	One of a number of conservation areas which collectively illustrate the nature of Sydney's early suburbs and Leichhardt's suburban growth particularly between 1871 and 1891, with pockets of infill up to the end of the 1930s (ie prior to World War II). This area illustrates a number of layers of development from an early pre-suburban villa of 1876 to small scale tradesmen and workers' housing from the 1870s through to the 1930s. It is significant for its surviving development from the pre-World War II period (ie pre-1939). Demonstrates the close physical relationship between industry and housing (both middle class and workers' housing) in nineteenth century cities. Demonstrates the nature of some private subdivisions before the introduction of the Width of Streets and Lanes Act of 1881 required roads to be at least one chain wide. Source: Inner West Council, 2013, 'Conservation Area 11 – Hornsey Street', viewed 1 November 2016 <http://www.leichhardt.nsw.gov.au/Planning---Development/Planning-Controls--DCPs--LEPs--VPAs-/Heritage/Conservation-Area-11-Hornsey-Street>	
Heritage Impact Assessment	The two-storey commercial property at 32 Victoria Road (Rozelle Rugs Centre) would be demolished to accommodate the associated road widening of Victoria Road in this area. This would not have an impact on the heritage values of the HCA. Care must be taken when demolishing the subject building as it is 'attached' to No.5 Lilyfield Road; the row of adjacent terraces. There are some sections of early sandstone kerbing in two locations along the Victoria Road frontage of 32 Victoria Road (and another section on the Hornsey Street frontage). These interrupted sections are interspersed with concrete kerbing at the bus stop and corners. These stones should be salvaged and provided to Inner West Council.	
Impact Type	Demolition of a non-contributory building, setting, vibration and settlement	
Impact Ranking	Neutral	

Table 6-17 Heritage significance assessment and impact assessment for Whites Creek Stormwater Channel No 95

Name	Whites Creek Stormwater Channel No 95	
Address	Railway Parade to Parramatta Road Annandale	
Significance	Local – Sydney Water S170 (#4570343)	
Description	This channel drains an area of 262 hectares lying to the south of Rozelle Bay and is generally located between Balmain Road, Leichhardt and Johnston Street, Annandale. The catchment area of the channel is within the municipalities of Leichhardt and Marrickville. From the outlet in Rozelle Bay, the drain proceeds in a meandering course in a southerly direction crossing Brennan, Piper, Booth, Styles and Albion Streets before terminating at Parramatta Road. The channel is 3.92 km in length and is predominantly brick (56%) and concrete (42%) in fabric. The channel cross section is composed of the following; circular (38%), covered (30%) and open channel (27%). The main channel has the following Branches stemming from it; Piper Street, Moore Street, Styles Street and Parramatta Road. The size of the channel outlet is 7.4m x 1.3m. Part of the stormwater drain runs through Whites Creek Valley Park, a picturesque recreational area. Various bridges are built over the channel and they add to the historic and aesthetic values of the drain. In addition, the highly significant Whites Creek Aqueduct (Bondi sewer) passes overhead.	
Statement of Significance	The Whites Creek Stormwater Channel was constructed progressively during the period 1898 to 1938 (although most of the channel was completed before 1909). Prior to 1890, stormwater was carried by either combined sewers or natural water courses. This led to unsanitary public health conditions and in 1890 Bruce Smith, the then secretary of Public Works, proposed a separate system of stormwater drains be built to alleviate the problem. By 1900 numerous stormwater drains, including Whites Creek SWC, had been completed or were under construction. Consequently, Whites Creek SWC is of historical significance as it was one of the earliest purpose built stormwater drains to be constructed. In addition, the channel has added significance due to its connection with Whites Creek Sewer Aqueduct which passes over the channel. The aqueduct is historically significant as it was one of the first reinforced concrete aqueducts to be built (refer to Listing Card SHI 4570954 for more details). The operational curtilage of Whites Creek includes the channel bed, walls and coping. The visual curtilage of the channel will vary along the length of the channel depending on the surrounding land uses. To formulate a specific curtilage statement that includes details of surrounding land use and encroachment of various developments would require further investigations and is beyond the scope of this study. However, in general the visual curtilage can be described as follows: · The upper reaches of the channel, located south of Booth and Moore Streets Annandale, is an underground structure, and holds no cultural landscape value · The open sections of the channel stretches from Booth and Moore Streets to the discharge point at Rozelle Bay · At its lower reaches visual curtilage is limited to where the channel can be observed between the Rozelle Rail Yards and Railway Parade and from within the Whites Creek Valley Parkland. Source: Sydney Water, 2014, 'Whites Creek Stormwater Channel No 95', viewed 1	

Name	Whites Creek Stormwater Channel No 95
	November 2016 <http://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/heritage-detail/index.htm?heritageid=4570343&FromPage=searchresults>
Comparative analysis	Prior to 1842, there was no formal record of any stormwater drainage systems in Sydney. The Tank Stream, Sydney's first water supply had become polluted which lead to the spread of disease and realisation that combined sewers needed to be constructed to take the place of polluted surface streams. During the mid-nineteenth century, the construction of five combined sewers commenced in order to dispose of the city's stormwater and sewage into the Harbour. The five original combined sewers were Bennelong Stormwater Channel No 29, Blackwattle Bay Stormwater Channel No 17, Hay Street Stormwater Channel, Tank Stream and Woolloomooloo Stormwater Channel. These five sewers were responsible for greatly improving public health, hygiene and living standards for the city's residents and are historically and technologically significant as excellent examples of the engineering and construction techniques of the city's early infrastructure. A precedent was set in establishing separate stormwater channels around the suburbs of Sydney to better improve public health. Various channels were built around the 1900s including the Whites Creek Stormwater Channel, Johnstons Creek Stormwater Channel, Doody Street and Shea's Creek Stormwater Channel. These channels all represent a group of the earliest purpose-built stormwater drains constructed in Sydney following the 1890 direction of the Secretary for Public Works to build a stormwater system separate to the sewer. The Whites Creek Stormwater Channel No 95 is comparable to the channels constructed as part of the late nineteenth and early twentieth century including Hawthorne Canal, Long Cove Creek and Iron Cove Creek.

Name	Whites Creek Stormwater Channel No 95
Heritage Impact Assessment	The interchange modifications (including widening, re-alignment and creation of a new left turn lane onto the City West Link and new lanes into the (future) Western Harbour Tunnel) would necessitate the encroachment into Buruwan Park, removal of plantings and a new/extended bridge over the White Creek Stormwater Channel No 95. Although this would be a new or an extension of the existing bridge over the stormwater channel, the actual channel under the bridge (and its operation) would not be physically impacted. The works would also involve the increasing of the span over Whites Creek and reshaping the land immediately to the south of Whites Creek to increase the overland capacity of the channel and mitigate flooding impacts. The new/extended bridge and the reshaping of land to the south of the channel would involve the removal and replanting of vegetation, which would further alter the visual setting of the heritage item at this location. However, this vegetation does not have heritage values in itself, and the works would generally be in keeping with the works currently being proposed by Sydney Water for Whites Creek. Sydney Water is proposing a waterway rehabilitation and naturalisation project for an approximately 420m section of Whites Creek (about 200m west from the outlet at Rozelle Bay, however this would not include the section of Whites Creek immediately affected by the project). Investigations are being undertaken to determine which parts need to be repaired, and if it could be undertaken using natural materials (ie replacing concrete banks with ones made of rock and native plants). The ability to 'naturalise' would depend on available space, land conditions and other constraints. The M4-M5 Link project would undertake rehabilitation and naturalisation in the section of the Whites Creek channel east of the new bridge towards Rozelle Bay. This would likely include a sandstone wall to replace the northern channel wall and naturalisation on the south side. Details of this are yet to be finalised. Consultation would be undertaken with Sydney Water to ensure a compatible design. The pedestrian/cycle bridge would straddle White Creek to the east and west of the new/extended bridge and be a new piece of infrastructure in the landscape. While the design and support structure is yet to be finalised, it is unlikely that this would have a direct impact on the channel.
Impact Type	Partial demolition, reshaping, setting, vibrations
Impact Ranking	Moderate adverse

Table 6-18 Heritage significance assessment and impact assessment for Arched Bridge, Whites Creek

Name	Arched Bridge, Whites Creek	
Address	Whites Creek (adjacent to Railway Parade)	Not accessible for photo
Significance	Local – SREP 26 (Schedule 4, Part 3, #8)	
Description	No information available and inaccessible to make a description	
Statement of Significance	No information available	
Heritage Impact Assessment	This heritage item is outside of the project footprint. There would be no direct or indirect impacts owing to the physical separation from the project footprint, and as the item is surrounded by an embankment on the southern side (along Railway Parade) and the vegetated land between White Creek and the City West Link.	

Name	Arched Bridge, Whites Creek
Impact Type	Nil
Impact Ranking	Neutral

Table 6-19 Heritage significance assessment and impact assessment for Street trees – row of Palms

Name	Street trees – row of Palms	
Address	Railway Parade, Annandale	
Significance	Local – Leichhardt LEP 2013 (#I78)	
Description	From the southern end of Railway Parade to the northern end on the west side of the road near Whites Creek, a row of 14 mature Phoenix Canariensis palms are spaced out at regular intervals. The palms at the southern end are very tall and well established while those further north are a bit smaller and some are surrounded by garden beds.	
Statement of Significance	Railway Parade streetscape has local historic and aesthetic significance as the palms are associated with inter-war period plantings and the influence of J. H. Maiden. The palm trees are a uniform group that provide shade and beautify the street. The garden beds and other vegetation enhance the streetscape. Source: OEH, 2012, 'Street Trees', viewed 17 July 2017 <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=1940011>	
Heritage Impact Assessment	According to the Urban Design Report and visualisations, the proposed pedestrian and cycle bridge is to be located to the west of the Whites Creek Stormwater Channel. Therefore, these street trees (located on the eastern side of the channel, along Railway Parade) would not be directly impacted. Other (non-listed) trees in the portion of land bounded by Brenan Street to the south, Whites Creek Channel to the east and the light rail line to the north, would be removed to accommodate the ramp and supports of the bridge.	
Impact Type	Setting, vibration	
Impact Ranking	Neutral	

Table 6-20 Heritage significance assessment and impact assessment for Avenue of *Phoenix canariensis*

Name	Avenue of *Phoenix canariensis*	
Address	Railway Parade, Annandale	
Significance	Local – Leichhardt LEP 2013 (#I79)	
Description	From the southern end of Railway Parade to the northern end on the west side of the road near Whites Creek, a row of 14 mature Phoenix Canariensis palms are spaced out in regular spaces. The palms at the southern end are very tall and well established while those further north are a bit smaller and some are surrounded by garden beds.	
Statement of Significance	Railway Parade streetscape has local historic and aesthetic significance as the palms are associated with inter-war period plantings and the influence of J. H. Maiden. The palm trees are a uniform group that provide shade and beautify the street. The garden beds and other vegetation enhance the streetscape. Source: OEH, 2012, 'Street Trees', viewed 17 July 2017 <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=1940011>	
Heritage Impact Assessment	According to the Urban Design Report and visualisations, the proposed pedestrian and cycle bridge is to be located to the west of the Whites Creek Stormwater Channel. Therefore, these street trees (located on the eastern side of the channel, along Railway Parade) would not be directly impacted. Other (non-listed) trees in the portion of land bounded by Brenan Street to the south, Whites Creek Channel to the east and the light rail line to the north, would be removed to accommodate the ramp and supports of the bridge.	
Impact Type	Setting, vibration	
Impact Ranking	Neutral	

Table 6-21 Heritage significance assessment and impact assessment for White Bay Power Station

Name	White Bay Power Station	
Address	Victoria Road and Robert Street, Rozelle	
Significance	State – State Heritage Register (#01015) Sydney Regional Environmental Plan – City West REP No. 26 – Sch. 4, Part 3 (#11) Ausgrid S170 (#74)	

Name	White Bay Power Station	
		Source: Dictionary of Sydney
Description	White Bay Power Station is located approximately 4km west of the Sydney CBD. The site is bounded to the south by Victoria Road and to the west by Robert Street, Rozelle. It is situated adjacent to a small inlet of Sydney Harbour. The White Bay Complex is composed of the following principal elements: · Two **steel stacks** - the stacks are made of plate welded steel with guy wires and vibration dampeners at top and base. Only the northern-most stack remains, the other having been demolished · A **coal handling unit** serviced by a spur rail line - the coal handling unit has a dumping shed immediately behind the stacks where the rail coal trucks deposited their load. Here it was crushed and sized in jaw crushers and then conveyed by belt and bucket to overhead coal hoppers in the station Boiler House. The whole of the conveyor line is in steel section sheathed in corrugated steel. The whole of the coal handling system is of considerable heritage significance and of high industrial archaeological significance · **Turbine hall** building incorporating administrative offices, the old laboratory and a workshop - the turbine house (or hall) was built in two stages as demand for power increased. The massive rendered brick and reinforced concrete building housed not only the generating equipment but also extensive administrative offices and a laboratory at the southern end. Electrical and mechanical workshops and some of the station circuit breakers were located here. This structure contains the most significant system in the precinct. The power generating system consists of the headers, gauges, condensers, steam feed water pumps, electric feed water pumps, the two 50MW Parsons turbo alternators and their salt water steam condensers. The system is the oldest complete system in NSW. The hall also has a viewing platform in the annex, a large overhead crane and the engine beds of a smaller turbo alternator which was removed and scrapped some time ago. The turbines and their associated artefacts have high significance as a system. The Turbo Alternators, gauges and valves have high significance in their own right. This building is an example of confident industrial architecture, with overtones of the Arts and Crafts Design Movement in the continuous vertical piers of the northern facade. The original prominence of the facade had been somewhat reduced by the 1950s boiler house attached to the left, as well as the infill between the facade of the switch house to the right. However, the full impact would be restored if the later structures were removed. The volume of the turbine hall is an extremely impressive space. It is considerably longer, though narrower, than the Turbine Hall at Ultimo Power House. The construction of the first (southern) half is brickwork. It was always intended to extend the building, but by the 1920s concrete had replaced brick as the preferred material for buildings of this scale. The external walls of the northern part are of poured concrete. The machinery bases, and what were the internal walls to the second Boiler House (since demolished) are in unusual coke breeze blocks, of similar size to sandstone masonry. The lower galleries in the first stage are concrete over permanent corrugated steel formwork. Later additions are in precast concrete arched sections. The main steelwork is stamped with the names of British manufacturers · **Boiler house** - the boiler house is a massive brick and reinforced concrete structure. It is the third and final Boiler House constructed at the station and stands on the site of the first. The second, formerly located to the south, has been demolished. The boiler house is in fair condition considering the time it has been 'mothballed' (Godden 1989: 19). This structure once contained four Babcock and Wilcox pulverised fuel boilers, the Boiler Control Room, twelve massive ball mills for pulverising coal and coal and ash handling equipment. Very few of the relics in the Boiler House date from the first phase of development. The building itself is a brick and reinforced concrete masonry	

Name	White Bay Power Station
	structure in reasonably good condition although it is now showing the inevitable signs of age. The Boiler Control Room, which dates from the early 1950s is of high significance and is the most important item in the Boiler House. All relics within the Boiler House have high industrial archaeological importance · A **switch house** and **substation** · **Ancillary structures** including coal loading wharf and coal handling system.
Statement of Significance	White Bay Power Station was the longest serving Sydney power station and is the only one to retain a representative set of machinery and items associated with the generation of electricity in the early and mid-twentieth century. It retains within its fabric, and in the body of associated pictorial, written archives and reports and oral history recordings, evidence for the development of technology and work practices for the generation of electrical power from coal and water. This development of power generation at White Bay contributed to the expansion of the economy of Sydney and NSW. As a result of its remarkably intact survival, it retains the unique ability to demonstrate, by its location, massing, design, machinery and associated archives, the influence and dominance that early power-generating technology exerted on the lives and urban fabric of inner cities in the first half of the twentieth century. The extant items within the surviving operational systems are of an impressive scale and exhibit a high degree of creative and technical achievement in their design and configuration. They encompass all aspects of the generation of electrical power, and represent all phases from the inter-war period through to the more sophisticated technologies of the mid twentieth century. They are of exceptional technical significance with research potential to yield information not available from any other source. Aesthetically, White Bay Power Station contains internal and external spaces of exceptional significance. These spaces include raw industrial spaces of a scale, quality and configuration which is becoming increasingly rare and which inspire visitors and users alike. Externally, it is a widely recognised and highly visible landmark, marking the head of White Bay and the southern entry to the Balmain Peninsula and its industrial waterfront. It retains a powerful physical presence and industrial aesthetic and is the most important surviving industrial building in the area. White Bay Power Station has strong and special associations and meanings for the local community, for former power station workers and for others who have used the site, and is of high social significance. It is a potent symbol of the area's industrial origins and working traditions, aspects of community identity that are strongly valued today by both older and new residents. It is one of the few surviving features in the area that provide this symbolic connection. It is the only coal based industrial structure, dependent on a waterside location to survive adjacent to the harbour in the Sydney Region. It also forms part of a closely related group of large scale industrial structures and spaces (White Bay Container Terminal, Glebe Island Silos, Container Terminal and Anzac Bridge) which along with the former White Bay Hotel, define a major entry point to the city from the west. It is of exceptional structural significance to the State of NSW. Source: Office of Environment and Heritage, 2004, 'White Bay Power Station', viewed 1 November 2016 < http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5001335>

Name	White Bay Power Station
Heritage Impact Assessment	The project temporarily encroaches into the south western boundary of the curtilage of the White Bay Power Station. The minor encroachment occurs during the construction phase of the project as a result of the alignment of the temporary Victoria Road bridge. However, the works would be some distance from the Power Station building itself and the building would not be physically impacted by the project The indicative cross section of the replacement of the Victoria Road bridge assessed as part of this HIA show that the concrete deck atop a concrete post and beam structure which is separated a fair (6-7m) distance from the sandstone cutting in order to accommodate a shared path. At this stage of the project, there is inadequate design information available to make a comprehensive assessment of the visual and physical impacts of the support structure for the new road bridge on the railway cutting and the White Bay Power Station. Further design consideration of the support structure for the new road bridge, impact on the railway cutting and its visibility from within the White Bay Power Station curtilage needs to be assessed during detailed design and construction planning. However, this is likely to be a minor adverse impact.
Impact Type	Setting, minor curtilage encroachment
Impact Ranking	Minor adverse

Table 6-22 Heritage significance assessment and impact assessment for Annandale (Railway Parade) Railway Bridge

Name	Annandale (Railway Parade) Railway Bridge	
Address	Railway Parade, Annandale	
Significance	Local – SREP 26 (Schedule 4, Part 3, #7) Railcorp S170 (#4803231)	
Description	Underbridge (1919) A single-span, riveted-steel half-through Pratt truss of 27.43 m (90 feet) span across the full width of Railway Parade. The span is supported by brick abutments. Overhead frames carry electric wires for the double-track light rail system which crosses the bridge.	

Name	Annandale (Railway Parade) Railway Bridge
Statement of Significance	The Annandale (Railway Parade) railway bridge has local significance as an integral part of a separate railway network built between 1910 and 1922 for freight trains to traverse the metropolitan area independent of the passenger train network. The independent freight train network was a highly effective solution to the competing demands of the freight and passenger services on an otherwise congested metropolitan system. The riveted steel half-through truss bridge is a heavy-duty structure in keeping with design policy to allow for future heavy traffic loads, locomotives and rolling stock. This type of half-through Pratt truss is comparatively rare in the NSW railway system. The bridge retains its original fabric and structure. Source: OEH, 2009, 'Annandale (Railway Parade) Railway Bridge', viewed 17 July 2017, <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4803231>
Heritage Impact Assessment	This heritage item is outside of the project footprint. Therefore, the works would not directly impact on the underbridge itself as it would be retained and continue to function during construction (for the Inner West light rail). However, the new/extended bridge over Whites Creek would result in encroachment of infrastructure towards the heritage item, changes in its visual setting (ie less trees and diminishing of its parkland setting) and also potentially some indirect impacts from vibrations from construction works.
Impact Type	Setting, vibration
Impact Ranking	Minor adverse

Table 6-23 Heritage significance assessment and impact assessment for Annandale (Johnston Street) Underbridge

Name	Annandale (Johnston Street) Underbridge	
Address	Johnston Street and The Crescent	
Significance	Local – SREP 26 (Schedule 4, Part 3, #9) Rail Corp S170 (#4803229)	
Description	Underbridge (1920) A two-span half-through (pony) Pratt truss bridge of riveted steel crossing Johnston Street and The Crescent. Each span is supported by brick piers and brick abutments. Overhead catenary frames carry electric wires for the double-track light rail system which crosses the bridge.	
Statement of Significance	The Annandale (Johnston Street) underbridge has local significance as an integral part of a separate railway network built between 1910 and 1922 for freight trains to traverse the metropolitan area independent of the passenger train network. The independent freight train network was a highly effective solution to the competing demands of the freight and passenger services on an otherwise congested metropolitan system. The riveted steel half-through Pratt truss bridge is significant as an example of a heavy-duty structure in keeping with NSW Railways design policy to allow for anticipated future heavy traffic loads, locomotives and rolling stock. This type of half-through Pratt truss is comparatively rare in the NSW railway system. The bridge retains its original fabric and structure. Source: OEH, 2009, 'Annandale (Johnston Street) Underbridge', viewed 17 July 2017, < http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4803229>	
Heritage Impact Assessment	The addition of a right turn lane from The Crescent onto Johnston Street necessitates the widening of the road under the underbridge, adjacent to the bridge piers. This would result in the grassed verge being reduced, the footpath, kerb and guttering being closer and the associated signage/traffic lights being located closer to the bridge piers. There is sufficient room to accommodate the road widening without physical impact to the bridge piers. While the visual setting of this small area would change, it would not be dissimilar to the current context. Therefore, the works would not directly impact on either the underbridge, which would be retained and continue to function during construction (for the Inner West light rail), or on the retaining wall along The Crescent. However, some indirect impacts from vibrations could be experienced from the eastward road widening along The Crescent, and the southward road widening along Johnston Street.	
Impact Type	Setting, vibration	
Impact Ranking	Neutral	

Table 6-24 Heritage significance assessment and impact assessment for Stormwater Canal

Name	Stormwater Canal	
Address	Lilyfield Road, Rozelle	
Significance	Local – SREP 26 (Schedule 4, Part 3, #6)	
Description	The Lilyfield Stormwater Canal is exposed and extends under the study area. However, no physical inspection could be undertaken on this portion of the canal to enable an assessment of the elements present on the site and their relative heritage significance. It is likely that this concrete lined, brick topped canal was constructed to formalise and direct the overland flows from the residential areas to the north, and from the surrounding industrial areas, for discharge into Rozelle Bay.	
Statement of Significance	No information on this heritage item.	
Comparative analysis	There is little historical information regarding the Stormwater Canal at Lilyfield Road and establishing its date of construction is difficult. Generally, following the 1890 direction of the Secretary for Public Works to build a stormwater system separate to the sewer, multiple stormwater systems were constructed around Sydney locales. Other stormwater canals (though to a larger scale) that discharge into Rozelle Bay includes Johnstons Creek and Whites Creek canals.	
Heritage Impact Assessment	Demolition of the channel would result in the permanent loss of the heritage item. It would remove evidence of early stormwater management infrastructure associated with the industrialisation of this area.	
Impact Type	Full demolition	
Impact Ranking	Major adverse	

Table 6-25 Heritage significance assessment and impact assessment for 'Cadden Le Messurier'

Name	'Cadden Le Messurier'	
Address	84 Lilyfield Road, Rozelle	
Significance	Local – SREP 26 (Schedule 4, Part 3, #3)	
Description	Modified late nineteenth century commercial building, with significant changes to the façade and joinery. The awning/first floor verandah has been removed. The historic photograph of the Former Easton Park Hotel (below) shows the side of this verandah.	
Statement of Significance	No official statement of significance in the listing for this item. It is representative of the predominantly Victorian development of the area, which expanded in conjunction with industrialisation of the area.	
Comparative analysis	Commercial buildings were a common feature in Rozelle and Balmain due to the 1880s industrial growth of the area. Significant characteristics of these suburbs included one to two storey commercial premises and small industrial/warehouse buildings throughout the area. This building has similar architectural features as many other Victorian developments in the area (in particular with its decorative mouldings, urns and pediments along and above the parapet). This is not a noteworthy or distinctive example of its typology.	
Heritage Impact Assessment	Demolition of this commercial building would result in the permanent loss of the historic and aesthetic significance of this item. It is representative of the predominantly Victorian development of the area, which expanded in conjunction with industrialisation of the area.	
Impact Type	Full demolition	
Impact Ranking	Major adverse	

Table 6-26 Heritage significance assessment and impact assessment for Former Hotel

Name	Former Hotel	
Address	78 Lilyfield Road, Rozelle	  Photograph of Former Easton Park Hotel c1930. (Source: Australia Gday Pty Ltd)
Significance	Local – SREP 26 (Schedule 4, Part 3, #2)	
Description	Late nineteenth century building, in the Victorian regency style. This former hotel has had its first storey balconies, domical vault and awnings removed, and alterations to its ground floor as evident by the historic photo (above). Established in 1878 as Flood's Hotel, in 1908 William Hollin's took over the licence and the pub was known as Hollin's Hotel. The name was later changed to the Easton Park Hotel, named after a local alderman. The hotel closed in 1957. Source: Jon G courtesy of Australia Gday Pty Ltd, 'Former Easton Park Hotel in Rozelle (Sydney)' viewed 21 July 2017, <http://www.gdaypubs.com.au/NSW/sydney/rozelle/50305/former-easton-park-hotel.html>	
Statement of Significance	No official statement of significance in the listing for this item. It is representative of the predominantly Victorian development of the area, which expanded in conjunction with industrialisation of the area.	
Comparative analysis	During the late nineteenth century, Victorian regency style, corner hotel buildings were quite common in Rozelle and Balmain, as well as across Sydney. These were associated with the working-class areas and manufacturing/industrial sites. The first hotel in Balmain opened in 1842 and provided a basis for the social and political life of the growing suburb. There are many examples of this type of building within the LGA and elsewhere, which are still functioning as hotels, are more intact and retain more of their original features. Other similar examples in Rozelle include the 3 Weeds Hotel (at 193 Evans Street, formerly the Red Lion Hotel, established in 1881), and the Bald Rock Hotel (at 17 Mansfield Street, established in 1876).	

Name	Former Hotel
Heritage Impact Assessment	Demolition of this commercial building would result in the permanent loss of the historic and aesthetic significance of this item.
Impact Type	Full demolition
Impact Ranking	Major adverse

6.7.5 Potential heritage items

During the surveys, the Rozelle, Lilyfield and Annandale areas subject to this assessment were surveyed to identify items with potential heritage value that are not listed and may be impacted by the project. This was achieved via a pedestrian and vehicle survey of the project footprint.

The following structures described in **Table 6-27** and **Table 6-28** were identified as a potential heritage item from the assessment undertaken as part of the Rozelle Rail Yards site management works. Two additional structures were also identified as having potential heritage value based on their association with the State heritage listed White Bay Power Station, and are described in **Table 6-29** to **Table 6-30**.

Table 6-27 Heritage significance assessment and impact assessment for potential heritage item

Address	Victoria Road Bridge, Rozelle	
Assessment of Significance	The Victoria Road bridge has local significance as a representative example of brick overbridges constructed in the 1920s, as part of the roll out of the separate freight line across the Sydney rail network. The bridge is a noticeable landscape feature that provides evidence of the Rozelle Rail Yard's industrial and transport legacy.	
Assessed level of significance	Local for historical and representativeness	
Proposal	Full demolition	
Heritage impact assessment	Demolition of the Victoria Road Overbridge would result in the permanent loss of the potential historic and representative significance of this item, which would be a major adverse impact to this item.	
Impact type	Full demolition	
Impact ranking	Major adverse	

Table 6-28 Heritage significance assessment and impact assessment for potential heritage item

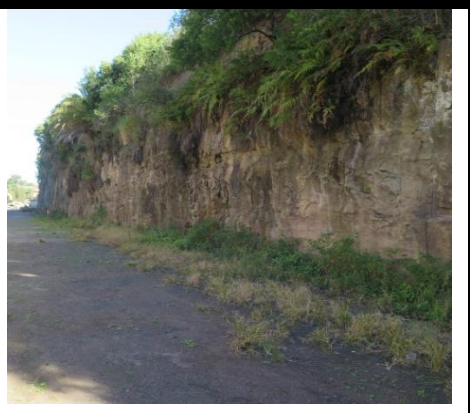
Address	Sandstone Cutting, Rozelle	
Assessment of Significance	The sandstone cutting has some local significance as a representation of the scale and nature of works undertaken for the construction and alignment of the goods rail line. The height and size of the cutting provides evidence of the early ambitions for the train marshalling yard to be a busy interchange. The cutting is a prominent landscape feature, defining the northern limit of the marshalling yard and more generally the topography of the twentieth-century industrial-maritime landscapes of White Bay and Rozelle Bay. There are potential links to quarrying activities on Glebe Island.	 
Assessed level of significance	Local for historical and technical/research	
Proposal	Partial demolition	
Heritage impact assessment	Driving of tunnels through the sandstone cutting and the partial obscuring of the sandstone cutting with landscaping (to grade up and cover the tunnel dive structure) would result in the permanent loss of the potential historic and technical significance of some sections of this item, which would be a moderate adverse impact to this item.	
Impact type	Partial demolition	
Impact ranking	Moderate adverse	

Table 6-29 Heritage significance assessment and impact assessment for potential heritage item

Address	White Bay Power Station Southern Penstock	
Assessment of Significance	The southern penstock is one of two within the broader White Bay Power Station complex. The penstocks are graded 'High Significance' in the White Bay Power Station 2013 CMP as an element of the substantially intact cooling water system, which was integral to the operation of the complex. They play an important role in contributing to the significance of the adjacent White Bay Power Station. According to the CMP, 'where these spaces or elements form part of a space of higher significance or contain machinery or equipment elements of higher significance, any action must respect the higher significance'.	 
Assessed level of significance	State	
Proposal	Vibration	
Heritage impact assessment	The project temporarily encroaches into the south western boundary of the curtilage of the White Bay Power Station which is a State Heritage Register (SHR) listed item. The minor encroachment occurs during the construction phase of the project as a result of the alignment of the temporary Victoria Road bridge. However, the works would be some distance from the Power Station building itself and the building would not be physically impacted by the project. This new temporary replacement bridge could physically and indirectly impact this heritage element and its associated water channels (locations unknown) and would need to be avoided if possible. A method for protecting the structure during works would need to be designed to protect the penstock, its associated water channels (current location and extent unknown), and to distribute the loads away from the heritage asset. Any cover or bridging structure must not be supported on the penstock itself.	
Impact type	Vibration	
Impact ranking	Neutral	

Table 6-30 Heritage significance assessment and impact assessment for potential heritage item

Address	Former White Bay Hotel site foundations (plinth and archaeology)	
Assessment of Significance	The former White Bay Hotel site foundations on Victoria Road, which is located adjacent to the south boundary of the White Bay Power Station, was constructed in 1916 by Tooth and Co. Brewers. This hotel was the second hotel built near the site following resumption of land and demolition of the first hotel in 1915 to build the Power Station. The former White Bay Hotel played an integral part of the landmark identity of the White Bay Power Station. The hotel has had a strongly working class tradition and had strong association with the workers of White Bay Power station dating from 1917, as well as other nearby industries dating from the 1860s. Following years of dereliction, the White Bay Hotel was destroyed by fire in September 2008. The site of the hotel was acquired by SHFA in June 2010 and debris cleared. The former White Bay Hotel site foundations contain little heritage significance following its destruction by fire and subsequent clearing of the site.	 
Assessed level of significance	Local	
Proposal	Full demolition	
Heritage impact assessment	The former White Bay Hotel site foundations (plinth and archaeology) is excluded from the SHR curtilage for the White Bay Power Station, however, it is identified in the 2013 CMP as being of Moderate significance. The site is now only a concrete slab as the hotel was destroyed by fire over a decade ago. Its 'demolition' as part of the road reconfiguration of Victoria Road would be a major adverse impact to this item.	
Impact type	Full demolition	
Impact ranking	Major adverse	

6.8 Area 4 – Iron Cove heritage study area (C8)

6.8.1 Overview

The study area for Iron Cove is shown on **Figure 6-7**.

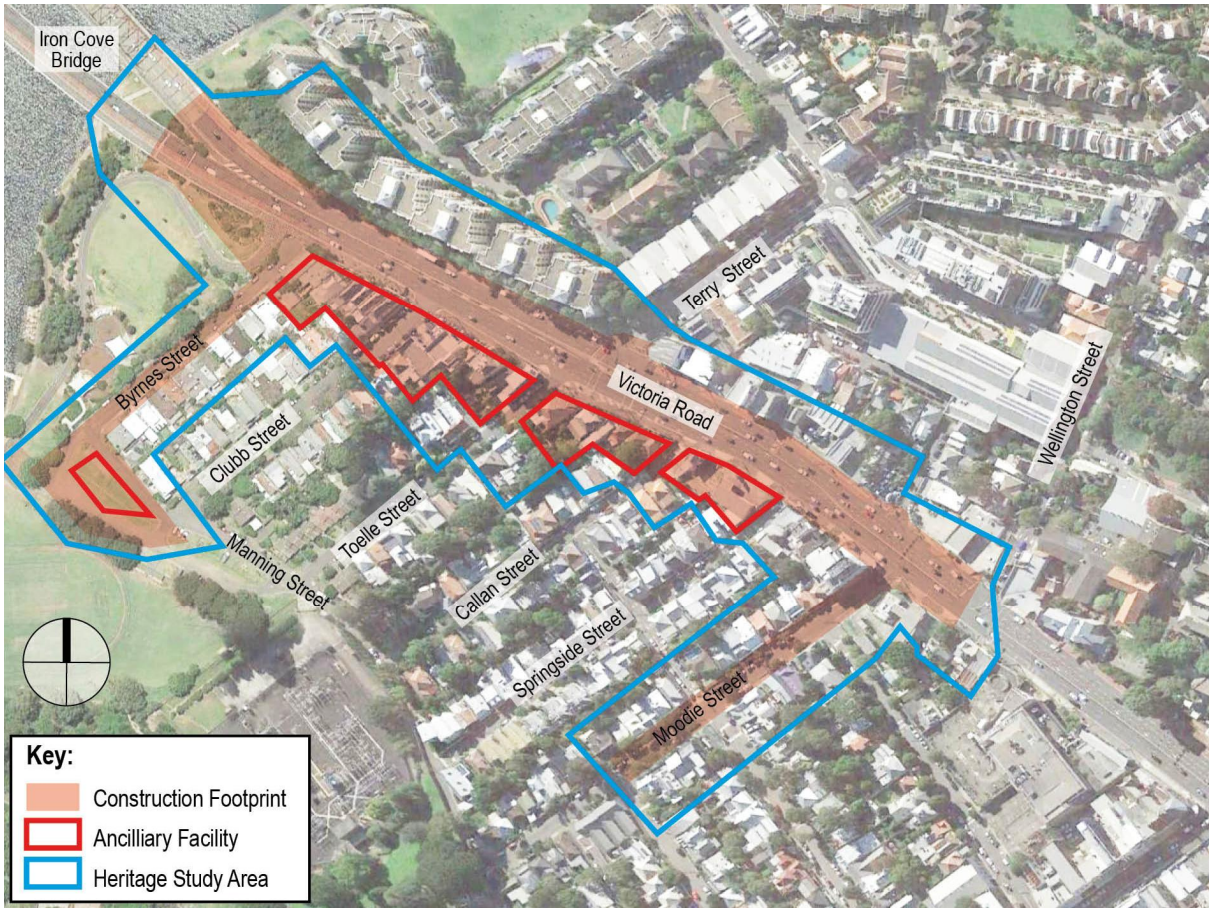


Figure 6-7 Iron Cove project footprint with heritage study area shown (Source: Google Maps with GML overlay)

Iron Cove Bridge links the suburb of Rozelle to the suburb of Drummoyne to its northwest. Area 4 (C8) is oriented along Victoria Road, a major thoroughfare located around four kilometres to the west of Sydney's CBD. The residential development, which fronts on to Victoria Road and occupies the adjacent cross streets, is predominantly late nineteenth century workers housing. To the north of Victoria Road, close to the bridge, is a multi-storey apartment complex.

The area to the south of Victoria Road is a small scale, irregular subdivision which demonstrates a variety of building types and construction methods including single-fronted cottages, two-storey terraces, free-standing timber and stone single storey cottages most with small front gardens.

6.8.2 Heritage items and conservation areas

Table 6-31 below sets out the listed heritage items and conservation areas in Area 4 – Iron Cove, and are also shown on **Figure 6-8**.

Table 6-31 Statutory heritage listings for heritage items in the Iron Cove heritage study area. Items with no shading may be subject to indirect impacts.

Item name	Address	Suburb	Significance	Listing	Impact Type
Iron Cove Bridge (aka RTA Bridge No. 65)	Victoria Road	Drummoyne	State	Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (#17) RTA S170 Register (#65)	Setting, vibration
Iron Cove Heritage Conservation Area		Drummoyne	Local	Leichhardt LEP 2013 (C6)	Setting, vibration

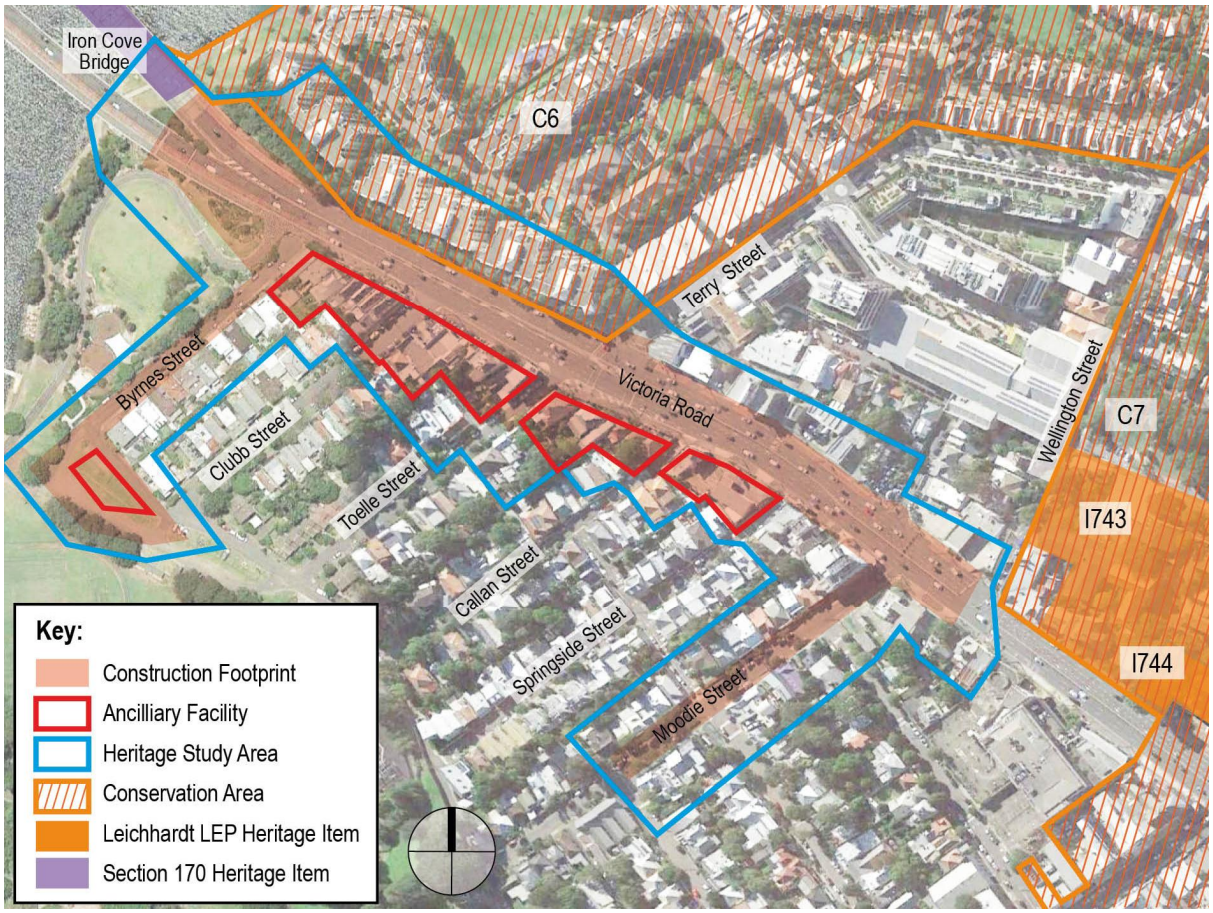


Figure 6-8 Iron Cove project footprint with heritage items shown

(Source: Leichhardt LEP 2013 Heritage maps, overlay by GML)

6.8.3 General heritage impact assessment

The Iron Cove Link civil site (C8) is not in the immediate vicinity of any individual heritage items, however it is in the wider vicinity of Iron Cove Bridge, Rozelle Public School, St Paul's Church and neighbourhood centre, The Valley HCA and is partially within the Iron Cove HCA. At Iron Cove, the

potential for heritage impacts would arise from impacts of the ventilation outlet on the visual setting, or potential vibration impacts as a result of road works along Victoria Road. Generally however, there are no substantial adverse heritage impacts resulting from the project.

6.8.4 Detailed heritage impact assessment

The following tables (**Table 6-32** to **Table 6-33**) provide an impact assessment for each statutory heritage item and HCA within the area with the potential to be directly or indirectly affected by the project. For these items and areas, a description and statements of significance (drawn from existing heritage citations) is provided, an assessment of the heritage impact of the proposed works on the heritage significance of each of the affected heritage items or HCAs is undertaken, and an overall ranking of the severity of the impact is identified.

Table 6-32 Heritage significance assessment and impact assessment for Iron Cove Bridge

Name	Iron Cove Bridge	
Address	Victoria Road, Drummoyne	
Significance	State – Sydney Regional Environmental Plan – City West REP No. 26 – Sch. 4 (#17)	
Description	Iron Cove Bridge is an impressive steel truss bridge. It consists of four 18m plate girder approach spans and seven 52m steel Pratt truss spans for a total length of 461.26m (1,535ft 10in). Four lanes of traffic are located within the truss spans and the overall width of the roadway is 13.70m between kerbs. The roadway consists of a 127mm reinforced concrete deck slab with an inset for tram tracks in the centre portion.	
Statement of Significance	Iron Cove Bridge is an outstanding steel truss bridge which forms a local landmark that has a 'gateway' quality for the suburbs of Balmain and Drummoyne due to its impressive size. The Bridge is comprised of aesthetically distinctive piers and abutments which reflect the Inter-War Art Deco style which was prevalent when it was first designed in 1942. Furthermore, it was the last steel truss bridge to be constructed in NSW in which rivets were used for field connections prior to the introduction of high strength bolts. Iron Cove Bridge has been assessed as being of State significance.	
Heritage Impact Assessment	This heritage item is outside of the project footprint and would not be physically or directly impacted by the Iron Cove Link works. Some visual impacts could result from the 20m tall ventilation outlet proposed – however, this is located a substantial distance from Iron Cove Bridge. Indirect impacts from vibration could result from the eastward road works along Victoria Road.	
Impact Type	Setting, vibration	
Impact Ranking	Minor adverse	

Table 6-33 Heritage significance assessment and impact assessment for Iron Cove HCA

Name	Iron Cove HCA	
Address		
Significance	Local – Leichhardt LEP 2013 (C6)	
Description	The Iron Cove Conservation Area is a northwest facing shoreline area, running from Victoria Road along the back of the Darling Street commercial zone and the Darling Street ridge to Rowntree Street and Cove Street. There are some relatively steep shoreline areas providing views to the Parramatta River, and a central flat plateau area around Turner Street.	
Statement of Significance	One of a number of conservation areas that collectively illustrate the nature of Sydney's early suburbs and Leichhardt's suburban growth particularly between 1871 and 1891, with pockets of infill up to the end of the 1930s (ie prior to World War II). This area is important for illustrating development particularly from 1870s–1910s, and this forms the major element of its identity, with later pockets of infill prior to World War II (ie pre-1939). Through the route of its main access roads, demonstrates the subdivision sections, closely related to the landform, drawn up by Surveyor Langley for the sale of Gilchrist's Balmain grant after 1852. Illustrates through its irregular small street layout, and varied allotment width and length (within a limited range), the many different groups of speculators and subdividers involved in the development of the area. Through the materials of its outer masonry walls, demonstrates the rapid advances in brick making in the Sydney area over the period 1870s–1910s. Through its now rare weatherboard buildings it continues to demonstrate the nature of that major construction material in the fabric of early Sydney suburbs.	
Heritage Impact Assessment	The 3-4 storey apartment buildings (Balmain Shores) which line the Victoria Road frontage to the HCA provide a physical and visual barrier to the Iron Cove Link works to be undertaken on Victoria Road. The proposed 20m tall ventilation outlet in the middle of Victoria Road (just south of Terry Street) while physically close to the HCA (~20m), is visually isolated from the HCA by the trees and buildings at the corner of Victoria Road and Terry Street, and the roadway The proposed substation (with an approximate footprint of 5m by 10m, and 4m high) and ventilation facility building (stretching from Callan Street to Springside Street) on either side of the intersection of Callan Street and Victoria Road is a substantial distance from the HCA. Therefore, there would be no impact on the heritage values of the HCA.	
Impact Type	Setting, vibration	
Impact Ranking	Neutral	

6.8.5 Potential heritage items

During the site investigations, the Iron Cove heritage study area was surveyed to identify items with potential heritage value that are not listed and may be impacted by the project. This was achieved via a pedestrian and vehicle survey of the study area.

The following buildings were identified on the site inspection to be of potential heritage significance, were subject to a heritage values assessment and impact assessment. These are outlined in **Table 6-34** to **Table 6-36**.

Table 6-34 Heritage significance assessment and impact assessment for potential heritage item

Address	**260-266 Victoria Road, Rozelle**	
Assessment of Significance	As a group of four these properties may have local significance as representative of a transitional early Federation style typical of their period. The houses have some historical interest as evidence of the late nineteenth century and early twentieth century development and subdivisions which occurred along Victoria Road.	  
Assessed level of significance	Local for aesthetic and representativeness	
Proposal	Full demolition	
Heritage impact assessment	The demolition of these four properties would result in a deterioration of streetscape of Victoria Road and the loss of their potential heritage significance.	
Impact type	Full demolition	
Impact ranking	Major adverse	

Table 6-35 Heritage significance assessment and impact assessment for potential heritage item

Address	**248-250 Victoria Road, Rozelle**	
Assessment of Significance	As a relatively intact example of a pair of early twentieth century residences the properties may have local significance as representative of Federation style. The houses have some historical interest as evidence early twentieth century development.	
Assessed level of significance	Local for aesthetic and representativeness	
Proposal	Full demolition	
Heritage impact assessment	The demolition of these two properties would result in a deterioration of streetscape of Victoria Road and the loss of their potential heritage significance.	
Impact type	Full demolition	
Impact ranking	Major adverse	

Table 6-36 Heritage significance assessment and impact assessment for potential heritage item

Address	8 Callan Street, Rozelle	
Assessment of Significance	The house at 8 Callan Street has aesthetic and representative significance at the local level as a good example of an interwar house with Arts and Craft Style details.	
Assessed level of significance	Local for aesthetic and representativeness (subject to further research)	
Proposal	Nil	
Heritage impact assessment	Owing to the physical separation between this property and the project footprint, there would be no physical impact. However, with the construction of the ventilation facility building (adjacent) and the substation (opposite and to the north) there would be a change in the setting of this property.	
Impact type	Vibration, setting	
Impact ranking	Neutral	

6.9 Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road) heritage study area (C9)

6.9.1 Overview

The study area for Annandale (around Pyrmont Bridge Road and Parramatta Road) (C9) is shown on **Figure 6-9**.

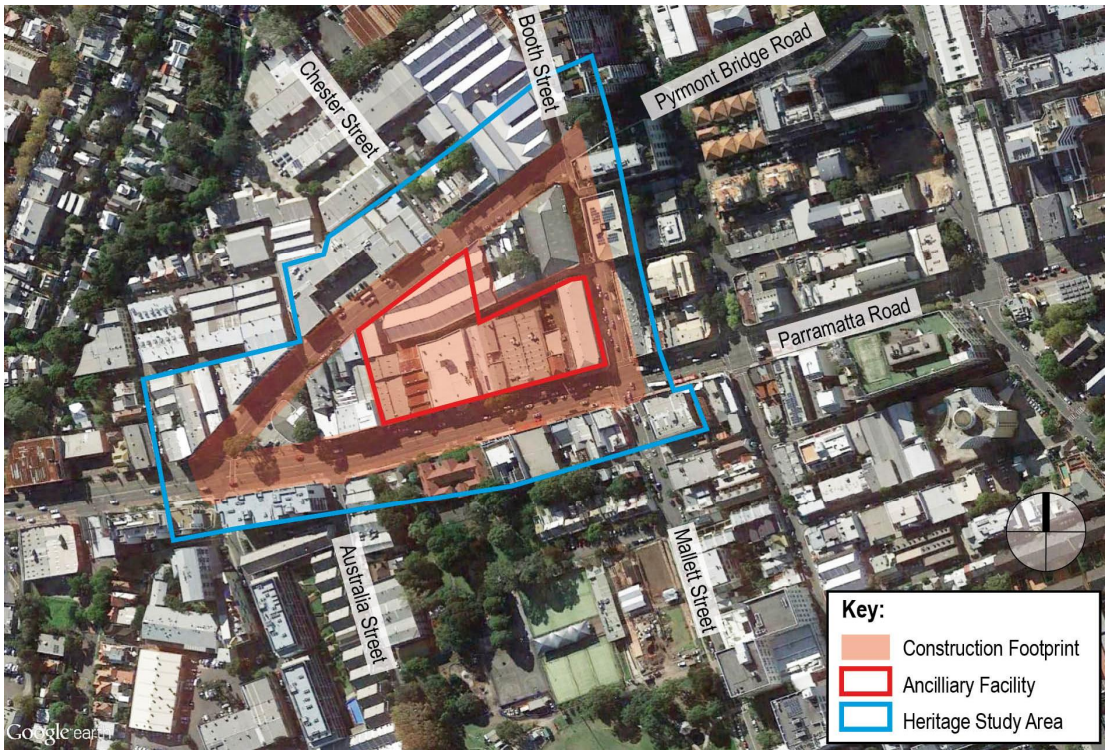


Figure 6-9 Project footprint at Annandale (around Pyrmont Bridge Road and Parramatta Road) with heritage study area shown

(Source: Google maps with GML overlay)

Annandale is located around three kilometres from Sydney's CBD and is characterised as a mixed use commercial/residential area oriented around Parramatta Road. The area is generally occupied by medium density development of predominantly industrial character. Buildings date primarily from the early to mid-twentieth century, but are increasingly being punctuated by contemporary apartment development.

Within Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road), the project comprises the Pyrmont Bridge Road tunnel site (C9) (a construction ancillary facility) and associated tunnelling for the Inner West subsurface interchange. The project footprint is bound by Parramatta Road to the south, Pyrmont Bridge Road to the north and Bignell Lane and Mallett Street to the east.

6.9.2 Heritage items and conservation areas

Table 6-37 below sets out the listed heritage items and conservation areas in Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road), and are also shown on **Figure 6-10**.

Table 6-37 Statutory heritage listings for heritage items in the Annandale (around Pyrmont Bridge Road and Parramatta Road) heritage study area. Items with no shading may be subject to indirect impacts

Item name	Address	Suburb	Significance	Listing	Impact Type
Kerb and gutter	Chester Street	Camperdown	Local	Leichhardt LEP 2013 (Item no. I613)	Setting, vibration
Warehouse, including interiors	52–54 Pyrmont Bridge Road	Camperdown	Local	Leichhardt LEP 2013 (Item no. I616)	Setting, vibration

Item name	Address	Suburb	Significance	Listing	Impact Type
Former Grace Bros Repository including interiors	6–10 Mallett Street	Camperdown	Local	Sydney LEP 2012 (Item no. I2242)	Setting, vibration
Bridge Road School (former Camperdown Public School), including interiors	127 Parramatta Road	Camperdown	Local	Marrickville LEP 2011 (Item no. I5)	Setting, vibration

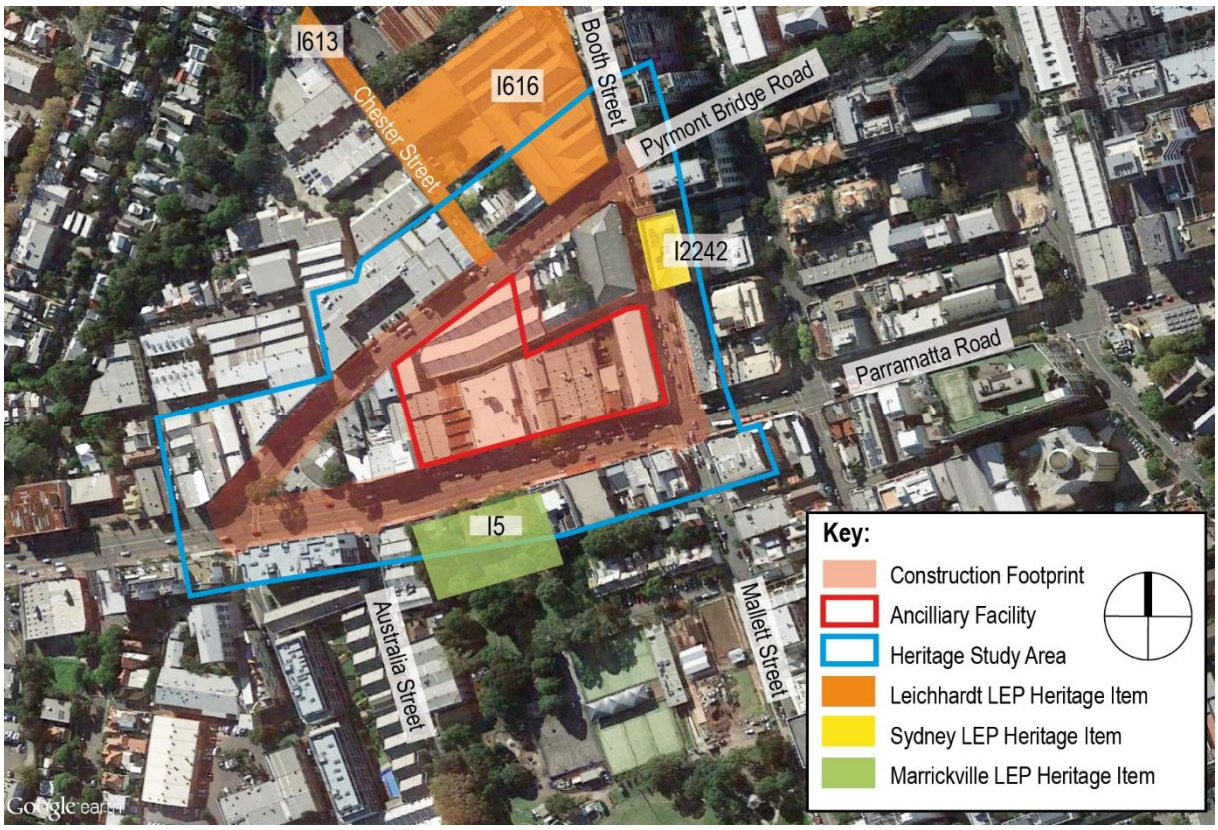


Figure 6-10 Statutory heritage listings for heritage items in the Annandale (around Pyrmont Bridge Road and Parramatta Road) study area.

Items with the potential to be directly affected by the M4-M5 Link are highlighted.

6.9.3 General heritage impact assessment

The potential for heritage impacts resulting from the project in the Annandale area would arise from the demolition of a potential heritage item and the construction of a civil and tunnel site in the vicinity of heritage items, and possible impacts from construction vibration and tunnelling activities.

The project would result in the loss of a number of early twentieth century warehouses which, despite not being heritage listed, nevertheless contribute to the character of the area and illustrate the precincts industrial past. There will be a permanent impact on the Parramatta Road streetscape as well as visual impacts from the installation of temporary construction sites, including site hoardings

and works, and new permanent infrastructure associated with the roadway including widened roadways, noise barriers and buildings and facilities.

Around 100 metres of Pyrmont Bridge Road, north of the Pyrmont Bridge Road tunnel site would be upgraded and resurfaced resulting in no further heritage impacts. The construction of a substation in the southwest corner of the tunnel site would also result in no/neutral heritage impacts as there is sufficient separation between the proposed substation and surrounding heritage items.

6.9.4 Detailed heritage impact assessment

The following tables (**Table 6-38** to **Table 6-41**) provide an impact assessment for each statutory heritage item and HCA within the area with the potential to be directly or indirectly affected by the project. For these items and areas, a description and statements of significance (drawn from existing heritage citations) is provided, an assessment of the heritage impact of the proposed works on the heritage significance of each of the affected heritage items or HCAs is undertaken, and an overall ranking of the severity of the impact is identified.

Table 6-38 Heritage significance assessment and impact assessment for Kerb and gutter

Name	Kerb and gutter	
Address	Chester Street, Annandale	
Significance	Local – Leichhardt LEP 2013 (Item no. I613)	
Description	Trachyte gutter located at the western end of Guihen Street and sandstone kerb extending along Chester Street.	
Statement of Significance	The trachyte and stone kerb and gutters in Chester Street and Guihen Street are of local historic and aesthetic and technological significance as relatively intact examples of late nineteenth century road construction and improvements. The integrity of the items, however, have been affected by the addition of concrete infill and elements and general wear and tear. Source: OEH, 2012, 'Kerb and gutter', viewed 17 July 2017, < http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=1940635>	
Heritage Impact Assessment	This heritage item is outside of the project footprint. Therefore, the works would not directly impact on the kerb and guttering. However, some indirect impacts from vibrations could be experienced from the construction site to the south and the tunnelling activities.	
Impact Type	Setting, vibration	
Impact Ranking	Neutral	

Table 6-39 Heritage significance assessment and impact assessment for Warehouse, including interiors

Name	Warehouse, including interiors	
Address	52–54 Pyrmont Bridge Road, Annandale	
Significance	Local – Leichhardt LEP 2013 (Item no. I616)	
Description	Single storey face brick Warehouse building constructed to the north eastern Booth Street and Pyrmont Bridge Road corner with high parapet which conceals the hipped and gabled roof forms clad in metal sheeting. The Pyrmont Bridge Road and Booth Street facades each comprise of three main sections each divided into bays with pilasters, recessed panels, timber framed windows and doors with brick arches over the openings. The façade is topped by a flat parapet with brick corbelling and dentilled details. The central bay features a gabled pediment and recessed bays framed by pilasters with brick detailing and corbelling and soldier course detail to the plinth. The northern end of the Booth Street façade also incorporates a two storey brick façade with recessed panels, contrasting brick details, timber framed double hung timber windows and doors and brick detailing to the flat and curved parapet and pilasters. The facades also feature steel roller doors and painted and fixed signage to the parapet.	
Statement of Significance	No. 52-54 Pyrmont Bridge Road is of local historic and aesthetic significance as a good and relatively intact representative example of a Federation period warehouse constructed in the early decades of the twentieth century that retains its original scale and distinctive face brick character and details. The building occupies a prominent corner site and makes a positive contribution to the Pyrmont Bridge Road and Booth Street corner and streetscapes. Source: OEH, 2012 'Warehouse', viewed 18 July 2017, < http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=1940638>	
Heritage Impact Assessment	This heritage item is outside of the project footprint and separated from the construction site by buildings. Therefore, the works would not directly impact on the warehouse. However, some indirect impacts from vibrations could be experienced from the construction site to the south and the tunnelling activities.	
Impact Type	Setting, vibration	
Impact Ranking	Minor adverse	

Table 6-40 Heritage significance assessment and impact assessment for Former Grace Bros Repository including interiors

Name	Former Grace Bros Repository including interiors	
Address	6–10 Mallett Street, Camperdown	
Significance	Local – Sydney LEP 2012 (Item no. I2242)	
Description	The building was constructed in approximately 1924 as a repository for Grace Bros. The site fronts Mallett Street and extends to Mason Street to the north and Isabella Street to the south. The repository comprises a five-storey brick building contained under a hipped roof concealed behind a parapet wall. The repository was constructed in the inter-war period. It exhibits typical features of this period applied to a utilitarian building including its heavy geometric massing, hipped roof concealed behind a parapet, symmetrical facades, face brick materials contrasting with rendered lintels, alternating square and rectangular openings, pilasters on the main street frontage and an emphatic cornice below the parapet. The brick rooftop tower on the south-west corner contains arched openings. This feature may have been designed to accommodate a water tower. Loading docks are still visible on the Isabella Street elevation. The building name 'Grace Bros Repository' is inscribed on the Mallett Street parapet. The former repository was adaptively reused for offices in the 1980s and the window frames replaced. This conversion maintained the external integrity of the building.	
Statement of Significance	Built in approximately 1924 as a furniture repository for major Sydney retailers, Grace Bros, this building represents the industrial development of Camperdown during the first half of the twentieth century. It is historically significant for its connection to the twentieth century growth of Sydney's retail industry, in particular relating to furniture. As the most intact of two former Grace Bros repositories on Mallett Street, the building provides evidence of the success, scale and expansion of the Grace Bros retail empire during the 1920s, one of Sydney's earliest major department stores. Architecturally, the building demonstrates a representative example of a purpose-designed warehouse from the inter-war period. It exhibits typical features of this period applied to a utilitarian building including the heavy geometric massing, symmetrical facades, face brick materials, rendered lintels, regular pattern of window openings, pilasters on the main street frontage, emphatic cornice, hipped roof concealed behind a parapet wall, and prominent rooftop tower. The imposing form of the building extending across the full width of the block and the prominent corner tower add to the building's landmark qualities in the local neighbourhood. The building makes an important contribution to the streetscapes of Mallett, Isabella and Mason Streets and is visible in the round from a number of near and distant vantage points in surrounding streets. The building design also likely represents the work of architects, D.T. Morrow & Gordon, who designed the adjoining furniture repository at 47-71 Pyrmont Road and a number of buildings for Grace Bros including the Grace Bros Emporium on Broadway and Grace Hotel in central Sydney. The adaptive reuse of the building as offices during the 1980s retained the external	

Name	Former Grace Bros Repository including interiors
	integrity of the building. It survives as the most intact of two buildings originally constructed as furniture repositories for Grace Bros during the 1920s on Mallett Street. For its association with the significant employer of the time, Grace Bros, the building may have value to the community of former Grace Bros workers involved in its furniture removals and storage operations from the 1920s to the 1960s. The former Grace Bros Repository is of local heritage significance in terms of its historical, aesthetic, associations, and representative value. Source: OEH, 2016, 'Former Grace Bros Repository including interiors', viewed 18 July 2017, <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5062454>
Heritage Impact Assessment	This heritage item is outside of the project footprint. Therefore, the works would not directly impact on the warehouse building. However, some indirect impacts from vibrations could be experienced from the construction site to the southwest and the tunnelling activities.
Impact Type	Setting, vibration
Impact Ranking	Minor adverse

Table 6-41 Heritage significance assessment and impact assessment for Bridge Road School (former), including interiors

Name	Bridge Road School (former), including interiors	
Address	127 Parramatta Road, Camperdown	
Significance	Local – Marrickville LEP 2011 (Item no. I5)	
Description	This large brick building has three projecting bays facing Parramatta Road, the central gable bearing the inscription 'Public School 1882'. Built of English bond brickwork with simple rendered detailing, the building features a simple moulded entablature over the flat arched windows to each projecting bay, plain rendered string and sills, and rock faced sandstone foundations. There is also a building to the west of the main building which was probably the headmaster's residence.	
Statement of Significance	This is one of a number of large public schools built in the district in response to the increased enrolments caused by the NSW Public Instruction Act of 1880. It illustrates the large suburban population which had been established in this area by the early 1880s. Source: OEH, 2011, 'Camperdown Public School', viewed 18 July 2017, <http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=2030069>	
Heritage Impact Assessment	This heritage item is outside of the project footprint and a fair distance from the construction site. Therefore, the works would not directly impact on the school building. However, some indirect impacts from vibrations could be experienced from the construction site to the north and the tunnelling activities along Parramatta Road.	
Impact Type	Setting, vibration and settlement	
Impact Ranking	Minor adverse	

6.9.5 Potential heritage items

During the surveys, areas of potential heritage value were investigated to look for items with heritage value that are not listed and may be impacted by the project. This was achieved via a pedestrian and vehicle survey of the study area.

The following building in **Table 6-42** was identified on the site inspection to be of potential heritage significance, was subject to a heritage values assessment and impact assessment.

Table 6-42 Heritage significance assessment and impact assessment for heritage item.

Address	164 Parramatta Road, Annandale (Former Bank of NSW)	
Assessment of Significance	The former Bank of NSW building has historic and aesthetic significance as a typical example of an inter-war commercial building purpose built as a bank, a typology rare in the context of Parramatta Road.	
Assessed level of significance	Local for historical, aesthetic and representativeness	
Proposal	Full demolition	
Heritage impact assessment	This would result in the loss of a potential item of historic and aesthetic significance from the Parramatta Road streetscape and would be a major adverse heritage impact for the item.	
Impact type	Full demolition	
Impact ranking	Major adverse	

6.10 Area 6 – St Peters Heritage Study Area (C10)

6.10.1 Overview

St Peters is located around seven kilometres from the Sydney CBD. The heritage study area (shown on **Figure 6-11**) is located to the south of Campbell Street and south of Sydney Park (a 40-hectare parkland which was formerly a brickworks, rubbish tip and other industrial uses including gas storage, manufacturing and warehousing). Prior to the construction of the New M5, the area was characterised by a largely open expanse of industrial land adjacent to the Alexandra Canal, the banks of which were generally occupied by large scale industrial buildings.

The St Peters heritage study area that forms part of the M4-M5 Link project coincides with the project footprint that was assessed as part of the New M5 project, extending to the east to encompass the terrace group at 2-34 Campbell Road, St Peters. Given the nature of the works to be undertaken in the St Peters project footprint as part of this project (installation of ventilation shafts), the heritage study area has not been broadened beyond the M4-M5 Link project footprint.

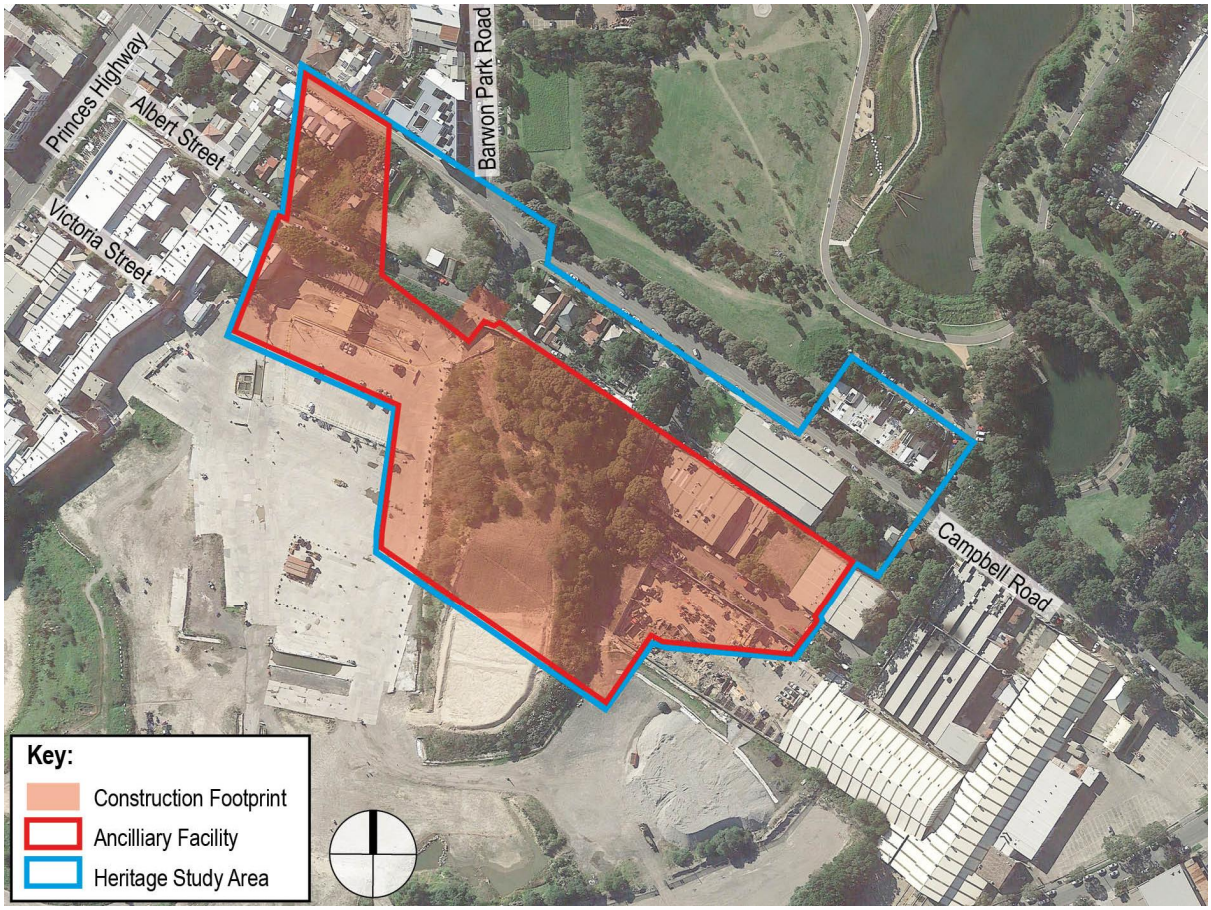


Figure 6-11 St Peters project footprint with heritage study area shown (Source: Google maps with GML overlay)

6.10.2 Heritage items and conservation areas

Table 6-43 sets out the listed heritage items and conservation areas in Area 6 – St Peters, and are also shown on **Figure 6-12**.

Table 6-43 Statutory heritage listings for heritage items in the St Peters heritage study area.

Items with the potential to be directly affected by the M4-M5 Link project are shaded. Items with no shading may be subject to indirect impacts.

Item name	Address	Suburb	Significance	Listing	Impact Type
Terrace group including interiors	2–34 Campbell Road	Alexandria	Local	Marrickville LEP 2011 (Item no. I12)	Setting

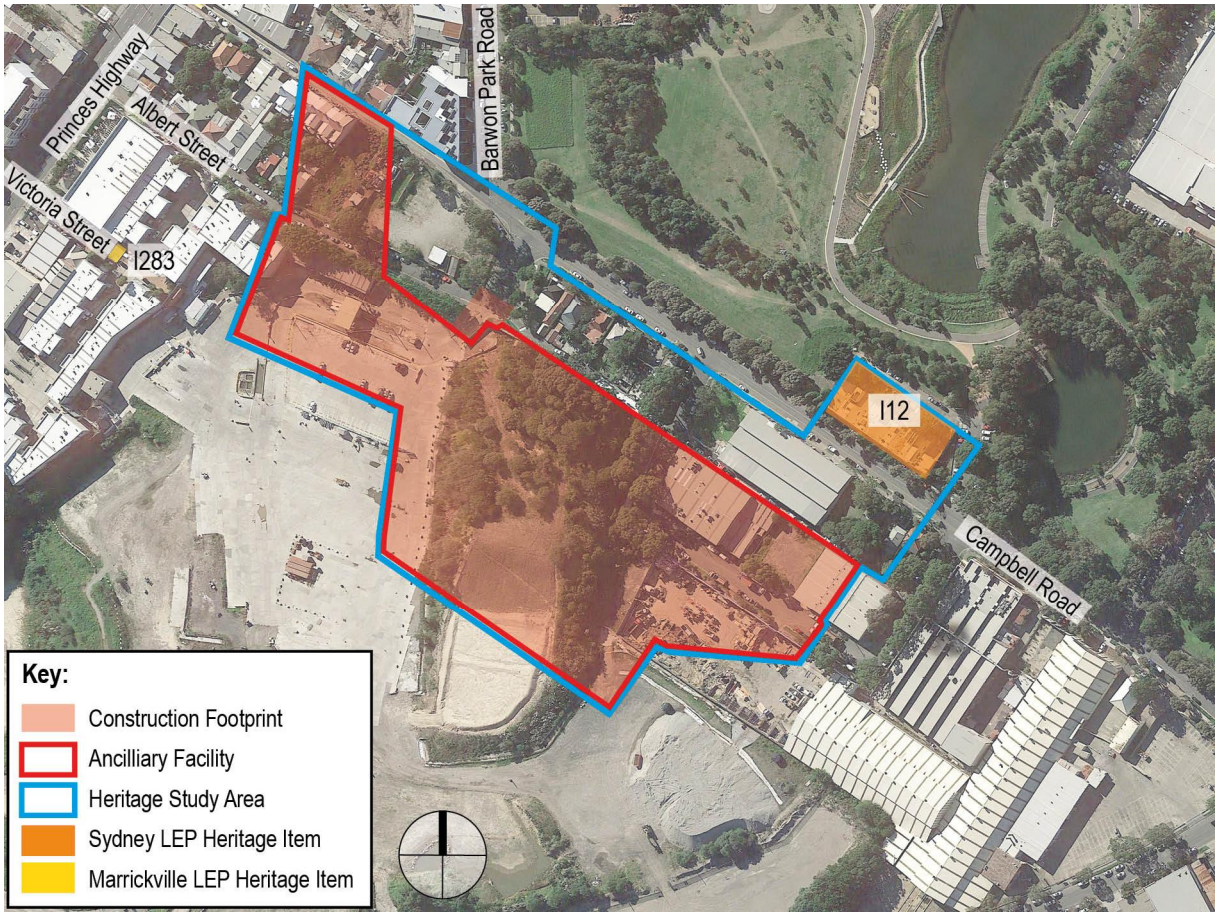


Figure 6-12 Statutory heritage listings for heritage items in the St Peters study area.

Items with the potential to be directly affected by the M4-M5 Link are highlighted.

6.10.3 General heritage impact assessment

Construction for the New M5 project has already resulted in the demolition of buildings within the M4-M5 Link project footprint. This included demolition of a heritage item (Rudders Bond Store at 53–57 Campbell Road). A photographic archival recording of the Rudders Bond Store (also known as the former Ralph Symonds Factory) was undertaken in September 2016 prior to its demolition. This report records the features and condition of the place prior to its demolition, and provides a discussion of its history and significance.

These direct and visual heritage impacts from construction of the new motorway infrastructure have already been assessed in the New M5 Non-Aboriginal HIA (AECOM 2015). The construction of the motorway operations complex, including a new ventilation facility at the St Peters interchange, near Albert Street and Campbell Lane at the centre of the Campbell Road civil and tunnel site would form a permanent addition to the built environment of this area.

6.10.4 Detailed heritage impact assessment

Table 6-44 provides an impact assessment for the statutory heritage item within the study area with the potential to be directly or indirectly affected by the project. For this items, a description and statement of significance (drawn from existing heritage citations) is provided, an assessment of the heritage impact of the proposed works on the heritage significance of the affected heritage item is undertaken, and an overall ranking of the severity of the impact is identified.

Table 6-44 Heritage significance assessment and impact assessment for Terrace group including interiors

Name	Terrace group including interiors	
Address	2–34 Campbell Road, Alexandria	
Significance	Local – Sydney LEP 2012 (Item no. I12)	
Description	Two storey Victorian Regency style terrace house group. Continuous front parapet, and continuous front galvanised iron roof for balconies, face brick front wall (painted over) and timber vertical slat balcony balustrade.	
Statement of Significance	The terrace group are historically significant as they represent early housing associated with the nearby brick making and potting works. They are located on the hill away from the former swampy areas in Waterloo and Alexandria area. Prior to the 1890s group housing is rare within the southern industrial suburbs in the City of Sydney.	
Heritage Impact Assessment	Assessment of the impacts of the New M5 project on these terraces has previously been assessed in the New M5 Non-Aboriginal HIA. The M4-M5 Link project would involve the construction of the motorway operations complex, including a ventilation facility and outlets at the St Peters interchange, located approximately 230 metres to the northwest of these heritage items. Owing to the physical separation of this site from the project footprint, and the proposed landscaping in between, it is not anticipated that the ventilation facility and outlets would have any adverse heritage impacts on the terrace row.	
Impact Type	Setting	
Impact Ranking	Neutral	

6.10.5 Potential heritage items

There were no buildings within this study area which warranted additional heritage assessment. Potential for vibration and settlement

6.11 Potential vibration impacts

Heritage items, potential heritage items and HCAs along the tunnel alignment and in the vicinity of construction works may be subject to ground movement (predominantly settlement and vibration). Areas most likely to be affected by settlement are usually where tunnelling is closest to the ground surface (shallowest).

The alignment of the tunnels and the locations of tunnel portals have given regard to maximising the use of the best possible geotechnical conditions. As the driven tunnels would be generally located from 20 metres to greater than 65 metres below the ground these works would not have an impact on historical archaeological remains and have therefore not been considered further.

Potential vibration impacts to heritage items have been assessed; with 11 listed heritage items located within safe working distances of the project that may experience vibration impacts (refer **Table 6-45**). The noise and vibration assessment (**Appendix J** (Technical working paper: Noise and vibration) identifies vibration criteria and impact assessment for sensitive receivers. The report identifies that the minimum 'safe limit' of peak vibration velocity at low frequencies for structures which may be particularly sensitive to ground vibration, such as historic buildings, is three millimetres per second. This minimum 'safe limit' is determined by the vibration guidelines adopted for the project, DIN 4150: Part 3-1999 *Structural vibration – Effects of vibration on structures* (Deutsches Institute fur Normung (DIN) 1999). This criterion could also be applied to buried archaeological artefacts. A summary of heritage listed buildings that are located within safe working distances of the project and may experience vibration impacts are identified in **Table 6-45**.

Operational ground-borne noise and vibration due to the movement of cars and trucks inside the tunnel is considered to be negligible and would not be expected to cause any noticeable impact at the surface level properties. As such, this noise and vibration source has not been considered further in this report. However, two listed heritage items (State listed Pressure Tunnel and Shafts, and S170 listed City Tunnel) are located underground and are in the vicinity of the mainline tunnels. Further assessment of these two items has been undertaken in **section 6.12** with regard to potential vibration impacts during construction.

These items would be managed in accordance with the recommendations of the noise and vibration assessment (**Appendix J** (Technical working paper: Noise and vibration). Appropriate monitoring and protection of the physical fabric of heritage items to be retained would be provided during construction of the project.

Table 6-45 Heritage items subject to potential vibration impacts

Heritage study area	Item name	Address	Construction type
Area 2	Leichhardt (Charles St) Underbridge	Dulwich Hill to Rozelle Goods Line 12.405km, Leichhardt	Steel bridge structure
Area 3	Whites Creek Stormwater Channel No 95	Railway Parade to Parramatta Road, Annandale	Stonework/concrete
Area 3	Annandale (Railway Parade) Railway Bridge	Railway Parade, Annandale	Steel structure
Area 3	Annandale (Johnston Street) Underbridge	Johnston Street, Annandale	Steel structure
Area 3	Easton Park	Denison Street, Rozelle	n/a
Area 3	Sewage Pumping Station No 6 (SP0006)	Lilyfield Road, Rozelle	Brickwork
Area 3	White Bay Power Station	Victoria Road, Rozelle	Brickwork, steelwork, concrete
Area 5	Kerb and gutter	Chester Street, Camperdown	Stonework/concrete
Area 5	Warehouse, including interiors	52-54 Pyrmont Bridge Road, Camperdown	Brickwork
Area 5	Bridge Road School (former Camperdown Public School), including interiors	127 Parramatta Road, Camperdown	Stonework/brickwork
Area 5	Former Grace Bros Repository, including interiors	6-10 Mallett Street, Camperdown	Brickwork

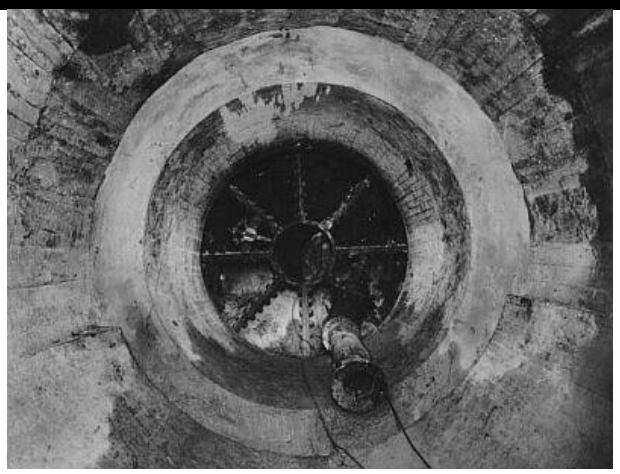
The noise and vibration assessment **Appendix J** (Technical working paper: Noise and vibration) of the EIS identifies listed heritage items only and represents a screening test applicable where a historic item is deemed to be sensitive to damage from vibration (following inspection) to be confirmed during detailed design.

No sensitive receivers (including heritage listed or potential heritage items) are located within the minimum working distances for road-headers during tunnelling works for the mainline tunnel alignment. The Construction Noise and Vibration Management Plan for the project would include relevant protocols for identifying and managing potential impacts to heritage items due to vibration intensive activities.

6.12 Detailed heritage impact assessment

Two listed heritage items are located in the vicinity of the mainline tunnels and have been assessed for potential heritage impacts. These are provided in **Table 6-46** and **Table 6-47** below.

Table 6-46 Heritage impact assessment for heritage item

Name	Pressure Tunnel and Shafts	
Address	Potts Hill Road to Waterloo Pumping Station Potts Hill to Waterloo, NSW	
Significance	State – State Heritage Register (#01630) and Sydney Water S170 (#4570942)	
Description	The pressure tunnel's maximum grade is 1 in 100, and its minimum is 1 in 2000. Its total length is approximately 16 kilometres. The pipes are lined with sand-cement mortar and the space between the liners and walls of the tunnel is filled with concrete to support the liner against deformation from internal pressures and as a protection against corrosion. Shafts were constructed along the Pressure Tunnel. The shaft structures or Pressure Tunnel buildings provide for access to each of the shafts and internal components. The shafts are metal lined and there are 11 Pressure Tunnel buildings, the first located at Potts Hill and the final one being the central workshops. The bitumen lining was replaced cement lining between 1961 and 1963.	
Curtilage	The curtilage of the Pressure Tunnel is to be taken as a distance of three metres around the existing infrastructure. The curtilage shaft buildings are defined by the property boundaries.	
Statement of Significance	The Pressure Tunnel is of high historical and technical significance as it represents a successful engineering response to the difficulties of increasing the volume of water from the Potts Hill Reservoir to the Pumping Station at Waterloo, a historically critical link in the water supply of Sydney. It is the third largest pressure tunnel in the world, representing a significant achievement in the provision of a dependable water supply by the Government and Water Board during the inter-war period.	
Heritage Impact Assessment	The heritage impact assessment is based on advice and assessment undertaken by AECOM's design team which is summarised as: *The M4-M5 mainline carriageway tunnels are expected to pass over the Sydney Water Pressure Tunnel.* *Based on the available information, a modelling study has demonstrated that the pressure tunnel is indicated to heave by 2mm and deflect by 1:5000.* *If the movement and deflection is transferred to the steel liner that form the pressure tunnel, these movement values are not expected to adversely affect the function of the Sydney Water tunnel and therefore should be acceptable to Sydney Water.* *Based on the results of the modelling, the pressure tunnel will experience minimal movement due to the excavation of the M4-M5 Link tunnels.* Further, **Appendix J** (Technical working paper: Noise and vibration) of the EIS includes a vibration assessment of the Sydney Water Pressure Tunnel and the Sydney Water City Tunnel with regard to vibration guideline values (DIN 4150 Guidelines). The assessment concluded that due to the proposed minimum distances between the Sydney Water pressure tunnel and the works (11 metre minimum offset	

Name	Pressure Tunnel and Shafts
	distance), adverse impacts from the effects of direct vibration is deemed unlikely. Therefore, the heritage assessment concludes that the tunnelling works for the M4-M5 Link project should not directly impact on the pressure tunnel.
Impact Type	Nil
Impact Ranking	Neutral

Table 6-47 Heritage impact assessment for heritage item

Name	City Tunnel	
Address	Potts Hill Reservoir to Dowling St Pumping Station Potts Hill to Waterloo, NSW	
Significance	Local – Sydney Water S170 (#4574202)	
Description	The tunnel begins at Potts Hill and passes under Chullora, Bankstown, Enfield, Canterbury, Ashfield, Petersham, Marrickville, Erskineville and Waterloo at depths varying between 15 and 67 metres. There are cross connections between the City Tunnel and the Pressure Tunnel. The tunnel is 2400mm and 3100mm in height, steel lined and 14 km in length. The City Tunnel was constructed by digging a tunnel, laying fully joint welded steel pipes, with the annular spaced filled with blue metal concrete. The pipes were internally cement lined during manufacture. It represented the latest in tunnelling technology of the time. The physical curtilage of the City Tunnel is to be taken as a distance of three metres around the existing infrastructure. The infrastructure associated with this item includes the tunnel, vertical shafts and the buildings attached to the shafts.	
Curtilage	The physical and operational curtilage is limited to the tunnel and any access chambers and supporting or associated structures from its original construction. The physical curtilage of the City Tunnel is to be taken as a distance of three metres around the existing infrastructure. The infrastructure associated with this item includes the tunnel, vertical shafts and the buildings attached to the shafts.	
Statement of Significance	The City Tunnel in its function largely is a duplicate of the Pressure Tunnel. It supplies water from Potts Hill to the city. The need for an additional pipeline was recognised in the early 1940s and it has been used in conjunction with the original Pressure Tunnel. The City Tunnel has made maintenance of the supply easier due to Sydney Water's ability to close sections of either tunnel for inspection and maintenance. It has increased the supply of water to the eastern and southern suburbs of Sydney. The City Tunnel has little cultural landscape value as it is located entirely below ground. The physical and operational curtilage is limited to the tunnel and any access chambers and supporting or associated structures from its original construction. The physical curtilage of the City Tunnel is to be taken as a distance of 3 m around the existing infrastructure. The infrastructure associated with this item includes the tunnel, vertical shafts and the buildings attached to the shafts.	
Heritage Impact Assessment	The heritage impact assessment is based on advice and assessment undertaken by AECOM's design team which is summarised as: *The M4-M5 mainline carriageway tunnels are expected to pass under the Sydney Water City Tunnel.* *Based on the available information, a modelling study has demonstrated that the city tunnel is indicated to settle by 4.5mm and deflect by 1:4500.* *If the movement and deflection is transferred to the steel liner that form the city tunnel, these movement values are not expected to adversely affect the function of the Sydney Water tunnel and therefore should be acceptable to Sydney Water.*	

Name	City Tunnel
	Based on the results of the modelling, the pressure tunnel will experience minimal movement due to the excavation of the M4-M5 Link tunnels. Further, **Appendix J** (Technical working paper: Noise and vibration) of the EIS includes a vibration assessment of the Sydney Water Pressure Tunnel and the Sydney Water City Tunnel with regard to vibration guideline values (DIN 4150 Guidelines). The assessment concluded that due to the proposed minimum distances between the Sydney Water pressure tunnel and the works, adverse impacts from the effects of direct vibration is deemed unlikely. Therefore, the heritage assessment concludes that the tunnelling works for the M4-M5 Link project should not directly impact on the city tunnel.
Impact Type	Nil
Impact Ranking	Neutral

6.13 Ground movement

Ground movement may occur in some areas along the tunnel alignment induced by tunnel excavation. The ground movement anticipated is predominantly settlement, which is downward (also termed subsidence). Upward movement may also occur and is known as heave.

There are two causes of ground movement. They are:

- Tunnel excavation induced ground movement, which is the movement of the soil and rock into the tunnel excavation. This is a short term effect, which happens as soon as the tunnel is excavated and can cause heave and/or settlement
- Soil consolidation (soil shrinkage), which is the dissipation of water from the soil as the groundwater draws down, such as due to inflow into underlying tunnels. This is a longer term effect, which may take some time to occur and causes settlement only.

Areas most likely to be affected by settlement are usually where tunnelling is closest to the ground surface (shallowest), around the tunnel portals and entry and exit ramps, and where soils are more likely to be compressible and thus have more voids which can compress. This would include the estuarine and alluvial soils and fill within the palaeochannel underneath the Rozelle Rail Yards.

An assessment has been carried out that indicates that settlement would be less than 20 millimetres over the majority of the tunnel alignment and in the range of 20 millimetres to 35 millimetres in some locations in the vicinity of the Rozelle interchange and at Lord Street in Newtown close to St Peters railway station.

Strict limits on the degree of settlement permitted would be imposed on the project. Surveys of building condition would be undertaken in the zone of tunnel influence prior to construction and a settlement monitoring plan developed for construction and operation.

6.14 Other heritage items and HCAs along the route

The following figures (**Figure 6-13** to **Figure 6-20**) illustrate the listed heritage items and conservation areas listed on local, State and S170 Registers located within a 100 metres buffer of the project tunnelling alignment. Potential for vibration associated with tunnelling has been described in **section 6.11**, and settlement impacts for the project have been identified a negligible as described in **section 6.13.** Based on these assessments, **Table 6-48** contains details of those heritage items and HCAs located above and directly intersecting with the project tunnelling alignment only. These items have generally been collated along the route moving from Haberfield to St Peters via Rozelle.

Table 6-48 Heritage items and HCAs on local, State and S170 Registers

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
Haberfield HCA	Haberfield	Local	Ashfield LEP 2013 C42	All depths	Refer to detailed impact assessment in **Chapter 6**	
Pioneers Memorial Park	217–219 Norton Street, Leichhardt	Local	Leichhardt LEP 2013 #I683	35m to 65m below ground	Unlikely to be impacted	Neutral
Whites Creek Aqueduct	Piper Street, Leichhardt	State	SHR (#01354) Sydney Water S170 (#4570954)	35m to 65m below ground	Unlikely to be impacted	Neutral
Street trees – Brush Box plantation	Leys Avenue, Leichhardt	Local	Leichhardt LEP 2013 #I660	10m to 35m below ground	Potential settlement and vibration	Neutral
Corner shop and residence – including interiors	42 Emma Street, Leichhardt	Local	Leichhardt LEP 2013 #I653	35m to 65m below ground	Unlikely to be impacted	Neutral
Leichhardt Street/Stanley Street HCA		Local	Leichhardt LEP 2013 C11	35m to 65m below ground	Unlikely to be impacted	Neutral
Street trees – row of Port Jackson Figs	Catherine Street, Leichhardt	Local	Leichhardt LEP 2013 #I638	35m to 65m below ground	Unlikely to be impacted	Neutral
Scarvell Estate HCA		Local	Leichhardt LEP 2013 C12	35m to 65m below ground	Unlikely to be impacted	Neutral
House – including	5 Coulon Street,	Local	Leichhardt LEP 2013 #I733	Greater than 65m	Unlikely to be	Neutral

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
interiors	Rozelle			below ground	impacted	
House – including interiors	7 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I734	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	9 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I735	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	11 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I736	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	13 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I737	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	15 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I738	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	17 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I739	Greater than 65m below ground	Unlikely to be impacted	Neutral
House – including interiors	21 Coulon Street, Rozelle	Local	Leichhardt LEP 2013 #I740	Greater than 65m below ground	Unlikely to be impacted	Neutral
St Thomas' Church group including interiors	668 Darling Street, Rozelle	Local	Leichhardt LEP 2013 #I745	35m to 65m below ground	Unlikely to be impacted	Neutral
Stone building – including interiors	75 Evans Street, Rozelle	Local	Leichhardt LEP 2013 #I758	35m to 65m below ground	Unlikely to be impacted	Neutral
Semi-detached house – including interiors	77 Evans Street, Rozelle	Local	Leichhardt LEP 2013 #I759	35m to 65m below ground	Unlikely to be impacted	Neutral
Semi-detached house – including interiors	79 Evans Street, Rozelle	Local	Leichhardt LEP 2013 #I760	35m to 65m below ground	Unlikely to be impacted	Neutral
Terrace – including interiors	101 Evans Street, Rozelle	Local	Leichhardt LEP 2013 #I762	35m to 65m below ground	Unlikely to be impacted	Neutral

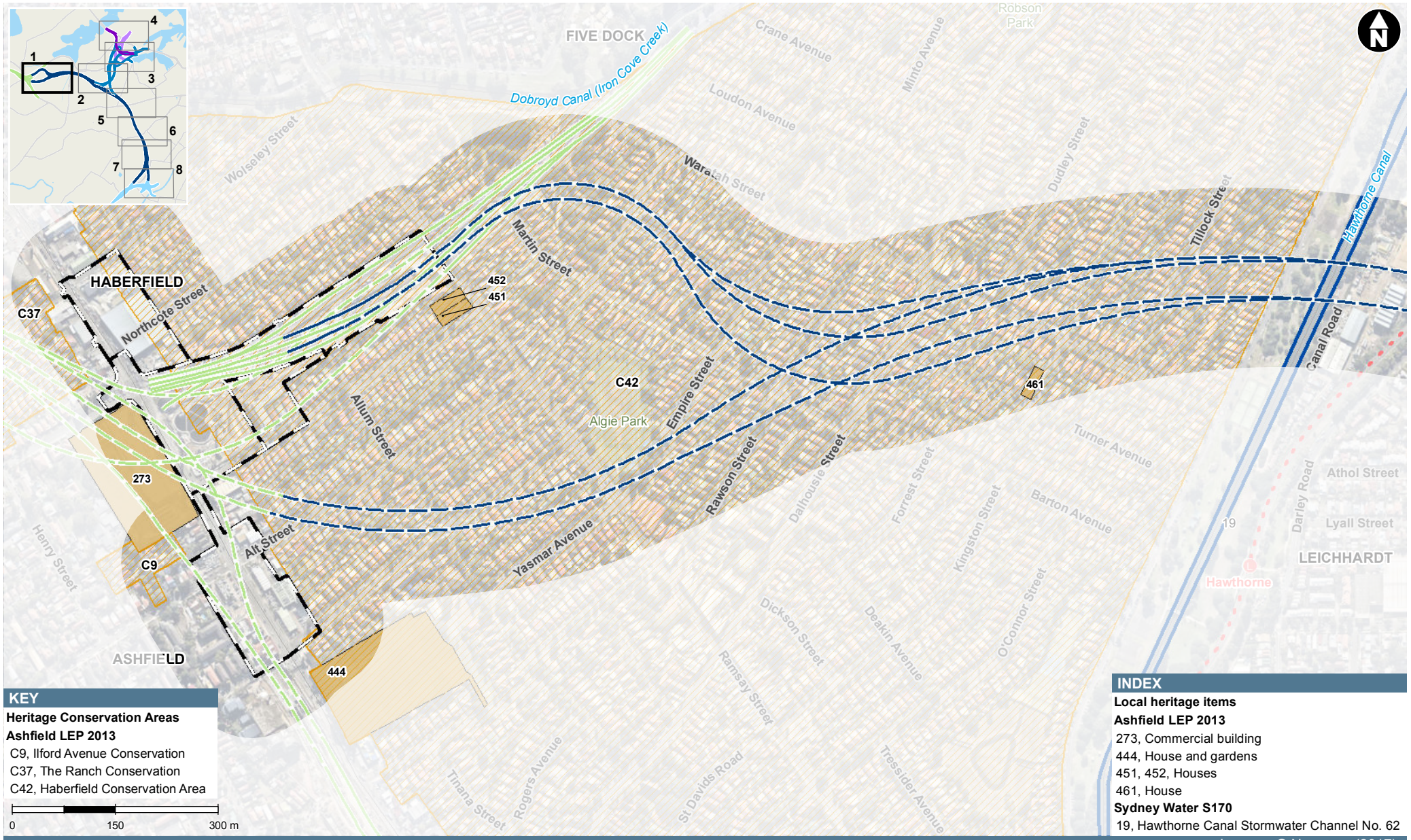
Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
Terrace – including interiors	103 Evans Street, Rozelle	Local	Leichhardt LEP 2013 #I763	35m to 65m below ground	Unlikely to be impacted	Neutral
Former Mechanics Institute – including interiors	114 Victoria Road, Rozelle	Local	Leichhardt LEP 2013 #I806	35m to greater than 65m below ground	Unlikely to be impacted	Neutral
Former tramway stables and substation garage – including interiors	10A Hancock Street, Rozelle	Local	Leichhardt LEP 2013 #I770	35m to greater than 65m below ground	Unlikely to be impacted	Neutral
Single storey shops – including interiors	731–735 Darling Street, Rozelle	Local	Leichhardt LEP 2013 #I748	35m to 65m below ground	Unlikely to be impacted	Neutral
Single storey commercial building – including interiors	736 Darling Street, Rozelle	Local	Leichhardt LEP 2013 #I749	35m to 65m below ground	Unlikely to be impacted	Neutral
Corner building – including interiors	22 Belmore Street, Rozelle	Local	Leichhardt LEP 2013 #I729	Greater than 65m below ground	Unlikely to be impacted	Neutral
Semi-detached house – including interiors	122 Foucart Street, Rozelle	Local	Leichhardt LEP 2013 #I766	35m to 65m below ground	Unlikely to be impacted	Neutral
Semi-detached house – including interiors	120A Foucart Street, Rozelle	Local	Leichhardt LEP 2013 #I767	35m to 65m below ground	Unlikely to be impacted	Neutral
Easton Park HCA		Local	Leichhardt LEP 2013 C18	Ground to 65m below ground	Refer to detailed impact assessment in **Chapter 6**	
Easton Park	Denison Street, Rozelle	Local	Leichhardt LEP 2013 #I752	Ground to 65m below ground	Refer to detailed impact assessment in **Chapter 6**	
Sewage Pumping Station No 6 (SP0006)	Lilyfield Road, Rozelle	Local	Sydney Water S170 # 4571704	Ground to 65m below ground	Refer to detailed impact assessment in **Chapter 6**	

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
Semi-detached house – including interiors	15 Burt Street, Rozelle	Local	Leichhardt LEP 2013 #I730	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Semi-detached house, including interiors	17 Burt Street, Rozelle	Local	Leichhardt LEP 2013 #I731	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Smith's Hall including interiors	56 Burt Street, Rozelle	Local	Leichhardt LEP 2013 #I732	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Corner shop and residence – including interiors	67 Denison Street, Rozelle	Local	Leichhardt LEP 2013 #I753	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Shop and residence including interiors	69 Denison Street, Rozelle	Local	Leichhardt LEP 2013 #I754	10m to 35m below ground	Potential settlement and vibration	Minor adverse
House 'Rotherhithe Cottage' including interiors	73 Denison Street, Rozelle	Local	Leichhardt LEP 2013 #I755	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Cottage and former broom factory including interiors	84 Foucart Street, Rozelle	Local	Leichhardt LEP 2013 #I765,	35m to 65m below ground	Unlikely to be impacted	Neutral
Brennan's Estate HCA		Local	Leichhardt LEP 2013 C16	10m to greater than 65m below ground	Refer to detailed impact assessment in **Chapter 6**	
Former shop and residence including interiors	62 Ryan Street, Lilyfield	Local	Leichhardt LEP 2013 #I723	Great than 65m below ground	Unlikely to be impacted	Neutral
Lilyfield (Catherine St) Overbridge	Catherine Street, Lilyfield		RailCorp S170 #4800245 SREP 26 #12	10m to 35m below ground	Potential settlement and vibration	Minor adverse
Street trees	Annandale Street,	Local	Leichhardt LEP 2013 #I9	10m to 65m below	Potential settlement	Neutral

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
	Annandale			ground	and vibration	
Street trees-Brush Box	Johnston Street, Annandale	Local	Leichhardt LEP 2013 #I66	35m to 65m below ground	Unlikely to be impacted	Neutral
Annandale Public School – including interiors	25 Johnston Street, Annandale	Local	Leichhardt LEP 2013 #I34	35m to 65m below ground	Unlikely to be impacted	Neutral
Annandale House gates	25 Johnston Street, Annandale	Local	Leichhardt LEP 2013 #I35	35m to 65m below ground	Unlikely to be impacted	Neutral
'Norton House' – including interiors	33 Johnston Street, Annandale	Local	Leichhardt LEP 2013 #I36	35m to 65m below ground	Unlikely to be impacted	Neutral
Annandale HCA		Local	Leichhardt LEP 2013 C1	10m to 65m below ground	Potential settlement and vibration	Neutral
Cardigan Street Conservation Area		Local	Marrickville LEP 2011 C8	10m to 35m below ground	Potential settlement and vibration	Neutral
Corner shop – including interiors	88 Chelmsford Street, Newtown	Local	Marrickville LEP 2011 #I141	35m to 65m below ground	Unlikely to be impacted	Neutral
Victorian Georgian house and stables – including interiors	38 and 54 Albermarle Street, Newtown	Local	Marrickville LEP 2011 #I130	35m to 65m below ground	Unlikely to be impacted	Neutral
Group of Victorian Style Terraces – including interiors	92–98 Chelmsford Street, Newtown	Local	Marrickville LEP 2011 #I142	35m to 65m below ground	Unlikely to be impacted	Neutral
Former electricity substation	134 Lennox Street, Newtown	Local	Marrickville LEP 2011 #I163	35m to 65m below ground	Unlikely to be impacted	Neutral
St Joseph's Boys School – including	93 Chelmsford Street, Newtown	Local	Marrickville LEP 2011 #I309	35m to 65m below ground	Unlikely to be impacted	Neutral

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
interiors						
Bedford Street Retail Group – including interiors	15, 27 and 37 Bedford Street and 167 Probert Street, Newtown	Local	Marrickville LEP 2011 #I138	35m to 65m below ground	Unlikely to be impacted	Neutral
North Kingston Estate		Local	Marrickville LEP 2011 C11	35m to 65m below ground	Unlikely to be impacted	Neutral
Pressure Tunnel and Shafts	Potts Hill Road to Waterloo Pumping Station Potts Hill to Waterloo	State	SHR #01630 Sydney Water S170 4570942	35m to 65m below ground	Refer to detailed impact assessment in **section 6.12**	
Community building 'St George's Hall' (352 King Street) including interior	344–358 King Street, Newtown	Local	Sydney LEP 2012 #I1014,	35m to 65m below ground	Unlikely to be impacted	Neutral
Saints Constantine and Helen Greek Orthodox Church including buildings and their interiors, front fence and grounds	366–378 King Street, Newtown	Local	Sydney LEP 2012 #I1015,	35m to 65m below ground	Unlikely to be impacted	Neutral
Service station 'Rising Sun' (426 King Street) including interior and front forecourt	424–430 King Street, Newtown	Local	Sydney LEP 2012 #I1016,	35m to 65m below ground	Unlikely to be impacted	Neutral
Commercial building including interior	482–496 King Street, Newtown	Local	Sydney LEP 2012 #I1017	35m to 65m below ground	Unlikely to be impacted	Neutral
Commercial building including interior	522–524A King Street, Newtown	Local	Sydney LEP 2012 #I1018	35m to 65m below ground	Unlikely to be impacted	Neutral

Item Name	Address	Significance	Listing	Depth	Impact Type	Impact Ranking
City Tunnel	Potts Hill Reservoir to Dowling St Pumping Station	Local	Sydney Water S170 # 4574202	35m to 65m below ground	Refer to detailed impact assessment in **section 6.12**	
Formerly 'Molloys' shop – including interiors	539 King Street, Newtown	Local	Marrickville LEP 2011 #I156	35m to 65m below ground	Unlikely to be impacted	Neutral
Shop counters – including interiors	555 King Street, Newtown	Local	Marrickville LEP 2011 #I157	35m to 65m below ground	Unlikely to be impacted	Neutral
Holmwood Estate		Local	Marrickville LEP 2011 C15	35m to 65m below ground	Unlikely to be impacted	Neutral
Newtown/Erskineville	King Street	Local	Sydney LEP 2012 C47	35m to 65m below ground	Unlikely to be impacted	Neutral
King Street and Enmore Road		Local	Marrickville LEP 2011 C2	35m to 65m below ground	Unlikely to be impacted	Neutral
St Peters Railway Station Group – including interiors	King Street, St Peters	State	SHR #5012222 Marrickville LEP 2011 #I272	10m to 35m below ground 35m to 65m below ground	Potential settlement and vibration	Minor adverse
St Peters Public School – including interiors	93A Church Street, St Peters	Local	Marrickville LEP 2011 #I271	35m to 65m below ground	Unlikely to be impacted	Neutral



KEY

Heritage Conservation Areas
Ashfield LEP 2013
C9, Ilford Avenue Conservation
C37, The Ranch Conservation
C42, Haberfield Conservation Area

INDEX

Local heritage items
Ashfield LEP 2013
273, Commercial building
444, House and gardens
451, 452, Houses
461, House
Sydney Water S170
19, Hawthorne Canal Stormwater Channel No. 62

LEGEND

Imagery © Nearmap (2017)

Existing features
Light rail
Light rail stop

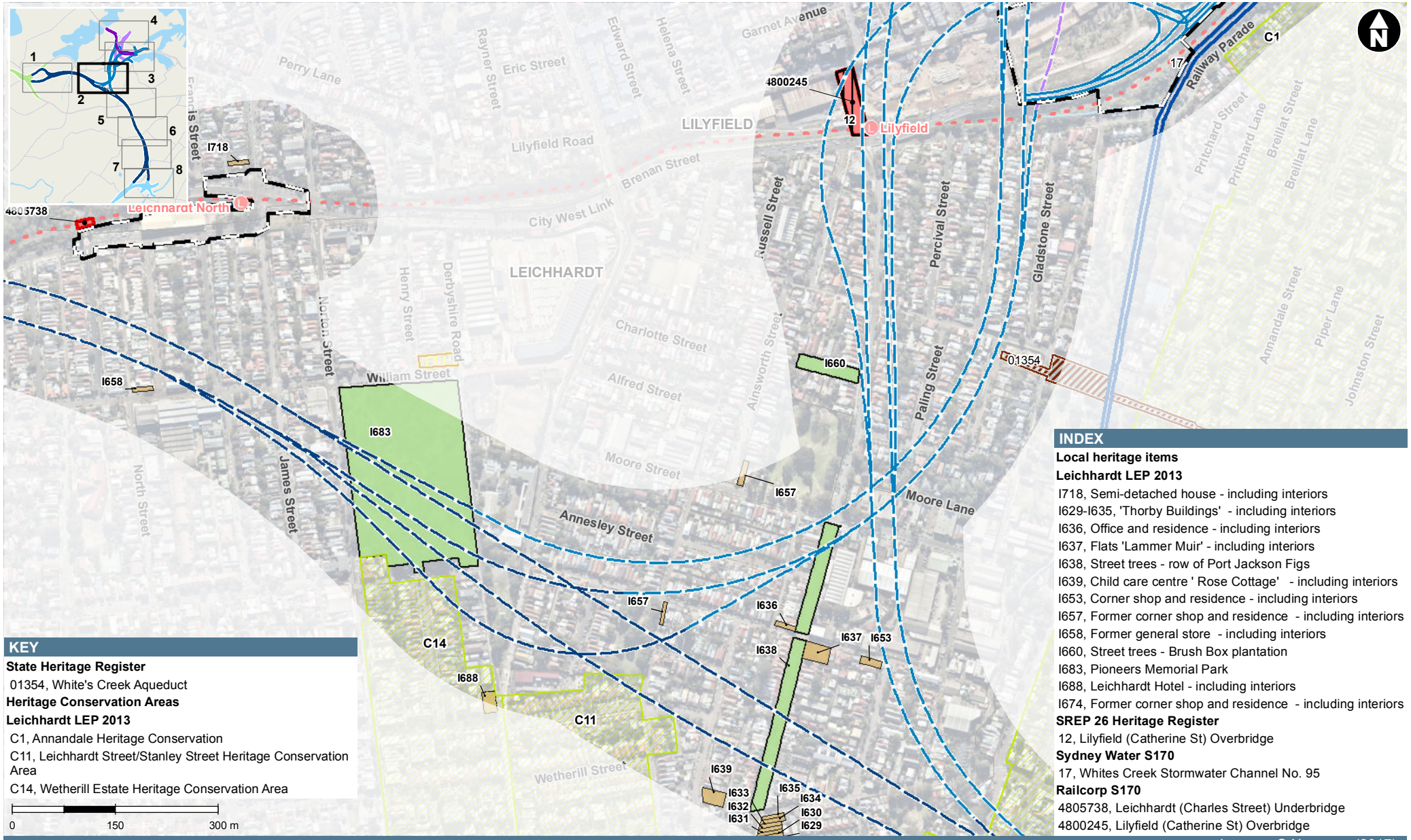
M4 East
Surface road
Tunnel

M4-M5 Link
Mainline tunnel
Surface road
Tunnel
Project footprint

Ashfield LEP 2013
Heritage Conservation Area
Heritage item

S170 Agency Heritage Register
S170 Sydney Water

Figure 6-13 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 1



KEY

State Heritage Register

01354, White's Creek Aqueduct

Heritage Conservation Areas

Leichhardt LEP 2013

C1, Annandale Heritage Conservation

C11, Leichhardt Street/Stanley Street Heritage Conservation Area

C14, Wetherill Estate Heritage Conservation Area

0 150 300 m

INDEX

Local heritage items

Leichhardt LEP 2013

I718, Semi-detached house - including interiors
I629-I635, 'Thorby Buildings' - including interiors
I636, Office and residence - including interiors
I637, Flats 'Lammer Muir' - including interiors
I638, Street trees - row of Port Jackson Figs
I639, Child care centre ' Rose Cottage' - including interiors
I653, Corner shop and residence - including interiors
I657, Former corner shop and residence - including interiors
I658, Former general store - including interiors
I660, Street trees - Brush Box plantation
I683, Pioneers Memorial Park
I688, Leichhardt Hotel - including interiors
I674, Former corner shop and residence - including interiors

SREP 26 Heritage Register

12, Lilyfield (Catherine St) Overbridge

Sydney Water S170

17, Whites Creek Stormwater Channel No. 95

Railcorp S170

4805738, Leichhardt (Charles Street) Underbridge
4800245, Lilyfield (Catherine St) Overbridge

LEGEND

Imagery © Nearmap (2017)

Existing features
- Light rail
- Light rail stop

M4-M5 Link

Mainline tunnel
- Tunnel

M4-M5 Link

Rozelle interchange
- Surface road
- Tunnel
- Project footprint

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

State Heritage Register
- Item

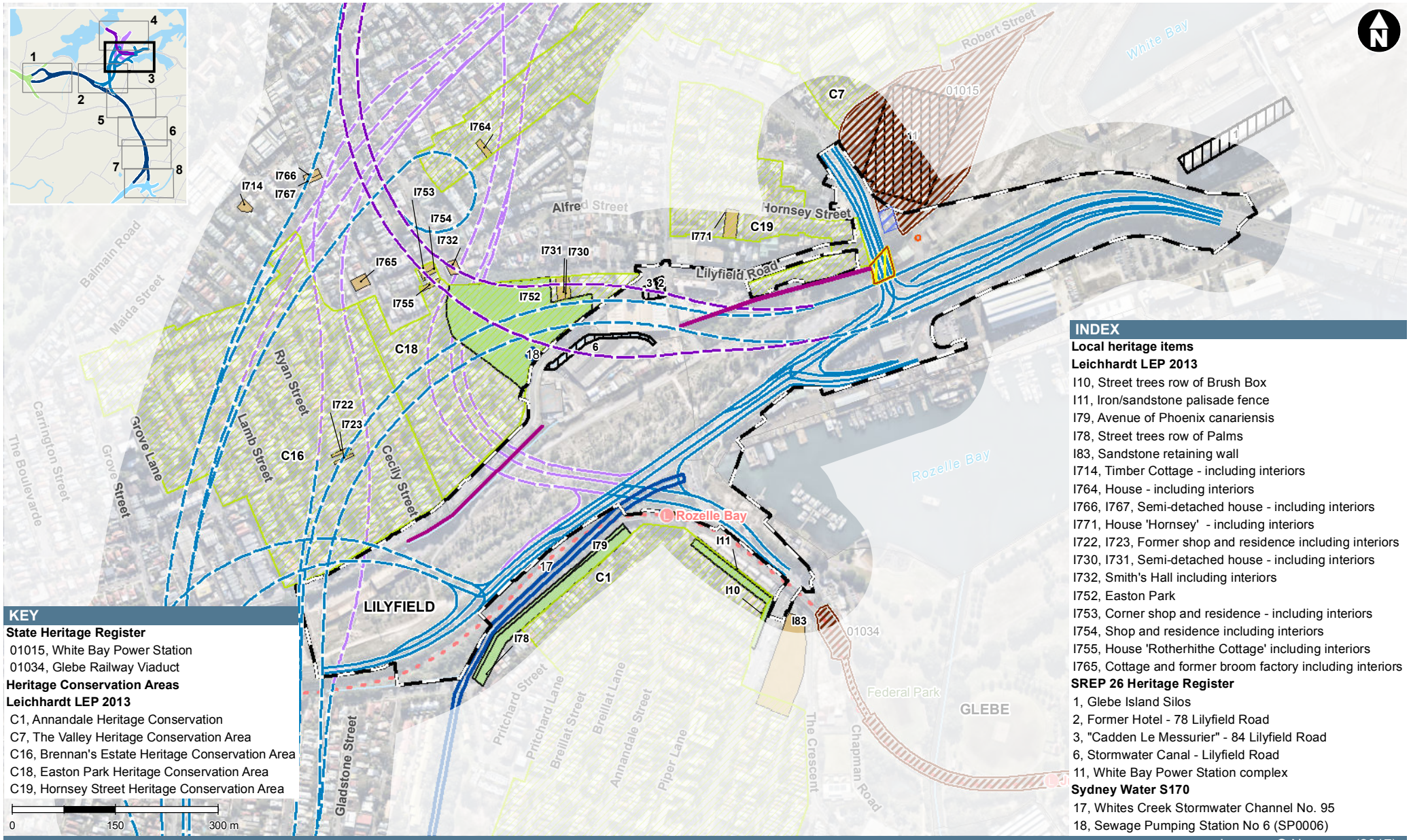
SREP 26 Heritage Register
- Item

Leichhardt LEP 2013
- Heritage Conservation Area
- Heritage item
- Landscape heritage item

S170 Agency Heritage Register
- S170 Sydney Water
- S170 RailCorp item

Potential heritage item
- Item

Figure 6-14 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 2



KEY

State Heritage Register

01015, White Bay Power Station

01034, Glebe Railway Viaduct

Heritage Conservation Areas

Leichhardt LEP 2013

C1, Annandale Heritage Conservation

C7, The Valley Heritage Conservation Area

C16, Brennan's Estate Heritage Conservation Area

C18, Easton Park Heritage Conservation Area

C19, Hornsey Street Heritage Conservation Area

INDEX

Local heritage items

Leichhardt LEP 2013

I10, Street trees row of Brush Box

I11, Iron/sandstone palisade fence

I79, Avenue of Phoenix canariensis

I78, Street trees row of Palms

I83, Sandstone retaining wall

I714, Timber Cottage - including interiors

I764, House - including interiors

I766, I767, Semi-detached house - including interiors

I771, House 'Hornsey' - including interiors

I722, I723, Former shop and residence including interiors

I730, I731, Semi-detached house - including interiors

I732, Smith's Hall including interiors

I752, Easton Park

I753, Corner shop and residence - including interiors

I754, Shop and residence including interiors

I755, House 'Rotherhithe Cottage' including interiors

I765, Cottage and former broom factory including interiors

SREP 26 Heritage Register

1, Glebe Island Silos

2, Former Hotel - 78 Lilyfield Road

3, "Cadden Le Messurier" - 84 Lilyfield Road

6, Stormwater Canal - Lilyfield Road

11, White Bay Power Station complex

Sydney Water S170

17, Whites Creek Stormwater Channel No. 95

18, Sewage Pumping Station No 6 (SP0006)

LEGEND

Imagery © Nearmap (2017)

Existing features

Light rail

Light rail stop

M4-M5 Link

Rozelle interchange

Surface road

Tunnel

Project footprint

Iron Cove Link

Tunnel

Proposed future WHTBL connections (civil construction only)

Surface road

Tunnel

State Heritage Register

Item

SREP 26 Heritage Register

Item

Leichhardt LEP 2013

Heritage Conservation Area

Heritage item

Landscape heritage item

S170 Agency Heritage Register

S170 Sydney Water

Potential heritage item

Item

Sandstone cutting

Item listed under the White Bay Power Station Conservation Management Plan (CMP)

Southern Penstock

Former White Bay Hotel Archaeology

Figure 6-15 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 3

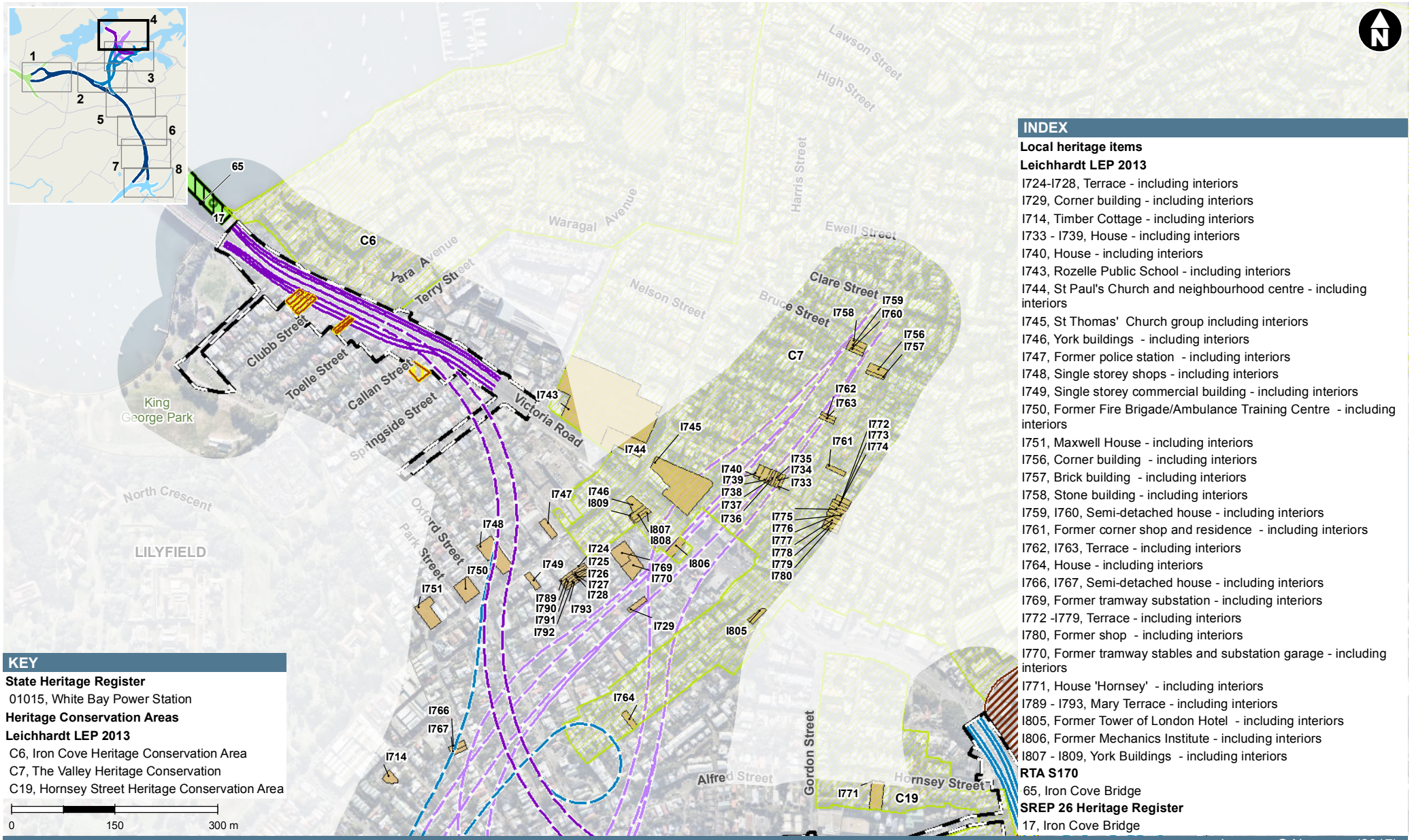
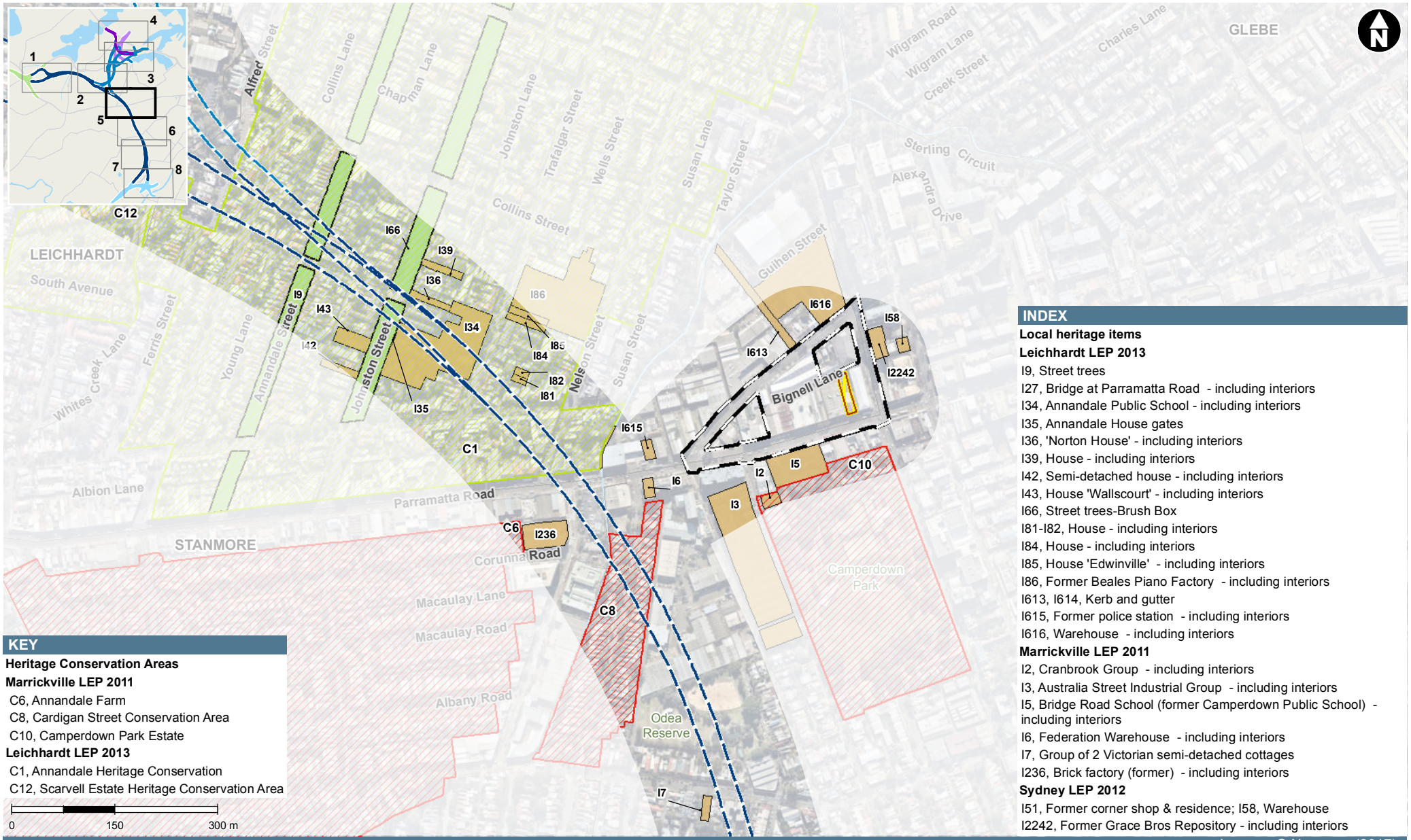


Figure 6-16 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 4



KEY

Heritage Conservation Areas

Marrickville LEP 2011

C6, Annandale Farm

C8, Cardigan Street Conservation Area

C10, Camperdown Park Estate

Leichhardt LEP 2013

C1, Annandale Heritage Conservation

C12, Scarvell Estate Heritage Conservation Area

INDEX

Local heritage items

Leichhardt LEP 2013

I9, Street trees

I27, Bridge at Parramatta Road - including interiors

I34, Annandale Public School - including interiors

I35, Annandale House gates

I36, 'Norton House' - including interiors

I39, House - including interiors

I42, Semi-detached house - including interiors

I43, House 'Wallscourt' - including interiors

I66, Street trees-Brush Box

I81-I82, House - including interiors

I84, House - including interiors

I85, House 'Edwinville' - including interiors

I86, Former Beales Piano Factory - including interiors

I613, I614, Kerb and gutter

I615, Former police station - including interiors

I616, Warehouse - including interiors

Marrickville LEP 2011

I2, Cranbrook Group - including interiors

I3, Australia Street Industrial Group - including interiors

I5, Bridge Road School (former Camperdown Public School) - including interiors

I6, Federation Warehouse - including interiors

I7, Group of 2 Victorian semi-detached cottages

I236, Brick factory (former) - including interiors

Sydney LEP 2012

I51, Former corner shop & residence; I58, Warehouse

I2242, Former Grace Bros Repository - including interiors

LEGEND

M4-M5 Link Mainline tunnel

Tunnel

M4-M5 Link Rozelle interchange

Tunnel

Project footprint

Leichhardt LEP 2013

Heritage Conservation Area

Marrickville LEP 2011

Heritage Conservation Area

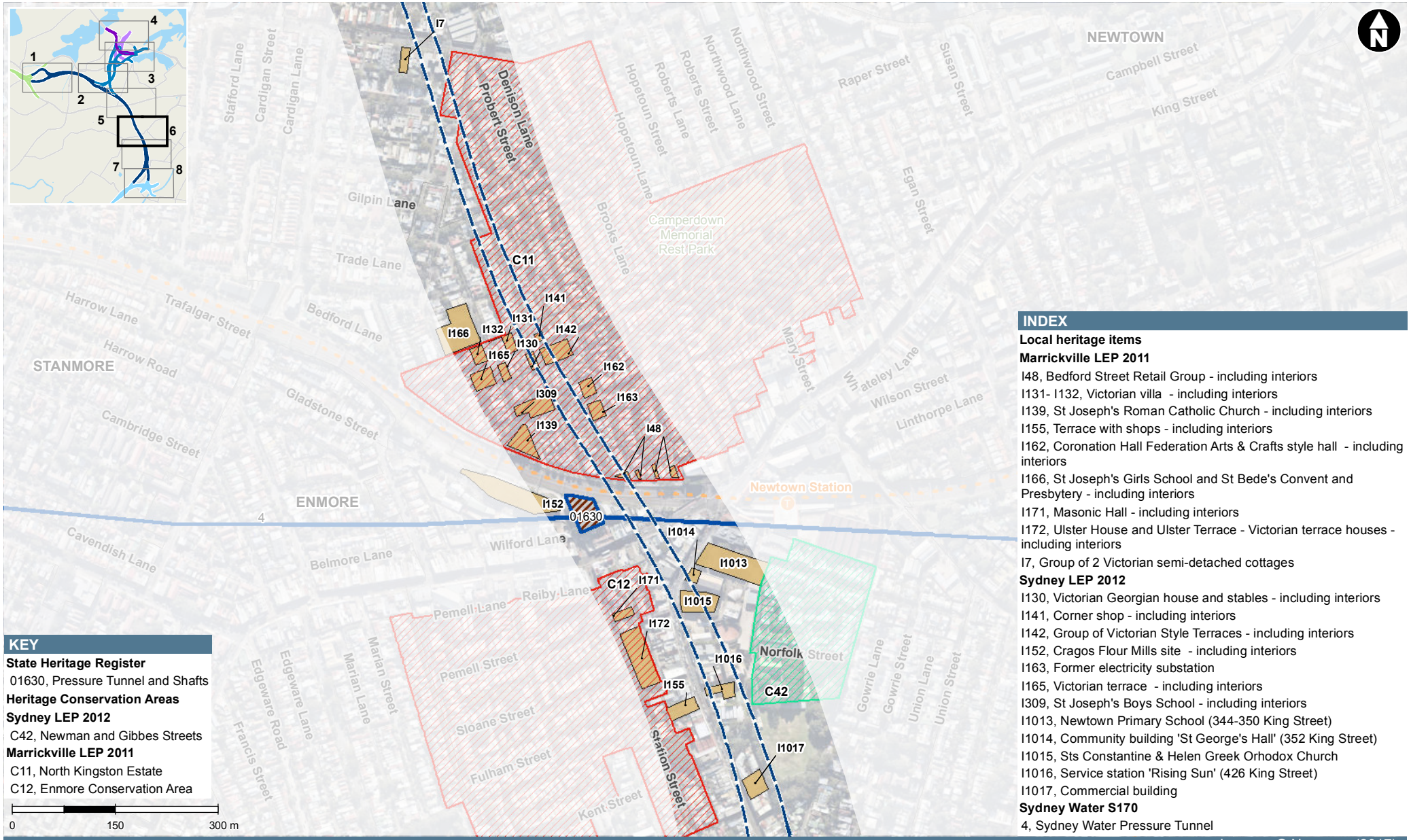
Heritage item

Landscape heritage item

Potential heritage item

Item

Figure 6-17 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 5



KEY

State Heritage Register

01630, Pressure Tunnel and Shafts

Heritage Conservation Areas

Sydney LEP 2012

C42, Newman and Gibbes Streets

Marrickville LEP 2011

C11, North Kingston Estate

C12, Enmore Conservation Area

INDEX

Local heritage items

Marrickville LEP 2011

I48, Bedford Street Retail Group - including interiors

I131- I132, Victorian villa - including interiors

I139, St Joseph's Roman Catholic Church - including interiors

I155, Terrace with shops - including interiors

I162, Coronation Hall Federation Arts & Crafts style hall - including interiors

I166, St Joseph's Girls School and St Bede's Convent and Presbytery - including interiors

I171, Masonic Hall - including interiors

I172, Ulster House and Ulster Terrace - Victorian terrace houses - including interiors

I7, Group of 2 Victorian semi-detached cottages

Sydney LEP 2012

I130, Victorian Georgian house and stables - including interiors

I141, Corner shop - including interiors

I142, Group of Victorian Style Terraces - including interiors

I152, Cragos Flour Mills site - including interiors

I163, Former electricity substation

I165, Victorian terrace - including interiors

I309, St Joseph's Boys School - including interiors

I1013, Newtown Primary School (344-350 King Street)

I1014, Community building 'St George's Hall' (352 King Street)

I1015, Sts Constantine & Helen Greek Orhodox Church

I1016, Service station 'Rising Sun' (426 King Street)

I1017, Commercial building

Sydney Water S170

4, Sydney Water Pressure Tunnel

Imagery © Nearmap (2017)

LEGEND

Existing features
- Railway
- Railway station

M4-M5 Link
- **Mainline tunnel**
- Tunnel

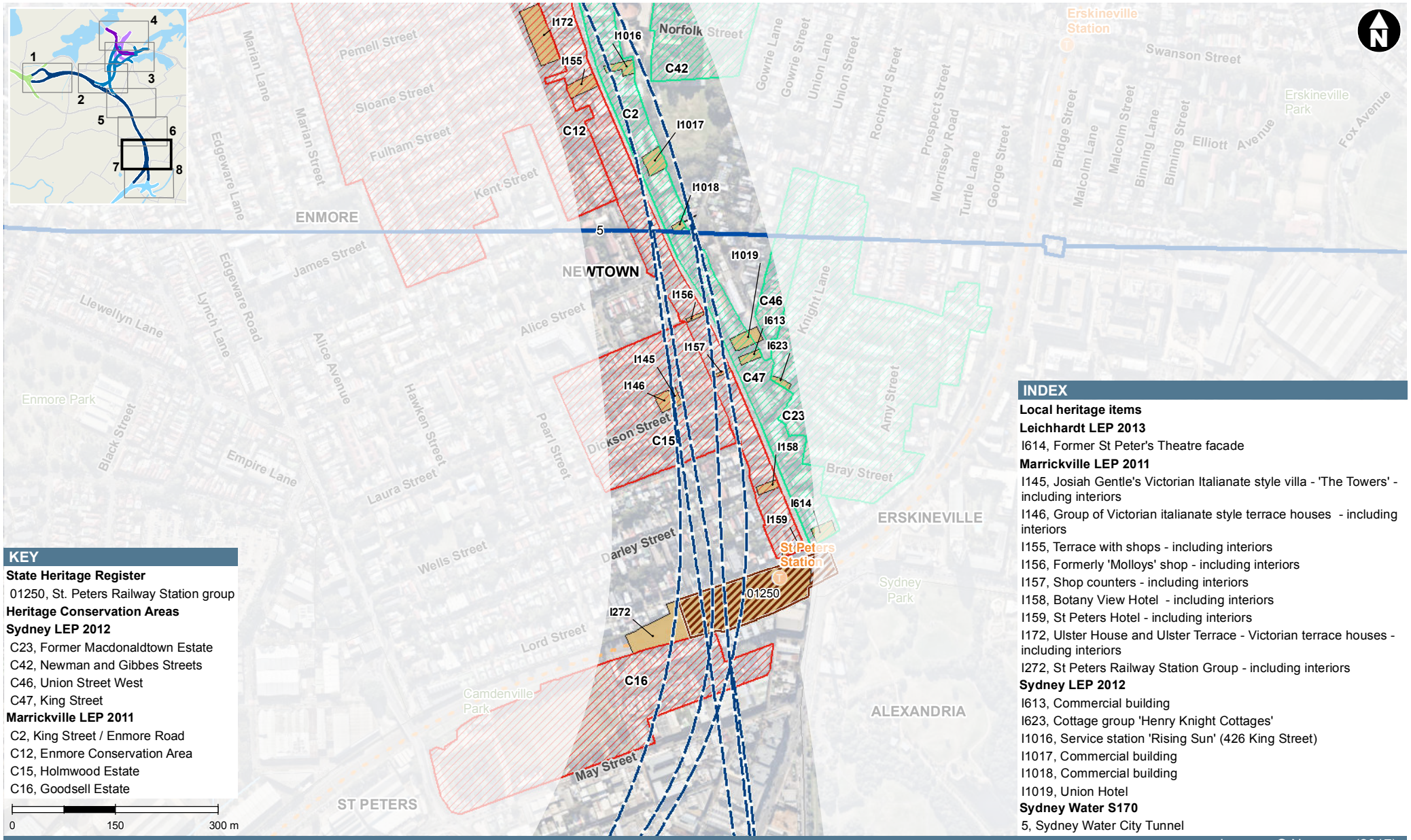
State Heritage Register
- Item

Marrickville LEP 2011
- Heritage Conservation Area

Sydney LEP 2012
- Heritage Conservation Area
- Heritage item

S170 Agency Heritage Register
- S170 Sydney Water

Figure 6-18 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 6



KEY

State Heritage Register

01250, St. Peters Railway Station group

Heritage Conservation Areas

Sydney LEP 2012

C23, Former Macdonaldtown Estate
C42, Newman and Gibbes Streets
C46, Union Street West
C47, King Street

Marrickville LEP 2011

C2, King Street / Enmore Road
C12, Enmore Conservation Area
C15, Holmwood Estate
C16, Goodsell Estate

INDEX

Local heritage items

Leichhardt LEP 2013

I614, Former St Peter's Theatre facade

Marrickville LEP 2011

I145, Josiah Gentle's Victorian Italianate style villa - 'The Towers' - including interiors
I146, Group of Victorian italianate style terrace houses - including interiors
I155, Terrace with shops - including interiors
I156, Formerly 'Molloys' shop - including interiors
I157, Shop counters - including interiors
I158, Botany View Hotel - including interiors
I159, St Peters Hotel - including interiors
I172, Ulster House and Ulster Terrace - Victorian terrace houses - including interiors
I272, St Peters Railway Station Group - including interiors

Sydney LEP 2012

I613, Commercial building
I623, Cottage group 'Henry Knight Cottages'
I1016, Service station 'Rising Sun' (426 King Street)
I1017, Commercial building
I1018, Commercial building
I1019, Union Hotel

Sydney Water S170

5, Sydney Water City Tunnel

LEGEND

Imagery © Nearmap (2017)

Existing features
Railway
Railway station

M4-M5 Link
Mainline tunnel
Tunnel

State Heritage Register
Item

Marrickville LEP 2011
Heritage Conservation Area

Sydney LEP 2012
Heritage Conservation Area
Heritage item

S170 Agency Heritage Register
S170 Sydney Water

Figure 6-19 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 7

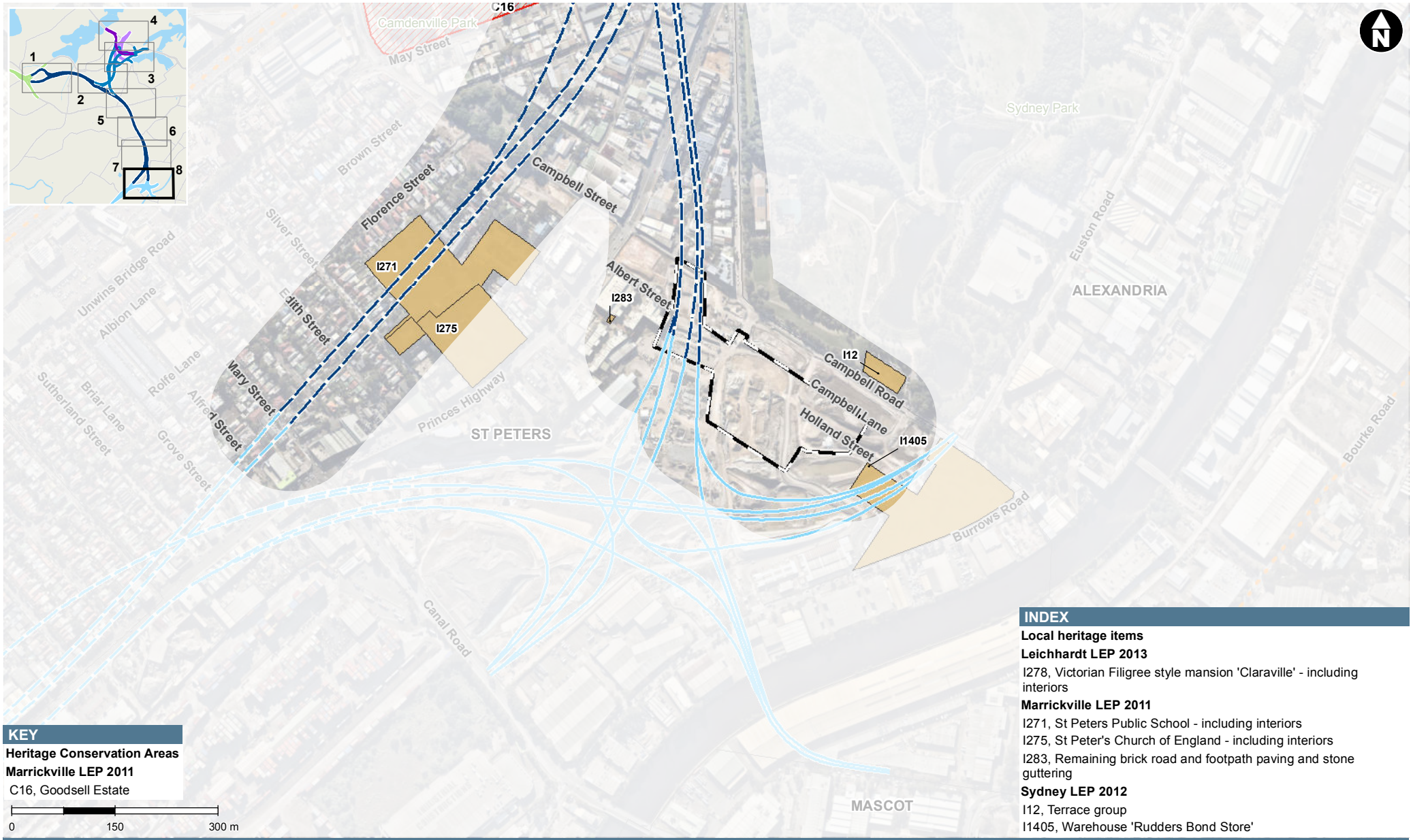


Figure 6-20 Statutory heritage listings for heritage items and conservation areas located above the tunnel alignment – Map 8

7 Assessment of cumulative impacts

7.1 Introduction

The M4-M5 Link project is part of the WestConnex program of works which, as a whole, has resulted in wide reaching impacts on the urban fabric of greater metropolitan Sydney, including on items and areas of heritage significance. A review of each WestConnex project's heritage impacts has been carried out and an assessment of the overlaps undertaken to determine the overall impacts of the WestConnex projects to date.

Other major infrastructure projects such as CBD and South East Light Rail and Sydney Metro City and Southwest Metro overlap with the project at Lilyfield and St Peters. Therefore, this assessment also considers the whole WestConnex project in the context of other current or planned infrastructure projects across Sydney. Proposed future projects that interface with the M4-M5 Link, including the Western Harbour Tunnel and Beaches Link and the Sydney Gateway projects are subject to separate environmental assessments and are not included in the assessment below.

The following section provides a summary of the approved projects that comprise the WestConnex program of works and separate interfacing projects which are considered to be relevant to understanding and assessing the cumulative heritage impacts of the project as a whole (including the Rozelle Rail Yards site management works). The summaries below include an explanation of the heritage assessments undertaken for each project, the residual heritage impacts and any mitigation or legacy measures that have been employed. Each project's timing and geographical relationship to M4-M5 Link are also explained.

7.2 WestConnex projects

7.2.1 New M5

The New M5 comprises a new, multi-lane road link between the existing M5 East motorway east of King Georges Road and St Peters. The project will also include an interchange at St Peters and connections to the existing road network. The New M5 precedes the M4-M5 Link and is currently under construction. The project will overlap with the M4-M5 Link at the St Peters interchange and these two projects share the same civil and tunnel site at Campbell Road.

The New M5 was assessed for State and local non-Aboriginal landscape and built heritage as well as historic archaeology. The project directly and/or indirectly impacted 58 heritage items, with major adverse impacts brought about by the demolition of three heritage items; being the Rudders Bond Store, the terrace group at 28-44 Campbell Street and a house at 82 Campbell Street. Extensive mitigation measures were identified including the development of heritage interpretation plans, monitoring, archival recording, as well as salvage and reuse of architectural elements and original features where possible. Minimal impacts to historic archaeology were recorded.

Overall, the heritage impact of the New M5 project was found to be moderate.

For the area of overlap between the New M5 and the M4-M5 Link projects, no additional property acquisitions or demolitions would be required, and owing to the physical separation and the existing and proposed intermediary buildings/structures/landscaping between the motorway operations complex (including a new ventilation facility and outlet) and the heritage items in the vicinity (ie terrace group on Campbell Road and brick road and stone guttering on Victoria Street), negligible indirect visual setting impacts would be encountered.

7.2.2 King Georges Road Interchange Upgrade

Construction was completed on the WestConnex King Georges Road Interchange Upgrade in December 2016. The upgrade included the installation of a new interchange at ground level in preparation for the New M5 and resulted in significant alteration to this area/streetscape. The EIS for the King Georges Road Interchange Upgrade found that there would be no direct heritage impacts as a result of the project.

7.2.3 M4 Widening

WestConnex M4 Widening construction was completed in mid-2017. Works comprised the creation of an additional lane in each direction between Homebush and Parramatta. These works have only a proximal spatial relationship with the M4-M5 Link being located approximately 3.5km from the Wattle Street interchange.

The M4 Widening project was assessed for impacts on non-Aboriginal built and landscape heritage and historic archaeology. 22 heritage listed items were identified in the immediate vicinity, including two items listed on the State Heritage Register however, none were physically or visually impacted by the project. Only potential vibration impacts to these items were recorded. The potential for the works to have impacts on intact non-Aboriginal archaeological resources was deemed minimal.

The report identified scope to mitigate any indirect heritage impacts through careful limitation of any possibilities of structural/cosmetic damage to listed buildings and through the employment of an approved unexpected finds policy. The EIS for the M4 Widening found that there would be no direct physical impacts on adjacent heritage items and no visual impacts on those items. The type of impact that could occur to the heritage items was from vibratory works in close proximity to the structures.

7.2.4 M4 East

WestConnex M4 East has preceded the M4-M5 Link and the two projects overlap via the mainline tunnels at the Wattle Street interchange, Wattle Street civil and tunnel site, Haberfield civil and tunnel site and ventilation facility and Northcote Street civil site – for Option A. These two projects could also overlap at the Parramatta Road interchange and the Haberfield civil site – for Option B. Construction of the M4 East is currently underway and involves the construction of three lanes travelling in each direction through two new mainline tunnels including dive structures, cut-and-cover tunnels, and noise barriers around the Wattle Street interchange, Parramatta Road interchange, a ventilation facility and ancillary facility near Parramatta Road, as well as other associated construction facilities.

The M4 East project was assessed for impacts on built and landscape heritage as well as historical archaeology. The HIA recorded major adverse impacts in particular to the Haberfield HCA brought about by the demolition of 11 heritage listed houses and 29 contributory houses within the garden suburb subdivision. At Homebush, minor visual impacts on three heritage items were identified. At North Strathfield and Concord, 14 heritage items and one HCA of local significance (Canada Bay LEP 2013) were affected by the project with three of the heritage items demolished, four partially demolished and seven affected by visual impacts. At Cintra Park, impacts on landscape heritage items were considered minor and reversible. The project impacted on some potential historical archaeological resources of a local level of significance however this was considered manageable via avoidance and mitigation.

The HIA concluded that the M4 East project represents major adverse levels of heritage impacts. The HIA report identified the inability to mitigate irreversible adverse heritage impacts. Mitigation recommendations were extensive and included development of interpretation plans, archaeological monitoring and unexpected finds policies, archival recording as well as salvage and incorporation of items of historic and aesthetic values into the urban design of new public spaces.

For the area of overlap between the M4 East and the M4-M5 Link projects, no additional property acquisitions or demolitions were required for Option A, and only a couple of property acquisitions and demolitions of non-significant buildings would be required for Option B. No direct physical impacts would be encountered for the Haberfield HCA, but there would be cumulative impacts from the continuation of use of construction compounds for Option A, and extension of visual impacts on the Haberfield HCA associated with the new construction compounds for Option B.

Below is a summary table of the assessed overall heritage impacts of each stage of the WestConnex program of works.

WestConnex project	Overall heritage impact ranking
New M5	Moderate adverse
King Georges Road Interchange Upgrade	Nil
M4 Widening	Nil
M4 East	Major adverse
M4-M5 Link	Moderate adverse

7.3 Major Roads and Maritime and other transport projects

7.3.1 CBD and South East Light Rail

The CBD and South East Light Rail (CSELR) links the CBD to the city's southeast via the construction of new light rail lines including associated infrastructure, bridges, tunnels, substations, stabling and maintenance facilities and construction works depots.

As part of CSELR, a new depot is being constructed adjacent (to the west) to the M4-M5 Link Rozelle interchange site. The non-Aboriginal heritage impacts of the CSELR were assessed in a HIA which found, for the Rozelle area, that there was some Aboriginal archaeological resource potential, some potential impacts on potential historical archaeology and no adverse impacts on built and landscape heritage.

The combination of these two infrastructure projects to be constructed on immediately adjoining sites in the Rozelle area represents a substantial transformation of the area's character and urban form. However, the topography at the western end of the Rozelle Rail Yards (ie lower than Lilyfield Road and the Brennan's Estate HCA), provides substantial visual and spatial separation and keeps both projects visually contained. While some of the infrastructure may extend above the road level of Lilyfield Road, the retention of street trees along Lilyfield Road would help to minimise the visual impact of both projects on the HCA. This would minimise but does not ameliorate the intrusion in the curtilage of the Brennan's Estate HCA.

7.3.2 Sydney Metro – City and Southwest Metro

The M4-M5 Link mainline tunnels are proposed to cross under the Sydney Metro City and South West line near Angel Street at Newtown. Owing to the underground location of the Sydney Metro tunnel to the north of St Peters interchange and the construction site for the Sydney Metro being to the northeast of Sydenham train station, there would be no perceivable overlap or direct heritage impacts as a result of the construction of these two projects.

7.3.3 Rozelle Rail Yards site management works REF

The Rozelle Rail Yards were assessed for built and landscape heritage items as well as for historical (non-aboriginal) archaeological potential by GML in 2016. The Rozelle Rail Yards themselves are not heritage listed however the site contains a number of relics, industrial remnants and pieces of redundant rail infrastructure that warranted further investigation and heritage assessment. This involved a site inspection, reference to aerial photographs and maps, consideration of the history of the area and the assessment of heritage values for a number of items followed by impact assessment.

No listed heritage items are being demolished as part of the site management works. However, the REF HIA identified a number of items of potential local heritage significance in and around the Rozelle Rail Yards site. Some of these potential local heritage items are being demolished as part of the site management works; being a lighting tower and Port Authority building. Mitigation measures including archival recordings of these items and salvage and storage of the lighting tower and rail gantries for potential reuse in future development of the Rozelle Rail Yards were recommended in the REF. The site management works are expected to be complete prior to construction of the M4-M5 Link project

commencing. Overall, the heritage impact of the Rozelle Rail Yards site management works project was found to be minor.

Subsequent/additional to the REF works, the M4-M5 Link project will demolish the Victoria Road bridge, tunnel through sections of the sandstone cutting, and demolish the Stormwater Canal (aka Easton Park drain). These will have a cumulative impact of demolishing more listed and potential local heritage items at the Rozelle Rail Yards.

7.4 Conclusion

Importantly, the M4-M5 Link project has been assessed to have an overall moderate heritage impact, due to the subterranean nature of the majority of the interventions. The aboveground motorway infrastructure (eg ventilation facilities and outlets, substations, water treatment plants, etc) have been located and designed with to reduce heritage impacts. At Haberfield, for Option A, construction compounds from the M4 East phase of work have been reused and their footprint reduced, and for Option B or new construction compounds, they have been selected to have minimal heritage impact.

The overall cumulative impacts of the WestConnex program of works to date on heritage items can be described as major and irreversible given the scale of the construction project. It has had a substantial impact by severing and eroding the legibility of a large part of the Haberfield conservation area (which was identified as being of State significance); it has removed evidence of subdivision layouts, modest Federation domestic architecture and estate landscaping (gardens, fences and tree lined streets). Elsewhere, the demolition of locally significant heritage items (including the Rudders Bond Store) incrementally diminishes the early and mid-twentieth century industrial building stock from the southern and inner west suburbs of Sydney.

The WestConnex project comprises one of the most comprehensive upheavals to the road network that the city has experienced in recent years, for example since the construction of the Warringah Freeway, and in particular the impacts to the built fabric of the inner west suburbs are substantial. However, it should also be recognised that the cumulative impact to heritage has been dramatically reduced by tunnelling and through the site selection process for construction areas.

Further impacts to heritage from the M4-M5 Link project have also been avoided through:

- Design and refinement of the Rozelle interchange
- Avoiding heritage items such as Easton Park, the Sewage Pumping Station No.6, the former State Rail Authority (SRA) cable store and traffic office at Leichhardt
- Retaining important elements of the White Bay Power Station site
- Avoiding impacts to heritage items and HCAs at Camperdown.

The site management works and main works in the Rozelle Rail Yards would permanently remove evidence of a significant period of rail infrastructure within a broader network of Sydney industrial and freight sites, known as the goods lines, as well as the distinct industrial landscape. However, the M4-M5 Link project would reuse and incorporate heritage elements from some of the items removed during the site management works in the urban design and landscape plan for Rozelle, acknowledging heritage themes and interpretation of impacted sites.

Sydney is currently experiencing an unprecedented level of investment in large-scale road infrastructure and major public transportation projects, resulting in extensive changes to the character of the urban, suburban and foreshore landscapes across the city. As a result, the heritage fabric, features and values of the items and areas which these projects are located are being subjected to increased development pressures. While these projects will be transformative, place-making and creating the next layering of history in an area, it must be acknowledged that it is sometimes leads to impacts on heritage items and areas which has cultural and social value that enhances the liveability of urban areas.

The heritage impacts from the project are being addressed and managed through the implementation of a range of environmental mitigation measures including archival recording, heritage interpretation and urban design and landscape initiatives.

8 Management of impacts

The detailed design and construction of the M4-M5 Link project would be managed to ensure that, as far as possible, the identified potential heritage and archaeological impacts are minimised and/or avoided by implementation of a range of general and specific measures. These measures do not include operational management measures as impacts on items of heritage and archaeological significance are limited to construction activities (other than vibration).

The management measures provided in **Table 8-1** have been developed to avoid, reduce and manage identified potential impacts to non-Aboriginal heritage. These measures would be further developed on a case by case basis during detailed design. The final management measures would be documented in the Construction Heritage Management Plan (CHMP).

Table 8-1 Environmental management measures – non-Aboriginal heritage

Impact	No.	Environmental management measure	Timing
Impacts on heritage items	NAH01	Construction Heritage Management Plan (CHMP) will be prepared and implemented as part of the Construction Environmental Management Plan. The CHMP would include: · Measures that will be implemented to manage potential impacts to items of heritage significance · Inclusion of heritage awareness and management training for relevant personnel involved in site works. · Details regarding the conservation and curation of any historical artefacts recovered during works.	Construction
	NAH02	An Interpretation Strategy will be developed and implemented to identify and interpret the key heritage values and stories of the heritage areas affected by the project and inform the development of the Urban Design and Landscape Plan for the project, in accordance with NSW Heritage Office *Interpreting Heritage Places and Items Guideline August 2005*. The Interpretation Strategy will: · Build on themes, stories and initiatives proposed as part of other stages of WestConnex to ensure a consistent approach to heritage interpretation for the project. · Include themes and stories including the Rozelle railways historic functions, trains and trams transport, industrialisation and The Rozelle-Darling Harbour Goods Line. · Identify how the rail related infrastructure salvaged from the Rozelle Rail Yards will be reused.	Construction
	NAH03	Photographic recording will be undertaken of: · Infrastructure associated with the White Bay Power Station site that could be affected by the project. · Whites Creek Stormwater Channel No 95 (in the area to be impacted) · Stormwater Canal at Lilyfield Road · 'Cadden Le Messurier' at 84 Lilyfield Road · Former Hotel at 78 Lilyfield Road · Victoria Road bridge · Each house at 260–266 Victoria Road	Construction

Impact	No.	Environmental management measure	Timing
		· Each house at 248–250 Victoria Road · Former Bank of NSW (164 Parramatta Road). It will be undertaken in accordance with the NSW Heritage Office guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006). The photographic recording will occur prior to any works that have the potential to impact upon the items and the report development process will include the identification of appropriate stakeholders to receive copies of the documentation.	
	NAH04	As part of the CHMP, a Historical Archaeological Research Design (HARD) will be prepared before the start of proposed works within each of the following Historical Archaeological Management Units (HAMUs): HAMU 3,HAMU 6, HAMU 7, HAMU 9, HAMU 10, and HAMU 11. The HARD will be prepared by a qualified archaeologist in consultation with the NSW Heritage Council and would include: · Descriptions of clear significance thresholds for possible archaeological items that may be uncovered during works · A methodology and scope for a program of archaeological excavation, investigation, and recording of any historical archaeological remains that will be impacted by the project · Requirement for post-excavation reporting, including artefact analysis and additional historical research, where necessary, and long term management of records · Details of what will happen with any artefacts uncovered and associated reports.	Construction
	NAH05	Before excavation of archaeological management sites, a suitably qualified Excavation Director who complies with *Criteria for Assessment of Excavation Directors* (Heritage Council of NSW 2011) will be engaged to advise on matters associated with historic archaeology. Where archaeological excavation is required, the Excavation Director will oversee excavation and advise on archaeological matters.	Construction
Heritage impacts due to vibration	NAH06	Potential vibration impacts to features of heritage significance will be managed in accordance with the Construction Noise and Vibration Management Plan prepared for the project.	Construction
Heritage impacts due to settlement	NAH07	Potential heritage impacts due to settlement and ground movement caused by the project will be managed in accordance with the relevant measures identified in **Chapter 12** (Land use and property) of the EIS and monitored in accordance with the Settlement Monitoring Plan.	Construction
Impacts to unexpected items of potential heritage conservation significance or human remains	NAH08	Any items of potential heritage conservation significance or human remains discovered during construction will be managed in accordance with an Unexpected Heritage Finds and Humans Remains Procedure developed for the project in accordance with relevant guidance provided by the Heritage Council of NSW, the NSW Heritage Division of the Office of Environment and Heritage and *Unexpected Archaeological Finds* (Roads and Maritime 2015a). The procedure will detail requirements regarding notification of relevant agencies and	Construction

Impact	No.	Environmental management measure	Timing
		the NSW Police and will be implemented for the duration of construction.	
Impacts on potential salvageable items	NAH09	A Heritage Salvage Strategy will be prepared to identify the salvage potential of the fabric and features from heritage items and potential heritage items that will be demolished to facilitate the project. This could include timber joinery, fireplaces, stained glass, stairs, decorative tiles, bricks, steel truss structures, windows etc. The strategy will also identify options and a process for dissemination of salvaged items to owners, community groups and interested parties.	Construction
	NAH10	Sandstone kerbing in the vicinity of 32 and 34 Victoria Road, Rozelle that will be removed to facilitate the project will be salvaged and provided to Inner West Council.	Construction
Loss of heritage where items are required to be demolished	NAH11	The railway cutting on the eastern side of Victoria Road, associated with the White Bay Power Station, will be considered during the development of the detailed design for the realigned Victoria Road and associated bridge. The final design will seek to avoid impact to the railway cutting and maintain the visual relationship between the cutting and the White Bay Power Station site. Landscaping sympathetic to the relationship, developed in consultation with a heritage specialist, will be included in the Urban Design and Landscape Plan for the project.	Construction
	NAH12	A condition assessment of the southern penstock (and its associated water channels) will be carried out by a heritage specialist and a structural engineer prior to any works in the vicinity with the potential impact upon the item. If required any conservation works required to limit potential impacts on deteriorated fabric (loose bricks, corroded steel) will be identified and implemented prior to construction.	Construction
	NAH13	The southern penstock and its associated water channels (location and extent unknown) will be protected during works associated with the reconstruction of the Victoria Road Bridge.	Construction
Potential impact to Whites Creek Stormwater Channel No. 95	NAH14	The new bridge over the Whites Creek Stormwater Channel must not impact the extant significant heritage fabric of the channel and should be a solely independent structure.	Construction
Potential impacts to Leichhardt (Darley Road)	NAH15	Landscaping, following the construction of the substation, should consider screening the substation and water treatment plant, from the Leichardt (Charles Street) Underbridge. The design and location of the landscaping will be informed by a heritage specialist and should seek to create a visual separation between the new structure and the heritage item.	Construction

Annexures

Annexure A – WestConnex M4-M5 Link – Buildings subject to heritage assessment

The project brief for this HIA requires the identification and assessment of places with potential heritage values not recognised on heritage registers. This annexure sets out the methodology for and identification of potential heritage items.

Those areas that would be demolished for surface works and those within the heritage study areas were surveyed for their potential heritage values. Properties located above the tunnels are unlikely to be directly impacted (other than possible damage from settlement and vibration) by the project works and the value of assessing their potential significance would be limited.

The following methodology was used to identify potential heritage items:

- Field surveys (limited to the street) to identify properties with potential aesthetic and representative significance and to assess integrity of the external form, details and associated landscapes
- Review of non-statutory registers to identify whether the heritage significance of the property had been recognised
- Review of relevant Local Environmental Plans, Development Control Plans and the State Heritage Inventory to identify whether the property is included within a heritage conservation area
- Review of the State Heritage Inventory and relevant heritage studies to assess whether the property could be considered rare in the Local Government Area
- Historical research into the development of the area to identify properties that may have historical heritage values.

Once potential heritage items had been identified, preliminary heritage inventory sheets have been prepared for each item, which include:

- A brief overview history
- A description of the item
- Assessment of item's heritage significance against the NSW heritage criteria
- An assessment of the item's integrity and intactness, based on inspection from the street only
- A summary statement of significance
- Photographs of the item.

Preliminary heritage assessments of buildings subject to heritage assessment

The tables below set out the properties which were determined to warrant heritage assessment by the GML team. Assessments were restricted to a visual analysis from the street and limited historical research and were therefore predominantly bases on potential aesthetic and representative significance. Inaccessible or obscured buildings were not assessed.

Area 1 – Haberfield/Ashfield (Option B)

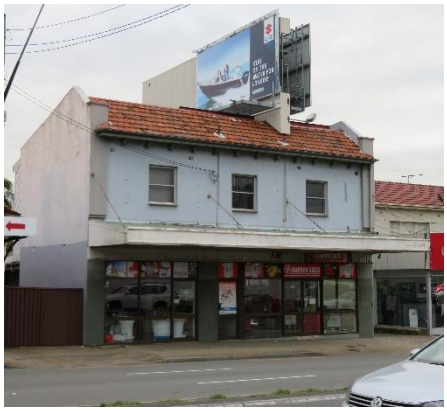
Address	242-246 Parramatta Road, Ashfield		
Construction Date	Corner building—1922		
Description	'Simpsons Corner' is a two-storey corner building with dual frontages and an awning to the street. The building is constructed of brick (painted) with a decorative stepped parapet and signage on the front facade. Early shop windows have been overhauled and the awning modified/replaced completely overtime Adjacent buildings comprise a two storey and single storey brick buildings with modern glass shopfronts to the street.		
Condition	Fair/Poor- interiors not inspected.		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Very few original features exist at the property internally (as viewed from the street) and externally and the site has been substantially altered over time.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	







Address	248-250 Parramatta Road, Ashfield	
Construction Date	Pre-1943	
Description	Two storey brick shop building with residences/rooms above possibly dating from the early 20th Century. The buildings are set under an altered roof form with contemporary terracotta tiles and exposed rafters visible beneath the eaves. A billboard structure has been fixed within the roof planes. Modernised shop windows and entrances are located at the ground floor, sheltered by an awning which has been stripped of any signage. At the upper level three contemporary double hung windows open south.	
Condition	Fair/Poor- interiors not inspected.	
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.	



Address	248-250 Parramatta Road, Ashfield		
Modifications	The rear of the site has been subject to a number of later additions. Very few original features exist at the property with the front façade updated and altered over time.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	252 Parramatta Road, Ashfield		
Construction Date	1915-1920s		
Description	Two-storey building encapsulated within the car dealership showroom building. A modern car showroom structure has been built around the earlier building, enclosing it with contemporary elements including glass and modern signage.		
Condition	Unable to assess.		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Heavily modified. The earlier building's setting has been lost and its character is unable to be interpreted from any publicly accessible area along Parramatta Road.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	119 Alt Street, Ashfield		
Construction Date	c1915 (Federation)		
Description	Single-storey red brick Federation bungalow set under a main hipped roof with a single gable portion projecting to the front and a covered porch to the entryway. The front façade features simple timber barge boards, timber battening beneath the front gable end, timber framed casement windows with simple lead lights and matching half glazed front door. The building retains its original envelope and form however individual materials appear to have been altered/replaced over time.		
Condition	Good		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Some timber and joinery appears to be replacement.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	136 Bland Street, Haberfield		
Construction Date	c1901 (Federation)		
Description	Single storey brick Federation cottage with hipped roof over the main house and projecting gable portion with timber detailing to the gable end. The front porch is sheltered leading to the entry and features timber posts and matching timber valance detailing beneath the eaves. Windows are timber framed casement with simple lead lights, with a timber or shingled base to the bay window that opens to the front porch.		
Condition	Good		
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield CA.		
Modifications	Some joinery appears to have been replaced/overhauled. Other modifications unknown.		
Heritage Criteria	**Historical**	**Local**	
	Historical Association	**-**	

Address	136 Bland Street, Haberfield		
	Aesthetic	**Local**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	**Local**	
	Integrity	-	

Address	138 Bland Street, Haberfield		
Construction Date	c1901 (Federation)		
Description	Single storey brick Federation cottage with hipped roof over the main house extending to shelter the front porch. The house has a projecting gable portion with timber detailing and rendered panel beneath the gable end. The property features other typical Federation details such as exposed rafters to the eaves, terracotta ridge tiles and finials, timber framed casement windows with small lead light panes and two rough cast chimney stacks with terracotta chimney pots.		
Condition	Good		
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield CA.		
Modifications	Some joinery and features are likely to have been replaced/overhauled. There is a later skillion roofed extension to the rear of the house. The low brick wall to the front boundary of the property is a later addition.		
Heritage Criteria	**Historical**	**Local**	
	Historical Association	**-**	
	Aesthetic	**Local**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	**Local**	
	Integrity	-	

Address	195 Parramatta Road, Haberfield		
Construction Date	Late Twentieth Century		
Description	Single storey utilitarian commercial building with glass shop frontage.		
Condition	N/A		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	N/A		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	135 Bland Street, Haberfield		
Construction Date	C1901 (Federation)		
Description	Single storey brick Federation cottage with hipped roof over the main house extending to shelter the front porch. The projecting gable roofed portion features a rough cast render and timber shingled awning over the front windows The property features other typical Federation details such as exposed rafters to the eaves, terracotta ridge tiles and finials, timber framed casement windows with small coloured panes and two rough cast chimney stacks with terracotta chimney pots.		
Condition	Good		
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield CA.		
Modifications	Some joinery and features are likely to have been replaced/overhauled.		
Heritage Criteria	**Historical**	**Local**	
	Historical Association	**-**	
	Aesthetic	**Local**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	**Local**	
	Integrity	-	

Address	137 Bland Street, Haberfield		
Construction Date	Possibly c1901		
Description	Single storey brick house, possibly a Federation cottage which has been stripped and re-skinned with modern brick or brick veneer. It features a hipped roof form, sheltered front entrance porch with baroque-style balusters, aluminium framed windows and a tiled pathway leading from the front entrance.		
Condition	N/A		
Assessment of Significance	The site is highly compromised and does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Heavily stripped and modified. No original external detailing remains in situ. Intactness of interior fabric/layout is unknown		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	139 Bland Street, Haberfield		
Construction Date	Mid to Late 20th Century		
Description	Single storey brick residence with arched brick openings to front porch and tiled entrance path through an open front yard. Front façade features aluminium framed windows and other generic modern finishes.		
Condition	N/A		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	N/A		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	124 Bland Street, Haberfield		
Construction Date	Mid to Late 20th Century		
Description	3-storey brick walk-up flat building serviced by small front garden and driveway running down the north-east boundary of the property. Flat building features standard aluminium windows, sliding doors opening to balconies and minimal detailing.		
Condition	N/A		
Assessment of Significance	None, property is typical of 1960s-1970s residential flat development ubiquitous to greater metropolitan Sydney.		
Modifications	N/A		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	142 Alt Street, Ashfield		
Construction Date	Late 19th Century		
Description	Single storey late 19th Century cottage with main house set under gable roof form and front façade featuring centred entrance door framed by two double hung sash windows.		
Condition	Fair		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Some features are likely to have been replaced/overhauled.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	144 Alt Street, Ashfield		
Construction Date	c1900 (Federation)		
Description	Single storey brick Federation cottage with hipped roof over the main house extending to shelter the front porch. The property features other typical Federation details such as exposed rafters to the eaves, terracotta ridge tiles and finials, timber framed casement windows with small coloured panes and rough cast chimney stack with terracotta chimney pots.		
Condition	Good		
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the streetscape.		
Modifications	Some joinery and features are likely to have been replaced/overhauled.		
Heritage Criteria	**Historical**	Local	
	Historical Association	**-**	
	Aesthetic	Local	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	137 Alt Street, Ashfield		
Construction Date	**c1900 (Federation)**		
D**escription**	Single storey brick Federation cottage with hipped roof over the main house extending to shelter the front porch. Many original features lost.		
Condition	Good		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	The property has been modified and stripped over time.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	139 Alt Street, Ashfield		
Construction Date	c1900 (Federation)		
Description	Single storey brick Federation cottage set on a rough cast sandstone base featuring typical details such as exposed rafters to the eaves, terracotta ridge tiles and finials, timber framed casement windows with small coloured panes and rough cast chimney stack with terracotta chimney pots.		
Condition	Good		
Assessment of Significance	The site demonstrates local heritage significance as a contributory item to the broader Haberfield CA.		
Modifications	No major modifications evident externally.		
Heritage Criteria	**Historical**	Local	
	Historical Association	**-**	
	Aesthetic	Local	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	Local	
	Integrity	-	

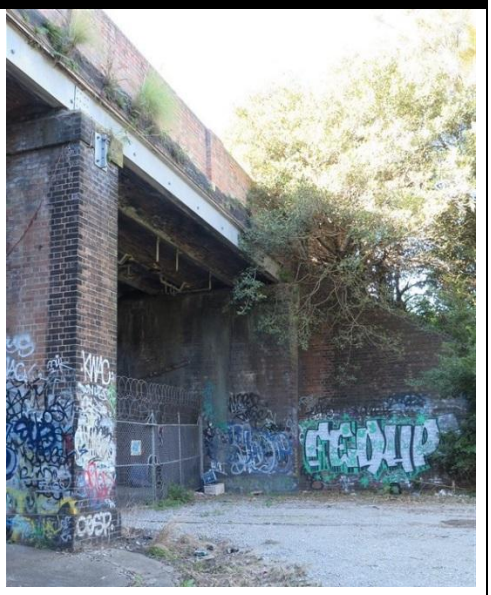
Address	298 Parramatta Road, Ashfield		
Construction Date	Mid to Late 20th Century		
Description	Two storey contemporary brick commercial building featuring contemporary finishes and minimal detailing.		
Condition	Fair		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Unknown		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	207-213 Parramatta Road, Haberfield		
Construction Date	c1915		
Description	Row of modest single storey Federation bungalows with double gabled frontages.		
Condition	Fair – Good		
Assessment of Significance	The site does not demonstrate heritage significance to a level that warrants listing on any statutory register.		
Modifications	Most of the properties have been highly modified with very few original features intact within the row.		
Heritage Criteria	**Historical**	-	
	Historical Association	**-**	
	Aesthetic	**-**	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Area 2 – Leichhardt

No buildings within the study area were identified as potential heritage items therefore no heritage assessments were required.

Area 3 – Rozelle, Lilyfield and Annandale (Rozelle Rail Yards, The Crescent, Rozelle Bay and Victoria Road)

Address	Victoria Road Bridge, Rozelle	
Construction Date	c1922	
Description	The Victoria Road bridge dates from the 1920s, the same era as its Catherine Street counterpart. The Catherine Street overbridge is listed as a local heritage item on the Leichhardt LEP as 'a good representative example of a large brick overbridge constructed in the 1920s as part of the NSW railway network'. The Victoria Road bridge is constructed of concrete on brick piers, which carries Victoria Road across the former rail yard, with the brick piers forming bays below. The piers are subject to graffiti damage. The bridge was likely constructed using bricks from the State Brickworks at Homebush Bay, which made bricks for use by the Department of Public Works and other state government departments. The bridge continues to function as a road bridge today.	

Address	Victoria Road Bridge, Rozelle		
Condition	Fair–vegetation overgrowth and graffiti.		
Summary of Significance	The Victoria Road bridge has local significance as a representative example of brick overbridges constructed in the 1920s, as part of the roll out of the separate freight line across the Sydney rail network. The bridge is a noticeable landscape feature that provides evidence of the Rozelle Rail Yard's industrial and transport legacy.		
Modifications	Not known		
Heritage criteria	**Historical**	Local	
	Historical association	-	
	Aesthetic	-	
	Social	-	
	Technical/research	-	
	Rarity	-	
	Representativeness	Local	
	Integrity		

Address	Sandstone Cutting, Rozelle	
Construction Date	c1916	
Description	The sandstone cutting which runs along the northern boundary of the Site dates from the early twentieth century and remains a prominent landscape feature of the Rozelle Rail Yards. Tool marks and drill holes for blasting or manual splitting are visible along the rock face and vegetation grows out of the rock face.	
Condition	Condition varies. Parts of the cuttings are obscured by vegetation or other engineering structures. Drill marks at the eastern and western ends of the cuttings indicate that some sandstone may have been extracted in blocks rather than blasted out, which may suggest the use of stone from the area for ballast or engineering works, or conceivably for building.	
Summary of Significance	The sandstone cutting has some local significance as a representation of the scale and nature of works undertaken for the construction and alignment of the goods rail line. The height and size of the cutting provides evidence of the early ambitions for the train marshalling yard to be a busy interchange. The cutting is a prominent landscape feature, defining the northern limit of the marshalling yard and more generally the topography of the twentieth-century industrial-maritime landscapes of White Bay and Rozelle Bay. There are potential links to quarrying activities on Glebe Island.	
Modifications	It is not clear whether extraction occurred in a single phase during construction of the yards or whether some stone was extracted previously from the area. Modifications appear to have occurred in some sectors to stabilise the rock and/or enable construction under or against the rock.	
Heritage criteria	**Historical**	Local
	Historical association	-
	Aesthetic	-
	Social	-
	Technical/research	Local
	Rarity	-
	Representativeness	-
	Integrity	Good





Area 4 – Iron Cove

Address	260-266 Victoria Road, Rozelle	
Construction Date	c1909	
Description	Row of four detached single storey early Federation-era houses staggered according to both the alignment and gradient of Victoria Road from east to west. Nos 260 and 262 have had their front yards enclosed with modern fences and their entrances are at ground level through a small front yard while Nos 264 and 266 maintain their original transverse steps up leading up to a small entry porch sheltered by a bullnose profile corrugated iron awning. The houses are of brick construction with rendered front facades and hipped roofs in painted corrugated iron. In all four houses a front room steps forward under a projecting gable (rough cast gable end detail remaining at 260 and 262) beneath which are two double hung sash windows with small coloured glass panes and a decorative tile insert between.	
Condition	Fair/good	
Assessment of Significance	As a group of four these properties may have local significance as representative of a transitional early Federation style typical of their period. The houses have some historical interest as evidence of the late nineteenth century and early twentieth century development and subdivisions which occurred along Victoria Road.	
Modifications	The properties have been substantially modified. The houses have lost their decorative timber detailing from the front façade including barge boards and capping, gable decorations, finials and timber brackets to front entry porch. Nos 264 and 266 have lost their rough cast gable end panels and 260 has lost its rendered label course. 266 is highly modified, and has lost its decorative wrought iron balustrade, the front steps have been altered/overclad in modern travertine (?) and the original bullnose front porch awning has been replaced with a modern skillion roof form. Nos 260 and 262 were unable to be observed in full due to high boundary walls.	
Heritage Criteria	**Historical**	Local
	Historical Association	**-**
	Aesthetic	**-**
	Social	-







Address	260-266 Victoria Road, Rozelle		
	Technical/Research	-	
	Rarity	-	
	Representativeness	Local	
	Integrity	-	

Address	4 Clubb Street, Rozelle		
Construction Date	c1890		
Description	Highly modified single-storey Victorian worker's cottage with bullnose profile veranda roof extending across the width of the house supported by timber veranda posts. Construction is timber with weatherboard cladding which may be original. There is a small front yard entrance yard which has been recently landscaped enclosed by a wooden picket fence. A recent attic conversion has led to a highly modified roof form with a dormer window projecting out from the front roof plane and a gabled extension form adjoining the rear of the original cottage form. The front elevation of the property has two pairs of casement windows with small paned coloured glass fan lights above and a front entrance door directly in between. All joinery appears to be new/21st century.		
Condition	Good – recently renovated.		
Assessment of Significance	Despite the cottage at 4 Clubb Street having some historic interest it appears highly modified and does not meet the threshold for local listing.		
Modifications	Externally the house retains very little of its original detailing and minimal evidence of its early construction techniques. The roof form and fabric is new and associated rainwater disposal system (gutters and downpipes) are modern Colorbond. All weatherboard cladding, window and front door joinery, veranda posts, glazing and front fencing appears to date from the 21st century with possible intervention in the original configuration of these elements. The bullnose form of the veranda roof may be original; however, roof fabric is new corrugated steel.		
Heritage Criteria	**Historical**	-	

Address	4 Clubb Street, Rozelle		
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	6 Byrnes Street, Rozelle		
Construction Date	c1910		 
Description	A Federation Queen Anne style residence with an asymmetrical form. The house is face brick with a skillion roofed veranda with decorative posts and joinery. The gabled wing features a bay window with corrugated iron roof. The gable is brick with decorative carved timber fretwork to the edge of the gable roof. The modified skillion and gabled roof is corrugated metal. The garden slopes slightly away from the house at the front and is enclosed with a face brick fence, covered in some areas with vegetation.		
Condition	Good		
Assessment of Significance	The house at 6 Byrnes Street has some interest aesthetically however does not meet the threshold for listing at a local level.		
Modifications	Original form of the building has been modified at the rear with a second story addition. Fretwork and bargeboard on the gable end have been replaced.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	256 Victoria Road, Rozelle		
Construction Date	C1895		
Description	Extensively modified timber late nineteenth century worker's cottage with a corrugated iron hipped roof. The properties narrow frontage is sheltered by a flat veranda roof, supported by square timber posts with timber valance above. The front elevation has an asymmetric front door and pair of timber double hung sash windows open to the yard. The front yard has been covered with a concrete slab and pavers and converted to a driveway. There is a timber fence across the street front and narrow garden bed along the southern boundary. Development abuts the property closely on both north and south sides.		
Condition	External condition good.		
Assessment of Significance	Although the original building is of interest in the development of the area, it is highly modified and does not meet the threshold for local listing.		
Modifications	All external finishes including cladding, roofing, guttering, timber joinery, external landscaping and fencing date from the 21st century.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	248-250 Victoria Road, Rozelle		
Construction Date	c1909		
Description	A pair of two storey Federation-era terraces with a central pediment, chimney with corbelled brick top and painted brickwork. Part of the original face brickwork remains on one of the pair. There is a decorative cast iron balustrade to the first floor veranda as well as timber valance and corner brackets (age unknown). The roof of the first floor verandas is corrugated iron in a bullnose form. Each of the pair have timber sash windows (Venetian) to the ground floor and glazed doors to the top floor veranda. The cast cement urns to side parapets remain. The front yards to the pair are accessed through gates in the decorative iron fence. The floor of the veranda is paved with small garden bed along the fence line.		
Condition	Exterior condition good.		
Assessment of Significance	As a relatively intact example of a pair of early twentieth century residences the properties may have local significance as representative of Federation style. The houses have some historical interest as evidence early twentieth century development.		
Modifications	Modification to top floor windows. Possible modification to timber valance and corner brackets to veranda		
Heritage Criteria	**Historical**	Local	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	Local	
	Integrity	-	

Address	6, 8, 10 Toelle Street, Rozelle		
Construction Date	C1890		
Description	Semi-detached, single storey cottage in the Federation style, that is divided into three houses. The hipped roof is covered with terracotta tiles and rendered cement chimneys with corbelled tops. The walls are dressed sandstone covered by a skillion corrugated iron veranda roof. The veranda roof is supported by a variety of timber and metal poles and the veranda floor is tiled. The street slopes to the west with numbers 8 and 10 accessed by steps up from street level. All three houses have a sandstone retaining wall across the street front, topped with a timber picket fence.		
Condition	Fair condition externally.		
Assessment of Significance	The houses at 6,8 and 10 Toelle Street do not meet the threshold for local listing.		
Modifications	Section of veranda roof replaced. Mismatched supports to the veranda suggests they have been replaced at an unknown date.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	236 Victoria Road, Rozelle		
Construction Date	C1933		 
Description	A single storey, face brick Inter-war house with face brick pilasters to the front façade and chamfered brick window sills. The hipped roof is terracotta tiled with some replacement tiles. The front yard is enclosed by a low face brick fence with a small yard planted to the wall of the building. Timber fencing encloses the rear of the building on the western boundary.		
Condition	Good condition externally.		
Assessment of Significance	The house at 236 Victoria Road does not meet the threshold for local listing.		
Modifications	Significant modification to the front and rear of the property.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	234 Victoria Road, Rozelle		
Construction Date	C1909		 
Description	A single storey house in the Federation style. The house is face brick with a bullnose roofed veranda with decorative timber posts and corner brackets. One wall of the house has painted bricks. The roof of the house is a steep sloped hipped roof in corrugated iron. Access to the side and rear of the building is via an unpaved driveway. The front yard is enclosed by a low brick fence with decorative ironwork between piers. Mature trees and grass make up the front garden, with a concrete path giving access to the covered veranda and front door.		
Condition	Fair conditional externally.		
Assessment of Significance	The house at 234 Victoria Road does not meet the threshold for local listing.		
Modifications	Replacement of the roof, potential modification to the rear of the building.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	

Address	234 Victoria Road, Rozelle		
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	232 Victoria Road, Rozelle		
Construction Date	C1890		
Description	A late nineteenth century single storey row house with rendered walls, and raised motif and bracket to the moulded parapet. The tiled veranda is covered by a skillion corrugated metal roof with cast iron corner brackets. The front garden is both pathed and tiled with areas of raised garden beds. The yard is enclosed with a decorative metal fence.		
Condition	External condition good.		
Assessment of Significance	The house at 232 Victoria Road does not meet the threshold for local listing.		
Modifications	Façade and veranda extensively modified, potential modification to the rear of the building.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	8 Callan Street, Rozelle		
Construction Date	C1922		
Description	A single storey interwar face-brick house in the Arts and Craft style with an asymmetrical form. The roof is hipped and gabled with terracotta tiles and exposed eaves. The house has brick chimneys with terracotta pots. The gable wing features a three-casement bay window with a pressed metal hood and shingle awning. The gable ends are roughcast with simple shaped timber bargeboards. The veranda to the front of the house has been enclosed with timber windows added behind the timber fretwork to the original veranda roof. The yard is enclosed by a face-brick and bullnose retaining wall topped with metal fence, behind which sits a raised garden bed.		
Condition	External condition is good.		
Assessment of Significance	The house at 8 Callan Street has aesthetic and representative significance at the local level as a good example of an interwar house with Arts and Craft Style details.		
Modifications	Modification to the form and fabric of the house.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	Local	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	Local	
	Integrity	-	

Area 5 – Annandale (around Pyrmont Bridge Road and Parramatta Road)

Address	164 Parramatta Road, Annandale (Former Bank of NSW)	
Construction Date	1936- 1937	
Description	Two storey inter-war stripped classical former Bank of NSW building with sandstone pilasters to the front façade and simple red brick parapet concealing a hipped roof. The building is symmetrical in form and massing and consistent with other purpose built banks of its era. It is set on a simple sandstone base with an emphatic square portal leading to the entrance. Above the doorway on the frieze it is possible to make out where the bronze lettering reading 'Bank of NSW' once was. The building has three smaller multi pane double hung sash windows above two larger ones at ground level and conforms to the prevailing setback of this particular stretch of Parramatta Road.	
Condition	Good/fair externally.	
Assessment of Significance	The former Bank of NSW building has historic and aesthetic significance as a typical example of an inter-war commercial building purpose built as a bank, a typology rare in the context of Parramatta Road.	
Modifications	The building has lost some of its finer details including its original brass lettering, front door and usual utilitarian bank items such as night safes/deposit boxes. The brickwork around the middle window at the upper level appears to have been altered.	
Heritage Criteria	**Historical**	Local
	Historical Association	-
	Aesthetic	Local
	Social	-
	Technical/Research	-
	Rarity	-
	Representativeness	Local
	Integrity	-

Address	99 Pyrmont Bridge Road, Annandale (James Squire Brewery)		
Construction Date	c1930		
Description	Former furniture factory. Currently used as a brewery (since 1988). Exposed face brick		
Condition	Good		
Assessment of Significance	While the site does retain some social/historical significance as a local landmark, it does not meet the threshold for listing at the local level due to its high levels of alteration and modification.		
Modifications	External façade heavily modified. Significant changes to accommodate current use of site since the 1980s.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	79 Pyrmont Bridge Road, Annandale (Storage King)	
Construction Date	c1930	
Description	Large purpose built two-storey industrial complex occupying entire block. Repeating framed masonry bays to front façade inset with steel windows. Decorative brick corbelling to the parapet.	
Condition	Good	
Assessment of Significance	Property makes some contribution to the industrial character of the streetscape however the high level of modifications necessitated by the conversion of the building to a self-storage function means that it is unlikely to meet the threshold for listing at a local level.	
Modifications	Exterior brickwork painted and all industrial signage/livery removed. Substantial internal modification and strip out likely to have occurred.	

Address	79 Pyrmont Bridge Road, Annandale (Storage King)		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Address	67-77 Pyrmont Bridge Road, Annandale (terraces)		
Construction Date	Pre-1890		
Description	Five heavily modified two-storey Victorian terraces of the same era with staggered arrangement to the street frontage. Site specific response of the terrace typology adapted to site topography and orientation.		
Condition	Fair/Poor- interiors not inspected.		
Assessment of Significance	These terraces do not meet the threshold for listing at the local level due to their high levels of alteration and modification.		
Modifications	All verandas have been infilled, new fencing installed and roofs replaced. Loss of original joinery and detailing throughout.		
Heritage Criteria	**Historical**	-	
	Historical Association	-	
	Aesthetic	-	
	Social	-	
	Technical/Research	-	
	Rarity	-	
	Representativeness	-	
	Integrity	-	

Area 6 – St Peters

There were no buildings within this study area which warranted additional heritage assessment.

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[23] Cusick, A 1989, 'Leichhardt West: Original Land Grants and Subdivisions', *Leichhardt Historical Journal*, June 1989, vol 16, p 48.
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Appendix V

Technical working paper: Aboriginal heritage

WestConnex

Roads and Maritime Services

WestConnex – M4-M5 Link

Technical working paper: Aboriginal heritage

August 2017

Client: Roads and Maritime Services

ABN: 76 236 371 088

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Glossary of terms and abbreviations

Term	Definition
A	
Aboriginal archaeological site	The present spatial extent of visible Aboriginal archaeological material(s) at a given location
Aboriginal cultural heritage	The tangible (objects) and intangible (dreaming stories, song lines and places) cultural practices and traditions associated with past and present day Aboriginal communities
AHIMS	Aboriginal Heritage Information Management System. A register of NSW Aboriginal heritage information maintained by the NSW Office of Environment and Heritage.
Aboriginal object	Any deposit, object or material evidence (not being a handicraft made for sale), including Aboriginal remains, relating to the Aboriginal habitation of NSW
Aboriginal place	Any place declared to be an Aboriginal place under section 94 of the *National Parks and Wildlife Act 1974* (NSW)
ACHMP	Aboriginal Cultural Heritage Management Plan
ADI	Australian Defence Industries
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical)
ALRA	*Aboriginal Lands Right (Northern Territory) Act 1976* (Commonwealth)
AHIP	Aboriginal Heritage Impact Permit. Under the *National Parks and Wildlife Act 1974* (NSW) (NPW Act), a person can apply for an AHIP as a defence to a prosecution for harming Aboriginal objects or Aboriginal places. AHIPs are issued under Part 6 of NPW Act
AMBS	Australian Museum Business Services
Archaeological potential	The likelihood of undetected surface and/or subsurface archaeological materials existing at a location
Artefact	Any object which has been physically modified by humans
ATSIHP Act	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Commonwealth)
B	
C	
Campbell Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at St Peters
CBD	Central business district
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility and provide basis for estimating and to determine further investigations needed for detailed design
Construction	Includes all physical work required to construct the project
Construction ancillary facilities	Temporary facilities during construction that include, but are not limited to, construction sites (civil and tunnel), sediment basins, temporary water treatment plants, pre-cast yards and material stockpiles, laydown areas, parking, maintenance workshops and offices
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessment considered alone
Cut-and-cover	A method of tunnel construction whereby the structure is built in an open excavation and subsequently covered.

Term	Definition
Cutting	Formation resulting from the construction of the road below existing ground level, the material is cut out or excavated
D	
Darley Road civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Leichhardt
DECCW	Department of Environment, Climate Change and Water (replaced in 2011 by the NSW Office of Environment and Heritage)
Detailed design	The phase of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction
DP&E	NSW Department of Planning and Environment
E	
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2000 (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ERS	Eastern Regional Sequence
Exposure	An area of land surface where the ground surface is visible, usually as the result of thinner vegetation cover, erosive forces or human-caused disturbance. In archaeological surveys, the percentage of ground surface that is visible is recorded. These percentages of exposure are then used to calculate effective coverage
F	
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. 'Feasible' relates to engineering considerations and what is practical to build. 'Reasonable' relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community expectations and nature and extent of potential improvements
G	
GI	Ground integrity
GPS	Global positioning system
GSV	Ground surface visibility. A term used to describe the area of the ground's surface that is visible during archaeological field surveys
H	
Haberfield civil and tunnel site/Haberfield civil site	Construction ancillary facilities for the M4-M5 Link project located at Haberfield
Heritage item	A place, building, work, relic, moveable object or precinct listed on a statutory heritage register
I	
ILUA	Indigenous Land Use Agreement
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment
In situ	In the natural or original position. Applied to a rock, soil, or fossil when occurring in the situation in which it was originally formed or deposited

Term	Definition
Inner West Council/ Inner West LGA	The amalgamation of the former local government areas of Ashfield Leichhardt and Marrickville, proclaimed on 12 May 2016
Interchange	A grade separation of two or more roads with one or more interconnecting carriageways
Iron Cove Link	Around one kilometre of twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge
Iron Cove Link civil site	A construction ancillary facility for the M4-M5 Link project south of Victoria Road at Rozelle, near the eastern abutment of Iron Cove Bridge
J	
K	
King Georges Road Interchange Upgrade	A component of the WestConnex program of works. Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project
L	
LALC	Local Aboriginal Land Council
LEP	Local environmental plan
LGA	Local government area
M	
M4 East Motorway/project	A component of the WestConnex program of works. Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange
M4 East mainline stub tunnels	Eastbound and westbound extensions of the M4 East mainline tunnel being built as part of the M4 East project (to connect with the M4-M5 Link)
M4 East mainline connection	The underground connection between the M4-M5 Link mainline tunnels and the M4 East mainline stub tunnels
M4 Widening	A component of the WestConnex program of works. Widening of the existing M4 Motorway from Parramatta to Homebush
M4-M5 Link	The project which is the subject of this EIS. A component of the WestConnex program of works
Mainline tunnels	The M4-M5 Link mainline tunnels connecting with the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters
Methodology	The method for analysis and evaluation of the relevant subject matter
Mid-block	Section of road between two intersections
MLALC	Metropolitan Local Aboriginal Land Council
MNES	Matters of National Environmental Significance
Motorway	High-speed, high-volume controlled access roads. May be tolled or untolled
N	
New M5 Motorway/project	A component of the WestConnex program of works. Located from Kingsgrove to St Peters (under construction)
New M5 mainline stub tunnels	Northbound and southbound extensions of the New M5 mainline tunnel being built as part of the New M5 project (to connect with the M4-M5 Link)
New M5 mainline connection	The underground connection between the M4-M5 Link mainline tunnels and the New M5 mainline stub tunnels
Northcote Street civil site	A construction ancillary facility for the M4-M5 Link project located at Haberfield
NPW Act	*National Parks and Wildlife Act 1974* (NSW)

Term	Definition
NT Act	*Native Title Act 1993* (Commonwealth)
NPW Regulation	National Parks and Wildlife Regulation 2009 (NSW)
O	
OEH	NSW Office of Environment and Heritage
P	
PAC	Planning Assessment Commission
PACHCI	*Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (NSW Roads and Maritime Services 2011)
PAD	Potential Archaeological Deposit. The hypothesised presence of archaeological deposit where there is uncertainty due to a lack of visibly eroding artefacts, lack of test excavation either locally or in analogous landforms in the region
Parramatta Road East civil site	A construction ancillary facility for the M4-M5 Link project at Haberfield
Parramatta Road West civil and tunnel site	A construction ancillary facility for the M4-M5 Link project at Ashfield
PJAP	Port Jackson Archaeological Project
Portals	The locations where a tunnel meets a surface road
Project	A new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange
Project footprint	The land required to construct and operate the project. This includes permanent operational infrastructure (including the tunnels), and land required temporarily for construction
Proponent	The person or organisation that proposes to carry out the project or activity. For the purpose of the project, the proponent is NSW Roads and Maritime Services
Pyrmont Bridge Road tunnel site	A construction ancillary facility for the M4-M5 Link project at Annandale
Q	
R	
RAP	Registered Aboriginal parties
REF	Review of environmental factors
RHDA	Rouse Hill Development Area
Roads and Maritime	NSW Roads and Maritime Services
Rozelle civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Lilyfield and Rozelle
Rozelle interchange	A new interchange at Lilyfield and Rozelle that would connect the M4-M5 Link mainline tunnels with City West Link, Anzac Bridge, the Iron Cove Link and the proposed future Western Harbour Tunnel and Beaches Link
Rozelle Rail Yards	The Rozelle Rail Yards is bound by City West Link to the south, Lilyfield Road to the north, Balmain Road to the west, and White Bay to the east. Note that the project only occupies part of the Rozelle Rail Yards site

S	
SEARs	Secretary's Environmental Assessment Requirements. Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 115Y of the *Environmental Planning and Assessment Act 1979* (NSW)
SEPP	State Environmental Planning Policy
SMC	Sydney Motorway Corporation
St Peters interchange	A component of the New M5 project, located at the former Alexandria Landfill site at St Peters. Approved and under construction as part of the New M5 project. Additional construction works proposed as part of the M4-M5 Link project.
Stone artefact	Any piece of rock modified by human agency
Stub tunnel	Driven tunnels constructed to connect to potential future motorway links
T	
The Crescent civil site	A construction ancillary facility for the M4-M5 Link project located at Annandale
Tunnel portal	The entrance/exit to the tunnel
U	
V	
Ventilation facility	Facility for the mechanical removal of air from the mainline tunnels, or mechanical introduction of air into the tunnels. May comprise one or more ventilation outlets
Ventilation outlet	The location and structure from which air within a tunnel is expelled
Victoria Road civil site	A construction ancillary facility for the M4-M5 Link project located at Rozelle
W	
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent)
Wattle Street civil and tunnel site	A construction ancillary facility for the M4-M5 Link project located at Haberfield
WestConnex program of works	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, New M5 and M4-M5 Link projects
X	
Y	
Z	

Executive summary

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

As part of the environmental impact statement (EIS) for the project, an Aboriginal heritage assessment has been undertaken to satisfy the relevant requirements of the Secretary's Environmental Assessment Requirements (SEARs) for the project. Specifically, this assessment was undertaken to assess potential impacts of the project on Aboriginal heritage and to support the preparation of an EIS.

The assessment has also been undertaken in accordance with the relevant provisions of the Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime 2011). This procedure was developed by Roads and Maritime to guide consultation and investigation of Aboriginal cultural heritage. It sets out an assessment process that incorporates elements of the NSW Office of Environment and Heritage's (OEH) *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (NSW Department of Environment, Climate Change and Water (DECCW) 2010).

A PACHCI Stage 1 Aboriginal heritage assessment was undertaken by AECOM in May 2016. The findings of that PACHCI Stage 1 assessment concluded that a survey of the study area (PACHCI Stage 2 assessment) was necessary to determine potential impacts (direct and indirect) to Aboriginal heritage values, and to identify appropriate mitigation measures (where required).

The study area (see **Figure 6-2**) for this Aboriginal heritage assessment was based on the project footprint, that comprises the footprint of all temporary (construction) and permanent (operational) project land required for the project, including construction areas and associated ancillary facilities and permanent infrastructure.

A search of the Aboriginal Heritage Information Management System (AHIMS) database for previously recorded Aboriginal sites within the study area was undertaken on 21 September 2016 (search number #246070). No previously recorded Aboriginal sites were identified within the study area. The nearest site, rockshelter with midden (site #45-6-2278), is mapped as occurring about 50 metres to the north of the Rozelle Rail Yards. It is located above an area proposed for subsurface tunnel construction. Access to #45-6-2278 has not been provided due to its location within private property but the area containing it has been subject to a separate study to determine potential vibration and settlement impacts. It was determined that for tunnelling works associated with the project, #45-6-2278 is located beyond the minimum safe working distance for vibration intensive plant, with vibration impacts associated with tunnelling works expected to be negligible.

Aboriginal community consultation for the project has been undertaken in accordance with the Stage 2 PACHCI process, which comprised participation in the archaeological survey by the Metropolitan Local Aboriginal Land Council (MLALC) and a review of the findings contained in this technical working paper. No native title applicants or Aboriginal owners were identified.

An archaeological survey for the project was undertaken by AECOM archaeologist Dr Andrew McLaren accompanied by MLALC Aboriginal Sites Officer, Jay Daley. Survey was targeted, focusing on those portions of the study area that appeared, from the examination of recent aerial photographs, to retain some Aboriginal archaeological potential. Key observations made during the archaeological survey were as follows:

- The study area predominantly consists of highly disturbed terrain that is unlikely to retain Aboriginal archaeological materials in surface or subsurface contexts
- No surface expressions of Aboriginal objects were identified during the survey
- As no AHIMS registered Aboriginal sites occur within the study area, none would be either directly or indirectly impacted by the project. The closest AHIMS site is mapped as occurring about 50 metres to the north of the Rozelle Rail Yards. No direct impacts are anticipated from the project and indirect impacts from vibration are expected to be negligible. As no access has yet been provided to assess this site, its current condition is to be confirmed with a site survey during detailed design, with ongoing observation and monitoring recommended to be undertaken during the construction program, as needed
- At a part of the study area adjacent to Whites Creek, exposed sandstone bedrock was observed on the short but relatively steep slope below the Rozelle Bay light rail stop. However, no grinding grooves or pigment/engraved art were noted during the current survey.

Given the extent of previous disturbance within the study area, no direct or indirect impacts on Aboriginal cultural values are anticipated as a result of the project. As such, it is concluded that further impact assessment in accordance with Stage 3 of the PACHCI is not required. Based on the above findings, the following recommendations are made:

- Should any unexpected finds of Aboriginal places, objects or deposits be identified during the construction of the project, the *Standard Management Procedure for Unexpected Heritage Items* (Roads and Maritime 2015) is to be followed
- Prior to construction and if possible due to property access, a suitably qualified archaeologist is to visit AHIMS site #45-6-2278 to verify the site and confirm its current condition. If verified, a baseline condition assessment and baseline vibration monitoring is to be carried out before construction vibration generating activities start. If the site is verified, vibration levels are to be monitored to ensure they do not to exceed three millimetres per second at AHIMS site #45-6-2278. At the completion of construction, a condition assessment would be completed with recommendations for remediation measures if required.

1 Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Together with the other components of the WestConnex program of works and the proposed future Sydney Gateway, the project would facilitate improved connections between western Sydney, Sydney Airport and Port Botany and south and south-western Sydney, as well as better connectivity between the important economic centres along Sydney's Global Economic Corridor and local communities.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

1.1 Overview of WestConnex and related projects

The M4-M5 Link is part of the WestConnex program of works. Separate planning applications and assessments have been completed for each of the approved WestConnex projects. Roads and Maritime has commissioned Sydney Motorway Corporation (SMC) to deliver WestConnex, on behalf of the NSW Government. However, Roads and Maritime is the proponent for the project.

In addition to linking to other WestConnex projects, the M4-M5 Link would provide connections to the proposed future Western Harbour Tunnel and Beaches Link, the Sydney Gateway (via the St Peters interchange) and the F6 Extension (via the New M5).

The WestConnex program of works, as well as related projects, are shown in **Figure 1-1** and described in **Table 1-1**.

Table 1-1 WestConnex and related projects

Project	Description	Status
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the EP&A Act granted on 21 December 2014. Open to traffic.
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
King Georges Road Interchange Upgrade	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.
New M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.

Project	Description	Status
M4-M5 Link (the project)	Tunnels connecting to the M4 East at Haberfield (via the Wattle Street interchange) and the New M5 at St Peters (via the St Peters interchange), a new interchange at Rozelle and a link to Victoria Road (the Iron Cove Link). The Rozelle interchange also includes ramps and tunnels for connections to the proposed future Western Harbour Tunnel and Beaches Link project.	The subject of this EIS.
Related projects		
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
Western Harbour Tunnel and Beaches Link	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
F6 Extension	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.

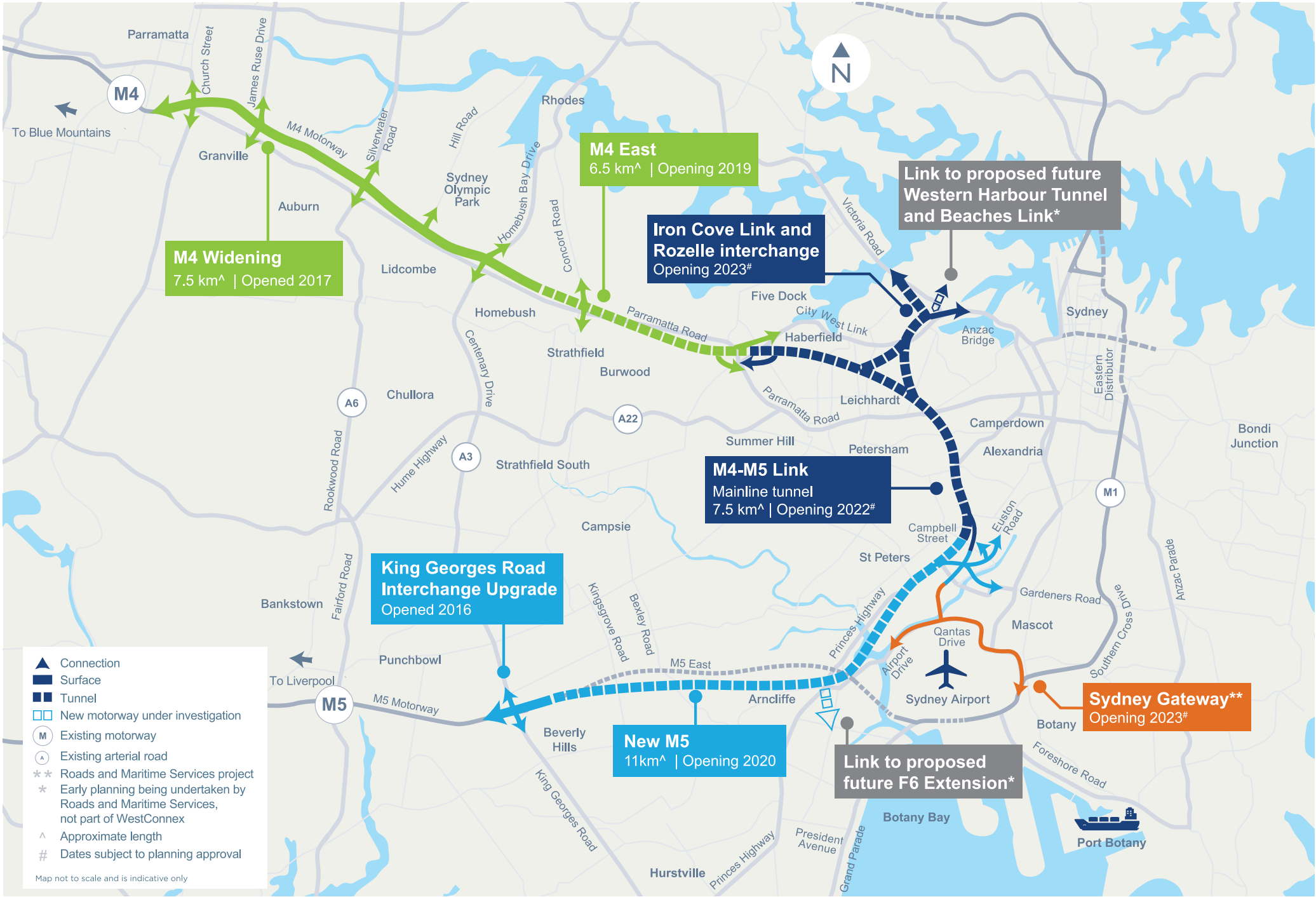


Figure 1-1 Overview of WestConnex and related projects

1.2 Purpose of this report

AECOM has been engaged to undertake an Aboriginal heritage assessment for the project. This assessment forms part of the EIS for the project and has been undertaken in accordance with Roads and Maritime's *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime 2011).

The purpose of this report is to address the Secretary's Environmental Assessment Requirements (SEARs) by identifying any potential Aboriginal cultural heritage values within the study area and provide appropriate recommendations for any further assessment and/or identify appropriate management and mitigations measures.

The PACHCI process was developed by Roads and Maritime to guide consultation and investigation of Aboriginal cultural heritage. It sets out an assessment process that incorporates elements of the NSW Office of Environment and Heritage's (OEH):

- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (NSW Department of Environment, Climate Change and Water (DECCW) 2010)
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010a)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b)
- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011).

The PACHCI comprises three broad steps:

- Stage 1 – An initial desktop assessment is undertaken by Roads and Maritime, or its consultant, to determine whether consultation with a heritage advisor and a site survey is required
- Stage 2 – A site survey is undertaken by a heritage advisor and representative from the Local Aboriginal Land Council (LALC), Aboriginal archaeological assessment is undertaken and the associated report is prepared
- Stage 3 – A full Aboriginal archaeological assessment in accordance with OEH's *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010) is completed. In addition, Aboriginal community consultation is conducted in accordance with OEH's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010).

The requirement for a Stage 3 assessment is based on whether the Stage 2 assessment identifies Aboriginal sites or areas of archaeological sensitivity that would be impacted by the project. Due to enforced time requirements to allow Registered Aboriginal parties (RAPs) time to provide feedback on the proposed project methodology and report outputs, Stage 3 assessments typically take six months to complete. Consideration should be given during design to avoiding all impacts on Aboriginal sites and areas of archaeological sensitivity to avoid the need for a Stage 3 PACHCI assessment and subsequent project delays.

A PACHCI Stage 1 Aboriginal heritage assessment was undertaken by AECOM in May 2016. Based on the findings of the PACHCI Stage 1 assessment, it was concluded that a survey of the study area (PACHCI Stage 2 assessment) was necessary to determine potential impacts (direct and indirect) to Aboriginal heritage values, and to identify appropriate mitigation measures (where required). This report is the PACHCI Stage 2 assessment. Given the extent of previous disturbance within the study area, no direct or indirect impacts on Aboriginal cultural values are anticipated as a result of the project. As such, it is concluded that further impact assessment in accordance with Stage 3 of the PACHCI is not required.

1.3 SEARs and agency comments

EISs are prepared to assess the environmental impacts of major projects, including State significant infrastructure projects, under Part 5.1 of the EP&A Act. This Aboriginal heritage assessment forms part of the EIS being prepared for the M4-M5 Link and assesses the potential Aboriginal impacts of the project.

EISs are subject to a range of legislative and policy requirements as set out in the SEARs. **Table 1-2** sets how the requirements relevant to Aboriginal heritage are addressed in this report.

Table 1-2 How SEARs have been addressed in this report

SEARs	
Aboriginal heritage	
Requirement relating to Aboriginal Cultural Heritage	**Section where addressed in EIS**
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of listed heritage items inclusive of: (a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; (b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan.	**Chapters 6** and **7** of this technical report.
3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (DECCW 2010).	**Section 11.2** of this technical report.
4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	**Section 4.2** of this technical report.
OEH requirement relating to Aboriginal Cultural Heritage	**Section where addressed in EIS**
1.1 The EIS must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the project and document these in the EIS. This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by the Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW (DECCW 2011).	**Chapters 6**, **7** and **8** of this technical report.
1.2 Where Aboriginal cultural heritage values are identified, consultation with Aboriginal people must be undertaken and documented in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW). The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the EIS.	**Section 4.2** of this technical report
1.3 Impacts on Aboriginal cultural heritage values are to be assessed and documented in the EIS. The EIS must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the EIS must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.	**Chapters 9**, **10** and **11** of this technical report.

1.4 Assessment team

1.4.1 AECOM

This assessment was led by Dr Darran Jordan. He has a doctorate in archaeology from the University of Sydney, a Bachelor of Arts (Honours, 1st Class) with majors in prehistorical and historical archaeology from the University of Sydney and a Bachelor of Arts from the University of Western Sydney, majoring in Text and Writing, sub-majoring in historical studies. He has also undertaken numerous short courses covering such diverse subjects as Aboriginal cultural consultation, stone tool

identification, archaeological field techniques, and archaeological drawing and writing. He is a senior archaeologist/heritage specialist and team leader at AECOM and has over eleven years of professional experience in Indigenous and non-Indigenous cultural heritage management.

The site inspection was undertaken by Dr Andrew McLaren. He has a doctorate in archaeology from Cambridge University, attained a Master of Cultural Heritage degree at Deakin University and a Bachelor of Arts (Honours, 1st Class) with majors in Anthropology and Archaeology from the University of Queensland. He is a member of the Australian Archaeological Association, the Institute of Field Archaeologists and the Lithic Studies Society. He is also an associate member of the Australian Association of Consulting Archaeologists. He is a senior archaeologist/heritage specialist at AECOM and has over eight years of professional experience in Indigenous and non-Indigenous cultural heritage management.

Dr Darran Jordan was the primary author of this report, which was reviewed by Dr Andrew McLaren.

1.4.2 Aboriginal representation

Assessments for Roads and Maritime are required to utilise the PACHCI. This document outlines a consultation process that is consistent with the *Aboriginal cultural heritage consultation requirements for proponents* (DECCW 2010a) and the National Parks and Wildlife Regulation 2009 (NSW) (NPW Regulation). Consultation guidelines are utilised in heritage assessments to ensure that appropriate consultation is undertaken with representatives of the Aboriginal community. This assessment was undertaken under the PACHCI process, which stipulates that PACHCI Stage 2 assesses a project's potential to harm Aboriginal cultural heritage, and to determine whether formal Aboriginal community consultation is required. Under a Stage 2 assessment, the Roads and Maritime Aboriginal Cultural Heritage Officer is to identify the LALC relevant to the study area and contact the administrator to organise appropriate representation for fieldwork and consultation. For this assessment, Roads and Maritime Aboriginal Cultural Heritage Officer identified that the study area was within the bounds of the Metropolitan Local Aboriginal Land Council (MLALC) and that their Aboriginal Sites Officer was the appropriate representative to attend fieldwork.

MLALC was formed in 1983 when the *Aboriginal Lands Right (Northern Territory) Act 1976* (Commonwealth) (ALRA) was established. It was originally known as the Redfern Land Council, changing its name to MLALC in 1985. The MLALC boundary covers 25 local government areas (LGAs) and the MLALC provide a variety of services including site assessment, Welcome to Country, cultural awareness training, site monitoring, site tours and site protection. Their staff consists of professional, qualified and highly skilled Aboriginal Land and Conservation Management Officers accredited in Conservation and Land Management. The MLALC Cultural Heritage Unit also has access to the cultural knowledge of some of Sydney's most unique Aboriginal sites, many of which were showcased in their book Footprints on Rock, about the Aboriginal art and heritage of the Sydney region. For this assessment, MLALC assigned their trained and accredited Aboriginal Sites Officer, Jay Daley, to attend the fieldwork and provide input into known, potential and intangible Aboriginal cultural heritage values within the study area. Jay Daley was also able to confer with other MLALC staff regarding the assessment in order to draw upon a larger pool of cultural knowledge, as appropriate. Other representatives at MLALC included Gadigal Elder Uncle Charles Madden, Uncle Allen Madden, Uncle Raymond Davison, Larisa Cooper (Land and Culture Officer) and James Smith (Cultural Educator).

MLALC Aboriginal Sites Officer, Jay Daley, was present during all fieldwork for this project and reviewed the findings contained in this technical working paper. These assessment works were conducted under the Stage 2 PACHCI process, in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010) with reference to the SEARs requirement to identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* (NSW) (NPW Act) and in accordance with the principles and methods of assessment identified in the SEARs guidelines.

1.5 Study area

The study area for this Aboriginal heritage assessment was based on the project footprint, comprising the footprint of all temporary (construction) and permanent (operational) project infrastructure and associated ancillary facilities. The location of the study area is shown on **Figure 6-2**.

1.6 Structure of this report

This report is the Aboriginal Heritage Assessment for the project and is structured as follows:

Chapter 1 presents the background information on the project

Chapter 2 presents the features of the project

Chapter 3 outlines the legislative requirements

Chapter 4 details the assessment methodology

Chapter 5 contains the landscape context

Chapter 6 contains information on the archaeological context

Chapter 7 contains information on the ethnographic context

Chapter 8 contains the results

Chapter 9 contains the assessment of impacts

Chapter 10 contains the cumulative impact assessment

Chapter 11 summarises the findings and recommendations.

2 The project

2.1 Project location

The project would be generally located within the City of Sydney and Inner West local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters. The local context of the project is shown in **Figure 2-1**.

2.2 Overview of the project

Key operational features of the project are shown in **Figure 2-1** and would include:

- Twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction
- Connections of the mainline tunnels to the M4 East project, comprising:
  - A tunnel-to-tunnel connection to the M4 East mainline stub tunnels east of Parramatta Road near Alt Street at Haberfield
  - Entry and exit ramp connections between the mainline tunnels and the Wattle Street interchange at Haberfield (which is currently being constructed as part of the M4 East project)
  - Minor physical integration works with the surface road network at the Wattle Street interchange including road pavement and line marking
- Connections of the mainline tunnels to the New M5 project, comprising:
  - A tunnel-to-tunnel connection to the New M5 mainline stub tunnels north of the Princes Highway near the intersection of Mary Street and Bakers Lane at St Peters
  - Entry and exit ramp connections between the mainline tunnels and the St Peters interchange at St Peters (which is currently being constructed as part of the New M5 project)
  - Minor physical integration works with the surface road network at the St Peters interchange including road pavement and line marking
- An underground interchange at Leichhardt and Annandale (the Inner West subsurface interchange) that would link the mainline tunnels with the Rozelle interchange and the Iron Cove Link (see below)
- A new interchange at Lilyfield and Rozelle (the Rozelle interchange) that would connect the M4-M5 Link mainline tunnels with:
  - City West Link
  - Anzac Bridge
  - The Iron Cove Link (see below)
  - The proposed future Western Harbour Tunnel and Beaches Link
- Construction of connections to the proposed future Western Harbour Tunnel and Beaches Link project as part of the Rozelle interchange, including:
  - Tunnels that would allow for underground mainline connections between the M4 East and New M5 motorways and the proposed future Western Harbour Tunnel and Beaches Link (via the M4-M5 Link mainline tunnels)
  - A dive structure and tunnel portals within the Rozelle Rail Yards, north of the City West Link / The Crescent intersection
  - Entry and exit ramps that would extend north underground from the tunnel portals in the

Rozelle Rail Yards to join the mainline connections to the proposed future Western Harbour Tunnel and Beaches Link

- A ventilation outlet and ancillary facilities as part of the Rozelle ventilation facility (see below)

· Twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge (the Iron Cove Link). Underground entry and exit ramps would also provide a tunnel connection between the Iron Cove Link and the New M5 / St Peters interchange (via the M4-M5 Link mainline tunnels)

· The Rozelle surface works, including:

- Realigning The Crescent at Annandale, including a new bridge over Whites Creek and modifications to the intersection with City West Link

- A new intersection on City West Link around 300 metres west of the realigned position of The Crescent, which would provide a connection to and from the New M5/St Peters interchange (via the M4-M5 Link mainline tunnels)

- Widening and improvement works to the channel and bank of Whites Creek between the light rail bridge and Rozelle Bay at Annandale, to manage flooding and drainage for the surface road network

- Reconstructing the intersection of The Crescent and Victoria Road at Rozelle, including construction of a new bridge at Victoria Road

- New and upgraded pedestrian and cyclist infrastructure

- Landscaping, including the provision of new open space within the Rozelle Rail Yards

· The Iron Cove Link surface works, including:

- Dive structures and tunnel portals between the westbound and eastbound Victoria Road carriageways, to connect Victoria Road east of Iron Cove Bridge with the Iron Cove Link

- Realignment of the westbound (southern) carriageway of Victoria Road between Springside Street and the eastern abutment of Iron Cove Bridge

- Modifications to the existing intersections between Victoria Road and Terry, Clubb, Toelle and Callan streets

- Landscaping and the establishment of pedestrian and cycle infrastructure

· Five motorway operations complexes; one at Leichhardt (MOC1), three at Rozelle (Rozelle West (MOC2), Rozelle East (MOC3) and Iron Cove Link (MOC4)), and one at St Peters (MOC5). The types of facilities that would be contained within the motorway operations complexes would include substations, water treatment plants, ventilation facilities and outlets, offices, on-site storage and parking for employees

· Tunnel ventilation systems, including ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels

· Three new ventilation facilities, including:

- The Rozelle ventilation facility at Rozelle

- The Iron Cove Link ventilation facility at Rozelle

- The Campbell Road ventilation facility at St Peters

· Fitout (mechanical and electrical) of part of the Parramatta Road ventilation facility at Haberfield (which is currently being constructed as part of M4 East project) for use by the M4-M5 Link project

· Drainage infrastructure to collect surface and groundwater for treatment at dedicated facilities. Water treatment would occur at

- Two operational water treatment facilities (at Leichhardt and Rozelle)

- The constructed wetland within the Rozelle Rail Yards

- A bioretention facility for stormwater runoff within the informal car park at King George Park at

Rozelle (adjacent to Manning Street). A section of the existing informal car park would also be upgraded, including sealing the car park surface and landscaping

- Treated water would flow back to existing watercourses via new, upgraded and existing infrastructure
- Ancillary infrastructure and operational facilities for electronic tolling and traffic control and signage (including electronic signage)
- Emergency access and evacuation facilities, including pedestrian and vehicular cross and long passages and fire and life safety systems
- Utility works, including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities. A Utilities Management Strategy has been prepared for the project that identifies management options for utilities, including relocation or adjustment. Refer to **Appendix F** (Utilities Management Strategy) of the EIS.

The project does not include:

- Site management works at the Rozelle Rail Yards. These works were separately assessed and determined by Roads and Maritime through a Review of Environmental Factors under Part 5 of the EP&A Act (refer to **Chapter 2** (Assessment process) of the EIS)
- Ongoing motorway maintenance activities during operation
- Operation of the components of the Rozelle interchange which are the tunnels, ramps and associated infrastructure being constructed to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project.

Temporary construction ancillary facilities and temporary works to facilitate the construction of the project would also be required.

2.2.1 Staged construction and opening of the project

It is anticipated the project would be constructed and opened to traffic in two stages (as shown in **Figure 2-1**).

Stage 1 would include:

- Construction of the mainline tunnels between the M4 East at Haberfield and the New M5 at St Peters, stub tunnels to the Rozelle interchange (at the Inner West subsurface interchange) and ancillary infrastructure at the Darley Road motorway operations complex (MOC1) and Campbell Road motorway operations complex (MOC5)
- These works are anticipated to commence in 2018 with the mainline tunnels open to traffic in 2022. At the completion of Stage 1, the mainline tunnels would operate with two traffic lanes in each direction. This would increase to generally four lanes at the completion of Stage 2, when the full project is operational.

Stage 2 would include:

- Construction of the Rozelle interchange and Iron Cove Link including:
  - Connections to the stub tunnels at the Inner West subsurface interchange (built during Stage 1)
  - Ancillary infrastructure at the Rozelle West motorway operations complex (MOC2), Rozelle East motorway operations complex (MOC3) and Iron Cove Link motorway operations complex (MOC4)
  - Connections to the surface road network at Lilyfield and Rozelle
  - Construction of tunnels, ramps and associated infrastructure as part of the Rozelle interchange to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project
- Stage 2 works are expected to commence in 2019 with these components of the project open to traffic in 2023.

2.3 Construction activities

An overview of the key construction features of the project is shown in **Figure 2-2** and would generally include:

- Enabling and temporary works, including provision of construction power and water supply, ancillary site establishment including establishment of acoustic sheds and construction hoarding, demolition works, property adjustments and public and active transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway operations complexes and other ancillary operations buildings
- Realignment, modification or replacement of surface roads, bridges and underpasses
- Implementation of environmental management and pollution control facilities for the project.

A more detailed overview of construction activities is provided in **Table 2-1**.

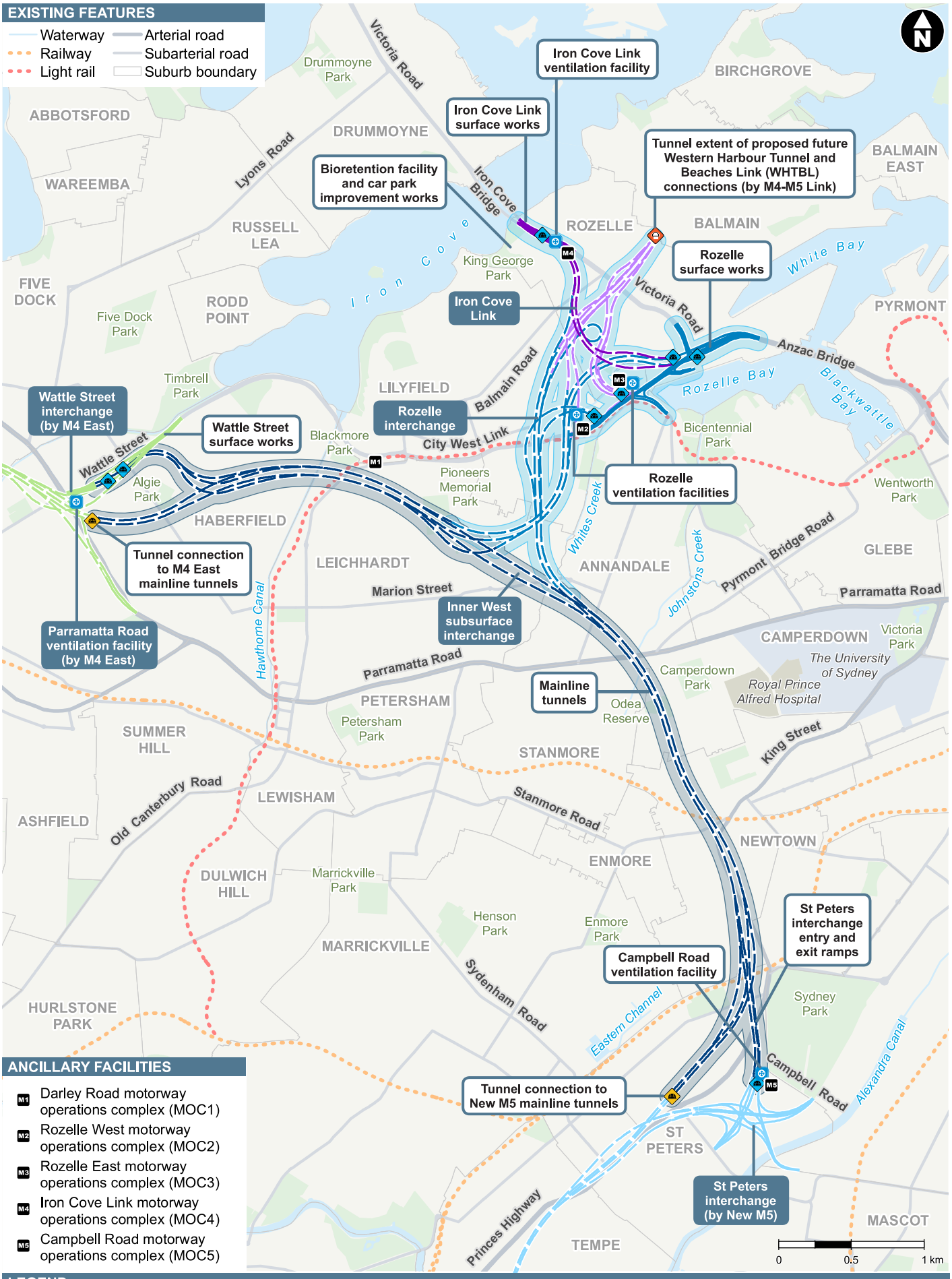


Figure 2-1 Overview of the project

Table 2-1 Overview of construction activities

Component	Typical activities
Site establishment and enabling works	· Vegetation clearing and removal · Utility works · Traffic management measures · Install safety and environmental controls · Install site fencing and hoarding · Establish temporary noise attenuation measures · Demolish buildings and structures · Carry out site clearing · Heritage salvage or conservation works (if required) · Establish construction ancillary facilities and access · Establish acoustic sheds · Supply utilities (including construction power) to construction facilities · Establish temporary pedestrian and cyclist diversions
Tunnelling	· Construct temporary access tunnels · Excavation of mainline tunnels, entry and exit ramps and associated tunnelled infrastructure and install ground support · Spoil management and haulage · Finishing works in tunnel and provision of permanent tunnel services · Test plant and equipment
Surface earthworks and structures	· Vegetation clearing and removal · Topsoil stripping · Excavate new cut and fill areas · Construct dive and cut-and-cover tunnel structures · Install stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls and secant pile walls (where required) · Construct required retaining structures · Excavate new road levels
Bridge works	· Construct piers and abutments · Construct headstock · Construct bridge deck, slabs and girders · Demolish and remove redundant bridges

Component	Typical activities
Drainage	· Construct new pits and pipes · Construct new groundwater drainage system · Connect drainage to existing network · Construct sumps in tunnels as required · Construct water quality basins, constructed wetland and bioretention facility and basin · Construct drainage channels · Construct spill containment basin · Construct onsite detention tanks · Adjustments to existing drainage infrastructure where impacted · Carry out widening and naturalisation of a section of Whites Creek · Demolish and remove redundant drainage
Pavement	· Lay select layers and base · Lay road pavement surfacing · Construct pavement drainage
Operational ancillary facilities	· Install ventilation systems and facilities · Construct water treatment facilities · Construct fire pump rooms and install water tanks · Test and commission plant and equipment · Construct electrical substations to supply permanent power to the project
Finishing works	· Line mark to new road surfaces · Erect directional and other signage and other roadside furniture such as street lighting · Erect toll gantries and other control systems · Construct pedestrian and cycle paths · Carry out earthworks at disturbed areas to establish the finished landform · Carry out landscaping · Closure and backfill of temporary access tunnels (except where these are to be used for inspection and/or maintenance purposes) · Site demobilisation and preparation of the site for a future use

Twelve construction ancillary facilities are described in this EIS (as listed below). To assist in informing the development of a construction methodology that would manage constructability constraints and the need for construction to occur in a safe and efficient manner, while minimising impacts on local communities, the environment, and users of the surrounding road and other transport networks, two possible combinations of construction ancillary facilities at Haberfield and Ashfield have been assessed in this EIS. The construction ancillary facilities that comprise these options have been grouped together in this EIS and are denoted by the suffix a (for Option A) or b (for Option B).

The construction ancillary facilities required to support construction of the project include:

· Construction ancillary facilities at Haberfield (Option A), comprising:
    - Wattle Street civil and tunnel site (C1a)

- Haberfield civil and tunnel site (C2a)
- Northcote Street civil site (C3a)

· Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b)

· Darley Road civil and tunnel site (C4)

· Rozelle civil and tunnel site (C5)

· The Crescent civil site (C6)

· Victoria Road civil site (C7)

· Iron Cove Link civil site (C8)

· Pyrmont Bridge Road tunnel site (C9)

· Campbell Road civil and tunnel site (C10).

The number, location and layout of construction ancillary facilities would be finalised as part of detailed construction planning during detailed design and would meet the environmental performance outcomes stated in the EIS and the Submissions and Preferred Infrastructure Report and satisfy criteria identified in any relevant conditions of approval.

The construction ancillary facilities would be used for a mix of civil surface works, tunnelling support, construction workforce parking and administrative purposes. Wherever possible, construction sites would be co-located with the operational footprint to minimise property acquisition and temporary disruption. The layout and access arrangements for the construction ancillary facilities are based on the concept design only and would be confirmed and refined in response to submissions received during the exhibition of this EIS and during detailed design.

2.3.1 Construction program

The total period of construction works for the project is expected to be around five years, with commissioning occurring concurrently with the final stages of construction. An indicative construction program is shown in **Table 2-2**.

Table 2-2 Indicative construction program

Construction activity	Indicative construction timeframe																											
	2018				2019				2020				2021				2022				2023							
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mainline tunnels																												
Site establishment and establishment of construction ancillary facilities			■	■	■	■	■	■	■	■																		
Utility works and connections			■	■	■	■	■																					
Tunnel construction				■	■	■	■	■	■	■	■	■	■															
Portal construction				■	■	■	■	■																				
Construction of permanent operational facilities												■	■	■	■	■												
Mechanical and electrical fitout works														■	■	■												
Establishment of tolling facilities															■	■												
Site rehabilitation and landscaping																■	■	■	■									
Surface road works																	■	■	■									
Demobilisation and rehabilitation																			■									
Testing and commissioning																■	■	■	■									
Rozelle interchange and Iron Cove Link																												
Site establishment and establishment of construction ancillary facilities				■	■	■	■	■																				
Utility works and connections and site remediation				■	■	■	■	■																				
Tunnel construction									■	■	■	■	■	■	■	■	■											
Portal construction						■	■	■																				
Construction of surface road works						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
Construction of permanent operational facilities						■	■	■	■	■	■	■	■	■	■													
Mechanical and electrical fitout works													■	■	■	■	■	■	■									
Establishment of tolling facilities																		■										
Site rehabilitation and landscaping																			■	■								
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Testing and commissioning																			■	■	■	■	■					

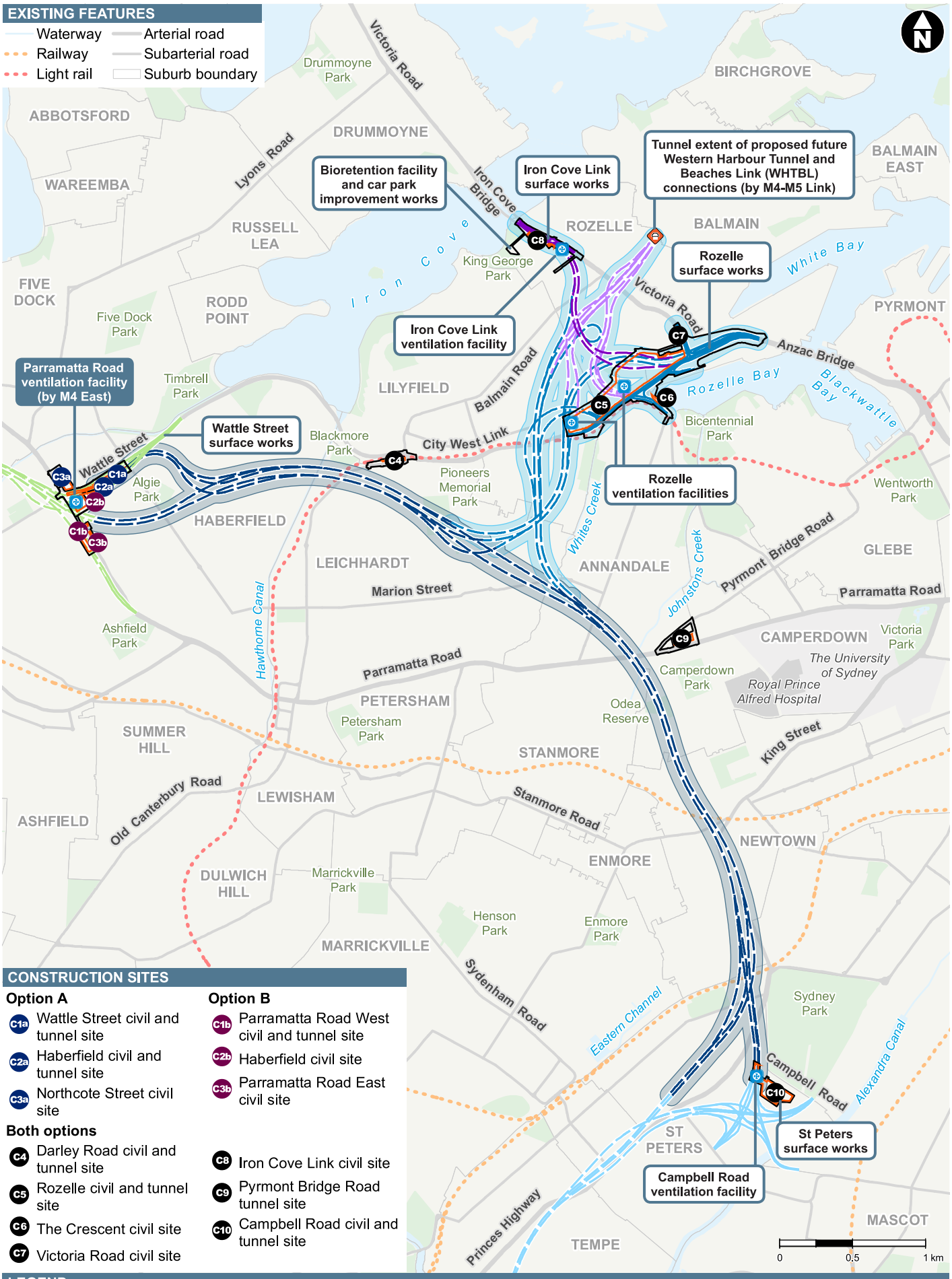


Figure 2-2 Overview of project footprint and ancillary facilities

3 Legislative considerations

3.1 Introduction

A number of planning and legislative documents govern how Aboriginal objects, areas and places are managed in NSW. The following section provides an overview of the requirements under each as they apply to the project.

3.2 NSW legislation

3.2.1 Environmental Planning and Assessment Act 1979 (NSW)

The EP&A Act and the Environmental Planning and Assessment Regulation 2000 (NSW) (EP&A Regulation) provides the framework for environmental planning and assessment in NSW. The EP&A Act and EP&A Regulation also provide opportunity for public involvement in the environmental impact assessment process in most circumstances. In NSW, environmental impacts are interpreted as including impacts on Aboriginal cultural heritage.

As indicated in **Chapter 1**, approval for the project is being sought under Part 5.1 of EP&A Act, with the environmental impact assessment being documented within an EIS. The current Aboriginal heritage assessment has been prepared for inclusion in this EIS. The project is subject to Part 5.1 of the EP&A Act and would be subject to approval by the NSW Minister for Planning. The SEARs for the project require the assessment of the project impacts on Aboriginal cultural heritage.

Pursuant to section 89J of the EP&A Act, Aboriginal Heritage Impact Permits (AHIPs) are not required for projects approved under Division 5.1 of Part 5 of the EP&A Act. Impacts on Aboriginal heritage values associated with approved State significant development and State significant infrastructure projects are typically managed under Aboriginal Cultural Heritage Management Plans (ACHMPs). ACHMPs are statutorily binding once approved by the Planning Assessment Commission (PAC) or the NSW Department of Planning and Environment (DP&E) under delegation from the Secretary.

3.2.2 National Parks and Wildlife Act 1974 (NSW)

The NPW Act, administered by OEH, is the primary legislation for the protection of Aboriginal cultural heritage in NSW. The NPW Act gives the Director-General of OEH responsibility for the proper care, preservation and protection of 'Aboriginal objects' and 'Aboriginal places', defined under the Act as follows:

- An Aboriginal object is any deposit, object or material evidence (that is not a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with the occupation of that area by persons of non-Aboriginal extraction (and includes Aboriginal remains)
- An Aboriginal place is a place declared so by the Minister administering the NPW Act because the place is or was of special significance to Aboriginal culture. It may or may not contain Aboriginal objects.

Part 6 of the NPW Act provides specific protection for Aboriginal objects and places by making it an offence to harm them and includes a 'strict liability offence' for such harm. A 'strict liability offence' does not require someone to know that it is an Aboriginal object or place they are causing harm to in order to be prosecuted. Defences against the 'strict liability offence' in the NPW Act include the carrying out of certain 'Low Impact Activities', prescribed in clause 80B of the NPW Regulation or the demonstration of due diligence.

An AHIP issued under section 90 of the NPW Act is required if impacts on Aboriginal objects and/or places cannot be avoided. An AHIP is a defence to a prosecution for harming Aboriginal objects and places if the harm was authorised by the AHIP and the conditions of that AHIP were not contravened. Consultation with Aboriginal communities is required under OEH policy when an application for an AHIP is considered and is an integral part of the process. AHIPs may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons.

Section 89A of the NPW Act requires notification to the Director-General of the location of identified Aboriginal objects within a reasonable time, with penalties for non-notification. As the project has been declared State significant infrastructure it requires compliance with different parts of the NPW Act.

3.2.3 Standard Instrument – Principal Local Environmental Plan

The SEARs state that Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan, must be considered in relation to the project. The definition contained in the Dictionary included with the plan states:

> *Aboriginal place of heritage significance means an area of land, the general location of which is identified in an Aboriginal heritage study adopted by the Council after public exhibition and that may be shown on the Heritage Map, that is:*
>
> *a) the site of one or more Aboriginal objects or a place that has the physical remains of pre-European occupation by, or is of contemporary significance to, the Aboriginal people. It may (but need not) include items and remnants of the occupation of the land by Aboriginal people, such as burial places, engraving sites, rock art, midden deposits, scarred and sacred trees and sharpening grooves, or*
>
> *b) a natural Aboriginal sacred site or other sacred feature. It includes natural features such as creeks or mountains of long-standing cultural significance, as well as initiation, ceremonial or story places or areas of more contemporary cultural significance.*

Heritage conservation for Aboriginal places of heritage significance is defined in section 5.10 of the Standard Instrument – Principal Local Environmental Plan which states:

> *The consent authority must, before granting consent under this clause to the carrying out of development in an Aboriginal place of heritage significance:*
>
> *a) consider the effect of the proposed development on the heritage significance of the place and any Aboriginal object known or reasonably likely to be located at the place by means of an adequate investigation and assessment (which may involve consideration of a heritage impact statement), and*
>
> *b) notify the local Aboriginal communities, in writing or in such other manner as may be appropriate, about the application and take into consideration any response received within 28 days after the notice is sent.*

In general, section 115ZF(2) of the EP&A Act excludes the application of environmental planning instruments to State significant infrastructure projects (except as those instruments apply to the declaration of State significant infrastructure or critical State significant infrastructure). Regardless of the above, consistent with good environmental assessment practice, the provisions of the State Environmental Planning Policies (SEPPs) and deemed SEPPs have been considered. As the project is subject to Part 5.1 of the EP&A Act and will be submitted for approval by the NSW Minister for Planning, no other environmental planning instruments were relevant to this Aboriginal heritage assessment.

Local environmental plans (LEPs) do not apply to State significant infrastructure projects, but they have been considered here to address the requirement of the SEARs. The project is located within the City of Sydney and Inner West LGAs. The Inner West LGA was formed on 12 May 2016 upon the amalgamation of the former Ashfield, Leichhardt and Marrickville LGAs. Existing LEPs for the former Ashfield, Leichhardt and Marrickville areas remain in force until a combined LEP has been gazetted for the new Inner West LGA. Schedule 5 of each LEP was searched for relevant environmental heritage items.

No Aboriginal sites were listed on the Ashfield Local Environmental Plan 2013. Four Aboriginal midden and rockshelter sites were identified in the suburb of Birchgrove in the Leichhardt Local Environmental Plan 2013 (one on Louisa Road (A4) and three on Numa Street (A6, A7 and A8)), but were determined to be outside the study area.

It was further noted that the King George Park Draft Plan of Management referred to two 'incomplete land claims' lodged by MLALC. These were not deemed relevant to the assessment as the land claims were not complete, and land claims under the *Aboriginal Land Rights Act 1983* (NSW) do not necessarily denote Aboriginal cultural or scientific archaeological values. Land Councils are not required to establish cultural association with lands when making land claims under the *Aboriginal Land Rights Act 1983* (NSW). One of the two land claims referred to has, since preparation of the Draft Plan of Management, been determined by way of refusal.

Kendrick Park, listed on the Marrickville Local Environmental Plan 2011 (I308), contained a shell midden within its bounds; this was also determined to be outside the study area. No Aboriginal sites were listed on the Sydney Local Environmental Plan 2012.

It was concluded that there were no Aboriginal items listed in any relevant LEPs that would be subject to either direct or indirect impacts from the proposed works. Canada Bay Council also identified that there is a shell midden (currently unregistered) in Timbrell Park at Five Dock. No impacts are currently proposed in this area and no direct or indirect impacts are foreseen regarding this midden site.

3.3 Commonwealth legislation

3.3.1 Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Commonwealth) (ATSIHP Act) provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. The stated purpose of the ATSIHP Act is the *'preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition'* (Part I, section 4).

Under the Act, '*Aboriginal tradition*' is defined as *'the body of traditions, observances, customs and beliefs of Aboriginals generally or of a particular community or group of Aboriginals, and includes any such traditions, observances, customs or beliefs relating to particular persons, areas, objects or relationships'* (Part I, section 3). A '*significant Aboriginal area*' is an area of land or water in Australia that is of *'particular significance to Aboriginals in accordance with Aboriginal tradition'* (Part I, section 3). A '*significant Aboriginal object*', on the other hand, refers to an object (including Aboriginal remains) of like significance.

For the purposes of the ATSIHP Act, an area or object is considered to have been be injured or desecrated if:

a) In the case of an area:

   i. it is used or treated in a manner inconsistent with Aboriginal tradition;

   ii. the use or significance of the area in accordance with Aboriginal tradition is adversely affected; and

   iii. passage through, or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal tradition

b) in the case of an object:

   i. it is used or treated in a manner inconsistent with Aboriginal tradition.

The ATSIHP Act can override state and territory laws in situations where a state or territory has approved an activity, but the Australian Government Minister for the Environment prevents the activity from occurring by making a declaration to protect an area or object. However, the Minister can only make a decision after receiving a legally valid application under the ATSIHP Act and, in the case of long term protection, after considering a report on the matter. Before making a declaration to protect an area or object in a state or territory, the Minister must consult the appropriate minister of that state or territory (Part 2, section 13).

No declarations relevant to the study area have been made under the ATSIHP Act.

3.3.2 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The EPBC Act took effect on 16 July 2000. Under the EPBC Act, proposed 'actions' that have or are likely to have a significant impact on a Matter of National Environmental Significance (MNES) must be referred to the Australian Minister for the Environment. An 'action' is defined as a project, development, undertaking, activity or a series of activities or alteration. An action must also be referred if:

- It is undertaken on Commonwealth land and will have or is likely to have a significant impact on the environment
- It is undertaken outside Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land
- It is undertaken by the Commonwealth and will have or is likely to have a significant impact on the environment.

The EPBC Act defines 'environment' as including both natural and cultural environments, and therefore includes Aboriginal and non-Aboriginal heritage. Under the Act protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate. The Register of the National Estate has been suspended and is no longer a statutory list; however, it remains available as an archive.

The heritage registers mandated by the EPBC Act were consulted on 21 September 2016 in relation to this project. No registered Aboriginal heritage items or places with significance to Aboriginal people have been located within the study area.

3.3.3 Native Title Act 1993 (Commonwealth)

The *Native Title Act 1993* (Commonwealth) (NT Act) provides for the recognition and protection of native title for Aboriginal peoples and Torres Strait Islanders. The NT Act recognises native title for land over which native title has not been extinguished and where persons able to establish native title are able to prove continuous use, occupation or other classes of behaviour and actions consistent with a traditional cultural possession of those lands. It also makes provision for Indigenous Land Use Agreements (ILUA) to be formed as well as a framework for notification of Native Title Stakeholders for certain future acts on land where Native Title has not been extinguished.

Initial searches of the *Schedule of Applications (unregistered claimant applications*), *Register of Native Title Claims*, *National Native Title Register*, *Register of Indigenous Land Use Agreements* and *Notified Indigenous Land Use Agreements* were undertaken on 26 May 2016 through the National Native Title Tribunal online search facility as part of the PACHCI Stage 1 assessment. Updated searches were undertaken 10 October 2016 for the Inner West Council LGA and the City of Sydney LGA. No relevant listings were identified within the bounds of the study area.

4 Assessment methodology

The methodology adopted for this assessment was developed in accordance with the requirements of the Stage 2 PACHCI process (refer to **Annexure A**). The steps in the Stage 2 PACHCI process meet the requirements for the project SEARs. Key components of the methodology include:

- Desktop assessment
- Consultation with the LALC
- Archaeological survey of the study area
- Preparation of an Aboriginal heritage assessment report (this report).

4.1 Desktop assessment

The desktop assessment comprised:

- A search of OEH's Aboriginal Heritage Information Management System (AHIMS) database
- A review of the landscape context of the study area
- A review of relevant archaeological and ethnohistoric information for the study area (including a review of the previous EIS documents and Aboriginal heritage assessments for this project and area)
- Identification of areas of potential Aboriginal archaeological sensitivity within the study area.

4.2 Aboriginal community consultation

In accordance with the Stage 2 PACHCI process (refer to **Annexure A**), the following Aboriginal community consultation process was adopted:

- Identification of key Aboriginal stakeholders and the relevant LALC through searches of the National Native Title Register and Registrar of Aboriginal Owners
- Engagement of identified Aboriginal stakeholders to participate in the archaeological survey
- Preparation (by identified Aboriginal stakeholders) of a cultural heritage survey report.

Searches of the National Native Title Register and Register of Aboriginal Owners did not identify any Aboriginal stakeholders.

As is stated in the PACHCI document: "the aim of Stage 2 is to undertake further assessment and a survey with specific Aboriginal stakeholders and an archaeologist to assess a project's potential to harm Aboriginal cultural heritage, and to determine whether formal Aboriginal community consultation and a cultural heritage assessment report is required".

The MLALC was identified as the relevant LALC for this assessment. Jay Daley, a representative from MLALC, participated in the archaeological survey and reviewed the findings of this technical working paper.

4.3 Archaeological survey

The aim of the archaeological survey was to identify and record existing surface evidence of past Aboriginal activity within the study area, as well as areas of subsurface archaeological potential. The study area for this assessment was based on the project footprint (study area) comprising the footprint of all temporary (construction) and permanent (operational) project infrastructure and associated ancillary facilities. An overview of the project footprint and ancillary facilities is shown on **Figure 2-1**.

Archaeological survey for the project was undertaken by AECOM archaeologist Dr Andrew McLaren accompanied by MLALC Aboriginal Sites Officer Jay Daley on 21 September 2016. Owing to levels of past disturbance, survey was targeted, focusing on those portions of the study area that appeared,

from the examination of recent aerial photographs, to retain some Aboriginal archaeological potential. It was determined that these areas included the following construction ancillary facilities:

- Construction ancillary facilities at Haberfield (Option A), comprising:
  - Wattle Street civil and tunnel site (C1a)
  - Haberfield civil and tunnel site (C2a)
  - Northcote Street civil site (C3a)
- Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b)
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- Iron Cove Link civil site (C8)
- Campbell Road civil and tunnel site (C10).

The Crescent civil site (C6), Victoria Road civil site (C7) and Pyrmont Bridge Road tunnel site (C9) were determined to be unlikely to retain Aboriginal archaeological potential due to high levels of past disturbance and impact, and were not subject to further survey.

The archaeological survey was completed by pedestrian transects, walking those parts of the study area determined to be the least disturbed. Notes were taken on the ground surface visibility (GSV), ground integrity (GI) and archaeological sensitivity. GSV is a limiting factor in that it can obscure surface expressions, if any are present. All data was recorded on a hand-held differential global positioning system (GPS). Digital photographs were also taken. The results of the archaeological survey are discussed in **Chapter 8**.

5 Landscape context

Environmental variables such as topography, geology, hydrology and vegetation would have played a critical role in influencing how Aboriginal people moved within and utilised the landscape. Accordingly, any attempt to predict or interpret the character and distribution of Aboriginal sites in a given area must consider such environmental factors.

5.1 Topography

While the natural topography of the study area has been extensively modified through historical land use activities, available soil landscape mapping (Chapman & Murphy, 1989) indicates a varied topography linked to surface geology (**Figure 5-1** and **Figure 5-2**). Sections of the study area have been classified as being Disturbed Terrain (xx), defined as locations where: 'soils have been disturbed to a depth of at least 100 cm. Most of the original soil has either been removed, buried or greatly disturbed'. This is: 'terrain disturbed by human activity. Disturbed areas are often landscaped and artificially drained' (Chapman & Murphy, 1989:132–134). In such areas the Aboriginal archaeological component is usually either highly disturbed or completely destroyed. Outside of areas of Disturbed Terrain (xx), which are concentrated along watercourses (eg Whites Creek, Johnstons Creek, Hawthorne Canal (formerly Long Cove Creek) and Alexandra Canal (formerly Sheas Creek)), the majority of land within the study area has been mapped as belonging to one of two soil landscapes – the shale-based Blacktown (bt) soil landscape and the sandstone-based Gymea (gy) soil landscape. A small area of land adjacent to the duplicated Iron Cove Bridge forms part of the Hawkesbury soil landscape (ha).

Chapman and Murphy (1989: 30) describe the topography of the Blacktown soil landscape as consisting of gently undulating rises with local relief 10–30 metres and slopes generally less than five per cent, but up to 10 per cent. Crests and ridges are broad (200–600 metres) and rounded with convex upper slopes that grade into concave lower slopes. Bedrock outcrops are absent (Chapman & Murphy, 1989: 30-31).

The topography of those portions of the study area mapped as part of the Gymea soil landscape is described as consisting of undulating to rolling rises and low hills with local relief 20–80 metres and slopes of 10–25 per cent. Sideslopes in these areas exhibit narrow to wide (10–100 metres) outcropping sandstone benches, which often form broken scarps of less than five metres (Chapman & Murphy, 1989: 64).

The topography of the Hawkesbury soil landscape is described as consisting of rolling to very steep hills with local relief between 40 and 200 metres and slope gradients from 35 per cent to 70 per cent. Crests and ridges are convex and narrow. Slopes are moderately inclined to precipitous. Sandstone bedrock outcrops occur as horizontal benches and broken scarps up to 10 metres high (Chapman & Murphy, 1989: 45).

5.2 Hydrology

Parts of the study area are located close to Rozelle Bay and Iron Cove, both of which would have provided a range of marine resources in the past. Other named watercourses within and surrounding the study area include Whites Creek, Johnstons Creek, Hawthorne Canal (formerly Long Cove Creek), Dobroyd Canal (Iron Cove Creek) and Alexandra Canal (formerly Sheas Creek). It is likely that the study area would have been well-resourced in the past in terms of both freshwater and marine resources. However, deposits associated with Aboriginal use of these aquatic features are unlikely to have survived within the study area due to historical land use activities (eg channelisation and bank stabilisation works, residential/industrial development).

5.3 Geology & soils

Reference to the Geological Mapsheet for Sydney (9130) indicates that the surface geology of the study area incorporates two natural geological formations and one man-made geological unit, the latter comprising man-made fill (mf) (see **Figure 5-2**). Natural geological formations represented within the study area include the Ashfield Shale component of the Middle Triassic Wianamatta Group and the Hawkesbury Sandstone, also of Middle Triassic antiquity.

The Ashfield Shale is the lowermost of the Wianamatta Group formations and has been described as consisting of a 'sequence of dark-grey to black, sideritic claystone – siltstone which grades upwards into a fine sandstone – siltstone laminate' (Bembrick et al., 1991: 17). A medium to coarse-grained quartz sandstone with minor shale and laminate lenses, Hawkesbury Sandstone weathers cavernously to form overhangs (ie rockshelters) but also occurs as flatted-topped outcrops (platforms) and isolated boulders (McDonald 2008). Utilised rockshelters, grinding grooves and rock art, both engraved and pigment, are common archaeological features of this formation, which also contains stone suitable for the production of flaked stone artefacts in the form of pebbles of white vein quartz, typically less than six millimetres in diameter (Attenbrow 2010: 43; Corkill 1999: 54).

The study area also includes the highly disturbed Rozelle Rail Yards. This area has included extensive quarrying of the sandstone outcrops, excavation and levelling of soil, the laying or asphalt, concrete and rail lines and the construction of associated buildings and other structures. As a result of this past disturbance the rail yards have been classified as Disturbed Terrain (xx) soil landscapes.

Soils within the study area have been mapped as belonging to the Blacktown (bt), Gymea (gy), Hawkesbury (ha) and Disturbed Terrain (xx) soil landscapes.

5.4 Flora and fauna

The study area has been extensively cleared of its original vegetation, with road and residential development activity having significantly altered the area. Plant species present across the study area now are all regrowth. The original native vegetation is likely to have been open sandstone woodland and heathland with such species as flax-leaved wattle (*Acacia linifolia*), myrtle wattle (*Acacia myrtifolia*), smooth-barked apple (*Angophora costata*), heath banksia (*Banksia ericifolia*), blue flax lily (*Dianella caerulea*), Sydney peppermint (*Eucalyptus piperita*), scribbly gum (*Eucalyptus racemose*), prickly-leaved paperbark (*Melaleuca stypheloides*), thyme-leaved paperbark (*Melaleuca thymifolia*), basket grass (*Oplismenus aemula*) and Kangaroo grass (*Themeda australis*), with multiple types of Aboriginal use in food, medicine and manufacture (Leichhardt Council, 2012: 24). The previously disturbed Rozelle Rail Yards had become extensively overgrown with a variety of vegetation since the diminished use of the area. This necessitated the implementation of site management works to clear the vegetation in this area (see **section 6.4.2**).

Fauna species that may have been present in the area in the past include the Superb Fairy Wren (*Malurus cyaneus*), Tawny Frogmouth (*Podargus strigoides*), Southern Boobook (*Ninox boobook*), Spotted Pardalote (*Pardalotus punctatus*), Yellow Thornbill (*Acanthiza nana*), Eastern Spinebill (*Acanthorhynchus tenuirostris*), Eastern Yellow Robin (*Eopsaltria australis*), Grey Fantail (*Rhipidura albiscapa*), Red-Browed Finch (*Neochmia temporalis*), Blue-tongued Lizard (*Tiliqua Scincidae*), Eastern Banjo Frog (*Limnodynastes dumerilii*), Common Eastern Froglet (*Crinia signifera*), Peron's Tree Frog (*Litoria peronii*), Dwarf Tree Frog (*Litoria fallax*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Pied Oystercatcher (*Haematopus longirostris*) and the Eastern Bentwing-bat (*Miniopterus fuliginosus*) (Leichhardt Council, 2012: 11). Although the current area is only an indication of what species may have been in this vicinity in the Aboriginal past, it does indicate that faunal species for food and other resources would have been present. It is likely that the area was well resourced in terms of both flora and fauna in the Aboriginal past, with both land animals and marine resources accessible.

5.5 Land use

The study area has been highly disturbed throughout the process of urban development for roads, commercial/industrial development for businesses and rail, and residential areas. This includes high levels of past impact in the development and use of the Rozelle Rail Yards. This has included extensive vegetation clearance, landscape modification, channelising of creek channels, road development and the installation of related infrastructure. The level of disturbance means that any Aboriginal deposits that were present are likely to have been destroyed if they were present within the highly disturbed sections of the study area. The purpose of survey undertaken for this assessment was to ground truth any remnant areas that are less disturbed and have the potential to contain intact subsurface cultural deposits.

5.6 Key observations

Key observations from the background review of the landscape context of the study area are as follows:

- While the natural topography of the study area has been extensively modified through historical land use activities, available soil landscape mapping (Chapman & Murphy, 1989) indicates a varied topography linked to surface geology. In general, the topography of the study area can be described as undulating
- Parts of the study area are located close to Rozelle Bay and Iron Cove, both of which would have provided a range of marine resources in the past. Other named watercourses within and surrounding the study area include Whites Creek, Johnstons Creek, Hawthorne Canal (formerly Long Cove Creek), Dobroyd Canal (Iron Cove Creek) and Alexandra Canal (formerly Sheas Creek). It is likely that the study area would have been well-resourced in the past in terms of both freshwater and marine resources
- Natural geological formations represented within the study area include the Ashfield Shale component of the Middle Triassic Wianamatta Group and the Hawkesbury Sandstone, also of Middle Triassic antiquity. Utilised rockshelters, grinding grooves and rock art, both engraved and pigment, are common archaeological features of the Hawkesbury Sandstone, which also contains stone suitable for the production of flaked stone artefacts in the form of pebbles of white vein quartz, typically less than six millimetres in diameter
- The study area has been highly disturbed throughout the process of urban development for roads, commercial/industrial development for businesses and rail, and residential areas. This has included extensive vegetation clearance, landscape modification, channelising of creek channels, road development and the installation of related infrastructure. Aboriginal archaeological materials are unlikely to survive in highly disturbed areas.

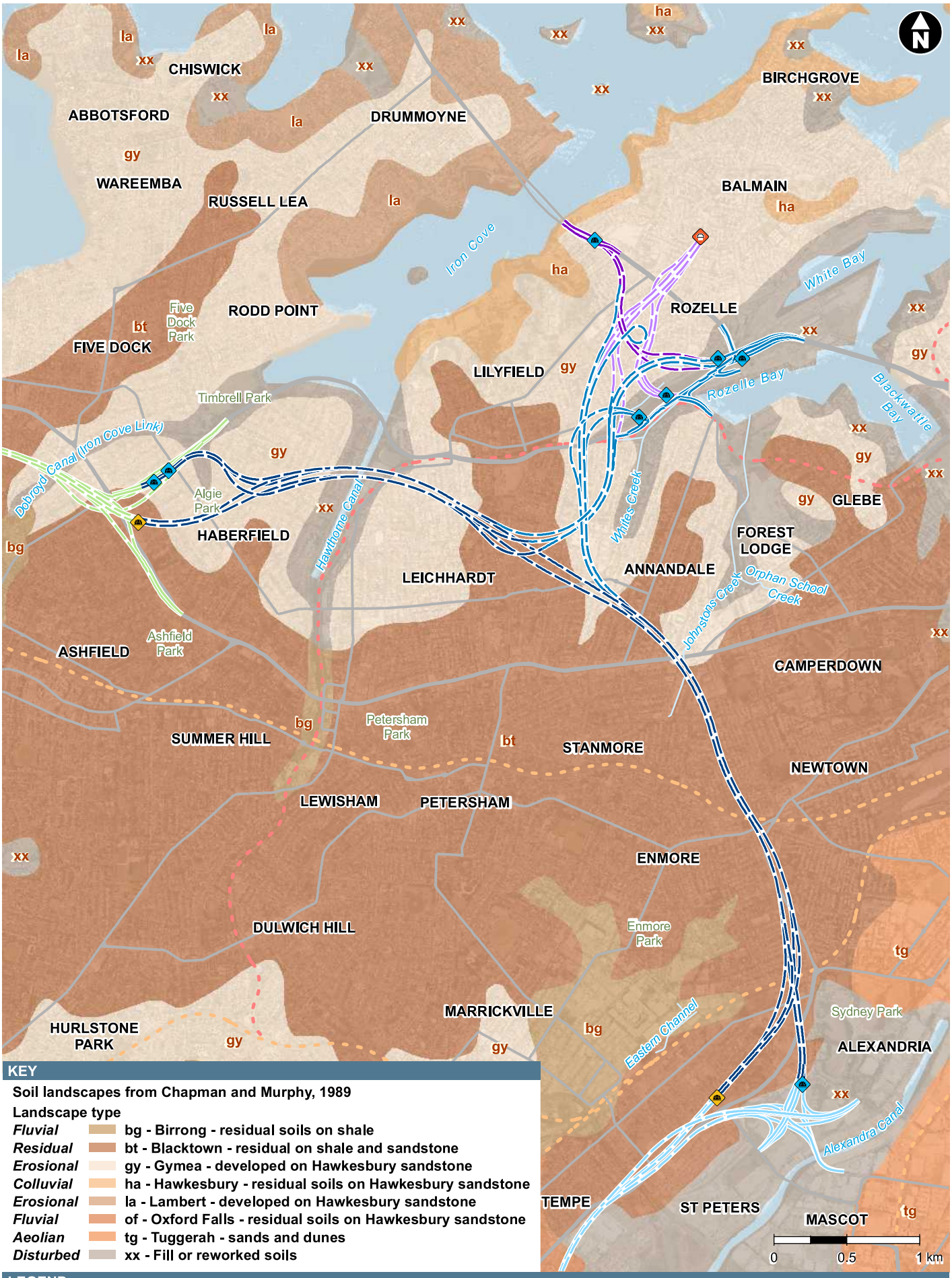
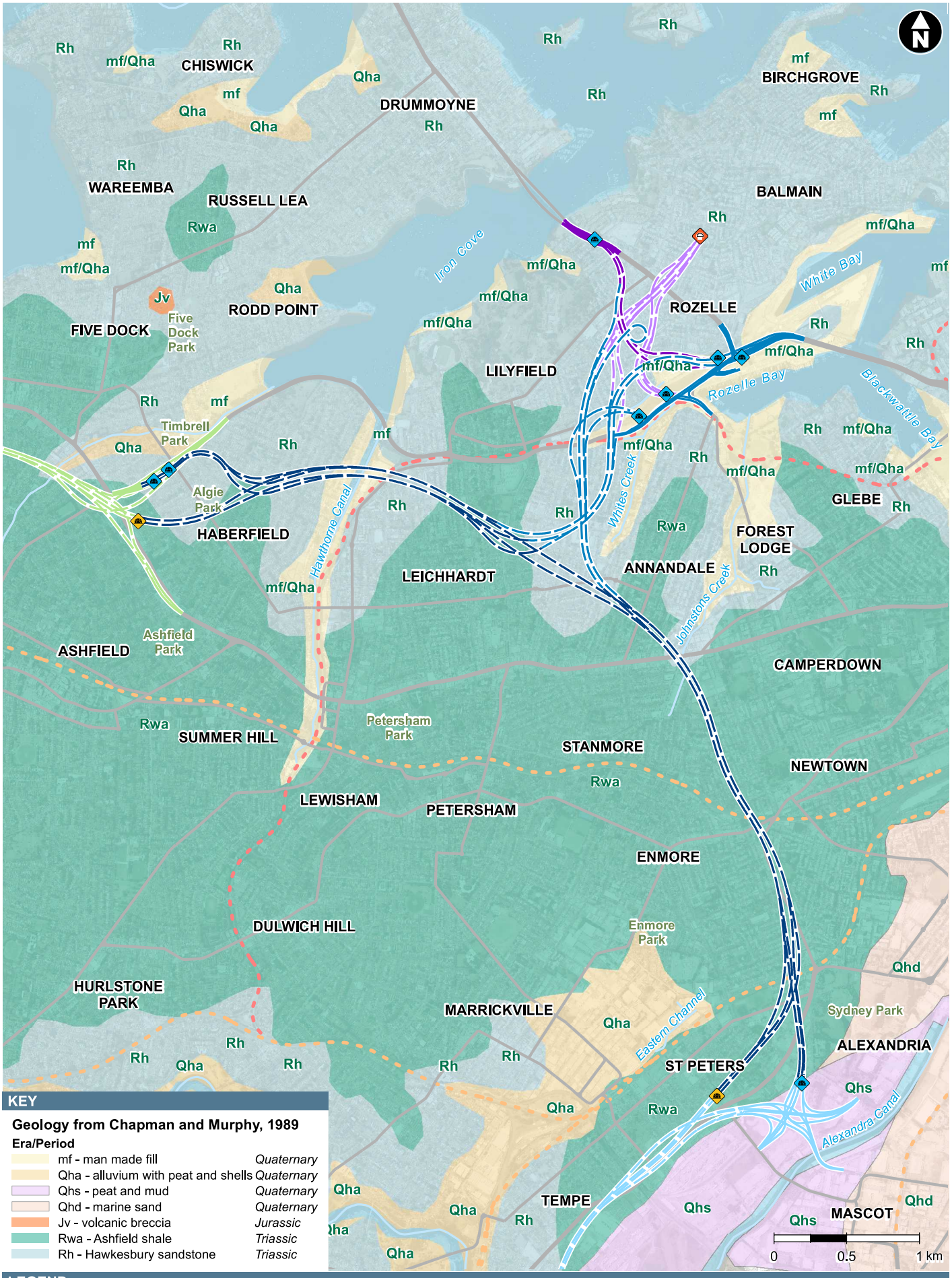


Figure 5-1 Soil landscapes



KEY

Geology from Chapman and Murphy, 1989

Era/Period		
mf	man made fill	*Quaternary*
Qha	alluvium with peat and shells	*Quaternary*
Qhs	peat and mud	*Quaternary*
Qhd	marine sand	*Quaternary*
Jv	volcanic breccia	*Jurassic*
Rwa	Ashfield shale	*Triassic*
Rh	Hawkesbury sandstone	*Triassic*

LEGEND

Existing features
- Waterway
- Railway
- Light rail
- Arterial road
- Subarterial road

Project features
- Tunnel portal
- Tunnel extent
- Tunnel connection

M4 East
- Surface road
- Tunnel

New M5
- Surface road
- Tunnel

M4-M5 Link

Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Figure 5-2 Regional geology

6 Archaeological context

6.1 The Sydney region

Available archaeological data indicate that Aboriginal people have occupied the Sydney region[1] for at least 36,000 years (Jo McDonald CHM 2005b; Williams et al. 2014). Late Pleistocene/early Holocene occupation of the region is evidenced by radiometric dates from both coastal and hinterland sites (see Attenbrow, 2010: 18, Table 3.1). Excavated material culture assemblages from these periods have been interpreted as evidence of relatively small populations of Aboriginal people employing settlement patterns of high residential and low logistical mobility (Attenbrow 2010: 152-154; McDonald 2008: 39). Late Pleistocene/early Holocene chipped stone assemblages attest to a preference for silicified tuff sourced from secondary geological sources such as the Hawkesbury-Nepean River gravels (McDonald 2008; Williams et al. 2014). However, they also indicate the exploitation of other raw material types such as silcrete, quartzite, petrified wood and quartz. Direct freehand percussion appears to have been the dominant reduction technique employed by Late Pleistocene/early Holocene Aboriginals knappers, with bipolar flaking comparatively poorly represented in available assemblages. Retouched 'tools' include unifacially-flaked pebble implements, dentated saws, burins and a variety of scrapers, with unmodified utilised flakes also well represented (Kohen et al. 1984; Williams et al. 2014). Stone tools such as these will have been complemented by a range of organic implements such as wooden digging sticks, spears and boomerangs. However, these do not survive archaeologically (Attenbrow 2010: 154).

Compared with the late Pleistocene/early Holocene, archaeological evidence for mid-to-late Holocene Aboriginal occupation of the Sydney Region abounds (for recent syntheses see Attenbrow 2010; McDonald 2008). In keeping with broader Australian developments (eg Allen and O'Connell 1995; Beaton 1985; Brumm and Moore 2005; Attenbrow et al. 2009; Lourandos 1983, 1997; Lourandos and Ross 1994), the social and economic systems of Aboriginal groups living in the region during this period appear to have become increasingly complex. Available archaeological data, for example, suggest a significant increase in site establishment and population densities over time, as well as a concomitant growth in the size and complexity of social aggregation (but see Attenbrow (2012) and Hiscock (2008) for cautionary notes on the interpretive significance of radiometric date graphs). Growing economic specialisation is indicated by the emergence and/or proliferation of complex fishing and stoneworking technologies, with the latter linked variously to increased foraging risk associated with greater climatic variability as well as other variables such as redefinition of social space, reduction of resources and increased logistical pre-equipping (Attenbrow et al. 2009; McDonald 2008: 40). Complex, long-distance exchange networks are also attested archaeologically (eg Attenbrow et al. 2012; Grave et al. 2012) as are important developments in artistic activities (McDonald 2008). Higher levels of stylistic heterogeneity in pigment and engraved art across the region, for example, have been linked to increasing territoriality (McDonald 2008: 42).

With some modification, McCarthy's (1967) *Eastern Regional Sequence* (ERS) of stone artefact assemblages remains the dominant chronological framework for Aboriginal occupation of the region. Based on appreciable changes in the composition of chipped stone artefact assemblages over time, the ERS hypothesises a three phase sequence of 'Capertian' (earliest), 'Bondaian' and 'Eloueran' (most recent) assemblages and was developed on the basis of McCarthy's (1948, 1964) pioneering analyses of stratified flaked stone assemblages from Lapstone Creek rockshelter, on the lower slopes of the Blue Mountains eastern escarpment, and Capertee 3 rockshelter in the Capertee Valley north of Lithgow. At present, the most widely cited characterisation of the ERS in the Sydney region is that of a four-phase sequence beginning with the *Pre-Bondaian* (McCarthy's *Capertian*) and moving successively through the Early, Middle and Late phases of the *Bondaian*, the last of which equates to McCarthy's (1967) *Eloueran* phase. The tripartite division of the Bondaian is based principally on the presence/absence and relative abundance of backed artefacts (Attenbrow 2010: 101). However, other factors, such as changes in the abundance of bipolar artefacts and different stone materials, as well as the presence/absence of edge-ground hatchet-heads are also relevant.

[1] Following Attenbrow (2012a), the land bounded by the coast on the east, by the Hawkesbury-Nepean River on the north and west, and by a line running east–west through Picton and Stanwell Park in the south.

Table 6-1 MCarthy's (1967) Eastern Regional Sequence (ESR) of stone artefact assemblages

Current phasing	McCarthy's (1967) phasing	Approximate date range	Backed artefact frequency	Bipolar artefacts	Edge-ground hatchet heads
Pre-Bondaian	Capertian	40,000-8,000 BP	Absent	Rare	Absent
Early Bondaian	Bondaian	8,000-4,000 BP	Very low	Rare	Absent
Middle Bondaian		4,000-1,000 BP	Very high	Increasingly common	Present
Late Bondaian	Eloueran	1,000 BP to European contact	Low	Very common	Present

6.2 The Port Jackson Archaeological Project

The Port Jackson Archaeological Project (PJAP) was initiated by Val Attenbrow (Senior Fellow, Australian Museum) as a vehicle for investigating pre-colonial Aboriginal land and resource use patterns in the Port Jackson catchment (Attenbrow 1990, 1991, 1992a, 1992b, 1994). Still ongoing, the PJAP has generated a substantial body of data concerning pre-contact Aboriginal occupation of the catchment and remains one of the comprehensive sources of data on Aboriginal archaeological site distribution within it. Alongside desktop analyses of AHIMS and privately-held site data, the PJAP has involved the relocation and re-recording of numerous previously identified (but poorly described) sites as well as targeted survey in parts of the catchment with few, if any, sites. Archaeological excavations have also been undertaken at several sites (eg Attenbrow et al. 2008; Attenbrow 1992a), with analysis of recovered cultural materials completed for some sites but not others. Of particular interest here are the results of Attenbrow's (1990, 1991) analysis of the distribution of then known shell middens and open archaeological deposits within the catchment (n = 369, with 335 middens and 34 open deposits respectively), with eight sub-catchments recognised on the basis of major rivers and creeks and further subdivided into freshwater, estuarine and ocean zones (**Figure 6-1**).

Key patterns to emerge from Attenbrow's analysis were as follows:

- Shell middens occur only in sub-catchments with estuarine and/or ocean zones. Shell is present in freshwater zone sites but in quantities insufficient for their classification as middens (**Figure 6-1**)
- Archaeological deposits tend to occur in freshwater zones (**Figure 6-1**)
- The majority of sites are located in areas underlain by Hawkesbury sandstone, with comparatively few sites located in areas underlain by Wianamatta Shale
- Most sites occur within council reserves or on undeveloped Crown Land
- Middens and deposits occur in higher densities in sub-catchments that include estuary mouths
- Most middens and deposits occur in rockshelters as opposed to 'open' contexts
- Most middens and deposits occur on landform elements within 10 metres of high water level (ie in foreshore zones)
- Ridgetops and ridge-side sites are comparatively poorly represented.

The distributional patterning revealed by Attenbrow's (1991) analysis can be interpreted in a number of ways. Taken at face value, site distribution patterns suggest an occupational emphasis on coastal/estuarine environments and the Hawkesbury Sandstone, with hinterland/freshwater environments and areas underlain by Wianamatta shales less intensively utilised. Greater numbers of people living in these areas can also be inferred. However, as Attenbrow (2010: 51) has cautioned, equating larger numbers of sites with increased activity and/or populations without taking into

consideration the size and contents of these sites, as well as the effects of natural and anthropogenic processes is, at best, problematic. Variations in the numbers and densities of Aboriginal sites between aquatic zones and geological formations must be interpreted with due reference to such variables. Key issues for the Port Jackson catchment include marked differences in levels of archaeological site visibility and preservation potential between areas, variable urban and industrial development pressures and archaeological sampling bias (Attenbrow 2010: 52). Whilst recognising the distributional biases introduced by such variables, reference to the results of large scale surveys in comparatively undisturbed estuarine areas to the north of the Hawkesbury River (eg Vinnicombe 1980) suggest that the general trends in site distribution revealed by the PJAP may, at least in part, reflect the original distribution of these sites (ie more sites and deposits along shores compared with slopes and very few sites on ridgetops). As Attenbrow (2010: 53) has suggested, it seems reasonable to conclude that 'many activities, including those relating to tool-making which probably happened at base campsites, took place close to the estuarine and freshwater waterways as well as the marine shorelines'.

Table 6-2 Port Jackson catchment: number of shell middens and archaeological deposits in each sub-catchment (after Attenbrow 2010: 51, Table 5.1)

Sub-catchment	Area (km2)	Aquatic zone(s)	No. of middens	No. of arch. deposits	Density (no./sq km)
1. Middle Harbour	92.5	F; Est; O	171	7	1.9
2. Lane Cove River	96.5	F; Est	86	9	0.98
3. Vineyard Creek	41	F; Est	36	2	0.92
4. Darling Mills Creek	32.5	F	0	10	0.3
5. Upper Parramatta River	71	F	0	3	0.04
6. Duck River	81	F; Est	0	3	0.04
7. Concord to Sydney Harbour Bridge	50	F; Est	20	0	0.4
8. Sydney Harbour Bridge to South Head	20.5	F; Est; O	22	0	1.1
Total	**485**	**-**	**335**	**34**	**-**

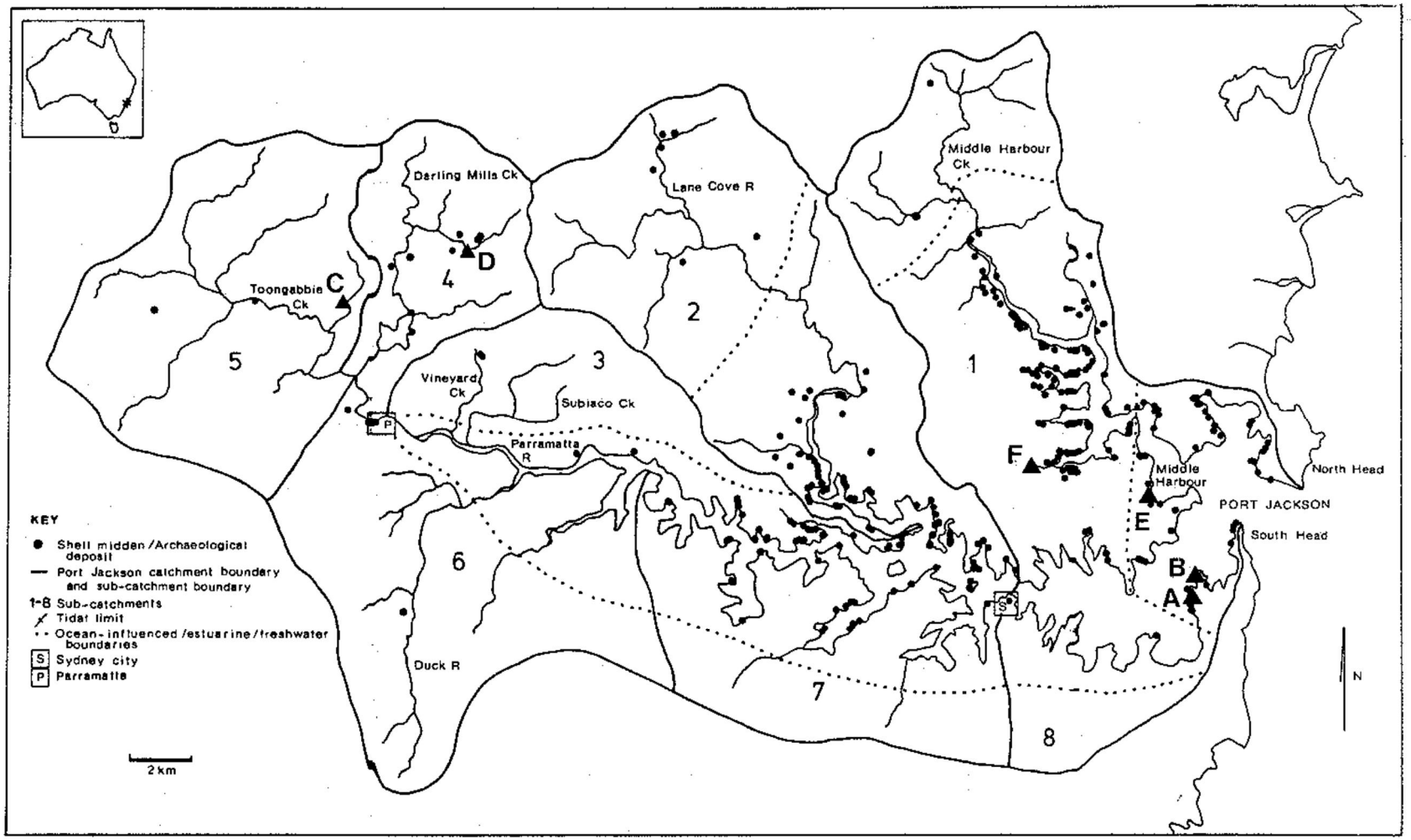


Figure 6-1 Map of the Port Jackson catchment

Map of the Port Jackson catchment showing Attenbrow's (1991) sub-catchments and zones, previously recorded shell middens and archaeological deposits (as at 1994) and the location of excavated rockshelter sites (A = Mt Trefle; B = Hydrofoil; C = John Curtain Reserve; D = Darling Mills Creek; E = Balmoral Beach; and F = Cammeray) (after Attenbrow 1994: 3, Fig. 1)

6.3 The Cumberland Plain

Concentrated archaeological investigation of the Aboriginal archaeological record of Sydney's Cumberland Plain can be traced to the early-to-mid 1980s, a period marked by a rapid growth in residential and other forms of development across the Plain. Intensive development activities since this time have secured the Cumberland Plain's place as one of the most intensively investigated archaeological regions in Australia, with hundreds, if not thousands, of Aboriginal archaeological investigations involving survey and/or excavation having now been undertaken, the majority as part of larger environmental impact assessments associated with residential development and affiliated infrastructure projects. Unsurprisingly, these investigations have varied significantly in scale and scope, ranging from targeted small-scale surveys to complex, multi-phase survey and excavation projects over large areas. Nonetheless, together they have revealed a rich and diverse record of past Aboriginal occupation, with thousands of Aboriginal archaeological sites now registered on OEH's AHIMS database. Key investigation themes are detailed in brief below.

6.3.1 Open artefact sites: Distribution, contents and definition

Surface and subsurface distributions of stone artefacts, variously referred to as open artefact sites, open sites and open camp sites are the most common and widely distributed form of Aboriginal archaeological site on the Cumberland Plain (see Attenbrow 2010: Plate 12; Przywolnik 2007: 46, Table 4.2). Other site types, such as scarred trees, quarries, grinding grooves and rock shelters with deposit and/or art or Potential Archaeological Deposits (PAD), have also been identified but are comparatively rare. Accordingly, open artefact sites remain the most intensively investigated component of the Aboriginal archaeological record of the Cumberland Plain, with site distribution and the technology of associated flaked stone artefact assemblages, in particular, comprising key research topics (eg Australian Museum Business Services (AMBS) 2000; Craib et al. 1999; Jo McDonald CHM 2001, 2003, 2005a, 2006a, 2006b, 2006c, 2007, 2009a, 2009b; Kohen 1986; White & McDonald 2010).

Existing archaeological survey data for the Cumberland Plain indicate a strong trend for the presence of open artefact sites along watercourses, specifically, on creek banks and 'flats' (ie flood/drainage plains), terraces and bordering lower slopes. Although this distribution pattern can be attributed in part to geomorphic dynamics and archaeological sampling bias, with extensive fluvial erosion activity along watercourses resulting in higher levels of surface visibility and, by extension, concentrated survey effort, an occupational emphasis on watercourses is supported by the results of numerous subsurface investigations (eg AECOM 2013b, 2015; AMBS 2000; Craib et al. 1999; GML 2012; Jo McDonald CHM 2001, 2003, 2005a, 2006a, 2006b, 2007, 2009a, 2009b). Collectively, these investigations have demonstrated that assemblage size and complexity tend to vary significantly in relation to stream order and landform, with larger, more complex[2] assemblages concentrated on elevated, low gradient landform elements adjacent to higher order watercourses. Outside of these contexts, surface and subsurface artefact distributions have typically been found to be sparse and discontinuous and are often referred to as 'background scatter', being 'artefactual material which is insufficient in number or in association with other material to suggest focussed activity in a particular location' (Douglas and McDonald 1993).

Flaked stone artefacts dominate archaeological finds assemblages from recorded open artefact sites on the Cumberland Plain, with heat shattered rock also well represented. Items such as complete and broken grindstones, hammerstones and edge-ground hatchet heads have also been recorded though comparatively infrequently. With the notable exception of 'knapping floors', a relatively common component of the Aboriginal archaeological record of the Cumberland Plain, associated archaeological features (eg hearths and heat treatment pits) have likewise proven elusive (but see AHMS 2013; McDonald and Rich 1994; Jo McDonald CHM 2009a for examples). Investigated knapping floors across the Plain have varied considerably in size and complexity, with the largest and most complex examples identified through excavation as opposed to surface survey (eg Jo McDonald CHM 2001, 2005a, 2006b, 2007). Backed artefacts (ie Bondi points, geometric microliths and elouera)

[2] Those containing a wider variety of raw materials and technological types and/or higher mean artefact densities and features such as knapping floors.

are a common feature of knapping floors and most of these features were likely specifically associated with their production. As in other NSW contexts, most notably the Hunter Valley (eg Hiscock 1993; Moore 2000), available evidence supports the suggestion that backed artefact manufacture on the Cumberland Plain was a highly structured or systematic activity.

Although relevant to a variety of site types, geomorphic processes such as soil erosion and colluvial/fluvial aggradation are of particular relevance to the identification and definition of open artefact sites. As in other archaeological contexts (eg Dean-Jones & Mitchell 1993; Fanning & Holdaway 2004; Fanning et al. 2009; Holdaway et al. 2000), it is now widely accepted by archaeologists working on the Cumberland Plain that the visibility of open artefact sites across the Plain can, for the most part, be attributed to contemporary and/or historical geomorphic processes which have variously exposed or obscured them. As demonstrated by numerous large scale salvage projects across the Cumberland Plain, surface artefacts invariably represent only a fraction of the total number of artefacts present within recorded surface open artefact sites, with a typical surface to subsurface artefact ratio of 1:25 proposed (Jo McDonald CHM 2005b: 35). Artefact exposure, unsurprisingly, is highest on erosional surfaces and lowest on depositional ones. At the same time, in many areas, surface artefacts have been shown through dispersed testing to form part of more-or-less continuous subsurface distributions of artefacts, albeit with highly variable artefact densities linked to environmental variables such as distance to water, stream order and landform (eg White & McDonald 2010). Critically, the presence or absence of surface artefacts on the Cumberland Plain is not a reliable indicator of Aboriginal archaeological sensitivity.

6.3.2 Flaked stone artefact technology

Virtually indestructible, flaked stone artefacts are a ubiquitous element of the Aboriginal archaeological record of the Cumberland Plain and have assumed a prominent position in archaeological reconstructions of past Aboriginal land use across the region. To date, hundreds, if not thousands, of surface-collected and excavated flaked stone assemblages from across the Cumberland Plain have been analysed, with individual assemblage sizes, research questions, aims, analytical methodologies and terminological schemes varying significantly between researchers and projects. Studies to date have ranged from basic descriptive accounts of assemblage composition in typological terms to detailed reconstructions of past stone reduction and quarrying behaviours through rigorous technological analyses. Particularly informative analyses in the context of the Cumberland Plain include those conducted by Jo McDonald CHM (2001, 2003, 2005a, 2006a, 2006b, 2006c, 2007, 2009a, 2009b) as part of archaeological salvage projects associated with development activities within the Rouse Hill Development Area (RHDA), the former Australian Defence Industries (ADI) site at St Marys and the Colebee Release Area. Technological analyses of stone artefact assemblages recovered from fluvial sand bodies adjacent to the Parramatta (Jo McDonald CHM, 2005b, 2005c, 2006b) and Hawkesbury Rivers (AHMS 2013; Williams et al. 2012) have likewise proven highly informative, particularly with respect to the documentation of diachronic changes in raw material use and stone artefact technologies.

Available technological and typological data for surface collected and excavated flaked stone artefact assemblages from the Cumberland Plain suggest that the majority of these assemblages belong to what is known as the 'Australian small-tool tradition', a term coined by Gould (1969) to describe what was then thought to be the first appearance, in the mid-Holocene[3], of a new suite of flaked stone tool forms in the Aboriginal archaeological record of Australia, including backed artefacts, adzes and points (both unifacially and bifacially flaked). Complex, hierarchically-organised reduction sequences associated with the production of these tools contrast markedly with the simple sequences of earlier periods (Moore 2011). Tools of the Australian small-tool tradition, it has been suggested, formed part of a portable, standardised and multifunctional tool kit aimed specifically at risk reduction (Hiscock 1994, 2002, 2006). Stone artefact assemblages from late Pleistocene and early Holocene contexts, in contrast, are described by archaeologists as belonging to the 'Australian core tool and scraper tradition', a term first used by Bowler et al. (1970) to describe the Pleistocene assemblages recovered

[3] More recent research into the chronology of backed artefacts and points in Australia (eg Hiscock & Attenbrow 1998, 2004; Hiscock 1993b) has demonstrated a long history of production and use for these implement types, with both types now known to have been produced, albeit in small numbers, in the early Holocene and likely in the late Pleistocene as well.

from Lake Mungo in western New South Wales. Bowler et al. (1970) saw the main components of these assemblages – core tools, steep-edged scrapers and flat scrapers – as characteristic of early Australian Aboriginal assemblages and as being of a distinctly different character to those associated with the proceeding small-tool tradition. In south-eastern Australia, including the Cumberland Plain, the Australian 'small-tool' and 'core tool and scraper' traditions are most commonly described in terms of McCarthy's (1967) ERS, with 'Capertian' assemblages assigned to the latter tradition and 'Bondaian' assemblages, the former.

Flaked stone artefact assemblages from excavated and surface collected open artefact sites on the Cumberland Plain attest to the exploitation of a diverse range of lithic raw materials (Corkill 1999, 2005). However, two rock types – silcrete and silicified tuff (also known as indurated mudstone) – dominate the region's existing stone artefact record. Other, less commonly exploited raw materials represented in excavated and surface collected assemblages include quartz, quartzite, petrified wood, chert and various fine-grained volcanics. Alongside silcrete and silicified tuff, these materials occur variously in a number of geological formations and units across the Cumberland Plain (for a detailed review see Corkill 1999). Oft-cited sources, for example, include the Tertiary St Marys (Ts) and Rickabys Creek Gravel (Tr) formations, as well as the various unconsolidated Pleistocene units that line as terraces the present day and abandoned channels of the Nepean-Hawkesbury River (eg Agnes Bank Sand (Qpa) and Cranebrook Formation (Qpc)).

In common with the Sydney region as a whole (Attenbrow 2010: 120-121), various excavated assemblages from the body and peripheries of the Cumberland Plain (eg Jo McDonald CHM 2001a, 2005a; Williams et al. 2012; Williams et al. 2014) attest to a shift, over time, in the relative significance of particular raw materials for flaked stone artefact manufacture, principally silcrete and silicified tuff but also quartz. An 'early' (ie Pre-Bondaian) emphasis on the procurement and reduction of silicified tuff, for example, appears to have given way to a 'later' (ie Bondaian) emphasis on silcrete. Quartz use, meanwhile, appears to have peaked in the late Holocene. For the Cumberland Plain, these changes have been linked, in particular, to broader changes in settlement organisation, with a decline in levels of residential mobility over time prompting more intensive use of locally available stone (Jo McDonald CHM 2005a).

In the northwestern portion of the Cumberland Plain, the Tertiary St Marys Formation has been singled out as a particularly important source of silcrete for stone artefact manufacture. Mapped at various localities across the Mulgoa Creek, South Creek and Eastern Creek catchments, the best known and most intensively investigated outcrops of this formation occur on Plumpton Ridge, a low but locally prominent ridgeline separating the floodplains of Eastern and Bells Creek between the suburbs of Plumpton and Riverstone. The subject of numerous archaeological investigations since the early 1980s (eg AMBS 2002b; Baker 1996; McDonald 1986), recent large-scale archaeological salvage works across what is now Stonecutters Ridge Golf Club have unequivocally identified Plumpton Ridge as a major Aboriginal quarry site (Jo McDonald CHM 2006c). At the same time, they have highlighted a number of important trends in relation to the procurement and reduction of silcrete obtained from this source. Trends in the relative frequencies of raw material types, artefact types and the size of silcrete artefacts in local excavated assemblages, for example, have been attributed to a process of 'distance-decay'. As one of only three systematically investigated Aboriginal quarry sites on the Cumberland Plain, the other two being the ADI-EPI and ADI-FF22 sites within the former ADI site at St Marys (Jo McDonald CHM 2006a, 2008a), Plumpton Ridge is widely regarded as a feature of high scientific and cultural significance.

Backed artefacts dominate the retouched components of the majority of dated and undated Bondaian assemblages from the Plain and, as such, the technology of their manufacture has received considerable analytical and interpretive attention. Studies by Jo McDonald CHM (2001, 2003, 2005a, 2006a, 2006b, 2007, 2009a, 2009b), in particular, have demonstrated that backed artefact manufacture on the Cumberland Plain was a highly structured or systematic activity involving a complex system of raw material procurement, transportation, preparation and reduction. Differences in the technological character of recovered cores across the region attest to a significant degree of variability in the methods used by Aboriginal knappers to produce flakes for backed artefact manufacture. However, certain techniques (eg asymmetric alternating flaking and Hiscock's (1993) 'tranchet technique') are particularly well represented. Evidence for the deliberate heat treatment of silcrete blanks, both as part of systematic backed artefact manufacture activities and other reduction activities, is abundant and widespread, with excavated and surface collected assemblages attesting to the use of heat at various points in the reduction process. As in other contexts (eg Hiscock 1993),

the thermal alteration of Cumberland Plain silcrete appears to have significantly improved the flaking quality of the stone, increasing the lustre and smoothness of fracture surfaces.

6.3.3 Chronology of occupation

In common with the Sydney region as a whole, evidence for late Pleistocene/early Holocene (ie Pre-Bondaian/Early Bondaian) Aboriginal occupation of the Cumberland Plain is sparse, with confirmed or potential evidence from these periods obtained from a limited (less than 15) number of sites. Examples include Rouse Hill sites RH/CC2 (Jo McDonald CHM 2001), RH/SC5 (Jo McDonald CHM 2002b), RH/CD12 (Jo McDonald CHM 2002a) and RHCD7 (Jo McDonald CHM 2007); Richmond site RMI (Jo McDonald CHM 1997a); PT12 near Pitt Town (Williams et al. 2012; Williams et al. 2014); Power Street Bridge 2, Doonside (McDonald 1993), Regentville RS1, Regentville (Koettig & Hughes 1995; McDonald et al. 1996), the Parramatta CBD (AHMS 2013; Austral Archaeology, 2007; Jo McDonald CHM, 2005b, 2005c, 2006b) and the Windsor Museum site (Austral Archaeology 2011; Williams et al. 2012; Williams et al. 2014). Claims of a c.40 ka year old date for five 'flaked pebbles' recovered from a gravel pit associated with the Cranebrook Terrace near Penrith (Nanson et al. 1987) have been widely questioned, with legitimate concerns raised over the artefactual status of these pebbles, their provenance and association with available dates. For most sites, late Pleistocene/early Holocene occupation has been inferred on the basis of the technological and typological characteristics of recovered flaked stone artefact assemblages as opposed to radiometric dates.

At present, the oldest securely dated archaeological site on the Cumberland Plain is the PT12 site at Pitt Town, with compliance-based archaeological excavations across a source-bordering dune at this site, which overlooks the Hawkesbury River, producing a suite of OSL dates suggestive of Aboriginal occupation from at least 36,000 years ago (and potentially earlier) (Williams et al. 2012; Williams et al. 2014). Closer to the coast, Late Pleistocene/early Holocene occupation of a sandy fluvial terrace adjacent to the Parramatta River (ie the Parramatta Sand Sheet) has been by proposed by Jo McDonald CHM (2005b, 2005c, 2006b) and seems likely on the basis of available radiometric dates and assemblage characteristics.

In stark contrast to the late Pleistocene/early Holocene, evidence for mid-to-late Holocene (ie Middle to Late Bondaian) Aboriginal occupation of the Cumberland Plain abounds, with numerous excavated sites producing assemblages that can be confidently assigned to these periods on the basis of radiometric dates and/or their typological/technological profiles. Available radiometric dates indicate a steady increase in the number of sites occupied over the course of the Holocene, with a peak in the 2nd millennium BP (see, for example, Przywolnik 2007: 53, Fig. 4.6). Taken at face value, these data suggest a progressive increase in the Aboriginal population of the Cumberland Plain over the course of the Holocene. However, as argued by Hiscock (2008), albeit on a national scale, it seems likely that the directional population growth suggested by such data is, to a certain extent at least, a product of differential site preservation, with younger sites better preserved than older ones. Other factors, such as the burial of older sites through sediment deposition and bias in the location of archaeological surveys and excavations, may also be relevant.

Critical to any discussion concerning the antiquity of Aboriginal occupation across the Cumberland Plain are the well-documented difficulties surrounding the dating of open artefact sites with active 'biomantles' (sensu Paton et al. 1995; see Dean-Jones & Mitchell, 1993; Balek 2002; Hofman 1986; Johnson et al. 2005; Johnson 1989; Paton et al. 1995; Peacock & Fant 2002; Stein 1983). On the Cumberland Plain, the term biomantle is typically used as a collective descriptor for the 'A' soil horizons of the Plain's dominant texture contrast or duplex soil profiles[4], which tend to be relatively thin (less than 30 centimetres), and exhibit extensive evidence of bioturbation in the form of roots, open/infilled burrows, live insects and/or earthworms and stone lines[5]. However, the uppermost portions of underlying 'B' soil horizons can also exhibit such evidence and form part of the biomantle (eg AECOM 2015). As highlighted by Dean-Jones & Mitchell (1993) and others (eg Balek 2002;

[4] Such profiles are characterised by loamy topsoils and silty clay to clay subsoils, with boundaries between these two units typically clear to abrupt. Clayey subsoils have formed by *in situ* weathering of the parent material, while topsoils are derived from a combination of *in situ* weathering and the deposition of colluvially and/or fluvially transported materials.

[5] Stone lines, where present, typically occur at the interface between the A and B horizons.

Johnson 1989), excavated finds assemblages from archaeological sites with active biomantles are subject to a range of interpretive constraints, with intact depositional stratigraphy unlikely to be preserved and inset archaeological features (eg hearths and heat treatment pits) representing the only reliable means of dating (with any specificity) intercepted archaeological events (Mitchell 2009: 4). Any stone artefacts discarded at the surface in landscapes with active biomantles are likely, over time, to have been incorporated into the soil profile through bioturbation, with depth of artefact burial ultimately corresponding to the base of major biological activity (ie the base of the biomantle). Where biomantles remain relatively undisturbed, patterns of artefact discard may be preserved. However, in heavily disturbed contexts, the preservation of such patterning is unlikely (Mitchell 2009: 4).

For archaeologists working on the Cumberland Plain, the analytical and interpretive constraints posed by intensive bioturbation have, in combination with a real paucity of dateable features, led to a reliance on the dating of excavated archaeological finds assemblages through relative means, specifically, through consideration of the typological and technological composition of associated flaked stone artefact assemblages and reference to a modified version of McCarthy's (1967) ESR, the broad temporal parameters of which are now well established. While offering a useful chronological framework within which to assess diachronic changes in the stone artefact technologies and raw material use, the largely undated and palimpsest character of the Plain's lithic record represents a significant analytical and interpretive obstacle for period-specific reconstructions of Aboriginal mobility regimes (cf. Cowan 1999). Well dated assemblages from sites retaining stratified deposit(s) are rare, with the most comprehensively dated sequences to date coming from deep fluvial sand bodies adjacent to the Hawkesbury and Parramatta Rivers (ie AHMS 2013; Jo McDonald CHM 2005c; Williams et al. 2012, 2014). While the preservation and dating potential offered by such bodies has been amply demonstrated, the same cannot be said of alluvial valley fill sequences outside of these major river valley contexts, with comparatively little research directed towards investigating the age, genesis or evolution of alluvial valley fill sequences within the Cumberland Plain's numerous creek valleys, nor their potential for preserving at depth (ie within buried paleosols) Aboriginal archaeological materials of varying ages, including those of Late Pleistocene/Early Holocene antiquity (but see AHMS 2015; Barham 2005, 2007; Jo McDonald CHM 2005a for notable exceptions). Nonetheless, the limited work that has been conducted in this regard suggests considerable research potential, particularly with respect with the development of chronological frameworks for contextualising and interpreting flaked stone artefact assemblages recovered from such sequences.

6.3.4 Site distribution and occupation models

A number of Aboriginal site distribution and occupations models have been proposed for the Cumberland Plain over the past four decades, with early models (eg Kohen 1986; Smith 1989) based almost exclusively on surface evidence and more recent models (eg AMBS 2000; Jo McDonald CHM 1997b) taking into account both surface and excavated evidence. As indicated in **Table 6-3**, Aboriginal site distribution on the Cumberland Plain has been linked to a variety of environmental factors, with proximity to water, stream order, landform and geology (including proximity to known stone sources) variously highlighted as key determinants.

Table 6-3 Aboriginal site distribution and occupation models for the Cumberland Plain

Researcher(s)	Year	Summary of model
Dallas and Witter	1983	· Sites closer to silcrete and other raw material sources will tend to contain more cores and waste chips and less utilised material than sites which are located further away. They will also contain more block fractured pieces, a higher frequency of cortex, and the artefacts will generally be larger than those at sites not associated with raw material sources · In areas of raw material abundance, artefacts will be discarded earlier in the reduction sequence and will generally be larger and occur in a variety of forms · Raw material abundance, quality and size will influence assemblage variability · Sites located away from raw material sources will exhibit a wider variety of activities and a higher number of utilised pieces than those closer to them.
Kohen	1986	· Proximity to water and geological context key determinants for site location · Sites can be categorised as one of three types according to their function: · camping sites, which have a wide range of activities represented in the archaeological record · woodworking sites, where there is a high proportion of implements to debitage present · hunting sites, which contain a relatively small number of unworked flakes and are sometimes associated with backed blades · Greatest proportion of sites located on Wianamatta Shale substrates · Number of artefacts found at a site and site size more closely correlated to the nature and degree of disturbance at a site than any behavioural factors. The more disturbed the site, the greater the visibility and hence the greater quantity of artefacts recorded · Sites with high artefact densities tend to be found within 100 metres of permanent water sources.
Smith	1989	· Sites are most likely to occur in association with water sources. Permanency of the water source, however, is not a determining factor for site location, with a significant quantity of sites found along temporary creek lines · Sites on the Londonderry Clay/Rickabys Creek Formation are likely to be found in association with gravel exposures · Sites dominated by silcrete are less likely to be found west of Marsden Park and South Creek than east of those areas. Isolated finds in these areas are also less likely to be made from silcrete · Sites east of South Creek are likely to be principally stone tool and silcrete manufacturing and processing sites · Sites in the northern Cumberland Plain are expected to have a lower frequency of implements than those in the south · Woodland areas will typically contain sites at lower densities than open forest areas

Researcher(s)	Year	Summary of model
		· Surface sites appear to be more common than subsurface sites, and undisturbed stratified sites are rare due to the degree of disturbance · Sites with over 50 artefacts are rare, although very large sites (500+ artefacts) do occur. There is no apparent patterning to the occurrence of these large sites. The pattern of distribution of site size appears to be determined predominantly by visibility · Sites cannot be divided neatly into 'single use' categories, as most sites were the location of numerous activities.
Jo McDonald CHM	1997b	· Open sites with subsurface archaeological deposits are the most commonly occurring sites · Sites cannot be adequately characterized on the basis of surface evidence alone · Where open sites are found in stable and aggrading landscapes, many will be intact and have the potential for internal structural integrity, with sites in alluvium and other depositional environments containing the best potential for intact archaeological remains and stratification · Many sites contain extremely high artefact densities, with variability depending on the range of activity areas and site types present · Artefacts are not evenly distributed across the landscape. Site patterning can be related to broad environmental factors, with sites on permanent water being more complex than those situated on ephemeral or temporary water lines. However, there is not always a direct correlation between site location and the environment · Major confluences, particularly along major creeks, are prime site locations · Proximity to water and underlying geological units are key factors in site distribution. However, distribution can be further measured according to stream order, with sites located in close proximity to established, permanent, and resource rich drainage channels (eg 3rd and 4th order creeks) are more likely to have higher artefact densities and a greater diversity of tools than sites associated with lower order water courses · Temporary water sources and minor gullies tend to have single-use or occasionally repeated visits and hence lower density sites · Locations between creeks, such as ridge-tops and spurs, may possibly contain archaeological evidence, which may vary according to proximity to water sources · Sites in close proximity to an identified stone source will contain a range of size and cortex characteristics in their assemblages. As distance increases from the source, artefact size and percentage of cortex in the assemblage will decrease.
AMBS	2000	· Spatial patterning in chipped stone artefact distributions adjacent to major creek lines can – in certain instances – be accommodated under a three-tiered model of 'Activity Overprint Zones' incorporating 'complex', 'dispersed' and 'sparse' zones · Complex zones will exhibit overlapping knapping floors and high density concentrations of artefacts indicative of repeated, long-term occupation events · Dispersed zones may include knapping floors. However, these are

Researcher(s)	Year	Summary of model
		typically spatially discrete due to less frequent occupation · Sparse zones will exhibit consistently low frequencies/densities of artefacts. Artefact discard in these zones is likely to have resulted from discard in the context of use or loss rather than manufacture · Flaked stone artefact production and maintenance will leave a more obtrusive archaeological signature than resource extraction (eg food collection and processing). These activities will also occur closer to the residential core while resource extraction will typically occur away from it.

White and McDonald's (2010) analysis of lithic artefact distribution in the RHDA provides a suitably robust dataset for assessing the validity of some of the key predictions of the models outlined above. Based on the results of over a decade of intensive test excavation in the RHDA, this study remains the most comprehensive of its type currently available for the Cumberland Plain. As indicated, Aboriginal site distribution on the Cumberland Plain has been linked to a variety of environmental factors, with distance to water, stream order, landform and geology (including proximity to known stone sources) variously highlighted as important influences. White and McDonald's (2010) analysis both supports and negates various aspects of the postulated relationships between these factors and Aboriginal site patterning on the Cumberland Plain. Key findings can be summarised as follows:

- Artefact distributions do not, as implied by the models of Kohen (1986) and Smith (1989), form bounded 'sites' but rather 'landscapes'
- Artefact distribution does, as variably expressed by AMBS (2000), Kohen (1986), Jo McDonald CHM (1997b) and Smith (1989), appear to vary with proximity to water, albeit to different extents based on stream order
- Artefact density does, as suggested by Jo McDonald CHM (1997b), appear to vary significantly with stream order
- Artefact density does, as suggested by Jo McDonald CHM (1997b), appear to vary significantly with landform
- Aboriginal archaeological sites on the Cumberland Plain cannot, as proposed by Jo McDonald CHM (1997b), be adequately characterised on the basis of surface evidence alone. Most areas, regardless of surface indications, contain subsurface archaeological deposit(s)
- The orientation of open land surfaces appears to have influenced the selection of artefact discard locations in the lower portions of valleys, with generally higher densities on lower slopes facing north and north-east
- Distance from known silcrete sources does not, on present evidence at least, appear to have influenced intensity of artefact discard (cf. Dallas & Witter 1983)
- Trends in artefact density and distribution indicate long-term, large scale patterns. Short term models of settlement organisation are insufficient to account for these artefact distributions.
- Social and/or symbolic factors may have influenced site selection along with the distributions of economic and other resources.

6.4 Local context

6.4.1 Aboriginal Heritage Information Management System

A search of the AHIMS database was undertaken on 21 September 2016 (search number #246070) (search results are included in **Annexure B**). The search area was a rectangular shape containing the study area centred within its bounds. The reason for the larger search area was to provide a buffer around the study area and ascertain the spread of previously recorded Aboriginal sites across the wider region. The search results identified that there were no previously recorded sites within the bounds of the study area (see **Figure 6-2**).

Within the search area (an 11 kilometre by nine kilometre area centred on the study area), a total of 49 AHIMS sites were identified. These predominantly occur in coastal fringe areas and were most commonly midden and rockshelter sites.

Consideration of the location of previously recorded sites indicates that none are located within the study area, with the closest site – rockshelter with midden #45-6-2278 – mapped as occurring about 50 metres to the north of the Rozelle Rail Yards. The site is located above an area proposed for subsurface tunnel construction. Access to AHIMS site #45-6-2278 has not been provided due to its location within private property but the area containing it has been subject to a separate study to determine potential vibration and settlement impacts.

It was determined that for tunnelling works associated with the project, site #45-6-2278 is located beyond the minimum safe working distance for vibration intensive plant, with vibration impacts associated with tunnelling works expected to be negligible. Works were specifically designed to reduce the magnitude of settlement in the upper soil profiles. As the degree of movement experienced by a structure is dependent on its foundation type and how a structure responds to ground movements depends on its size, design and materials, ongoing observation and monitoring have been proposed during the construction program. The current condition of the site should be confirmed with a site survey, if possible, during detailed design and with ongoing observation and monitoring recommended to be undertaken during the construction program.

The details of the search results are summarised in **Table 6-4** and shown in **Figure 6-2**. The designation 'Not a Site' refers to areas that had been registered in AHIMS but later proved not to be legitimate Aboriginal sites (eg PADs found upon test excavation to not contain cultural deposits, Modified Trees found to be naturally rather than culturally scarred or grinding grooves found to be of non-Aboriginal origin). Once a registered location is verified not to be of Aboriginal origin its site type is renamed 'Not a Site' in the AHIMS register.

Table 6-4 AHIMS search results for the search area

Site type	Number	Per cent of total sites (%)
Midden	12	24.5
Rockshelter	12	24.5
PAD	8	16.3
Art site	8	16.3
Engraving	4	8.2
Artefact scatter	3	6.2
Not a site	1	2
Resource & gathering	1	2
Total	**49**	**100**

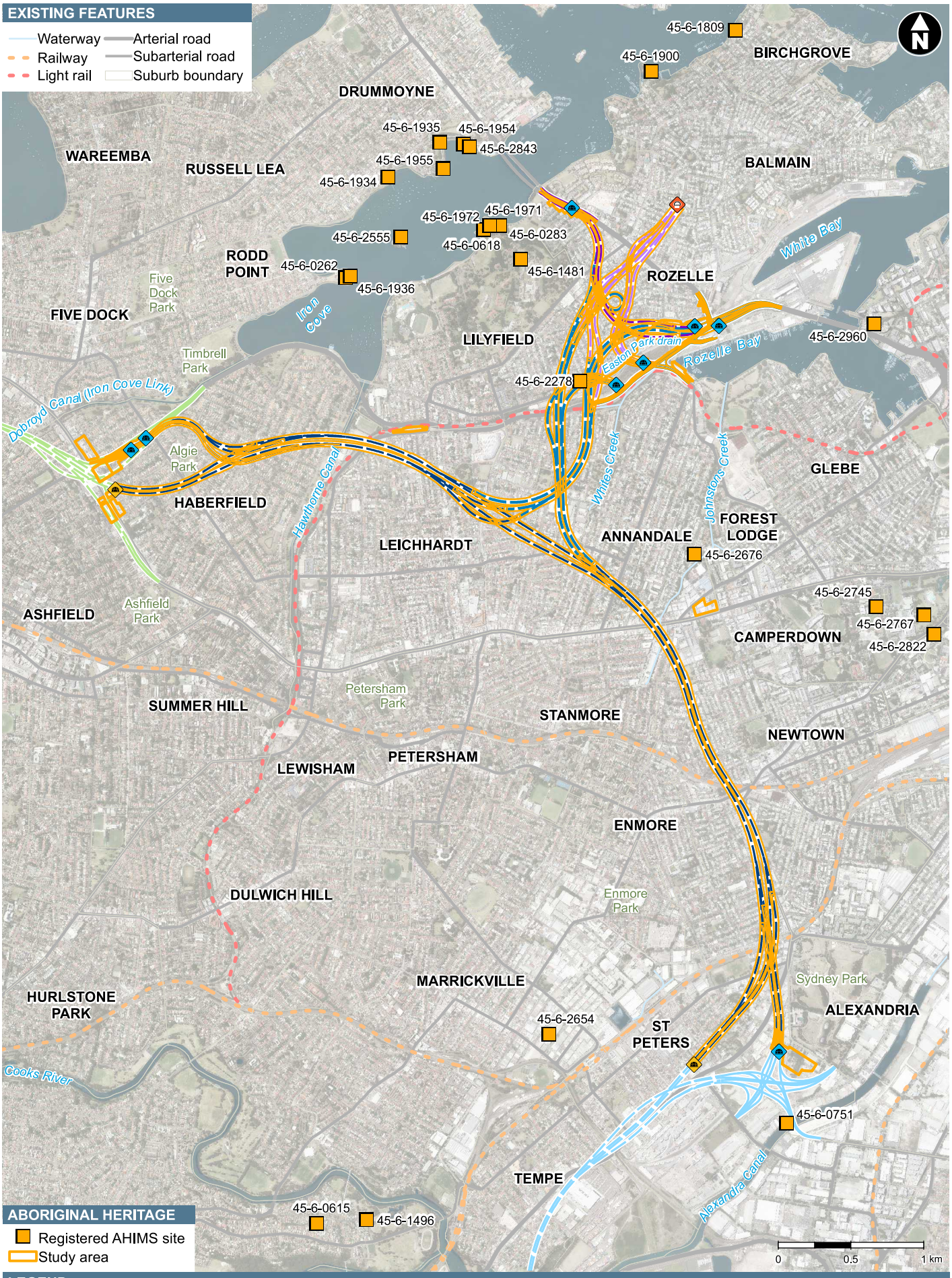


Figure 6-2 Study area AHIMS sites

6.4.2 Previous Aboriginal heritage investigations

Multiple Aboriginal archaeological investigations incorporating survey and/or excavation have been carried out in the larger region containing the study area. The results of some select examples of these investigations are summarised in **Table 6-5**.

Table 6-5 Relevant previous archaeological investigations within 10 kilometres of the study area

Author	Year	Key findings	Distance to study area
Rich	1985	An archaeological survey was undertaken at the Homebush Bay area as part of the development of conservation measures. A shell midden with an associated artefact scatter was identified at Charity Point. This site was recommended for protective measures. Other isolated artefacts were also identified, which were recommended for destruction under the conditions of a Consent to Destroy permit.	8.5 km
Don Godden & Associates	1986	A Conservation Plan was produced for heritage items at the Homebush area, being the State Brickworks and State Abattoir. No Aboriginal cultural heritage items or areas of PAD were identified in association with these items, most likely due to the associated historical past disturbance.	8.5 km
NSW Department of Planning	1994	An environmental plan was produced by the NSW Department of Planning in 1994. It was designed to manage the Homebush Bay area. The plan did not identify any issues with Aboriginal archaeology within the study area.	8.5 km
Newell	1997	An archaeological assessment was undertaken for 95 Ramsay Street at Haberfield, NSW. This study area was located at Lot 1 DP 180 212 and Lot 1 DP 926 992. No Aboriginal sites were identified.	3 km
Stuart	2000	A heritage impact statement was produced for a proposed Telecommunications Facility at 169–173 Parramatta Road, Haberfield. No Aboriginal sites were identified.	1.8 km
McLoughlin	2000	Using available data, McLoughlin produced a study of Estuarine wetlands distribution along the Parramatta River between 1788 and 1940. The conclusion was that mangroves were more limited to creek fringes in the past, with saltmarsh communities dominating the inter-tidal zone. From the late 19th century onwards the mangroves had been expanding into the saltmarsh areas, resulting in the landscape being as it is today.	8.3 km
Mary Dallas Consulting Archaeologists	2000	An Aboriginal Heritage Management Plan was produced for the public area at Callan Point. Four midden sites were identified here in close proximity to Rozelle Hospital.	1.3 km
Newell	2002	An updated archaeological assessment was undertaken for 95 Ramsay Street at Haberfield (Lot 1 DP 180 212 & Lot 1 DP 926 992). No Aboriginal sites were identified.	3 km

Author	Year	Key findings	Distance to study area
Navin Officer Heritage Consultants	2005	An inspection was undertaken of an area proposed for a turnback with other rail facilities at Homebush Railway Station. No Aboriginal sites areas of PAD were identified. The project was recommended to proceed.	8 km
Comber Consultants Pty Ltd	2011	An Aboriginal archaeological cultural heritage assessment was undertaken for a proposed shared pathway project along the Johnstons Stormwater Canal in the Glebe area. The canal, once a natural creek line (Johnstons Creek) was found to be highly channelised with concrete sides and base. No Aboriginal sites were registered along its extent.	0.4 km
Burwood Council	2013	A Plan of Management document was produced for the Wangal Park area. Due to the highly disturbed nature of the site, it was concluded that there was almost no potential for re-establishing self-sustaining vegetation communities, noting that revegetation and ongoing management were required.	4.8 km
AECOM Australia Pty Ltd	2015b	PACHCI Stage 1 WestConnex M4 East Aboriginal heritage assessment identified that although there was widespread disturbance across the area, where there were coastal areas and waterways that had not been highly disturbed there was a potential for intact deposits.	3.8 km
AECOM Australia Pty Ltd	2015c	PACHCI Stage 2 WestConnex New M5 Aboriginal heritage assessment identified widespread high levels of disturbance and did not identify any Aboriginal sites.	Adjacent to study area
AECOM Australia Pty Ltd 2016	2016	PACHCI Stage 2 Aboriginal heritage assessment undertaken as part of a review of environmental factors (REF) for site management works identified high levels of disturbance within the Rozelle Rail Yards and did not identify any Aboriginal sites.	Within study area

Rozelle Rail Yards – Site management works review of environmental factors

As mentioned above in **Table 6-5**, a review of environmental factors (REF) under Part 5 of the EP&A Act was prepared for a suite of site management works on part of the former Rozelle Rail Yards. To support this REF, a Stage 2 PACHCI Assessment was undertaken in November 2016 by AECOM (2016). The assessment included desktop review, Aboriginal community consultation and an archaeological survey. The targeted archaeological survey was undertaken on 27 May 2016.

The assessment described the site as a highly developed rail yard area with sections of regrowth vegetation due to disuse. Following the survey these key observations were made:

- The study area (which comprised of part of the Rozelle Rail Yards only) consists of highly disturbed terrain that is unlikely to retain Aboriginal archaeological materials in surface or subsurface contexts
- No surface expressions of Aboriginal objects or areas of Aboriginal archaeological sensitivity/PAD were identified
- No AHIMS registered Aboriginal sites occur within the study area and none are likely to be either directly or indirectly impacted by the proposal
- To manage potential impacts during the site management works, management measures were recommended to be implemented, including:

- Should additional study areas be proposed that are outside the curtilage of the study area as it is defined for this assessment, then these areas should also be subject to a PACHCI Stage 2 assessment
- Should any unexpected finds of Aboriginal places, objects or deposits be identified during the proposed works, then the Roads and Maritime *Unexpected Heritage Items Procedure, Standard Management Procedure* (2015) should be followed.

The Rozelle Rail Yards assessment findings were that the area had been subject to high levels of disturbance in the past and that intact in situ subsurface deposits were not likely to occur. No surface expression of artefacts or other Aboriginal site types were identified (AECOM Australia Pty Ltd 2016).

6.5 Aboriginal site predictions

With regard to the archaeological context of the study area, the assessment made the following predictions about the Aboriginal archaeological record in the area:

· Aboriginal shell midden sites are the most likely to occur in this general area, usually occurring in tidal estuarine foreshore zones (that is, within 10 metres of high water level). It is unlikely that any shell midden sites will occur within the study area, because of the high levels of disturbance of those areas where they may once have occurred

· Rockshelters are another common site type in the wider region and could occur in areas where in situ natural overhangs are extant

· Any Aboriginal archaeological sites are highly unlikely to occur in areas previously subjected to high levels of landscape modification and disturbance.

In order to test these site predictions a targeted survey was undertaken of the study area. Areas of known high levels of disturbance were not surveyed in detail, with a vehicle inspection used to cover these. Areas of fewer disturbances, such as public parks, were surveyed for both surface material and any subsurface archaeological potential. The results of the investigation of these areas are provided in **Chapter 8**.

7 Ethnographic context

7.1 Introduction

Information regarding the ways in which Aboriginal people likely used pre-contact landscapes is available to archaeologists through two primary sources: archaeological (ie survey and excavation) data and historical records. **Chapter 6** has summarised the Aboriginal archaeological context of the study area on a regional and local scale. This section builds on this foundation by summarising relevant ethnohistoric information for the study area. As in other parts of NSW and Australia more broadly, non-Aboriginal people occupying the Sydney Region began to document Aboriginal culture from first contact, with explorers, missionaries, settlers and the like recording their observations of Aboriginal people and/or their material culture in letters, journals and official reports. Many of these accounts are overtly Eurocentric in tone and the content and veracity of some is, at best, questionable. Nonetheless, taken together, they form an important source of information on Aboriginal lifeways at the time of British colonisation and can, in conjunction with available archaeological data, be used to generate working predictive models of prehistoric Aboriginal land use.

Key sources, both primary and secondary, for the post-contact languages and lifeways of the Aboriginal people occupying the Sydney region at the time of British colonisation include: Attenbrow (2010); Barrallier (1802 [1975]); Bradley (1792 [1961]); Brook & Kohen (1991); Collins (1798 [1975], 1802 [1971]; Dawes (1790a, 1790b); Flynn (1994, 1995a, 1995b); Hunter (1793 [1968]); Kohen (1985, 1986, 1988, 1993); Kohen and Lampert (1987); Kohen et al. (1999); Matthews (1903); McDonald (2008); Phillip (1789 [1970], 1791[1963]); Tench (1793 [1979]); Troy (1994); White (1790 [1962]) and Worgan (1788). While a detailed review of these sources is beyond the scope of this assessment, salient information is summarised below.

7.2 The Darug language and people

Available sources indicate that study area falls within the traditional country of the Darug people, who spoke the Darug (also spelt Dhaŕ-rook, Dharrook, Dhaŕook, Dharruk and Dharug) language. Darug is believed to have been spoken from the Hawkesbury River in the north, to Appin in the south, and from the coast west across the Cumberland Plain into the Blue Mountains. Early sources (eg Collins 1798 [1975]; 1802 [1971]; Tench 1793 [1961]; Dawes 1790a, 1790b; Phillip in Hunter 1793 [1961]) and more recent linguistic research (eg Troy 1994) indicates that two distinct dialects of Darug were spoken at the time of European contact, a coastal dialect, spoken on the Sydney peninsula and the country to the north of Port Jackson, and a hinterland dialect, spoken on the Cumberland Plain from Appin in the south to the Hawkesbury River in the north (Attenbrow 2010: 34). This linguistic division is thought to correspond to a broader economic division between 'coastal' and 'hinterland' Darug-speaking peoples, with the accounts of several early observers (eg Bradley 1792 [1961]; Collins 1798 [1975], 1802 [1971]; Phillip 1788 in Attenbrow 2010: 63; Tench 1793 [1979]) suggestive of a 'coastal', marine-oriented subsistence economy[6] and contrasting 'inland' economy focused on the exploitation of land mammals, plant foods and freshwater faunal resources. Notably, early sources (eg Barrallier 1802 [1975]; Collins 1798 [1975]; Tench 1793 [1961]) suggest that there was little contact between coastal and hinterland groups.

Some idea of population size for the coastal Darug at contact is provided by Attenbrow (2010), who suggests that the area around Port Jackson likely supported a minimum population density of 0.75 persons/one square kilometre (ie one person per 1.3 cubic kilometres). Attenbrow's estimate is based Governor Phillip's own estimate of the Aboriginal population of this area, made in 1788. Phillip, reporting to Lord Sydney on 15 May 1788, estimated a total population of not 'less than one thousand five hundred' (Phillip 1788 in Attenbrow 2010: 17). Attenbrow (2010:17), citing Hunter (1793 [1968]: 62), notes that 'population densities for the hinterland (west of Parramatta) were initially assessed by the colonists as being less than those along the coast' but implicitly urges interpretive caution given

[6] Note that available archaeological evidence suggests that the historically documented seafood bias in the diets of coastal Darug speaking peoples has been overemphasised, with excavated bone assemblages from coastal rockshelter sites (eg Balmoral Beach, Angophora Reserve) attesting to the importance of terrestrial and avian fauna in coastal diets.

the deleterious effects of 1789 smallpox epidemic, which 'had killed many people living to the west of Rose Hill before Phillip's 1791 expedition crossed the Cumberland Plain to the Hawkesbury-Nepean River'. More recently, Kohen (1995) has estimated a minimum overall density of around 0.5 persons per square kilometre for the hinterland zone.

In common with other regions of New South Wales (eg Attenbrow 2010) and Australia more broadly (Peterson, 1976), available historical records suggest that the primary units of social organisation amongst the Darug were the clan and band. Kohen (1993: 15) equates the term 'clan' with 'band', defining both as 'groups of people who lived together and hunted together'. However, Attenbrow (2010) draws a distinction between the two, with clans comprising local descent groups and bands, land-using groups who, though not necessarily all of the same clan[7], camped together and cooperated daily in hunting, fishing and gathering activities. Individual bands will have habitually occupied and exploited the resources of particular tracts of land within the overall territory of their clan. However, the territorial boundaries of each band will have been permeable or elastic in the sense of complex kinship ties facilitating inter-band territorial movements and the reciprocal use and/or exchange of resources. Early accounts (eg Collins 1798 [1975: 453]; Tench 1793 [1979: 292]) indicate that clan names were derived from the country on which the members of the clan lived.

The size of the individual bands occupying the Cumberland Plain at contact was no doubt activity and season dependent. However, an upper limit of around 50 individuals, consisting of several nuclear families, has been suggested (Kohen 1988: 239). Individual band sizes notwithstanding, much larger groups of Aboriginal people, numbering in the hundreds, are known to have come together for events such as corroborees, ritual combats and feasts (Attenbrow 2010; Kohen et al. 1999). Unlike many Australian Aboriginal groups, social organisation amongst the Darug did not comprise a class system based on moieties or sections but rather was based on clan membership attained through patrilineal descent (Attenbrow 2010: 57; Kohen 1993: 35). Totemic affiliations were inherited from a person's father and, along with clan membership, were the basis upon which marriages were arranged and initiations carried out.

Available historical records indicate that a wide range of marine and freshwater fauna were exploited by Darug-speaking peoples for food and other resources (for a detailed discussion see Attenbrow 2010: 62-84). Along the coast, an emphasis on the exploitation of marine resources, principally fish and shellfish, is attested in the writings of several early observers (eg Bradley 1792 [1969: 133]; Collins 1798 [1975: 456, 461, 495]; Phillip 1788 in Attenbrow 2010: 63; Tench 1793: 125, 195 [1979]: 233, 287). Further inland, historical records suggest an emphasis on the hunting of land mammals (eg Barrallier 1802 [1975:2 n4]; Collins 1798 [1975: 456]; Tench 1793: 121 [1979: 230]), with kangaroos, wallabies, possums, gliders, fruit bats (ie flying foxes), dingos, koalas and wombats variously reported as having been either hunted and/or eaten (Attenbrow 2010: 71). Possums, in particular, appear to have been major food source in the hinterland, with a number of early observers remarking on the tree climbing skills of the 'woods people' and detailing procurement techniques (eg Hunter 1793 [1968]; Tench 1793 [1979]; Collins 1798 [1975]; Barrallier 1802 [1975]). Freshwater fish, shellfish and eels, as well as platypus, are also known to have been exploited by hinterland groups (eg Barrallier 1802 [1975: 2]; Collins 1798 [1975: 461-63], 1802 [1971: 321-22]; Phillip in Hunter 1793 [1968: 523]; Tench 1793 [1979: 230]), as are birds.

Compared with their faunal counterparts, the plant food resources of coastal and hinterland Darug-speaking peoples are poorly represented in the writings of early colonial observers. Nonetheless, available descriptions do suggest that plants formed a regular part of the diets of groups in both areas (see Attenbrow 2010: 77-8). Along from the coast, a 'vegetable catalogue' consisting of 'a few berries, the yam and fern root, the flowers of the different Banksia, and at times some honey' is reported by Collins (1798 [1975: 462-63]). Along the Hawkesbury-Nepean River, yams appear to have been particularly important food item (see, for example, Hunter 1793 [1968: 153]) and it has been suggested that the establishment of European farms along the banks of the river, which resulted in the widespread destruction of traditional yam beds, was an important contributing factor to the significant Aboriginal-Settler hostilities that occurred in this area (Kohen 1985).

[7] Some individuals may have been related through marriage.

A wide range of hunting and gathering 'gear' was employed by Darug speaking peoples, with distinctive repertoires for men and women (McDonald 2008: 24). Men's gear included several different forms of spears (variously barbed), spear throwers, clubs, 'swords', boomerangs, shields and hafted stone hatchets known as mogo. Women's toolkits, in contrast, included fishing hooks, lines and sinkers, digging sticks and various containers (shell and wood). Net bags made from plaited wood fibre appear to have been used both men and women (see Attenbrow 2010: 91). Bark canoes were also widely used (Attenbrow 2010: 87).

Two principal forms of shelter appear to have been utilised by Darug speaking peoples at the time of European contact: rockshelters and small huts built from sheets of bark, branches and bushes. In keeping with the linguistic division of the Darug language into coastal and hinterland dialects, differences in the nature of huts built along the coast and in the hinterland are attested in early colonial writings, with the former reportedly larger and 'formed of pieces of bark from several trees put together in the form of an oven with an entrance, and large enough to hold six or eight people' (Collins 1798 [1975: 460]). Unlike those living along the coast, Darug-speaking peoples occupying the Cumberland Plain appear to have relied heavily on bark huts (Hunter 1793 [1968]: 60-61). Regarding settlement duration, as Attenbrow (2010: 54) has observed, 'there is little direct historical evidence for the length of time people stayed at any one campsite (be it a rockshelter or bark hut), how often they moved, or what motivated them to move to another campsite'. Kohen and Lampert (1987), for their part, have argued that 'some bands probably lived at one campsite for months of each year and regularly returned to it'. However, this argument is not universally accepted (eg Attenbrow 2010: 55; McDonald 2008).

Evidence for ceremonial or ritual behaviour amongst Darug-speaking peoples can be found in the writings of a number early observers, with documented 'ceremonial' activities including corroborees, male initiation ceremonies, ritual combats and various burial, body adornment and personal decoration practices (Attenbrow 2010: 126-42). While available colonial records provide only scant information on the belief systems of Darug-speaking peoples, reference to the 19th century writings of people such as L.E Threlkeld, A.W Howitt, R.H Matthews, W. Ridley and W.J Enright, suggest that spiritual authority amongst Darug clans was likely vested in a number of ancestral beings, with Baiame or Daramulan – the supreme creative being – a central figure (Attenbrow 2010: 127).

In common with other parts of NSW and Australia more generally, the post-contact history of the Darug-speaking peoples of the Sydney region is primarily one of dispossession and loss, with groups alienated from their traditional hunting, gathering and camping grounds, populations decimated by a combination of introduced diseases[8] and frontier violence (Attenbrow 2010: 14-15, 21-22) and surviving groups subject to various colonial initiatives aimed at assimilating them into an ostensibly superior European way of life. Nonetheless, active resistance and friendly relations are also attested in available records.

[8] As highlighted by Attenbrow (2010: 21-22), a major initial cause of depopulation amongst the Darug was the April 1789 smallpox epidemic, which 'hit the local [Aboriginal] population horrific effect' and is estimated to have killed 'well over half' of Sydney's Aboriginal population (Attenbrow 2010: 21).

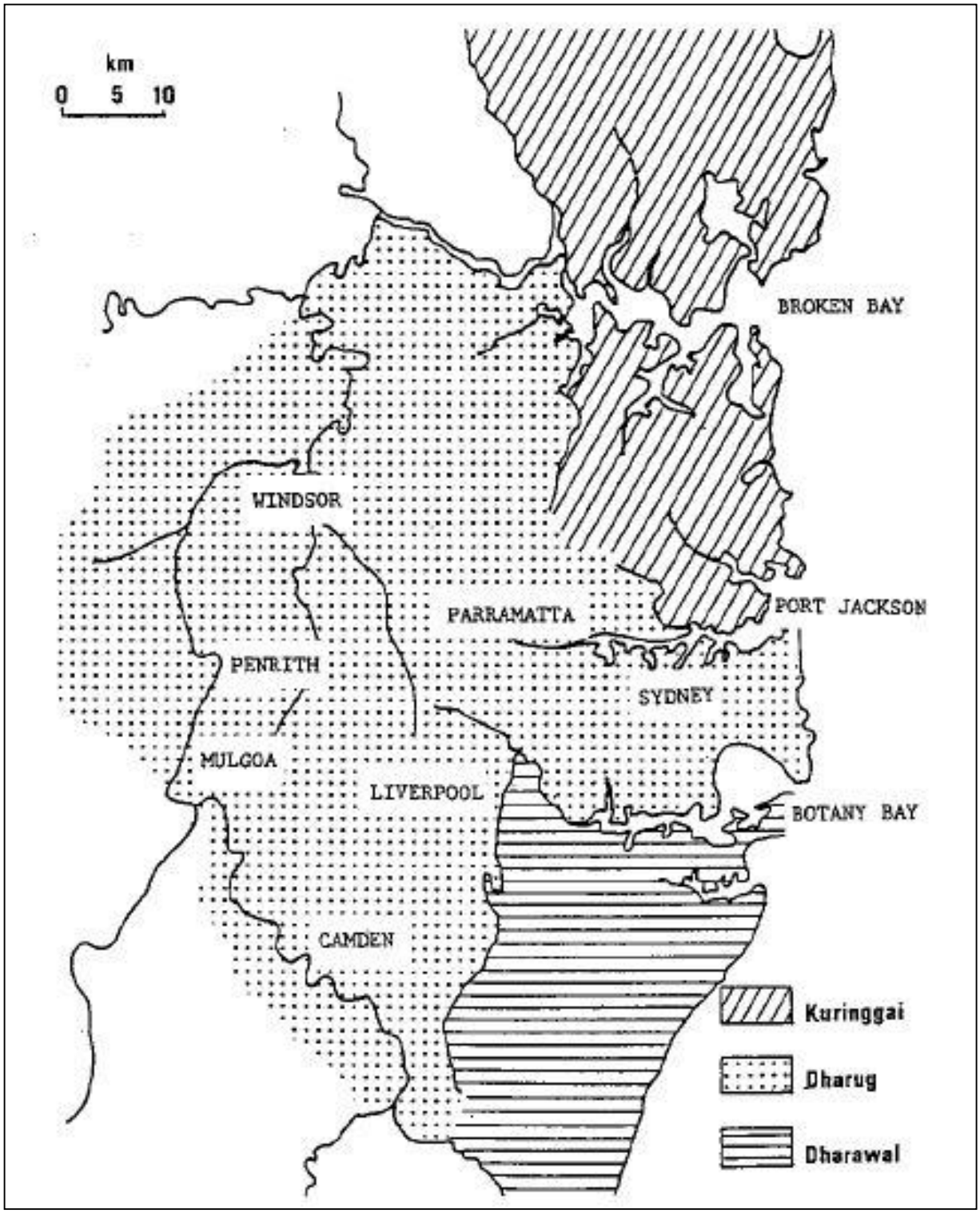


Figure 7-1 Aboriginal language group boundaries in the Sydney region (from Kohen 1993: 241, Fig. 1)

8 Survey and results

8.1 Overview

A targeted archaeological survey of the study area was undertaken by AECOM archaeologist Dr Andrew McLaren and MLALC representative Jay Daley on 21 September 2016. No native title owners or claimants were identified. These works followed on from a previous AECOM assessment for site management works for the Rozelle Rail Yards which included a survey undertaken by AECOM archaeologist Dr Darran Jordan and MLALC representative Jay Daley on 27 May 2016. The area subject to that assessment was determined to be highly disturbed. No sites or areas of archaeological sensitivity were noted in that assessment (AECOM Australia Pty Ltd 2016). It was considered likely that similar areas of disturbance would be identified in the larger project area during the site survey component of this assessment. This proved to be accurate, the results of which are outlined further in the following sections.

8.2 Site survey methodology

Pedestrian transects were walked across those parts of the study area determined to be least disturbed on the basis of aerial photographs (C2a/b, C3a, C4, C5, C6, C8 and C10 as previously described in **section 4.3**). Other disturbed areas were ground-truthed through a vehicle survey (C1a, C1b, C3b, C7 and C9). All mature remnant trees and sandstone outcrops within the study area were inspected for signs of cultural modification. All areas of exposure within the study area were inspected for surface expressions of Aboriginal artefacts. Notes were taken during the inspection and photographic recordings made of each inspected location.

8.3 Site survey findings

Field inspection focused on vegetated areas identified on 2016 aerials as being potentially undisturbed. Despite some reduced ground surface visibility during the survey, evidence of high levels of past ground disturbance were identified throughout the study area. The following sections describe the results of the survey in each area, as shown on **Figure 2-2**. This survey continued on from earlier assessments undertaken for the M4 East project and the site management works at the Rozelle Rail Yards, both of which have since commenced construction.

The M4 East project had a broader survey undertaken for it, which targeted areas of known sites and archaeological potential across a wider area that was located to the north and south of the existing M4 and Parramatta Road corridor, between Homebush and Haberfield/Ashfield. The survey for this assessment targeted those areas that had been specified for impacts, which included areas within the broader project boundary already assessed for the M4 East project. Other areas of the project that are not compounds but are proposed to be disturbed by the project, such as local road works, were assessed as part of the desktop research and through vehicle survey as extensive impacts in existing road corridor and highly developed areas would have destroyed any Aboriginal heritage that was once located there.

8.3.1 Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a), Haberfield civil site (C2b) and Northcote Street civil site (C3a) at Haberfield

This area has been subject to previous Aboriginal heritage assessment as part of the M4 East project, and is now under construction. During this previous assessment for M4 East, no Aboriginal archaeological sites or areas of PAD or intangible cultural heritage values were identified.

A pedestrian survey was undertaken of this area at the corner of Wattle Street and Parramatta Road as part of this project to inspect and verify the findings for areas not yet cleared by M4 East. The vegetated area that was visible at the intersection of Wattle Street and Parramatta Road could be described as a ‘vegetated traffic island’. The visual inspection suggested that this island was likely highly disturbed (artificially levelled) during the construction of Wattle Street and/or Parramatta Road. No mature trees were present (ie no trees with the potential for cultural scarring) nor were any Aboriginal objects identified during the field inspection. GSV across the ‘island’ was generally very poor due to fallen tree matter.

No known, potential or intangible cultural heritage values were identified.

8.3.2 Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b) at Haberfield/Ashfield

A vehicle survey of this area confirmed that it was heavily impacted by past road, residential, commercial and industrial developments with high levels of disturbance noted. No known, potential or intangible cultural heritage values were identified.

8.3.3 Darley Road civil and tunnel site (C4) at Leichhardt

A pedestrian survey was undertaken of two areas. At the time of the survey, the site consisted of a disused building which has subsequently been adapted for a commercial purpose. Notwithstanding the change in land use, this area is highly developed and contains no sites or subsurface potential. The second portion surveyed was a cleared area bordered to the west by Darley Road and to the east by Norton Street which was determined to be a landscaped road verge. The verge is separated from Darley Road/City West Link by a concrete footpath. Localised subsurface disturbances were noted during the field inspection, including a grated storm drain and capped geotechnical drill hole at the western end of the road verge. This land is outside of the project footprint and would not be affected by the project.

An east-west oriented concrete stormwater pipe was observed in the vegetated area at the eastern end of the Leichhardt North light rail stop, which suggests that the road verge has been highly disturbed through pipeline installation at some point in the past (assuming that the pipe continues through the verge on its observable east-west trajectory).

This area at the eastern end of the Leichhardt North light rail stop has been highly disturbed by the installation of a stormwater pipe. No known, potential or intangible cultural heritage values were identified.

8.3.4 Rozelle civil and tunnel site (C5) at Rozelle

A pedestrian survey was previously undertaken of this area through the Rozelle Rail Yards site (as part of a REF for site management works). The site consists of highly disturbed terrain that is unlikely to retain Aboriginal archaeological materials in surface or subsurface contexts. No surface expressions of Aboriginal objects or areas of Aboriginal archaeological sensitivity/PAD were identified. The potential for intact in situ subsurface Aboriginal cultural deposits to be present here was assessed as low due to the level of past disturbance which is likely to have destroyed any sites that may have been in this area in the past. This area is defined as Disturbed Terrain (xx) (Chapman & Murphy, 1989:132–134) and past impacts have included cut and fill, as well as excavation to depths below current ground level for the installation of drainage, infrastructure and levelling. Based on past impacts known in this area, it was assessed that the proposed site management works in the disturbance area, where it was proposed to impact deeper than 500 millimetre depths in Disturbed Terrain (xx), would be unlikely to impact upon intact in situ subsurface Aboriginal cultural deposits.

No known, potential or intangible cultural heritage values were identified. This area has low subsurface archaeological potential.

Surface works at Rozelle (around Whites Creek)

This site is associated with the widening and improvement works to Whites Creek around The Crescent and Rozelle Bay at Annandale, and includes an area of land adjacent to Whites Creek and Brenan Street.

A pedestrian survey was undertaken of this area from the shared path through Buruwan Park, along Whites Creek and through the areas around The Crescent and Johnston Street. Whites Creek and the adjacent bank have been highly modified through concrete channelisation and earthworks/landscaping respectively. Outcropping sandstone bedrock was noted to the south of the shared path in Buruwan Park, occurring on a short but relatively steep sideslope below the Rozelle Bay light rail stop. No grinding grooves or pigment/engraved art were noted on exposed portions of the bedrock during the current survey.

Key disturbances in this inspection area included creek channelisation, creek bank modification, landscaping, path construction, the installation of park benches and telephone poles. Based on the level of past impacts, no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.5 The Crescent civil site (C6) at Annandale

A pedestrian survey was undertaken of the area. This area has been subject to high levels of past disturbance with earthworks, building construction, subsurface infrastructure and ground levelling for boating facilities, roadways and carparks. Based on the level of past impacts, no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.6 Victoria Road civil site (C7) at Rozelle

This site was assessed as highly disturbed areas and was ground-truthed through a vehicle survey. It was confirmed as being highly disturbed. Based on the level of past impacts, no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.7 Iron Cove civil site (C8) at Rozelle

A pedestrian survey was undertaken of this area. The visual inspection indicated that the grassed area to the south of Victoria Road, which forms part of King George Park, comprised an artificial, landscaped landform associated with the eastern approach to the duplicated Iron Cove Bridge. The location for the bioretention facility and improved car park works at King George Park (adjacent to Manning Street) comprised a mixture of hardstand and grassed areas.

This area was assessed as a highly disturbed, modified landform. Based on the level of past impacts no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.8 Pyrmont Bridge Road tunnel site (C9) at Annandale

This site was assessed as highly disturbed areas and was ground-truthed through a vehicle survey. It was confirmed as being highly disturbed. Based on the level of past impacts no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.9 Campbell Road civil and tunnel site (C10) at St Peters

A pedestrian survey was undertaken of this area from Woodley and Holland streets, as well as Campbell Lane. The visual inspection confirmed that the vegetated areas adjacent to Woodley and Holland Streets, as well as Campbell Lane, consisted exclusively of one or more revegetated deposits of historical fill, with the deposit adjacent to Woodley and Holland streets being several metres high. Sandstone boulders were common in this area and were readily visible from the street.

Vegetation included a mixture of introduced and exotic species. A heavily degraded brick wall (possibly a retaining wall) abutted and underlay the fill material along Woodley Street and Campbell Lane, which had been reinforced more recently, presumably to prevent further collapse, and fenced off. This area was assessed in the field as highly disturbed. Based on the level of past impacts no subsurface archaeological potential was identified for this area. No known, potential or intangible cultural heritage values were identified.

8.3.10 Summary

No surface Aboriginal objects or places were identified within the study area. MLALC representative, Jay Daley, did not identify any specific areas of Aboriginal cultural attachment or intangible cultural heritage values, although he noted that Aboriginal people would have been present in the wider area in the past. No issues were raised by the MLALC representative regarding the proposed works having an impact on known or potential Aboriginal sites or deposits or intangible cultural heritage values. Results of the archaeological survey of the investigation areas are provided in **Table 8-1**, with photos in **Annexure C**. Rating scales used for GSV and GI are provided in **Annexure D**.

Outcropping sandstone bedrock was noted to the south of the shared path through Buruwan Park, linking Railway Parade to The Crescent at Annandale, occurring on a short but relatively steep side slope below the Rozelle Bay light rail stop. No grinding grooves or pigment/engraved art were noted on exposed portions of the bedrock during the current survey.

Table 8-1 Investigation area results

Investigation area	Approximate length of transect	Description	Average GSV (%)	Average GI	Key disturbance factors	Findings
Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a), Haberfield civil site (C2b) and Northcote Street civil site (C3a)	100 m	Highly disturbed	5	Low	Earthworks, levelling, creation of traffic island	Retains no subsurface archaeological potential
Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b)	360 m	Highly disturbed	5	Low	Development of roads, residential and industrial structures and related infrastructure	Retains no subsurface archaeological potential
Darley Road civil and tunnel site (C4)	100 m	Highly disturbed	40	Low	Pipeline, earthworks	Retains no subsurface archaeological potential
Rozelle civil and tunnel site (C5) and The Crescent civil site (C6)	1.5 km	Highly developed rail yard area with sections of regrowth vegetation due to disuse	20	Low	Earthworks, fill, drainage works, ventilation outlet, and other general development.	Retains no subsurface archaeological potential
Surface works at Rozelle (around Whites Creek)	100 m	Majority highly disturbed with small undisturbed section	5	Low to Moderate	Concrete channelisation, earthworks/landscaping, bike/footpath	Retains no subsurface archaeological potential. Natural sandstone benches were noted but no grinding grooves and/or engraved/pigment art were observed on exposed sections of bedrock.
Victoria Road civil site (C7)	200 m	Highly disturbed	5	Low	Development of roads, buildings and associated infrastructure	Retains no subsurface archaeological potential

Investigation area	Approximate length of transect	Description	Average GSV (%)	Average GI	Key disturbance factors	Findings
Iron Cove Link civil site (C8)	100 m	Highly disturbed	10	Low	Landscaping	Retains no subsurface archaeological potential
Pyrmont Bridge Road tunnel site (C9)	200 m	Highly disturbed	5	Low	Development of roads, buildings and associated infrastructure	Retains no subsurface archaeological potential
Campbell Road civil and tunnel site (C10)	100 m	Highly disturbed	5	Low	Earthworks, fill, development of path and wall	Retains no subsurface archaeological potential

9 Assessment of impacts

9.1 Direct impacts

Direct impacts are those that would result from the construction of tunnelling, surface roads, interchanges, ancillary and operational facilities, utilities, upgrades of existing roads and construction compounds. Direct impacts have the potential to damage or destroy Aboriginal sites where the sites are located within the project footprint.

As no Aboriginal sites or areas of archaeological sensitivity or intangible cultural heritage values were identified within the project footprint, no direct impacts on Aboriginal heritage values are anticipated as a result of the project.

9.2 Indirect impacts

Indirect impacts are those that would result from vibration during construction and blasting activities, and settlement-related impacts from tunnelling. Indirect impacts have the potential to damage or destroy Aboriginal sites where the sites are located within impact zones.

Consideration of the location of previously recorded sites indicates that rockshelter with midden site #45-6-2278 is located about 50 metres to the north of the Rozelle Rail Yards site. As there will be underground tunnels excavated in the general area beneath site #45-6-2278 indirect impacts could potentially be caused by vibration and settlement.

The noise and vibration assessment undertaken for the project (SLR 2017) assessed the potential vibration impacts from mainline tunnelling works (refer to **Appendix J** (Technical working paper: Noise and vibration)) of the EIS. The assessment identified criteria to be applied to certain structures in accordance with the guideline: DIN 4150: Part 3-1999 *Structural vibration – Effects of vibration on structures* (Deutsches Institute fur Normung 1999). The guideline identifies the minimum 'safe limit' of peak vibration velocity at low frequencies for structures which may be particularly sensitive to ground vibration (such as heritage buildings), as three millimetres per second. It is also accepted that this criterion could also be applied to buried archaeological artefacts. The noise and vibration assessment determined that AHIMS site #45-6-2278 is outside the minimum safe working distance for vibration intensive plant, and vibration impacts associated with tunnelling works are expected to be negligible.

Although indirect impacts are not anticipated, during construction, as a precaution, vibration and settlement monitoring are recommended.

10 Assessment of cumulative impacts

10.1 Other WestConnex projects

10.1.1 M4 East

The M4 East project involves the construction and operation of an upgrade and extension of the M4 Motorway from Homebush Bay Drive at Homebush to City West Link at Haberfield (Wattle Street and Parramatta Road). This includes twin tunnels about 5.5 kilometres long and associated surface works to connect to the existing road network.

The Aboriginal heritage assessment undertaken for M4 East involved consultation with MLALC and an archaeological survey as per the PACHCI Stage 2 process. The targeted archaeological survey was undertaken over two days on 8 and 9 April 2015 as part of the M4 East Aboriginal archaeological assessment.

Following the survey these key observations were made:

- Areas of highly disturbed terrain are unlikely to retain Aboriginal archaeological materials in surface or subsurface contexts
- No surface expressions of Aboriginal objects or places were identified
- The closest AHIMS registered site was #45-6-2339, located at Phillips Park at Lidcombe, 1.6 kilometres to the west of the project corridor. Although outside the bounds of the project and not proposed for direct or indirect impacts, it was inspected during the current survey. The site card for #45-6-2339 lists 10 artefacts and shell fragments. Shell fragments in a disturbed context were present but no artefacts were identified during this inspection
- Two areas of potential Aboriginal heritage sensitivity were identified:
    - Mason Park, off Underwood Road at Homebush
    - Queen Elizabeth Park, between Broughton Street and Addison Avenue at Concord.

The M4-M5 Link project overlaps with the M4 East project at Haberfield (at Wattle Street and Parramatta Road), with the M4-M5 Link project utilising land within or potentially beyond the existing civil and tunnel sites (depending if Option B at Haberfield/Ashfield is selected) during construction and connecting into underground stub tunnels being constructed as part of the M4 East project.

In the areas of overlap, there are no potential sites or features at the Wattle Street or Parramatta Road locations. The M4-M5 Link would therefore not impact any of the previously identified AHIMS sites or areas of identified potential Aboriginal heritage sensitivity assessed and managed as part of the M4 East project. Management measures adopted for the M4 East project for Aboriginal heritage will be carried over for the M4-M5 Link project to ensure consistency.

No significant impacts on Aboriginal heritage are anticipated as a result of the M4-M5 Link project as described in the findings of this current assessment (refer to **Chapter 8**). Cumulative impacts on Aboriginal heritage are therefore not anticipated as a result of the M4-M5 Link project's interaction with the M4 East project.

10.1.2 New M5

The New M5 project involves the construction and operation of a new multi-lane road link tunnel between the existing M5 East Motorway, east of King Georges Road, and St Peters. The project also includes an interchange at St Peters and connections to the existing road network.

The Aboriginal heritage assessment undertaken for the New M5 EIS involved consultation with MLALC and an archaeological survey as per the PACHCI Stage 2 process. The targeted archaeological survey was undertaken over four days in November 2014.

During the survey, five sandstone rock overhangs were identified as PADs based on habitation area size and presence of potential deposit. Four of these were located within the Wolli Creek Valley, and one was located at Stotts Reserve, Bardwell Park. The sites were registered with AHIMS.

Given the extent of previous disturbance within the project footprint, as well as the proposed construction activities, it was concluded unlikely that direct or indirect impacts on Aboriginal cultural values would occur as a result of the project.

The M4-M5 Link project overlaps with the New M5 project at St Peters only (within the St Peters interchange). None of the areas previously identified as potential archaeological deposits are within the M4-M5 Link project footprint and would therefore not be impacted by this project.

No significant impacts on Aboriginal heritage are anticipated as a result of the M4-M5 Link project as described in the findings of this current assessment (refer to **Chapter 8**). Cumulative impacts on Aboriginal heritage are therefore not anticipated as a result of the M4-M5 Link project's interaction with the New M5 project.

10.1.3 Other WestConnex projects

The proposed works and previous heritage assessment for King Georges Road Intersection Upgrade and M4 Widening were also considered. However, impacts in relation to Aboriginal heritage were considered to be negligible. These projects do not interface with the M4-M5 Link project.

10.1.4 Summary of the WestConnex scheme

PACHCI Stage 2 assessments have been completed for each stage of WestConnex. Management measures have been identified for each stage of WestConnex to mitigate potential impacts. Across the WestConnex scheme it is considered that direct or indirect impacts on Aboriginal cultural values are unlikely provided these measures are implemented. Consistent management measures include:

- Should a scope change for this project be proposed and new areas outside the curtilage of the study area be proposed for impact, then these areas should also be subject to a PACHCI Stage 2 assessment
- Should any unexpected finds of Aboriginal places, objects or deposits be identified during the project, then the Roads and Maritime *Standard Management Procedure for Unexpected Heritage Items* (Roads and Maritime 2015) should be followed.

10.2 Other projects

10.2.1 Rozelle Rail Yards site management works

The Rozelle Rail Yards site management works assessed for Aboriginal sites, cultural significance and subsurface potential and the findings included in the REF. This involved a site inspection, reference to aerials and maps, as well as consideration of the history of the area. The resulting findings were that the area had been subject to high levels of disturbance in the past and that intact in situ subsurface deposits were not likely to occur. No surface expression of artefacts or other Aboriginal site types were identified (AECOM Australia Pty Ltd 2016). Stop work procedures are to be followed should any unexpected finds be identified during works.

10.2.2 CBD and Southeast Light Rail Project

The CBD and South East Light Rail Project (CSELR) involves the construction of about 13 kilometres of new light rail track from circular quay to central, Kingsford and Randwick by Surry Hills and Moore Park and maintenance and stabling facilities. Of relevance to the M4-M5 Link project, the CSELR Rozelle maintenance depot will be located next to the existing Lilyfield light rail stop, west of the rockshelter with midden Aboriginal site (AHIMS #45-6-2278) adjacent to the western portion of the Rozelle Rail Yards.

Works have begun for the CSELR Rozelle maintenance depot and construction is expected to be completed in 2018 (operational in 2019). The construction of the facility would therefore potentially coincide for a limited period with the M4-M5 Link project.

Aboriginal heritage was assessed as part of the CSELR EIS with the Rozelle maintenance depot, with the majority of the site identified as within Zone 3 archaeological potential, where Aboriginal archaeological evidence may be present; however due to nature and extent of modern land use it is likely to be disturbed.

Construction of the CSELR within Zone 3 may impact on Aboriginal archaeological evidence where excavation is proposed. Areas defined as having the potential to contain Aboriginal objects will be managed in accordance with the archaeological investigation and salvage recommendations. The M4-M5 Link project is located adjacent to the CSELR project (Rozelle maintenance depot) at Rozelle. The CSELR did not identify areas of potential archaeological deposits and identified that any potential archaeology, if present, would be highly disturbed.

No significant impacts on Aboriginal heritage are anticipated as a result of the M4-M5 Link project as described in the findings of this current assessment (refer to **Chapter 8**). Cumulative impacts on Aboriginal heritage are therefore not anticipated as a result of the M4-M5 Link project's interaction with the CSELR project. Both projects would be managed through unexpected finds protocols.

10.2.3 Western Harbour Tunnel

The construction footprint for the proposed future Western Harbour Tunnel and Beaches Link would extend into the Rozelle Rail Yards, and the area assessed as part of the M4-M5 Link project. This area has therefore already been assessed in **section 10.2.1**.

11 Summary of findings and recommendations

11.1 Summary of findings

Following the survey these key observations were made:

- The study area predominantly consists of highly disturbed terrain that is unlikely to retain Aboriginal archaeological materials in surface or subsurface contexts
- No surface expressions of Aboriginal objects were identified during the survey and no intangible cultural heritage values were identified by the MLALC representative
- As no AHIMS registered Aboriginal sites occur within the study area, none would be either directly or indirectly impacted by the project. The closest AHIMS site is mapped as occurring about 50 metres to the north of the Rozelle Rail Yards. No direct impacts are anticipated from the project and indirect impacts from vibration are expected to be negligible. Its current condition is to be confirmed with a site survey during detailed design, with ongoing observation and monitoring recommended to be undertaken during the construction program
- At a part of the study area adjacent to Whites Creek, exposed sandstone bedrock was observed on the short but relatively steep slope below the Rozelle Bay light rail stop. However, no grinding grooves or pigment/engraved art were noted during the current survey.

11.2 Management recommendations

Given the extent of previous disturbance within the study area, no direct or indirect impacts on Aboriginal cultural values are anticipated as a result of the project. As such, it is concluded that further impact assessment in accordance with Stage 3 of the PACHCI is not required.

Based on the above key findings, management measures are recommended as outlined in **Table 11-1**.

Table 11-1 Recommended environmental management measures

Impact	No.	Environmental management measure	Timing
Construction			
Impacts on unexpected finds of Aboriginal places, objects or deposits	AH1	Any items of potential Aboriginal archaeological or cultural heritage conservation significance or human remains discovered during construction will be managed in accordance with the Unexpected Heritage Finds and Humans Remains Procedure developed for the project.	Construction
Impacts of vibration on Aboriginal places, objects or deposits	AH2	Subject to gaining access from the relevant landholder, a suitably qualified archaeologist would visit AHIMS site #45-6-2278 prior to the commencement of any vibration intensive construction activities in the vicinity to verify the site to confirm and record its current condition.	Construction
	AH3	If the AHIMS site #45-6-2278 is verified, an assessment will be completed by a suitably qualified and experienced person prior to the commencement of any vibration intensive construction activities in the vicinity. The assessment will consider all vibration intensive activities that will occur in the vicinity, the likely vibration levels and relevant vibration criteria and identify the management measures, including monitoring, that will be implemented to prevent and reduce potential impacts. A final condition assessment will be carried out at the completion of construction detailing recommendations for remediation measures if required.	Construction

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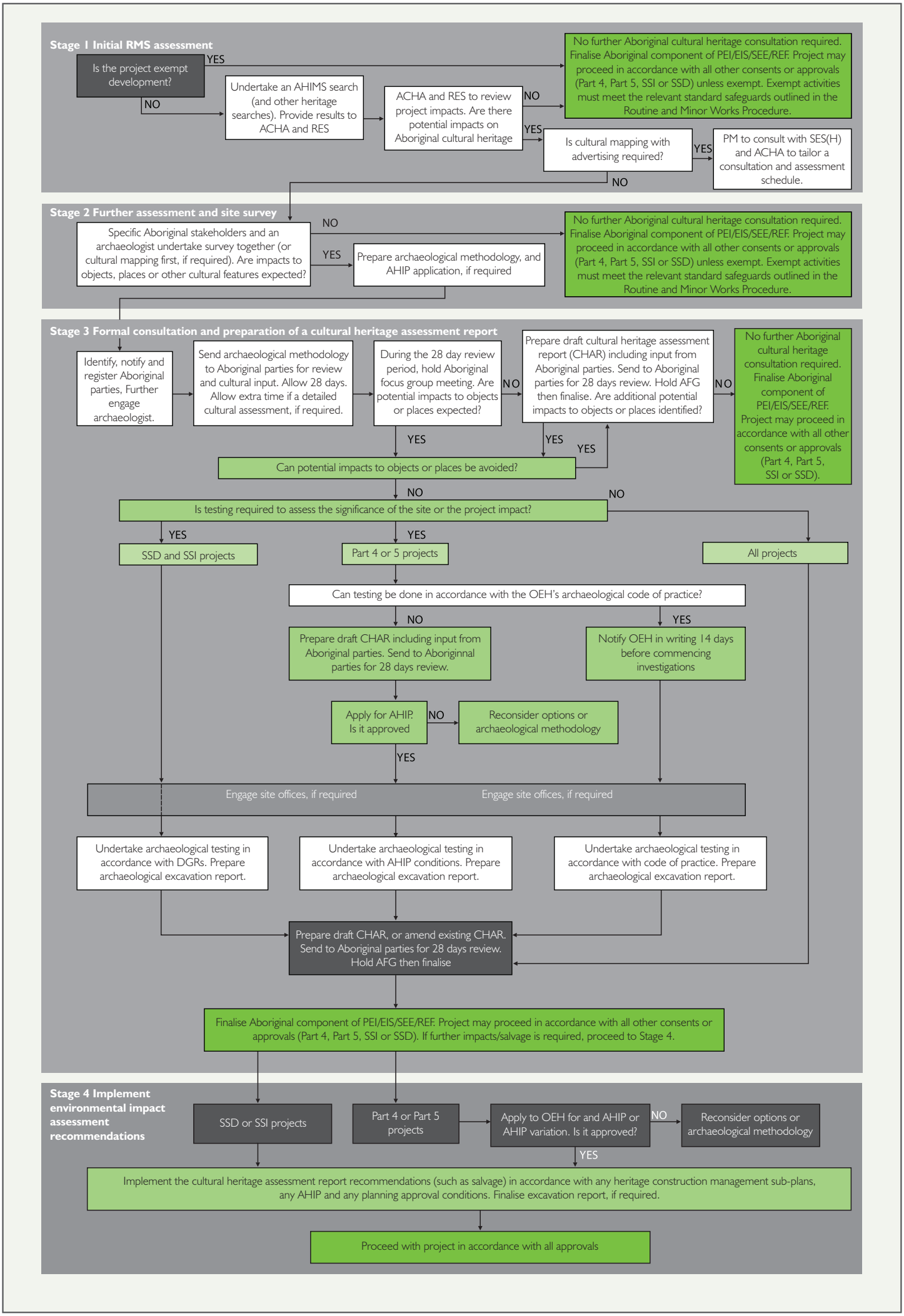
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Annexures

Annexure A PACHCI process



The PACHCI process (Roads and Maritime Services, 2011)

Annexure B Search results

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 60491677, 1.1

Client Service ID : 246070

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-6-2382	Goat Island 2	AGD	56	333100	6252480	Closed site	Valid	Artefact : -, Shell : -, Aboriginal Ceremony and Dreaming : -		
	Contact	**Recorders**	Klim Gollan					**Permits**		
45-6-2278	Lilyfield Cave	AGD	56	330310	6250290	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	102201
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-2287	Yerroulbin Cave	AGD	56	332010	6253210	Closed site	Valid	Shell : -, Artefact : -, Art (Pigment or Engraved) : -	Shelter with Art,Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-0535	Quarantine Park	AGD	56	326210	6252970	Open site	Not a Site	Earth Mound : -	Not an Aboriginal Site	1308,1809
	Contact	**Recorders**	Val Attenbrow,Val Attenbrow,Laura-Jane Smith					**Permits**		
45-6-2145	France/Exile Bay, Concord.	AGD	56	325900	6252400	Open site	Valid	Shell : -, Artefact : -	Midden	1809,1911
	Contact	**Recorders**	Mr.R Taplin					**Permits**		
45-6-0262	Rodd Point;Rodd Park;	AGD	56	328700	6251000	Open site	Valid	Shell : -, Artefact : -	Midden	2047
	Contact	**Recorders**	Val Attenbrow,Michael Guider					**Permits**		
45-6-0266	Chiswick;Drummoyne;	AGD	56	327674	6252823	Open site	Valid	Art (Pigment or Engraved) : -	Rock Engraving	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-0283	Rozelle Hospital 1;Rozelle Ho5555;	AGD	56	329760	6251360	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Val Attenbrow					**Permits**		
45-6-0615	Undercliffe Road	AGD	56	328500	6244500	Closed site	Valid	Shell : -, Artefact : -, Art (Pigment or Engraved) : -	Midden,Shelter with Art	99514
	Contact	**Recorders**	Ms.Bronwyn Conyers,D Burns					**Permits**		
45-6-1268	Balls Head Reserve;	AGD	56	332786	6253288	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1900	White Horse Pt.	AGD	56	330800	6252420	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1901	Long Nose Point 1.;Birchgrove;9 Numa Street;	AGD	56	332000	6253030	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1481	Rozelle Hospital 3	AGD	56	329902	6251129	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Val Attenbrow,Michael Guider					**Permits**		
45-6-2555	Rodd Island	AGD	56	329080	6251280	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		

Report generated by AHIMS Web Service on 21/09/2016 for Andrew Peter Mclaren for the following area at Lat, Long From : -33.9252, 151.071 - Lat, Long To : -33.8455, 151.1973 with a Buffer of 0 meters. Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 49

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-6-0618	Rozelle Hospital 2, Rozelle Hospital 1	AGD	56	329650	6251330	Open site	Valid	Shell : -, Artefact : -, Art (Pigment or Engraved) : -	Midden,Rock Engraving	
	Contact	**Recorders**	Val Attenbrow,Michael Guider					**Permits**		
45-6-0628	Balls Head Reserve Waverton	GDA	56	333129	6253420	Open site	Valid	Art (Pigment or Engraved) : -	Rock Engraving	
	Contact	**Recorders**	Michael Guider,D Lautrec,Mr.R Taplin,Aboriginal Heritage Office					**Permits**		
45-6-2142	Hen & Chicken Bay, Five Dock.;	AGD	56	326200	6251250	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Mr.R Taplin					**Permits**		
45-6-1232	Balls Head Unbelievable Cave	GDA	56	332839	6253390	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	Michael Guider,D Lautrec,Aboriginal Heritage Office					**Permits**		
45-6-1142	Abbotsford;Kangaroo Feet Cave;	AGD	56	326670	6252712	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	ASRSYS					**Permits**		
45-6-1143	Mortdale;Tide Floor Cave;	AGD	56	325932	6253064	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	ASRSYS					**Permits**		
45-6-1934	Half Moon Bay Cave;	AGD	56	328990	6251690	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1935	Sisters Bay Cave	AGD	56	329350	6251930	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1936	Rodd Point Cave;	AGD	56	328730	6251010	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-0751	Shea's Creek Dugong	GDA	56	331839	6245378	Open site	Destroyed	Artefact : -, Aboriginal Resource and Gathering : -, Non-Human Bone and Organic Material : -	Open Camp Site	
	Contact	**Recorders**	ASRSYS,AECOM Australia Pty Ltd (previously HLA-Envirosciences),Mr.Luke Kirkw(					**Permits**		
45-6-1496	Shea's Creek	AGD	56	328842	6244524	Open site	Valid	Shell : -, Artefact : -	Midden	30,591,940
	Contact	**Recorders**	ASRSYS					**Permits**		
45-6-0891	Balls Head Reserve 5 Hands Cave	GDA	56	333139	6253455	Closed site	Valid	Shell : -, Artefact : -, Art (Pigment or Engraved) : -	Shelter with Art,Shelter with Midden	
	Contact	**Recorders**	Michael Guider,D Lautrec,Aboriginal Heritage Office					**Permits**		

Report generated by AHIMS Web Service on 21/09/2016 for Andrew Peter Mclaren for the following area at Lat, Long From : -33.9252, 151.071 - Lat, Long To : -33.8455, 151.1973 with a Buffer of 0 meters. Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 49

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-6-1954	Sisters Bay Cave 2	AGD	56	329510	6251920	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1955	Sisters Bay 3;	AGD	56	329370	6251750	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**	3653,3690	
45-6-1956	Five Dock Bay Cave	AGD	56	328430	6253220	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1957	Goat Island Cave;	AGD	56	333010	6252710	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-1971	Rozelle Hospital 5, Rozelle Hospital 3	AGD	56	329740	6251360	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Val Attenbrow,Michael Guider					**Permits**		
45-6-1972	Rozelle Hospital 4	AGD	56	329690	6251360	Closed site	Valid	Shell : -, Artefact : -	Shelter with Midden	
	Contact	**Recorders**	Val Attenbrow,Michael Guider					**Permits**		
45-6-1809	Birchgrove	AGD	56	331380	6252700	Closed site	Valid	Shell : -, Artefact : -, Art (Pigment or Engraved) : -	Midden,Shelter with Art	
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-0026	Whale rock	AGD	56	332800	6253300	Open site	Valid	Art (Pigment or Engraved) : -	Rock Engraving	
	Contact	**Recorders**	D Earle,Michael Guider,D Lautrec					**Permits**	2885	
45-6-0027	Balls Head Berry Island	GDA	56	333214	6253390	Closed site	Valid	Art (Pigment or Engraved) : -, Shell : -, Artefact : -, Burial : -	Burial/s,Shelter with Art,Shelter with Midden	
	Contact	**Recorders**	Michael Guider,Aboriginal Heritage Office					**Permits**		
45-6-2629	Broadway 1	AGD	56	333060	6249100	Open site	Valid	Artefact : -		102494,102763,102765
	Contact	**Recorders**	Dominic Steele Archaeological Consulting					**Permits**	1299	
45-6-2654	Fraser Park PAD	AGD	56	330100	6245800	Open site	Valid	Potential Archaeological Deposit (PAD) : -		98669
	Contact	**Recorders**	Navin Officer Heritage Consultants Pty Ltd					**Permits**	1639	
45-6-2676	Johnstons Creek	AGD	56	331100	6249100	Closed site	Valid	Art (Pigment or Engraved) : 2, Artefact : 5		102142,102763

Report generated by AHIMS Web Service on 21/09/2016 for Andrew Peter Mclaren for the following area at Lat, Long From : -33.9252, 151.071 - Lat, Long To : -33.8455, 151.1973 with a Buffer of 0 meters. Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 49

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-2666	Wattle Street PAD 1	AGD	56	333150	6249450	Open site	Valid	Potential Archaeological Deposit (PAD) : -		102494,102763,102765
	Contact	**Recorders**	Dominic Steele Archaeological Consulting					**Permits**	1738	
45-6-2680	Broadway Picture Theatre PAD 1	AGD	56	333150	6249000	Open site	Valid	Potential Archaeological Deposit (PAD) : -		102142,102494,102763,102765
	Contact	**Recorders**	Jim Wheeler					**Permits**	1854	
45-6-2745	University of Sydney Law Building PAD	AGD	56	332350	6248740	Open site	Valid	Potential Archaeological Deposit (PAD) : -		102201,102494,102763,102765
	Contact	**Recorders**	Doctor.Jo McDonald					**Permits**	2153,2320,2443	
45-6-2767	Tent Embassy	AGD	56	332680	6248680	Open site	Valid	Aboriginal Resource and Gathering : 1		102494,102763,102765
	Contact T Russell	**Recorders**	Bill Lord					**Permits**		
45-6-2822	USYD: Central	AGD	56	332750	6248550	Open site	Valid	Artefact : -		100302,102494,102763,102765
	Contact	**Recorders**	Jo McDonald Cultural Heritage Management					**Permits**	2554	
45-6-2843	Canada Bay Midden	AGD	56	329550	6251900	Closed site	Valid	Shell : -		100436
	Contact T Russell	**Recorders**	Kate Sullivan					**Permits**	3075	
45-6-2960	Jackson Landing Shelter	GDA	56	332442	6250870	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102494,102763,102765
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Mr.Paul Irish					**Permits**		
45-6-2966	Balls Head shelter NSC-073	GDA	56	332879	6253500	Open site	Valid	Potential Archaeological Deposit (PAD) : -, Shell : -		
	Contact	**Recorders**	Mr.Phil Hunt,Aboriginal Heritage Office					**Permits**		
45-6-2967	5 Hands Shelter B NSC-074	GDA	56	332134	6253455	Open site	Valid	Shell : -		
	Contact	**Recorders**	Mr.Phil Hunt,Aboriginal Heritage Office					**Permits**		
45-6-3071	445-473 Wattle Street PAD	GDA	56	333285	6249412	Open site	Valid	Potential Archaeological Deposit (PAD) : 1		
	Contact	**Recorders**	Biosis Pty Ltd - Sydney					**Permits**		
45-6-3064	445-473 WATTLE ST PAD	GDA	56	333285	6249412	Open site	Valid	Potential Archaeological Deposit (PAD) : 1		102763

Report generated by AHIMS Web Service on 21/09/2016 for Andrew Peter Mclaren for the following area at Lat, Long From : -33.9252, 151.071 - Lat, Long To : -33.8455, 151.1973 with a Buffer of 0 meters. Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 49

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 60491677, 1.1

Client Service ID : 246070

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
Contact		Recorders	Biosis Pty Ltd - Sydney					Permits		

Report generated by AHIMS Web Service on 21/09/2016 for Andrew Peter Mclaren for the following area at Lat, Long From : -33.9252, 151.071 - Lat, Long To : -33.8455, 151.1973 with a Buffer of 0 meters. Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 49

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Annexure C Site photos



Plate 1 Campbell Road civil and tunnel site (C10)



Plate 2 Darley Road civil and tunnel site (C4)



Plate 3 Rozelle civil and tunnel site (C5)



Plate 4 Buruwan Park, adjacent to Whites Creek in Annandale



Plate 5 Iron Cove Link civil site (C8)



Plate 6 Campbell Road civil and tunnel site (C10)

Annexure D Rating schemes

Table D.1 Ground Surface Visibility (GSV) rating scheme

GSV rating	% GSV
Very poor	0-10
Poor	11-30
Fair	31-50
Good	51-70
Very good	71-90
Excellent	91-100

Table D.2 Ground Integrity (GI) rating scheme

GI rating	Definition
Low	Area has been subject to significant disturbance through natural and/or anthropogenic processes (eg heavy earthworks).
Moderate	Area has been subject to moderate disturbance (eg native vegetation clearance) but retains a reasonable degree of integrity.
High	Area remains in a natural or near-natural state.

Table D.3 Archaeological Sensitivity rating scheme

Rating	Definition
Nil	Land with no potential for subsurface archaeological deposit(s) due to past ground disturbance(s).
Low	Subsurface archaeological deposit(s) may be present. Relative to areas of high sensitivity, lower artefact counts, densities and assemblage richness values expected. Integrity of deposit(s) will be dependent on the nature of localised land disturbances.
High	Subsurface archaeological deposit(s) likely to be present. Relative to areas of low sensitivity, higher artefact counts, densities and assemblage richness values expected. Integrity of deposit(s) will be dependent on the nature of localised land disturbances.

Appendix W

Detailed greenhouse gas calculations

WestConnex

Roads and Maritime Services

WestConnex – M4-M5 Link

Detailed greenhouse gas calculations

August 2017

Client: Roads and Maritime Services

ABN: 76 236 371 088

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1 Greenhouse gas calculation methodology

The following steps have been taken in estimating the greenhouse gas (GHG) emissions associated with the construction and operation of the M4-M5 Link project (the project), in accordance with the Transport Authorities Greenhouse Group (TAGG) Workbook[1] 2013:

- The GHG emissions relevant to the stages of project construction and operation have been identified
- The GHG inventory boundary of the EIS has been determined, which defined the emissions sources to be considered in the assessment and those to be excluded (refer to Table 22-1 of **Chapter 22** (Greenhouse gas) of this EIS for further details)
- The emissions sources have been quantified (see **Table 2-1** and **Table 4-1**)
- For the different emissions sources, emissions factors have been established and the emissions calculated.

This document provides the methodology used for calculating GHG emissions from fuel use, electricity consumption, vegetation removal, the embodied energy of materials used and the decomposition of waste generated during the project.

1.1 Guiding principles

The assessment has been conducted according to the following GHG accounting and reporting principles:

- Relevance – select and use GHG sources, sinks, data and methodologies appropriate for the project/organisation and intended use of GHG inventory results
- Completeness – include all relevant GHG emissions and information which support methodology and criteria used
- Consistency – use consistent data, calculation/modelling methods, criteria and assumptions to enable valid comparisons
- Transparency – include clear, sufficient and appropriate information to enable others to understand the basis for results and make decisions regarding use of GHG inventory results with reasonable confidence
- Accuracy – reduce bias and uncertainties, as much as practical.

In addition to the accounting and reporting principles presented above, the issue of materiality has also been assessed in the GHG assessment. This is a core accounting and auditing principle which ensures that sources, assumptions, values and procedures included in the GHG assessment are material to the project. As materiality is valued within the context of the project being assessed, this can vary significantly between projects.

The materiality checklist provided in the TAGG Workbook (2013) has been used to identify potential sources of emissions to be included or excluded in the assessment. Based on this guidance the use of inert materials such as imported fill, sand and fly ash are considered to be insignificant to the assessment (represent less than five per cent of total emissions) and are excluded from the assessment boundary.

Vegetation clearance has been included in the GHG assessment boundary in line with the materiality checklist, as more than 0.5 hectares of vegetation would be required to be removed as part of the

[1] The TAGG was formed by Australian state road authorities, including NSW Roads and Maritime Services and the New Zealand Transport Agency as a collaborative effort to share information regarding the estimation, reporting and minimisation of GHG emissions. The TAGG Workbook provides a consistent methodology for estimating the GHG emissions from activities that may contribute significantly to the overall emissions associated with the construction, operation and maintenance of road projects.

project. Cumulative impacts associated with additional clearing required as part of the Rozelle Rail Yards site management works has also been assessed. Specific methodologies for the calculation of emissions from each emissions source (eg fuel use, electricity consumption, vegetation clearance, material use and waste) are provided in the following sections.

1.2 Fuel

The method used to calculate the Scope 1 GHG emissions from the combustion of liquid fuels, for transport energy purposes is given by the formula below, sourced from the National Greenhouse Accounts (NGA) Factors 2016:

Greenhouse gas emissions (t CO_2-e) = ((Q x ECF)/1000) x (EF_{CO2} + EF_{CH4} + EF_{N2O})

Where: Q is the quantity of fuel (in kL)

ECF is the relevant energy content factor (in GJ/kL)

EF_{CO2} is the relevant Carbon dioxide (CO_2) emission factor (in kg CO_2-e/GJ)

EF_{CH4} is the relevant Methane (CH_4) emission factor (in kg CO_2-e/GJ)

EF_{N2O} is the relevant Nitrous oxide (N_2O) emission factor (in kg CO_2-e/GJ)

The method used for calculating the Scope 3 GHG emissions from the combustion of liquid fuels, for transport energy purposes is given by the formula below, as given by the NGA Factors 2016:

Greenhouse gas emissions (t CO_2-e) = (Q x ECF x $EF_{Scope\ 3}$)/1000

Where: Q is the quantity of fuel (in kL)

ECF is the relevant energy content factor (in GJ/kL)

$EF_{Scope\ 3}$ is the relevant emission factor (in kg CO2-e/GJ)

The Scope 1 and Scope 3 emission factors for diesel (post 2004 vehicles) are given in **Table 1-1**.

Table 1-1 Scope 1 and Scope 3 emission factors for the use of fuels (post 2004 vehicles) (NGA Factors 2016 Tables 4 and 40)

Fuel	Energy content factor (GJ per kL)	Scope 1 emission factor (kg CO_2-e/GJ)			Scope 3 emission factor (kg CO_2-e/GJ)	Emissions per unit quantity (t CO_2-e per kL)		
		CO_2	CH_4	N_2O		Scope 1	Scope 2	Scope 3
Diesel	38.6	69.9	0.01	0.6	3.6	2.7217	N/A	0.1390

1.3 Electricity

The method used to calculate the Scope 2 and Scope 3 GHG emissions from the consumption of purchased electricity is given by the formula below, as given by the NGA Factors 2016:

Greenhouse gas emissions (t CO_2-e) = Q x ($EF_{for\ scope}$ /1000)

Where: Q is the quantity of purchased electricity (in kWh)

$EF_{for\ scope}$ is the Scope 2 or Scope 3 emissions factor for NSW (in kg CO2-e/kWh).

The emission factors for the consumption of purchased electricity are given in **Table 1-2**.

Table 1-2 Scope 2 and Scope 3 emission factors for the use of purchased electricity for NSW/ACT (NGA Factors 2016 Table 41)

Fuel	Emissions per unit quantity		Units
	Scope 2	Scope 3	
Electricity	0.00084	0.00012	t CO_2-e per kWh

1.4 Vegetation removal

The TAGG Workbook (2013) provides a methodology for estimating the loss of carbon sequestration potential associated with the removal of vegetation that would be required as part of land clearing activities during the project. The methodology provided in Appendix E of the TAGG Workbook was developed by GHD (2012) and is in line with the methodology used by the Australian Government Department of the Environment to estimate Australia's national GHG emissions for reporting under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

The methodology is based on a conservative approach, in line with relevant GHG guiding and reporting principles, and the following assumptions:

- All carbon pools are removed as part of the clearance of vegetation (eg debris and soil)
- All carbon removed is converted to CO_2 and released to the atmosphere
- Sequestration as a result of any revegetation works carried out as part of the project has not been included in the assessment.

The methodology estimates the GHG emissions associated with the loss of carbon sequestration that exists in vegetation at the time of clearing and the potential carbon that could have been sequestered in the future if the vegetation was not cleared. The GHG emissions associated with the loss of CO_2 sequestration potential through the removal of vegetation have been calculated using the following steps:

- The potential maximum biomass class ('Maxbio' class) has been determined for the project location using vegetation maps provided in Appendix E of the TAGG Workbook
- The class of vegetation (Table 1 of the TAGG Workbook Appendix E) and the area in hectares for each vegetation type to be cleared as part of the project has been identified
- The vegetation clearance emissions factors have been identified for each vegetation class for the selected 'Maxbio' class from Table 2 of the TAGG Workbook Appendix E
- The GHG emissions associated with the loss of CO_2 sequestration potential have been estimated by multiplying the area of vegetation to be cleared (in hectares) by the corresponding emissions factor (t CO_2-e per hectare) for each vegetation type
- The total estimate of GHG emissions associated with the loss of CO_2 sequestration potential for the project has been obtained by adding the results for each vegetation type.

Vegetation clearance emissions factors for the project are identified in **Table 1-3**.

Table 1-3 Vegetation clearance emissions factors (TAGG Workbook Appendix E 2013)

Maxbio class	Vegetation type	Vegetation class	Emissions factor (t CO_2-e per hectare)
Class 3 (100 - 150 tonnes of dry matter per hectare)	Local parklands, urban backyards and the Rozelle Rail Yards comprising previously cleared, non-native vegetation dominated by exotic grasses, with some planted native and non-native species.	I (Grassland)	110

Note: the 'Maxbio' class is derived from the Australian Greenhouse Office and estimates the maximum tonnes of dry vegetation matter per hectare for a specific location. Conservative assumptions were used to classify non-native vegetation types.

1.5 Construction materials and waste

Indirect Scope 3 GHG emissions from the embodied energy of materials used in the project and the decomposition of waste generated by the project have been calculated according to the formula below:

Greenhouse gas emissions (t CO_2-e) = Q (t) x EF (tCO_2-e/t)

Where: Q is the quantity of material or waste (in tonnes).

EF is the relevant Emission Factor (in t CO_2-e per tonne of material/waste).

Emission factors have been sourced from the TAGG Workbook (2013) and the NGA Factors 2016, as given in **Table 1-4**.

Table 1-4 Material Emission Factors (TAGG Workbook 2013; NGA Factors 2016)

Material	Emission factor (t CO_2-e/t)	Assumptions
Construction materials		
Concrete (cast insitu)	0.155	TAGG Workbook (2013) Appendix D Concrete 40MPa (1:1.5:3)
Concrete (precast)	0.119	SimaPro: Concrete block, at plant/DE U
Cement (Portland Cement)	0.82	TAGG Workbook (2013) Appendix D
Steel	1.05	(Structural) TAGG Workbook (2013) Appendix D
Aggregate/ road base	0.007	TAGG Workbook (2013) Appendix D
Asphalt	0.058	Hotmix Asphalt TAGG Workbook (2013) Appendix D
Mains water	0.001	SimaPro: Water, drinking, Sydney/AU U
Waste		
Construction and demolition waste	0.2	NGA Factors 2016, Table 44

2 Construction greenhouse gas assessment activity data

This section details the quantification of the GHG emission source data used to estimate emissions associated with construction of the project, including the sources of information used and assumptions made.

Twelve construction ancillary facilities are described in this EIS (as listed below). To assist in informing the development of a construction methodology that would manage constructability constraints and the need for construction to occur in a safe and efficient manner, while minimising impacts on local communities, the environment, and users of the surrounding road and other transport networks, two possible combinations of construction ancillary facilities at Haberfield and Ashfield have been assessed in this EIS. The construction ancillary facilities that comprise these options have been grouped together in this EIS and are denoted by the suffix a (for Option A) or b (for Option B).

The construction ancillary facilities required to support construction of the project include:

- Construction ancillary facilities at Haberfield (Option A), comprising:
  - Wattle Street civil and tunnel site (C1a)
  - Haberfield civil and tunnel site (C2a)
  - Northcote Street civil site (C3a); or
- Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b); and
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- The Crescent civil site (C6)
- Victoria Road civil site (C7)
- Iron Cove Link civil site (C8)
- Pyrmont Bridge Road tunnel site (C9)
- Campbell Road civil and tunnel site (C10).

Table 2-1 details the GHG emission source data and emissions factors used in the GHG assessment. The table identifies where input data differs between construction ancillary facilities for Option A and Option B. The seven additional construction ancillary facilities (C4 to C10) are included in the assessment for each option.

The number, location and layout of construction ancillary facilities would be finalised as part of detailed construction planning during detailed design and would meet the environmental performance outcomes stated in the EIS and the Submissions and Preferred Infrastructure Report and satisfy criteria identified in any relevant conditions of approval.

Table 2-1 Construction GHG emission source data and emissions factors

Emissions source category	Emissions source	Assumptions	Quantity	Unit	Emissions factors			
					Scope 1	Scope 2	Scope 3	Units
Fuel use - diesel consumption	Mobile construction plant & equipment	Assumed to include fuel consumption for mobile plant and equipment for all construction works onsite.	12,000	kilolitres (kL)	2.722		0.139	t CO_2-e per kL
	Fuel use (diesel) – transport of materials, spoil and waste to/from site	Assumed to include transport of materials and items transported by heavy vehicles to/from site. Number of transport loads estimated from daily heavy vehicle numbers for each construction ancillary facility as detailed in **Chapter 6** (Construction work) of the EIS. Spoil movements assumed to be via road.	Option A: 33,545 Option B: 30,883	kilolitres (kL)	2.722		0.139	t CO_2-e per kL
Fuel use - petrol consumption (gasoline)	Construction plant, equipment and vehicle use onsite	Assumed to include fuel consumption of light vehicles onsite.	30	kilolitres (kL)	2.313		0.123	t CO_2-e per kL
	Transport of project vehicles - light vehicles	Assumed to include fuel consumption for transport of construction workforce to and from the site.	Option A: 3,706 Option B: 3,617	kilolitres (kL)	2.313		0.123	t CO_2-e per kL

Emissions source category	Emissions source	Assumptions	Quantity	Unit	Emissions factors			
					Scope 1	Scope 2	Scope 3	Units
Electricity purchased from the grid	Electricity consumption to power roadheaders and other associated plant and equipment onsite (eg temporary tunnel ventilation, water treatment and site offices)	Assumed to include electricity consumption of tunnelling machinery, tunnel lighting and ventilation during construction, site offices and other onsite electrical plant and equipment for each construction ancillary facility the duration of the construction period.	Option A: 100,020,000 Option B: 96,250,000	kilowatts per hour (kWh)		0.00084	0.00012	t CO_2-e per kWh
Vegetation clearance	Removal of vegetation from project sites	Local parklands, urban backyards and the Rozelle Rail Yards comprising previously cleared, non-native vegetation dominated by exotic grasses, with some planted native and non-native species.	10.8	Hectares	110			t CO_2-e per hectare
Embodied energy of construction materials	Concrete - cast insitu	2.3 t/m^3 (TAGG Appendix C) Assume 40MPa	920,000	tonnes (t)			0.155	t CO_2-e per tonne
	Concrete - precast	2.3 t/m^3 (TAGG Appendix C) Assume 40MPa	74,175	tonnes (t)			0.155	t CO_2-e per tonne
	Cement (Portland Cement)	Excludes concrete	122,000	tonnes (t)			0.82	t CO_2-e per tonne
	Steel - structural steel	-	450	tonnes (t)			1.05	t CO_2-e per tonne
	Steel – reinforcing steel	-	15,000	tonnes (t)			1.05	t CO_2-e per

Emissions source category	Emissions source	Assumptions	Quantity	Unit	Emissions factors			
					Scope 1	Scope 2	Scope 3	Units
								tonne
	Asphalt	-	70,000	tonnes (t)			0.058	t CO_2-e per tonne
	Aggregate	-	20,000	tonnes (t)			0.007	t CO_2-e per tonne
	Mains water	1 kilolitre per tonne	2,000,000	tonnes (t)			0.001	t CO_2-e per tonne
Waste	Construction and demolition waste	Estimate based on benchmarking of quantity of construction and demolition waste for M4 East and New M5 projects	50,000	tonnes (t)			0.2	tCO2-e per tonne

Note: Estimated quantities have been rounded to the nearest whole number.

3 Detailed construction greenhouse gas assessment results

Table 3-1 gives the GHG assessment results for the emissions estimated to occur during construction of the project, reported according to Scope 1, Scope 2, Scope 3 and total emissions, where Option A is selected as the preferred construction option at Haberfield. GHG emissions are reported in this assessment as tonnes of carbon dioxide equivalent (tCO_{2}-e).

Table 3-1 Detailed construction GHG emissions results for Option A

Emissions source category	Emissions source	Quantity	Unit	GHG emissions (t CO2-e)				
				Scope 1	Scope 2	Scope 3	Total	% Total
Fuel use - diesel consumption	Mobile construction plant & equipment	12,000	kilolitres	32,336		2,455	**34,791**	6.59
	Fuel use (diesel) – transport of materials, spoil and waste to/from site	33,545	kilolitres	90,392		6,863	**97,255**	18.42
Fuel use – petrol consumption (gasoline)	Construction plant, equipment and vehicle use onsite	30	kilolitres	69		5	**74**	0.01
	Transport of project vehicles - light vehicles	3,706	kilolitres	8,483		671	**9,154**	1.73
Electricity purchased from the grid	Electricity consumption during construction	100,020,000	kilowatt hours		86,017	13,003	**99,020**	18.75
Vegetation clearance	Removal of vegetation from project sites	10.8	hectares	1,188			**1,188**	0.23
Construction materials	Concrete - cast in situ	920,000	tonnes			142,600	142,600	27.00
	Concrete - precast	74,175	tonnes			11,497	11,497	2.18
	Cement (Portland Cement)	122,000	tonnes			100,040	100,040	18.95

Emissions source category	Emissions source	Quantity	Unit	GHG emissions (t CO2-e)				
				Scope 1	Scope 2	Scope 3	Total	% Total
	Steel - structural steel	450	tonnes			473	473	0.09
	Steel – reinforcing steel	15,000	tonnes			15,750	15,750	2.98
	Asphalt	70,000	tonnes			4,060	4,060	0.77
	Aggregate	20,000	tonnes			140	140	0.03
	Mains water	2,000,000	tonnes			2,000	2,000	0.38
Waste	Construction and demolition waste	50,000	tonnes			10,000	10,000	1.89
Totals				**132,468**	**86,017**	**309,557**	**528,042**	100%
% Total				25.09	16.29	58.62	**100%**	

Note: Estimated quantities have been rounded to the nearest whole number.

Table 3-2 gives the GHG assessment results for the emissions estimated to occur during construction of the project, reported according to Scope 1, Scope 2, Scope 3 and total emissions, where Option B is selected as the preferred construction option at Haberfield/Ashfield. GHG emissions are reported in this assessment as tonnes of carbon dioxide equivalent (t CO_{2}-e).

Table 3-2 Detailed construction GHG emissions results for Option B

Emissions source category	Emissions source	Quantity	Unit	GHG emissions (t CO2-e)				
				Scope 1	Scope 2	Scope 3	Total	% Total
Fuel use - diesel consumption	Mobile construction plant & equipment	12,000	kilolitres	32,336		2,455	**34,791**	6.74
	Fuel use (diesel) – transport of materials, spoil and waste to/from site	30,883	kilolitres	83,218		6,318	**89,536**	17.34
Fuel use – petrol consumption (gasoline)	Construction plant, equipment and vehicle use onsite	30	kilolitres	69		5	**74**	0.01
	Transport of project vehicles - light vehicles	3,617	kilolitres	8,277		655	**8,932**	1.73
Electricity purchased from the grid	Electricity consumption during construction	96,250,000	kilowatt hours		82,775	12,513	**95,288**	18.45
Vegetation clearance	Removal of vegetation from project sites	10.8	hectares	1,188			**1,188**	0.23
Construction materials	Concrete - cast in situ	920,000	tonnes			142,600	142,600	27.61
	Concrete - precast	74,175	tonnes			11,497	11,497	2.23
	Cement (Portland Cement)	122,000	tonnes			100,040	100,040	19.37

Emissions source category	Emissions source	Quantity	Unit	GHG emissions (t CO2-e)				
				Scope 1	Scope 2	Scope 3	Total	% Total
	Steel - structural steel	450	tonnes			473	473	0.09
	Steel – reinforcing steel	15,000	tonnes			15,750	15,750	3.05
	Asphalt	70,000	tonnes			4,060	4,060	0.79
	Aggregate	20,000	tonnes			140	140	0.03
	Mains water	2,000,000	tonnes			2,000	2,000	0.39
Waste	Construction and demolition waste	50,000	tonnes			10,000	10,000	1.94
Totals				**125,088**	**82,775**	**308,506**	**516,369**	100%
% Total				24.23	16.03	59.74	**100%**	

Note: Estimated quantities have been rounded to the nearest whole number.

4 Emissions from road infrastructure operation and maintenance activities

This section estimates the GHG emissions that would be generated from the annual operation and major maintenance activities for the project's road infrastructure.

Emissions associated with the operation of road infrastructure have been estimated based on the annual consumption of electricity, purchased from the grid. Annual use of electricity is based on estimates of annual electricity consumption for powering tunnel lighting and ventilation, building services, heating ventilation and air-conditioning (HVAC) systems, surface plants, wastewater treatment, pumps and drainage, communications systems, electronic signage and other associated electrical systems.

Default quantity factors, provided in the TAGG Workbook have been used to quantify activity data associated with the maintenance of the tunnel and road pavements. Emission estimates for the use of fuel and materials for the maintenance of the road pavement are based on one major rehabilitation of asphalt pavement with the top 150 millimetres replaced and five per cent of pavement replaced for patching/repair every 50 years, and five per cent of concrete pavement replaced with only the top layer requiring replacement every 50 years (in accordance with 'typical' maintenance activities given in the TAGG Workbook).

Specific methodologies for the calculation of emissions are provided in **section 1** of this document. **Table 4-1** details the GHG emission source data and emissions factors used in the assessment of GHG emissions generated from the operation and maintenance of road infrastructure.

Table 4-1 Operation and maintenance GHG emission source data and emissions factors

Emissions source category	Emissions source	Assumptions	Quantity	Units	Emissions per unit quantity			
					Scope 1	Scope 2	Scope 3	Units
Electricity consumption	Annual electricity consumption of road infrastructure and associated management systems – Mainline tunnels	The electricity consumption is assumed to include power for tunnel lighting and ventilation, building services, HVAC systems, surface plants, wastewater treatment, pumps and drainage, communications systems, electronic signage and other associated electrical systems.	19,941,946	kilowatt hours (kWh) per year		0.00084	0.00012	tCO_2-e per kWh
	Annual electricity consumption of road infrastructure and associated management systems – Rozelle interchange		30,796,842	kilowatt hours (kWh) per year		0.00084	0.00012	tCO_2-e per kWh
Fuel use - diesel consumption	Mobile maintenance plant and equipment, project vehicles	TAGG workbook Table 7-3 (2013)	1,214	kilolitres	2.7217		0.1390	t CO_2-e per kL
Maintenance materials	Steel	TAGG workbook Table 7-3 (2013)	42	tonnes			1.05	t CO_2-e per t
	Bitumen	TAGG workbook Table 7-3 (2013)	3,969	tonnes			0.63	t CO_2-e per t
	Aggregate	TAGG workbook Table 7-3 (2013)	81,176	tonnes			0.005	t CO_2-e per t
	Cement - Portland Cement	TAGG workbook Table 7-3 (2013)	321	tonnes			0.82	t CO_2-e per t

5 Detailed operation and maintenance emissions results

Table 5-1 gives the GHG assessment results for the emissions estimated to occur during operation of project infrastructure, reported according to Scope 1, Scope 2, Scope 3 and total emissions.

Table 5-2 gives the GHG assessment results for the emissions estimated to occur during maintenance of project infrastructure, reported according to Scope 1, Scope 2, Scope 3 and total emissions.

Table 5-1 Annual operational GHG emissions results

Emissions source category	Emissions source	Quantity	Unit	GHG emissions (t CO_2-e per year)			
				Scope 1	Scope 2	Scope 3	Total
Annual electricity consumption – mainline tunnels	Annual use of electricity for powering tunnel lighting and ventilation, building services, HVAC systems, surface plants, wastewater treatment, pumps and drainage, communications systems, electronic signage and other associated electrical systems.	19,941,946	kilowatt hours (kWh) per year		16,751	2,393	19,144
Annual electricity consumption – Rozelle interchange		30,796,842	kilowatt hours (kWh) per year		25,870	3,695	29,565
Total					**42,621**	**6,088**	**48,709**

Table 5-2 Total maintenance GHG emissions results

Emission source category	Emission source	Quantity	Unit	GHG emissions (t CO_2-e)				
				Scope 1	Scope 2	Scope 3	Total	%
Fuel use - diesel consumption	Mobile maintenance plant and equipment, project vehicles	1,214	kilolitres	3,271		248	3,519	52.3
Maintenance materials	Steel	42	tonnes (t)			44	44	0.7
	Bitumen	81,176	tonnes (t)			406	406	6.0
	Aggregate	3,969	tonnes (t)			2,500	2,500	37.1
	Cement - Portland Cement	321	tonnes (t)			264	264	3.9
Total				**3,271**	**0**	**3,462**	**6,733**	**100%**
Total %				**48.6%**	**0%**	**51.4%**	**100%**	

6 Emissions from operational road use

As improvements to traffic flow and congestion are achieved through increased speeds, reduced travel distances and reduced frequency of stopping, fuel efficiency is improved and subsequently GHG emissions associated with road use are reduced. As such, it is anticipated that the project would result in GHG emissions savings when compared to the base case 'do minimum' scenario (without the project).

6.1 Methodology

To assess the indirect Scope 3 GHG emissions associated with fuel combustion of vehicle traffic using the project, and to evaluate any potential GHG emissions savings as a result of the project, the following road use scenarios were considered:

- At opening (2023): it is proposed that the project would be constructed and fully operational in 2023. The following scenarios have been assessed in the project year of opening:
  - Operation 'do minimum' or 'without project' (2023): assumes that NorthConnex, M4 Widening, M4 East, King Georges Road Interchange Upgrade and New M5 are completed and open to traffic, but that the M4-M5 Link has not been built. It is called 'do minimum' rather than 'do nothing' as it assumes ongoing improvements will be made to the broader transport network over time including some new infrastructure and intersection improvements to improve capacity and cater for traffic growth
  - Operation 'with project' (2023): with the 'do minimum' projects completed and the M4-M5 Link completed and open to traffic
  - Operation 'cumulative' (2023): with 'do minimum' projects and M4-M5 Link completed and open to traffic, and in addition, the proposed future Sydney Gateway and Western Harbour Tunnel projects are completed and open to traffic
- Future 10 years after opening (2033): assessment of the future operation of the project and transport network elements 10 years after opening. The following scenarios have been assessed in the future 10 years after project opening:
  - Operation 'do minimum' or 'without project' (2033): with the same 2023 'do minimum' projects complete and some upgrades to the broader transport network over time to improve capacity and cater for traffic growth but does not include the M4-M5 Link
  - Operation 'with project' (2033): with the 'do minimum' projects completed and the M4-M5 Link completed and open to traffic
  - Operation 'cumulative' (2033): with the 'do minimum' projects and M4-M5 Link completed and open to traffic, and in addition, the proposed future Sydney Gateway, Western Harbour Tunnel, Beaches Link and the F6 Extension projects completed and open to traffic.

These scenarios are summarised in Table 22-5 of **Chapter 22** (Greenhouse gas) of the EIS. The proposed construction program has the mainline tunnels planned for completion in 2022 and the Rozelle interchange, including the Iron Cove Link, planned for completion in 2023.

Traffic volumes were modelled for 2023 and 2033 in line with **Appendix H** (Technical working paper: Traffic and transport) of the EIS. These future years were chosen as they provide an indication of road network performance at project opening (2023), and 10 years after opening (2033).

The analysis is based on the vehicle kilometres travelled (VKT) and the average speed of vehicles travelling on key routes within the GHG assessment study area, as generated by WestConnex Road Traffic Model version 2.3 (WRTM v2.3), ie the strategic traffic model developed and operated by

Roads and Maritime. The GHG assessment for operational road use involved calculation of the following inputs:

- Average speed for each road link[2]
- VKT for both light and heavy vehicles
- Rate of fuel consumption
- Total fuel quantity
- Fuel quantity by fuel type
- Calculation of GHG emissions.

It is acknowledged that the assessment uses the methodology described in the guideline document, Austroads Guide to Project Evaluation Part 4: Project Evaluation Data, Part 6 (2008), which has since been removed from Austroads publications due to uncertainties in the accuracy of the fuel consumption coefficients provided therein (see **section 6.2.4**). However, as the project uses outputs of the WRTM, which provides strategic-level demand forecasts for the Sydney Metropolitan area in place of other analytical intersection assessment tools (eg SIDRA, which includes a carbon accounting function), no alternative methodology was available to assess operational road use emissions for the project. As a result, Scope 3 road use emissions estimated in this assessment are considered to be subject to the limitations of the fuel consumption coefficients used and the assumptions used to generate traffic forecasts as part of the WRTM.

6.2 Calculation of operational road use emissions

6.2.1 GHG study area boundary

The GHG assessment study area contains major transport corridors and infrastructure, covering parts of the main travel demand corridors in Sydney: Parramatta to the Sydney central business district (CBD) via Strathfield, Parramatta to the Sydney CBD via Ryde, Sydney Airport to the Sydney CBD, and Victoria Road to St Peters. These corridors are some of the most highly congested road corridors in Sydney, with demand on some sections already exceeding capacity during peak periods. This congestion increases travel time and variability. The study area also allows for a cumulative assessment of proposed future transport corridors, such as Sydney Gateway, Western Harbour Tunnel, Beaches Link and the F6 Extension.

The GHG study area boundary was chosen to assess emissions associated with changes in daily traffic volumes and performance on the road network (both increases and decreases) as a result of the project. As the project does not replace a single existing route within the road network, the GHG study area boundary was selected to include key routes that currently serve as alternate routes to the project as well as other roads within the vicinity that were considered to be influenced by the project.

These key routes for the GHG study area boundary were identified in accordance with **Appendix H** (Technical working paper: Traffic and transport) of the EIS, using:

- Difference plots from WRTM v2.3 – the difference plots showed the percentage change in traffic flows between different road network scenarios and confirmed the study area would cover the material changes in traffic volumes as a result of the project.
- Screenline analyses – used to examine how traffic patterns may change between the alternative parallel corridors through the study area. Four screenlines were selected to analyse directional and two-way traffic volume outputs from the different modelling scenarios for each common future year.

[2] As classified within WRTM v2.3 and include Motorway, Highway, Regional Arterial, Arterial, Sub-arterial, Collector and Minor.

Key routes within the GHG study area boundary include:

- Parramatta Road between Five Dock and Broadway
- City West Link and Anzac Bridge/Western Distributor
- Victoria Road between Lyons Road and Anzac Bridge
- The Sydney Harbour Bridge and Sydney Harbour Tunnel
- Cahill Expressway, Eastern Distributor and Southern Cross Drive
- The eastern extent of the M4 East Motorway, between Five Dock and the Wattle Street interchange
- The existing M5 Motorway and New M5 Motorway, between the Princes Highway and General Holmes Drive
- Princes Highway, King Street and City Road, between Rockdale and Ultimo
- Roads surrounding the Wattle Street interchange, the Rozelle interchange, and the St Peters interchange.

Further information regarding the difference plot and screenline analyses, and the project's operational study area, is provided in **Appendix H** (Technical working paper: Traffic and transport) of the EIS.

6.2.2 Average speed by road type

For each scenario, the average weekday speeds on links within the study area were sourced from the WRTM v2.3, for each direction of traffic in the AM peak, inter-peak, PM peak and evening periods. Average speed is influenced by the level of congestion experienced for each link, as well as factors such as the number of traffic lights, road or tunnel gradient and ramp curvature.

6.2.3 Vehicle kilometres travelled

For each scenario, VKT for light and heavy vehicles on each link within the study area was sourced from the WRTM v2.3, for each direction of traffic in the AM peak, inter-peak, PM peak and evening periods. The average VKT for each daily time period was multiplied to give the average volume of traffic for each time period over 365 days per year. The VKT assessed is based on model outputs of average weekday traffic (AWT) projections. This provides a conservative assessment for annual VKT based on higher weekday traffic volumes, rather than average daily traffic (ADT), as generally ADT volumes are lower than AWT on most roads and similar on a few roads.

6.2.4 Rate of fuel consumption

The rate of fuel consumption was calculated for each vehicle type within the traffic impact footprint, using the basic fuel-speed formula given below (Equation 1 in Austroads Guide to Project Evaluation Part 4: Project Evaluation Data, Part 6 (2008)):

$$\textit{Fuel Consumption (L/100km)} = A + (B/V) + (CxV) + (DxV^2)$$

Where: A, B, C, D are the fuel consumption parameter values given in **Table 6-1**.

V is the all day average link speed in km/h

Table 6-1 Fuel consumption parameter values on freeways − litres/100 km (Austroads Guide to Project Evaluation Part 4: Project Evaluation Data Table 6.3)

Vehicle type	A	B	C	D
Cars	-18.433	1306.02	0.15477	0.0003203
Light commercial vehicle (LCV)	-27.456	2060.5	0.1911	0.000851
Rigid trucks	-65.056	4156.75	0.49681	0.0006798
Articulated vehicles	-80	6342.8	0.48496	0.0020895

Buses	-80	5131.63	0.60539	0.0015775

As the GHG emissions from road use were assessed for two vehicle categories (light vehicles and heavy vehicles), weighted average fuel consumption parameters were applied according to the likely proportional makeup of vehicle types within each category, based on the most recent Australian Bureau of Statistics (ABS) NSW Registration vehicle type data for the census date 31 January 2016 (released July 2016), as given in **Table 6-2**. **Table 6-3** details the likely proportional makeup of cars and light commercial vehicles (LCVs) within the category of 'light vehicles' and of rigid trucks, articulated vehicles and buses within the category 'heavy vehicles'. The weighted average fuel consumption parameters applied are given in **Table 6-4**.

Table 6-2 ABS NSW Registration vehicle type data for calculating weighted average fuel consumption parameters for light and heavy vehicles (ABS 9309.0 Motor Vehicle Census at the Census date 31 January 2016)

Category	2016 NSW registrations	Proportion of total vehicles	Heavy/ Light vehicle	Sub-classification according to fuel consumption parameters	Proportion heavy/light
Articulated trucks	21,450	0.40%	H	Articulated vehicles	0.11
Buses	25,939	0.48%	H	Buses	0.14
Heavy rigid trucks	91,242	1.70%	H	Rigid trucks	0.48
Non-freight carrying trucks	2,908	0.05%	H	Rigid trucks	0.02
Light rigid trucks	48,788	0.91%	H	Rigid trucks	0.25
Total	**190,327**	**3.54%**	**-**	**-**	**1.00**
Light commercial vehicles	804,665	14.97%	L	LCV	0.16
Motor cycles	229,296	4.27%	L	Cars	0.04
Passenger vehicles	4,134,786	76.93%	L	Cars	0.80
Campervans	15,345	0.29%	L	Cars	0.00
Total	**5,184,092**	**96.46%**	**-**	**-**	**1.00**

Table 6-3 Estimated proportional makeup of light and heavy vehicles according to vehicle type

Category	Cars	LCV	Rigid Trucks	Articulated vehicles	Buses
Light vehicles	0.84	0.16	0	0	0
Heavy vehicles	0	0	0.75	0.11	0.14

Table 6-4 Fuel consumption parameter values on freeways for light and heavy vehicles − litres/100 km (adapted from Austroads Guide to Project Evaluation Part 4: Project Evaluation Data Table 6.3)

Vehicle category	A	B	C	D
Light	-19.87668000	1426.73680000	0.16058280	0.00040521
Heavy	-68.79200000	4533.69870000	0.51070770	0.00096055

Rates of fuel consumption calculated according to the parameters in **Table 6-1** are applicable for 2008 (year of publication of Austroads Guide to Project Evaluation). Annual rates of fuel efficiency improvement were applied to calculate rates of fuel consumption, for light and heavy vehicles, in 2023 and 2033, according to road transport fuel intensity projections by vehicle type, given by SKM (2011) in Australian Transport Emissions Projections to 2050 (see **Table 6-5**), as follows:

- Rates of fuel consumption for 2023 were calculated by applying the annual percentage change in fuel intensity from 2020 to 2030, given in **Table 6-5**, to the rate of fuel consumption in the year 2020
- Rates of fuel consumption for 2033 were calculated by applying the annual percentage change in fuel intensity from 2030 to 2050, given in **Table 6-5**, to the rate of fuel consumption in the year 2030.

Table 6-5 Estimated fuel intensity projections by Road Type (SKM (2011) Australian Transport Emissions Projections to 2050)

Vehicle Type	Annual % fuel intensity change (2020-2030)	Annual % fuel intensity change (2030-2050)	Heavy/Light vehicle classification	Annual % fuel intensity change (2020-2030) (based on vehicle proportions)	Annual % fuel intensity change (2030-2050) (based on vehicle proportions)
Passenger	-1.4	-1.8	Light	-1.37	-1.80
Motorcycles	-0.8	-0.8			
LCV	-1.2	-1.8			
Buses	0.3	1.1	Heavy	-0.53	-0.64
Rigid	-0.6	-0.9			
Articulated	-1.1	-1.1			

6.2.5 Total fuel quantity combusted

For each scenario, VKT was factored by the rate of fuel consumption for each road type to determine the total quantity of fuel consumed in each scenario.

6.2.6 Fuel quantity combusted by fuel type

The analysis considered three fuel types: petrol, diesel and LPG. The total quantity of fuel combusted in each scenario, for 2023 and 2033, was apportioned according to fuel type, based on Australian Bureau of Statistics Survey of Motor Vehicle Census at the Census date 31 January 2016. Estimates of the proportional makeup of light and heavy vehicles by fuel type are given in **Table 6-6**.

Table 6-6 Fuel type proportions for light and heavy vehicles (calculated from data in ABS 9309.0 Motor Vehicle Census for the Census date 31 January 2016)

Vehicle Category	Fuel Type	Estimated Proportion
Light vehicles	Petrol	0.795
	Diesel	0.181
	LPG/CNG/dual fuel/hybrid (assume LPG)	0.024
Heavy vehicles	Petrol	0.061
	Diesel	0.928
	LPG/CNG/dual fuel/hybrid (assume LPG)	0.011

6.3 Detailed operational road use emission results

6.3.1 The GHG emissions calculation

The Scope 3 GHG emissions associated with the use of petrol, diesel and LPG in each scenario for 2023 and 2033 were calculated according to the formula below, as given by the NGA Factors 2016:

Greenhouse gas emissions (t CO_2-e) = (Q x $EF_{full\ fuel\ cycle}$)/1000

Where: Q is the quantity of fuel (in kL).

$EF_{full\ fuel\ cycle}$ is the relevant emission factor (in kg CO_2-e/kL).

The emission factor applied represents the full fuel cycle, which is the sum of Scope 1 and Scope 3 emissions. The emission factors for petrol, diesel and LPG, for general transport as a conservative assumption, are given in **Table 6-7**.

Table 6-7 Scope 1, Scope 3 and full fuel cycle emission factors for general transport (Source: NGA Factors 2016 Tables 4 and 40)

Fuel	Energy content factor (GJ per kL)	Scope 1 emission factor (kg CO_2-e/GJ)			Scope 3 emission factor (kg CO_2-e/GJ)	Emissions per unit quantity (t CO_2-e per kL)			Full fuel cycle (t CO_2-e per kL)
		CO_2	CH_4	N_2O		Scope 1	Scope 2	Scope 3	
Petrol (gasoline)	34.2	67.4	0.5	1.8	3.6	2.38374	N/A	0.12312	2.50686
Diesel oil	38.6	69.9	0.1	0.5	3.6	2.7213	N/A	0.13896	2.86026
Liquid petroleum gas (LPG)	26.2	60.2	0.6	0.7	3.6	1.6113	N/A	0.09432	1.70562

The estimated GHG emissions per annum from the use of fuel in each scenario for 2023 and 2033 are given in **Table 6-8** below.

Table 6-8 Scope 3 GHG emissions results for operational road use

Route	GHG emissions (t CO_2-e)						Difference between scenarios (t CO_2-e)			
	'Do minimum' (without project)		'With project'		'Cumulative'		'With project' – 'Do minimum'		'Cumulative' – 'Do minimum'	
	2023	2033	2023	2033	2023	2033	2023	2033	2023	2033
Existing road network (within the study area)	9,891,755	11,687,799	9,491,704	11,140,131	9,242,368	10,811,985	-400,052	-547,668	-649,387	-875,814
M4-M5 Link	N/A	N/A	38,471	42,917	46,886	54,686	38,471	42,917	46,886	54,686
Totals	**9,891,755**	**11,687,799**	**9,530,175**	**11,183,048**	**9,289,254**	**10,866,671**	**-361,581**	**-504,751**	**-602,501**	**-821,128**

Note: negative values indicate a savings in GHG emissions for the 'with project' and 'cumulative' scenarios compared with the 'do minimum' (without project) scenario. N/A = not applicable (the 'do minimum' scenario does not include the project).

Appendix X

Climate change risk assessment framework

WestConnex

Roads and Maritime Services

M4-M5 Link

Environmental Impact Statement

Climate change risk assessment framework

August 2017

Client: Roads and Maritime Services

ABN: 76 236 371 088

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Glossary of terms and abbreviations

Term	Meaning
Adaptation	The process of adjustment to actual or expected climate and its effects. Adaptation can be autonomous or planned (CSIRO and BoM 2015a).
ARI	Average recurrence interval. An indicator used to describe the frequency of floods. The average period in years between the occurrence of a flood of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a one per cent chance (i.e. a one-in-100 chance) of occurrence in any one year. Floods generated by runoff from the study catchments are referred to in terms of their ARI, for example the 100 year ARI flood.
AR5	IPCC Fifth Assessment Report
BoM	Bureau of Meteorology
Bushfire	Bushfires in Australia occur as grass fires or forest fires.
Climate change	A change in the state of the climate that can be identified (eg by statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer (CSIRO and BoM 2015a).
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realised (CSIRO and BoM 2015a).
CO_2	Carbon dioxide. A naturally occurring gas, also a by-product of burning fossil fuels from fossil carbon deposits, such as oil, gas and coal, of burning biomass, of land use changes and of industrial processes (eg cement production). It is the principle anthropogenic greenhouse gas that affects the Earth's radiative balance (CSIRO and BoM 2015a).
CSIRO	Commonwealth Scientific and Industrial Research Organisation.
Emissions scenario	A plausible representation of the future development of emissions of substances that are potentially radiatively active (eg greenhouse gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships (CSIRO and BoM 2015a).
ENSO	El Niño–Southern Oscillation. A fluctuation in global scale tropical and subtropical surface pressure, wind, sea surface temperature and rainfall, and an exchange of air between the southeast Pacific subtropical high and the Indonesian equatorial low (CSIRO and BoM 2015a).
Extreme temperature	Definitions vary; however, this document uses 'extreme temperature' to denote days above 35˚C.
Extreme rainfall	There is no consistent global definition for extreme rainfall. It can be defined by either relative rainfall at a location (amount relative to averages), or absolute rainfall amounts (eg over 100 millimetres in a single day). In this document, an extreme rainfall event is defined as the wettest day in 20 years.
FFDI	Forest fire danger index.
Fire weather	Weather conditions conducive to triggering and sustaining wild fires, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity, and wind. Fire weather does not include the presence or absence of fuel load (CSIRO and BoM 2015a).

Term	Meaning
Greenhouse gas	Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere (CSIRO and BoM 2015a).
IOD	Indian Ocean Dipole. Large-scale mode of interannual variability of sea surface temperature in the Indian Ocean. This pattern manifests through a zonal gradient of tropical sea surface temperature, which in its positive phase from September to November shows cooling off Sumatra and warming off Somalia in the west, combined with anomalous easterlies along the equator (CSIRO and BoM 2015a).
IPCC	Intergovernmental Panel on Climate Change
Mean rainfall	The arithmetically averaged total precipitation recorded during a calendar month or year (BoM 2007).
NARCliM	NSW/ACT Regional Climate Modelling
O/C	Overall construction cost
PMF	Probable Maximum Flood. The flood that occur as a result of the probable maximum precipitation on a study catchment. The probable maximum flood is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of flood prone land (ie the floodplain).
RCP	Representative concentration pathways. Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/cover (CSIRO and BoM 2015a).
Roads and Maritime	NSW Roads and Maritime Services
WCL	Workers compensation liability

1 Risk assessment framework

Table 1-1 and **Table 1-2** provide the likelihood and consequence criteria used for the climate change risk assessment. The criteria are from the *Guidelines for Risk Management* (NSW Roads and Maritime Services (Roads and Maritime) 2014).

Table 1-1 Likelihood criteria

Likelihood rating	Description		Probability parameters	
Extreme	Almost certain	The event is expected to occur in most circumstances	>90% probability	>1 in one year
High	Likely	The event will probably occur in most circumstances	51% to 90% probability	1 in 10 years
Medium	Moderate	The event should occur at some time	21% to 50% probability	1 in 50 years
Low	Unlikely	The event could occur at some time	10% to 20%	1 in 100 years
Negligible	Rare	The event might occur in exceptional circumstances	<10% probability	1 in 1000 years

Source: Guidelines for Risk Management (Roads and Maritime 2014)

Table 1-2 Consequence criteria – impacts on the project objectives (Roads and Maritime Guidelines for Risk Management)

Consequence rating	Time		Cost		Safety		Environment Delivery Operation	Traffic flow peak hour	Local traffic	Community attitude	Fit for purpose Defects Accidents Maintenance costs
	Development	Delivery	Development	Delivery	Delivery	Operation					
Extreme	Year	Months	$(25% overall construction cost)	$(10% overall construction cost)	Worker's Compensation Liability > $250,000 Death, permanent loss of physical or mental amenity	Multiple Worker's Compensation Liability > $250,000 Death, permanent loss of physical or mental amenity	Major environmental damage and/or delay due to legal finding in Land and Environment Court	No improvement	Severe disruption	Severe community protests	Functional failure
High	Months	Months	$(15% overall construction cost)	$(7% overall construction cost)	Worker's Compensation Liability $10,001 – $250,000 Lost time >= 5 days	Worker's Compensation Liability >$250,000 Death, permanent loss of physical or mental amenity	Serious environmental damage and/or delay due to public inquiry or NSW Environment Protection Authority (EPA) major notice	Marginal improvement	Disruption	Community protests	Serious functional failure

Consequence rating	Time		Cost		Safety		Environment Delivery Operation	Traffic flow peak hour	Local traffic	Community attitude	Fit for purpose Defects Accidents Maintenance costs
	Development	Delivery	Development	Delivery	Delivery	Operation					
Medium	Months	Months	$(7.5% overall construction cost)	$(4% overall construction cost)	Worker's Compensation Liability $1,001 – $10,000 Lost time 1-4 days	Worker's Compensation Liability $10,001- $250,000 Lost time >= 5 days	Environmental damage and/or EPA infringement notice			Daily complaints	Minor functional failure
Low	Months	Weeks	$(1% overall construction cost)	$(1% overall construction cost)	Worker's Compensation Liability $251 – $1000 Lost time >= 1 day	Worker's Compensation Liability $1001 – $10,000 Lost time 1-4 days	Minor environmental damage and/or minor EPA infringement notices, written community complaints	km/hr		Complaints	
Negligible	Weeks	Nil	$(0.1% overall construction cost)	$(0.1% overall construction cost)	Worker's Compensation Liability $1 – $250 First aid treatment (no lost time)	Worker's Compensation Liability $252 – $1000 Lost time >= 1 day	Minor repairable environmental damage Verbal community comment	km/hr		Negligible complaints	

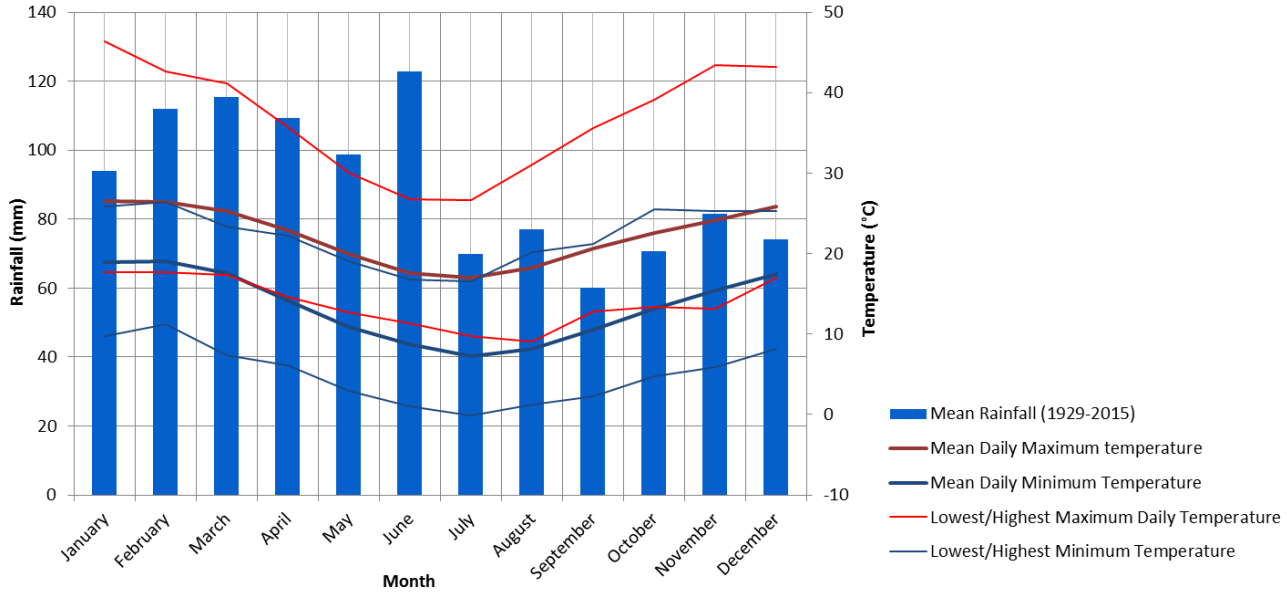
Source: Guidelines for Risk Management (Roads and Maritime Services 2014)

2 Existing and historical climate

2.1 Existing climate

Figure 2-1 shows the climate profile for the project region, indicated by weather monitoring data obtained from the Sydney Airport AMO Bureau of Meteorology (BoM) Monitoring Station for the period 1939 to 2015 (1929 to 2015 for rainfall data). Climate data from the Sydney Airport monitoring station is representative of conditions across the project corridor, as it is located around three kilometres from the eastern end of the project, within a similar physical environment (built up, coastal and low elevation).

Figure 2-1 indicates that the wettest month in the project region is June, followed by February and March. The driest month is September. Generally, January through to June has more rainfall than the second half of the year. Historical rainfall records between 1929 and 2015 show an annual mean rainfall of 1085.3 millimetres. Mean maximum daily temperatures range between 17°C and 18.3°C in winter, and between 25.8°C and 26.4°C in summer.



Source: Sydney Airport AMO BoM Monitoring Station

Figure 2-1 Climate profile for Sydney

2.2 Historical trends

2.2.1 Mean surface temperature

Surface air temperatures have been increasing along the east coast of Australia since national records began in 1910, and in particular, since 1960 (Commonwealth Scientific and Industrial Research Organisation (CSIRO) and BoM 2015). Mean surface temperature along the east coast of Australia has increased by about 0.8˚C since 1910 (CSIRO and BoM 2015).

2.2.2 Extreme heat

Historical observations show that mean temperature changes in Australia have been accompanied by large increases in extreme temperatures (CSIRO and BoM 2015). There has been a recent significant increase in the frequency of high temperature extremes and heatwave events, and a decline in the frequency of low temperature extremes (CSIRO and BoM 2015). The number of very warm months has increased five-fold in the past 15 years, and the number of very cool months has declined by around a third (CSIRO and BoM 2015).

2.2.3 Mean annual rainfall

Rainfall in Australia is highly variable, spatially and temporally, and is influenced by a number of key local processes such as the El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). As a result of the high rainfall variability in Australia, attributing observed rainfall changes to climate change is difficult. With the exception of the summer months, observations indicate declines in average rainfall of 10 to 20 per cent in south-eastern Australia over the cooler months (April to September), with some areas experiencing declines throughout the whole century (CSIRO and BoM 2015). Although there remains uncertainty regarding the cause, this decline has been linked to changes in the frequency and impact of ENSO and IOD, which are influenced by increasing greenhouse gases and reductions in ozone (CSIRO and BoM 2015).

2.2.4 Extreme rainfall

In Australia, extreme rainfall is driven by ENSO, east coast low pressure systems, tropical cyclones, monsoon troughs, severe thunderstorms, cut-off lows and mid-latitude fronts (CSIRO and BoM 2011; King et al. 2013). Historical rainfall observations show that the percentage of Australia's area receiving a greater than the 90th percentile of annual rainfall from heavy rainfall events has been increasing since the 1970s (CSIRO and BoM, 2015). However, there is large regional variability, with the east coast region experiencing a significant reduction in extreme rain events (CSIRO and BoM 2015).

2.2.5 Fire weather

In most Australian states, forest fire (or bushfire) weather risk is quantified using the McArthur Forest Fire Danger Index (FFDI) (Luke & McArthur 1978). FFDI is calculated using observed and modelled data on air temperature, relative humidity and wind speed in combination with an estimate of fuel levels. The FFDI incorporates fuel state through the 'drought factor', which depends on daily rainfall and time since the last rain, with an aim to account for long-term and short-term rainfall and its impact on fuel moisture.

FFDI values are classified into one of six fire danger ratings, ranging from low to catastrophic. These categories and their associated FFDI values are shown in **Table 2-1**.

Table 2-1 Forest fire danger index rating categories

Fire danger rating category	Forest fire danger index (FFDI)
Catastrophic	100+
Extreme	75–99
Severe	50–74
Very high	25–49
High	12–24
Low to moderate	0–11

Due to the strong relationship between bushfire risk and the weather, climate change will have a significant impact on future fire weather (CSIRO and BOM 2015). Past observations show an increase in annual cumulative FFDI across Australia over the period 1973 to 2010. The trend is particularly evident in south-eastern Australia, where the fire season has extended further into spring and autumn. Across Australia, including at the Sydney Airport and Richmond BoM stations, there has also been an increase in higher FFDI values, indicating that extreme fire weather days have become more frequent over time.

2.2.6 Sea level

The sea level at any point in time is the consequence of the mean sea level, the state of the tides, wave set up, responses to air pressure and local and remote near-shore winds, and may sometimes be affected by additional flows of water from on shore (NSW Department of Environment Climate Change and Water (DECCW) 2009).

Over the period of 1966 to 2009, relative sea level has risen around Australia at an average rate of 1.6 millimetres per year, when the influence of ENSO on sea level is removed (CSIRO and BoM 2015). Extreme sea levels are caused by a combination of factors including storm surges, wind, waves and astronomical tides. Along the NSW coastline, the majority of storm surges are caused by east coast low weather patterns (CSIRO and BOM 2015). Rising sea levels exacerbate extreme sea levels.

3 Screening

Table 3-1 provides the risk screening matrix developed for the project. On one axis are the key project components; the other axis presents the key climate variables relevant to the project. Where there is a relationship between a climate variable and a project element, this has been indicated in the matrix with an '✓'. Identified relationships form the basis of the development of risk scenarios in the following section, noting that one relationship might result in multiple risks, and multiple relationships may combine to result in a single risk.

Table 3-1 Risk screening matrix

		Project components											
		Tunnel drainage	**Elevated/bridge structures**	**Surface road upgrades**	**Surface drainage**	**Water treatment facilities**	**Cuttings, embankments and retaining walls**	**Pavement and base layers**	**Ancillary infrastructure (signs, traffic signals, buildings, etc)**	**Power supply**	**Tunnel ventilation (including ventilation outlet)**	**Landscaping**	**M4-M5 Link road users**
Climate variable	**Extreme rainfall**	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
	Mean rainfall										✓	✓	
	Extreme temperature		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
	Mean surface temperature										✓	✓	
	Mean annual wind speed		✓						✓		✓		
	Atmospheric carbon dioxide (CO_2)	✓	✓	✓	✓		✓		✓				
	Bushfire weather									✓	✓		✓
	Sea level rise			✓	✓	✓	✓		✓	✓		✓	
	Extreme sea level			✓	✓		✓		✓	✓		✓	

4 Detailed risk assessment

The following tables provide the risk scenarios identified for the project, along with their likelihood and consequence ratings and subsequent risk levels. **Table 4-1** identifies risks for 2030 up to 2090 under RCP8.5 (high emissions).

Table 4-1 Detailed risk assessment for 2090 under a high scenario (RCP8.5)

Risk scenario	Likelihood	Consequence	Risk level
Extreme rainfall and sea level rise			
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges) leads to exacerbated localised flood risks at the Rozelle interchange surface road connections and the new intersection at The Crescent and Victoria Road/Anzac Bridge.	High • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Rozelle Bay is tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	High • Existing flooding along The Crescent and City West Link will be exacerbated by future climate change, which may result in road closure and network issues and potentially affect the safety of road users • Risk of significant loss and damages as the project in this location is anticipated to be located under the existing sea level.	Extreme
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges) leads to exacerbated localised flood risks at the Hawthorne Canal, Whites Creek, Iron Cove Creek and Cooks River.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Localised flooding could lead to temporary road closure and some adverse effects on road users. The risk of loss and damages remains low in these areas however due to the low water levels associated with localised flooding.	Medium

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges) adversely affects performance of surface drainage system at the Rozelle interchange surface road connections and the new intersection at The Crescent and Victoria Road/Anzac Bridge due to increased runoff, leading to localised flooding of surface roads, and potential flooding of ancillary infrastructure, landscaped areas and within the project tunnels.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090 • The Rozelle Rail Yards are generally a low flood hazard area and not subject to flooding from Whites Creek as the Inner West Light Rail line and City West Link provide physical barriers to flow; however, during the probable flood maximum (PMF) Whites Creek overtops the road at The Crescent and flows in an easterly direction along City West Link, merging floodwaters from Rozelle Rail Yards and Whites Creek.	High • Localised basin in Rozelle currently subject to localised flooding • Existing drainage infrastructure does not have capacity to handle current PMF conditions, failure leads to flooding.	High

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall adversely affects performance of surface drainage system in the vicinity of the Iron Cove Link at Victoria Road and local road upgrades due to inundation, leading to localised flooding of surface roads and through the tunnel outlet.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Existing overland flow paths along Victoria Road within the Iron Cove catchment are predominantly medium flood hazard, but there are localised areas of high flood hazard on the northern carriageway of Victoria Road for the 100 year average recurrence interval (ARI).	Medium • Localised flooding would reduce capacity of roadway • Localised flooding could impact road users • Localised flooding leading to damage to substations and power outages.	Medium
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges) adversely affects performance of surface drainage system in the vicinity of intersections, ancillary infrastructure, substations, and landscaped areas and through tunnel outlets.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events.	Medium • Localised flooding would reduce capacity of roadway • Localised flooding could impact road users • Localised flooding leading to damage to substations and power outages.	Medium

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges), leads to an intrusion of saltwater into bioretention basins, such as the wetland proposed for the Rozelle Rail Yards and the proposed bioretention facility associated with the Iron Cove Link surface works, located within King George Park, adjacent to Manning Street at Rozelle.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Increased saltwater intrusion may prevent wetlands from properly performing, with increased salinity resulting in a loss of freshwater dependant vegetation within the wetlands, and leading to a potential uncontrolled release of stormwater and increased risk of localised flooding.	Medium
Increase in the intensity and frequency of extreme rainfall adversely affects performance of tunnel drainage system due to increased groundwater infiltration, leading to reduced capacity of drainage sump and pumping system and subsequent localised tunnel flooding.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Decrease in mean rainfall and increase in evaporation (due to increased mean surface temperature) may change the likelihood of flooding during dry periods due to impacts on infiltration and groundwater recharge rates. It is expected that the event could occur at some time.	Medium • Localised flooding could adversely affect the safety of tunnel users, and operational personnel. The risk of significant loss and damages remains low due to low water levels associated with localised flooding • Localised flooding could lead to damage to substations and power outages • Localised flooding could lead to damage and functional failure of ancillary infrastructure • Localised flooding could lead to temporary tunnel closure which could in turn have some adverse impacts on the road network level of service.	Medium

Risk scenario	Likelihood	Consequence	Risk level
Sea level rise causes reduced performance or failure of the water treatment system (culverts, pumping stations) due to increased water levels at the location of the submerged discharge infrastructure in Alexandra Canal and Hawthorne Canal and deterioration from saline intrusion.	Medium • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Saline intrusion would result in the accelerated deterioration of stormwater removal systems • Accelerated deterioration would result in additional operation and maintenance costs due to the retrofit works needed.	Medium
Sea level rise causes reduced performance or failure of water treatment system due to increased water levels at the location of the submerged discharge infrastructure in Rozelle Bay and deterioration from saline intrusion.	Medium • Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Reduced performance of water treatment system may result in the requirement for retrofitting works to the water treatment discharge infrastructure.	Medium
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges), leads to exacerbated risk of flooding of landscaped areas, particularly around the Rozelle interchange surface connections and the St Peters interchange.	Medium • Extreme rainfall is projected to increase by between 5 per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	Low • Landscaped areas damaged from flooding may result in reduced visual amenity, as well as reduced habitat value and ecosystem function. This could adversely impact flora and fauna. Damaged landscaped areas may result in increased costs for rehabilitation and maintenance.	Low

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise leads to exacerbated risk on bicycle and pedestrian facilities such as the Bay Run connection at Iron Cove Bridge, connections at City West Link/The Crescent/Victoria Road/Anzac Bridge at Rozelle and at other surface portal locations (ie Wattle Street).	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • The waterways throughout the project are tidal and thus influenced by an increase in sea level. Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Pedestrian and bicycle facilities inundated from flooding would result in disruptions to users as well as prevent mobility during hazardous events. Damaged infrastructure may result in increased costs for rehabilitation and maintenance.	Medium
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges), leads to exacerbated risk of slope instability or landslips at surface works.	Low • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Risk of slope instability during extreme rainfall events may be exacerbated by a decrease in mean rainfall, and increase in evaporation (due to increase in mean temperature) • Cuttings and embankments are minimal.	Low • Subsidence or a landslip could result in minor volumes of material movement and may cause minor damage to pavement, localised sedimentation of the roadway, and associated minor safety hazards to users of the roadway.	Negligible

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall, combined with sea level rise (and increased extreme sea levels during storm surges) leads to exacerbated risk of events causing power outages (including subsequent pumping station failure) due to increased flooding.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Sea level is projected to rise by around 0.88 metres by 2090.	Medium • Power outage could result in traffic delays or reduced safety for road users and operational personnel due to functional failure of powered infrastructure.	Medium
Increase in the intensity and frequency of extreme rainfall and exacerbated risk of failure of the water treatment facility due to water inflow exceeding capacity of treatment facility at Rozelle Bay.	Medium • Extreme rainfall is projected to increase by between five per cent and 40 per cent by 2090. While there is substantial uncertainty around the direction of change of mean rainfall, projections show an increase in the frequency and intensity of extreme rainfall events • Decrease in mean rainfall and increase in evaporation (due to increased mean surface temperature) may reduce the likelihood of high inflows to the water treatment system during dry periods • The design of the water treatment plant incorporates contingency for high inflows of water, whereby high inflows from the western section of the project (towards Rozelle Bay) can overflow from the first holding tank into the deluge holding tank and then be discharged straight into Rozelle Bay.	Low • The contingency for high flows incorporated into the design of the water treatment plant would mitigate flooding of the water treatment system and drainage system. However, there may be downstream water quality impacts when untreated water is discharged directly into Rozelle Bay.	Low

Risk scenario	Likelihood	Consequence	Risk level
Increase in the intensity and frequency of extreme rainfall leads to exacerbated risk of road incidents and increases the safety risk for operational personnel and road users.	Low • Road incidents as a result of extreme rainfall events already occur across the road network. The contribution of the projected changes in extreme rainfall to the risk of road incidents is expected to be minor.	High • A road incident could lead to injury or fatality of road users • A road incident could lead to temporary road closure which could in turn have significant adverse impacts on the road network level of service.	Medium
Mean rainfall and mean temperature			
Decrease in mean rainfall and increase in mean surface temperature and the intensity and frequency of extreme heat events adversely impacts landscaped areas.	Low • While there is substantial uncertainty around the direction of change of mean rainfall, some models show a decrease in mean rainfall of at least 15 per cent by 2090 • Mean surface temperature is projected to increase by up to 4.7°C by 2090 • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year respectively, by 2090.	Low • Landscaped areas unable to adapt to changing climate may result in reduced visual amenity, as well as reduced habitat value and ecosystem function • Deteriorated landscaped areas may result in increased costs for rehabilitation and maintenance.	Negligible
Decrease in mean rainfall combined with an increase in mean surface temperature and the frequency and intensity of extreme heat events, leads to exacerbated risk of dust storms adversely impacting the performance of tunnel ventilation system.	Low • While there is substantial uncertainty around the direction of change of mean rainfall, some models show a decrease in mean rainfall of at least 15 per cent by 2090 • Mean surface temperature is projected to increase by up to 4.7°C by 2090 • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090.	Medium • Reduced in tunnel air quality could have adverse impacts on the health of tunnel users and operational personnel • Increased particulate matter could result in reduced performance of tunnel ventilation systems which may require temporary closure of the tunnels, which in turn could have adverse impacts on the road network level of service.	Low

Risk scenario	Likelihood	Consequence	Risk level
Atmospheric CO_2			
Increase in atmospheric CO_2 and the frequency and intensity of extreme heat events leads to accelerated deterioration of ancillary infrastructure (maintenance bays, ventilation facilities, substations) due to corrosion and thermal expansion of steel reinforcement in concrete and thermal expansion of steel, protective cladding, and coatings.	Low • Atmospheric CO_2 is projected to continue to increase • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • Accelerated deterioration rates due to increasing CO_2 and heat extremes are expected to be minor compared to baseline deterioration rates.	Low • Accelerated deterioration could lead to structural damage, which would result in reduced safety operational personnel • While potential impacts would be identified during routine maintenance procedures, accelerated deterioration would result in increased maintenance and operational costs for rectification works. These costs would be anticipated to be low in the scope of the entire project.	Negligible
Increase in atmospheric CO_2 and the frequency and intensity of extreme heat events leads to accelerated deterioration of bridge and surface pavement and structures (retaining walls, batters) due to corrosion and thermal expansion of steel reinforcement in concrete and thermal expansion of steel, protective cladding, and coatings.	Low • Atmospheric CO_2 is projected to continue to increase • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • The proposed structures have a long design life, over a period which projected climate trends are likely to be experienced • Accelerated deterioration rates due to increasing CO_2 and heat extremes are expected to be minor compared to baseline deterioration rates.	Low • Accelerated deterioration could reduce the structural integrity of structures and may result in damage • Deterioration or damage would result in reduced safety for users and operational personnel • While potential impacts would be identified during routine maintenance procedures, accelerated deterioration would result in increased maintenance and operational costs for rectification works. These costs would be anticipated to be low in the scope of the entire project • Closures for increased maintenance may result in adverse impacts on road network level of service.	Negligible

Risk scenario	Likelihood	Consequence	Risk level
Increase in atmospheric CO_2 and the frequency and intensity of extreme heat events leads to accelerated deterioration of the surface drainage system due to thermal expansion and corrosion of steel and reinforced concrete structures.	Low • Atmospheric CO_2 is projected to continue to increase • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • The proposed structures have a long design life, over a period which projected climate trends are likely to be experienced • Accelerated deterioration rates due to increasing CO_2 and heat extremes are expected to be minor compared to baseline deterioration rates.	Low • While potential impacts would be identified during routine maintenance procedures, accelerated deterioration of the concrete and steel components of the surface drainage system could result in increased maintenance costs and potential safety risks. These costs would be anticipated to be low in the scope of the entire project • Damages to the surface drainage system could increase localised flood risk • Increased maintenance may result in increased road/lane closures and adverse impacts on road network level of service.	Negligible
Increase in atmospheric CO_2 and the frequency and intensity of extreme heat events leads to accelerated deterioration of tunnel drainage system due to corrosion of steel and reinforced concrete structures.	Low • Atmospheric CO_2 is projected to continue to increase • The tunnel drainage system has a long design life, over a period which the projected climate trends are likely to be experienced • Accelerated deterioration rates due to increasing CO_2 are expected to be minor compared to baseline deterioration rates • Although temperatures within the tunnel are likely to be influenced by external surface temperatures, the subsurface tunnel is anticipated to maintain a cooler environment compared with external surface temperatures.	Low • While potential impacts would be identified during routine maintenance procedures, accelerated deterioration of the concrete and steel components of the tunnel infrastructure and tunnel drainage system could result in increased operational costs and reduced safety due to increased tunnel flood risk. These costs would be anticipated to be low in the scope of the entire project.	Negligible

Risk scenario	Likelihood	Consequence	Risk level
Bushfire risk			
Increased frequency and intensity of bushfire events due to increased bushfire weather adversely affects performance of tunnel ventilation system and subsequently road users as a result of smoke pollution.	Low • The annual number of days with severe fire danger is projected to increase by 130 per cent by 2090, however the probability that a bushfire will cause smoke pollution that is heavy enough to reduce the performance of the tunnel is low.	Medium • Reduced in tunnel air quality could have adverse impacts on the health and safety of tunnel users and operational personnel.	Low
Increased frequency and intensity of bushfire events leads to failure of communications network due to direct fire damage to network infrastructure.	Medium • The annual number of days with severe fire danger is projected to increase by 130 per cent by 2090, with risk of impacts on communications network infrastructure, leading to indirect impacts on the project through communications outages.	High • Communications outages could result in a loss of operational capability and reduced safety for road users and operational personnel due to unavailability of telecommunication services, particularly in the event of an emergency, with the potential for need for temporary closure of motorway tunnels without these essential services.	High
Increased frequency and intensity of bushfire events leads to failure of power supply infrastructure due to direct fire damage to the energy transmission network.	Medium • The annual number of days with severe fire danger is projected to increase by 130 per cent by 2090, with risk of impacts on power supply infrastructure, leading to indirect impacts on the project through power outages.	High • Power outage could result in traffic delays or reduced safety for road users and operational personnel due to functional failure of powered infrastructure. Powered infrastructure includes tunnel lighting, traffic signals, ventilation facilities, pumping stations, with the potential for need for temporary closure of motorway tunnels without power to these essential systems.	High

Risk scenario	Likelihood	Consequence	Risk level
Extreme heat			
Increase in frequency and intensity of extreme heat events causes higher temperatures within the tunnel for road users.	Low • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • Temperatures within the tunnel would be influenced by external surface temperatures as outside air would be drawn into the tunnel through the portals with the in-coming movement of vehicles and through mechanical ventilation fans. Higher temperatures are likely to be experienced within the tunnel as external surface temperatures increase, particularly on extreme temperature days • Although temperatures within the tunnel are likely to be influenced by external surface temperatures, the tunnel is anticipated to maintain a cooler environment compared with external surface temperatures.	Medium • High tunnel temperatures could have adverse impacts on the health of tunnel users and operational personnel.	Low
Increase in frequency and intensity of extreme heat events leads to reduced efficiency and function of vehicles utilising the tunnel, increasing the number of vehicles overheating and breaking down.	Low • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • The tunnel is anticipated to maintain a cooler environment compared with surface temperatures and the likelihood of heat stress impacts on vehicles is low.	Low • The tunnel design includes breakdown bays and provision of a shoulder on the left and the right side of the road which could be used to provide temporary accommodation for broken down vehicles and access for emergency vehicles.	Negligible

Risk scenario	Likelihood	Consequence	Risk level
Increase in frequency and intensity of extreme heat events increases the risk of heat stress conditions for operational personnel.	Low • Measures to manage heat stress are considered in the project Work Health and Safety Management Plan.	High • Heat stress could have adverse impacts on the health of operational personnel.	Medium
Increase in frequency and intensity of extreme heat events causes power outages due to spikes in energy demand across the grid for cooling systems.	High • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090.	Medium • Power outage could result in traffic delays or reduced safety for road users and operational personnel due to functional failure of powered infrastructure.	High
Increase in frequency and intensity of extreme heat events leads to accelerated deterioration of road pavement.	Low • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090 • The design life of road pavement is short. Road maintenance including resealing would occur at intervals too short for impacts to occur.	Low • Accelerated deterioration of road pavement could result in increased maintenance costs. The thermal tolerance of road pavement is relatively high.	Negligible
Increase in frequency and intensity of extreme heat events leads to reduced efficiency of power generation and transmission, resulting in increased electricity consumption.	High • The number of days above 35°C and 40°C are projected to increase by an average of 11 days and two days per year, respectively, by 2090.	Low • Increased electricity consumption would result in increased operational costs.	Medium

Risk scenario	Likelihood	Consequence	Risk level
Wind speed			
Changes in wind speed adversely affect structural stability of structures on platforms, particularly elevated ramp structures at the Rozelle interchange.	Negligible • Wind speed in not projected to increase more than one per cent by 2090 • A large degree of redundancy is built into the design of elevated ramp structures for structural stability and safety.	Low • Changes in wind speed are unlikely to result in structural damage to elevated structures; however, it may cause minor structural stress.	Negligible
Changes in wind speed adversely affect performance of tunnel ventilation system.	Negligible • Wind speed in not projected to increase more than one per cent by 2090.	Low • The impacts of wind on the performance of tunnel ventilation system would be negligible.	Negligible
Changes in wind speed adversely affect structural stability of ancillary infrastructure such as maintenance bays and substations.	Negligible • Wind speed in not projected to increase more than one per cent by 2090.	Low • A large degree of redundancy is built into the design of infrastructure for structural stability and safety • Increased maintenance may result in increased road/lane closures and adverse impacts on road network level of service • Increased maintenance costs.	Negligible