REPORT

Remediation Implementation Report

Camellia Rosehill Place Strategy: Package C – Environment

Submitted to:

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Executive Summary

New South Wales Department of Planning and Environment (DPE), in collaboration with City of Parramatta Council (Council), industry, the community and State agencies, is leading the development of the Camellia-Rosehill Place Strategy (CRPS) and Master Plan for the Camellia –Rosehill Precinct (the Precinct). The Precinct is defined by Parramatta River to the north, Duck River to the east, the M4 Motorway to the south and James Ruse Drive to the west, all of which form physical boundaries to the Precinct. The Precinct boundaries are shown in Figure 1.

The Precinct is presently dominated by industrial activity, with large amounts of land also allocated to Rosehill Gardens Racecourse and stabling yards for Parramatta Light Rail and Sydney Metro. Its industrial legacy means that soils are heavily contaminated across most of the Precinct.

Located in the geographic heart of Sydney, the Precinct has an important strategic role in the Greater Parramatta and Olympic Peninsula (GPOP). Previous investigations have identified that the area should be retained for urban service and industrial land with a town centre, but that the costs of infrastructure and contamination remediation should be carefully considered when making future land use decisions.

The Place Strategy and Master Plan has been prepared for the whole Precinct and draws on the substantial body of previous investigations, including ongoing collaboration with industry, the community and state agencies.

The overarching objective of the Place Strategy is to provide an integrated 20-year vision, which recognises the strategic attributes of the Precinct, guides future land use and infrastructure investment decisions and which can be delivered with the support of State and local agencies.

DPE engaged Golder Associates Pty Limited to deliver technical studies for Package C (Environment), to inform the CRPS and Master Plan for the Precinct. The Environment package includes: Remediation Strategy; Air, Noise, and Odour Assessment; and Integrated Water Cycle Management Strategy (IWCMS). This Implementation Report has been prepared as a part of the Remediation Strategy component of the Environment package.

The objective of this Implementation Report is to provide guidance on viable remediation options and to formulate an overall Remediation Strategy, including associated indicative cost estimates, for the Master Plan land use scenario. The cost estimates are intended to assist in informing the feasibility of future land uses and development. The report builds on the Baseline Analysis Report (Golder, 2021, Appendix D) which provides Precinct scale mapping of contamination risk. The proposed Remediation Strategy presented in this report has been developed to align with the CRPS Vision Statement.

An Enquiry by Design (EbD) process was undertaken to inform the preparation of the Place Strategy. The EbD was an interactive process which explored a number of Master Plan options for Camellia-Rosehill which could deliver the vision for the Precinct and resulted in a Draft Master Plan which was the subject of public consultation as part of the Camellia-Rosehill Directions Paper. The Draft Master Plan was further refined following exhibition of the Directions Paper and consideration of the submissions received.

The draft place strategy was publicly exhibited on 17 December 2021 until 4 March 2022. The draft master plan was further refined following exhibition of the draft place strategy and consideration of the submissions received. Refer to the DPE's finalisation report for further information.

A range of remediation options have been considered for the management of soil and groundwater contamination within the Precinct. The proposed Remediation Strategy outlined in this report includes:

- Soil/fill capping and containment, with excavation and offsite management of isolated hot spots (e.g., underground petroleum storage systems (UPSS)).
- Excavation and capping of foreshore areas in select areas where required. The scope of the foreshore remediation activities will be dependent on the level of public access to be permitted. In some scenarios, the existing mangroves may need to be removed to allow remediation to occur. The reinstatement of the mangroves will need to be considered in these scenarios.
- Hexavalent chromium (and potentially chlorinated hydrocarbon) groundwater treatment using a Permeable Reactive Barrier (PRB) along the Parramatta River foreshore.
- Ongoing Monitored Natural Attenuation (MNA) for Precinct-wide petroleum hydrocarbons with the use of remediation corridors (easements) to facilitate future groundwater remediation programs.

This strategy is largely driven by the Precinct-wide approach of minimising contamination disturbance and generation of waste requiring offsite management, whilst considering opportunities for a Precinct-wide approach for groundwater remediation. It is recognised that contamination disturbance and waste generation may be unavoidable in some circumstances in order to minimise potential flooding impacts beyond the Precinct. In these circumstances, management controls should be implemented to mitigate potential impacts associated with the proposed disturbance of contaminants.

Consistent with these approaches, the report assessed the viability of purpose-built on-site containment facilities. The report discusses that whilst there are obvious benefits for the on-site containment facilities (reduced waste and costs), there are several factors that should be considered in the planning (e.g., legislative requirements, flooding impacts, staging, ongoing management liabilities). The report identifies one potentially suitable location for a containment facility but notes that more sites may be required to accommodate the estimated levels of surplus spoil generated by the Precinct redevelopment works. The viability of using spoil beneath new road and/or other service corridors should also be explored.

In this report, the Master Plan has been assessed from a contamination risk perspective. The risks were assessed by reviewing the proposed development land uses against existing land use and contamination risk identified as part of the Baseline Analysis Report (Golder, 2021) (refer to Appendix D). The outputs from this scenario assessment are shown in Figure 4. The risk assessment identified several sites where the remediation likelihood was highlighted as “likely”. These included the proposed residential areas at the 181 James Ruse Drive and 1 Grand Avenue sites, the proposed open space / public recreational area located south of the PLR[1] SaM[2] site, and several open space areas located in the foreshore setback areas.

Indicative cost estimates have been prepared for the Precinct remediation works required to deliver the Remediation Strategy for the Master Plan. These cost estimates include consulting costs; New South Wales Environmental Protection Authority (NSW EPA) Accredited Site Auditor costs; capping / redevelopment costs; hot spot remediation costs; ongoing contamination management and/or monitoring costs; and foreshore remediation costs. Due to a lack of site-specific, publicly available, information at most landowner sites within the Precinct, these cost estimates have largely been developed using hypothetical scenario sites.

[1] Parramatta Light Rail

[2] Stabling and Maintenance

It is noted that two landowner sites within the Precinct (181 James Ruse Drive and 1 Grand Avenue) are subject to existing Remediation Action Plans (RAPs) where the extent of contamination and proposed remediation methods are defined in publicly available documents. Site-specific area-based remediation rates were adopted for these areas.

The cost estimates presented provide a high-level indication of the potential costs which could, but need not necessarily, be incurred in remediating the Precinct for redevelopment, subject to the scenario-specific assumptions. These cost estimates are highly sensitive to the scenario-specific assumptions adopted regarding the volume of soils requiring off-site disposal or on-site containment, extent and characteristics of contamination, the approach to remediation, and the ongoing contamination management and/or monitoring requirements.

In summary, the cost analysis completed in this study identified the following:

- The estimated area-based remediation costs across the Precinct range from approximately $350M AUD to $550M AUD. The estimated foreshore remediation costs across the Precinct ranged from $28.2 M AUD to $46.7 M AUD.
- The capping / redevelopment costs were the highest of all remediation cost categories tested and could contribute up to 75% of the total costs. These costs were driven by an assumption that the raising of site elevations will be restricted in some areas to ensure compliance with flood management performance criteria. In some areas, surplus spoil will be generated to accommodate the capping systems. This surplus spoil would require management through either disposal off-site as waste, or reuse within the Precinct in a purpose-built containment facility.
- The ongoing management/ monitoring costs are comparable to the capital costs of the soil/fill hot-spot remediation works. This is an important point as it supports the concerns of stakeholders that the relatively high ongoing costs need to be identified in appropriate funding mechanisms and that local authorities (e.g., Council) are not burdened with these ongoing costs.

The recommended next steps for implementing the Remediation Strategy are as follows:

- Establish governance mechanisms for Precinct-wide remediation and/or management activities.
- Review options to accommodate surplus spoil (soil/fill) within the Precinct.
- Facilitate a Precinct-wide groundwater remediation approach.
- Establish planning controls to ensure that the Precinct is or can be made suitable for the Master Plan to enable rezoning decisions.
- Establish planning controls for the staging the remediation and/or management activities to avoid land use conflicts.
- Facilitate “clean” infrastructure corridors.
- Prepare Precinct-wide documentation to support the planning process.

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Disclaimer

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List of Abbreviations

AHD	Australian Height Datum
ASS	Acid Sulfate Soils
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CBD	Central Business District
CLM	Contaminated Land Management
the CLM Act	*NSW Contaminated Land Management (CLM) Act 1997*
Council	City of Parramatta Council
CRPS	Camellia – Rosehill Place Strategy
DCP	Development Control Plan
DPE	New South Wales Department of Planning and Environment
EbD	Enquiry by Design
EIS	Environmental Impact Statement
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licences
GPOP	Greater Parramatta and Olympic Peninsula
GSC	Greater Sydney Commission
IWCMS	Integrated Water Cycle Management Strategy
LCAP	Land Contamination Action Plan
LEP	Local Environment Plan
LNAPL	Light Non-aqueous Phase Liquid
LUIS	Land Use and Infrastructure Strategy
MNA	Monitored Natural Attenuation
NSF	Maintenance and Stabling Facility
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Contaminated Sites) Measure
NSW	New South Wales
NSW EPA	New South Wales Environmental Protection Authority

PAH	Polycyclic Aromatic Hydrocarbons
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PFOS	Perfluorooctane sulfonate
PIC	Infrastructure Compact Pilot
the Precinct	Camellia – Rosehill Precinct
PLR	Parramatta Light Rail
the POEO Act	*NSW Protection of the Environment Operations Act 1997*
the POEO Waste Regulation	*the Protection of the Environment Operations (Waste) Regulation 2014*
PRB	Permeable Reactive Barrier
RAP	Remediation Action Plan
RRE	Resource Recovery Exemption
RRO	Resource Recovery Order
SaM	Stabling and Maintenance
SEPP	State Environmental Planning Policy
SEPP 55	*State Environmental Planning Policy No 55– Remediation of Land*
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UPSS	Underground Petroleum Storage Systems
UST	Underground Storage Tank
VCHs	Volatile chlorinated hydrocarbons
WA DOH	Western Australia Department of Health

1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) has been engaged by New South Wales Department of Planning and Environment (DPE) to deliver the technical studies for Package C (Environment), which will inform the Camellia–Rosehill Place Strategy (CRPS) and the Master Plan for the Camellia–Rosehill Precinct (the Precinct). The environment package includes: Remediation Strategy; Air, Noise, and Odour Assessment; and Integrated Water Cycle Management Strategy (IWCMS). This Implementation Report has been prepared as a part of the *Remediation Strategy* component of the environment package.

1.1 Project Background

The Camellia Rosehill Precinct (~321ha) plays a strategic role in the Greater Parramatta and the Olympic Peninsula (GPOP). Camellia was identified by the NSW Government as a priority growth area in 2014, resulting in precinct wide Land Use and Infrastructure Strategy in 2015 and subsequently development of a Town Centre Master Plan in 2018. Work on the Town Centre was paused pending outcomes of Greater Sydney's 2019 Draft Place-based Infrastructure Compact (PIC) Pilot which aimed to ensure infrastructure delivery was matched with growth across the 26 precincts in the GPOP corridor. The PIC recommended that Camellia be retained for urban service and industrial land, however, should the Government seek to progress a town centre (in the form of the 2018 plan or a modified form), before any rezoning a number of issues had to be resolved. The NSW Government was determined that a coordinated and strategic approach was required, and a place strategy be prepared for the whole Precinct, drawing on previous work and including ongoing collaboration with industry, the community and state agencies.

The DPE has engaged a range of technical services to determine opportunities and challenges at the precinct. These technical studies have informed the development of the Place Strategy and Master Plan for the precinct.

An Enquiry by Design (EbD) process was undertaken to inform the preparation of the Place Strategy. The EbD was an interactive process which explored a number of Master Plan options for Camellia-Rosehill which could deliver the vision for the precinct and resulted in a Master Plan which was the subject of public consultation as part of the Camellia-Rosehill Directions Paper. The Master Plan was further refined following exhibition of the Directions Paper and consideration of the submissions received.

1.2 Camellia Rosehill Vision

Camellia-Rosehill has an important strategic role as an industry and employment hub within the Greater Parramatta and Olympic Peninsula (GPOP) Economic Corridor. By 2041, the precinct will be enhanced with service and circular economy industries and new recreational and entertainment facilities, all enabled by better transport access via light rail, active transport and road connections.

A well-designed town centre next to the light rail stop will be the focus of community activity.

A new urban services precinct and retention of heavy industrial land will ensure Camellia-Rosehill fulfills its potential to be an employment powerhouse.

New homes and jobs will be close to public transport supported by new quality public spaces including public open spaces, public facilities high quality street infrastructure, and walking and cycling paths.

Key environmental features such as Parramatta River, Duck River and their wetlands will be protected and enhanced. Camellia's rich heritage will be preserved, celebrated and promoted.

Country and culture will be valued and respected with the renewal guided by Aboriginal people.

The precinct will be net zero ready and set a new standard for environmental sustainability with embedded renewable energy networks, integrated remediation and water management strategies, and circular economy industries.

Recycled water will be connected to all residences, businesses and public spaces and will support the integrated network of green infrastructure.

Camellia will be a showcase of recovery and restoration – a place of economic prosperity but also a place where people love to live, work, and enjoy.

1.3 The Camellia-Rosehill Master Plan

The Master Plan is shown in Figure 2 and forms the basis of the Place Strategy.

Key features of the Master Plan include:

- Provision for approximately 10,000 dwellings within a Town Centre serviced by light rail
- Provision for approximately 15,400 jobs
- A new primary school and primary and secondary high school
- District open space facilities
- Introduction of a new entertainment precinct and an urban services area
- Initiatives to Care for Country and continued protection of heritage listed sites
- Retention of the existing state heritage sewerage pumping station (SPS) 067 within the town centre
- Measures to mitigate land use conflicts and risks including buffers and setbacks from existing fuel pipelines and between the existing sewerage pumping station and future surrounding residential uses
- Access to the Parramatta River, Duck River and Duck Creek foreshores and potentially the wetland
- New transport infrastructure including a local road network, potential bus services, additional connections into and out of the precinct, and opportunities to integrate Parramatta Light Rail Stage 2
- An extensive active transport network
- A comprehensive Remediation Strategy
- A Sustainability Strategy and Integrated Water Cycle Management Strategy.

1.4 Objective and Scope of this Report

The objective of this report is to provide guidance on the possible Remediation Strategy for the Master Plan land use scenario. The proposed Remediation Strategy presented in this report has been developed to align with the CRPS Vision Statement (DPE, 2021), which provides important planning and policy context for the CRPS. Specifically, this strategy aims to ensure that all new development continues to remediate the heavily contaminated lands of the Precinct and support the improvement of Parramatta River, Duck River, and Duck Creek water quality.

The scope of the report is as follows:

- Provide an overview of the Precinct's environmental setting.

- Review contaminated land management (CLM) considerations from various stakeholders and policies.
- Summarise the available and viable contamination remediation and management options and identify a proposed Remediation Strategy.
- Provide an understanding of CLM related impacts under the Master Plan.
- Present indicative cost estimates for remediation works under the Master Plan.
- Provide recommendations to inform further development and refinement of the CRPS.

This report builds on the Golder (2021) Remediation Strategy, Baseline Analysis Report (**Appendix D**) which provided Precinct scale mapping of contamination risk. This ranking of potential land contamination was divided into the three broad and subjective contamination risk categories (High, Medium or Low). Both this report and the Golder (2021) report also refer to, and build on the findings of, the two-stage contamination and remediation specialist study prepared for the Precinct (Golder (2015a &b)) on behalf of DPE to support the Precinct-wide Land Use and Infrastructure Strategy (LUIS) exhibited in August 2015.

1.5 Relevant Legislation

1.5.1 Contaminated Land Management Act 1997

In NSW, the responsibility for the regulation and/or management of contaminated land is shared by the NSW EPA, DPE and planning consent authorities (usually local councils).

The *NSW Contaminated Land Management (CLM) Act 1997 (the CLM Act)* is the primary Act under which contaminated land in NSW is regulated by the NSW EPA. Under the *CLM Act* the NSW EPA regulates contaminated sites where the contamination is Significant Enough to Warrant Regulation (SEWR), i.e., sites where intervention by the EPA is warranted.

If land contamination is determined to be significant enough to warrant regulation (s.12), the EPA may declare the land as significantly contaminated under s.11 of the *CLM Act*. If it is regulated under the *CLM Act* it will receive notices relating to the management of this contamination. These notices are published on the record of notices for public view. The contaminated land public record is a searchable database of:

- Orders (e.g., Management Order, Maintenance Order) made under Part 3 of the *CLM Act*.
- Notices available to the public under s.58 of the *CLM Act*.
- Approved voluntary management proposals (VMPs) under the *CLM Act* that have not been fully carried out and where EPA approval has not been revoked.
- Site Audit Statements provided to the EPA under s.53B of the *CLM Act* that relate to significantly contaminated land.
- Where practicable, copies of anything formerly required to be part of the public record.
- Actions taken by EPA (or the previous State Pollution Control Commission) under s.35 or s.36 of the *Environmentally Hazardous Chemicals Act 1985 (EHC Act)*[3].

[3] Sections 35 and 36 of the *EHC Act* have been repealed. Notices under these sections are treated by the *CLM Act* as management orders.

If the land is subject to an Environment Protection Licence (EPL), contamination at declared land may be regulated under the *Protection of the Environment Operations (POEO) Act 1997 (the POEO Act)* (Section 1.5.3) through special conditions on the licence.

Ongoing maintenance orders may be issued under s. 28 of the *CLM Act*. These may be active e.g., to maintain and monitor management systems; or passive e.g., restrictions from disturbing onsite capping and can be amended or ended by the NSW EPA. The NSW EPA may also place restrictions and public positive covenants on land titles (s.29) under s.88E of the *NSW Conveyancing Act 1919*. Both s.28 orders and s.29 restrictions or covenants may be placed on land which was the subject of either a management order or an approved voluntary management proposal. In most cases, an Environmental Management Plan (EMP) is prepared for the ongoing management of contamination at the site and compliance with the EMP is enforceable under the maintenance order or covenant.

The majority of sites in the precinct are affected by contamination, and multiple sites are subject to an instrument under the CLM Act requiring management of contamination or are identified as notified sites. Under the *CLM Act* (s. 60) there are also obligations on landowners to notify the NSW EPA (detailed in the NSW EPA (2015) Guidelines on the Duty to Report Contamination under the *CLM Act)* when contamination on their site exceeds criteria published in approved guidelines, or there is a risk of off-site migration of contamination. The NSW EPA has a duty to examine and respond to the information it receives about actual or possible contamination of land. The NSW EPA also publishes lists of notified sites. There are several sites located in the Precinct that are notified under the *CLM Act*. Some of these sites may require regulation under the *CLM Act*.

Due to the widespread nature of land contamination across the Precinct a high level of confidence is required in the assessment and management of contaminated land to adequately inform the planning process. For all potentially contaminated land, the investigation, remediation and validation, and/or management should be completed in accordance with guidelines made or approved by the NSW EPA under Section 105 of the *CLM Act*. The National Environment Protection (Assessment of Contaminated Sites) Measure 1999 (the NEPM) (NEPC 2013) sets the national framework for the assessment of contaminated sites. The NEPM is endorsed under the *CLM Act*.

In cases where uncertainty remains regarding site suitability for an intended land use, a Site Auditor accredited under the *CLM Act* should be engaged. The Site Auditor can provide an independent review of contaminated site assessment, remediation, and validation reports and/or environmental management plans in order to provide greater certainty to planning authorities and the community that the site is suitable for the proposed land use.

1.5.2 Environmental Planning and Assessment Act 1979

The *NSW Environmental Planning and Assessment Act 1979 (EP&A Act)* is the primary NSW legislation for regulating land use and development. The *EP&A Act* establishes strategic land use planning provisions and establishes a framework for assessing environmental impacts of all development types. The assessment level depends on the development's size, scale, and location.

Contaminated sites that are not regulated by the NSW EPA are usually managed by local councils through the land use planning processes specified in Part 4 of the *EP&A Act*. However, in the case of State Significant Development (SSD), State Significant Infrastructure (SSI) and Critical State Significant Infrastructure (CSSI), and in various other instances specified in the Act or in an Environmental Planning Instrument (EPI), the Minister for Planning and Public Spaces is the consent authority and has primary responsibility for management.

The Precinct land use/zones are currently controlled by the Parramatta Local Environmental Plan 2011.

1.5.2.1 State Environmental Planning Policy 55

For over 20 years the *State Environmental Planning Policy No 55– Remediation of Land* (*SEPP 55*), made under the *EP&A Act,* and the *Managing Land Contamination, Planning Guidelines (DUAP,1998)* which underpin it, have provided a state-wide planning approach for the remediation of contaminated land. In particular, *SEPP 55* provides for Category 1 and Category 2 remediation. Projects classified as Category 1 require development consent, while projects classified as Category 2 do not require development consent.

SEPP 55 and the *Contaminated Land Planning Guidelines*, whilst still relevant to the management of contamination in the Precinct, are currently under review. A draft for comment was circulated in 2018 and it is understood that DPE is continuing to work with NSW EPA and other stakeholders to finalise the guidance and draft instrument. As part of this review, it was proposed to transfer the requirement for planning authorities to consider contamination when rezoning land to a direction under Section 9.1 of the *EP&A Act*.

During April 2020, the Minister for Planning and Public Spaces approved the removal clause 6 from SEPP 55 and transferred the requirements to a Ministerial direction (No 2.6) Remediation of Contaminated Land. The direction is likely to apply to majority of the land parcels located within the Precinct. Under the direction:

A planning proposal authority must not include in a particular zone (within the meaning of the local environmental plan) any land specified in paragraph (2) if the inclusion of the land in that zone would permit a change of use of the land, unless:

(a) the planning proposal authority has considered whether the land is contaminated, and

(b) if the land is contaminated, the planning proposal authority is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for all the purposes for which land in the zone concerned is permitted to be used, and

(c) if the land requires remediation to be made suitable for any purpose for which land in that zone is permitted to be used, the planning proposal authority is satisfied that the land will be so remediated before the land is used for that purpose.

In order to satisfy itself as to paragraph (4)(c), the planning proposal authority may need to include certain provisions in the local environmental plan.

In summary, rezoning should only proceed on the basis that measures are in place to ensure the potential for contamination and suitability of land or any proposed land use are assessed once detailed proposals are made.

This might be communicated in Local Environmental Plan with supporting guidance included in a Precinct specific Development Control Plan or Development Code.

Specifically, it is noted that change to a more sensitive land use on some sites could result in *significant contamination* as defined under the *CLM Act.* This should be avoided as it would trigger additional notification, remediation and/or management responsibilities.

Further there will need to be assurances that exempt and complying development will also capture where and when contamination assessment is to be undertaken in the planning process.

1.5.3 Protection of the Environment Operations Act 1997

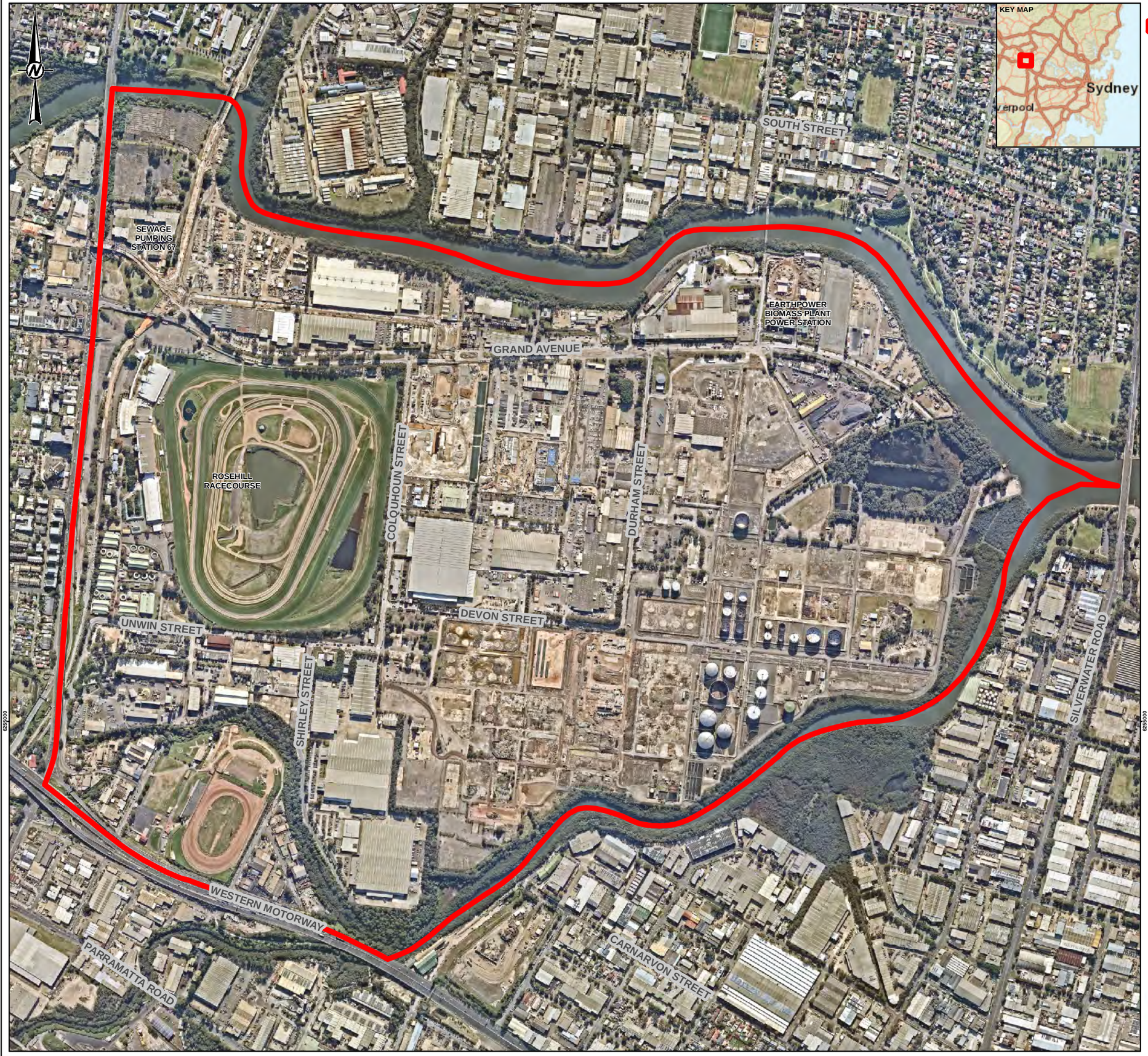
The *POEO Act* is one of the key environment protection legislations administered by NSW EPA.

The *POEO Act* provides a single integrated licensing arrangement to control the air, noise, water and waste impacts of an activity. The NSW EPA is the regulatory authority for the licensing of activities specified under Schedule 1 of the *POEO Act 1997* (scheduled activities) and in most cases councils are the regulatory authority for non-scheduled activities.

There are several sites located in the Precinct that are licensed for scheduled activities under the *POEO Act*.

The *POEO Act 1997* also provides the key mechanisms (including the issuing of three types of environment protection notices including: clean up, prevention and prohibition notices) for protecting the environment. It also provides the regulatory regime for waste management under the *Protection of the Environment Operations (Waste) Regulation 2014*.

Any proposed Precinct remediation works would be required to be completed in compliance with the relevant requirements of the *POEO Act* and regulations.



LEGEND

Camellia Precinct Boundary

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
PRECINCT BOUNDARY

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	07-07-2022
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	013	6	1

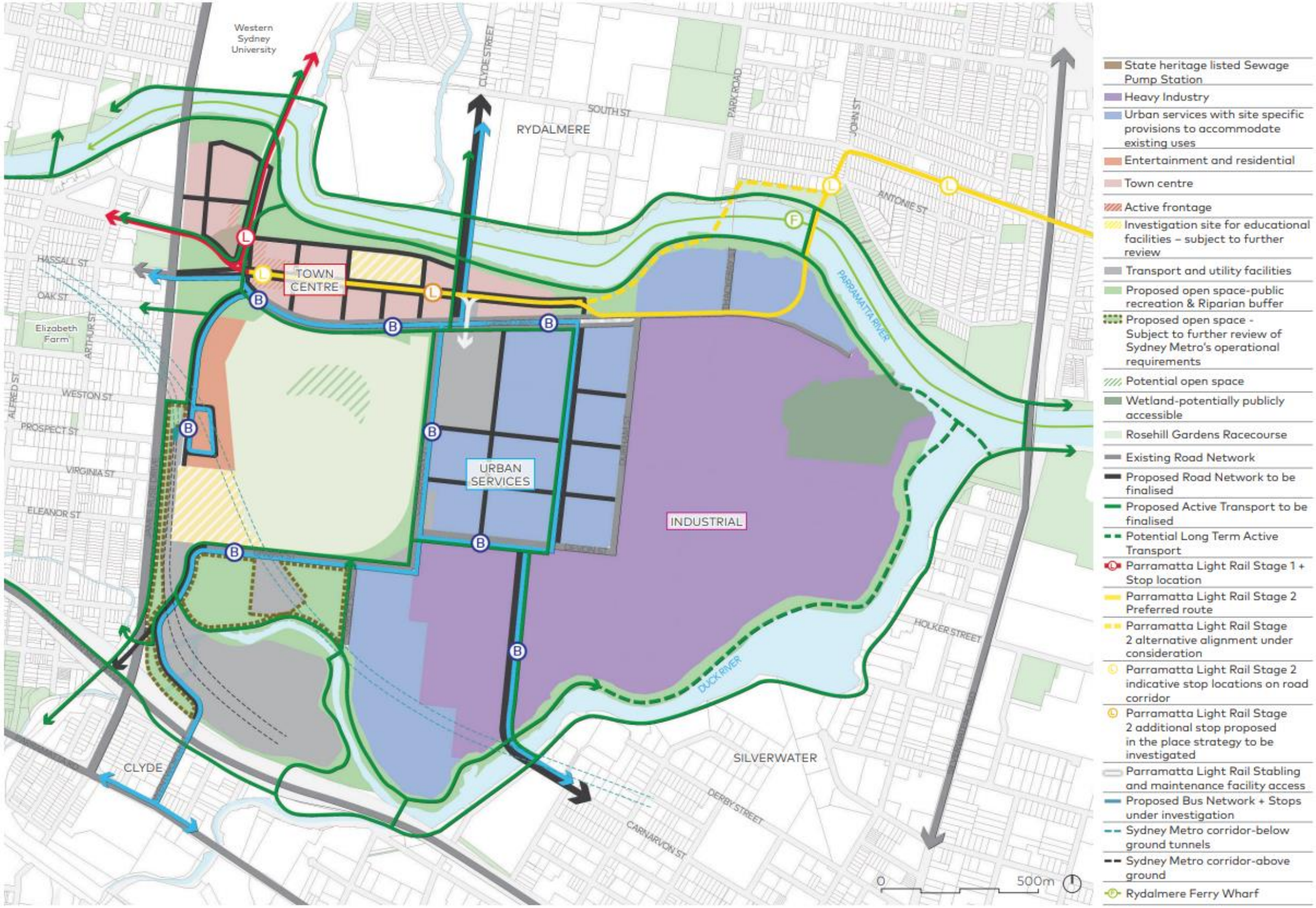


Figure 2: Master Plan Diagram

2.0 PRECINCT ENVIRONMENTAL SETTING

2.1 Location, Topography, and Drainage

The Precinct can be defined as a peninsula of land bounded by Parramatta River to the north, Duck River to the east, Parramatta Road to the south and James Ruse Drive to the west (refer Figure 1). It consists of the suburbs of Camellia and parts of Rosehill, Granville, and Clyde.

With the arrival of the first colonial settlers, the land was cleared for rural activities. Subsequently Camellia evolved into a significant industrial precinct.

The Precinct comprises low lying land sloping from a high point of approximately 12 m Australian Height Datum (m AHD) adjacent to Rosehill Railway Station, falling to approximately 7 m AHD at Rosehill Gardens Racecourse and to approximately 3 m AHD in the east near the confluence of the Parramatta and Duck Rivers.

The Precinct drains naturally to the Parramatta River and the Duck River. The south-west corner of the Precinct is also drained by Duck Creek, a tributary of Duck River, and a small section of A'Becketts Creek which drains into Duck Creek.

Flood risk mapping (1:100 year recurrence interval) provided indicates that large parts of the Precinct are at risk of flooding (WSP, 2021a).

2.2 Soils and Landfilling

The soil in the vicinity of Rosehill Railway Station, the highest natural part of the Precinct, is mapped as the Glenorie soil landscape, comprising Yellow Podzolic Soils subject to high soil erosion hazard, and localised impermeable high plastic subsoil. However, these soils are likely to have been modified by development in the area.

Early land maps of the area indicate in the south-eastern portion the presence of "salt marsh". A review of the Prospect/Parramatta River Acid Sulfate Soil (ASS) Risk Map (Edition 2, Department of Land and Water Conservation, 1997) indicates that the area today is underlain by 'Disturbed Terrain' which may include areas filled to reclaim low lying swamps. Soil Conservation maps indicate generally extensively disturbed terrain, including "complete disturbance, removal or burial of soil."

The Sydney 9130 100:000 Scale Geological Sheet (NSW Department of Mineral Resources, 1983) maps the eastern third of the Precinct as comprising man-made fill – dredged estuarine sand and mud, demolition rubble, industrial and household waste.

No maps of the extent of landfilling have been sighted beyond those of the 1:100,000 scale geology and soil maps referred to above. The fill was placed to increase the level of the land in the lower areas adjoining the Parramatta River, Duck River and Duck Creek. Hence the depth of fill is considered likely to be greatest in the northern, southern, and eastern margins of the Precinct.

The fill overlies Tertiary (Miocene) estuarine (tidal) sediments of sand, clay, and peat, with extensive ferruginous mottles. The clay is thought to be an estuarine silt or mud which was overlain by a laterite horizon and subsequently altered to a plastic, grey, clay with extensive ferruginous mottles.

The extent of Acid Sulphate Soils in the Precinct has been mapped by City of Parramatta Council (Council) as part of the *Parramatta Local Environmental Plan 2011* (LEP). The provisions of Clause 6.1 of the LEP would trigger the need for development consent and preparation of an Acid Sulphate Soils Management Plan for development across the majority of the Precinct depending upon the depth of works below ground surface and/or the depth of lowering of the groundwater table.

2.3 Geology

The geology of the western third of the Precinct is mapped as comprising fluvial (river flow), Quaternary, silty to peaty quartz sand, silt, and clay, with ferruginous and humic cementation in places and common shell layers NSW Department of Mineral Resources (1983). The Quaternary deposits include basal Pleistocene (early-mid Quaternary) deposits of stiff clay and sandy clay with minor sand, shell, and peat layers in many areas. The eroded surface of the Pleistocene sediments is commonly deeply weathered; the uppermost clays are leached, iron stained, and mottled white, red, and light grey.

The Tertiary and Quaternary sediments are underlain by Ashfield Shale (black to dark-grey shale and laminite deposited in a prodelta to delta environment) of the Middle Triassic Wianamatta Group.

The Ashfield Shale is underlain by the fluvial (river flow) deposited Hawkesbury Sandstone (medium to coarse-grained lithic sandstone). The top of the Hawkesbury Sandstone is mapped as sloping across the Precinct downwards from a depth of approximately 5 metres below mean seal level in the north to a depth of approximately 40 metres below mean sea level in the south.

In summary, the underlying geology comprises fill material, sediments, and residual clays overlying bedrock.

2.4 Hydrogeology

The Camellia Peninsula is an elevated terrace of alluvial materials exposed during the recession of sea level in the early Pleistocene. The eastern part of the peninsula was previously an area of tidal flats and mangrove swamps between the Parramatta and Duck Rivers. The following water bearing units are identified on the Camellia Peninsula:

- Hawkesbury Sandstone / Mittagong formation;
- Wianamatta Group (Minchinbury Sandstone/Ashfield Shale);
- Quaternary Sediments; and
- Fill material.

The presence of groundwater in the bedrock of the Precinct will be influenced by the geology (Section 2.3) and is summarised as follows:

- The Wianamatta Group Ashfield Shale generally yields saline water which is also hard. The water is generally too saline even for stock watering and there are not many bores in the Wianamatta Group within the Sydney area.
- Hawkesbury Sandstone – water is generally of good quality ranging in salinity from 200 to 840 mg/L total salts. Water bearing zones are encountered mostly at depths of 10 metres to 50 metres. Low yields generally limit use to domestic and small-scale stock requirements which are not applicable to the Precinct.

It is noted that the Precinct is located in an area serviced by reticulated potable water supply as well as an industrial water recycling plant. There are no known users of groundwater in the Precinct. Given the high salinity and/or low yield of groundwater, it is considered unlikely that attempts to use groundwater for industrial purposes would be successful.

The principal groundwater units likely to be impacted by groundwater contamination on the Precinct are the overlying Quaternary sediments and fill materials (Section 2.3).

Groundwater levels in fill and Quaternary sediments compiled for the Camellia Peninsula[4] indicate that the groundwater level on the peninsula ranges from approximately 7 m AHD beneath Rosehill Gardens Racecourse in the west of the Precinct to a tidal mean of about 0 m AHD beneath the mudflats fringing the northern, eastern, and southern side of the peninsula. The resulting regional groundwater flow would generally be radial towards the Paramatta and Duck Rivers with a groundwater divide along the centreline of the peninsula. On the Parramatta Light Rail (PLR) Stabling and Maintenance (SaM) facility remediation site, for example, regional groundwater levels indicate a general groundwater flow in a north-easterly direction over the majority of the site, with an almost easterly groundwater flow direction along the southern site boundary.

In summary, in the low-lying areas underlain by significant thickness of estuarine deposits and man-made fill, the groundwater table is expected to be shallow and typically within three metres to five metres of the ground surface. For example, groundwater was present within the Quaternary sediments and has been encountered at depths between 0.8 metres and 4.5 metres below ground level (for example along Grand Avenue by Douglas Partners, April 2013 and GW Engineers, December 2010). The pre-remediation groundwater levels on the PLR SaM site were generally found to have ranged between RL 3.5 m AHD and RL 6 m AHD across the site with the lower elevation occurring in the northern part of the site and the higher elevation in the central and/or southern part of the site.

The CMJA assessments in the northeast of the Precinct (CMJA, 2007a-d) generally encountered groundwater at 3 to 3.25 m below ground surface and flow was towards the Parramatta River, with groundwater levels on several of the assessment sites influenced by tidal variations.

DPE (2020) and AECOM (2019) note that groundwater flow direction on the southern portion of the former Shell refinery site is generally towards the south-east and east, following the riverbank contour of Duck River. Groundwater is represented in this area as a shallow unconfined aquifer within estuarine alluvial sediments at depths between 1 and 3 metres below ground level (bgl).

2.5 Implications of Environmental Setting on Contamination Risk

The environment of the Precinct is characterised by low gradients; fill material; sediments varying between sand, clays, and laterites; overlying relatively impermeable shale and sandstone bedrock. The fill material and more permeable sediments, with shallow groundwater, create an environment where contaminants may infiltrate the ground and then migrate downwards and laterally through the more permeable zones. The fill material which has been placed across the historically lower areas of the Precinct presents a potential source of contamination. The presence of potential acid sulphate soils would require management during excavation works to prevent generation of acid forming conditions.

The waters of the Parramatta River, Duck River, Duck Creek, and A'Becketts Creek represent potential receptors for contamination migrating through soil erosion, stormwater, and groundwater. Subsurface infrastructure, such as utilities and stormwater drainage pipes may provide also preferential pathways facilitating migration of contaminants in the shallow sub-surface environment towards the waterways.

2.6 Land Use Contamination Impacts

The Golder (2021) Baseline Report (Appendix D) identified those properties within the Precinct where available information indicates that they are at risk of contamination due to historical industrial and/or landfilling activities. Information on actual contamination concentrations is limited due to lack of access to reports of investigations of soil and groundwater conditions undertaken on private lands. Furthermore, there may be other unexpected contamination which may be identified at a later stage. Nonetheless the following generalised comments are made about potential contamination at the Precinct.

[4] Compiled as part of the PLR Stage 1 SaM site remediation.

The most widely spread contaminants across the Precinct are considered to be:

- Asbestos – Asbestos wastes from the James Hardie manufacturing operations have resulted in large scale asbestos contamination at 181 James Ruse Drive, 1 Grand Avenue, and on the former quarries backfilled with asbestos waste on the north side of Devon Street. Asbestos material has also been reported as uncontrolled fill in shallow soil along Grand Avenue, in the railway easement north of the Boral Plasterboard Plant at 3 Thackeray Street, within Clyde Refinery, on the north-east corner of Tennyson Street, at the PLR SaM sites, at the former CSR site and at the Sydney Raceway at 2 Deniehy Street.

  The long-term asbestos manufacturing process in the area has likely also resulted in the deposition of asbestos dust within the vicinity of the former manufacturing site. The key contamination risks associated with the presence of asbestos are disturbance causing airborne particles which may be inhaled and present a risk of causing asbestos-related cancers.

- Hexavalent chromium originating from the former Chrome Chemicals manufacturing facility at 6-8 Grand Avenue and possible also the former Wesco Paints facility at 13 Grand Avenue, a former tannery at 14 Thackeray Street and a former timber treatment facility involving use of wood preservatives used in the timber yard at 16 Grand Avenue. Hexavalent chromium waste materials reportedly were used as fill material resulted in contamination at 6-8 Grand Avenue, 37 Grand Avenue, 39 Grand Avenue, 41 Grand Avenue, 12 Grand Avenue, 14 Grand Avenue and the Clyde Refinery site, including immediately west of the Wetland area. Hexavalent chromium is a known carcinogen, the main pathway is via inhalation of dusts and aerosols and direct exposure resulting in skin absorption and potential ingestion. Hexavalent chromium also presents a health risk to sensitive ecological species.

- Petroleum hydrocarbons as dissolved phase and/or phase separated (LNAPL) at the Clyde Refinery site, the SAMI bitumen plant site at 12 Grand Avenue, the Hymix Australia site at 14 Grand Avenue, the EDI Downer site at 1 Unwin Street.

  To a lesser extent they were also identified as COPC at 1 Grand Avenue, 181 James Ruse Drive and associated with potential refuelling facilities at 10 Grand Avenue, 17 Grand Avenue, the Rosehill helipad site and Rapid Oil Distributors on Deniehy Street.

  Petroleum hydrocarbons may present both human health and ecological risks associated with the presence of chemical species such as benzene, toluene, ethyl benzene, xylenes and polycyclic aromatic hydrocarbons (including naphthalene). Dissolved phase petroleum hydrocarbons LNAPL also present a potential risk of explosion in underground services.

- VCHs in fill soil and groundwater (carbon tetrachloride, chloroform, dichlorodifluoromethane and trichlorofluoromethane) are known to be present on the PLR SaM site located at 4-8 Grand Avenue, as well as on the adjoining CSR site located at 10 Grand Avenue. It is not known where these contaminants have migrated in groundwater/ below ground services to other adjoining sites.

  VCHs present both human health and ecological risks. Risk to human health from exposure to VCHs depends on exposure concentration and length of exposure. Short term impacts of exposure to high concentrations include (but are not limited to) headaches, dizziness and drowsiness. Long-term impacts of exposure to high concentrations include (but are not limited to) impacts to the central nervous system, kidneys and liver. Due to their volatile nature VCHs can migrate through the subsurface in the vapour state from soil and/or groundwater sources. Vapours can accumulate in buildings, entering through cracks in foundations and at points where services enter buildings.

- Perfluoroalkyl and polyfluoroalkyl (PFAS) substances in groundwater are known to be present on the Shell refinery site and may have migrated on to adjoining sites in groundwater.

PFOS and PFOA are both very stable chemicals that bioaccumulate, do not break down, and can persist for a long time in the environment. Due to their widespread use in a range of industrial and consumer products over many decades PFAS contamination is commonly found in the environment at low levels. Although there is no consistent evidence of human health impacts related to PFAS, the potential effects to human health cannot be excluded, and NSW EPA are taking very cautious approach to regulating PFAS.

Landfill gas may be present at the James Hardie Devon Street landfill site and in select locations on the sites located at 12 Grand Avenue and on the PLR SaM, site located at 4-8 Grand Avenue. Landfill gases can become potentially explosive, asphyxiating or acute toxicants when they are encountered at elevated concentrations. Landfill gases become most hazardous when they intrude into buildings and structures, such as utility access pits and inspection chambers, where they can accumulate.

Golder (2021) Remediation Strategy, Baseline Analysis Report (Appendix D) provided a Precinct scale mapping of contamination risk. This ranking of potential land contamination was divided into the three broad and subjective contamination risk categories (High, Medium or Low) (refer to Figure 2).

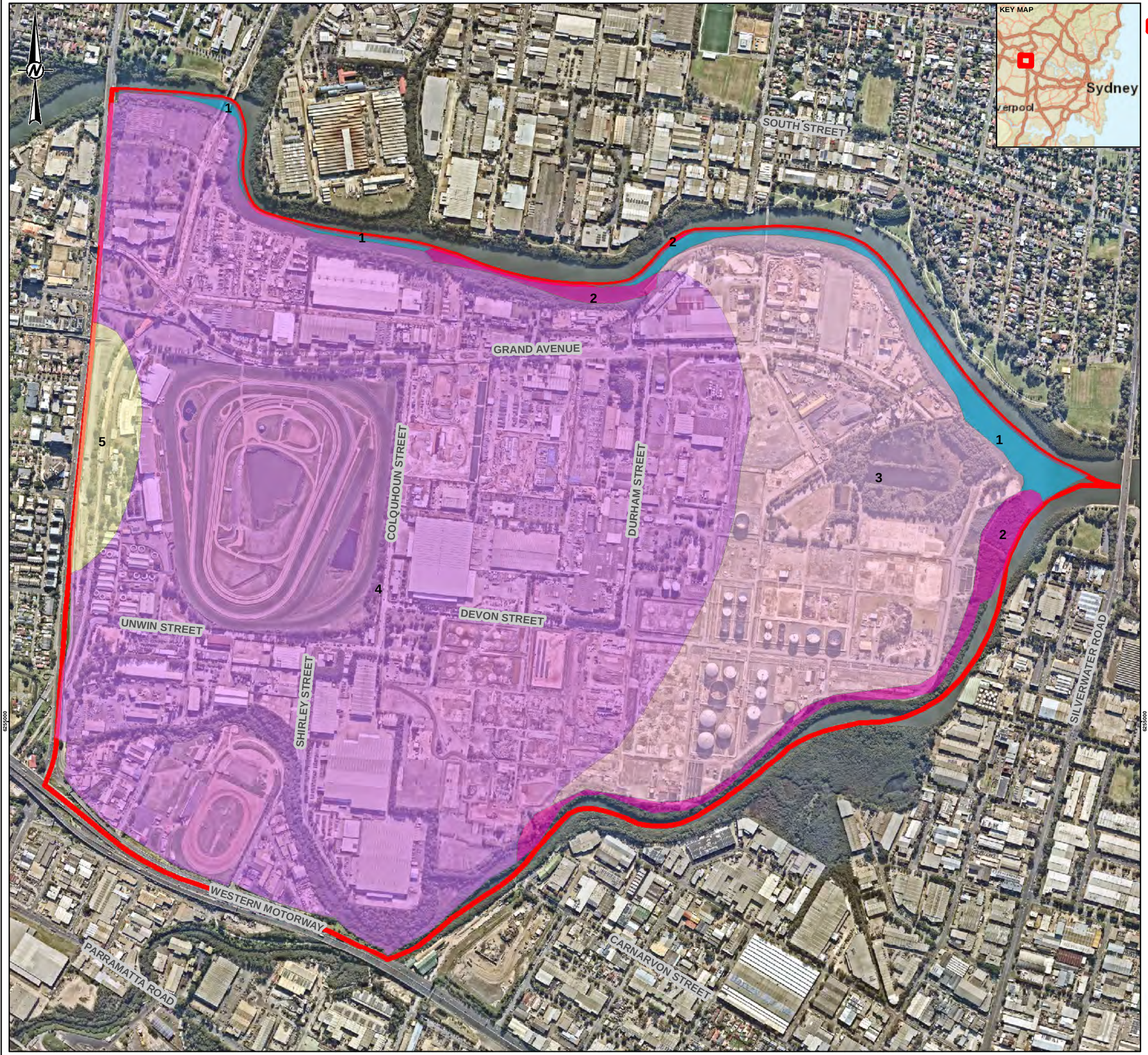
2.7 Land Use Considerations for Geotechnical Constraints and Acid Sulfate Soils

In addition to Precinct contamination the Golder (2021) report also considered geotechnical constraints and ASS within the Precinct. Key geotechnical issues were identified as including:

- Allowable bearing pressures (deep and shallow).
- Design parameters for ground treatment areas (compressibility, strength, consolidation properties).
- Allowable total and differential settlement, including long term creep settlement.
- Chemical attack on buried concrete (soil and groundwater, ASS, pH, sulphate, chloride).
- Generally shallow depth to groundwater.

Whilst geotechnical constraints were identified it was established that most potential issues could be addressed with engineering design and issues would be unlikely to preclude specific land uses.

It was also determined that potential acid sulfate soil issues can be managed for a range of land use scenarios, involving soil disturbance, using an ASS Management Plan. Temporary or permanent excavations involving lowering of the groundwater table should, however, be avoided to minimize the potential for generating acidic conditions and/ or triggering requirements for contaminated groundwater treatment/ ongoing management.



LEGEND

- Camellia Precinct Boundary
- Class 1
- Class 2
- Class 3
- Class 4
- Class 5

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021
2. ACID SUFATE SOILS CLASSIFICATION: PARRAMATTA CITY COUNCIL 2015

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
ACID SULFATE SOILS DISTRIBUTION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	07-07-2022
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	013	6	3

3.0 KEY STAKEHOLDER POLICY CONSIDERATIONS

The recommended Remediation Strategy required to facilitate each of the future land use scenarios needs to give consideration to the relevant policies of key stakeholders, such as DPE, the Greater Sydney Commission, the NSW EPA, Council and NSW Health.

3.1 Guidance Framework for Remediation Options

The NSW EPA's preferred position on the selection of remediation options, as stated in the NSW EPA (2017) Guidelines for the NSW Site Auditor Scheme (3rd edition), is based on the Assessment of Site Contamination Policy Framework set out in NEPC (2013) Volume 1: Schedules A and B, Section 6, Clause 16. The draft supporting document to the NEPM (NEPC 2013): "*Key Principles for the Remediation and Management of Contaminated Sites*", broadly summarises the remediation and management of contaminated sites under the headings of: Prevention; Management; and Implementation. This is outlined below:

Prevention of contamination includes controlling the spread of existing contamination and application of the precautionary principle for decommissioning and redevelopment of potentially contaminated sites.

Management of contamination includes the development of strategies to protect all segments of the environment with the fundamental goal of remediation being to render a site suitable for its proposed use. The preferred hierarchy of options for site soil remediation and/or management is broadly summarised as follows:

- *On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and*
- *Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or*

If the above are not practicable:

- *Consolidation and isolation of the soil on site by containment with a properly designed barrier; and*
- *Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material;*
- *A less sensitive land use to minimise the need for remedial works which may include partial remediation; or*
- *Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.*

Implementation strategies including: the need to report contaminated sites to the relevant authorities; public notification of known contamination; and in the case of in-situ management strategies, the development of legally enforceable long term site management plans.

When deciding which management /remediation option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option. For example, to the extent practical, the requirement for off-site disposal should be minimised. In cases where no readily available or economically feasible method is available for remediation, it may be possible to adopt appropriate regulatory controls or develop other forms of remediation.

It should be emphasised that the appropriateness of any particular option will vary depending on a range of local factors. Acceptance of any specific option or mix of options in any particular set of circumstances is therefore a matter for the responsible participating jurisdiction.

For groundwater contamination, the preferred hierarchy for clean-up objectives in the NSW DEC (2007) *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*, is as follows:

1) Clean up so natural background water quality is restored.

2) Clean up to protect the relevant environmental values of groundwater, and human and ecological health.

3) Clean up to the extent practicable.

Clean up to natural background groundwater quality is technically possible but would be difficult and expensive (cost and time prohibitive). This is due to the historical use of the Camellia- Rosehill Precinct by heavy industry, which has resulted in wide-spread poor groundwater quality, including multiple sources of contamination as such remediation of groundwater quality to numerical clean-up criteria is also considered impractical. Thus the 2nd and 3rd points in the hierarchy list are the most applicable in this case.

NSW DEC (2007) states that "*…In all cases where clean-up to restore environmental values cannot be achieved:*

- *it is still necessary to clean up to the extent practicable, to minimise the impact on environmental values;*
- *human and ecological health must be protected;*
- *plume containment should be implemented to prevent the plume from spreading;*
- *ongoing groundwater monitoring may be required;*
- *the possibility of cleaning up the groundwater contamination should be periodically reassessed to account for emerging technologies;*
- *provisions are required for long-term resourcing and responsibility for any ongoing management strategy; and*
- *information must be recorded and disseminated.*"

3.2 Other Relevant Policies

Other relevant policies referenced as part of the review included the following:

- DPE (2020). Cleaning Up Our Act: The Future for Waste and Resource Recovery in NSW Issues Paper.
- Greater Sydney Commission (GSC) (2018), Central City District Plan.
- NSW EPA (2014b) Waste Avoidance and Resource Recovery Strategy 2014-21.
- NSW Government (2016) Waste Less, Recycle More Initiative.

Verbal feedback from stakeholders provided during recent interactions as part of the EbD process has also been considered.

The following is a summary of key Remediation Strategy considerations:

NSW EPA considerations

Previous feedback from the NSW EPA provided in responses to their review of previous studies was considered. This correspondence included:

- NSW EPA (May 2014). Letter Correspondence to Parramatta City Council, comments on the document titled: Draft Discussion Paper – The Future of the Camellia Precinct – March 2014 – Parramatta City Council.

- NSW EPA (October 2015). Letter Correspondence to NSW Department of Planning and Environment, comments on the document titled: Camellia Precinct Land Use and Infrastructure Plan.
- NSW EPA (May 2016). Letter Correspondence to NSW Department of Planning and Environment, comments on the document titled: Golder (2015b) Camellia Precinct Contamination and Remediation Study – Stage 2.
- NSW EPA (September 2017). Letter Correspondence to NSW Department of Planning and Environment, comments on the document titled: Greater Parramatta Interim Land Use and Infrastructure Implementation Plan.
- NSW EPA (March 2018). Letter Correspondence to NSW Department of Planning and Environment, comments on the document titled: Draft Camellia Town Centre Master Plan.

NSW EPA feedback was summarised as follows:

- The NSW EPA (2014) stated preference for minimal disturbance of asbestos impacted soils on former James Hardie manufacturing sites, with a preference for onsite management. The NSW EPA (2015) reiterated this point in relation to the proposed remediation of the former James Hardie site (181 James Ruse Drive) and the associated community concern relating to potential health impacts associated with the proposed disturbance of asbestos.
- The NSW EPA (2014) stated concerns regarding more sensitive land use proposals on and adjoining the Parramatta River foreshore areas, with increased public access, given the hexavalent chromium, and to a lesser extent asbestos and chlorinated hydrocarbon contamination in these areas currently being managed under less sensitive, industrial, land use exposure scenarios.
- The NSW EPA (2104) noted that the known hydrocarbon, chromium and other potential contamination of the former Shell refinery and its potential suitably for surplus lands to be remediated for new heavy industrial land uses.
- NSW EPA (2014) noted that current EPA licensed waste resource and recovery facilities located in the Precinct are important to achieve State recycling targets in the delivery of the NSW Government (2014) Waste Avoidance and Resource Recovery Strategy 2014-21. It was acknowledged that whilst these facilities may require relocation, there was a preference for them to the relocated within the Precinct.
- NSW EPA (2014) noted concerns regarding proposals to potential locate new residential developments in close proximity to existing EPA licensed industrial premises, creating potential land use conflicts.
- NSW EPA (2015) stated that any Precinct remediation strategies should consider learnings from the remediation and redevelopment of Homebush Bay and the Rhodes peninsula. The redevelopment of these precincts for high density housing caused land use conflicts as some sites were occupied whilst others were still being remediated. It was recommended that staging requirements be considered to avoid land use conflicts.
- NSW EPA (2015) acknowledged the benefit of adopting a coordinated approach to the management of contamination risks and remediation within the Precinct as part of redevelopment. It was recommended that the Remediation Strategy be underpinned by a Precinct specific Land Contamination Action Plan (LCAP) to provide clear guidance to the community, landowners, developers and government on expectations in relation to the management of land contamination during Precinct redevelopment. This LCAP was highlighted as important to guiding the appropriate management of contamination extending into waterways and foreshore areas. The NSW EPA (2015) reiterated the importance of enhanced remediation strategies to improve the existing management of hexavalent chromium contamination and impacts on groundwater and surface water for foreshore land adjoining the Parramatta River.

- NSW EPA (2016) noted that where foreshore land in the Precinct is potentially impacted by contamination, its assessment and remediation should be completed concurrently with any rezoning and/or development of the adjoining land.
- Whilst NSW EPA (2017) cites that under *State Environmental Planning Policy No 55 – Remediation of Land* (*SEPP 55)* land within the Precinct should not be rezoned until requirements under *SEPP 55* are met including considerations of whether land is contaminated, suitable for its proposed land use or can be remediated to be made suitable to the proposed land use. Since April 2020 these requirements have been transferred to a Ministerial direction (No 2.6) Remediation of Contaminated Land under the *NSW Environmental Planning and Assessment Act 1979 (EP&A Act)*. In summary, rezoning should only proceed for the majority of the sites located within the Precinct on the basis that measures are in place to ensure the potential for contamination and suitability of land or any proposed land use are assessed once detailed proposals are made. The NSW EPA cite the possible use of provisions in LEPs and/or any supporting Development Control Plans (DCPs) or Development Code for this purpose.
- NSW EPA (2017) noted that for all potentially contaminated land, the investigation, remediation and validation and/or management should be completed in accordance with guidelines made or approved by the NSW EPA under Section 105 of the *NSW Contaminated Land Management (CLM) Act 1997 (the CLM Act).* Further it was noted that in cases where uncertainty remains regarding site suitability for an intended land use, a Site Auditor accredited under the *CLM Act* should be engaged to provide an independent review of contaminated site assessment, remediation and validation reports and/or environmental management plans in order to provide greater certainty to planning authorities and the community that the site is suitable for the proposed land use.
- NSW EPA (2017) noted that where rezoning identifies locations for sensitive land uses (e.g., schools), suitability assessments may be required at the time of rezoning. Further it was noted that where possible sensitive land uses should be proposed on low-risk sites with no previous industrial history.
- NSW EPA (2017) noted that remediation works completed to date in the Precinct are likely to have been to facilitate suitability for existing land uses only and more sensitive land use proposals will likely require more extensive remediation and/or ongoing management.
- NSW EPA (2017) note that where redevelopment within the Precinct results in a change to pre-existing contamination, consideration should be given to whether the contamination is likely to be significant enough to warrant regulation under the *CLM Act*.
- NSW EPA (2017) flagged the potential for the *Exempt and Complying Development SEPP* and supporting codes leading to land being used for unsuitable purposes and the need for clarity of when and where contaminated land assessment needs to be completed as part of the planning process.
- NSW EPA (2018) comments on the Draft Camellia Town Centre Master Plan and noted the proposal to site a school on former industrial land. A previous recommendation that where possible sensitive land uses should be proposed on low-risk sites with no previous industrial history was reiterated. The need to consider staging requirements to avoid land use conflicts was also reiterated.
- NSW EPA (2018) notes that a proposed separation cap of 500 mm of soil cover to provide protection to human receptors from contaminated soil across the proposed town centre would allow attenuation of potential contamination vapour concentrations migrating vertically through the soil profile. Concerns were raised with this capping solution as it would not address residual dissolved phase groundwater contamination. Golder acknowledges these concerns and notes that the proposed Remediation Strategy (Section 5.0) addresses potential volatile contamination with the proposed application of vapour barriers.

- NSW EPA (2018) cited the WA DOH (2009) guidance and a minimum separation cap of 500 mm of soil cover with a geotextile marker layer and an ongoing management plan. It was noted that whilst the cap of 500 mm of soil cover to provide protection to human receptors from contaminated soil across the proposed town centre might be adequate to manage asbestos exposures, the adequacy of this approach for other contaminants of potential concern was not considered. Golder acknowledges these concerns and notes that the proposed Remediation Strategy (Section 5.0) addresses the full range of contaminants of potential concern anticipated within the Precinct.

Preliminary EbD workshop considerations

- As agreed in the Preliminary EbD Workshop, the proposed *Remediation Strategy* is to be underpinned by the guiding principle of *no risk of harm to human health or the environment*.
  NSW EPA (2015 & 2017) similarly stated the LUIS should deliver the following outcome: "*To ensure that land is assessed and remediated/managed so that the land is suitable for the proposed land use and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment.* Further NSW EPA (2015) stated that a key outcome for the strategy is *"to facilitate the remediation of contaminated land within the Precinct".*

- Council expressed a reluctance (as part of the preliminary EbD workshop) to take ownership of remediated land which will be onerous to maintain into the future, unless costs for these ongoing management can be funded by third parties (e.g., in the case of residential redevelopment on foreshore areas, foreshore park maintenance might be funded by strata contributions through a Planning Agreement, but this assumes a high density residential land use).

- As cited in the DPE (2018) Draft Camellia Town Centre Master Plan, a cohesive ground plane was proposed which involved capping the proposed town centre to address contamination and flooding issues. This proposal included the exclusion of basement parking from developments. It was instead proposed that car parking be provided above ground in the building podiums. As part of the EbD Workshops it was proposed that the Precinct Remediation Strategy should generally preclude basement levels (for e.g., car parking) so as to ensure minimal disturbance of contaminated soil and to minimise generation of waste fill/soil requiring on/off site management and to minimise requirements for ongoing management (e.g., contaminated groundwater and/or hazardous ground gases in basements). This approach is also aligned with the proposal to investigate opportunities for Precinct based adaptable car parking and infrastructure in lieu of private provision of car parking.

- Based on the contamination status of the Precinct the inclusion of sensitive land use exposure scenarios (such as freehold residential development with gardens and accessible soil) was considered to be unfeasible due the anticipated associated requirements for extensive remediation and/or ongoing management. As noted by the NSW EPA such land uses would only really be feasible on low-risk sites and would have the potential to generate large volumes of waste fill/soil requiring on/off site management. There is, however, a proposal for schools under the Master Plan, so the most sensitive land use of school/ kindergarten, which is equivalent to low density (freehold) residential is applicable.

- As part of the EbD workshops it was established that, if possible, a Precinct-wide approach to the remediation/management of groundwater contamination should be adopted prior to the creation of potential sub-Precinct land use zonings. Where this is not possible, it was recommended that provisions be included to ensure future Precinct development does not preclude future remediation opportunities with the availability of new remediation technologies (e.g., the establishment of remediation corridors/ easements to allow future access to apply groundwater treatment technologies). It was established that the hexavalent chromium impacted groundwater and surface water would particularly benefit from a Precinct-wide remediation strategy.

Previous environmental studies completed in the Precinct have strongly advocated such an approach at eastern end of the peninsula for sites adjoining the Parramatta River. This would be substantially more effective and cost efficient than independent approaches and fit with ecologically sustainable development principles.

- Directive 1 of the NSW Government (March 2020) Cleaning Up Our Act: The Future for Waste and Resource Recovery in NSW Issues Paper, is to “generate less waste”. The proposed Precinct Remediation Strategy should where possible minimise the generation of waste that requires management in offsite landfill facilities.

3.3 Enquiry by Design Outcomes

A series of outcomes were identified by the collective stakeholder group as part of the EbD workshops. These outcomes were documented in the Workshop Scenario Report (Cox, 2021). Of these outcomes the following are considered to have direct relevance to the development of *Remediation Strategies* for the Master Plan.

Landholdings

- Viva Terminal is retained in part (operational terminal facilities only).
- Parramatta Light Rail (PLR) Stage 1 Precinct footprint, including the Stabling and Maintenance (SaM) facility which is currently undergoing remediation and construction, and associated tracks and station are to be retained as planned.
- Sydney Metro West Maintenance and Stabling Facility (MSF) is to be retained as proposed. There is an assumption that the land acquired for this facility will be remediated as part of the proposed construction works. It is also assumed that the land to the north of the MSF and Duck Creek and south of Unwin Street, is to be used as a construction compound and that it will be remediated for ongoing commercial industrial land use.
- Rosehill Gardens is retained in part (racecourse and supporting infrastructure only).

Sustainability

- Towards zero waste. Waste generation is to be minimized (NSW Government Cleaning Up Our Act: The Future for Waste and Resource Recovery in NSW Issues Paper).
- Low carbon high performance precincts. As per the Planning Priority C19 in GSC (2018) the Precinct should prioritize reducing carbon emissions and managing energy, water and waste efficiently. GSC (2018) introduces concept of precinct-based car parking and infrastructure in lieu of private provision of car parking.

Connection with Country

- Retain and enhance continuous walking track along Parramatta and Duck Rivers with access to wetlands and linked green space.

Flood Management

- Evacuation routes can be achieved.
- On-site stormwater management.
- No net loss of flood storage due to cut/fill.

Open Space

- Waterfront activation and access to the foreshore wherever accessible and amenable.

This reflects Planning Priority C13 in GSC (2018): *Protecting and improving the health and enjoyment of the District's waterways*, which includes enhancing the quality of, and access to, waterways such as the Parramatta River and Duck River.

Ecology

- Wetland and mangroves are to be retained.

It is noted that the wetland is located on the Viva Clyde refinery site and is not accessible to the public.

Transport

- Decoupled/Precinct parking, particularly where residential land uses will increase the demand for parking.

4.0 CONTAMINATION REMEDIATION OPTIONS

4.1 Range of Available Options

A general summary of the available contamination remediation and management options is provided with reference to the Golder (2012) *Preliminary Remediation Options Discussion Paper, Camellia Precinct, NSW,* dated 25 June 2012 prepared by Golder for Council.

This summary is high level and based on the information available for the Precinct. It does not include the selection of specific remediation/management options for specific sites.

Several categories of technologies exist for the remediation of identified soil and water contaminants in the Precinct. These include:

- Isolation;
- Immobilisation;
- Toxicity reduction;
- Degradation or destruction;
- Physical separation; and
- Removal (excavation or extraction).

Remediation options can also be categorised into remediation methods which:

- Can be applied to remediate contaminants in soil, groundwater, or both soil and groundwater. It is also noted that stormwater at many sites within the Precinct is impacted by site contaminants, however, for the purposes of this summary it is assumed that addressing contamination issues in soil and groundwater will address this issue;
- Are applied in the ground (in situ) or out of the ground (ex situ);
- Are suitable for specific contaminants or a range of contaminants; and
- Either:
  - Removes (or degrades) contaminants from the site; or
  - Does not remove contaminants from the site but results in either transformation of the contaminants so they are less mobile or harmful, or isolation of contaminants to control exposure to humans or the environment.

Table 1 provides a summary of the technologies identified under each of these broad headings.

A description of each remediation option is provided in Appendix A and summarised in Table 1. Technologies have been considered in terms of suitability to remediation contaminants in groundwater, soil or both soil and groundwater.

Table 1: Remediation Options Summary

Phase	Technology	Inorganic Contaminants				Organic Contaminants			Waste Reduction	Minimise Disturbance	Considerations for Implementation in the Precinct
		Asbestos	Hexavalent Chromium	Metals	Arsenic	Volatile chlorinated hydrocarbons	'light-end' TPH and BTEX	PAHs and 'heavy-end' TPH			
Groundwater	Air Sparging, In-Well Air Stripping	×	×	×	×	✓✓✓	✓✓✓	×	✓✓✓	✓✓	**Not supported** as a Precinct-wide approach as it only applies to limited CoPC. May be under consideration for local application on specific sites e.g., Viva site
	Pump and Treat	×	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓	✓✓	✓✓✓	**Not supported** – may be applicable in a more temporary capacity for treatment of localised areas of contamination on select sites, e.g., associated with UPSS removal, temporary groundworks. It has also been adopted as a contingency option on the PLR SaM site. Not supported as a Precinct-wide approach for hexavalent chromium treatment along Parramatta River as cost of operation and maintenance would be significant and it is not certain that the upper contaminated water bearing zone would be productive enough, particularly due to its heterogeneous nature. A significant amount of investigation works would be required to establish detailed knowledge of the site hydrogeology. Such as system might also draw in water from the River. Some studies have suggested an alternative approach that might include the installation of a collection trench as an alternative to a pumping system, particularly in low permeability materials. This approach would need to demonstrate that inflows from the River are minimised. Ongoing treatment costs are expected to be high.
	Permeable Reactive Barrier (PRB)	×	✓✓✓	✓✓✓	✓	✓✓✓	✓✓	✓	✓✓	✓✓	**Supported** – Preferred technology is proven for the treatment of hexavalent chromium using a zero valent iron (ZVI) medium, application to other Precinct COPC would require bench scale testing. Optimisation of design would also be required, e.g., confirmation of type of treatment media, thickness of treatment zone, potential use of funnel and gate design. Further investigation, testing and modelling would be required. Technology has been applied extensively (particularly in Europe) and filtering gates can be manufactured so that the treatment media can be replaced easily (e.g., use of filters in metal cartridges inserted vertically into the ground with an inspection hatch at the surface). The gates can be orientated perpendicular to an impermeable barrier wall with a drainage zone to encourage groundwater flow into the treatment zone and the width of the zone designed so as to increase residence times to optimize treatment as required. Drainage from the treatment zone though the wall can also be controlled. As the preferential path through the barrier is the gate, this means that any reactions which have the potential to cause clogging can also be easily addressed/ maintained. Technology is preferred as it does not require secondary treatment of groundwater and truncates contaminant transport pathway to the River. Ongoing monitoring and maintenance costs would however apply.
Soil and Groundwater	Bioremediation	×	✓	×	×	✓✓	✓✓✓	✓	✓✓	✓✓	**Not supported** generally due to lengthy timeframes for site-specific proof of concept. May be applicable for localised treatment of areas of more light end petroleum soil contamination on select sites, e.g., associated with UPSS removal and the Viva site. Was also considered for potential source treatment on the PLR SaM site but was not adopted.
	Chemical Treatment	×	✓✓	✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	**Not supported**. Involves the addition of chemical reagents (e.g., oxidising or reducing agents) into the ground or to excavated soil to degrade/transform contaminants to harmless products. Although the chemical reagents treat the contaminants in groundwater, it also treats soils. Commonly a contaminant 'rebound' effect occurs, which means that several reagent applications are required.

Phase	Technology	Inorganic Contaminants				Organic Contaminants			Waste Reduction	Minimise Disturbance	Considerations for Implementation in the Precinct
		Asbestos	Hexavalent Chromium	Metals	Arsenic	Volatile chlorinated hydrocarbons	'light-end' TPH and BTEX	PAHs and 'heavy-end' TPH			
											May be applicable to localised source treatment, e.g., It was considered for potential source treatment on the PLR SaM site but was not adopted. Can apply to hexavalent chromium (e.g., reducing agents) and could be incorporated as a groundwater treatment option in a PRB system or through direct injections into subsurface. Direct injections can however be costly if many injection sites are required to treat a large area. Product costs can also be high. Associated monitoring is also a requirement to confirm effectiveness and/or rebound potential if treatment zone becomes depleted.
	Containment (capping or cut-off wall)	✓✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓	Capping systems are **supported** as a preferred option for soil. A cut-off wall is **not supported** as a preferred option for Precinct-wide groundwater remediation. The installation of a barrier wall could be applied as a Precinct-wide groundwater solution for land adjoining the Parramatta River to halt the transport of contaminated groundwater to the River. There would however need to be ongoing operation and maintenance in the form of a pump and treat system to ensure a lower water level inside the wall to prevent contaminant transport, pressure build up and/or surface seepages. The additional pump and treat requirement means the option is less preferable to PRB for groundwater.
	Electrokinetics	×	✓✓	✓✓✓	✓	×	×	×	✓	✓✓	**Not supported** – the technology still in development and is only applicable to limited COPC. It may have future application for small scale localised remediation approaches. The technology still requires contaminant recovery/ removal and would generate waste requiring management.
Soil and Groundwater	Flushing	×	×	✓✓	×	✓✓	✓✓	✓✓	✓✓	✓✓✓	**Not supported** – Soil flushing involves mobilisation of organic compounds or metals by leaching contaminants from in-situ soils so that they can be extracted without excavating the contaminated materials. This option is not applicable to main widespread soil hexavalent chromium soil contamination. By its nature it is likely to be limited in suitable application to small areas and not amenable to a Precinct-wide approach. Further it is generally only applied to optimise pump and treat, which has been identified as a secondary, less preferred option.
	Multi-Phase Extraction	×	×	×	×	✓✓	✓✓	✓✓	✓✓	✓✓	**Not supported** as a Precinct-wide approach as only applies to limited CoPC. May be under consideration for local application on specific sites e.g., Viva site or on select sites associated with, for example, UPSS removal.
	Nanoremediation	×	✓✓	✓	✓	✓✓	✓	✓✓	✓✓	✓✓✓	**Not supported** – the technology still emerging. May have future application for small scale localised remediation approaches, where contamination remediation not amenable to a Precinct-wide approach.
	Monitored Natural Attenuation	×	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	**Supported** – as part of preferred remediation efforts at the Precinct, most likely for low-level contamination in groundwater (asbestos excluded) that has been shown to not present a risk to human health and the environment, or after active remediation has been undertaken. However, the long timeframe required and need for long-term management, including monitoring, may influence regulatory acceptance and must be considered in land use planning. MNA is likely most applicable to petroleum hydrocarbon contamination in groundwater associated with the Viva former refinery site.
	Phytoremediation	×	✓	✓✓	✓	✓	✓✓	✓	✓✓✓	✓✓	**Not supported** – Involves use of living plant material to treat contamination e.g., by removal, degradation, containment (fixation), or take up of contaminants in shallow soils and sediments. Some deep-rooted plants (including some eucalypts) can be used to take up groundwater to provide

Phase	Technology	Inorganic Contaminants				Organic Contaminants			Waste Reduction	Minimise Disturbance	Considerations for Implementation in the Precinct
		Asbestos	Hexavalent Chromium	Metals	Arsenic	Volatile chlorinated hydrocarbons	'light-end' TPH and BTEX	PAHs and 'heavy-end' TPH			
											hydraulic control of a groundwater plume in a similar method to pump and treat. Application of phytoremediation at the Precinct could potentially be used in conjunction with other remediation technologies as a passive, sustainable low-cost method of managing low-level residual contamination in shallow soils. For example root exudates can create reducing environment which may promote Cr(VI) reduction, although this would require further investigation to confirm its viability as a potential option.
	Thermal Treatment	✖	✖	✖	✖	✓✓✓	✓✓✓	✓✓	✓✓	✓✓	**Not supported** as a Precinct-wide approach as only applies to limited CoPC. Thermal remediation involves heating contaminated soil and groundwater (ex-situ or in-situ) to destroy or volatilise contaminants or to mobilise compounds in the ground so that they can be removed by collection wells for treatment. Thermal methods are generally expensive as they have significant energy requirements and produce secondary waste streams, but they can be cost effective when used to remediate source areas where non-aqueous phase liquids (NAPLs) may be present and treat compounds which are bound strongly to the soil and cannot be easily remediated otherwise. Treatment can often allow effective reuse, minimising waste generated requiring off-site management. Most effective treatment methods are often ex-situ, requiring extensive site disturbance. Thermal options within the Precinct are limited by site access restrictions, need for vapour treatment and require significant regulatory and planning approvals. It is however under consideration for localised application on areas of the Viva site.
Soil	Soil Vapour Extraction (SVE)	✖	✖	✖	✖	✓✓✓	✓✓✓	✖	✓✓	✓✓	**Not supported** – as a Precinct-wide approach as only applies to limited CoPC. SVE removes contaminants, in the form of vapours, from the soil above the groundwater table. This option would be limited for application within the Precinct by site access restrictions, need for a vapour treatment system and subsequent regulatory approvals. It may be applicable on areas of the Viva site.
	Soil Washing, Solvent Extraction	✖	✓✓	✓	✓✓	✓	✓	✓✓	✓	✓	**Not supported** – the technology applies an extracting agent, to mobilise organic compounds or metals, to excavated soils. It usually requires a slurry mixing process. The treated slurry requires management and it is an intensive process which would not be amenable to a Precinct-wide remediation approach as it involves extensive site disturbance and generates wastes requiring management. Its application would likely be limited to small scale hot spot treatment.
	Immobilisation (fixation, stabilisation, solidification, vitrification)	✓	✓✓	✓✓✓	✓✓	✓	✓	✓✓	✓	✓	**Not supported** – These technologies, whilst proven for the majority of the Precinct COPC, do not offer a Precinct-wide approach as they tend to be COPC specific and not appropriate for waste streams with co-contamination. Further, the most effective immobilisation technologies often involve soil excavation for ex situ treatment, which is not conducive to minimization of disturbance (particularly where asbestos is present) and can result in a treated waste stream unsuitable for onsite reuse. The technologies can also raise uncertainty regarding the long-term durability of treated materials. Its application in the Precinct would likely be limited to the localised treatment of contamination hot spots to facilitate off-site waste management as a lower category of waste.

Phase	Technology	Inorganic Contaminants				Organic Contaminants			Waste Reduction	Minimise Disturbance	Considerations for Implementation in the Precinct
		Asbestos	Hexavalent Chromium	Metals	Arsenic	Volatile chlorinated hydrocarbons	'light-end' TPH and BTEX	PAHs and 'heavy-end' TPH			
	Excavation	✓✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓	✓	**Supported** for localised treatment of hot spots of soil contamination or where site elevations cannot be increased to mitigate flood risks. **Not supported** for Precinct-wide application. Remediation involving extensive excavation and replacement of soil is cost prohibitive and goes against the guiding principle of minimising the generation of waste that requires management in offsite landfill facilities. Extensive excavation is also the least preferred option in areas of extensive asbestos impacts due to risk of mobilisation of airborne fibres. Extensive excavation is not supported in areas of the Precinct where the land has been reclaimed with waste as it could generate large waste volumes and disrupt or damage existing infrastructure.

Notes:

✓ Technology that may result in removal of contaminants from the site

✓ Technology does not result in removal of contaminant but may result in reduction in harm to human health or the environment from contaminants

× Not suitable for the identified contaminant

✓✓✓ Highly Effective (relative to other options)

✓✓ Effective

✓ Somewhat Effective

4.2 Viable Remediation Options

Although there are a full range of remediation technologies applicable to the Medium and High-risk sites located in the Precinct, in accordance with the Remediation Strategy design constraints and considerations presented in Section 3.0 the following is a description of viable remediation technologies considered appropriate to apply to the Precinct proposed land use scenarios.

The viable soil/fill remediation options are principally focused on remediation technologies which, in line with the abovementioned considerations and constraints, include:

- Minimisation of disturbance of contamination (particularly asbestos).
- Minimisation of the generation of large volumes of waste requiring off-site management.

They include isolation, and/or excavation (principally to be applied to localised hot spots). For isolation/ capping options, the importation of capping materials may, however, raise site levels and potentially contribute to flooding risks. As such capping approaches may generate surplus waste materials requiring offsite management to mitigate flood risks. For this reason, this Remediation Strategy will interface with a IWCMS (WSP, 2021b) that is also being completed as part of the CRPS.

Viable groundwater options are focused on achievement of a Precinct-wide remediation strategy for the hexavalent chromium impacted groundwater and surface water entering the Parramatta River foreshore zone, and to a lesser extent chlorinated hydrocarbons. This may be achievable with a Permeable Reactive Barrier (PRB), which is considered a degradation and/or toxicity reduction technology.

Monitored Natural Attenuation (MNA) is more likely applicable to the widespread petroleum hydrocarbon (and potentially PFAS) contamination in groundwater across the Precinct, particularly the former refinery site.

Other potentially applicable remediation technologies, not considered further herein, are described in Appendix A and summarised in Table 1.

4.2.1 Containment

Containment technologies can be used to attempt to prevent the movement of contaminants by isolating them within an area. Containment technologies can also include capping and subsurface barriers that are used to prevent exposure to site users and further contamination of groundwater when other treatment options are not physically or economically feasible for a site. Capping systems are typically a constructed barrier at the ground surface to:

- Prevent contact with contaminated soils.
- Reduce surface water infiltration to contaminated soil for prevention of further groundwater contamination.
- Control vapour emissions from the soils.
- Improve aesthetics and provide a suitable surface for ongoing land use.

Caps are typically constructed of layers of soil, clay, drainage materials and impermeable geomembranes. Depending on the intended land use they may also be concrete.

Subsurface barrier technology involves the installation of an engineered impermeable barrier wall (such as a slurry wall, a grout curtain or a sheet pile wall) around the contaminated material. This prevents groundwater from migrating through a contaminated area and prevents further impacts to non-contaminated areas. Subsurface barriers are commonly used in conjunction with surface caps to isolate a contaminated area. They may also include vertical vapour barriers in the vadose zone.

Caps are potentially suitable to manage risks associated with all identified contaminants within the Precinct, though additional consideration would be required for control of vapours from some organic contaminants such as BTEX and volatile chlorinated hydrocarbons. Subsurface barriers are potentially suitable to manage risks associated with all identified contaminants and are mainly dependent on the subsurface conditions.

Caps and subsurface barriers are well developed technologies, commonly used throughout Australia and globally, and are relatively inexpensive for large sites.

Caps can be used to control risks to humans and the environment, and subsurface barriers prevent the spread of contamination in the subsurface, but these technologies do not result in removal of the contaminants. Ongoing management of the cap/barrier and residual contamination is required, which must be considered in land use planning.

Capping and containment has recently been applied on the PLR SaM site with the construction of a hydraulic barrier wall and a vertical vadose zone vapour barrier around the site boundary to contain contaminated groundwater and vapour combined with a surface capping system. The surface capping broadly includes: capillary break layers (to prevent wicking and surface blooming of hexavalent chromium); vapour management to mitigate vapour exposure pathways; low-permeability layers to mitigate infiltration and vapour pathways; drainage and structural fill.

The main issues for application of containment as a remediation option within the Precinct will include accessibility, ongoing management and acceptance by regulators and the community.

4.2.2 Excavation

Excavation comprises digging up contaminated soil so that it can be disposed of in an appropriate engineered landfill (on-site or off-site) or treated and reused at site. Excavation is effective in removing/ isolating contaminants from the site but is limited by accessibility, typically large volumes of waste generated and the need to manage the excavated materials. Excavation can be physically limited by the practicable limit of an excavation. Excavated materials can be managed using on-site treatment of excavated materials[5] but is subject to the availability of a suitable technology as it presents an opportunity to incorporate sustainability concepts and principles through minimisation of disposal to land fill and beneficial reuse of treated soils.

On-site treatment methods (see description of technologies presented in Appendix A and Table 1) are proven and commercially available for identified contaminants including metals and hydrocarbons. However, treatment of asbestos containing materials is not likely achievable. Thus, it is most likely that excavated materials containing asbestos would be required to be disposed of at an engineered landfill or contained on site. Whilst off-site treatment options for hydrocarbon contaminants are proven and commercially available in Australia the transport effort to these facilities would be prohibitive. It is, however, noted that remediation works currently proposed on the Viva site include the potential use of bioremediation and/or thermal treatment options.

On-site disposal of excavated materials at a containment cell designed to manage the waste is a viable option but could create flooding issues. The off-site disposal of excavated materials at an engineered landfill designed to manage the waste would not satisfy the current NSW Government and Precinct-wide objective of waste avoidance and resource recovery and is also likely to be cost prohibitive. If contaminated soils are not able to be managed on-site then off-site disposal would be the most effective option and result in least disruption to future land use.

[5] Preferred option of the NSW EPA, refer to Section 3.1

In summary, given the large extent of remediation potentially required within the Precinct, it is likely that significant volumes of materials may require excavation to reduce contamination risks to acceptable levels. This approach may need to be applied to localised contamination sources (e.g., fill/soils impacted by underground petroleum storage systems (UPSS)).

It is likely that in most cases surplus excavated materials would be required to be disposed of offsite to a suitably licensed engineered landfill as waste. Alternatively, there may be options to contain surplus excavated materials on site or at a specially constructed containment cell within the Precinct[6]. Ongoing management of an on-site containment cell(s) would be required.

4.2.3 Permeable Reactive Barrier

Permeable Reactive Barriers (PRBs) are a permeable wall (i.e., allows groundwater to flow through it easily) in the ground designed to intercept and treat contaminated groundwater as it flows passively through the wall. Reactive materials in the wall either trap contaminants or transform them to a less harmful form. Clean groundwater flows out the other side of the wall. They differ to subsurface barriers in that PRBs are designed to allow groundwater flow through them rather than prevent flow.

Common reactive materials include organic materials, a type of scrap iron (called ‘zero valent iron’), limestone and many other natural minerals. Zero valent iron is used as a reactive material in PRBs to treat hexavalent chromium and chlorinated hydrocarbons under similar (reducing) conditions and will also treat arsenic and other metals but only under different (oxidising) conditions. Organic materials can be used to bind organic contaminants or promote bioremediation.

PRBs are installed downgradient of a source zone as either a ‘funnel and gate’ or ‘continuous trench’ system. There are available technologies that allow the “gates” to be constructed using cassettes/ cartridges containing reactive media that can be replaced.

PRBs can be installed by trenching, a common construction technique, if the contaminated groundwater is shallow (as is inferred to be the case at The Precinct) and surface improvements do not interfere with access. PRBs at the Precinct could potentially be used to prevent the spread of contaminants in groundwater from a site towards the Parramatta River. PRBs could potentially be used to treat most identified contaminants in groundwater but is an inefficient method of cleaning up a source area and will be ineffective for contamination in the unsaturated zone and asbestos. Although there are some synergies in PRB types (e.g., potentially a zero valent iron barrier to treat chromium and chlorinated hydrocarbons), application of this technology at Camellia might require a ‘sequential PRB’ due to the different treatment mechanisms required.

It is recognised that, while the PRB technology is viable conceptually, further feasibility studies would need to be completed during the design phase to confirm this assumption. Additional studies / treatability trials and logistics necessary to facilitate a PRB option might be expected to include:

- Batch and column tests.
- Hydrogeochemical and geochemical modelling.
- Hydrogeological modelling.
- Further field investigations of the aquifer and aquitard geochemistry and their natural ability to attenuate contaminants, in particular hexavalent chromium, and chlorinated hydrocarbons (potentially both).

[6] Subject to necessary approvals e.g., a Precinct-wide Resource Recovery Order (RRO) / Resource Recovery Exemption (RRE)

Furthermore, the ongoing maintenance and monitoring costs of the PRB need to be considered in subsequent feasibility studies. Ongoing maintenance and monitoring costs may include:

- Replacement of the reagent(s) (e.g., zero valent iron). Ongoing replacement / rejuvenation of PRBs may also require that land be set aside for ongoing remediation works (i.e., an easement along the alignment of the PRB(s)). Ongoing maintenance / rejuvenation of PRBs may also impact on site operations and/or availability[7]
- Appropriate disposal or regeneration of reagent(s).
- Equipment and manpower costs.
- Documentation of site activities.
- Demonstrating the PRB(s) are functioning as intended (i.e., ongoing performance and environmental monitoring).

4.2.4 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the reliance on natural attenuation processes (such as natural degradation of organic contaminants, binding of inorganic compounds to soil) to remediate a site. In this way, natural attenuation processes have to be shown to be effective at controlling risk or cleaning up the contamination within a timeframe that is reasonable compared to that offered by other more active methods. Natural attenuation is typically only acceptable to regulators when there is no current risk to humans or the environment and ongoing monitoring is possible.

Monitored natural attenuation would likely form part of remediation efforts at the Precinct, most likely for low-level contamination (asbestos excluded) that has been shown to not present a risk to human health and the environment, or after active remediation has been undertaken. However, the long timeframe required and need for long-term management, including monitoring, may influence regulatory acceptance and must be considered in land use planning.

MNA is likely most applicable to petroleum hydrocarbon contamination in groundwater associated with the Viva former refinery site.

4.2.5 Pump and Treat

‘Pump and treat’ is a developed and commercially available method for cleaning up polluted groundwater. It can also be used for containment of contaminated groundwater. Pump and treat can also clean up contaminated soils in the saturated zone, though it is an inefficient method to do so. Contaminated groundwater is extracted (pumped) to the surface where it can be treated. Pump-and-treat is most often used when other remediation methods are not feasible, as an interim remediation measure or a method of preventing migrating of contaminated groundwater. A treatment plant is required to treat extracted water.

‘Multi-phase’ extraction is a combination of pump and treat and soil vapour extraction whereby contaminated groundwater, vapours in the ground and liquid chemicals still present in the ground are pumped to the surface for treatment. This technology is commonly used for organic contaminants in areas where significant leaks/spill of petroleum products or chlorinated hydrocarbons have occurred.

[7] It is noted that setbacks have been created from the main watercourses to minimising flood impacts to surrounding land. Future planning may consider the creation of easements within these setbacks for the future installation and maintenance of a PRB or other groundwater remediation technologies along the foreshore.

A groundwater extraction system may include numerous pumps configured so that contaminated groundwater will not flow from a site (e.g., at the downgradient site boundary – towards the Parramatta River) or to reduce the mass of a contaminant in the ground (i.e., pumping from the ‘source’ area). Systems are relatively flexible in terms of accessibility, though an area of land and utility connections are required for the treatment plant.

Pump-and-treat is applicable to all contaminants in groundwater and results in removal of contaminants from the subsurface. It is not suitable for asbestos and contaminants in the ground above the groundwater table (unsaturated zone). It is less effective at cleaning up contaminant sources and contaminants bound to aquifer materials, in which case it often has to be operated for extended periods (often years or decades) if the source is still present. Pump-and-treat has been used at some sites in the Precinct to reduce migration of contaminated groundwater, but will likely have to operate for an extended period before actual clean-up of the site occurs. Pump-and-treat is a contingency remediation option at the PLR SaM site.

Pump and treat likely most applicable to localised treatment of contaminated groundwater, for example associated with UPSS removal and/or during localised excavations for example to access inground infrastructure. In these instances, it is usually undertaken using mobile treatment plants. Basement excavations in contaminated groundwater zones, within the Precinct, although not proposed, would likely require the installation and operation of more permanent pump-and-treat systems.

5.0 PROPOSED REMEDIATION STRATEGY

This section presents the proposed Remediation Strategy for the Precinct. The proposed strategy was largely developed to respond to key stakeholder considerations (refer to Section 3.0) including the adoption of a Precinct-wide approach of minimising contamination disturbance and generation of waste, whilst considering opportunities for a Precinct-wide approach for groundwater remediation.

The proposed Remediation Strategy is not intended to prohibit the adoption of “alternative” or “new” technologies that are less preferred for Precinct-wide application and not presented below. Notwithstanding, if alternative technologies are proposed to be adopted in future developments, applicants will need to demonstrate that the technology is viable on an individual site basis and are consistent with the guiding principles of this strategy (refer to Section 8.0).

5.1 Strategy Overview

With consideration to the remediation options discussed in Section 4.0, the proposed Remediation Strategy for the Precinct includes:

- Soil/fill capping and containment, with excavation and off-site management of isolated hot spots (e.g., UPSS).
- Excavation and capping of foreshore areas.
- Hexavalent chromium (and chlorinated hydrocarbon) groundwater treatment using an PRB along the Parramatta River foreshore.
- Ongoing MNA for Precinct-wide petroleum hydrocarbons, with the use of remediation corridors (easements) to facilitate future groundwater remediation programs (e.g., for VCH impacts).

Under the proposed Remediation Strategy, the following comments apply:

- There are few remediation technologies that can address all identified contaminants; hence this approach provides a viable Precinct-wide approach.
- All remediation technologies will leave some level of residual contamination and as such ongoing management, including monitoring, of residual contamination will be required to ensure that potential risks are controlled.
- Given the ubiquitous nature of asbestos and hexavalent chromium contamination, which transcend individual property boundaries at the Precinct, it provides a holistic remediation approach to address legacy issues in areas of multiple properties, rather than on an individual site basis. There may be associated regulatory and planning implications, and cooperation between multiple property owners may, however, be difficult to obtain.
- The technologies applicable to remediation of asbestos are fairly limited to removal (excavation), isolation (capping) or immobilisation (solidification/vitrification). Given the ubiquitous nature of asbestos at the Precinct, and the preference for non-disturbance and waste generation, isolation provides the preferred approach with asbestos remaining on site, but with associated risks controlled.
- These same technologies – removal (excavation of soil and ‘pump and treat’ of groundwater) and isolation (capping) are applicable to other Precinct-wide contaminants. This is because they are ‘bulk’ remediation techniques which are largely not dependent on the type of contaminant but more the site conditions.

- While there are several other remediation technologies potentially applicable for contaminants (other than asbestos), due to the different properties and behaviour of the contaminants they generally rely on slightly different techniques or chemicals which may not be compatible (refer Appendix A). For example, chemical treatment is applicable to a range of contaminants, but the specific method used to treat hexavalent chromium will be different to that used to treat other metals or organic contaminants. Thus, treatability of contaminants (other than asbestos) can be broadly categorised into:
  - Organic contaminants – these compounds can be degraded or destroyed, can be volatile and can be present sorbed to soil/waste, in groundwater or as free product.
  - Inorganic compounds – these compounds cannot be destroyed, but they can be transformed to less harmful or mobile forms, they are generally not volatile and can be found sorbed to soil/waste and in groundwater.
- The adoption of 'bulk' remediation technologies for the proposed Remediation Strategy provides a Precinct-wide approach. The application of other technologies would require a more complex approach to link relevant technologies to achieve site clean-up in the most cost-effective manner. This does not mean that more "boutique" remediation technologies would not actually be considered on an individual site basis, they just do not currently fit with the Precinct-wide approach and costing.
- The IWCMS Strategy prepared for the CRPS (WSP, 2021b) identifies the requirement to minimise the flooding impacts beyond the Precinct. The importation of capping materials may raise site elevations and create unacceptable flooding impacts. It is noted that if the ground levels cannot be raised due to unacceptable flooding impacts, soil/fill materials may need to be excavated to accommodate the capping systems. The implications of excavating soils to accommodate the capping systems are:
  - Increased disturbance of contamination. In these cases, applicants will need to demonstrate what management controls will be implemented to mitigate potential impacts associated with the proposed disturbance of contaminants (e.g., temporary emissions enclosures).
  - Increased volumes of waste requiring off-site management (e.g., landfilling) or beneficial reuse within the Precinct in engineered containment facilities. This will generate higher development costs (refer to Section 7.0).

5.2 Containment Options

5.2.1 Capping

For the purposes of scoping and costing a preferred Remediation Strategy a series of conceptual soil/fill capping options were developed to address the full range of potential contamination and land use scenarios across the Precinct. Where capillary break layers are proposed, this is in response to hexavalent chromium contamination which can move through the subsurface under capillary action and form surface blooms of contamination. The ground gas protection systems may relate principally to the management of landfill gas or volatile organic compounds such as chlorinated or petroleum hydrocarbons. Further details of these concept capping options are provided in Appendix B and broadly include the following:

- Physical Separation Only – Recreational.
- Physical Separation Only – Buildings / Pavements.
- Physical Separation and Capillary Break Layer – Recreational.
- Physical Separation and Capillary Break Layer – Building / Pavements.
- Physical Separation and Ground Gas Protection System – Building / Pavements.

- Physical Separation, Capillary Break Layer and Ground Gas Protection System – Building / Pavement.

The Buildings/ Pavements capping options would apply to the high density residential, the commercial/ industrial, and infrastructure corridor land use scenarios.

The capping systems identified above are typically designed for a life of 20 to 100 years. The design life depends on several factors, including the quality of the materials that are specified, and the amount of redundancy incorporated into the design. The design life requirements for each capping area would be specified during the design phase in response to the remediation design life objectives.

It is noted that the quality of the capping materials alone would not necessarily dictate the design life. It would also be influenced by other factors including, for example, cost and time constraints and/or the local availability of materials specified as part of the remediation design and construction procurement process. These factors would be specified during the procurement phase. It is also worth highlighting that improving the capping design life through redundancy could have a significant impact on the remediation costs. For example, redundancy can be achieved by incorporating additional features into the design which could increase the overall thickness of the cap. As noted in Section 7.3, the remediation costs are, however, highly sensitive to capping thickness due to flooding performance and waste management considerations.

For the proposed Parramatta River foreshore areas containment strategies would likely involve the localised excavation (for offsite management) of asbestos wastes and/or chromium-impacted soil/fill to a nominated depth followed by replacement with low permeability capping and armouring with heavy rock to prevent wash erosion along river frontage. These containment strategies may also extend to the Duck River and Duck Creek foreshore areas, but in these areas the removal of contaminated soil fill to accommodate low permeability capping and rock armour would likely be less extensive (if at all).

5.2.2 On-site Soil Containment (Filling / Mounding)

As noted in Section 4.2, Precinct capping approaches may generate surplus spoil. Consistent with the Precinct-wide objective of minimising the generation of spoil classified as waste for management at a licensed offsite facility, options for on-site soil containment facilities (mass filling / mounding) should be explored within the Precinct. Whilst there are obvious benefits for the use of on-site containment facilities, there are several factors that should be considered in their planning and approval. Considerations and recommendations for the planning and approval of containment facilities are provided in Section 8.0.

5.3 Groundwater Remediation

As noted above, this Remediation Strategy relies on the adoption of a Precinct-wide approach to remediating groundwater. Wherever possible, the primary control of source removal should be adopted. For the reasons stated in Section 4.0, the use of PRB technology is supported in this proposed Remediation Strategy. Notwithstanding, further feasibility studies would need to be completed during the design phase to confirm the viability of the PRB technologies. It is possible that PRB(s) may need to be supplemented by other remediation technologies (e.g., pump and treat) to ensure objectives are achieved.

The proposed PRB(s) extent would potentially incorporate foreshore areas adjacent to sites with hexavalent chromium fill/soil leaching to stormwater and/or groundwater. The currently inferred extent of the PRB(s) is indicated in Section 7.2. The extent of the PRB(s) would need to be confirmed through further investigations. The optimum alignment of the proposed PRB(s) with respect to the existing properties and the mangroves is has not been determined. It is possible that some removal and rehabilitation of existing mangroves would need to occur to accommodate groundwater treatment systems. However, it is noted that setbacks have been proposed to be created from the main watercourses to minimise flood impacts to surrounding land (WSP 2021b). These setbacks provide an opportunity to create easements for the future installation and maintenance of a PRB(s) or other groundwater remediation technologies along the foreshore.

5.4 Basement Parking

This Remediation Strategy is not supportive of basement parking to the following reasons:

- It is inconsistent with the guiding principle of minimising contamination disturbance and waste generation.
- It is inconsistent with the parking strategies specified in other Implementation Reports prepared for the CRPS[8], which promote the provision of unbundled and decoupled parking.
- Other potential contamination risks associated with basement parking will need to be considered and mitigated:
  - Management of contaminated groundwater that is intercepted and/or drawn towards the basements during construction and/or occupation. It is also noted that contaminated groundwater could migrate across property boundaries as a result.
  - Management of hazardous ground gases that are encountered during construction and occupation of the basements.
  - Depending on the nature of the contaminants present in the groundwater, potential impacts on the durability of materials being considered for the basement lining and drainage systems.

Development proposals seeking to include basement parking will need to demonstrate how these challenges will be addressed and how they comply with the guiding principles of this Remediation Strategy (refer to Section 8.0).

[8] Arcadis, 2021 & Kinesis, 2021

6.0 CONTAMINATION RISK ASSESSMENT

As noted in Section 2.6, potential land contamination was divided into the three broad and qualitative contamination risk categories (High, Medium, or Low) (refer to Figure 3). Remediation and/or management options may be required to enable some of the Precinct properties to be redeveloped to the proposed land uses under the Master Plan.

With consideration to the Master Plan land use overlay (refer to Figure 2), each existing land use has been allocated a likelihood ranking for whether remediation would be required to achieve the identified land use, as per the risk matrix identified in Table 2 below. The likelihood rankings include “unlikely”, “possible” and “likely”.

As per the guiding principles this matrix assumes that there won’t be any freehold residential development in the Precinct (e.g., gardens with access to soil). There are however proposals for schools/ educational facilities, so the most sensitive land use of school/ kindergarten, which is equivalent to low density (freehold) residential is applicable.

Table 2: Land Contamination Risk Ranking

Land Contamination Risk Rank	Definition of Risk Rank	Likelihood that remediation is needed to Achieve Identified Land Use			
		School / Kindergarten	High Density Residential	Recreational	Commercial / Industrial
Low	**Soil Contamination is Likely & Groundwater Contamination is Possible**. The information suggests that there may have been some activities on the site that have resulted in localised contamination of the land but the site is not likely to be a source site for groundwater impact.	Possible	Unlikely	Unlikely	Unlikely
Medium	**Soil & Groundwater Contamination is Likely.** The information suggests that the site activities may have contaminated the land and/or groundwater. Some remediation of soil will potentially be required and there will be a potential need for groundwater remediation.	Possible with some restrictions	Possible	Possible	Unlikely
High	**Soil &/or Groundwater Pollution**. The information suggests that the site activities are likely to have caused pollution that would likely require soil remediation and/or active groundwater remediation.	Likely	Likely	Likely	Possible

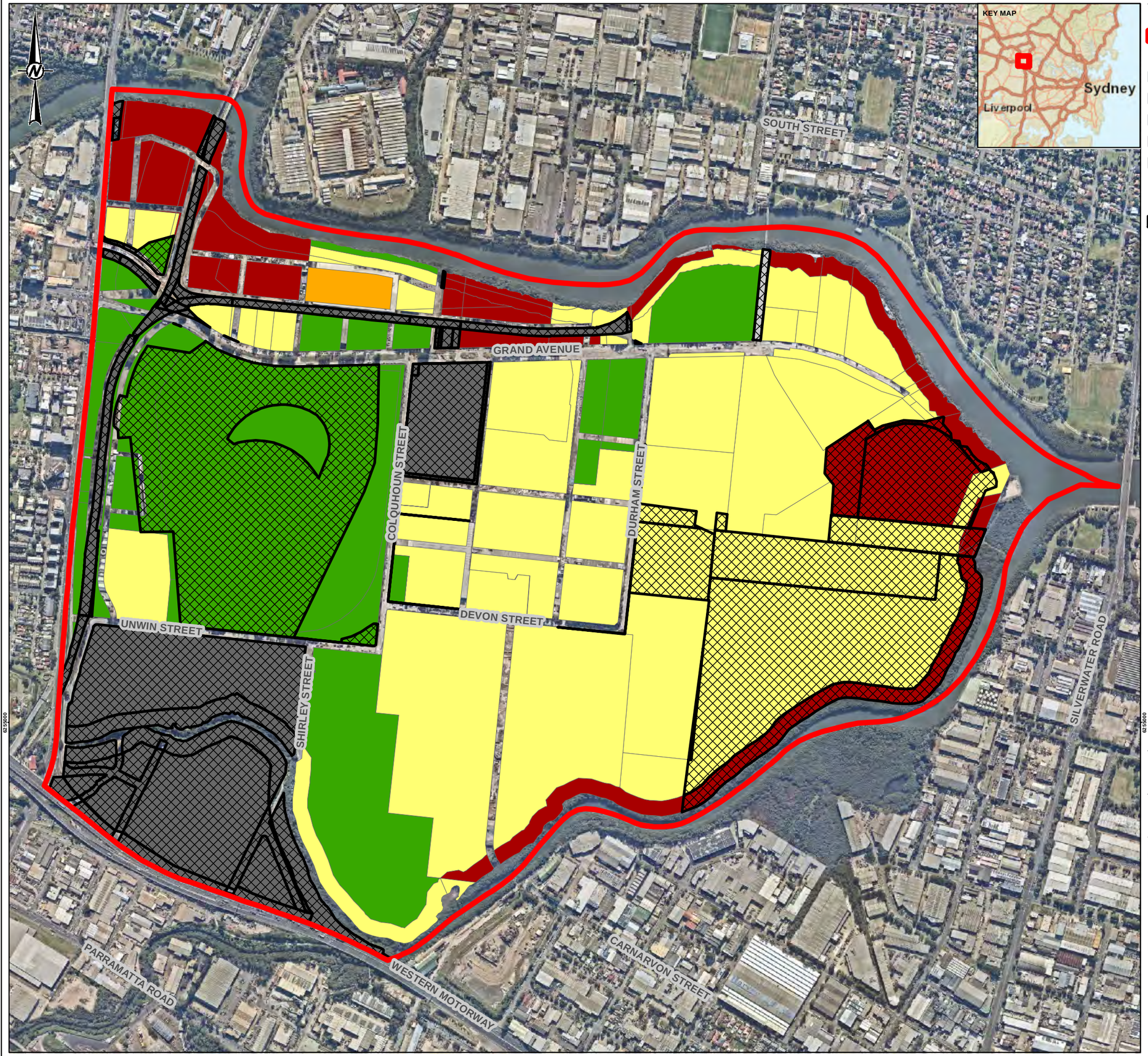
The outcome of this risk assessment is presented as Figure 4. The land uses highlighted as “likely” as would be expected to coincide with proposed land uses which are more sensitive such as high density residential, education and/or public open space.

Under the Master Plan the following observations regarding proposed land use implications for contamination management are noted:

- The proposed residential land use of 181 James Ruse Drive and 1 Grand Avenue sites are highlighted as land uses where remediation is “likely’ to be required. Remediation of these sites to accommodate

residential land use will be possible and assumes there is no requirement for access to soils associated with freehold residential land use.

- Setbacks have been created from the main watercourses to minimise potential flooding impacts to surrounding land. This creates an opportunity to improve amenity along the Parramatta River, Duck River and Duck Creek by providing recreational / open space areas. These more sensitive land use has resulted in the majority of these foreshore areas to be highlighted as “likely”.
- The proposed school located on the former Australian Kerosene and Mineral Company owned land (in the approximate position of what is now 11 Grand Avenue and occupied by Australian Pharmaceutical Industry (API) Pty Ltd) is highlighted as possible with some restrictions. The location of this school is similar to the location proposed in the DPE (2018) Town Centre Master Plan.
- The proposed residential and entertainment land uses west of the Rosehill Racecourse are highlighted as unlikely to require remediation. This may reflect the limited available contamination information available for this area and no history of heavy industry or landfilling in this area of the Precinct. The adjoining Carlingford rail corridor may however have contributed to some contamination requiring management. The absence of documented contamination in these areas does not preclude unexpected finds during future stages of development.
- The other areas of Precinct where remediation is “unlikely” principally relates to land proposed for existing ongoing land use. Here the assumption is that the contamination at the site is already remediated and/or managed to allow the existing land use, noting that this may not necessarily always be the case, or there is limited information on site contamination. Future modification or redevelopment of these sites would trigger contamination assessment and/or remediation under the land use planning process. These include the Boral site located in the northeast of the Precinct, selected land parcels located directly north and south of Grand Avenue and the former Capral Aluminium site.
- The majority of the other areas of the Precinct indicate remediation as “possible” which generally reflects the ongoing commercial/ industrial land uses and or documented contamination, where some level of remediation is warranted to accommodate a finer grained built environment.



LEGEND

- Camellia Precinct Boundary

Remediation Likelihood

- Likely
- Possible
- Possible with some Restrictions
- Unlikely
- TfNSW Metro and PLR Land
- Roads and areas within Scenario extents not included in a property
- Excluded from costing

GDA56 500

0 250 500

1:10,000 METRES

NOTE(S)
1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)
1. IMAGERY NEARMAP 2021

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY STAGE 3 REPORT AND COSTING

TITLE
CAMELLIA PRECINCT REMEDIATION LIKELIHOOD PREFERRED SCENARIO

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	07-07-2022
DESIGNED	DMN
PREPARED	DMN
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
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7.0 REMEDIATION COST ANALYSIS

7.1 Uncertainties in Cost Estimates

Estimates of the potential costs for the management of Precinct contamination reflect the current uncertainties in available contamination data, suitability and practicality of proposed remediation methods and the required time and cost required to manage the issues for the various redevelopment scenarios.

There is heterogeneity in the presence and extent of unacceptable chemicals and wastes in the soils and buildings across the Precinct, which is the result of:

- Over 100 years of industrial land use including chemical industries, oil refineries and asbestos product manufacture.
- The widespread use of fill across the Precinct.

There is therefore uncertainty in the nature and volumes of contaminated fill/soil to be managed or remediated, for example, uncertainties in the:

- The lateral extent and depth (volumes) of currently known contaminated fill/soil;
- Potential volumes of suspected and unknown contaminated fill/soil;
- Other sources of impacted materials, such as contaminated utilities, building demolition waste, underground storage tanks, transport features such as roads; and
- Degree of contamination (i.e., the types, concentration and commingling of contaminants present).

This uncertainty relating to the volume and heterogeneity of the contamination presents challenges for the selection of:

- Soil risk management and remediation strategies for the Precinct to meet the future land use objectives; and
- Selection of practicable remediation approaches for each waste type to deliver the overall strategy (consideration of technical, logistical, and cost factors).

Preparation of a risk-based soil remediation volume model was therefore undertaken to assist informing the feasibility of future land uses and development. Remediation volume estimates have been made using a risk-based analysis of the data considering uncertainty and the identified risks.

7.2 Cost Estimate Methodology

7.2.1 Semi-quantitative Screening Method

The principles for the semi-quantitative screening method were as follows:

- The high-level cost estimates were separated into the following categories:
  - Consulting costs.
  - NSW EPA Accredited Site Auditor costs.
  - Capping / redevelopment costs.
  - Hot spot soil remediation costs (e.g., UPSS, hot-spot removal).
  - Ongoing contamination management and/or monitoring costs.

- For each of the cost categories, a series of area-based rates was derived (refer to Appendix C for the detailed methodology, scope and key assumptions for deriving the rates).
- Each landowner parcel was assigned an area-based rate for each of the categories. Geospatial Information System (GIS) software was used to assist with this task, particularly where the Master Plan areas were overlayed on multiple landowner areas, or portions of landowner areas.
- The area-based rates selected for each landowner parcel were multiplied by the area of each respective landowner parcel to determine an overall cost estimate.
- Several areas were excluded from the cost analysis. These areas are identified in Figure 3, and are as follows:
  - The properties associated with the Parramatta Light Rail, including the Stabling and Maintenance (SaM) facility. Remediation works are already being undertaken at these properties.
  - The properties associated with the Clyde Sydney Metro West Stabling and Maintenance (SaM) facility. Remediation works are due to be completed as a part of the Sydney Metro West project.
  - The Rosehill Racecourse. No redevelopment, beyond recreational land use additions, is envisaged under the Master Plan.
  - Sydney Water pumping station. No redevelopment is envisaged under the Master Plan.
  - Viva terminal land (eastern portion). Ongoing heavy industrial uses are envisaged.

Lineal-meter rates for foreshore remediation activities were also prepared. These included soil remediation activities, but also groundwater treatment using a PRB along the Parramatta River foreshore. The rates cater for varying degrees of public access. This is reflective of the proposed accessibility requirements envisaged for the Master Plan. Rates were developed for three scenarios:

1) A foreshore area containing contaminated fill/soils (Figure 5 below – green). In these areas, it is assumed that access to the foreshore will be limited (e.g., raised boardwalks, fenced / restricted areas), which would reduce the risk of exposure.

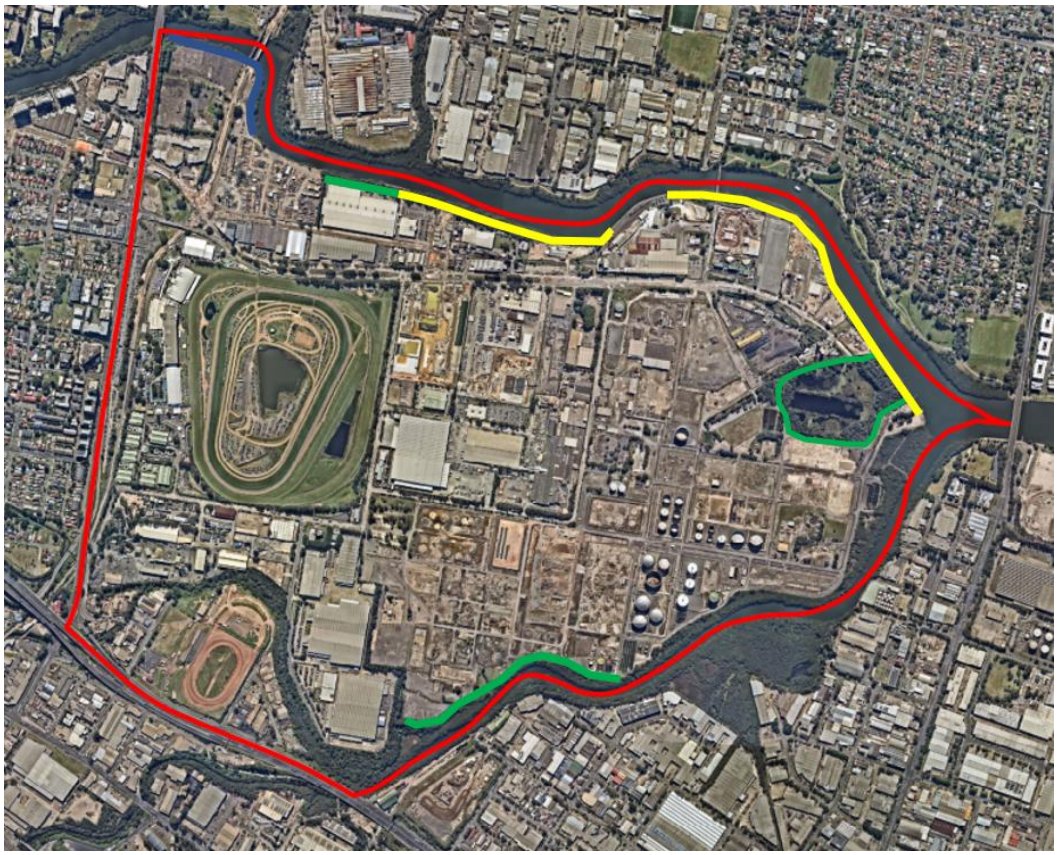
2) A foreshore area containing contaminated fill/soils, including soils that are grossly contaminated with asbestos (Figure 5 below – blue).

3) A foreshore area containing contaminated soils which is adjacent to sites with hexavalent chromium fill/soil leaching to stormwater and/or groundwater (including the construction of a PRB) (Figure 5 below – yellow). In some cases, where assessment data has not been reviewed, the extent of this treatment has been based on the assumed extent of hexavalent chromium contamination. It is worth noting that this rate does not include ongoing monitoring and maintenance that may be required for the PRB.

For Items 2 and 3 above, it is assumed that that full public access will be provided to the foreshore. These rates have been applied on a lineal meter basis, as indicated in Figure 5 below. The following assumptions / exclusions were made:

- The retaining wall at the foreshore on the 1 Grand Avenue site will be retained, and/or replaced with a similar (equivalent) structure and will maintain ongoing containment of documented asbestos impacts.
- The recently completed embankment stabilisation / remediation works carried out at 33A Grand Avenue will be sufficient, and no further work to remediate the immediate foreshore is required. Notwithstanding, further remediation work may be required in the 40-metre setback designated for open space in this area. The costs allocated to the setback remediation works are covered in the area-based costs described above.

- The remediation of the foreshore adjacent to the Viva Energy site has been excluded on the basis that public access will not be possible in the near future.
- The remediation of the foreshore Clyde Maintenance and Stabling Yard has been excluded on the basis that this will be addressed as part of the Sydney Metro West project.



(green: foreshore containing contaminated soils; blue: foreshore containing contaminated soils including gross asbestos impacts; yellow: foreshore adjacent to sites with potential hexavalent chromium)

Figure 5: Foreshore remediation cost allocation

Both the area-based rates and linear-meter rates for foreshore remediation activities are presented in Appendix C. This includes a detailed methodology, scope, and key assumptions for deriving the rates.

It is noted that the cost estimates presented in this report include potential costs associated with excavation works to support development, however they largely exclude costs associated with removal of excess spoil to support potential basements/ or inground structures/ services. The potential costs associated with a typical contaminated spoil disposal scenario where the development requires a single level basement is also included in Appendix C for reference. This costing does not include costs associated with groundwater management during and post construction.

Potential costs associated with the assessment and remediation of the wetlands to allow public access (raised boardwalks and viewing platforms) have also been presented in Appendix C. The scope of these works will need to be further refined in subsequent stages.

7.2.2 Probabilistic Cost Analysis

Golder used Monte Carlo analysis to further quantify uncertainties in the estimated costs. This is a type of probabilistic analysis frequently used to model systems and scenarios in which uncertainty exists and lets users account for risk in analysis and decision making. In a Monte Carlo analysis, probabilities are assigned to scenario outcomes. The model is then run many times (10,000 times in this case) and the model estimates the probability of a certain cost occurring. The program @RISK™ was used to carry out the Monte Carlo analysis.

The 'Low', 'Medium' and 'High' cost ranges developed from the semi-quantitative analysis (described in Section 7.2.1) were used to develop a continuous cumulative probability function for each individual site area. This allows the @Risk model to form a stochastic parameter input for the risk-based analysis. The risk analysis modelling program (@Risk) then estimates the contamination remediation and management costs by sampling the probabilistic functions for the contamination costs associated with each site area over 10,000 simulations of the model.

Key outputs from the model can be presented as both cumulative distribution curves and tabulated numerical data for the total contamination management costs and its modelled components. Cumulative probability curves that show on the X-axis the potential total contamination cost and on the Y-axis, the probability that the cost is not exceeded (as a %). The degree of uncertainty is reflected in the slope of the curve and the length of the tail. The smaller the uncertainty, the steeper the curve. The smaller the length of tail, the lower the risk of "outliers" that contribute to cost risk.

The key to the presentation of potential remediation costs in this manner is that the range of potential remediation cost exposures can be illustrated taking into account the range of uncertainties at the time of the estimate. The impact of inherent uncertainties can be seen, and the reader can determine the degree of risk in adopting a contamination management strategy or development scenario and implement risk management techniques focused on the risk drivers. In particular, the elements that are driving the cost uncertainty can be identified and targeted if required for additional strategy consideration or further investigation to reduce uncertainty to a level acceptable to the relevant stakeholders.

The described outputs are presented in Section 7.3.

7.3 Cost Estimate Summary

A summary of the indicative risk-based remediation costs is presented in Figure 6 below. It is noted that these estimates relate to the area-based items only and do not include foreshore remediation costs, which are summarised further below. The figure identifies that the estimated area-based remediation costs across the Precinct range from approximately $350M AUD to $550M AUD.

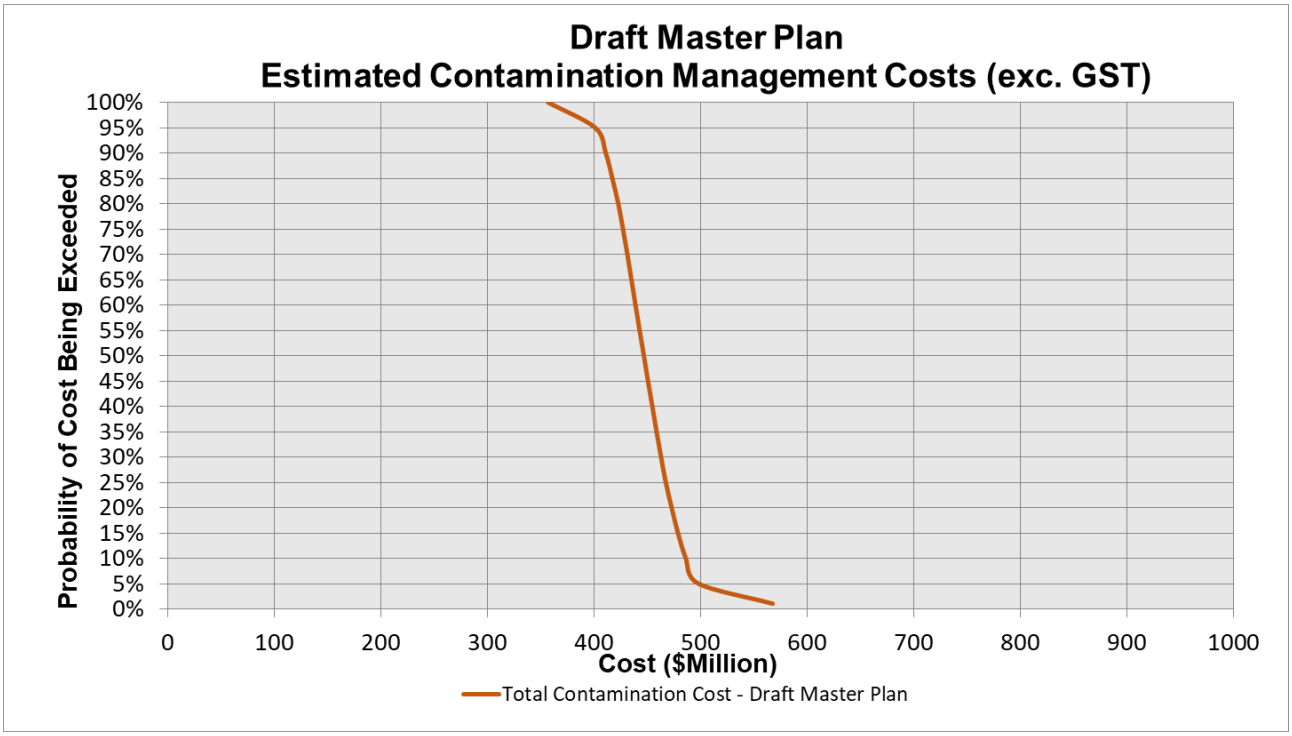


Figure 6: Summary of risk-based remediation cost estimates (area-based items only, does not include foreshore remediation)

A summary of the Master Plan costs associated with each remediation/management category is presented in Figure 7. The figure clearly illustrates that costs associated with the capping / development are highest. These costs are driven by an assumption that the raising of site elevations will be restricted in some areas to ensure compliance with flood management performance criteria. In some areas, surplus spoil will therefore be generated to accommodate the capping systems. This surplus spoil would require management through either disposal off-site as waste, or beneficial reuse[9] within the Precinct in a purpose-built containment facility (refer to Section 5.0). The outcome highlights the potential costs that will be associated with surplus spoil management in the Precinct.

Due to the flatter appearance of the capping / development cost curve, the figure identifies that these costs are also the most uncertain. The key factors contributing to this uncertainty include:

- The thickness of the capping layers identified in Section 5.0 and Appendix B.
- The quantity of surplus spoil that will be generated in order to accommodate capping whilst complying with Precinct-wide flood management performance criteria.
- For the surplus spoil generated, the proportion of spoil which is required to be disposed off-site as waste versus the proportion of spoil which may be suitable for containment on the Precinct within a purpose-built containment facility.
- For the surplus spoil designated for disposal off-site as waste, the degree of contamination and therefore resulting waste classification assumptions that are applied.
- The rates applied for the excavation, loading, haulage and disposal of wastes.

[9] Subject to relevant regulatory planning and approval.

It is noted that many of the uncertainty factors highlighted above could be improved through further site investigation, modelling and design optimisation.

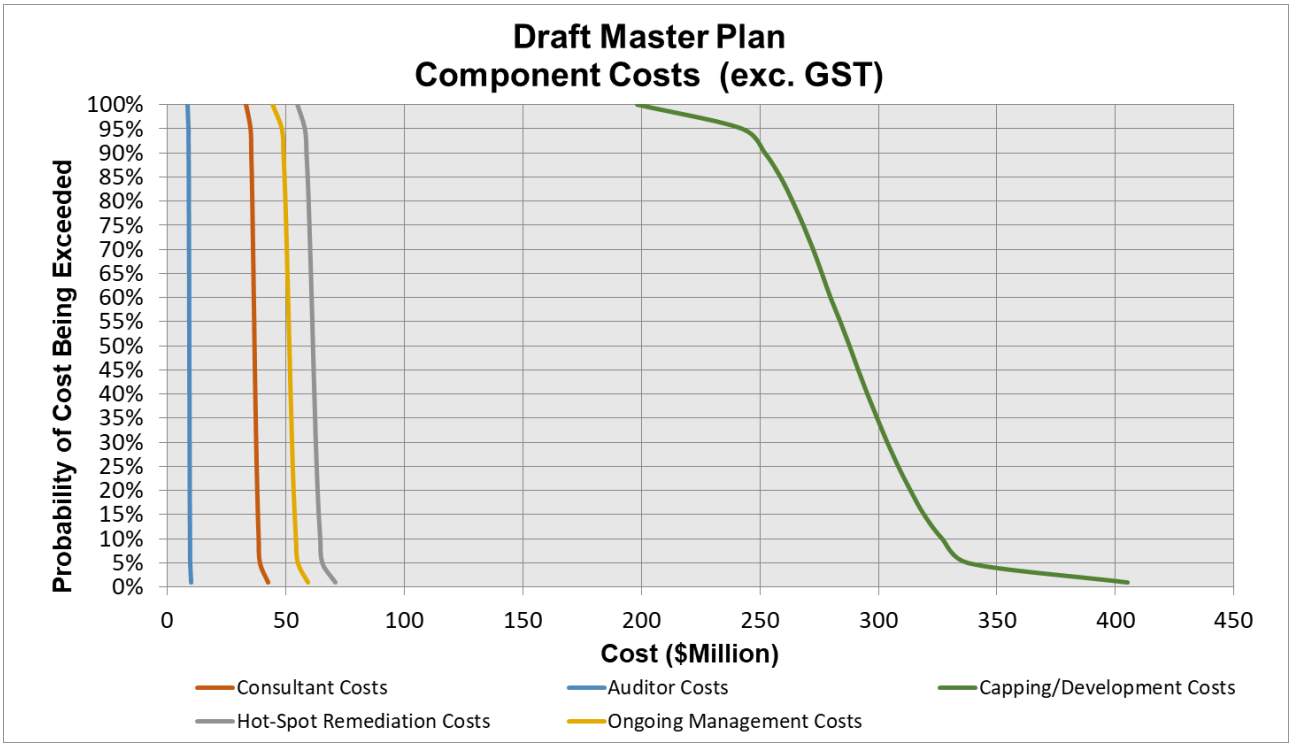


Figure 7: Master Plan cost estimates – by category (area-based items only, does not include foreshore remediation)

To distinguish between the remaining cost categories, a summary of the Master Plan costs that were less than $120 M is presented in Figure 8 below. The figure illustrates that the Site Auditor and consultant costs are the least expensive and the costs associated with the hot-spot remediation works and the ongoing management are more expensive. Notably, the ongoing management/ monitoring costs are comparable to the capital costs of the hot-spot remediation works[10]. This is an important point as it supports the concerns of stakeholders that prospective developers need to ensure that the relatively high ongoing costs are covered under appropriate funding mechanisms and that local authorities (e.g., Council) are not burdened with these ongoing costs.

[10] The modelled ongoing management costs presented in Figure 8 have been calculated as a Net Present Value across a period of 50 years applying a discount rate of 3% per annum. The annual area-based ongoing management costs range from $ 4,000 to $ 96,800 AUD ex GST / ha. Specific assumptions behind the annual ongoing management costs are presented in **Appendix C**.

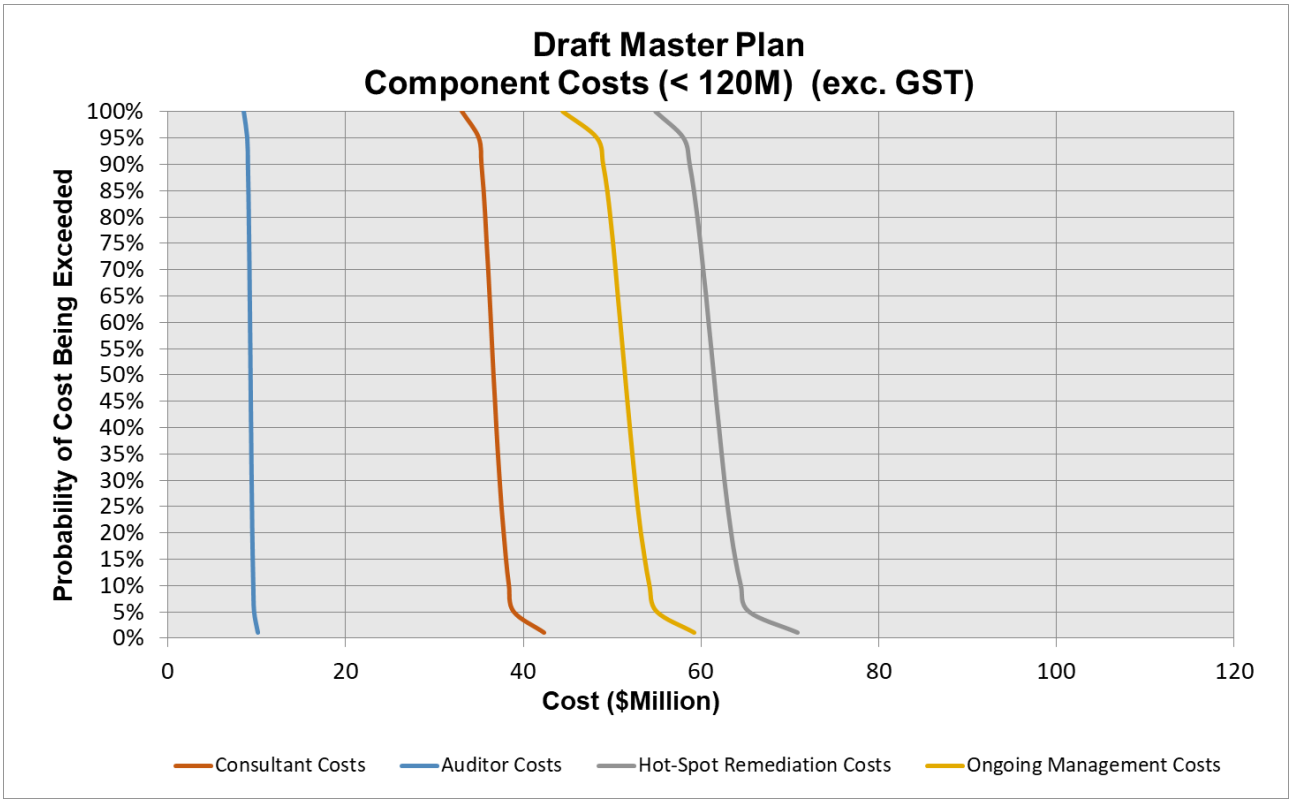


Figure 8: Master Plan cost estimates – by category (<$120M), (area-based items only, does not include foreshore remediation)

The foreshore remediation cost estimates are presented in Table 3 below. As expected, the costs allocated to the sites with hexavalent chromium contamination in groundwater were the highest. This is due to the costs associated with the construction of the PRB.

Table 3: Estimated Foreshore Capital Remediation Costs Estimates

Foreshore remediation category	Linear Meter Rate ($AUD / metre)			Approx. total length of remediation (m)	Cost Estimate ($AUD ex GST)		
	Low	Medium	High		Low	Medium	High
A foreshore area containing contaminated soils	1,600	1,900	2,500	2,000	$ 3.2 M	$ 3.8 M	$ 5.0 M
A foreshore area containing contaminated soils, including soils that are grossly contaminated with asbestos	6,100	7,600	9,900	800	$4.9 M	$ 6.1 M	$7.9 M
A foreshore area containing contaminated soils which is adjacent to sites with hexavalent chromium contamination in groundwater	11,600	14,400	18,800	1,800	$ 20.1 M	$ 25.9 M	$ 33.8 M
Total Estimated Costs					$ 28.2 M	$ 35.8 M	$ 46.7 M

8.0 GUIDING PRINCIPLES

Throughout this report a proposed Remediation Strategy is identified that is informed by several guiding principles. These guiding principles are expected to also inform the development of planning controls with respect to remediation and/or other contamination management activities completed within the Precinct. These guiding principles are summarised below:

- Ensure that land is assessed and remediated/managed so that the land is suitable for the proposed land use and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment.
- Ensure that the selected remediation technologies promote minimal disturbance and that the principle of waste minimisation is supported.
- Ensure that a Precinct-wide approach to remediating groundwater is adopted. Wherever possible, the primary control of source removal should, however, be adopted.
- Ensure staging controls are implemented that ensure that land use conflicts caused by remediation and/or contaminated land management activities are avoided.
- Ensure that remediation is coordinated with landscape and water management strategies (including flooding and water sensitive urban design) and infrastructure provision (i.e., utilities).
- Ensure that residual contamination liabilities are appropriately identified, apportioned, funded, and governed.

9.0 RECOMMENDATIONS FOR IMPLEMENTATION

During the EbD workshops, measures for implementing the proposed Remediation Strategy were discussed. These were discussed in consultation with various stakeholders including DPE, Council, NSW EPA, NSW Population and Health, Sydney Olympic Park Authority (SOPA) and other technical specialists and representatives from government agencies. Golder recommends the following implementation pathways:

- Establish governance mechanisms for Precinct-wide remediation and/or contamination management activities.
- Review options including treatment and reuse to accommodate surplus contaminated spoil (soil/fill) within the Precinct.
- Facilitate a Precinct-wide groundwater remediation approach.
- Establish planning controls to ensure that the Precinct is or can be made suitable for the Master Plan to enable rezoning decisions.
- Establish planning controls for the staging the remediation and/or contaminated land management activities to avoid land use conflicts.
- Facilitate “clean” infrastructure and/or vegetation corridors.
- Identify and apportion residual contamination liabilities.
- Prepare Precinct-wide documentation to support the future planning process.

These recommendations are described in further detail below.

Establish governance mechanisms

The Remediation Strategy outlined in this report relies heavily on the containment, and ongoing management of residual contamination. Ongoing management measures (typically documented in an Environmental Management Plan (EMP)) are implemented to ensure that the environment is protected, and users of the site are not exposed to residual contamination. For example, an EMP may:

- Restrict excavations in areas where contamination has been contained.
- Require that capping layers be regularly monitored and maintained.
- Require that vapour/gas management systems be incorporated into future buildings where unacceptable vapour or ground gas risks are present.
- Require that regular monitoring of groundwater and/or surface water be conducted to ensure that unacceptable levels of contamination are not reaching sensitive environmental receptors.

Failure to implement controls such as these may result in unacceptable impacts to human health and the environment. To ensure controls are implemented appropriately, the NSW EPA has mandated that EMPs are made legally enforceable. This can be achieved through several mechanisms (e.g., notices issued under the *CLM Act 1997*, or development conditions issued by a development consent authority). Notwithstanding, the NSW EPA has longstanding concerns about EMP enforceability for residual contamination, citing a lack of oversight and enforcement during the EMP implementation phase.

Implementing and enforcing management protocols in the Precinct will be challenging due to the heavily contaminated status of the Precinct, and reliance on ongoing management measures to ensure site suitability. Furthermore, management protocols will likely be applied for multiple land holdings and require compliance from dozens of landowners / occupiers / operators.

Future stages of the Precinct planning should consider establishing an overarching body to govern the management protocols across the Precinct. Governance bodies may include (but are not necessarily limited to):

- Establishing a new government agency (e.g., SOPA at Sydney Olympic Park).
- An owner's corporation that engages environmental consultants to assist with managing the land (e.g., Botany Industrial Park Corporation).
- A suitable agency could establish an internal division to oversee the implementation of management controls.
- Authority could be given to City of Parramatta to oversee the implementation of management controls

SOPA provides a good example of the level of effort and oversight required to successfully manage residual contamination issues on a Precinct level to ensure ongoing protection of human health and the environment. It is recognized, however, that establishing a new government agency will be a challenge due to the large allocation of private landownership in the Precinct. Adopting Precinct-wide management approaches can also be costly and, in the case of establishing a new government agency, may require legislative reform. Conversely, an overarching governance body could reduce burdens to individual landowners, ensure a consistent approach to the management of contaminated land across the Precinct, and ultimately should reduce unacceptable risks to human health and the environment.

Review options, including treatment and reuse, to accommodate surplus spoil (soil/fill) within the Precinct

Consistent with the Precinct-wide objective of minimising the generation of soil waste, options for on-site spoil containment facilities (mass filling / mounding) should be explored within the Precinct. The planning of these activities should consider the following aspects:

- Under the State environmental legislation, there is a fundamental difference between "waste management" under the *NSW Protection of the Environment Operations Act 1997 (POEO Act*) and "on-site containment" under the *CLM Act*. Planning proposals will need to demonstrate how on-site spoil containment facilities might comply with the Protection of the Environment Waste Regulation 2014 (the *POEO Waste Regulation)* and/or the *CLM Act*. If the contaminated spoil materials are removed from a landowner site for off-site management then they are effectively a "waste" material and require assessment and management under the provisions of *the Waste Regulation*. If the surplus spoil materials generated by the redevelopment are classified as "waste", proposals for the mass filling / mounding within the Precinct would effectively be treated as landfilling, and trigger requirements for lengthy consent/ approval processes (potentially including an Environmental Impact Statements (EIS) and/or an Environmental Protection Licence (EPL)). Conversely, the "on-site containment" of contaminated soil/fill materials is a management approach that is accepted under the provisions of the *CLM Act*. If the Precinct could be considered as one contiguous site, the practice may be considered as on-site containment and the provisions of *the Waste Regulation* may not apply. Other regulatory mechanisms to facilitate the "on-site containment" of soils within the Precinct might include application and approval for a Precinct-wide Resource Recovery Order (RRO) / Resource Recovery Exemption (RRE) under the *Waste Regulation*. Such an approval might be applicable to low level contaminated surplus spoil containment (e.g., materials classifiable as General Solid Waste under the *Waste Regulation*). Similar exemptions have, for example, been approved previously for State infrastructure projects (e.g., the excavated public road material exemption 2014 where select surplus spoil/ waste can be applied to land within a road corridor for public road related activities including road construction, maintenance and installation of road infrastructure facilities.).
- Noting the previous point, and due to the potential for exposure during the excavation and transportation of the surplus spoil, the type of contaminated spoil accepted in a containment facility is likely to be limited to low level contamination. For instance, materials containing hot spot contamination, asbestos, acid sulfate soils (ASS), or sulfidic ores may be unsuitable for containment, although ASS might be suitable following treatment. Noting that widespread "highly contaminated" soil/fill present across the Precinct, such restrictions could limit the amount of material that is suitable for placement.
- Filling / mounding could reduce flood storage and potentially result in flooding impacts. Containment sites would need to be selected with consideration to the Precinct-wide flood management strategy.
- The variable nature of soil/fill material can make predicting soil bulking factors and compaction rates difficult. Poor planning may result in large quantities of soils becoming "homeless" and consigned for unplanned and costly off-site waste disposal. A detailed cut/fill assessment would be required, supported with an adequate density of spoil assessment and classification data, to inform the planning process.
- The containment facilities would require ongoing management of the cap/barrier and residual contamination. This would need to be considered in land use planning, with various liabilities apportioned to appropriate landowners/ stakeholders.

- There are many examples of where creating on-site containment facilities has been a success. These examples, however, are typically on contiguous sites with common landownership (e.g., linear infrastructure projects, Sydney Olympic Park). This activity would be a challenge from a staging perspective as it relies on an extremely coordinated approach from multiple developers and containment facility operators.
- Subject to identifying an appropriate site for containment, consideration should be given to prioritising the management of surplus spoil from public sites designated for clean-up (e.g., schools, open space) in this facility. This may reduce the cost burden of remediating the public sites and ensure that no private landowner receives preferential treatment. Some of the proposed public sites are likely to generate spoil of more appropriate quality than others and this should be considered as part of the Precinct-wide planning process. For example, the racecourse has a low risk of contamination whereas the 181 James Ruse Drive site has a high risk of contamination (refer to Figure 2).

Facilitate a precinct-wide groundwater remediation approach

The proposed Remediation Strategy documented in this report includes Precinct-wide strategies to manage groundwater contamination. Adopting Precinct-wide approaches would be substantially more effective and cost-efficient than adopting piecemeal approaches for individual landowner / development sites. The adoption of Precinct-wide approaches is constrained by the presence of multiple-landowners and conflicting land uses across the Precinct. Many landowners are likely to resist a change in the short to medium term, creating future land use conflicts as sites redevelop.

Delivering a Precinct-wide groundwater remediation approach in the north-eastern area of the Precinct would be particularly challenging. As noted in this report, this area would benefit from broad-scale hexavalent chromium (and chlorinated hydrocarbon) groundwater treatment using an PRB along the Parramatta River foreshore. Previous attempts to deliver a similar holistic remediation approach were unsuccessful as the current land values and land uses did not support the feasibility of these approaches. Transitions to higher-yield land uses, as proposed along the Parramatta River, might provide an opportunity to deliver these remediation works. Funding studies would need to consider how these challenges are overcome. The Master Plan identifies that the PLR Stage 2 alignment traverses the foreshore of the Parramatta River. If this infrastructure project proceeds, this may present an opportunity for delivery and funding of foreshore remediation works (or part thereof) during its construction.

In addition to the benefits that a holistic remediation approach would deliver to individual landholdings, a Precinct-wide groundwater remediation approach would ultimately contribute to improved water quality in the Parramatta River and have broader societal benefits. This may create an opportunity to access alternative sources of funding beyond typical contributions from landholders and developers.

Regulators may also have a role play in encouraging site owners to "*get their house in order*" and promote group collaboration. The individual site operators will often be the owners of the site and the associated contamination legacy issues. These operators have the best knowledge and resources to address contamination issues while they have time between current operations and potential future redevelopment opportunities. The earlier some contamination issues are considered, the more options that may be available and often the issue can be treated at a lower cost.

Setbacks have been created from the main watercourses to minimising flood impacts to surrounding land. Future planning should also give consideration to the creation of easements within these setbacks for the future installation and maintenance of a PRB or other groundwater remediation technologies along the foreshore. The location and size of the required easements would be determined as part of the remediation design process.

Establish planning controls to ensure that the Precinct is or can be made suitable for the Master Plan to enable rezoning decisions.

None of the Precinct land can be rezoned until the obligations under Ministerial direction (No 2.6) Remediation of Contaminated Land are met. In accordance with this direction, in order to support any rezoning proposal for the Precinct there will be a requirement to demonstrate that land within the Precinct is or can be made suitable for the proposed land use. The Master Plan will need to ensure that land is assessed and remediated/managed so that the land is suitable for the Master Plan and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment. Where possible remediation of contamination in the Precinct needs to be facilitated. It is noted that the suitability status of the Precinct for the Master Plan has not yet been established. This would be determined in future stages of the planning and would need to be considered in the development of the Precinct-wide documentation described below.

Establish planning controls for staging the remediation and/or management activities

During the development of Homebush Bay and the Rhodes peninsula, individual sites for high density residential land use were developed and occupied and conflicts arose as adjoining sites were remediated and redeveloped. To prevent similar land use conflicts, there should be controls on staging of any proposed broad scale remediation activities within the Precinct. These controls should be developed to promote staging priorities for major remediation and redevelopment activities, such as a mechanism whereby development of selected sites may be restrained or controlled to account for future potential remediation impacts on adjoining land. It is expected that remediation staging planning controls would be investigated in subsequent phases of the planning implementation.

Prioritising sites with the highest contamination risk and maximum anticipated disturbance footprints is recommended. These areas would have the greatest potential to create land use conflicts because of the anticipated remediation activities, should they adjoin more sensitive land uses. For example, remediation works might be prioritised on the sites identified as having high risk contamination such as the 181 James Ruse Drive and 1 Grand Avenue properties, whilst the surrounding areas are still occupied by less sensitive commercial / industrial land use.

Areas designated for recreational open space could also be prioritised as these areas could potentially create buffer zones for more sensitive land uses from active remediation sites. For example, with reference to Figure 2 in Section 1.0, if completed first, the open space / public recreational area north of Grand Avenue could form a buffer between sensitive developments completed to the west, and remediation activities completed in the urban services area to the east.

As noted above, the construction and operation of potential on-site soil containment facilities should also be considered in the development of Precinct-wide staging controls.

Facilitate clean infrastructure and landscaping corridors

As noted previously, the Remediation Strategy relies on capping and management protocols to reduce the likelihood of future site users being exposed to residual contamination. Some of these management protocols may be overly restrictive in areas that require regular sub-surface access for maintenance purposes (e.g., service corridors, landscaping areas).

The planning process should consider providing for the creation of clean infrastructure and landscaping corridors. These corridors would be areas designated for semi-regular sub-surface access for infrastructure or landscaping purposes.

The design and placement of landscaping corridors would be carried out in consultation with landscaping specialists and consider the ideal type of vegetation required for each area, including its irrigation requirements. Excessive irrigation requirements have been known to be problematic on other contaminated redevelopment. In these areas, clean surface soils would also provide increased separation from underlying contaminated soils and reduce the likelihood of exposure when planting, or due to penetrations from deep-rooted vegetation. The experiences of similar developments such as Sydney Olympic Park should be referenced in landscaping design in areas of residual contamination.

Infrastructure corridors could be either co-located with existing infrastructure corridors (e.g., along pipeline easements) or be incorporated into the design of new infrastructure built for the Precinct. These corridors could take various forms but would be designed to ensure minimal soil disturbance is permitted following the completion of the remediation / redevelopment works. For example, the service corridors designs could consider lined concrete service channels, clean-soil buffers around sub-surface conduits, or opportunities for above-ground conduits.

Sub-surface utilities infrastructure (pits, conduits, trenches) should be designed to prevent ingress of groundwater or vapour and minimise the interaction between maintenance workers. Groundwater and vapour migration and accumulation in service lines could result in potential explosion and/or vapour inhalation risks.

Identify and apportion ongoing contamination liabilities

As noted throughout this report, the proposed Remediation Strategy relies heavily on the containment, and ongoing management of residual contamination which will create ongoing financial and legal liabilities. How these liabilities are apportioned to future parties (e.g., developers, landowners, local authorities) will need to be carefully planned. For example, the Master Plan identifies several areas designated as open space which may be accepted and maintained by Council. Council has expressed that it would be reluctant to accept any land that is burdened with financial and legal contamination liabilities. As far as possible contamination labilities will need to be apportioned through appropriate contractual and funding mechanisms.

Prepare precinct-wide documentation to support the planning process

Precinct-wide planning documentation should be prepared to assist in facilitating several of the previous recommendations. These documents could include (in hierarchical order):

- **Precinct specific Development Control Plan (DCP) or a standalone Contamination Land Action Plan (CLAP):** This is recommended to ensure that land is assessed and remediated/managed so that the land is suitable for the proposed use and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment. The NSW EPA has previously cited a need for a CLAP which does not substitute legal obligations of *CLM Act* and *SEPP 55* but underpins the Master Plan by providing the community, landowners, development industry and government with a clear strategy that includes information, guidance, expectations in relation to land contamination and its management to inform redevelopment of the Precinct. This Plan should identify Precinct specific contamination risk factors both during and post construction. The EPA has noted that particular emphasis should be on areas of Precinct extending to waterways and foreshore areas identified for public recreational land use. The CLAP might also include: Precinct-wide staging strategies; management of contaminated groundwater and/or stormwater associated with land; and management of waste to guide remediation.

- **Prepare a Precinct-wide Concept Level Remediation Strategies:** There is an opportunity for future development control plans prepared for the Precinct (noted above) to be informed by a Precinct-wide conceptual Remediation Action Plans (RAPs) which would identify a preferred approach for managing contamination across the Precinct. Each concept RAP could be reviewed by an NSW EPA Accredited Site Auditor to establish suitability. There are good examples of similar concept RAPs having been prepared for the other Sydney precinct developments including: the Wentworth Point Precinct DCP 2014; and the site-wide remedial concept plan prepared for the Bays Precinct Urban Transformation Area. These concept RAPs would:
  - Support rezoning of the Precinct for a range of land uses.
  - Supporting planning and documentation of future applications for individual sites within the Precinct.
  - Facilitate a co-ordinated approach to remediation/management of site contamination issues during future development of individual sites.
- **Precinct capping and containment strategy**: A Precinct-wide capping strategy should be developed in unison with a Precinct-wide flood management strategy. Detailed flood modelling would need to be undertaken to identify suitable cut and fill areas and where filling can occur that meets flood management performance criteria for the CRPS (minimising the flooding impacts beyond the Precinct). The strategy could also identify the quantity and location of possible on-site containment facilities. This could be supported by a detailed cut and fill assessment to avoid surplus soils becoming “homeless” during the redevelopment works and requiring costly off-site disposal. The strategy would need to consider and accommodate features within the precinct that have a fixed elevation (e.g., PLR or existing roadways).
- **Precinct-wide Hydrogeological and Groundwater Quality including but not limited to chromium, chlorinated hydrocarbons (e.g., DNAPL), petroleum hydrocarbons (e.g., LNAPL); and Chromium and Asbestos Waste Fill Summaries:** The collation of Precinct-wide summaries could assist with the characterisation of regional properties and conditions that need to be considered by planning authorities, environmental consultants, land developers and/or Site Auditors as part of their assessment of land suitability for its intended use.

  The types of information that should be considered in the groundwater quality summary include regional hydrostatigraphy, groundwater flow system and direction(s), background chemistry and quality of the shallow and deeper aquifer units across various part of the Precinct.

  The types of information that should be considered in the fill include hexavalent fill/soil contamination concentration, depth and extent data and asbestos in soil and/or buried asbestos type, depth and extent. Where possible the summary should also include visual and physical descriptions.

  These summaries would draw upon the large volume of existing contamination information prepared for individual sites. This information could be made public to environmental consultants and land developers. As further information is collected as part of public documents, such as DAs or Site Audit Reports this information could be collated and managed by a single public entity. There may be confidentiality issues associated with some of the existing studies, but there are already large volumes of information in the public domain associated with previous planning approvals. A similar summary was prepared as part of a regulation project completed by the NSW EPA (2010) (then the DECCW) in 2007 and summarised the known James Hardie asbestos contaminated sites/ areas across Sydney.

  The findings of the groundwater and soil summaries could be used to support a strategic, Precinct-wide approach to addressing groundwater contamination and present an opportunity to improve the water quality in the Parramatta River and Duck River.

The information from both summaries could also be used to inform concept Remediation Action Plans (RAPs) (see above).

The summaries could also have the following additional benefits:

- Assist with the fast tracking of site assessments and Site Audits as part of sub-Precinct scale redevelopment.
- Potential to reduce some of the contamination related costs for developers. For example, this may have benefits in the eastern portion of the Precinct where there is a high-density of small individual sites where hexavalent chromium impacted groundwater is currently being addressed by individual landowners using a piece-meal approach. A Precinct-wide study to develop a remediation strategy for hexavalent chromium impacted soil and groundwater would be substantially more effective and cost efficient than current independent approaches.

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APPENDIX A

Alternative remediation technologies available

IMMOBILISATION

Geochemical Fixation / Stabilisation

Geochemical fixation and stabilisation is the addition of chemicals or materials that bind or convert the contaminants into a form that is less mobile or less harmful to human health or the environment. It is a developed and commercially available technology, though is applied more commonly to metals and recalcitrant organic contaminants than readily degraded organic compounds for which there are other remediation options. The physical nature and handling characteristics of the waste are not necessarily changed by fixation/stabilisation.

Geochemical fixation is a well-developed technique used to treat hexavalent chromium (Cr (VI)) by adding chemicals that either directly or indirectly reduce Cr (VI) in groundwater and contaminated soil to Cr (III) which is less toxic, relatively insoluble and is fixed onto aquifer solids under typical conditions. Typical reagents include naturally occurring reducing agents such as ferrous iron, zero valent iron, sulphur, organic matter and calcium polysulphide. Microbes in the subsurface can also reduce Cr (VI).

Fixation can also be used to treat arsenic and other metals, though typically oxidising conditions are necessary, which may not be compatible with fixation of hexavalent chromium (which requires reducing conditions).

Fixation/stabilisation is either applied by mixing reagents with excavated contaminated materials or mixing or injection of liquid reagents into the ground. Methods are available for immobilisation of most identified inorganic contaminants, though it is less effective for Cr (VI), arsenic, mercury (if present) and is not suitable for asbestos and volatile hydrocarbons. Immobilisation methods may not be compatible and there is unlikely to be a single method that is suitable for all contaminants. Stabilisation can be relatively inexpensive to perform on excavated materials and in the ground, though this is highly dependent on the subsurface conditions (i.e., the ability to get the reagents into the ground in the desired locations).

The main issues for application within the Precinct will include accessibility, ability to achieve effective treatment in the ground, uncertainty of durability of treated materials and uncertainty whether effective treatment of areas impacted by multiple contaminants can be achieved.

Solidification

Solidification is the addition of binders or materials to physically change the structure of a waste so that contaminants are immobilised within the waste, usually in a ‘solid block’. Contaminants are not removed or destroyed. Solidification usually occurs in conjunction with stabilisation.

Vitrification

Vitrification is a high temperature process designed to immobilise contaminants by incorporating them into a vitrified matrix (i.e., ‘melts’ the contaminated soil) formed in the process which is durable and leach resistant. Vitrification can be applied to excavated materials and in the subsurface bypassing electric current through the impacted materials. Due to the associated significant energy use and high cost, vitrification is generally more suited to small sites or heavily contaminated sites with no other remediation alternatives.

Vitrification can be applied to most soils and most identified contaminants. Inorganic contaminants would not be removed. Petroleum hydrocarbons, other organic compounds and mercury (if present) would be removed via volatilisation (i.e., turned into vapour) or degradation. However, control and treatment of vapours produced would be required.

The main issues for application within the Precinct will include accessibility, high cost, high energy use, vapour issues during remediation, and durability of vitrified materials. Asbestos, Cr (VI), arsenic and other metals would not be removed, though organic contaminants would be degraded or destroyed.

CHEMICAL TREATMENT

Chemical treatment involves the addition of chemical reagents into the ground or to excavated soil to degrade/transform contaminants to harmless products. Although the chemical reagents treat the contaminants in groundwater, it also treats soils. Commonly a contaminant 'rebound' effect occurs, which means that several reagent applications are required.

Categories of chemical treatment include:

- Chemical oxidation – oxidants, such as oxygen, peroxide, persulphate, permanganate and chlorine compounds, destroy many types of organic compounds including chlorinated hydrocarbons, petroleum hydrocarbons, BTEX and PAHs. Oxidation of metals to transform them to an immobile form is also possible.
- Chemical reduction – reductants, such as calcium polysulphide, ferrous sulphate and zero valent iron, can be used to reduce Cr (VI) to Cr (III).

Chemical treatment is not suitable for asbestos and some heavy-end recalcitrant hydrocarbons.

Chemical oxidation of organic contaminants is a developed and commercially available technology. Chemical reduction of chromium is also a commonly used technology. Processes are rapid and robust; however, the main issues with this technology are potential geological constraints which mean it may be difficult to get chemicals into the ground in the desired areas, and changes to ground structure. Chemical treatment is most applicable to contaminants in the saturated zone.

A chemical treatment system may incorporate a series of injection wells or points for addition of reagents. Although the treatment process is rapid, typically a minimum of three applications are required. Chemical treatment is most efficient when applied to the contaminant source area but can be used to treat a groundwater plume. Systems are relatively flexible in terms of accessibility, requiring minimal space.

Chemical oxidation may potentially be effective for treatment of organic contaminants, while chemical reduction may be effective for treatment of hexavalent chromium. Due to the different treatment mechanisms application to multi-contaminant groundwater plumes would be difficult in parts of the Precinct. Although the treatment process is rapid and robust, consideration would need to be given to 'rebound' of contaminants, potential changes to ground conditions and handling of the chemicals.

BIOREMEDIATION

Bioremediation is the use of certain microbes (bacteria, fungi and archaea) to either directly degrade or consume a contaminant, or change the ground conditions to reduce the mobility or form of a contaminant. Thus, bioremediation can result in removal of contamination from a site or change it to a less harmful form. Typically, reagents or conditions are changed to optimise conditions for biological growth and remediation of contaminants. This may include addition of food (e.g., carbohydrates), nutrients, or other essential compounds (called electron donors or electron acceptors).

Bioremediation is a well proven technology for many volatile organic hydrocarbons, but is less well developed for heavy end organics and metals. Bioremediation is generally inexpensive relative to more active methods, but can be slow and generally needs significant work to show 'proof of concept'. While when first developed bioremediation was thought to be best suited to treating low levels of contamination, it is now recognised that in many cases (e.g., for organic compounds) bioremediation is best suited to treatment of high levels of contamination.

Bioremediation can potentially be used for the following Precinct contaminants:

- Hexavalent chromium can be treated by addition of organic matter (such as molasses) into the ground so that reducing conditions are created and Cr (VI) is transformed to Cr(III);
- Chlorinated hydrocarbons and some heavy-end petroleum hydrocarbons and PAHs will degrade under similar conditions;
- BTEX and light-end petroleum hydrocarbons under certain conditions (generally when there is oxygen in the groundwater); and
- Bioremediation of other metals is possible but less common.

Bioremediation of soils typically involves either land farming of soils or construction of soil biopiles with the addition of nutrients and/or oxidising chemicals to assist in the breakdown of contaminants. Land farming usually involves excavating, stockpiling, turning and mixing soils. This process is limited where there is a presence of asbestos. Bioremediation using constructed biopiles can either be passive or active. Contaminated soils are placed in above ground stockpiles and slotted pipes are run through the pile, which is covered with a plastic membrane. Passive systems rely on natural convective currents to circulate air though the pile, active systems involve air being driven through the system. In the active system the air may also be heated. Biopiles are more suited to treatment of hydrocarbon impacted soils cross contaminated with asbestos as there less potential for fibre release as it is a covered system.

A groundwater bioremediation system may incorporate a series of injection wells or a Permeable Reactive Barrier (Section 4.2.3 in report) for addition of reagents. Some systems may also incorporate groundwater pumping to speed up the remediation process. Application can either be to target contaminant source areas or to treat a groundwater plume. Systems are relatively flexible in terms of accessibility, requiring minimal space.

Bioremediation may potentially be effective for treatment of light-end organic contaminants, chlorinated hydrocarbons and hexavalent chromium. At the Precinct it is probably most suited to the treatment of light-end organic contaminants in soils. Due to the different conditions required for the various contaminants, application of bioremediation to multi-contaminant groundwater plumes would be difficult in parts of the Precinct. The potentially long-time frame and need to show ‘proof of concept’ of remediation must be considered in land use planning.

PHYTOREMEDIATION

Phytoremediation involves the use of plants to remove, degrade, contain, or take up contaminants in shallow soils and sediments. Some deep-rooted plants (including some eucalypts) can be used to take up groundwater to provide hydraulic control of a groundwater plume in a similar method to pump and treat. The plants may also help with erosion control and controlling rainfall runoff.

Application of phytoremediation at the Precinct could potentially be used in conjunction with other remediation technologies as a passive, sustainable low-cost method of managing low-level residual contamination in shallow soils.

SOIL VAPOUR EXTRACTION

Soil Vapour Extraction (SVE) removes contaminants, in the form of vapours, from the soil above the groundwater table (i.e., the unsaturated zone). Vapours are the gases that form when volatile organic contaminants or mercury evaporate. The vapours are removed from the ground by applying a vacuum to extraction wells in the ground to pull the vapours out for treatment. SVE is a developed and commercially available technology for volatile organic contaminants.

SVE systems typically are operated for medium duration (of the order of a year), though this can vary significantly depending on the contaminant and soil conditions and may require several treatments ‘cycles’. SVE is often used in conjunction with thermal treatment, air sparging and multi-phase extraction (Section 4.2.5 in report) to improve treatment time and efficiency.

An SVE system would comprise of an array of vacuum wells to extract soil vapours, a cap to seal the ground surface and a vapour treatment system. SVE is applicable to volatile organic compounds (e.g., BTEX, light-end petroleum hydrocarbons, light-end PAHs, and many chlorinated hydrocarbons) and mercury (to a lesser extent). SVE is not suitable for treatment of heavy-end organic compounds, chromium, metals, or asbestos.

This option would be limited for application within the Precinct by site access restrictions, need for a vapour treatment system and subsequent regulatory approvals.

AIR SPARGING / IN-WELL AIR STRIPPING

Air sparging uses air to help remove vapours from contaminated soil and groundwater below the water table. The air helps volatilise certain contaminants, which can then be removed using SVE. Air is pumped underground using air sparging wells, with air and vapours extracted using an SVE system. SVE and air sparging are often used at the same time to clean up both soil and groundwater.

In-well air stripping is a type of air sparging that helps volatilise certain contaminants in groundwater within a well.

THERMAL TREATMENT

Thermal remediation methods work by heating contaminated soil and groundwater. The heat can destroy or volatilise (turn into a gas) some types of contaminants or can help mobilise compounds in the ground so that they can then be removed by collection wells for treatment. Thermal methods are generally expensive as they have significant energy requirements and produce secondary waste streams, but they can be cost effective when used to remediate source areas where non-aqueous phase liquids (NAPLs) may be present and treat compounds which are bound strongly to the soil and cannot be easily remediated otherwise.

Thermal treatment can be conducted on excavated soils (ex situ) or in the ground (in situ). Ex situ methods include high temperature incineration (typically exceeding 500°C), whereby organic compounds are ‘burnt’ and destroyed, and thermal desorption using retorting or rotary kiln systems. In situ methods generally use thermal desorption using steam, hot water or electricity, which operate at relatively low temperatures (typically 100 to 300°C) to volatilise and degrade contaminants, with the gases captured and treated aboveground.

A soil vapour extraction system and sometimes a way to control groundwater flow (either subsurface barrier or pump and treat) are necessary.

Ex situ thermal treatment of excavated soils requires a thermal plant and vapour treatment system. Treated soils can often be reused on-site. In situ systems require an array of heater wells and vapour collection wells installed in the ground, a surface cap to help capture vapours and a vapour treatment system. Due to high energy requirements, large system may require significant associated infrastructure to be developed (e.g., high voltage electricity supply).

Thermal treatment would be potentially applicable to petroleum hydrocarbons, BTEX, PAHs, chlorinated hydrocarbons and mercury. Chromium, metals, and asbestos are not suitable for thermal treatment.

While thermal treatment is generally effective at achieving low residual contaminant levels and could likely treat to residential land use criteria, these technologies are expensive, of low sustainability values and have inherent risks from managing vapours and potential to further spread contaminants if not controlled properly.

Thermal options within the Precinct would be limited by site access restrictions, need for vapour treatment and require significant regulatory and planning approvals. While there are currently several commercial ex situ thermal systems being developed in Australia, there is limited in situ thermal treatment technology.

SOIL WASHING / FLUSHING / SOLVENT EXTRACTION

Soil flushing is used to mobilise organic compounds or metals in the ground by leaching contaminants from soils so that they can be extracted without excavating the contaminated materials. It can be used to enhance pump and treat remediation. A flushing liquid (commonly water, acid/base, surfactant or a solvent) is injected into or applied onto the area of contamination to mobilise the contaminants. There are various methods of application. After contact with the contaminated material, the flushing solution and contaminants are collected using a pump and treat system for disposal or treatment.

Soil flushing has been applied to organic contaminants, but is not well developed for application to metals.

Solvent extraction can be suited to treatment of organic chemicals that are strongly bound to soils (such as some heavy-end hydrocarbons) if they are not treatable via more cost-effective ways.

Soil washing is similar to soil flushing but applied to excavated soils. Soil washing of excavated soils would require a slurry mixing process. Management of treated slurries would be required and likely take considerable effort. Soil flushing involves addition of water or a solvent using surface flooding, sprinklers, injection wells, or infiltration systems.

Soil flushing can be used to optimise pump and treat systems. However, given that many of the identified contaminants at the Precinct may be treated using alternate methods, and significant chemical use would be required, potential application would likely be limited to small areas.

PHYSICAL SEPARATION

Physical separation is an ex-situ process that attempts to separate contaminated material from the rest of the soil matrix based on physical characteristics of the contaminant or soil. Methods include washing, screening and gravity methods. Physical separation works best when contamination is associated with a particular soil type, e.g., many contaminants are found to bind more strongly to very fine soil particles and not large soil particles, and so can be separated somewhat on this basis. Physical separation is generally used as a pre-treatment process as part of another ex-situ remediation method such as thermal treatment or chemical treatment.

EMERGING TECHNOLOGIES

Most of the identified contaminants have been recognised as compounds of concern for many years and, as such, the identified remediation technologies are relatively mature. This means that although improvements in our understanding of the science involved and application of these technologies will likely continue, improvement will be incremental and it is unlikely that completely new techniques will be developed.

Changes to non-technology based remediation factors may be just as significant as the effects of potential improvement to remediation technologies. These include reduction in remediation costs due to increased competition, increase in land value, changes to community attitudes, and regulatory and policy changes.

Nevertheless, several technologies that may offer significant development in the future are described below.

Nanoremediation

Nanoremediation involves the use of nano-scale reagents and materials, and has received considerable attention in recent years. Nano-scale chemical reagents and materials held much promise when first developed as they tend to be more reactive and effective than micro- or macro-scale equivalents. However, effective application of nano-scale products to remediation of soil and groundwater has since shown to be difficult due to the high reactivity. Nevertheless, improvements in the application of nano-scale reagents are likely.

Bioremediation

The understanding of bioremediation, including identification of microbes capable of degradation of specific compounds and genetically enhanced microbes, may improve the performance of bioremediation for treatment of recalcitrant organic compounds. Bioaugmentation – the addition of cultured microbes into the subsurface to enhance degradation processes – may also be improved.

Electrokinetics

Electrochemical / electrokinetic recovery is an in-situ process in which an electric field is applied across a section of contaminated soil or other material so encouraging the migration of contaminants towards one of the electrodes from where that contaminant can be recovered. The conductive medium is groundwater or an externally supplied fluid. Recovery would be undertaken using groundwater extraction. This technology may be applicable to chromium and other metals in sediments and clays.

APPENDIX B

Typical capping profiles

GOLDER
MEMBER OF WSP

Camellia-Rosehill Place Strategy

IMPLEMENTATION REPORT
INDICATIVE CAP TYPES

June 2021

Indicative Cap Types

INTRODUCTION & ASSUMPTIONS

These slides contain a summary and sketch of each indicative cap type to be included in the remediation strategy prepared for the Camellia-Rosehill Place Strategy (CRPS). These have been prepared to inform:

- Preliminary cost estimates for remediation activities on the Precinct.
- Preliminary assessment of likely fill requirements due to capping. This will inform the Integrated Water Cycle Management Strategy (IWCMS) prepared for the CRPS, and specifically the flooding assessment component of the IWCMS.

The following assumptions have been made in the development of these indicative cap types:

- These cap types are indicative estimates and based on our current outstanding of the contaminants present on the Precinct and our previous experience implementing management controls to mitigate risks associated with those contaminants. Further investigation and assessment would be required to refine these indicative cap types prior to the redevelopment of any land parcel.
- The cap types assume that vapour and gas protection measures will not be required in open space / recreational areas.
- The capping/cover thicknesses do not account for excess soils that will be generated from the site redevelopment (footings, services, excavation to achieve levels etc.). I.e. Further "*air space*" may be needed to accommodate these components.

Indicative Cap Types - Summary

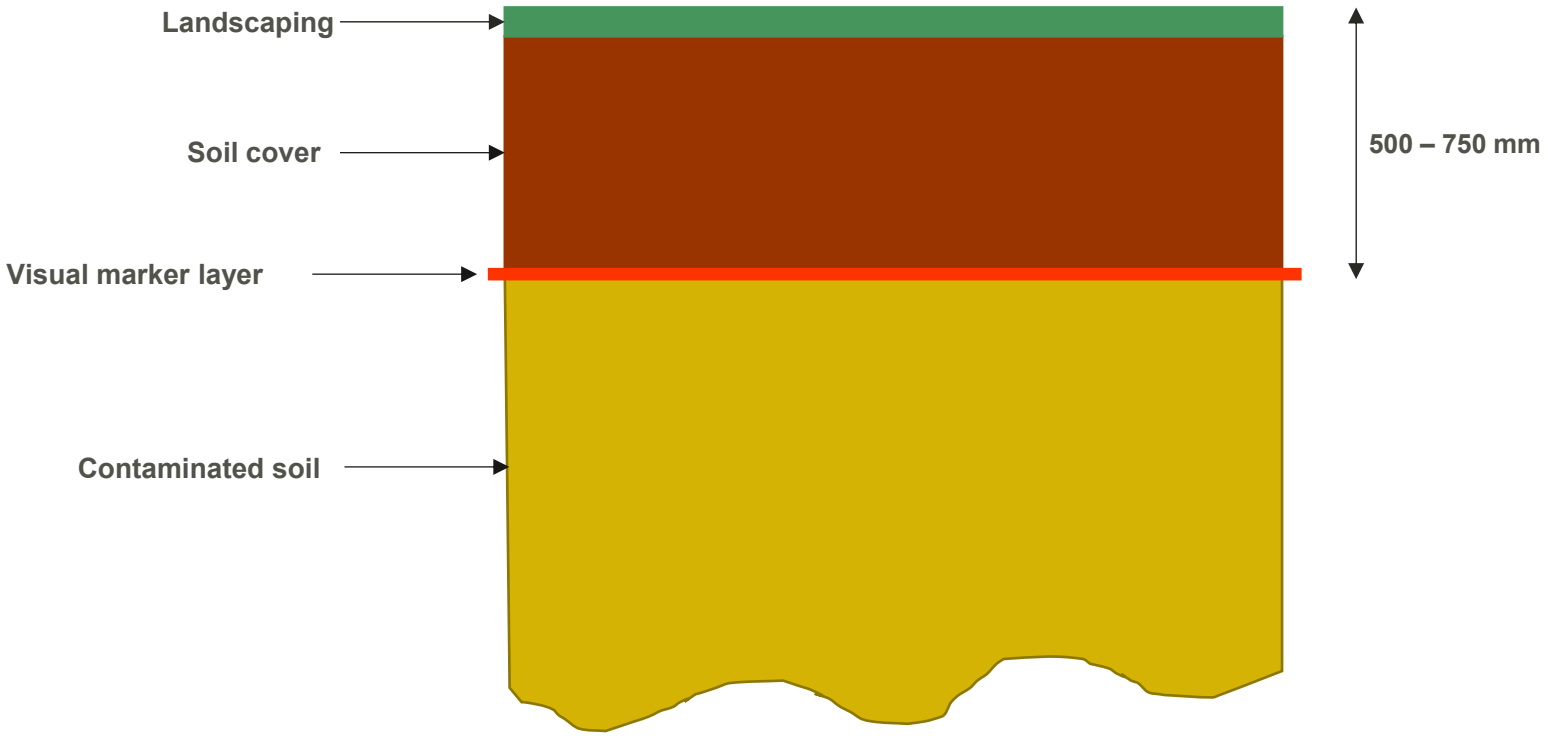
Indicative Cap Type	Land Use	Indicative Cap Features	Indicative Thickness (mm)	Guidance / Precedents
Physical Separation	Recreational	• Soil cover including landscaping • Visual marker layer (geotextile)	500 – 750^	ANZECC 1999, WA DOH 2009
Physical Separation	Buildings / Pavements	• Concrete Slab • Base / Sub-base • Visual marker layer (geotextile)	250 – 500	ANZECC 1999, WA DOH 2009
Physical Separation and Capillary Break Layer	Recreational	• Soil cover including landscaping • Infiltration barrier • Capillary break layer (coarse granular material) • Visual marker layer / separation layer (geotextile)	800 – 1450^	PLR Stabling and Maintenance Facility Remediation
Physical Separation and Capillary Break Layer	Buildings / Pavements	• Concrete slab • Base / Sub-base • Infiltration barrier • Capillary break layer (coarse granular material) • Visual marker layer / separation layer (geotextile)	550 - 1100	PLR Stabling and Maintenance Facility Remediation
Physical Separation and Ground Gas Protection (including landfill gas and chlorinated hydrocarbons)	Buildings / Pavements	• Concrete slab • Ground gas protection system (e.g. membrane and venting layer) • Base / Sub-base • Visual marker layer (geotextile)	300 – 600	NSW EPA 2020

Notes:
^ Depending on the landscaping requirements, deeper soil cover profiles may be required.

NSW EPA (2020), *Assessment and management of hazardous ground gases, Contaminated Land Guidelines*, NSW Environmental Protection Authority, December 2019
ANZECC (1999), *Guidelines for the assessment of on-site containment of contaminated soil*, Australian and New Zealand Environment and Conservation Council, September 1999
WA DOH (2009), *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia*, Western Australia Department of Health May 2009,

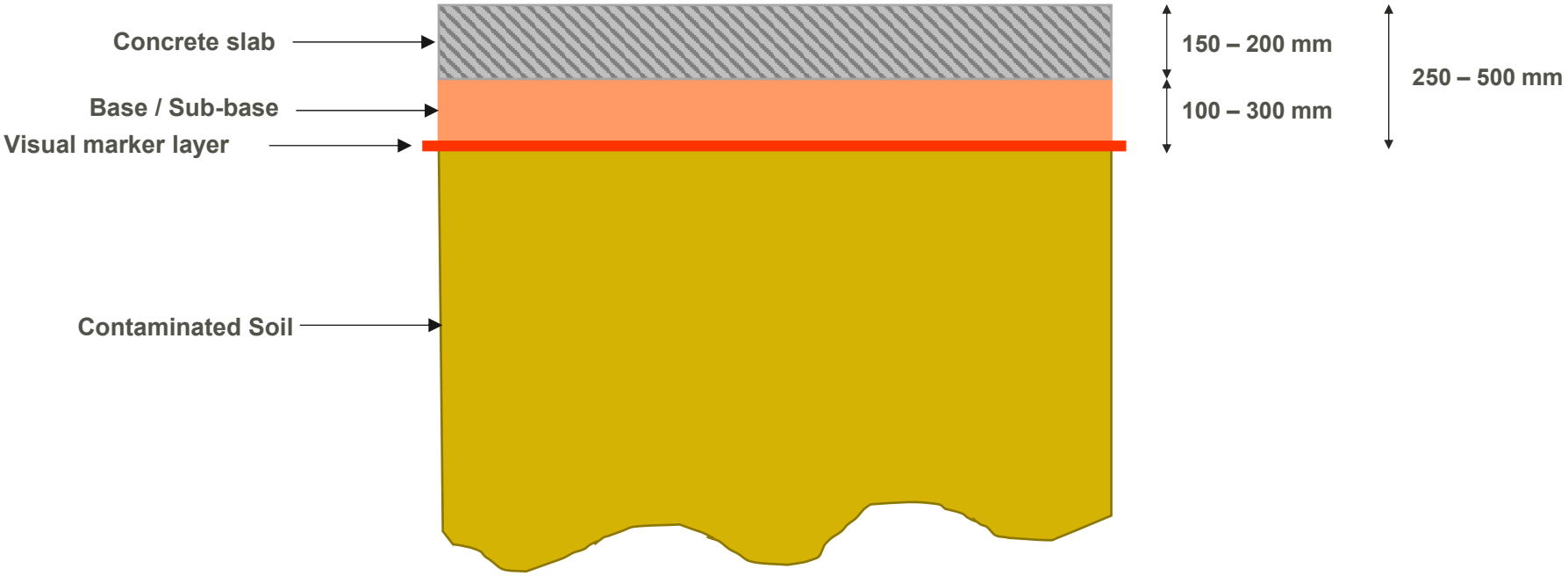
Indicative Cap Types - Sketches

PHYSICAL SEPARATION – RECREATIONAL



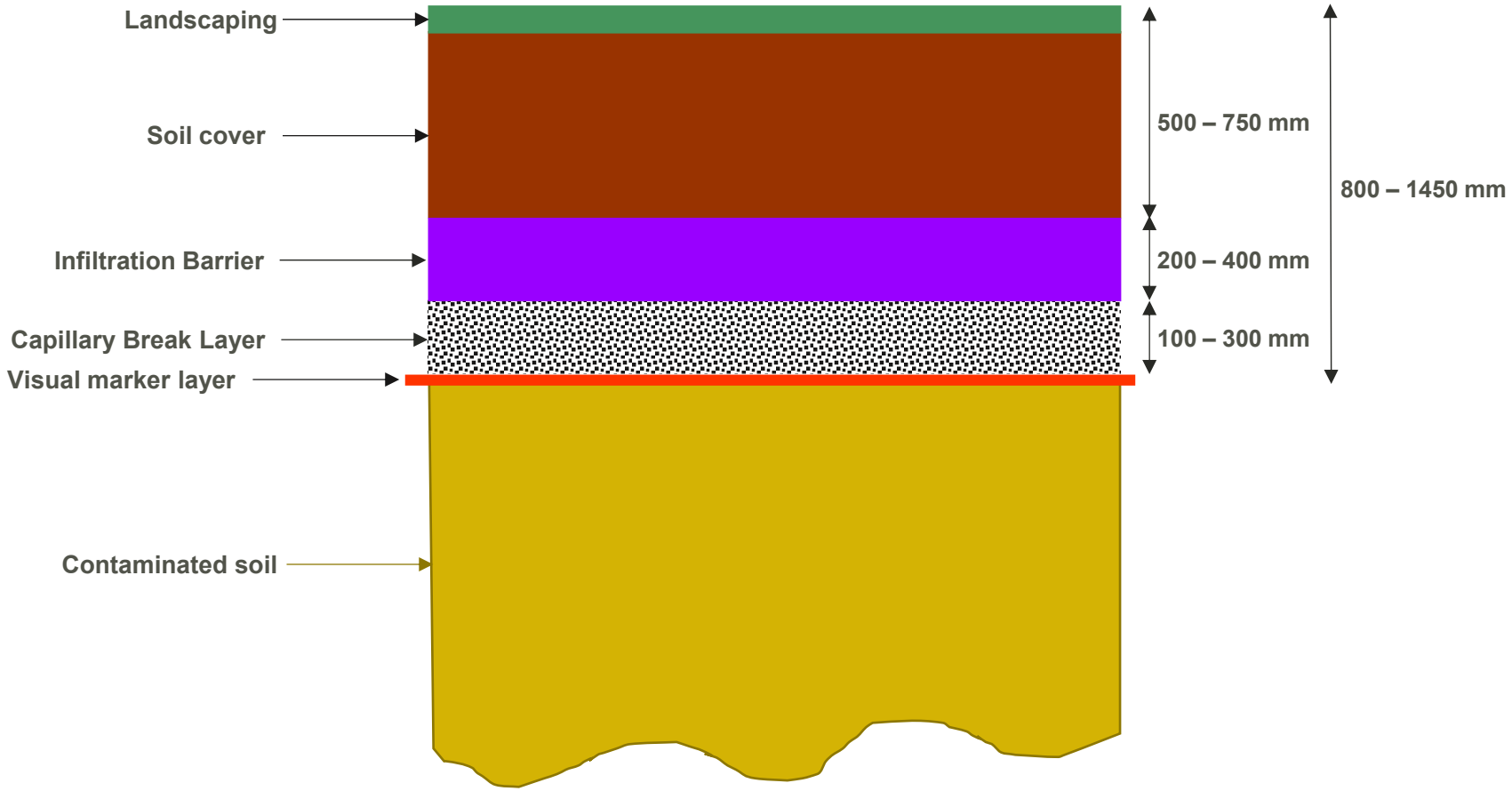
Indicative Cap Types - Sketches

PHYSICAL SEPARATION – BUILDINGS / PAVEMENTS



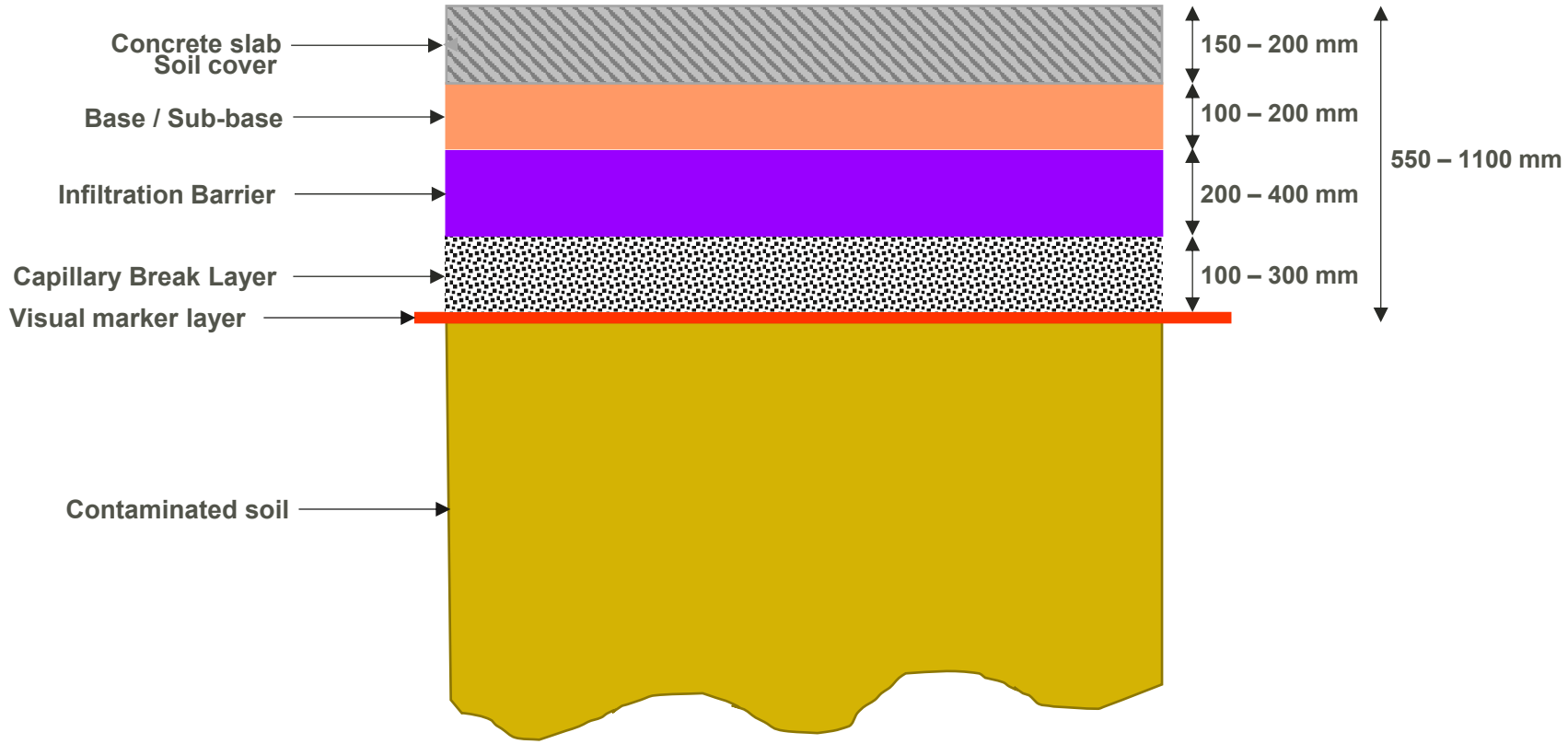
Indicative Cap Types - Sketches

PHYSICAL SEPARATION AND CAPILLARY BREAK LAYER– RECREATIONAL



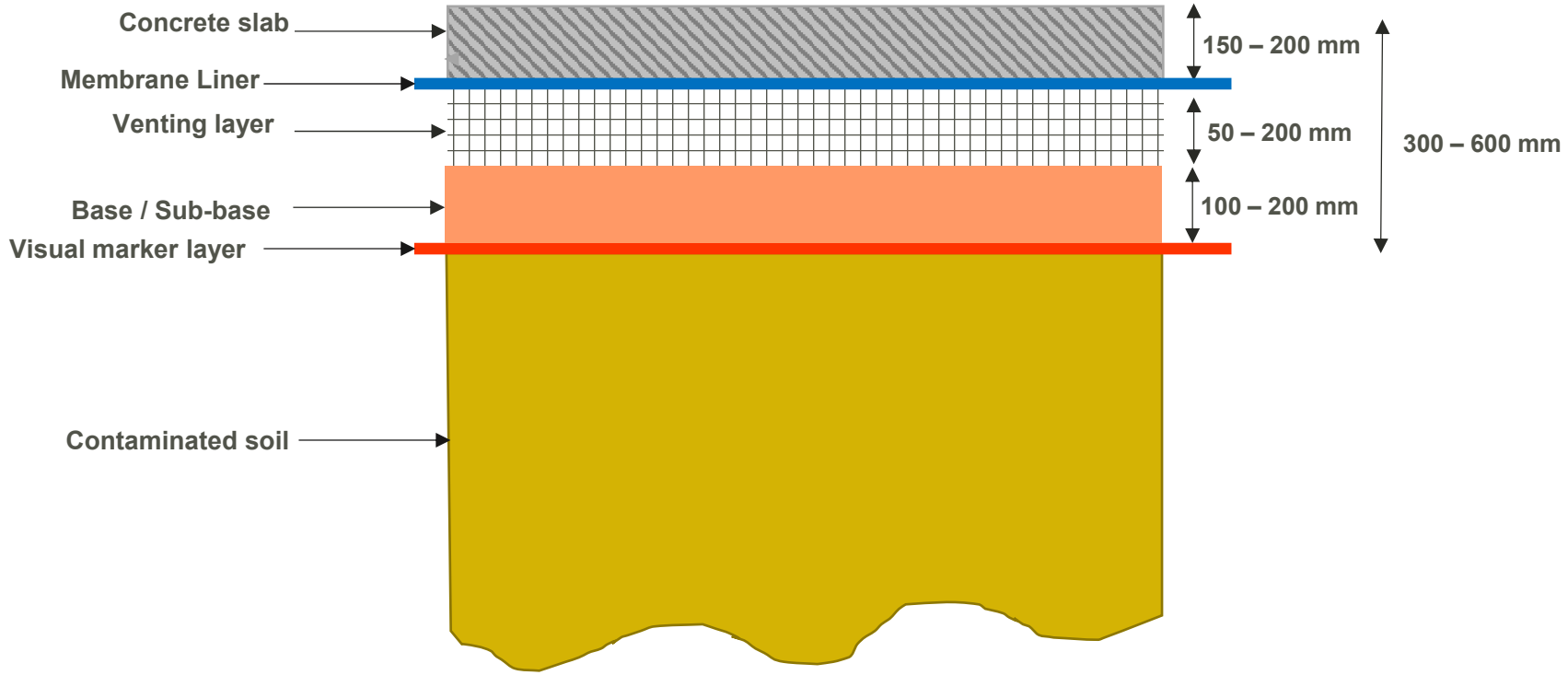
Indicative Cap Types - Sketches

PHYSICAL SEPARATION AND CAPILLARY BREAK LAYER– BUILDINGS / PAVEMENTS



Indicative Cap Types - Sketches

PHYSICAL SEPARATION AND GROUND GAS PROTECTION – BUILDINGS / PAVEMENTS



APPENDIX C

Methodology for remediation cost analysis

COST ESTIMATE METHODOLOGY

Consulting costs

Approach

Adopting a qualitative assessment for how much Contamination Land Management (CLM) related information was available, each landowner parcel on the Precinct was placed into one the following categories:

- No existing CLM related information available.
- Limited existing CLM related information available.
- Reasonable existing CLM related information available.
- Significant existing CLM related information available.

An estimate for consulting costs was prepared for a hypothetical site on the Precinct with no existing CLM related information available. The cost estimate for the hypothetical site was then used to derive cost ranges (low, medium, and high) for sites with no existing information, limited existing information, reasonable existing information, and significant amounts of existing information.

Scope

The broad scope of the consultant costs is in general alignment with the activities specified by relevant guidelines endorsed by the NSW EPA under Section 105 of the *CLM Act 1997*. The scope includes:

- *Desktop study*: including the completion of a Phase 1 Environmental Site Assessment (ESA), a Sampling, Analytical and Quality Plan (SAQP) and development of a preliminary Conceptual Site Model (CSM).
- *Intrusive investigations*: completion soil, groundwater and soil vapour site investigation programs and the completion of a Phase 2 Environmental Site Assessment (ESA) and risk assessment and refinement of the CSM.
- *Remediation planning*: including the preparation of a Remediation Action Plan (RAP); preparation of remediation designs and specifications; meetings with stakeholders; and procurement of a remediation contractor.
- *Services during remediation*: including site validation support during remediation, preparation of a Remediation Validation Report (RVR), preparation of an long term site environmental management plan, waste classification reporting, and occupational hygienist services during remediation.

Key assumptions

Key assumptions for the consulting costs on the hypothetical site include:

- A site area of 3 hectares.
- An area of contaminated fill/soil from site activities of between 100 and 200 square metres to a depth of one metre.
- The extent of contaminated fill/soil materials (separate to soil/fill contaminated by site activities) is between 50 and 200 square metres to a depth of one metre (presenting low range and high range estimates).
- One underground petroleum storage system (UPSS) is present on the site and requires decommission and removal.
- One metre of soil/fill material across the site will be classified as waste for off-site disposal.

- Remediation works on the site will be completed in six weeks. Full-time supervision will be provided by an environmental engineer/scientist for 50 hours per week. The scope of this supervision is to provide site validation support during remediation. It does not include full-time engineering supervision to facilitate QA/QC activities required for the installation of engineered liners.
- A total of 100 soil validation samples will be collected. No groundwater or soil vapour validation sampling will be required.
- Project management costs will be 10% of the overall consulting costs.
- The risk assessment completed as a part of the intrusive investigations will contain no detailed numerical modelling.
- The costs to facilitate planning approvals are not included.

The following calculations were then applied to determine rates for each of the following categories:

- *No existing CLM related information:* No adjustment. The cost estimate for the hypothetical site is based on that assumption that no existing CLM related information being available.
- *Limited existing CLM related information:* 25% reduction in the costs associated with the desktop study and intrusive investigations.
- *Reasonable existing CLM related information:* 50% reduction in the costs associated with the desktop study and intrusive investigations. 25% reduction in the costs associated with the remediation planning.
- *Significant existing CLM related information:* 75% reduction in the costs associated with the desktop study and intrusive investigations. 50% reduction in the costs associated with the remediation planning.

NSW EPA Accredited Site Auditor costs

Approach

A cost estimate for NSW EPA accredited site auditing costs was prepared for a hypothetical site on the Precinct. The area-based rate that was derived from this hypothetical scenario and was applied across all the areas of the Precinct that were considered in the cost analysis.

Scope

The scope of the Site Auditor services was assumed to be in compliance with the relevant provisions of the *CLM Act 1997* and guidelines made or endorsed under the CLM Act 1997, including, but not limited to, the NSW EPA (2017) Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme (3rd Edition). The scope includes:

- Site walkover inspections to review site conditions during various stages of the site assessment and remediation.
- Attendance at stakeholder meetings.
- Review of available reports, including the completion of data validation and review check lists.
- Provision of Interim Audit Advice correspondence with Site Auditor comments on available reports/ documents.
- Preparation of two Site Audit Reports (SAR) and Section B Site Audit Statement (SAS) which establishes the suitability of the RAP to make the site suitable for the proposed land use (or otherwise) and a Section A2 SAS which establishes the site suitability (or otherwise) through implementation of a Long-Term Environmental Management Plan to manage/ monitor residual site contamination.

Key assumptions

Key assumptions for the auditing costs on the hypothetical site includes:

- A site area of 3 hectares.
- Five site walkover inspections.
- Five stakeholder meetings.
- Five Interim Audit Advice letters.
- Two SAR and SAS.

Capping / development costs

Approach

As discussed in Section 5.2 in report, six different cap types are proposed to remediate the contamination specific to different areas of the Precinct (also refer to Appendix B). Each landowner parcel was allocated with one of the six capping types depending on the type of contamination identified and/or assumed at the individual site. An estimated area-based capping cost was prepared for each of the six capping types. These estimates considered costs associated with:

1) Remediation-specific elements associated with the construction of the cap (refer to assumptions below).
2) The management of surplus soils that need to be relocated to accommodate the capping systems (refer to assumptions below).

Scope

Area-based cost estimates (low, medium, and high) were prepared for the six capping types. For each of these capping types, costs were allocated for:

- Remediation-specific elements of the construction of the cap including:
  - Supply and installation of geotextile visual marker/ separation layer.
  - Supply and installation of drainage aggregate for inclusion in the Capillary Break Layer (CBL).
  - Supply and installation gas mitigation system (membrane and passive venting system).
- The excavation, loading, haulage and off-site disposal of all fill/soils needed to be relocated to accommodate the depth of capping layer.

Key assumptions

Key assumptions for the capping / development costs include:

- The costs include remediation-specific elements of the construction of the cap (e.g., visual marker/ separation layer, capillary break layer; ground gas protection measures). Features of the cap construction that would be considered in a typical site redevelopment without remediation (e.g., contractor management/mobilisation; vegetation removal; demolition; construction of slabs, pavements, footings, utilities; excavation to achieve levels etc) were not included.
- As noted in Section 3.3 in report, ensuring no net loss of flood storage due to cut / fill was identified as a non-negotiable outcome. For the purposes of this costing, it has been assumed that the raising of site elevations will be restricted in some areas to ensure compliance with flood management performance criteria. In some areas, surplus soils will be generated to accommodate the capping systems. These surplus soils would require management through either disposal off-site as waste, or reuse within the

Precinct in a purpose-built containment facility. Key quantity assumptions for this cost category are provided in **Table C1** below.

- Assumptions for the typical thicknesses for each capping type are presented in Appendix B.
- Soil bulk density – 2 tonne / m^3

Table C1: Capping / Development costing quantity assumptions

Description	Quantity / Rate			Unit
	Low Estimate	Medium Estimate	High Estimate	
Surplus soils that will be generated due to flood mitigation. Expressed as a proportion of the capping thickness, i.e., 100% – No change in surface elevation is permitted, and all the soils displaced by the capping layer are surplus and need to be managed, 0% – No flood mitigation required. All soils can be retained on-site.	30%	50%	70%	% of capping thickness
Proportion of spoil displaced by the cap being designated for on-site containment	75%	60%	40%	%
Proportion of spoil displaced by the cap being designated for off-site disposal	25%	40%	60%	%
Off-site Disposal: Excavation, Loading, Haulage and Disposal of General Solid Waste*	$ 200	$ 250	$ 325	$ AUD / tonne
Off-site Disposal: Excavation, Loading, Haulage and Disposal of Restricted Solid Waste*	$ 400	$ 500	$ 600	$AUD / tonne
Off-site Disposal: Excavation, Loading, Haulage and Disposal of Hazardous Waste (e.g., CrVI)*	$ 750	$ 1,000	$ 1,500	$AUD / tonne
Containment of soils within a cell/mound constructed within the Precinct: Excavation, Loading, Haulage, Placement, Cell construction fees (inc. design, contractor overheads, project management)**	$ 60	$ 75	$ 90	$ AUD / tonne

Notes: * We note that these rates are not overly conservative and do not accommodate for future NSW EPA levy increases. These rate assumptions have a significant influence on the cost of off-site disposal, and therefore the overall remediation cost.

** Rates are very preliminary and have been developed to inform the planning process. They are based on a containment facility of approximately 50,000 m^2, a side batter slope of 4H:1V, a mound height of 10 m, a truncated rectangular pyramid geometry, a liner and capping system (HDPE / GCL / geotextile / bearing soils).

Remediation costs

Approach

These soil/fill remediation costs were prepared to address hot-spot contamination (e.g., UPSS) beyond basic site capping requirements. Following the scenarios assessment process outlined in Section 6.0, each landowner parcel on the Precinct, for each of the scenarios, was placed into one the following categories:

- Remediation unlikely.
- Remediation possible (or possible with restrictions).
- Remediation likely.

An estimate for the area-based soil/fill remediation costs was prepared for a hypothetical site on the Precinct where significant remediation was unlikely, possible/ possible with restrictions or likely.

Scope

The scope of the remediation activities included hot-spot removal and UPSS decommissioning including tank pit fill/soil validation activities. These activities to be completed by a remediation contractor were assumed to include:

- Construction management including the preparation and maintenance of plans, and administration of the contract.
- Site mobilisation and demobilisation.
- Operation and maintenance of site facilities (site offices and amenities).
- Excavation, loading, haulage and offsite disposal of fill/soil wastes generated by the remediation activities.
- Removal, destruction, and offsite disposal of UPSS.

Key assumptions

Key assumptions for the remediation costs include:

- All soil/fill material "hot-spots" will be disposed off-site at a suitably licensed disposal facility. For the purposed of this costing, allowances have not been made for on-site treatment of fill/soils (e.g., landfarming/ bio-piling).
- In-situ groundwater remediation will be required at sites where remediation is “likely”. The scope of the groundwater remediation works has not been defined due to current uncertainties and the multitude of options that may be required (e.g., pump and treat, pump and disposal, in-situ treatment). An allocation of $50,000 to $100,000 AUD ex GST / ha has been allocated to sites where remediation is “likely”.
- Key quantity assumptions for each of the categories is included in **Table C2** below.
- Rates for excavation, loading, haulage and offsite disposal of waste fill/soil:
  - General Solid Waste (Special Waste – Asbestos) – $250 per tonne
  - Restricted Solid Waste (Special Waste – Asbestos) – $500 per tonne
  - Hazardous Waste (e.g., hexavalent chromium impacted fill/soil) – $1,000 per tonne[1]

  We note that these rates are not overly conservative and do not accommodate for future NSW EPA levy increases. **These rate assumptions have a significant influence on the cost of off-site disposal, and therefore the overall remediation cost.**

Table C2: Soil / fill remediation costing quantity assumptions

Description	Quantity			Unit
	Remediation Unlikely	Remediation Possible	Remediation Likely	
Site area	3	3	3	ha
Fill/soil bulk density	2	2	2	tonnes / m^3
Remediation Contractor assumptions				
Number of site establishments	1	1	1	site establishments

[1] Hazardous waste estimate assumes off-site treatment and then disposal as a lower category waste, or management in a specially licensed landfill monocell

Description	Quantity			Unit
	Remediation Unlikely	Remediation Possible	Remediation Likely	
Duration of UPSS & soil remediation works	1	4	6	weeks
Hot-spot removal assumptions				
Volume of soil/fill hot spots requiring off-site waste disposal	25	100	500	m^3 (in-situ)
UPSS decommissioning and tank pit validation				
Number of UPSS – 5,000 L	0	1	0	5,000 L UPSS
Estimated volume of UPSS spoil requiring off-site disposal per 5,000 L UPSS	0	40	0	m^3 / UPSS
Number of UPSS – 10,000 L	0	0	2	10,000 L UPSS
Estimated volume of UPSS spoil requiring off-site disposal per 10,000 L UPSS	0	0	125	m^3 / UPSS
Total volume of impacted UPSS soil requiring off-site disposal	0	0	250	m^3 (stockpiled)

Ongoing contamination management and/or monitoring costs

Approach

Each landowner parcel in the Precinct was allocated one of the following categories, based on the likelihood of remediation being required:

- Low ongoing management requirements (remediation unlikely).
- Medium ongoing management requirements (remediation possible/ possible with some restrictions).
- High ongoing management requirements (remediation likely).

Annual costs associated with ongoing contaminated land management and/or monitoring activities were estimated for each of the categories listed above at a hypothetical site. The ongoing costs were forecast over a 50-year period and converted to a net-present-value (NPV). The NPV was converted to an area-based cost.

Scope

The scope of the ongoing management and/or monitoring activities is as follows:

- Regular inspection of capped surfaces, containment facilities, inspection points etc.
- Regular monitoring of groundwater, surface water and ground gas.
- Reporting of the inspection / monitoring results.

Key assumptions

Key assumptions for the ongoing management and/or monitoring costs include:

- Low ongoing management requirements:
  - Annual inspection of capped surfaces, containment facilities, inspection points etc.
  - Annual inspection and monitoring report.

- Medium ongoing management requirements:
  - Annual inspection of capped surfaces, containment facilities, inspection points etc.
  - Annual monitoring of groundwater (5 locations), surface water (5 locations) and ground gas (5 sub-surface gas monitoring locations, no allowances for surface walkovers).
  - Annual inspection and monitoring report.
- High ongoing management requirements:
  - Quarterly inspection of capped surfaces, containment facilities, inspection points etc.
  - Quarterly monitoring of groundwater (10 locations), surface water (10 locations) and ground gas (10 locations sub-surface gas monitoring locations, no allowances for surface walkovers).
  - Quarterly inspection and monitoring report.
- Ongoing monitoring period – 50 years.
- Discount rate in NPV calculation – 3% per annum.

Foreshore remediation costs

Approach

A cost estimate has been prepared for three hypothetical portions of the Precinct foreshore area (500 metres in length):

- A foreshore area containing contaminated fill/soils. In these areas, it is assumed that access to the foreshore will be limited (e.g., raise boardwalks, fenced / restricted areas), which would reduce the risk of exposure.
- A foreshore area containing contaminated fill/soils, including soils that are grossly contaminated with asbestos. In these areas, it is assumed that that full public access will be provided to the foreshore.
- A foreshore area containing contaminated soils which is adjacent to sites with hexavalent chromium fill/soil leaching to stormwater and/or groundwater. In these areas, it is assumed that that full public access will be provided to the foreshore.

These cost estimates have been used to develop a lineal metre rate for foreshore remediation costs for the entire Precinct foreshore areas.

Scope

The proposed foreshore remediation works would comprise the following:

- Construction management including the preparation and maintenance of plans, and administration of the contract.
- Site mobilisation and demobilisation.
- Operation and maintenance of site facilities (site offices and amenities).
- Maintenance of environmental controls.
- Excavation, loading, haulage and disposal of fill/soil wastes generated by the remediation activities.

- Excavation and replacement of asbestos wastes and chromium-impacted soil/fill along the Parramatta River foreshore. The impacted fill/soils and/or waste would be removed and replaced with low permeability capping and armoured with heavy rock to prevent wash erosion along foreshore. In areas grossly impacted with asbestos, additional allowances have been included for emu-picking of asbestos impacts from the foreshore embankments prior to bulk excavation and for more intensive environmental and work health and safety controls.
- In foreshore areas with hexavalent chromium impacts in groundwater, the design and construction of a continuous PRB including:
  - Detailed design (including hydrogeological investigation, modelling, drawings and specifications).
  - Completion of a pilot trial.
  - Excavation of trench; treatment of acid sulfate soils (ASS) following the excavation of the trench; placement of geotextile, gravel, pipework and reactive media for the PRB. Assumes construction period of approximately 25 weeks.

Key assumptions

- No allowances have been made for ongoing maintenance (e.g., active media replacement) or monitoring activities associated with the PRB (e.g., groundwater monitoring wells up and down gradient of the PRB).
- Key quantity assumptions for each of the categories is included in **Table C3** below.

Table C3: Foreshore remediation costing quantity assumptions

Description	Quantity			Unit
	Impacted Soil	Impacted Soil (inc. gross asbestos)	Impacted Soil + Cr VI	
Length of foreshore area	500	500	500	metres
Fill/soil bulk density	2	2	2	tonnes / m^3
Remediation Contractor assumptions				
Number of site establishments	1	1	1	site establishments
Duration of remediation works	6	12	25	weeks
Soil/fill excavation and removal				
Width of foreshore area requiring soil / fill soil and waste removal	3	3	3	metres
Depth of foreshore area requiring soil / fill soil and waste removal	1	1	1	metres
PRB Construction				
Width of PRB	0	0	1	metres
Depth of PRB	0	0	5	metres
Tonnes of PRB soil requiring removal and disposal	0	0	5,000	tonnes

Consideration of existing available Precinct remediation cost information

Due to lack of site-specific publicly available CLM information at most landowner sites within the Precinct, the cost estimates described above have been developed using hypothetical scenario sites. It is noted, however, that two landowner sites within the Precinct (181 James Ruse Drive and 1 Grand Avenue) have existing publicly available RAPs which provide more certainty on the extent of contamination and proposed remediation methods on these sites.

Site-specific area-based rates have been adopted for these sites. The rates applied are generally consistent with those previously presented by Golder (2015b). The rates are presented in **Table C4** below. The disparity in rates between the two sites is generally reflective of the different remediation strategies adopted (181 James Ruse Drive – full site disturbance; 1 Grand Avenue – on-site capping).

Table C4: Site-specific area-based rates (181 James Ruse Drive and 1 Grand Avenue)

Site	Cost-estimate for remediation activities ($ / ha)		
	Low Range	Medium Range	High Range
181 James Ruse Drive	$ 4,000,000 / ha	$ 5,000,000 / ha	$ 6,000,000 / ha
1 Grand Avenue	$300,000 / ha	$400,000 / ha	$ 500,000 / ha

The Golder (2015b) rates generally included provisions for remediation activities (on-site containment, remediation of hot-spots, construction of a temporary emission control structures (for air borne asbestos fibre and volatile organic compound management) and wastewater treatment with an on-site treatment plant) but not for the other cost categories identified in the above sections (e.g., consulting costs, site auditor costs and ongoing management/ monitoring costs etc). For the overall cost-model, rates based on hypothetical sites were applied for the cost categories not previously considered by Golder (2015b).

A summary of the area-based rates and lineal-meterage rates for foreshore remediation is included in **Table C5 and C6**.

Table C5: Summary of area-based rates

Category	Decision	Rate	Area-based rate ($ / ha)		
			Low Range	Medium Range	High Range
CLM Consulting costs	How much information is currently available at the site?	None	$ 160,000	$ 205,000	$ 330,000
		Limited	$ 145,000	$ 185,000	$ 260,000
		Reasonable	$ 145,000	$ 165,000	$ 215,000
		Significant	$ 125,000	$ 140,000	$ 170,000
Auditing costs	N/A – Same rate applied across all areas	All areas	$ 35,000	$ 45,000	$ 55,000
Capping / development costs	What type of capping system is required?	Physical Separation Only – Recreational	$ 360,000	$ 1,200,000	$ 3,190,000
		Physical Separation Only – Buildings / Pavements	$ 210,000	$ 885,000	$ 2,440,000
		Physical Separation and Capillary Break Layer – Recreational	$ 685,000	$ 2,600,000	$ 7,360,000
		Physical Separation and Capillary Break Layer – Building / Pavements	$ 465,000	$ 1,830,000	$ 5,680,000
		Physical Separation and Ground Gas Protection System – Building / Pavements	$ 422,000	$ 1,200,000	$ 3,160,000
		Physical Separation, Capillary Break Layer and Ground Gas Protection System – Building / Pavements	$ 663,750	$ 2,210,000	$ 6,280,000
Remediation costs	What is the likelihood that hot-spot remediation (in addition to capping) will be required?	Likely	$ 240,000	$ 345,000	$ 520,000
		Possible	$ 85,000	$ 115,000	$ 160,000
		Unlikely	$ 40,000	$ 50,000	$ 60,000
Ongoing Management/ Monitoring costs (50 years)	What is the level of ongoing management/ monitoring required?	High	$ 670,000	$ 840,000	$ 1,350,000
		Medium	$ 100,000	$ 130,000	$ 210,000
		Low	$ 25,000	$ 35,000	$ 60,000

Table C6: Lineal-meterage rate estimate for foreshore remediation costs

Category	Lineal-Meterage Rate ($ AUD / l m)		
	Low Range	Medium Range	High Range
A foreshore area containing contaminated soils.	$ 1,600	$ 1,900	$ 2,500
A foreshore area containing contaminated soils, including soils that are grossly contaminated with asbestos.	$ 6,100	$ 7,600	$ 9,900
A foreshore area containing contaminated soils which is adjacent to sites with hexavalent chromium contamination in groundwater (exclusive of ongoing maintenance / monitoring costs associated with the PRB)	$11,600	$ 14,400	$ 18,800

Cost estimate for basement scenario

The cost estimates presented in this implementation report includes potential costs associated with excavation works to support development, however they largely exclude costs associated with removal of excess spoil to support potential basements/ or inground structures/ services. The potential costs associated with common contaminated soil disposal scenarios where the development requires a single level basement is outlined in **Table C7** below on a cost per square metre basis.

Table C7: Potential Soil Disposal Costs for Excess Contaminated from a Single-Level Basement Excavation ($/m2 of basement)

Waste Category	Depth of Basement (m)	Waste Soil Mass per m^2 of Basement (tonne) (density of 1.8 t/m^3)	Estimated Cost to Excavate, Load and Dispose ($ per tonne)	Soil Disposal Cost Estimate ($ per m^2 of basement)
General Solid Waste (GSW) – Special Waste (Asbestos)	3	6	200	$ 1,200
Restricted Solid Waste (RSW) – Special Waste (Asbestos)	3	6	500	$ 3,000
Hazardous Waste[2]	3	6	1,000	$ 6,000

The potential soil disposal costs for excess contaminated soil from a single level basement are based on the following assumptions:

- The estimated rate for treatment and disposal of Hazardous Waste is based on the assumption that on-site treatment of the material is not possible.
- We note that these disposal rates are not overly conservative and do not accommodate for future NSW EPA levy increases. These rate assumptions have a significant influence on the cost of off-site disposal, and therefore the overall remediation cost.
- Excludes the cost associated with:
  - Remediation excavations.
  - ASS Treatment
  - Groundwater collection and treatment costs during or post construction (assuming a drained basement is constructed).
  - Stockpile classification testing and preparation of off-site disposal waste classification advice.
  - Disposal of excavated material other than soil including but not limited to rock and demolition waste.
  - General works tendering, design and other service costs related to the development.
  - Detailed civil excavation costs associated with services, pavements and foundations.
  - Construction of the pavement separation layers, building slabs and foundations.
  - Long term environmental management costs; and
  - All other development costs not specified above.

[2] Hazardous waste estimate assumes off site treatment and then disposal as a lower category waste, or management in a specially licensed landfill monocell

To illustrate the additional cost penalty of removing contaminated soil to support a single level basement development we have provided a potential development scenario. For a 0.2-hectare site (2,000 m^2) (i.e., typical service station site) where the soil is typically classified as 20% Restricted Solid Waste soil and 80% General Solid Waste, the cost estimate for soil disposal for a single level basement would be approximately $3.1 M. This equates to an additional cost of approximately $15.6 M / ha over and above the costs associated with site remediation. These costs do not include groundwater collection and treatment, which can represent a significant ongoing cost.

Cost estimate for wetlands remediation

The Master Plan has indicated that the Wetlands on the Viva site could potentially be made publicly accessible in the future. The cost estimates presented in this section relate to remediation and ongoing management of the Wetlands. Remediation options for the Wetlands are limited due to the ecological significance of the area. Broad-scale remediation to address contamination issues (e.g., removal and replacement of existing butyl rubber barrier beneath the wetlands) would have significant impacts on ecological communities and would be inconsistent with the CRPS vision of protecting and enhancing the Parramatta River, Duck River and their wetlands. For the purpose of this cost estimate, it has been assumed that the area would be remediated by exclusion of access to contamination by potential site users. This would be achieved by the development of raised boardwalks and viewing platforms around the Wetland area. The remediation objectives would include no unacceptable risk to human health.

A cost estimate has been developed using area-based rates specified in **Table C5** for consulting costs (assuming “limited” information available), site auditor costs and ongoing management costs (assuming “low” requirements). The area adopted for this calculation was a 15-metre setback from the edge of the Wetland perimeter (850 × 15 m – 12,750 m^2). The potential area-based costs are presented in **Table C8** below.

The linear-meterage rate for a foreshore area containing contaminated soils (**Table C6**) were adopted. The length of the Wetland perimeter (850 m) was used for the calculation. The adoption of this rate is considered conservative as it is based on the assumption that a three-metre-wide corridor will be excavated to one metre depth. Under this scenario (raised boardwalks and viewing platforms), it is expected that the foundations of the structure would not generate the same quantity of spoil. The potential foreshore remediation costs are presented in **Table C9** below.

Table C8: Potential area-based costs, Wetlands

Cost Type	Total Cost ($ AUD)		
	Low Range	Medium Range	High Range
Consultant Costs (“limited” information available)	$ 185,000	$ 210,000	$ 275,000
Auditor Costs	$ 45,000	$ 60,000	$ 70,000
Ongoing Management Costs (low management requirements)	$ 25,000	$ 30,000	$ 50,000
Total Area Based Costs	**$ 255,000**	**$ 300,000**	**$ 395,000**

Table C9: Potential lineal-metre remediation costs, Wetlands

Rate Type	Total Cost ($ AUD)		
	Low Range	Medium Range	High Range
Remediation Cost – A foreshore area containing contaminated soils	$1,360,000	$1,615,000	$2,125,000

APPENDIX D

Baseline Analysis Report

GOLDER
MEMBER OF WSP

REPORT

Remediation Strategy Baseline Analysis Report

Package C - Environment

Submitted to:

Department of Planning, Industry and Environment

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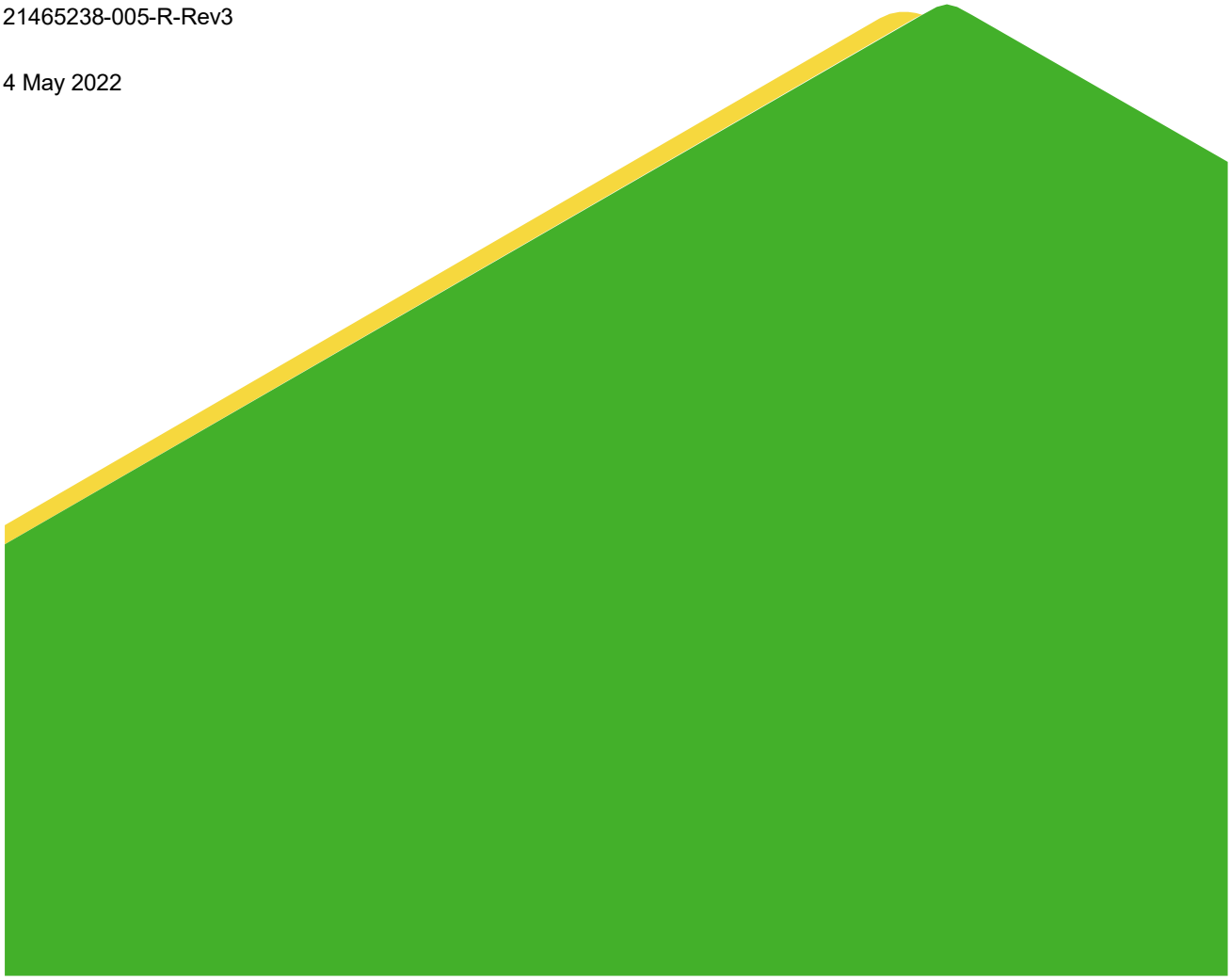
21465238-005-R-Rev3

4 May 2022



Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
DPIE	Vasiliki Cardassis	Rev 0	10 May 2021	Electronic
DPIE	Vasiliki Cardassis	Rev 1	30 June 2021	Electronic
DPIE	Vasiliki Cardassis	Rev 2	10 November 2021	Electronic
DPIE	Vasiliki Cardassis	Rev 3	4 May 2022	Electronic

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LIST OF ABBREVIATIONS

ACM	Asbestos Containing Material
AEI	Areas of Environmental Interest
AHD	Australian Height Datum
API	Australian Pharmaceutical Industries
AST	Aboveground Storage Tank
AWT	Australian Water Technologies
bgl	Below ground level
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CBD	Central Business District
CBL	Capillary break layer
CES	Consulting Earth Scientists
CFC	Chlorofluorocarbon
CLM	Contaminated Land Management
the CLM Act	NSW Contaminated Land Management (CLM) Act 1997
CMJA	CM Jewell & Associates Pty Ltd
CoA	Condition of Approval
CoP	City of Parramatta
COPC	Contaminants of Potential Concern
COPR	Chromium Ore Processing Residues
Council	City of Parramatta Council
CRPS	Camellia – Rosehill Place Strategy
CSSI	Critical State Significant Infrastructure
DA	Development Application
DECCW	Department of Environment, Climate Change and Water
DFSI	Department of Finance, Service and Innovation
DP	Deposited Plan
DNAPL	Dense Non Aqueous Phase Liquid
DPIE	New South Wales Department of Planning, Industry & Environment
DUAP	Department of Urban Affairs and Planning

the EHC Act	NSW Environmentally Hazardous Chemicals Act 1985
EIS	Environmental Impact Statement
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPI	Environmental Planning Instrument
EPL	Environment Protection Licences
GPOP	Greater Parramatta and Olympic Peninsula
GSC	Greater Sydney Commission
ICS	Integrated Capping System
IWCMS	Integrated Water Cycle Management Strategy
LEP	Local Environment Plan
LNAPL	Light Non-Aqueous Phase Liquid
LUIS	Land Use and Infrastructure Strategy
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Contaminated Sites) Measure
NSW EPA	New South Wales Environmental Protection Authority
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PFAS	per- and polyfluoroalkyl substances
PFOS	Perfluorosulfonate
PIC	Infrastructure Compact Pilot
the Precinct	Camellia – Rosehill Precinct
PLR	Parramatta Light Rail
the POEO Act	NSW Protection of the Environment Operations Act 1997
RAP	Remediation Action Plan
REF	Review of Environmental Factors
SaM	Stabling and Maintenance
SEE	Statement of Environmental Effects
SEPP	State Environmental Planning Policy
SEPP 55	State Environmental Planning Policy No 55– Remediation of Land
SEWR	Significant Enough to Warrant Regulation

SSD	State Significant Development
SSI	State Significant Infrastructure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UST	Underground Storage Tank
VCH	Volatile Chlorinated Hydrocarbons
VOC	Volatile organic compounds
VMP	Voluntary Management Proposal
VZB	Vadose zone vapour barrier

1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) has been engaged by New South Wales Department of Planning, Industry & Environment (DPIE) to deliver the technical studies for Package C (Environment), which will inform the Camellia –Rosehill Place Strategy (CRPS) and Master Plan for the Camellia–Rosehill Precinct (the Precinct). The environment package includes: Remediation Strategy; Air, Noise, and Odour Assessment; and Integrated Water Cycle Management Strategy (IWCMS). This Baseline Assessment Report has been prepared as a part of the remediation component of the environment package.

1.1 Overview

DPIE is leading the development of the CRPS, in collaboration with City of Parramatta Council (Council), industry, the community and State agencies. The Precinct covers an area of 321 hectares and is located 1.5 kilometres (km) east of Parramatta Central Business District (CBD). The Precinct is defined by Parramatta River to the north, Duck River to the east, the M4 Motorway to the south and James Ruse Drive to the west, all of which form physical boundaries to the Precinct (refer to **Figure 1**).

The Precinct plays a significant strategic role in Greater Parramatta and Olympic Peninsula (GPOP) through its contribution towards the GPOP Economic Corridor by accommodating advanced urban services. Through the development of the CRPS, the activation of the Parramatta River and Duck Creek foreshore and capitalisation on investment in Parramatta Light Rail and synergies with Rosehill racecourse, leading to opportunities for an amenity led mixed-use development have been noted as potential outcomes.

Camellia has been identified as a priority growth area since 2014. A Precinct wide Land Use and Infrastructure Strategy (LUIS) was exhibited in August 2015 followed by the Town Centre Master Plan in 2018. Work was paused pending the outcomes of the Greater Sydney Commission's (GSC) draft Place-based Infrastructure Compact (PIC) Pilot released in November 2019. The GPOP PIC aims to ensure infrastructure delivery is matched with growth across 26 precincts within the GPOP corridor. In March 2020, the GSC released its final recommendations on the GPOP PIC to Government. The PIC recommended that Camellia be retained for urban service land, however, noted the Government may proceed with the town centre (in its current or amended form) once the broader issues including the costs of infrastructure, economic and social benefits have been further considered.

The PIC process has highlighted the significant issues that need to be resolved to enable this Precinct to transition to either higher order urban services, or a mixed-use precinct. For this reason and in recognition of Camelia-Rosehill Precinct's economic potential and the need for planning of the Precinct to be holistic, coordinated and strategic, the NSW Government has determined that a Place Strategy for the whole Camellia-Rosehill precinct should be prepared. The CRPS will draw on the significant body of work that has already been undertaken and will be prepared in collaboration with Council, industry, the community and State agencies consistent with the Minister's 'precincts - a new approach'.

The overarching objective of the CRPS is to provide an integrated 20-year vision, which recognises the strategic attributes of the Precinct, guides future land use and infrastructure investment decisions and which can be delivered with the support of State and local agencies in an economically robust manner. The Strategy will be given statutory weight through a Ministerial 9.1 Direction and may inform a future state led rezoning proposal (if required), site specific development control plan, a local contribution plan and state infrastructure contributions framework.

Consultants have been engaged by DPIE to prepare a suite of technical environmental and planning studies that will inform the CRPS and Master Plan for the Precinct. These include:

- Package A: Integrated Master Plan

- Package B: Economics
- Package C: Environmental
- Package D: Infrastructure
- Package E: Delivery & Funding
- Package F: Hazard Risk - Land Use Safety Study
- Package G: Spatial Data

1.2 Purpose and scope of this report

The purpose of this report is to:

- Provide an understanding of the Precinct's context and alignment with relevant strategic plans and policies.
- Identify the key opportunities and constraints within the Precinct from a land contamination remediation perspective.
- Build on the assessments and studies previously completed to present up-to-date information that will form a strong evidence base to build Master Plan scenarios.

The scope of this report is as follows:

- Review background and historical information; to identify and confirm the location and extent of contamination, acid sulfate soils and groundwater issues within the Precinct.
- Review background geotechnical information; to identify preliminary geotechnical constraints and opportunities relating to future developments in the Precinct.
- Identify areas of potential contamination including groundwater within the Precinct that could have a material impact on future land uses and inform the preparation of CRPS and development of scenarios.
- Provide Precinct scale mapping of contamination risk.
- Identification of key contamination constraints and opportunities.

1.3 Relevant Legislation

1.3.1 Contaminated Land Management Act 1997

In NSW, the management of contaminated land is shared by the NSW EPA, DPIE and planning consent authorities (usually local councils).

The *NSW Contaminated Land Management (CLM) Act 1997 (the CLM Act)* is the primary Act under which contaminated land in NSW is regulated by the NSW EPA. Under the *CLM Act* the NSW EPA regulates contaminated sites where the contamination is Significant Enough to Warrant Regulation (SEWR), i.e., sites where intervention by the EPA is warranted.

If land contamination is determined to be significant enough to warrant regulation (s.12), the EPA may declare the land as significantly contaminated under s.11 of the *CLM Act*. If it is regulated under the *CLM Act* it will receive notices relating to the management of this contamination. These notices are published on the record of notices for public view. The contaminated land public record is a searchable database of:

- Orders (e.g. Management Order, Maintenance Order) made under Part 3 of the *CLM Act*.

- Notices available to the public under s.58 of the *CLM Act*.
- Approved voluntary management proposals (VMPs) under the *CLM Act* that have not been fully carried out and where EPA approval has not been revoked.
- Site Audit Statements provided to the EPA under s.53B of the *CLM Act* that relate to significantly contaminated land.
- Where practicable, copies of anything formerly required to be part of the public record.
- Actions taken by EPA (or the previous State Pollution Control Commission) under s.35 or s.36 of the *Environmentally Hazardous Chemicals Act 1985 (EHC Act)*[1].

If the land is subject to an Environment Protection Licence (EPL), contamination at declared land may be regulated under the *Protection of the Environment Operations (POEO) Act 1997 (the POEO Act)* (Section 1.3.3) through special conditions on the licence.

Ongoing maintenance orders may be issued under s. 28 of the *CLM Act*. These may be active e.g., to maintain and monitor management systems; or passive e.g., restrictions from disturbing onsite capping and can be amended or ended by the NSW EPA. The NSW EPA may also place restrictions and public positive covenants on land titles (s.29) under s.88E of the *NSW Conveyancing Act 1919*. Both s.28 orders and s.29 restrictions or covenants may be placed on land which was the subject of either a management order or an approved voluntary management proposal. In most cases, an Environmental Management Plan (EMP) is prepared for the ongoing management of contamination at the site and compliance with the EMP is enforceable under the maintenance order or covenant.

There are several sites located in the Precinct that are affected by an instrument under *CLM Act* requiring management of contamination.

Under the *CLM Act* (s. 60) there are also obligations on landowners to notify the NSW EPA (detailed in the NSW EPA (2015) Guidelines on the Duty to Report Contamination under the *CLM Act*) when contamination on their site exceeds criteria published in approved guidelines, or there is a risk of off-site migration of contamination. The NSW EPA has a duty to examine and respond to the information it receives about actual or possible contamination of land. The NSW EPA also publishes lists of notified sites.

There are multiple sites located within the Precinct that are either *CLM Act* notified or regulated sites (Section 6.1).

Due to the widespread nature of land contamination across the Precinct a high level of confidence is required in the assessment and management of contaminated land to adequately inform the planning process. For all potentially contaminated land, the investigation, remediation and validation and/or management should be completed in accordance with guidelines made or approved by the NSW EPA under Section 105 of the *CLM Act*. The National Environment Protection (Assessment of Contaminated Sites) Measure 1999 (the NEPM) (NEPC 2013) sets the national framework for the assessment of contaminated sites. The NEPM is endorsed under the *CLM Act*.

In cases where uncertainty remains regarding site suitability for an intended land use, a Site Auditor accredited under the *CLM Act* should be engaged. The Site Auditor can provide an independent review of contaminated site assessment, remediation and validation reports and/or environmental management plans in

[1] Sections 35 and 36 of the *EHC Act* have been repealed. Notices under these sections are treated by the *CLM Act* as management orders.

order to provide greater certainty to planning authorities and the community that the site is suitable for the proposed land use.

1.3.2 Environmental Planning and Assessment Act 1979

The *NSW Environmental Planning and Assessment Act 1979 (EP&A Act)* is the primary NSW legislation for regulating land use and development. The *EP&A Act* establishes strategic land use planning provisions and establishes a framework for assessing environmental impacts of all development types. The assessment level depends on the development's size, scale and location.

Contaminated sites that are not regulated by the NSW EPA are usually managed by local councils through the land use planning processes specified in Part 4 of the *EP&A Act*. However, in the case of State Significant Development (SSD), State Significant Infrastructure (SSI) and Critical State Significant Infrastructure (CSSI), and in various other instances specified in the Act or in an Environmental Planning Instrument (EPI), the Minister for Planning and Public Spaces is the consent authority and has primary responsibility for management.

The Precinct land use/zones are currently controlled by the Parramatta Local Environmental Plan 2011.

1.3.2.1 State Environmental Planning Policy 55

For over 20 years the *State Environmental Planning Policy No 55– Remediation of Land* (*SEPP 55*), made under the *EP&A Act,* and the *Managing Land Contamination, Planning Guidelines (DUAP,1998)* which underpin it, have provided a state-wide planning approach for the remediation of contaminated land. In particular, *SEPP 55* provides for Category 1 and Category 2 remediation. Projects classified as Category 1 require development consent, while projects classified as Category 2 do not require development consent.

SEPP 55 and the *Contaminated Land Planning Guidelines*, whilst still relevant to the management of contamination in the Precinct, are currently under review. A draft for comment was circulated in 2018 and it is understood that DPIE is continuing to work with NSW EPA and other stakeholders to finalise the guidance and draft instrument. As part of this review, it was proposed to transfer the requirement for planning authorities to consider contamination when rezoning land to a direction under Section 9.1 of the *EP&A Act*.

During April 2020, the Minister for Planning and Public Spaces approved the removal clause 6 from SEPP 55 and transferred the requirements to a Ministerial direction (No 2.6) Remediation of Contaminated Land. The direction is likely to apply to majority of the land parcels located within the Precinct. Under the direction:

A planning proposal authority must not include in a particular zone (within the meaning of the local environmental plan) any land specified in paragraph (2) if the inclusion of the land in that zone would permit a change of use of the land, unless:

(a) the planning proposal authority has considered whether the land is contaminated, and

(b) if the land is contaminated, the planning proposal authority is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for all the purposes for which land in the zone concerned is permitted to be used, and

(c) if the land requires remediation to be made suitable for any purpose for which land in that zone is permitted to be used, the planning proposal authority is satisfied that the land will be so remediated before the land is used for that purpose.

In order to satisfy itself as to paragraph (4)(c), the planning proposal authority may need to include certain provisions in the local environmental plan.

In summary, rezoning should only proceed on the basis that measures are in place to ensure the potential for contamination and suitability of land or any proposed land use are assessed once detailed proposals are made.

This might be communicated in Local Environmental Plan with supporting guidance included in a Precinct specific Development Control Plan or Development Code.

Specifically, it is noted that change to a more sensitive land use on some sites may result in *significant contamination* as defined under the *CLM Act* and this may trigger additional notification and management responsibilities.

Further there will need to be assurances that exempt and complying development will also capture where and when contamination assessment is to be undertaken in the planning process.

1.3.3 Protection of the Environment Operations Act 1997

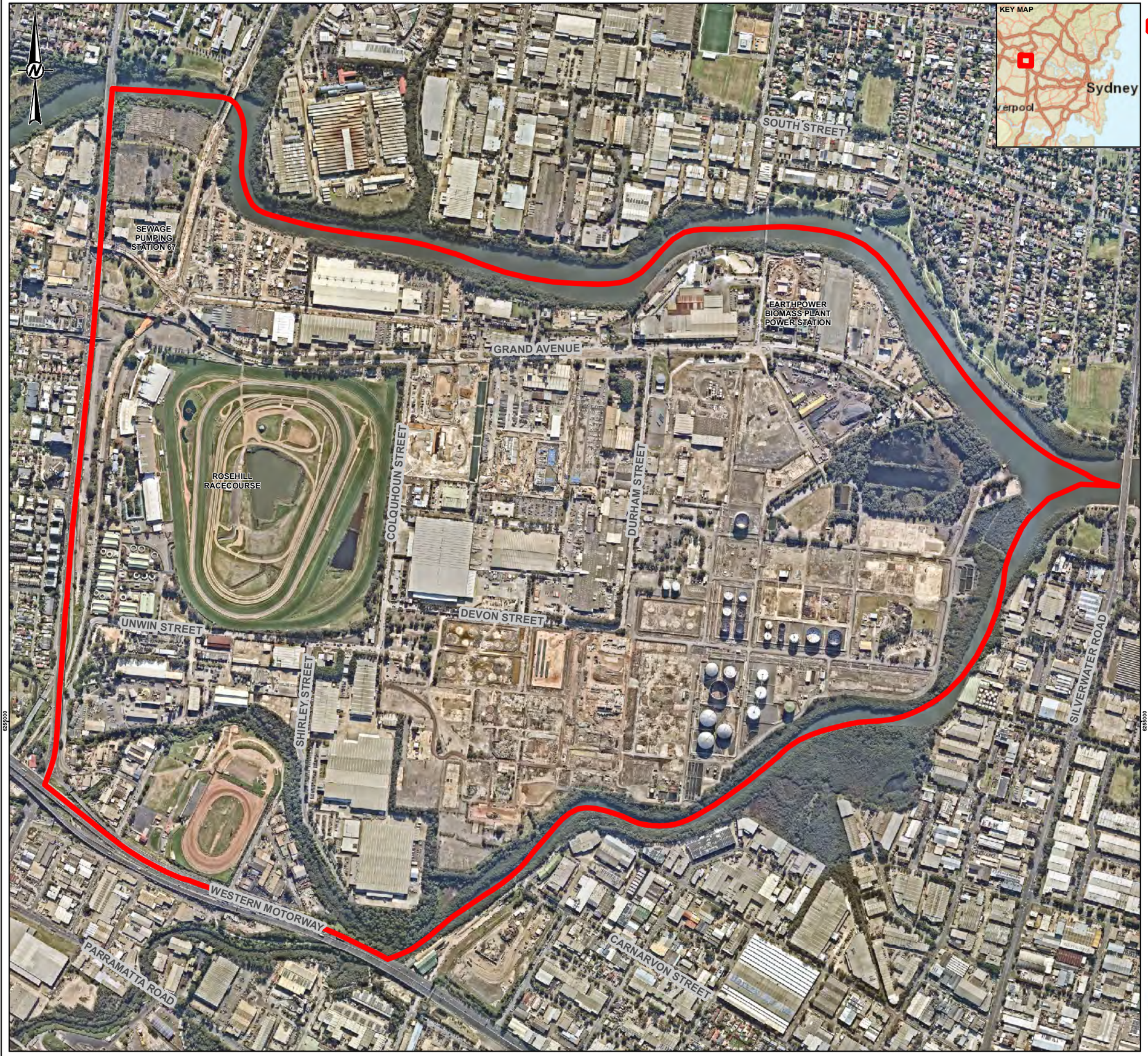
The *POEO Act* is the key piece of environment protection legislation administered by NSW EPA.

The *POEO Act* provides a single integrated licensing arrangement to control the air, noise, water and waste impacts of an activity. The NSW EPA is the regulatory authority for the licensing of activities specified under Schedule 1 of the *POEO Act 1997* (scheduled activities) and in most cases councils are the regulatory authority for non-scheduled activities.

There are several sites located in the Precinct that are licensed for scheduled activities under the *POEO Act* (Section 5.3).

The *POEO Act 1997* also provides the key mechanisms (including the issuing of three types of environment protection notices including: clean up, prevention and prohibition notices) for protecting the environment. It also provides the regulatory regime for waste management under the *Protection of the Environment Operations (Waste) Regulation 2014*.

Any proposed Precinct remediation works would be required to be completed in compliance with the relevant requirements of the *POEO Act* and regulations.



LEGEND

Camellia Precinct Boundary

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
PRECINCT BOUNDARY

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	001	A	1

2.0 BASELINE ANALYSIS METHODOLOGY

Golder previously prepared a two-stage contamination and remediation specialist study for the Camellia precinct (Golder (2015a &b)). The study was prepared on behalf of DPIE to support the Precinct wide LUIS. The scope of Part 1 of this study was similar to scope required by this Baseline Analysis Report to inform the CRPS. This Baseline Analysis Report builds on the assessments previously prepared by Golder (2015a & b) including: the previous review of published information sources such as historical information on the development of the Precinct: and published topographical, geological and soil maps, and selected groundwater bore data to establish the environmental setting of the Precinct.

2.1 Review background and historical information

Key information inputs to this process included the following review activities:

- High level review of post-2015 available reports relating to contamination and remediation within the Precinct. These included:
  - Environmental Impact Statements (EIS) associated specialist reports for recently proposed projects located within the Precinct including: the Parramatta Light Rail (PLR) (Stage 1) (SSI 8285[2]) project[3]; the Sydney Metro West project (SSI 10038) (potential contamination risk identified for the Clyde stabling and maintenance facility construction site and tunnel alignment); the Camellia Waste Facility (SSD[4]-4964); and the latest available information on projects located within the former Shell refinery site including: the Viva Energy Clyde Refinery Conversion Project (SSD 5147); the Western Area Remediation Project (SSD 9302); and the Central Sydney Industrial Estate and Downer Sustainable Road Resource Centre (SSD 10459).
  - Reports and correspondence made available by the NSW EPA.
  - Reports and correspondence made available by DPIE (including selected landowner supplied information).
  - Publicly available environmental assessment reports that have been prepared to inform Development Applications (DA) made to Council in the Precinct between 2014 and 2021.
- Update of information held on the NSW EPA's contaminated land public register to identify sites subject to existing notices and sites notified to the EPA as potentially contaminated and identify documented land use restrictions.
- Update of information held on the NSW EPA's public register under section 38 of the *POEO Act,* including information on sites within the Precinct subject to Environment Protection Licences (EPLs).
- Update of information held by Council on the Section 10.7 (previously Section 149) planning certificate relating to site contamination.
- Latest (post 2015) aerial imagery review.

2.2 Information ground truthing

A drive-by inspection of the Precinct was completed by Golder on 25 May 2021. The inspection was carried out to verify site conditions compared to the desk top document review and to make a record of the current

[2] State Significant Infrastructure.

[3] A Review of Environmental Factors (REF) under Part 5 of the *EP&A Act 1979* was completed for the first portion of the remediation works at the proposed PLR Stabling and Maintenance (SaM) Facility site located on Grand Avenue. The second portion was assessed through the EIS for the PLR (Stage 1) project.

[4] State Significant Development.

site land uses/activities. The findings of this drive-by inspection are noted throughout the report in respect of various individual properties and have been considered in summary presented in Section 7.0.

2.3 Contamination risk assessment

The data collated as part of the 2015 (Golder 2015 a & b) studies and updated and supplemented as part of the 2021 review, was compiled and used to assess and rank the risk of significant contamination issues throughout the Precinct that may influence future land use strategies. A Contamination Risk Assessment framework has been developed to assist with a preliminary ranking of contamination risks on individual sites throughout the Precinct using subjective risk categories.

The Contamination Risk Assessment considers the following factors, where relevant:

- Former and current site uses / activities (e.g. recreational, commercial, light industrial or heavy industrial).
- For industrial and commercial use, the following factors were also considered:
  - Industry type (e.g. manufacturing, oil refining, waste handling, non-hazardous commercial).
  - Date, duration and scale of operations.
  - Likelihood of large volumes of chemicals used on-site including potential underground or above ground storage tanks (USTs or ASTs).
  - Likelihood of more mobile contamination versus less mobile contamination.
- Proximity of other potentially contaminated land (e.g. location and extent of known groundwater contamination plumes) at and in the vicinity of the Precinct.
- Groundwater depth and likely flow direction at and in the vicinity of the Precinct.
- Location of land filling or historic reclamation activities.
- Current site condition based on observations made during the 'drive-by' inspections.

The contamination risk for each Lot was then qualitatively ranked. Key data gaps were noted and then implications for future land uses were assessed as part of a separate risk ranking process (as described in Section 9.0).

2.4 Geotechnical review

A preliminary geotechnical review was conducted as a part of this Baseline Analysis Report. This included a review of:

- The Sydney Geological Sheet 9130 (1:100,000)[5] and the Sydney Soil Landscape Series Sheet 9130 (1:100,000)[6].
- Geological and hydrogeological information in reports made available as part of this study.
- Golder's records from recently completed geotechnical assessments in the Precinct (e.g. PLR Stage 1 and Stabling and Maintenance (SaM) site remediation).

The results of this review were used to identify potential geotechnical issues and constraints as preliminary input for the master planning process, as well as provide general guidance on potential foundation types that would be suitable for the proposed range of mixed-use development.

[5] Herbert C. (1983)

[6] Chapman G.A. and Murphy C.L. (1989)

The outcomes of this review are presented in Sections 8.0 and 10.0.

2.5 Summary of information sources

The sources of information for the Baseline Analysis are identified in Table 1.

Table 1: Sources of Information for Baseline Analysis

Layer	Source
Lot and DP details	Digital cadastral data Department of Finance, Service and Innovation (DFSI) Spatial Services
Property boundaries	Digital cadastral data DFSI Spatial Services
Aerial photo image (current)	Nearmap Ltd
Historical aerial photographs: 1930, 1943, 1951, 1961, 1972, 1978, 1994, 2000, 2007, 2015, 2021	Copies of aerial photographs published by NSW Land and Property Information as electronic .tif files or hard copy photocopies. Review of photographs from 1930 – 2015 reported by Golder (2015a). This review has not been replicated herein but key relevant observations have been noted (Sections 4.4 and 5.1). Review of latest aerial (Nearmap image) is included Section 5.2 as part of the review of recent Precinct developments
Current land use zoning map	Digital data from the Parramatta Local Environment Plan 2011 supplied by Parramatta City Council
EPA Register of Notices issued under the *CLM Act.*	http://www.epa.nsw.gov.au/prclmapp/searchregister.aspx, EPA website, 26 June 2021
EPA Register of contaminated sites notified to the EPA issued under Section 60 of the *CLM Act*	http://www.epa.nsw.gov.au/clm/publiclist.htm, EPA website, 26 June 2021
EPA Register of sites holding Environment Protection Licences	http://www.epa.nsw.gov.au/prpoeoapp/, EPA website, 25 June 2021
Topography	Two-metre contours of the Precinct provided by NSW Land & Property Information
Geology	Sydney 9130 100:000 Scale Geological Sheet, NSW Department of Mineral Resources 1983
Soils	Sydney Soil Landscape Series Sheet 9130 (1:100,000 Scale), Soil Conservation Service of New South Wales, undated
Acid Sulphate Soils	Digital data from the Parramatta Local Environment Plan 2011 supplied by Council
Groundwater bore locations	National Groundwater Information System, maintained by the Australian Bureau of Meteorology
Section 10.7 Data	Digital data supplied by Parramatta City Council
Current site use	Drive-by inspection of Precinct by Golder on 25 May 2021

3.0 PRECINCT DESCRIPTION

3.1 Location and layout

The Precinct extent is presented in the attached **Figure 1.**

The Precinct is bound by James Ruse Drive to the west, the Parramatta River to the north and north-east, and Duck River and the Western Motorway (M4) to the south. The Precinct boundary adjacent to waterways is taken to be the mean high-tide limit.

3.2 Current Land Use Zoning

The current land use zoning for the Precinct, under *Parramatta Local Environment Plan 2011*, is presented in **Figure 2**. The land use zones of the Precinct are described in detail in the LEP and are summarised in the following.

3.2.1 Zone IN3 Heavy Industrial

The majority of the Precinct is zoned IN3 Heavy Industrial.

The key objectives of the IN3 Heavy Industrial zone are to support and protect a wide range of industrial and heavy industrial land uses which need to be separated from other land uses, and to encourage employment opportunities, whilst realising opportunities for potential public foreshore access on land currently contaminated and not suitable for public access.

3.2.2 Zone IN1 General Industrial

The land south of Duck Creek, excluding the Sydney Speedway and the Rosehill Heliport is zoned IN1 General Industrial. This area is currently used for a variety of small lot, light industrial uses.

The key objectives of the IN1 General Industrial zone are to support and protect a wide range of industrial and warehouse land uses, encourage employment opportunities, minimise impacts of industry on other land uses, and facilitate a range of non-industrial land uses that serve the needs of workers and visitors to land within this zone.

The land in this locality, including the Speedway and Heliport are included in the land to be acquired for the proposed Sydney Metro West Stage 1 Clyde SaM Facility.

3.2.3 Zone RE1 Public Recreation

Some land parcels bordering the Parramatta River, including 11B Grand Avenue and 1A Grand Avenue are zoned RE1 Public Recreation.

The key objectives of the RE1 Public Recreation zone are to enable land to be used for public open space or recreational purposes and protect and enhance the natural environment for recreational purposes, including creation of a riverfront recreational opportunity that enables a high-quality relationship between the built and natural environment.

3.2.4 Zone RE2 Private Recreation

Rosehill Gardens Racecourse, Sydney Speedway and the Rosehill Heliport are zoned RE2 Private Recreation.

The key objectives of the RE2 Private Recreation zone are to enable land to be used for a range of private open space or recreational purposes, including major sporting and entertainment facilities, and protect and enhance the natural environment for recreational purposes.

3.2.5 Zone B5 Business Development

The land between James Ruse Drive and the Carlingford Railway Line, and the site located at western end of Grand Avenue, are zoned B1 Business Development.

The key objectives of the B5 Business Development Zone are to enable a mix of business and warehouse/bulky goods uses that require a large floor area in locations close to centres. This zone also encourages a range of tourism, recreation, function and entertainment uses in proximity to the Rosehill Gardens Racecourse, the Parramatta River and the University of Western Sydney.

3.2.6 Zone SP2 Infrastructure

The following railways within the Precinct are zoned SP2 Infrastructure:

- The section of the Carlingford Line located parallel to James Ruse Drive.
- The goods railway line located parallel to and north of Grand Avenue.

The objectives SP2 Infrastructure zone are to provide for infrastructure and related uses and prevent incompatible development.

3.3 Land Use and Infrastructure Strategy and Draft Camellia Town Centre Master Plan

The 2015 Precinct wide Land Use and Infrastructure Strategy (LUIS) (Section 1.1) included the following key land use features:

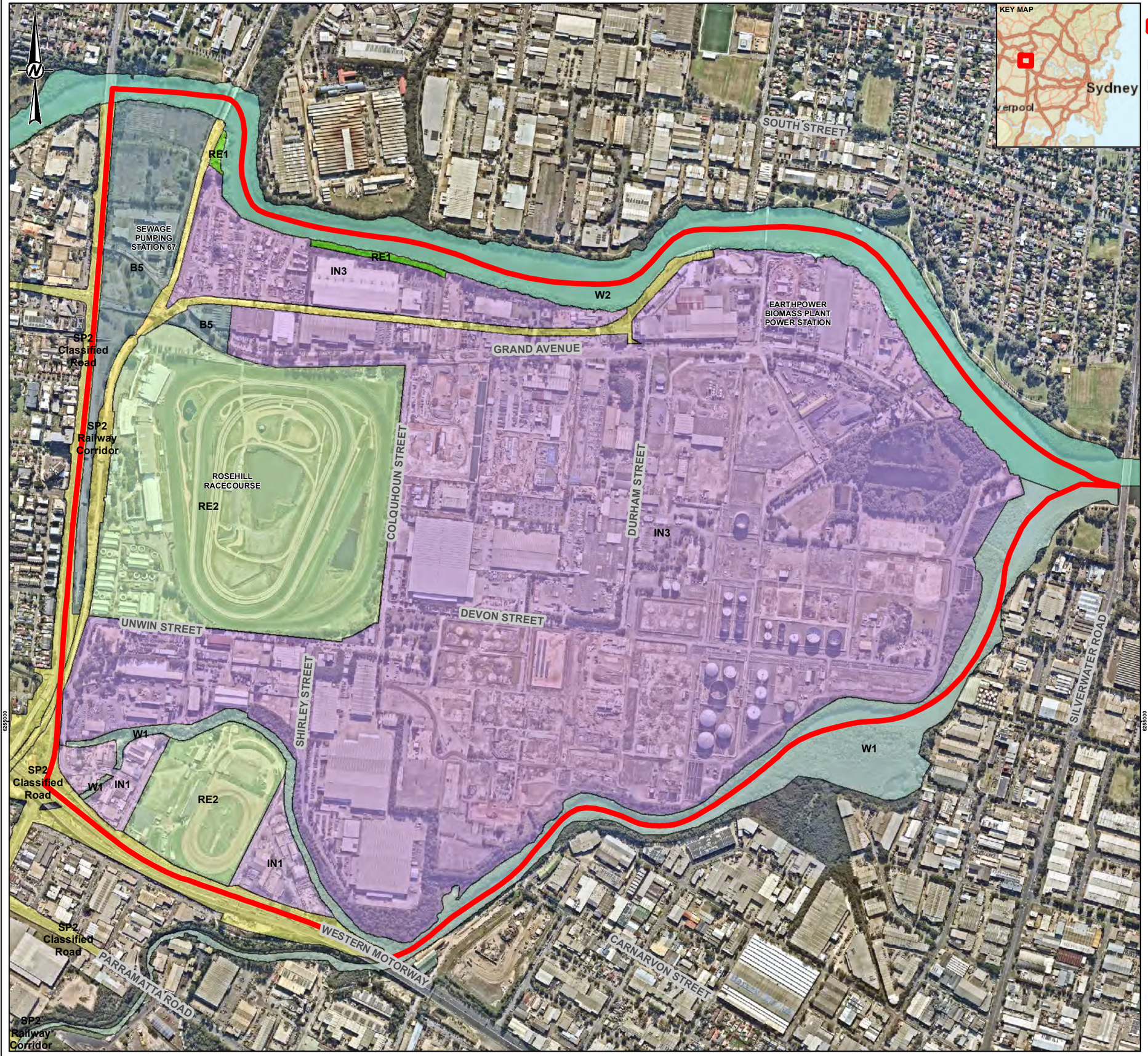
- Retention of heavy industry in the south and east of the Precinct except for the wetland in the east and two small portions of river frontage along the eastern end of Duck River, which would be Heritage Wetland.
- The use of the central and southern part of the Precinct, i.e. the land between Colquhoun Street and Durham Street and south of Unwin Street and Devon Street, except for Sydney Speedway and Rosehill Heliport, for General Industrial use. This represented a change from the Heavy Industrial zoning which applied to most of this area (excluding the areas south of Duck Creek for which there would be no change).
- Creation of a business/ entertainment precinct at Rosehill Gardens Racecourse.
- Mixed use development, including residential, in the north-west of the Precinct, around Rosehill and Camellia Stations. This represented a change from the current zonings of this area which included Heavy Industrial, Business Development and Private Recreation.
- Provision of an integrated transition zone in the northern part of the Precinct along the Parramatta River between the mixed-use precinct to the west and the industrial precinct to the east.
- Provision of public recreation along the Parramatta River foreshore area.

In summary, the LUIS provided for a transition from Heavy Industrial land use in the east, through General Industrial, to Business/Entertainment to Mixed Use in the north-west around the two railway stations. The proposed land use for land north of Rosehill Gardens Racecourse to the Parramatta River and the western third of the Rosehill Gardens Racecourse would be more sensitive. The proposal for land uses more sensitive than current zonings in large parts of the western two-thirds of the Precinct would exclude heavy industry from these areas.

In 2018 the draft Camelia Town Centre Master Plan was published and included a plan for the town centre adjacent to the Parramatta River, located in the northwest corner of the Precinct. It included mixed land use integrated with the Parramatta Light Rail (Stage 1) and regeneration the Parramatta River foreshore, including

a new river front parkland. The plan also proposed a ground filling strategy which created a uniform ground plane to address potential flooding issues.

Proposals to rezone land use, particularly to more sensitive land uses with increased risk of exposure to sensitive receptors, e.g. residential and/ or recreational open space needs to ensure the potential risk to human health or the environment is not increased. Typically rezoning to more sensitive land uses triggers requirements for remediation. In proposing rezoning there is a requirement to ensure land is suitable or can be made suitable for the rezoned use. As noted in Section 1.3.2.1 this requirement is captured under Ministerial direction (No 2.6) Remediation of Contaminated Land (under Section 9.1 of the *EP&A Act)* such that rezoning should only proceed on the basis that measures are in place to ensure the potential for contamination and suitability of land or any proposed land use are assessed once detailed proposals are made.



LEGEND

- Camellia Precinct Boundary

Camellia_Zoning

- B5
- IN1
- IN3
- RE1
- RE2
- SP2
- W1
- W2

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021
2. LAND ZONING: ENVIRONMENTAL PLANNING INSTRUMENT - LAND ZONING DPIE 2019

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
CURRENT LAND USE ZONING

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	001	A	2

PATH: V:\NSW DPIE\Camellia-Rosehill\99_PROJECTS\21465238-Place_Strategy\001 - Baseline Report\21465238-001-RevA-F002-LandZoning.mxd PRINTED ON: 2021-06-30 AT 7:54:51 AM

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4.0 ENVIRONMENTAL SETTING

The following sections provide a review the environmental setting of the Precinct to understand the implications for contamination and geotechnical behaviour.

The Precinct drains naturally to the Parramatta River and the Duck River, according to the topography. In general the northern half of the Precinct drains to the Parramatta River and the southern half drains to Duck River. The south-west corner of the Precinct is also drained by Duck Creek, a tributary of Duck River and a small section of A'Becketts Creek which drains into Duck Creek.

Flood risk mapping (1:100-year recurrence interval) provided by Council indicates that large parts of the eastern, southern and north-western areas of the Precinct are at risk of flooding (WSP, 2021).

4.1 Topography and Drainage

The Precinct comprises low lying land bound by the Parramatta River to the north and east, and Duck River to the east and south. The 1:4000 Scale Orthophotomap Series of the Precinct (Parramatta U0052-4 and U0052-5, Central Mapping Authority of New South Wales, First Edition 1977) indicate that the elevation of the Precinct varies from the highest natural point of approximately 12 m AHD adjacent to Rosehill Railway Station, falling to approximately 7 m AHD at Rosehill Gardens Racecourse and to approximately 3 metres Australian Height Datum (m AHD) in the east. The northern and southern boundaries of the Precinct adjoining the Parramatta and Duck Rivers are also low points. In summary the Precinct slopes downwards to the east, as well as downwards to the north from its mid-point and similarly downwards to the south.

4.2 Geology

The geology of the Camellia Peninsula comprises residual clays, sediments and fill material overlying bedrock.

The Sydney 9130 100:000 Scale Geological Sheet (Herbert C,1983) maps the eastern two-thirds of the Precinct (i.e. the part of the Precinct east of Rosehill Gardens Racecourse) as comprising man-made fill – dredged estuarine sand and mud, demolition rubble, industrial and household waste.

Parramatta City Council's acid sulphate soil risk maps identify all of the Precinct other than the high land near Rosehill Railway Station as being disturbed land (refer to **Figure 3**). Golder considers that the disturbed land has potential to have been impacted by fill material. Further comments on the fill material are provided in Section 4.4.

The fill overlies Tertiary (Miocene) estuarine (tidal) sediments of sand, clay and peat, with extensive ferruginous mottles. The clay is thought to be an estuarine silt or mud which was overlain by a laterite horizon and subsequently altered to a plastic grey clay with extensive ferruginous mottles.

The western third of the Precinct is mapped as comprising fluvial (river flow) Quaternary silty to peaty quartz sand, silt, and clay, with ferruginous and humic cementation in places and common shell layers. The Quaternary deposits include basal Pleistocene (early-mid Quaternary) deposits of stiff clay and sandy clay with minor sand, shell, and peat layers in many areas. The eroded surface of the Pleistocene sediments is commonly deeply weathered; the uppermost clays are leached, iron stained, and mottled white, red, and light grey.

The Tertiary and Quaternary sediments are underlain by Ashfield Shale (black to dark-grey shale and laminite deposited in a prodelta to delta environment) of the Middle Triassic Wianamatta Group,

The Ashfield Shale is underlain by the fluvial (river flow) deposited Hawkesbury Sandstone (medium to coarse-grained lithic sandstone). The top of the Hawkesbury Sandstone is mapped as sloping across the

Precinct downwards from a depth of approximately 5 metres below mean sea level in the north to a depth of approximately 40 metres below mean sea level in the south.

4.3 Soil (including Acid Sulphate Soil)

The Sydney Soil Landscape Series Sheet 9130 (Chapman G.A. and Murphy C.L., 1989) maps the soils within the Precinct (other than in the vicinity of Rosehill Railway Station) as “Disturbed Terrain”, which has been extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Land fill includes soil, rock, building and waste materials.

The wetland in the north-east part of the Precinct is mapped as a coastal swamp, with the soils comprising deep Organic Acid Peats, Peaty Podzols and Humus Podzols often overlying pale Siliceous Sands.

The soil in the vicinity of Rosehill Railway Station, the highest natural part of the Precinct, is mapped as the Glenorie soil landscape, comprising Yellow Podzolic Soils subject to high soil erosion hazard, and localised impermeable high plastic subsoil. However, these soils are likely to have been modified by development in the area.

The extent of Acid Sulphate Soils in the Precinct has been mapped by Council as part of the *Parramatta Local Environment Plan 2011* (Refer **Figure 3**). Clause 6 of the LEP states the following:

(1) The objective of this clause is to ensure that development does not disturb, expose or drain acid sulfate soils and cause environmental damage.

(2) Development consent is required for the carrying out of works described in the Table to this subclause on land shown on the Acid Sulfate Soils Map as being of the class specified for those works.

Class of land	Works
1	Any works.
2	Works below natural ground surface. Works by which the water table is likely to be lowered.
3	Works more than 1 metre below the natural ground surface. Works by which the water table is likely to be lowered more than 1 metre below the natural ground surface.
4	Works more than 2 metres below the natural ground surface. Works by which the water table is likely to be lowered more than 2 metres below the natural ground surface.
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum by which the water table is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1,2,3 or 4 land.

(3) Development consent must not be granted under this clause for the carrying out of works unless an acid sulfate soils management plan has been prepared for the proposed works in accordance with the Acid Sulfate Soils Manual and has been provided to the consent authority.

(4) Despite subclause (2), development consent is not required under this clause for the carrying out of works if:

(a) a preliminary assessment of the proposed works prepared in accordance with the Acid Sulfate Soils Manual indicates that an acid sulfate soils management plan is not required for the works, and

(b) the preliminary assessment has been provided to the consent authority and the consent authority has confirmed the assessment by notice in writing to the person proposing to carry out the works.

(5) Despite subclause (2), development consent is not required under this clause for the carrying out of any of the following works by a public authority (including ancillary work such as excavation, construction of access ways or the supply of power):

(a) emergency work, being the repair or replacement of the works of the public authority required to be carried out urgently because the works have been damaged, have ceased to function or pose a risk to the environment or to public health and safety,

(b) routine maintenance work, being the periodic inspection, cleaning, repair or replacement of the works of the public authority (other than work that involves the disturbance of more than 1 tonne of soil),

(c) minor work, being work that costs less than $20,000 (other than drainage work).

(6) Despite subclause (2), development consent is not required under this clause to carry out any works if:

(a) the works involve the disturbance of less than 1 tonne of soil, such as occurs in carrying out agriculture, the construction or maintenance of drains, extractive industries, dredging, the construction of artificial water bodies (including canals, dams and detention basins), foundations or flood mitigation works, or

(b) the works are not likely to lower the water table.

The distribution of acid sulphate soils in the Precinct as presented in **Figure 3** may be summarised as follows:

- Class 2 – A relatively short and narrow margin on the north boundary along the Parramatta River, and the eastern half of the northern bank of Duck River.
- Class 3 – The eastern third of the Precinct.
- Class 4 – The Central and western two thirds of the Precinct.
- Class 5 – The vicinity of Rosehill Railway Station, adjacent to James Ruse Drive within the Rosehill Gardens Racecourse property.

The provisions of Clause 6.1 would trigger the need for development consent and preparation of an Acid Sulphate Soils Management Plan for development across the majority of the Precinct depending upon the depth of works below ground surface and/or the depth of lowering of the groundwater table relative the acid sulphate soil risk class identified on the Acid Sulphate Soil Map contained in the Parramatta LEP. The Plan would require that potential acid sulphate soils disturbed by a development be treated and/or appropriately disposed of so as to prevent the generation of acidic conditions.

4.4 Landfilling and Reclamation

The Precinct has been subject to various periods of landfilling and reclamation. No maps of the extent of landfilling have been sighted beyond those of the 1:100,000 scale geology and soil maps referred to previously. The fill was placed to increase the level of the land in the lower areas adjoining the Parramatta River, Duck River and Duck Creek. Hence the depth of fill is considered likely to be greater in the northern, southern and eastern margins of the Precinct. Fill was initially placed in the Precinct to raise the level of the land prior to industrial development in the early to mid-20th century. The Golder (2015a) historical aerial photograph review identified several subsequent landfilling events in the Precinct including:

- The filling of an asbestos setting pond at 1 Grand Avenue between 1951 and 1961.
- Filling of land at 14 Thackeray Street and along the eastern end of Grand Avenue, including 12, 37 and 39 Grand Avenue during 1961.
- Filling from the south of the wetland located in the northeast of the Precinct on the Clyde Refinery site between 1961 and 1978. Filling of this area appeared to have been completed by 1994. It is widely reported that the wetland area received hexavalent chromium impacted fill (CM Jewell & Associates Pty Ltd (CMJA), 2005).

- Filling of the former clay quarry (James Hardie landfill, Section 6.1.2) located along the north side of Devon Street between 1961 and 1978, with filling appearing to progress from east to west. By 1994 the eastern end was occupied by a building and filling was continuing at the western end. All filling had been completed by 2000.
- Filling of former ponds at 15 Grand Avenue between 1972 and 1978 (the Mauri Foods site where regulation is being finalised, Section 6.1.1).
- Filling of former ponds at 4-8 Grand Avenue between 1978 and 1994. This had been completed by 2000.

The presence of fill material throughout the Precinct has been reported by various authors as noted in the following:

- Along the southern bank of the Parramatta River, at 11B Grand Avenue, approximately 2.0 metres of fill was identified overlying a natural sequence of clays, silts, sandy clays, silty sands and clayey sands, with rare lenses of cleaner sands (CM Jewell & Associates, March 2007b). The soil and groundwater at the site was found to not be impacted with hexavalent chromium.
- 11 Grand Avenue – The site of the former Goodyear tyre factory, located south of 11B Grand Avenue, and since remediated and redeveloped for occupation by Australian Pharmaceutical Industries (API). Although localised remediation of this site occurred prior to its most recent redevelopment, the site is documented to be underlain by 1-2 metres thickness of fill materials, with fill thickness increasing towards the north consistent with reclamation works along the frontage with the Parramatta River. Fill sources are undocumented but fill was noted as containing ash layers (Golder 1996).
- 181 James Ruse Drive – The site was extensively filled as part of its progressive acquisition during the 1950s and 1960s. Initially it was filled with coal ash and asbestos wastes and fill was progressively placed along the eastern portion, filling towards the Parramatta River in the north and alongside the rail line in the east. Site roads were also filled with ash and asbestos wastes. Fill materials ranging in approximate thickness from 0.0 to 4.0 metres below ground level (bgl) are present across the site, including up to 4 m thickness of placed asbestos fill mixed with gravels and sands, mainly in the eastern portion of the site. Waste fill placed in the southeast corner is also mixed with boiler ash. In addition, general fill (between 1 and 10 metres bgl) comprising reworked soils covers the remainder of the site. There is visual evidence of asbestos wastes in the foreshore area adjoining the Parramatta River (Golder 2015b).
- 1 Grand Avenue – Most of the area of this site is underlain by fill impacted with asbestos to varying degrees from deep fill (approximately 5 metres or greater bgl) containing abundant asbestos in the western part to relatively shallow fill (approximately 0.2 m bgl) in the eastern part (CES, 2008).
- 14 Grand Avenue - North-east corner of the Shell Refinery site, natural soils were overlain by an average thickness of 2 metres of infill material (AWT, May 1995). The fill material was impacted with hexavalent chromium.
- 4-8 Grand Avenue – Permeable fill material up to 2.6 metres depth was reported (AWT, May 1995). The fill material was impacted with hexavalent chromium. The recent remediation of this site to accommodate the PLR (Stage 1) SaM facility has confirmed fill materials across the site associated with former inground treatment ponds located to depths of between 4 and 6 m bgl as well as former (c.2009 – 2010) remediation areas infilled with either reworked natural materials or remediated fill/ overburden, including some materials impacted by asbestos, to create ongoing contaminated fill containment areas. In summary, impacted fill materials located on site at the commencement of the most recent program of remediation works (c. 2019 onwards) were present between 0.2 m bgl (i.e. below the surface slabs) and depths of between 2.3 and 4 m bgl. Fill materials are variably contaminated by the identified site contaminants of potential concern (CoPC), namely hexavalent chromium, volatile chlorinated hydrocarbons (VCH) and asbestos. The most recent remediation of the site includes a contaminated fill containment (comprising construction of a Hydraulic Barrier Wall

(HBW), integrating a vertical vadose zone vapour barrier (VZB)) of the site perimeter and construction of surface capping using an Integrated Capping System (ICS).

- 10 Grand Avenue – This site was assessed as part of a development application during 2017 (JBS&G, 2017). The site was noted to be impacted with imported fill with previous investigations reporting surface sandy fill materials, with anthropogenic inclusions, including asbestos cement sheeting, ranging to depths of up to 2.6 metres below surface ground level.
- 12 Grand Avenue – A Statement of Environmental Effects (SEE) prepared for the proposed boundary alteration and subdivision at the site (GHD, September 2020) confirms that the site has been subject to various periods of landfilling and reclamation, with fill placed to raise site levels containing hexavalent chromium wastes. Fill was also noted to be impacted with petroleum hydrocarbons. The SEE also noted that the Council owned portion of land proposed to be incorporated into the 12 Grand Avenue site was used as a landfill by Council from 1970 to 1996 and received road works wastes, municipal wastes and green waste.
- 27 Grand Avenue, the Sandown Rail corridor – This rail corridor runs parallel to Grand Avenue and along the Parramatta River foreshore area northwest of the Boral Australian Gypsum Limited (Boral site) located at 3 Thackeray Street. The western portion of the corridor was incorporated into the PLR (Stage 1) construction footprint. The residual corridor to the east is understood to have been filled with asbestos wastes from James Hardie, particularly the area adjoining the Parramatta River. This is based on a review of previous site assessment reports provided to Coffey and reviewed as part of the PLR Stage 1 Environment Assessment Contaminated Land Technical Paper 16 (Coffey, 2017). Coffey (2017) noted that fill comprising friable and non-friable asbestos was in the foreshore embankment. This was identified as part of a 2007 investigation, completed to establish if the area had been filled with hexavalent chromium wastes. Although no chromium wastes were identified in the embankment, subsequent capping works were completed c.2007 for the asbestos wastes at the site surface. Coffey (2017) noted that although additional remediation action was proposed it was not known whether this had been completed. A review of Nearmap aerial photography indicates that major earthworks (presumably remediation/ stabilisation works) were completed along the embankment during the period 2015 to 2016. There appears to have been rock armour placed along the edge of the river at the base of the embankment. Whilst some vegetation appears to have been removed to facilitate these works, it was not as dense as along other sections of the Parramatta River foreshore and is likely to represent an erosion zone.
- The presence of fill material (depth not specified) was also reported at 16 Grand Avenue and 37 Grand Avenue (AWT, 1995). The fill material at 16 Grand Avenue was found not to be impacted with hexavalent chromium. At 37 Grand Avenue, due to the presence of hexavalent chromium in groundwater it was concluded that the fill material was impacted with hexavalent chromium. CMJA (2007a) confirmed the site is covered by 1.5 metres of fill overlying alluvial deposits. Some asbestos materials were found in surface fill. The site is located on mostly reclaimed land with Chromium Ore Processing Residues (COPR), asbestos cement sheeting and other building demolition wastes. The northern half of the site is shown in historical aerials as former swamp land. The contamination of the site with COPR was confirmed as part of a Veolia prepared remediation fact sheet[7] prepared to support a development application for the redevelopment of the site to a Camellia Recycling Centre (Section 5.2).
- 39 Grand Avenue and 17 Grand Avenue – These sites were assessed as part of the 2007 assessment of Camellia Peninsula sites for hexavalent chromium wastes (CMJA 2007c). The site at 39 Grand Avenue, as noted in the aerial photograph review was subject to filling during the 1960s. The site at 17 Grand Avenue was an associated weighbridge site which was previously (prior to 1950s) occupied by the Rosehill train station. At the time of the assessment the 39 Grand Avenue site was occupied by a Patrick container yard located and it was confirmed as covered by 1.5 metres of fill overlying alluvial deposits. The weighbridge site was covered by 1 metre of fill over clay. The majority of the fill on the 39 Grand Avenue site was noted to comprise COPR with the northern part of the site shown in

[7] https://www.veolia.com/anz/our-services/services/municipal-residential/recovering-resources-waste/camellia-recycling-centre

historical aerials as former swamp land. Hexavalent chromium was not detected on the weighbridge site.

- 14A Grand Avenue - This site was also assessed as part of the 2007 assessment of Camellia Peninsula sites for hexavalent chromium wastes (CMJA 2007d). At the time of the assessment the 14A Grand Avenue site was occupied by Hymix Australia Pty Limited as a concrete batching plant. The site was confirmed as covered by 1.5 metres of fill overlying alluvial deposits with some asbestos containing materials located in surface fill.
- Thackeray Street – clay fill material beneath the road pavement to a depth of between 0.9 and 2.7 metres below ground surface, generally thickening to the north, comprising grey-brown gravelly sand or sandy gravel of crushed igneous rock and inclusions of fibre-cement fragments overlying further fill of grey-green sand with some gravel, dark grey gravelly silty sand, brown gravelly clay and brown silty clay with some gravel (Jeffrey and Katauskas 2010 and Douglas Partners 2012).
- Land located at the corner of Durham Street and Grand Avenue - forming part of Viva Energy's operational Parramatta Terminal site. The land was investigated in 2016 as part of a development application for redevelopment to a commercial vehicle retail outlet (ERM, November 2016). The report referenced contamination studies for adjoining land and confirmed the site is located in an area of historical land use with confirmed on and off site potentially contaminated land use activities including: the storage and handling of hydrocarbon-based fuels, during former rail gantry operation and the historical importation of uncontrolled fil materials. Minimum fill depths of 0.5 metres were anticipated on the site.
- Grand Avenue – along an approximately 1.3 km length of the median strip, from adjacent to 5 Grand Avenue in the west, through to boundary of 10 and 10A Grand Avenue in the east, test pitting at 22 locations identified fill at each location to depths between 0.3 and 0.5 metres. Fibre-cement sheeting fragments were evident at 10 of the locations, with asbestos confirmed to be present in six of seven samples subject to laboratory analysis, and asbestos was detected in soil samples at two locations. (Noel Arnold & Associates, September 2011). At three major median islands in Grand Avenue, fill material was detected beneath the concrete paving to depths of between 0.3 and 0.64 metres, comprising variable sand and gravel. No asbestos was detected in the analysed samples.
- Along Grand Avenue, east of Thackeray Street, fill material was found beneath the road pavement, comprising clay fill varying from 1.0 to 1.7 metres depth, over slag fill to a depth varying from 1.7 to 2.3 metres below ground level (Jeffery and Katauskas Pty Ltd 2010).
- 5 Devon Street - Several land parcels located north of Devon Street and west of Colquhoun Street are regulated by the NSW (Section 6.1.2) and described as the "James Hardie Landfill". This land is located on the site of a former clay pit (excavated for clay tile manufacturing c. 1915) which was progressively filled with waste including old roofing tiles and asbestos wastes (from the adjoining James Hardie manufacturing plant) and some uncontrolled fill, including potential putrescible waste. Fill thickness are understood to be up to 8 metres deep.
- The Viva Refinery site – AECOM (2019) (refer Section 5.2, SSD 9302) note that the refinery site is underlain by fill comprising of poorly compacted silt, sand, clay and gravel with isolated areas of slag rubble, furnace ash and concrete. Fill is reported to have been placed across the site to raise low lying swampy areas adjacent to tidal flats. Generally, fill depths range from 1.0 to 1.5 metres with a maximum recorded depth of 3.0 metres.
- 1A Unwin Street, Rosehill – A development application for the site in 2016 included and Environmental Impact Statement with a contamination report attached (Douglas Partners 2006). The 2006 site assessment completed when the site was being operated as an asphalt plant confirmed site fill materials underlain by alluvial soils. Fill was thickest in the eastern and southern portions of the site where depths of up to 6 mbgl were encountered. This site was also noted as a site of potential contamination concern for the Sydney Metro West Project (SSI-10038) (Section 5.2).

4.5 Groundwater

The Camellia Peninsula as an elevated terrace of alluvial materials exposed during the recession of sea level in the early Pleistocene. The eastern part of the peninsula was previously an area of tidal flats and mangrove swamps between the Parramatta and Duck Rivers. The following water bearing units are identified on the Camellia Peninsula:

- Hawkesbury Sandstone / Mittagong formation;
- Wianamatta Group (Minchinbury Sandstone/Ashfield Shale);
- Quaternary Sediments; and
- Fill material.

The presence of groundwater in the bedrock of the Precinct will be influenced by the geology (Section 4.2) and is summarised as follows:

- The Wianamatta Group Ashfield Shale generally yields saline water which is also hard. The water is generally too saline even for stock watering and there are not many bores in the Wianamatta Group within the Sydney area.
- Hawkesbury Sandstone – water is generally of good quality ranging in salinity from 200 to 840 mg/L total salts. Water bearing zones are encountered mostly at depths of 10 metres to 50 metres. Low yields generally limit use to domestic and small-scale stock requirements which are not applicable to the Precinct.

It is noted that the Precinct is located in an area serviced by reticulated potable water supply as well as an industrial water recycling plant. There are no known users of groundwater in the Precinct. Given the high salinity and/or low yield of groundwater, it is considered unlikely that attempts to use groundwater for industrial purposes would be successful.

The principal groundwater units likely to be impacted by groundwater contamination on the Precinct are the overlying Quaternary sediments and fill materials (Section 4.4).

Groundwater levels in fill and Quaternary sediments compiled for the Camellia Peninsula[8] indicate that the groundwater level on the peninsula ranges from approximately 7 m AHD beneath Rosehill Gardens Racecourse in the west of the Precinct to a tidal mean of about 0 m AHD beneath the mudflats fringing the northern, eastern, and southern side of the peninsula. The resulting regional groundwater flow would generally be radial towards the Paramatta and Duck Rivers with a groundwater divide along the centreline of the peninsula. On the PLR SaM remediation site, for example, regional groundwater levels indicate a general groundwater flow in a north-easterly direction over the majority of the site, with an almost easterly groundwater flow direction along the southern site boundary.

In summary, in the low-lying areas underlain by significant thickness of estuarine deposits and man-made fill, the groundwater table is expected to be shallow and typically within three metres to five metres of the ground surface. For example, groundwater was present within the Quaternary sediments and has been encountered at depths between 0.8 metres and 4.5 metres below ground level (for example along Grand Avenue by Douglas Partners, April 2013 and GW Engineers, December 2010). The pre-remediation groundwater levels on the PLR SaM site were generally found to have ranged between RL 3.5 m AHD and RL 6 m AHD across the site with the lower elevation occurring in the northern part of the site and the higher elevation in the central and/or southern part of the site.

[8] Compiled as part of the PLR Stage 1 SaM site remediation.

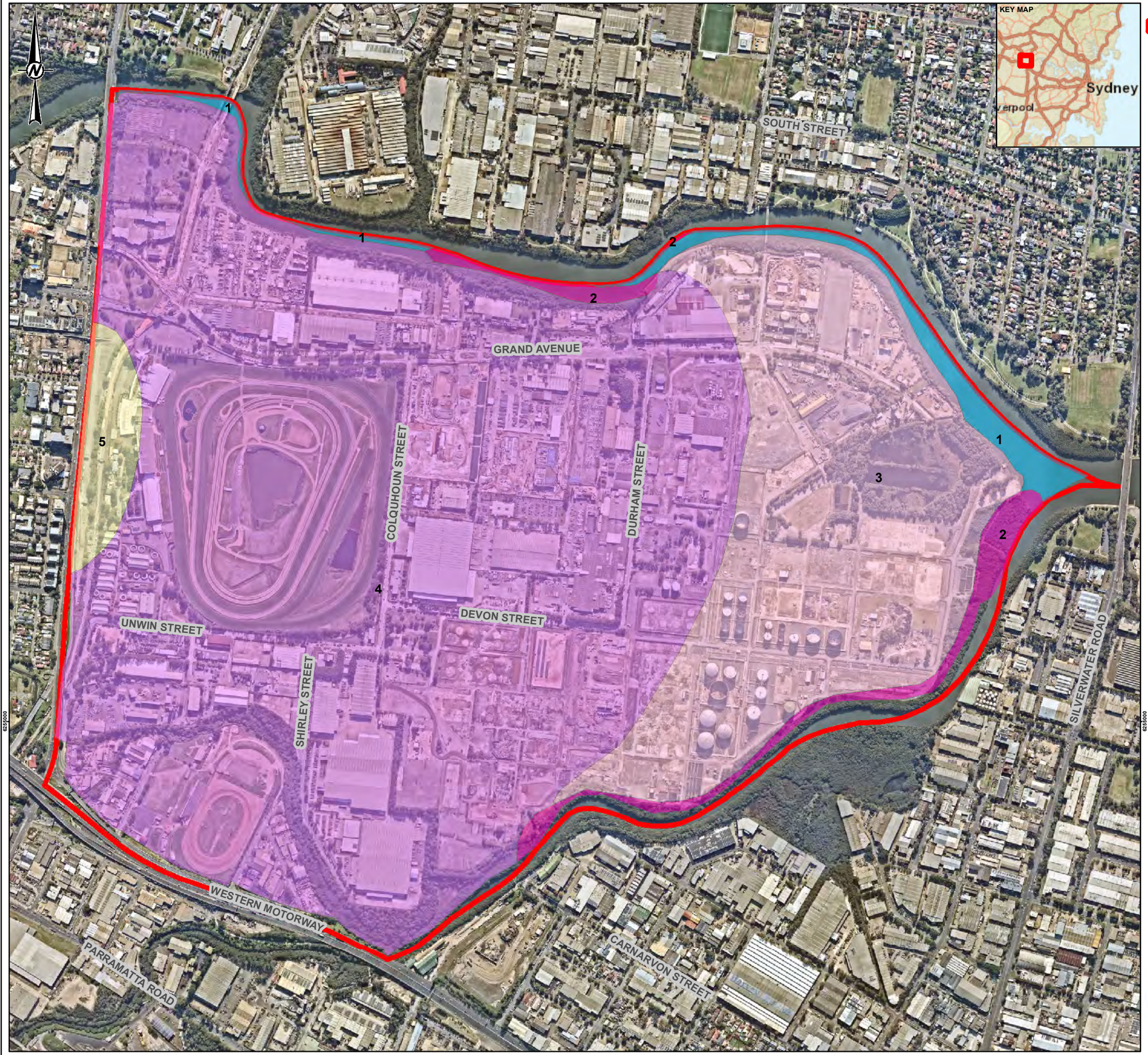
The CMJA assessments in the northeast of the Precinct (CMJA, 2007a-d) generally encountered groundwater at 3 to 3.25 m below ground surface and flow was towards the Parramatta River, with groundwater levels on several of the assessment sites influenced by tidal variations.

DPIE (2020) and AECOM (2019) note that groundwater flow direction on the southern portion of the former Shell refinery site is generally towards the south-east and east, following the riverbank contour of Duck River. Groundwater is represented in this area as a shallow unconfined aquifer within estuarine alluvial sediments at depths between 1 and 3 metres bgl.

4.6 Implications of Environmental Setting on Contamination Risk

The environment of the Precinct is characterised by low gradients; fill material; sediments varying between sand, clays and laterites; overlying relatively impermeable shale and sandstone bedrock. The fill material and more permeable sediments, with shallow groundwater, create an environment where contaminants may infiltrate the ground and then migrate downwards and laterally through the more permeable zones. The fill material which has been placed across the historically lower areas of the Precinct presents a potential source of contamination.

The presence of potential acid sulphate soils would require management during excavation works to prevent generation of acid forming conditions.



LEGEND

- Camellia Precinct Boundary
- Class 1
- Class 2
- Class 3
- Class 4
- Class 5

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021
2. ACID SUFATE SOILS CLASSIFICATION: PARRAMATTA CITY COUNCIL 2015

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
ACID SULFATE SOILS DISTRIBUTION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
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5.0 LAND USE

5.1 Historical Land Use

The following historical land use review is based on the review compiled as part of the Golder (2015a) *Contamination Study – Part 1 – High Level Contamination Review.* The Golder (2015a) Precinct historical land use review was primarily based on published historical records, historical reviews completed as part of Precinct wide contamination assessments and a review of historical aerial photography for the period 1930 to 2015. The land use review serves to demonstrate how historical land use in the Precinct with potentially contaminated land use activities has contributed to widespread contamination legacy issues.

5.1.1 History of Rosehill

The history of the Precinct was compiled by Golder (2015a) from the following sources:

- John McClymont (2009). www.dictionaryofsydney.org *Sydney Journal* 2(1) June 2009 Camellia John McClymont pp 82–91 ISSN 1835-0151 http://epress.lib.uts.edu.au/ojs/index.php/sydney_journal/index.
- *A History of the Extinct Residential Suburb of Camellia*, As researched 2004 by: Brian and Enid Turbit.
- AWT Ensight (Australian Water Technologies), *Chromium Contamination of Parramatta River at Camellia, Phase One Draft Report*, 22 May 1995.
- CM Jewell & Associates Pty Ltd*, Investigation of Chromium Contamination in Groundwater, Camellia Peninsula*, for Parramatta City Council, Report No. J1215.3R-rev1.Council, March 2007b.

5.1.1.1 General History

The Precinct was one of the first areas settled in Sydney. Charles Williams (alias Christopher Magee) was the first person granted land in Camellia, comprising comprised 30 acres (12 hectares) was located on the southern bend of the Parramatta River. Magee sold his grant to Lieutenant Cummings. In the 1793, approximately 40 hectares of the Camellia Peninsula was granted to John Macarthur and established as Elizabeth Farm. Macarthur then purchased the land grants of Magee and Cummings, and extended Elizabeth Farm's holdings to over 1100 acres (445 hectares) by acquiring another grant which he called Glenfindless Farm (825 acres, 334 hectares). Elizabeth Farm now included the entire area of the Precinct.

Macarthur's sons leased five acres (two hectares) of land on the southern banks of the Parramatta River, between the present Camellia Railway Station and James Ruse Drive, to Silas Sheather in 1852 for the Camellia Grove Nursery which specialised in growing Camellias.

By 1870 Silas' house on the property was surrounded by fruit trees, shrubs and beehives as well as the camellia nursery. Visitors could access the nursery by the paddle-wheel steamers, using the wharf adjacent to his property at the end of River Road West. A bridge, known as Sheather's Bridge, crossed Clay Cliff Creek (west of what is now James Ruse Drive) to his property.

Elizabeth Farm remained intact and in the Macarthur family until 1880 when the estate was sold to the solicitor Septimus A Stephen, who then subdivided it, advertising the area as 'Rosehill'. Large parts of the Camellia Peninsula were subdivided for industrial purposes.

Entrepreneur John Bennett bought a large slice of Rosehill and established a racecourse (which became Rosehill Gardens Racecourse) and recreation grounds in April 1885. By 1886 the Precinct had the following features:

- Rosehill Gardens Racecourse.
- Rosehill Railway Station and Camellia Railway Station (called Subiaco) on what is now the Carlingford line.

- The Ferries Ltd Tramway, extending east-west along the approximate alignment of the current Grand Avenue and Grand Avenue North.
- A railway siding extending eastwards from the Carlingford line, eastwards parallel to and south of Unwin Street, crossing Shirley Street, to the eastern part of the Precinct, referred to as the Shell Siding.
- A railway line extending from near Camellia Railway Station, eastwards, along the alignment of the current railway line in Camellia (the Sandown Line), to a meatworks at the eastern end, on the approximate location of the site at 14 Thackeray Street now occupied by Concrete Recyclers.
- Aust. Kerosene and Mineral Co. owned land in the approximate position of what is now 11 Grand Avenue, occupied by Australian Pharmaceutical Industry Pty Ltd.

In 1889 Silas Sheather purchased the two hectares of land he occupied under lease from Septimus Alfred Stephen. On Sheather's death in 1906, his land was leased to two Chinese gardeners named Charlie and Jimmy. Some of Sheather's land had already been purchased for a railway, and the balance was subdivided and gradually sold to small investors. The southern boundary of Sheather's land apparently became River Road West. The land was sold to James Hardie and Company in 1916.

Land east of Rosehill Gardens Racecourse was increasingly attractive to manufacturers, because of its river frontage and rail connections. In the 1910s Wunderlich established a plant in Rosehill (at 10 Grand Avenue, since occupied by CSR and more recently proposed for light industrial redevelopment including offices, car parking and warehousing) to produce the red tiles that were a feature of contemporary Federation housing. Clay for the roof tiles was excavated on the southern part of the property.

The clay pits eventually extended along the northern side of the full length of Devon Street and were later filled with waste including asbestos waste from the James Hardie factory (inferred from aerial photographs to be during the 1960s and 1980s). It is further noted that filling of the quarry with building material wastes (asbestos and tiles) was largely uncontrolled prior to the issue of a disposal licence in 1972 from the Metropolitan Waste Management Authority. Other uncontrolled imported wastes were likely received at the site prior to licensing. Given that the fill progression shown in historical aerial photographs was from east to west, it is likely that any uncontrolled fill is located in the eastern portion of the landfill.

During the 1910s, John Fell set up a shale oil refinery on the Duck River and in the 1920s began to refine crude oil. Development of the site was made possible by the construction of a railway siding and the Duck River wharf. In 1928, he sold the operation to Shell Oil, which expanded the operations during much of the twentieth century, forming the Clyde Oil Refinery, the oldest refinery in Australia and the largest industrial site facility in the Precinct. Refining operations ceased in 2012 and the site has since been converted to a fuel import, storge and distribution terminal (Clyde Terminal) operated by Viva Energy Australia Pty Limited (Viva) (Section 5.2). The refinery infrastructure has been demolished to ground level.

In the early 1900s, the area between Camellia Railway Station and Aston Street (now James Ruse Drive), i.e. part of the former James Hardie site, was developed as the residential suburb of Camellia, possibly for employees of the industries that were establishing in the area.

The Camellia to Sandown industrial branch line served James Hardie & Co employees.

There was reference to “the kerosene wharf” on the Parramatta River and Salt Works Point at the Camellia Peninsula. The specific timing and location of these features is not known.

The Metropolitan Water, Sewerage & Drainage Board constructed a bridge to a carry sewer pipe over the river near River Road West, Camellia, in the vicinity of the James Hardie site.

The new bridge for James Ruse Drive was opened on 22 June 1966 and the name changed from Aston Street sometime after 1977.

5.1.1.2 Transport to Camellia

In 1883 a steam tram line was constructed by Charles Edward Jeanneret from a wharf at the junction of the Parramatta and Duck Rivers through the Camellia Peninsula to Parramatta. The purpose of the tramway was to provide a faster and more reliable transport service between Parramatta and Sydney. The line travelled along its right of way leased from the Elizabeth Farm Estate and crossed a specially built bridge over Clay Cliff Creek. With the subdivision of the Elizabeth Farm Estate, the steam tramway became an important factor in opening the industrial sites of Camellia. Industrial customers such as Meggitt's at Parramatta depended on the tram/ferry as an inexpensive transport medium both to and from its works. In turn, the subdivision of a township to house workers followed, with convenient inexpensive transport to and from Parramatta.

Camellia Railway Station was opened as Subiaco Railway Station on 21 February 1885 and changed to Camellia, 14 September 1901 after “Camellia Grove”, which was the name of Silas Sheather’s property. The railway line was taken over by the state government in 1904 and converted to electric trains in 1959.

In 1886 approval was given to John Bennet to construct a private railway line (now part of the Carlingford Line) from the newly opened Clyde Station to his land on the Camellia Peninsula. The line terminated near the south bank of the Parramatta River, but was extended in 1891 to Black Wharf on the Parramatta River. In 1892 the Graziers Meat Export Co. of NSW built a meatworks at Sandown and a spur line was built (the Sandown line). The rail line also connected to the recently established Australian Kerosene Oil and Mineral Company works and the riverbanks at Sandown. Construction commenced in 1886 with Hudson Brothers erecting the steel bridges for the creek crossings. The second purpose of the line was to transport kerosene shale from the mines at Joadja and Newnes to John Fell's refinery near Sandown. The first wharf, named Black Wharf, was constructed with the Sandown platform adjacent to it and it opened on 24 October 1892, complete with a steam crane and a turntable. Remains of the Black Wharf are still visible from the river.

When the Bennett private line was taken over by the government, Sandown station changed its ownership also on 1 August 1901. The Sandown station, opened privately in October 1892, has since closed but the line is stayed in operation to serve the industries along the riverbank. There were two other later platforms on the line, those for James Hardie (April 1938) and Goodyear (January 1934). Both of these companies had private rail sidings into their factory sites, as did Wesco, Cream of Tartar, and the Shell Company.

During the years of World War II, for defence reasons, the spur line that ran into Shell was joined with a new branch line that ran from the main Clyde-Carlingford Line to enable a loop line to be formed.

During the 1920s to early 1930s Sydney Ferries Ltd operated a wharf at the eastern end of Grand Avenue, at 16 Grand Avenue. From 1956 to 1978 the wharf was used by Harbour Lighterage to ship gypsum along the Parramatta River. In 1978 Wilson Bros Timber purchased the land to ship timber by river barge.

5.1.1.3 Camellia's industries

Camellia's growth was tied to ongoing industrial development. The expanding pastoral industry needed fencing, inspiring Arthur and St John Lysaght to begin a galvanised iron and wire netting works in 1884, on a riverside block. The operation later moved to Newcastle.

In July 1885 the Australian Kerosene Oil and Mineral Company purchased 67 acres (27 hectares) of the Elizabeth Farm Estate from Hudson Brothers, comprising two parcels of land extending from what is now 11 Grand Avenue (now occupied by Australian Pharmaceutical Industries), 15 Grand Avenue (Mauri Yeast[9]), 3 Thackeray Street (Boral Plaster Board[10]) and 14 Thackeray Street (Concrete Recyclers). In 1888 the

[9] Now George Weston Foods (GWF) Limited

[10] Now Boral Australian Gypsum Limited

Kerosene Oil and Mineral Co. commenced operations at the site. The company had been mining shale oil for its kerosene content at Joadja since 1874. The 1887 private rail extension allowed the crude oil to be shipped to their works by rail from Mittagong for further processing. About 170 men were employed in the manufacture of kerosene, axle grease, soap and candles that were marketed under the brand name of 'Southern Cross'. Government contracts were held until the duty on kerosene was lifted in the early 1890s. This and the severe depression forced the mine to close, as did the Camellia refinery in 1894. The buildings demolished in 1916 when GR Sutton subdivided the land into 36 lots.

On the south-east corner of what is now James Ruse Drive and the former River Road, now within the former James Hardie site at 181 James Ruse Drive, Charles Sprod had an asbestos boiler covering works from 1924 to 1925 (present in the Sands Directories from at least 1926 to at least 1932) followed by a chemical factory, Australian Arsenic Production Ltd (Camellia Chemical Co.). Camellia Chemical Co.'s best known product was Camellia Weed Killer, 90% of its business was for the railways. The land was transferred to James Hardie Co Pty Ltd on 2 January 1963.

Davidson Products Co, Paint Manufacturers, were present on the east side of James Ruse Drive, near Australian Arsenic Production Co. Ltd in 1929 and 1930 (in the Sands Directories).

The James Hardie factory was established on the eastern side of Camellia Railway Station. An aerial photograph dated 1930 shows the James Hardie factory to the east of the railway line and the residential area to the west of the railway line.

The Metropolitan Water Sewerage & Drainage Board constructed a pumping station (still present) immediately west of Camellia Railway Station in 1930.

Anschau's Tannery was opened in 1895 on land adjacent to the Sandown Meat Co (understood to have been located at 14 Thackeray Street, now occupied by Concrete Recyclers) to purchase and tan the ready supply of skins from the slaughtered animals. The company closed when the Meat Co burned down in 1923.

Anschau's site was taken up by Continental Grain Ltd. Reportedly the material from demolition of the tannery was used as fill material in several areas around Camellia.

Another prominent industrial development was Wesco Paints (West Coast Kalsomine Co Aust Ltd), registered in 1920 and initially producing powder paints under the trade name of Kalsomine at 13 Grand Avenue. By 1965 the Wesco industrial chemists had developed a wide range of paints and enamels based on alkyd, epoxy, PVA, PVA Acrylic copolymers, polyurethane and silicones, and unique architectural finishes based on cement.

The James Hardie Company, an asbestos-cement products manufacturer, was established in 1916 and operated until 1996. Ten acres of land in the Precinct, originally owned by Henry Hudson, was purchased in 1916. Using the brand name 'Fibrolite' the company began manufacture of asbestos sheet cladding, including corrugated sheets used as a roofing medium. Gradually the range was expanded to include cement water pipe and plumbing accessories, moulded brake and clutch linings, and heat-insulating materials. Products included the marbled finished 'Tilux' for use in bathrooms and kitchens.

In around 1940, James Hardie & Co constructed a building on the corner of Tasman and Aston Streets adjacent to the Camellia residential area, on the western side of Camellia Railway Station. An aerial photograph dated 1951 showed white areas of asbestos slurry deposited in a dam located in the block between Palmer Street and Scarborough Street, south-east of the houses in the Camellia residential area. Asbestos reportedly was also used in low areas and as a street covering.

After both World Wars there was great demand for James Hardie's products. In 1954-55, of the 28,882 homes built in NSW, 15,050 were built of asbestos cement. By 1965, 1,500 people were employed by James Hardie.

The unprecedented growth required more land and factory space. Product storage space shortages became acute and expansion plans were thwarted for the want of more land and so the company obtained approval to purchase the houses and streets of the Camellia township, where many Hardie employees lived.

The land of the Camellia residential area was progressively transferred to ownership of James Hardie during 1962 and 1963. Gradually the local houses were removed and the area was used for the storage of asbestos products.

In 1925 the Ford Motor Company purchased a very large area and commenced construction of a large works in Camellia, but made little use of it because of the depressed financial period. In 1935 it constructed a new assembly plant on Parramatta Road, located with a rail link to the Homebush Abattoir Line. It then sold all of its land to the Shell Oil Company.

The Stauffer Chemical Company (Aust) Pty Ltd entered the Australian market in 1926 when it formed a partnership with Kemball-Bishop Ltd of the UK and TJ Edmonds Ltd of New Zealand. They formed the Australian Cream of Tartar Co Ltd and operated several other chemical companies, including Wesco Paints Pty Ltd, located either side of Grand Avenue (13 and 15 Grand Avenue and 4-8 Grand Avenue).

Chrome Chemicals Australia, a subsidiary of Stauffer Chemicals Ltd, manufactured sodium chromate for pigments at 6 Grand Avenue from the 1940s to 1960s. The chrome wastes (COPR) reportedly were subsequently deposited in the surrounding vicinity. The site was later owned by Akzo Nobel and chromium contamination was identified at 6 Grand Avenue in 1989 and a remediation strategy was developed. This site has since been demolished (2014) and acquired for the construction of the PLR (Stage 1) Stabling and Maintenance (SaM) facility and is currently undergoing remediation to facilitate this land use (Sections 4.4 and 5.2).

Goodyear Tyre and Rubber Company (Australia) Pty Ltd began tyre production in Camellia in 1933 at 11 Grand Avenue, on land formerly owned by the Australian Kerosene Oil and Mineral Co. They also manufactured components for the motor industry. The factory finished production in 1991 and the site remained vacant until 1997 when the buildings were demolished and the site was remediated and validated for commercial/ industrial land use. The Australian Pharmaceutical Industries facility was constructed on the site during the early 2000s.

The Commonwealth Oil Company was formed in London, and began mining shale oil at Newnes in the Wolgan Valley in 1906. They began retorting the shale oil in June 1911 but encountered technical and financial difficulties within months because of the rich content of kerosene in the shale. The company had acquired 140 acres of land on the confluence of the Duck and Parramatta Rivers in 1908, when John Fell and Company acquired the company's assets. John Fell, experienced in distilling oil from shale to keep pace with growing demand for higher-octane motor spirit, added to the output of the Newnes plant and introduced more advanced distilling machinery, and operations spread south along the Duck River, later becoming Clyde Refinery owned by Shell.

5.1.2 Summary of History of Land Use

The Precinct has a long history of mixed industrial development, dating back to the 1880s, served at various times by an extensive network of railway lines. Industrial development has included oil refining, a tannery, a meatworks, a lumber yard, and facilities manufacturing asbestos products (such as boards and pipes), plasterboard, bricks, roof tiles, chrome chemicals, chlorinated hydrocarbons, bitumen, rubber tyres, paints, arsenic-based herbicides, food products, paints, plastic pipes, and pharmaceuticals. Other industries have included solid and liquid waste storage, recycling and treatment, and concrete crushing operations.

5.2 Recent Redevelopment Proposals for Key Precinct Sites

Several of the key identified industrial sites have been redeveloped in recent years to light industrial land use, including the former Capral Aluminium site in Shirley Street, the former James Hardie landfill in Colquhoun/Devon Streets and the former Goodyear Tyre factory in Grand Avenue.

The former Akzo Nobel site (4-8 Grand Avenue) is in the process of being remediated and redeveloped as part of PLR (Stage 1) as is the site located at 13A Grand Avenue and portions of the former Sandown (western end) and Carlingford rail lines, including a portion of the former James Hardie site located at 1 Grand Avenue (see below).

Several industrial sites (such as 181 James Ruse Drive, 1 Grand Avenue, 10 Grand Avenue, large portions of the former Shell Refinery site and 37 and 39 Grand Avenue) have been cleared of buildings pending redevelopment.

Golder (2015a) noted that the Australian Turf Club is also proposing redevelopment of parts of its land at Rosehill Gardens Racecourse adjoining James Ruse Drive to more sensitive land use which may include tourist accommodation.

Golder (2015a) also noted that a DA had been lodged with Council for construction of high-density residential development on the arsenic, hydrocarbon and asbestos-impacted land at 181 James Ruse Drive.

The following Development Applications have also been lodged with/ determined by Council (since the Golder (2015a) study) for the following potentially contaminated sites:

- Demolition of existing structures, site clearing and remediation works followed by construction of a warehouse and distribution centre with associated carparking, landscaping and civil works at the former CSR site located at 10 Grand Avenue, Camellia (lodged 2017). During January 2021 an application was also made to subdivide the site (10 and 10A) to create a northern lot and southern lot with access to both lots from Grand Avenue, creating a battle axe lot to the south. Nearmap imagery (June 2021) indicates that these works may have commenced in the southern portion of the site (the battle axe lot). Access to the southern lot was noted as part of Golder's 25 May 2021 drive-by inspection.
- Modification to the approved construction and operation of a service station servicing trucks, including construction of hardstand areas, driveways, installation and works to refuelling infrastructure and bowsers and associated signage (lodged 2017), for the site located at 9 Devon Street, Rosehill. This is the land investigated in 2016 by ERM (2016) (Section 4.4). This site forms part of the former Shell Refinery site and is located on the northern boundary fronting Grand Avenue between 10 and 12 Grand Avenue. Nearmap imagery (June 2021) indicates that these works have been completed.
- Boundary adjustment to facilitate a land swap with Council and the subsequent subdivision of land at 12-12A Grand Avenue owned and operated by Colas (Road Holdings Australia Pty Limited) as a bitumen plant, with the eastern portion leased by Downer EDI Works Pty Ltd (lodged 2020). This is the site subject to the SEE (GHD, 2020), Section 4.4 and 6.3.
- Alterations and additions to an existing fuel depot including new above ground diesel tank and associated forecourt, canopy, comms room, bollards, trade waste system, signage and associated works for the site located at 17 Grand Avenue, formerly known as Jack Seatons Transport (AWT Ensight, 1995) (lodged 2019). It is noted that these works have not been completed at the time of reporting. The landowner has, however, indicated that the works are in progress..
- An application to construct and operate a resource recovery plant located within an enclosed shed, for the treatment of road sweepings and gully waste was lodged during 2016 for the site located at 1A

Unwin Street. This is the site of the Downer EDI bitumen plant which was investigated by Douglas Partners in 2006 (Section 4.4). The recycling operations were added to the facility but it is understood that the site has since been proposed for acquisition for the Sydney Metro West Clyde SaM facility (see below).

Development Applications have also been lodged with/determined by DPIE (since the Golder (2015a) study) for the following contaminated sites:

- The Golder (2015a) report referred to the ongoing Clyde Terminal Conversion Project whereby Shell, after ceasing its operation in 2012, sold the Clyde Refinery site to Viva. Viva obtained development consent in 2015 (SSD 5147) to: demolish the existing refinery infrastructure on the western part of the site; convert the existing infrastructure in the eastern part of the site for finished fuels storage; and continued operation as a fuel import, storage and distribution terminal (Clyde Terminal), including continued import of fuel by pipeline. Following substantial demolition of the western area Viva applied for development consent for the remediation of the western portion of the former Clyde refinery site to enable future commercial or industrial land use (the Viva Energy Clyde Western Remediation Area Project (SSD 9302)). AECOM prepared a concept remedial action plan to support the development application (AECOM, 2019). DPIE (2020) prepared a State Significant Development Assessment (SSD-9302) report for the project. The 40-hectare site forms the south-west portion of the former refinery site and is contaminated with petroleum hydrocarbons, heavy metals and per- and polyfluoroalkyl substances (PFAS) associated with the site's former use as an oil refinery. The conceptual remediation approach included:
  - Sequential excavation, stockpiling and treatment (landfarming, soil mixing, bio piling, direct thermal desorption, and off-site disposal) of soils.
  - Capture and redirect potentially contaminated surface water and groundwater to the existing wastewater treatment plant on the site. The treated wastewater would be discharged in accordance with an EPL.

  The DPIE (2020) SSD Assessment Report identified that the cost of the development works was approximately $31.5 Million. The SSD application was approved on 7 May 2020. Nearmap Imagery (June 2021) indicates that these works have commenced but have not been completed. Golder's site drive-by on 25 May 2021 also confirmed that these works appeared to be in progress.
- VE Property Pty Limited and Downer EDI Works Pty Limited (Downer) SSD Application (SSD-10459) for the sub-division and infrastructure works to create a 35-hectare Central Sydney Industrial Estate on the site for the former Shell refinery was approved on 31 January 2021. The proposed project also includes the development and operation of Downer's Sustainable Road Resource Centre as Stage 1 of the Estate. As noted above, Downer owns and operates an asphalt plant, recycling facility (street-sweeping waste recycling), offices and workshop at 1A Unwin Street, Rosehill (the Rosehill site). Downer also operates a reclaimed asphalt pavement recycling facility on land it leases at part of 12 Grand Avenue, Rosehill (the Camellia site). In late 2019, the Sydney Metro West project informed Downer that the Rosehill site was required for the Clyde SaM facility and would be compulsorily acquired. As such, Downer investigated alternative sites for the relocation of the Rosehill and Camellia operations. The proposed site is in the eastern portion of the Viva Energy Clyde Western Remediation Area Project. The EIS prepared as part of the application identifies that the site is being remediated under the Western Remediation Area Project (SSD 9302) (noted above). Nearmap Imagery (June 2021) indicated that works on the Downer site have commenced but have not been completed.

- The northern portion of the Precinct accommodates part of the Parramatta Light Rail (Stage 1) CSSI project (SSI 8285) alignment, including the SaM facility. TfNSW acquired the former Akzo Nobel site, located at 6 Grand Avenue, for the proposed SaM Facility which as noted above and in Section 4.4 is subject to ongoing remediation. The EIS for the Project was exhibited in 2017 and the accompanying PLR Stage 1 Environment Assessment Contaminated Land Technical Paper 16 (Coffey, 2017) identified several AEIs within the Precinct that would be included in the Project disturbance footprint. These included the former Akzo Nobel site, the former Sandown line rail corridor, a former scrap yard at 13A Grand Avenue and the former James Hardie properties located at 181 James Ruse Drive and 1 Grand Avenue. The SSI application was approved on 29 May 2018 and all AEI sites were investigated and, where necessary, remediated in accordance with the CoA. Nearmap Imagery (June 2021) indicates that construction works within the Precinct are ongoing.
- A SaM Facility is proposed to be constructed in Clyde as a part of the Sydney Metro West Project (SSI-10038). This also includes the construction of associated aboveground and belowground tracks to connect to the mainline tunnels. The contamination technical paper prepared for the EIS (Jacobs, 2020) identified several Areas of Environmental Interest (AEI) within the proposed SaM Facility footprint and more broadly across the Precinct. The SSI application was approved on 11 March 2021. The SSI Conditions of Approval (CoA) require that if moderate to high risk contaminated sites are to be disturbed by the construction works, then they are required to be investigated, if required, remediated to make the land suitable to the intended use. The CoA also require the Proponent to obtain a Site Audit Statement prior to SSI operations commencing. Nearmap Imagery (June 2021) and the Golder 25 May 2021 drive-by indicate that physical works on the Clyde SaM Facility have not yet commenced.
- Veolia submitted a development application (SSD 4964) in 2012 to redevelop its site located at 37 Grand Avenue a proposed recycling centres to process mixed non-putrescible waste. As part of the development application an Environmental Assessment was completed which included publishing a remediation fact sheet (Veolia, 2012). The development was approved in July 2016, but it is understood that this facility has not, however, since been constructed. It is therefore considered unlikely that the Permeable Reactive Barrier described in the remediation fact sheet, to prevent contaminants in the shallow groundwater and seepage water migrating across the northern boundary of the site into the wetlands adjacent to the Parramatta River, has been constructed[11]. The drive-by inspection completed by Golder on 25 May 2021 confirmed that the site was largely vacant and appeared to have be resurfaced.

5.3 Recent and Current Land Use Subject to an Environment Protection Licence

A search for Environment Protection Licences (EPLs) under the *POEO Act* 1997 was completed. This search identified several properties historically subject to EPLs. It is noted that Environment Protection Licensing provisions only came into effect in 1997 and did not address industries which ceased to operate prior to 1997. Sites which have been subject to EPL's by their nature represent activities with potentially greater risk of having activities with potential to cause contamination than sites which have not conducted activities requiring an EPL. However, it should be noted that not all instances of contamination are associated with sites subject to an EPL. Historical activities which preceded the EPL scheme and landfilling may also be a source of site contamination. The results of the search are listed in the following Table 2 and **Figure 4**.

[11] It is noted that the summary presented in Section 6.3 supports this assumption.

Table 2: List of Sites Historically Subject to an Environment Protection Licence

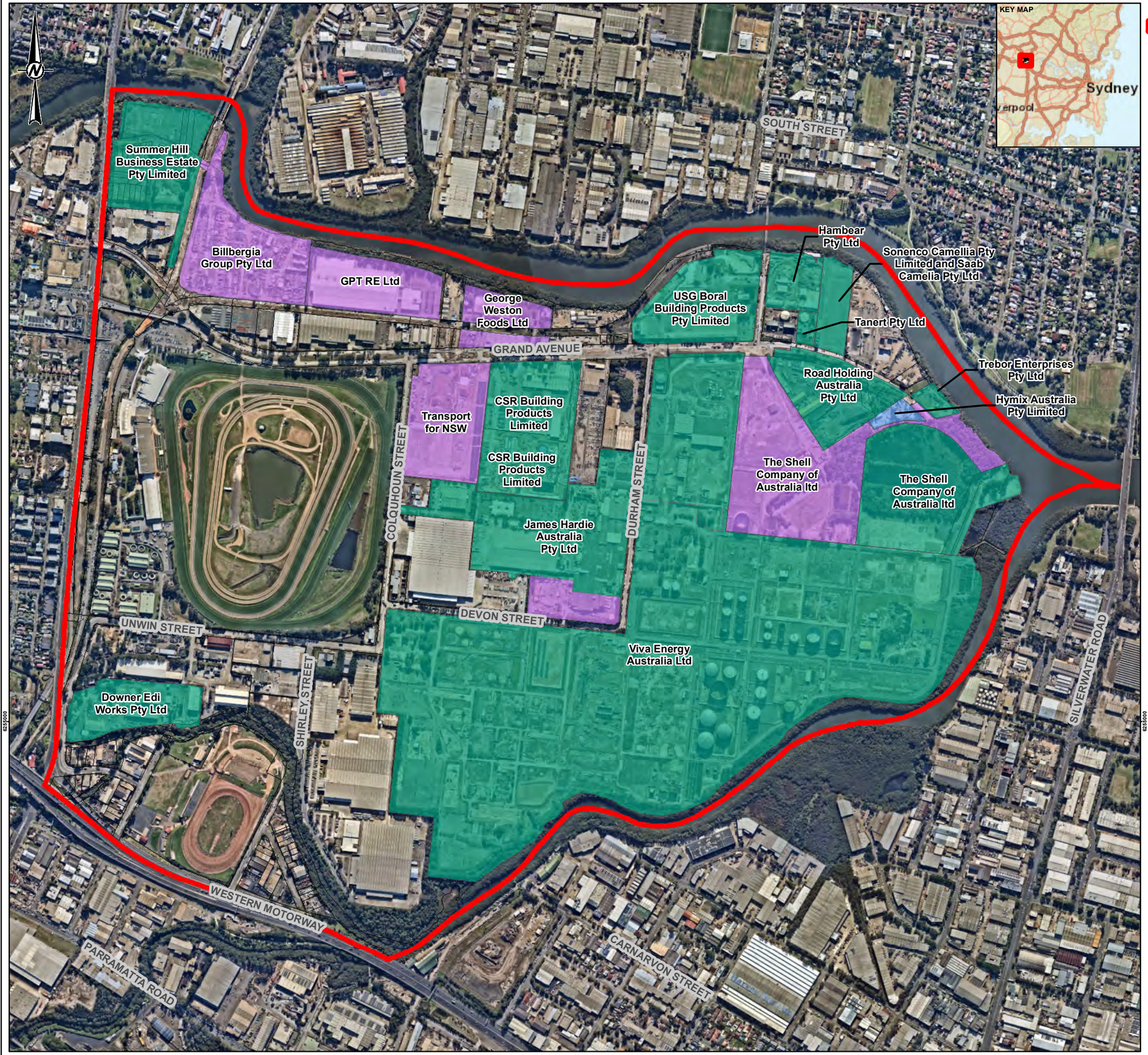
Name	Location	Regulated Activities	Current EPL Status
James Hardie Australia Pty Ltd	1 Grand Avenue, Camellia	Generation and/or storage of asbestos waste and filter cake.	Surrendered
Tekom Pty Ltd	6 Grand Avenue, Camellia	Waste storage, transfer, separating or processing.	Surrendered
Australian Pharmaceutical Industries Pty Ltd	11 Grand Avenue, Camellia	Waste storage - hazardous, restricted solid, liquid, clinical and related waste and asbestos waste. A penalty notice was issued in 2014. No further information relating the penalty was available.	Surrendered
Downer EDI Works Pty Ltd	12 Grand Avenue, Camellia	Recovery of general waste and waste storage. Materials handled include asphalt waste from road construction and waterproofing works.	Issued
SAMI Bitumen Technologies Australia Pty Ltd	12 Grand Avenue, Camellia	Chemical production waste generation. Chemical storage waste generation. Petroleum products storage. Petrochemical production. Penalty notice issued in June 2015 for odour emissions.	Issued
Hymix Australia Pty Ltd	14 Grand Avenue, Camellia	Concrete works.	No longer in force
Goodman Fielder Consumer Foods Pty Ltd	15 Grand Avenue, Camellia	Grape processing.	Surrendered
KLF Holdings Pty Ltd	16 Grand Avenue, Camellia	Waste storage. Waste processing (non-thermal treatment). Wastes permitted included building and demolition waste, virgin excavated natural material, asphalt waste, wood waste, waste tyres, garden waste, soil and general waste. Penalty notices issued in June 2014 and February 2016. Clean up notice (asbestos in stockpile) issued in October 2013.	Issued

Name	Location	Regulated Activities	Current EPL Status
Earthpower Technologies Sydney Pty Ltd	35 Grand Avenue, Camellia	Generation of electrical power otherwise than from coal, diesel or gas. Composting. Clean up notice issued in July 2006 (blocked drain).	Issued
Veolia Environmental Services (Australia) Pty Ltd	37 Grand Avenue, Camellia	Waste storage - other types of waste. Recovery of general waste.	Issued
USG Boral Building Products Pty Ltd	3 Thackeray Street, Camellia	Crushing, grinding or separating materials. Penalty notice issued in November 2013. Clean up notice issued in April 2019 (discharge of firefighting foam into Parramatta River).	Issued
Concrete Recyclers (Group) Pty Limited	14 Thackeray Street, Camellia	Recovery of general waste Waste storage - other types of waste. Clean up notice issued in June 2019 (asbestos), which was revoked in June 2019 following remediation.	Issued
CSR Building Products Limited	6 Grand Avenue, Rosehill[12]	Concrete works.	Issued
Atofina (Australia) Pty Ltd	5 Colquhoun Street, Rosehill	General chemicals storage.	Surrendered
James Hardie Australia Pty Ltd	10 Colquhoun Street, Rosehill	Cement or lime works, concrete works, and crushing, grinding or separating materials.	Issued
Iplex Pipelines Australia Pty Ltd	1 Devon Street, Rosehill	Hazardous, Industrial or Group A Waste Generation or Storage.	Surrendered

[12] Assumed to be site known as 10 Grand Avenue.

Name	Location	Regulated Activities	Current EPL Status
Suez Recycling & Recovery Pty Ltd	9 Devon Street, Rosehill	Waste storage - hazardous, restricted solid, liquid, clinical and related waste and asbestos waste. Non-thermal treatment of hazardous and other waste	Surrendered
Viva Energy Australia Pty Ltd (EPL 570)	Durham Street, Camellia	Non-thermal treatment of hazardous and other waste Petroleum products storage. Penalty notices issued in September 2012, September 2013 and June 2017.	Issued
Viva Energy Australia Pty Ltd (EPL 660)	Gate 4, Durham Street, Rosehill	Petroleum products storage.	Issued
Lyondellbasell Australia Pty Ltd	Durham Street, Camellia	Chemical production and storage. Plastic resins production. Chemical storage and waste generation.	Surrendered
Downer EDI Works Pty Ltd	1A Unwin Street, Rosehill	Recovery of general waste. Waste storage – other types of waste.	Issued
Statewide Planning Pty Ltd	181 James Ruse Drive, Camellia Pty Ltd	Contaminated soil treatment	Issued

As part of the EPL searches it was identified that clean-up notices had also been issued to Mr Bernie Fussell and Mr Clayton Fussell for the improper storage and emplacement of waste and debris on the property located at 19 Grand Avenue, Camellia NSW 2142. The NSW EPA determined that the activities would likely result in pollution to receiving air and water environments. It is noted that this property was not subject to an EPL.



LEGEND

Camellia Precinct Boundary

Sites Historically Subject to an EPL

EPL Status

- Issued
- Surrendered
- No longer in force

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021
2. ENVIRONMENTAL PROTECTION LICENCE DATA: NSW ENVIRONMENT PROTECTION AUTHORITY WEBSITE, HTTP://WWW.EPA.NSW.GOV.AU/PRPOEOAPP, JUNE 2021
3. DIGITAL CADASTRE SUPPLIED BY DPIE APRIL 2021

CLIENT

DPIE

PROJECT

CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE

SITES HISTORICALLY SUBJECT TO AN EPL

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	001	A	4

6.0 DOCUMENTED CONTAMINATED SITES

6.1 NSW EPA Contaminated Sites Registers

The NSW EPA maintains two registers of contaminated sites for NSW under the provisions of the *CLM Act*. The following sections list the sites within the Precinct which are currently on these registers. It should be noted that these registers list only those sites which have come to the attention of the EPA through the provisions of the *CLM Act* and do not necessarily list all sites within the Precinct that have been, or may have been contaminated, during the history of land use. To clarify, as noted in Section 1.3.1 these are contaminated sites where intervention may be (notified sites) or is (regulated sites) warranted by the NSW EPA.

6.1.1 Contaminated Sites Notified to the EPA

The NSW EPA maintains a "List of NSW contaminated sites notified to the EPA" under Section 60 of the *CLM Act*. Sites on this list indicate that the notifiers consider that the sites are contaminated and warrant reporting to EPA. The contamination at the site may or may not be significant enough to warrant regulation by the EPA and the EPA reviews relevant site information before making a determination as to whether or not the site warrants regulation. An online search for notified sites in the Precinct was completed on 26 June 2021. The results of the search are presented in Table 3 and **Figure 5**.

Table 3: List of Contaminated Sites Notified to the NSW EPA

Suburb/City	Site description and address	Activity that caused contamination	Management Class
Camellia	James Hardie Factory (former) 1 Grand Ave	Other Industry	Ongoing maintenance required to manage residual contamination (*CLM Act*)
Camellia	Council Reserve 11B Grand Ave	Metal Industry	Regulation under *CLM Act* not required
Camellia	Bitumen Manufacturer 12 Grand Avenue	Other Industry	Contamination currently regulated under *CLM Act*
Camellia	Wrigg 13 Grand Ave	Metal Industry	Under preliminary investigation order
Camellia	Hymix Concrete 14A Grand Ave	Metal Industry	Contamination currently regulated under *CLM Act*
Camellia	Hambear 14 Thackeray St	Metal Industry	Regulation under *CLM Act* not required
Camellia	Mauri Foods, 15 Grand Avenue	Other Industry	Regulation being finalised
Camellia	Railway Land 27 Grand Ave	Other Industry	Regulation under *CLM Act* not required
Camellia	Maritime Services Board 33A Grand Ave	Metal Industry	Regulation under *CLM Act* not required
Camellia	Veolia 37 Grand Avenue	Chemical Industry	Contamination currently regulated under *CLM Act*
Camellia	Former Asciano Properties 39 Grand Ave	Chemical Industry	Contamination currently regulated under *CLM Act*

Suburb/City	Site description and address	Activity that caused contamination	Management Class
Camellia	Sydney Water 41 Grand Ave	Chemical Industry	Contamination formerly regulated under the *CLM Act*
Camellia	Former Akzo Nobel site 6 Grand Avenue	Chemical Industry	Contamination currently regulated under *CLM Act*
Camellia	Shell Clyde Refinery Durham St	Other Petroleum	Contamination currently regulated under *POEO Act*
Rosehill	James Hardie Devon Street	Landfill	Ongoing maintenance required to manage residual contamination (*CLM Act*)
Rosehill	James Hardie Factory (former, western portion) 181 James Ruse Drive	Other Industry	Ongoing maintenance required to manage residual contamination (*CLM Act*)

6.1.2 Contaminated Sites Subject to EPA Regulation

An on-line search on 26 June 2021 of the EPA's "Record of Notices" issued under the *CLM Act* identified several sites within the Precinct as being subject to current or prior notices. These sites are listed in Table 4 and **Figure 6**.

Table 4: List of Notices issued by the EPA under the *CLM Act*

Suburb	Address	Site Name	Notices related to this site	Contaminants
Camellia	6-10 Grand Avenue	Akzo Nobel Chemicals	3 current and 16 former	Volatile chlorinated hydrocarbons and chromium
Camellia	12 Grand Avenue	Bitumen Manufacturer	2 current and 11 former	Hexavalent chromium, dissolved phase petroleum hydrocarbons, phase separated petroleum hydrocarbons
Camellia	14 Grand Avenue	Hymix	1 current and 2 former	Hazardous chemicals including chromium wastes
Camellia	1 Grand Avenue*	James Hardie Asbestos Factory	1 former	Asbestos, arsenic, zinc, phenol, PAHs.
Camellia	37 Grand Avenue	Legacy Chromium Contamination	7 current and 3 former	Hexavalent chromium in groundwater and in water seeping into Parramatta River from the site
Camellia	39 Grand Avenue	Legacy Chromium Contamination	7 current and 3 former	Hexavalent chromium in groundwater and stormwater and potentially contaminated surface water flows into the Parramatta River
Camellia	41 Grand Avenue	Sydney Water	3 former	Hexavalent chromium in groundwater and in discharges to the Parramatta River
Camellia	13 Grand Avenue	Allam Family Pty Ltd	1 current	Chromium

Suburb	Address	Site Name	Notices related to this site	Contaminants
Camellia	Durham Street	Shell Clyde Refinery	2 current	LNAPL, TPH, BTEX, PAH, chromium, lead, Perfluorooctane sulfonate
Rosehill	Devon/ Colquhoun Street	James Hardie Landfill	3 current and 10 former	Asbestos waste

* The figure attached to the voluntary remediation proposal indicates that the 181 James Ruse Drive property was also included.

6.2 Section 10.7 (2) and (5) Zoning Certificates

Local councils issue zoning certificates under Section 10.7 (2) and (5) of the *Environmental Planning and Assessment Act 1979*, which contain information on permissible uses of a property and identify restrictions on development. Section 10.7 Certificates contain information pertaining to potential or actual contamination at the subject site. The local authority has obligations under Section 10.7 (2) of the Act to include certain information in relation to contaminated land in planning certificates issued under Section 10.7 of the *Environmental Planning and Assessment Act 1979*.

Under Section 59 of the *CLM Act* the EPA has certain obligations to notify the local authority of certain information in relation to land contamination, i.e.:

"(1) The EPA must, as soon as practicable after the occurrence of any of the following in relation to land, inform the local authority for the area in which land is situated of that matter:
(a) the land being declared to be significantly contaminated land or ceasing to be significantly contaminated land,
(b) a management order in relation to the land being served on a person or being revoked,

(c) the EPA giving its approval or withdrawing its approval for a voluntary management proposal in relation to the land or a voluntary management proposal in relation to the land being completed to the satisfaction of the EPA,

(d) an ongoing maintenance order in relation to the land being served on a person or being revoked."

The local authority has obligations under Section 10.7 of the Act to include certain information in relation to contaminated land in planning certificates issued under Section 10.7 of the *Environmental Planning and Assessment Act 1979*.

"(2) For the purposes of section 10.7 of the Environmental Planning and Assessment Act 1979, the following matters are prescribed in addition to any other matters, prescribed by the regulations under that section, to be specified in a certificate under that section:

(a) that the land to which the certificate relates is significantly contaminated land—if the land (or part of the land) is significantly contaminated land at the date when the certificate is issued,

(b) that the land to which the certificate relates is subject to a management order—if it is subject to such an order at the date when the certificate is issued,

(c) that the land to which the certificate relates is the subject of an approved voluntary management proposal—if it is the subject of such an approved proposal at the date when the certificate is issued,

(d) that the land to which the certificate relates is subject to an ongoing maintenance order—if it is subject to such an order at the date when the certificate is issued,

(e) that the land to which the certificate relates is the subject of a site audit statement—if a copy of such a statement has been provided at any time to the local authority issuing the certificate."

Section 53B of the *CLM Act* requires site auditors to furnish local authorities with copies of site audit statements relating to site audits for the purposes of statutory requirements.

A summary of the information held by Council under Section 10.7 of the *Environmental Planning and Assessment Act 1979* was provided by Council. Council has classified land in the Precinct under the categories as defined in **Table A1** in Appendix A. The categorization of the land is presented in **Figure 7**.

The Section 10.7 data for the Precinct is presented in **Table A2** in Appendix A and **Figure** 7. The data indicates the following:

- Two sites are noted as being significantly contaminated land.
- Seven sites are noted as being subject to a Site Audit Statement.
- Seven sites are noted as being subject to a voluntary management proposal.
- Three sites are noted as being subject to an Asbestos Management Plan or other similar Environmental Management Plan.
- Three sites are noted as being subject to an ongoing maintenance order.
- Ten sites are noted as being properties identified in the Department of Environment, Climate Change and Water in April 2010 titled: 'James Hardie Asbestos Waste Contamination Legacy report (DECCW, 2010).
- Nineteen sites are notified as being properties which are potentially contaminated, where Council has records.
- Forty-fives sites are noted as being potentially contaminated, where Council may not have records.

For the purpose of the above, a site is considered one that has a unique street address. It should be noted that some sites will comprise multiple lots with respect to a Certificate of Title. The information above indicates the large number of properties known to be contaminated or considered to have potential to be contaminated. Review of the specific information within Council's property file for each property would need to be undertaken to further understand the basis of Council's classification of the contamination status of the properties. It is further noted that some of the information summarised in **Figure 7** may not reflect the information in **Figures 4, 5** and **6** and this may be a function of differences in stakeholder records. Golder is not able to comment on the accuracy of the information provided.

6.3 Previous Contamination Studies

A large number of contaminated land investigations have been completed across the Precinct over the years. Many of these investigations were undertaken for private landowners and are not publicly available. Some investigations were, however, completed on behalf of Council or other government authorities or have been included in DAs. Several reports were made available to Golder by Council as part of the Golder (2015a) study.

The review of relevant reports for key Precinct sites is presented on a site-by site basis in the following sections and has been updated with available relevant site-specific updates since 2015. It is noted, however, that some of the investigation reports accessed as part of this Baseline Study have not been referenced herein due to confidentiality arrangements. Relevant information from these documents was, however, considered in the development of the Precinct-wide Remediation Strategy.

It is also noted that other contamination investigations are likely to have been completed on various properties within the Precinct which have not been made available for review, particularly in relation to Notices issued by the EPA under the provisions of the *CLM Act*. Examples include the site located at 15 Grand Avenue (Mauri Yeast) where regulation is being finalised and the former James Hardie landfill sites located at 8 and 10 Colquhoun Street and 5 Devon Street where maintenance of remediation notices are in place to prevent contamination (primarily asbestos) disturbance.

- Land along the northern side of Grand Avenue and the Parramatta River mud flats

The AWT Ensight (1995) report noted that soil and groundwater in a 77-hectare area along the northern side of Grand Avenue, adjacent to the Parramatta River, from the vicinity of the James Hardie site to the eastern end and into the northern part of the Clyde Refinery site was known to be contaminated with chromium. There had been reported incidents of chromium polluted stormwater flowing into the Parramatta River and sightings of chromium salt crystals at the soil surface. The primary source of the chromium contamination was believed to have been the former Chrome Chemicals site at 6 Grand Avenue (the former Akzo site). Chromium contaminated waste (COPR) was reportedly disposed at various places to the east of Thackeray Street.

AWT Ensight (1995) undertook sampling of mangrove mud flat sediments at eight locations in front of surface drainage channels along the Parramatta River north of Grand Avenue, and two locations in Duck River, in May 1995. Surface water samples were collected at seven of the locations. The results indicated that no hexavalent chromium was detected in the mud flat sediments. Chromium was detected in the trivalent state (which has low toxicity and mobility) in the sediments. Hexavalent chromium (which is water soluble and has high human and ecological toxicity) was detected in surface water at four locations, two locations adjoining 15 Grand Avenue (now occupied by Mauri Yeast) and one location adjoining 39 Grand Avenue (now occupied by Asciano Property), and one location immediately downstream of 41 Grand Avenue (occupied by Sydney Water) Two of the locations corresponded with the highest concentrations of trivalent chromium in the mud flat sediments.

The report noted that chromium had been used in various industrial applications in the area of Grand Avenue and all may have contributed to contamination in surrounding land and the Parramatta River. Potential industrial sources included production of tanned leather (understood to have occurred at 14 Thackeray Street), pigments used in paint manufacture (understood to have occurred at Wesco Paints at 13 Grand Avenue), wood preservatives used in the timber yard (at 16 Grand Avenue) and chromate ore from the chromium factory (at 6 Grand Avenue). The most likely primary source of chromium was considered to be the former chromium factory at 6 Grand Avenue.

- 4-8 Grand Avenue, Akzo Chemicals, formerly Chrome Chemicals and now the PLR SaM construction site.

The AWT Ensight (1995) report noted the upper 0.35 to 2.6 metres of the soil surface was uncompacted, permeable fill, underlain by natural soils mainly being clay, with thin sandy clay lenses. A complex system of aquifers and aquicludes was reported, and due to the high permeability of the infill, the aquifer is recharged by site run-off, including a settling dam and concrete batch plant. Groundwater was inferred to be flowing towards the Parramatta River.

As noted in Section 4.4 some historic site remediation works were completed at the site to address offsite migration issues in groundwater in the approximate period c.2009 – 2010. Some source areas were remediated including subsequent infilling with either reworked natural materials or remediated fill/ overburden, including some materials impacted by asbestos, to create ongoing contaminated fill containment areas.

In summary the site has been impacted by historical site operations including chromium ore processing and chlorofluorocarbon (CFC) production, resulting in hexavalent chromium and chloroform, carbon tetrachloride and tetrachloroethene (as well as other volatile organic compounds (VOCs)) being present in soil and groundwater. Asbestos containing materials have also been observed in fill materials at the site. In addition, VOCs in soil vapour are reported across the site and hazardous ground gases in the central western portion, the latter relating to previous 2009-2010 remediation activities.

The most recent ongoing program of remediation works (c. 2019 onwards) are being completed to address both offsite migration issues (contaminated groundwater) to satisfy regulatory obligations in relation to contamination at the site and to mitigate future migration of contamination from the site onto surrounding lands. They are also being completed to render the site suitable for the proposed PLR SaM land use.

Remediation includes a Hydraulic Barrier Wall integrating a vertical vadose zone vapour barrier around the site perimeter and a backup groundwater treatment plant. The proposed groundwater remediation strategy also considered available remediation technologies to facilitate chlorinated solvent in-situ source treatment (e.g. chlorinated solvent contamination in the form of Dense Non Aqueous Phase Liquid (DNAPL) providing an ongoing source zone). These technologies were not, however, able to be implemented as the site ground profile is too clayey and heterogeneous preventing reliable and effective contact of chemicals/ treatment reagents with source DNAPL, including from potential remediation corridors. The timing for delivery of the PLR land use further precluded consideration of insitu source treatment options. The HBW and VZB have been completed and the HBW extends around the entire perimeter of the site, forming a closed polygon,. It is generally positioned 5 m inside the site boundary and comprises a soil-bentonite wall which keys into the underlying bedrock. It ranges from 9 m to 19 m in depth. The VZB is a vertical membrane placed along the HBW alignment to mitigate lateral vapour migration at the HBW.

The ICS, to be constructed to render the site as suitable for the PLR SaM commercial / industrial land use, is to be integrated with the HBW and VZB. The ICS incorporates several capping types depending on the proposed surface structures/ surfaces. Broadly it includes capillary break layers (to prevent wicking and surface blooming of hexavalent chromium), vapour management to mitigate vapour exposure pathways, low-permeability layers to mitigate infiltration and vapour pathways, drainage and structural fill. The final site remediation design will be documented and maintained under a site environmental management plan.

- 14 Grand Avenue, Northern portion of Viva (Shell) site including area located to the west of the Wetland.

AWT Ensight (1995) noted that several investigations had been completed at this site, commencing in 1973 by Coffey and Hollingsworth. A high percentage of groundwater, surface water and soil hexavalent chromium concentrations exceeded the applicable adopted assessment criteria. In 1990 Dames & Moore assessed approximately 1.28 hectares of the northeast corner of the refinery site, encountering fill material (thought to have originated from nearby manufacturing plants) overlying natural soils (marine mud and clay/sand layers). The soil in the western and central area of the study site was contaminated with hexavalent chromium (in highly permeable sand infill material) to a depth of less than one metre below ground surface. Soil contamination was confined to the infill material with an average thickness of 2 metres over an area of 10,000 m2. Groundwater was contaminated at certain locations. These observations are supported by the findings of the CMJA (2005) report which confirmed the northern part of the refinery site as having soil and groundwater impacted with hexavalent chromium, including land immediately adjoining the western perimeter of the Wetland area. CMJA (2005) noted that a butyl rubber barrier had been installed during the mid-1970s to prevent the migration of chromium contaminated groundwater into the Wetland area. The current integrity of the barrier is unknown and it is also unknown if the hexavalent chromium impacted materials have been subject to further investigation or management since the recommendations presented in the CMJA (2005) report.

- 14A Grand Avenue, Hymix Australia Pty Ltd.

AWT Ensight (1995) noted that Hymix purchased the land from Shell in1989/90 to build a concrete batch plant. Construction works for a stormwater drainage channel encountered contaminated soil resulting in "a significant yellow chromium plume" in the Parramatta River at the commencement of construction works. Chromium salts were reported to be present in surface and near surface soils, as well as surface water and groundwater. CMJA (2007d) confirmed hexavalent chromium impacts in site groundwater and provided recommendations for groundwater remediation options in the event that remediation might be warranted. Of these in situ chemical treatment was noted to be a preferred option along with some localized treatment of contamination hot spots. An integrated remediation approach with neighboring sites was noted to be unnecessary at this site. The site was noted to be fully paved, limiting surface exposures and windblown dust but it was noted that during the site's construction c. 1989, site soils were observed to be yellow/ green in colour and pooled water was also yellow.

- Clyde Refinery Site

The AECOM (2013) Clyde Terminal Conversion Project EIS, prepared for the Shell Company of Australia Ltd, in November 2013, briefly summarises the known ground contamination at the Clyde Refinery site at the time. Soil and groundwater conditions at the site have been investigated over a number of decades and the investigation results are provided annually to the EPA in accordance with the requirements of EPL 570. The information was collated in 2008 by ERM as part of the preparation of an Initial Conceptual Site Model. Since then, a program of both routine and non-routine environmental site assessments have been undertaken including a quarterly groundwater monitoring program. A Preliminary Investigation Order (PIO) was issued to Shell by the NSW EPA under the *CLM Act* on 22 June 2012 requiring Shell to provide certain information relating to contamination at the site, resulting in the preparation of an Environmental Conditions Summary Report by ERM in 2012. Groundwater was reported at depths generally between 1 to 4.5 m AHD, and flows generally to the east, south-east and south towards the bounding rivers, with a flat hydraulic gradient. Petroleum hydrocarbons and metals are present in groundwater across the site, however, the monitoring results reportedly did not indicate the presence of a widespread plume of contamination.

Soil impacts at the Clyde Refinery site were reported to be generally isolated and limited in extent, related to petroleum hydrocarbons, limited to fill materials and shallow soils (confined by underlying clay and influenced by a shallow water table), and primarily associated with process areas and tank farms. The concentration of metals (including speciated chromium and lead) collected as part of an environmental site analysis project completed in 2011 to 2012 were reported to be below the adopted commercial screening criteria. Asbestos has been identified in fill material to depths of approximately 2 metres in the north-east part of the site. No other contaminants analysed for soil samples (organochlorine pesticides, organophosphate pesticides, polychlorinated biphenyl compounds and phenols) were noted to be present at concentrations exceeding the adopted commercial and industrial screening criteria.

The DECCW[13] (2010) *Proactive Regulation Project, James Hardie Asbestos Waste Contamination Legacy, Summary Project Report*, dated April 2010 also identified potential asbestos waste as buried on the Clyde Refinery site. DECCW recommended that the owner (then the Shell Company of Australia Pty Ltd) ensure that location of asbestos be accurately surveyed and a management plan be developed prior to any disturbance of the area.

Groundwater impacts at the Clyde Refinery site were noted to be isolated and limited in extent and tending to occur within current and historic locations of processing areas and fuel storage or transfer. Groundwater impacts were also noted to be limited in vertical extent due to the presence of a layer of low

[13] Department of Environment, Climate Change and Water

permeability soil and the absence of contaminants within wells screened deeper than 4 metres below ground surface during historic monitoring. Concentrations of dissolved metals above the adopted ecological screening criteria for marine water quality were noted to have been identified in numerous wells across the site and these were noted to be associated with leachate derived from imported fill material or potentially representative of regional background conditions. Concentrations of hexavalent chromium above the adopted ecological screening criteria were noted to have been identified at a number of locations in the north-east portion of the site. This is consistent with the findings of CMJA (2005) (above) but there was no reference included to the hexavalent chromium impacts in fill soils in the north-eastern portion of the refinery site.

Perfluorosulfonate (PFOS) (a component of fire-fighting foam) (a PFAS) was reported to be present in four of ten monitored wells, however the results were not considered to indicate widespread gross contamination for this chemical. No other chemicals analysed for in groundwater samples (organochlorine pesticides, organophosphate pesticides, polychlorinated biphenyl compounds and phenols) were noted to be present at concentrations exceeding the adopted commercial and industrial screening criteria.

As noted in Section 5.2, the more recently prepared Viva Energy Clyde Western Remediation Area Project (SSD 9302) documentation, including the AECOM (2019) Conceptual Remedial Action Plan (RAP) provides further information on soil and groundwater impacts at the refinery site. This RAP includes the results of targeted site assessment works completed in the western remediation area footprint during 2018. This work included the assessment of soil, groundwater and surface water. COPC identified included petroleum hydrocarbons (TRH/ BTEX), heavy metals, polycyclic aromatic hydrocarbons (PAHs), phenols, polychlorinated biphenyls (PCBs), tetraethyl lead and PFAS. It was further noted that the refinery history meant the potential for other chemicals such as acids, sodium hydroxide, solvents and ethanolamine may also be present in drainage systems. Also noted was the potential for buried waste, leaded sludges and asbestos containing materials. As well as petroleum hydrocarbon impacts in soil and dissolved in groundwater, it was further noted that there was Light Non-Aqueous Phase Liquid (LNAPL) observed in soil and groundwater. This LNAPL was noted to be likely associated with a long history of losses over the refinery's history. AECOM (2019) also noted that the drains in the Clyde Western Remediation Area were referred to as "Continuously Oil Contaminated".

The conceptual RAP is focussed on addressing petroleum hydrocarbon impacts. Noting the stability of groundwater plumes the remediation proposal is focused on the source treatment including the excavation of petroleum hydrocarbon impacted soil for onsite treatment and the extraction of shallow LNAPL (where possible). It was proposed that residual soil contamination meeting clean-up criteria, or unable to be practically remediated, be managed onsite. It was further noted that whilst LNAPL would be removed to the extent practicable, further active groundwater remediation was considered unlikely as monitoring to date has indicated stable plumes with no risk of harm to human health or ecological receptors. It was also noted that natural source zone depletion of the LNAPL and subsequent natural attention of the dissolved phase would likely continue to reduce the mass of petroleum hydrocarbons over time in Western Remediation Area. As noted in Section 5.2, Nearmap Imagery (June 2021) indicates that implementation of these remediation works has commenced.

- 10 Grand Avenue

The site was historically occupied by CSR Building Limited (or associated companies) for over 100 years for the production and storage of red clay roof tiles. As noted in Section 4.4 this site was assessed as part of a development application during 2017 (JBS&G, 2017) for proposed light industrial redevelopment including offices, car parking and warehousing. The site has also recently been subdivided (10 and 10A)

to create a northern lot and southern lot with access to both lots from Grand Avenue, creating a battle axe lot to the south. The proposed site redevelopment does not include basements.

JBS&G (2017) notes that the site is impacted with fill contaminated with asbestos and that the western portion of the site is impacted by volatile chlorinated hydrocarbons (VCHs), predominantly chloroform, in soil and groundwater. The source of the VCHs was implied to be the neighbouring former Akzo Nobel site. Other VCH included carbon tetrachloride and tetrachloroethene. JBS&G (2017) notes that a human health risk assessment completed for the site determined that the risks from asbestos impacted soil and the potential vapour intrusion from VCHs into proposed industrial buildings requires remediation and/or management. JBS&G (2017) proposed capping of asbestos impacted fill to create physical separation and the use of a marker layer to control future access. Vapour mitigation in the form of a vapour liner was proposed for installation under proposed site buildings, with a contingency passive vapour venting system. Active treatment of the VCH source zone was noted to be impossible, based on the assumption that the source zone was primarily located on the adjoining property located to the west. JBS&G (2017) also noted that historical underground storage tanks (USTs), used for fuel storage, may also remain onsite and will require removal and excavation validation. Nearmap Imagery (June 2021) indicates that redevelopment of the southern portion of the site, and presumably remediation works, has commenced.

- 12 Grand Avenue

As noted in Section 4.4 this site was recently the subject of a proposed boundary alteration and subdivision. The majority of the site is currently operated as a bitumen plant, comprising a polymer modified bitumen and emulsion facility and a road sealant workshop, with the eastern portion leased by Downer EDI Works Pty Ltd.

GHD (2020) confirmed that the site has been subject to various periods of landfilling and reclamation, with fill placed to raise site levels containing hexavalent chromium wastes. Fill was also noted to be impacted with petroleum hydrocarbons. GHD (2020) also noted that the Council owned portion of land proposed to be incorporated into the 12 Grand Avenue site was used as a landfill by Council from 1970 to 1996 and received road works wastes, municipal wastes and green waste.

As noted in Section 5.3, the site has an EPL for recovery of general waste and waste storage. Materials handled include asphalt waste from road construction and waterproofing works. As noted in Section 6.1.2 the site is also regulated under the *CLM Act*, with several notices issued. Notice 21104 declared the site to be a remediation site due to: concentrations of hexavalent chromium present in site groundwater and potentially migrating towards the Parramatta River; the potential for hexavalent chromium at the site to adversely affect onsite workers and the aquatic ecosystems of the Parramatta River (presumably through surface contact/ potential blooming and impacts to site stormwater); and dissolved phase petroleum hydrocarbons and phase separated petroleum hydrocarbons (LNAPL) presenting a potential risk of explosion in underground services.

The land to be incorporated into the site under the subdivision proposal also has the potential to be impacted from former landfilling activities with COPC such as heavy metals, petroleum hydrocarbons, asbestos, ammonia and landfill gas.

- 16 Grand Avenue, Wilson Bros Timber.

AWT Ensight (1995) noted that this site was formerly used to access a wharf from the 1930s to early 1990s. Investigations by PPK Consultants Pty Ltd in 1993 did not detect hexavalent chromium in soil or groundwater samples from the site. The report reportedly concluded that “the fill materials on this site exhibited total chromium concentrations within the background level and no hexavalent chromium was detected” and that the infill used was not contaminated with chromium. It was noted that adjacent properties clearly exhibited signs of chromium contamination (yellow discolouration of the soil surface).

The previous site land use included a timber yard and more recently it is subject to an EPL (Section 5.3) for waste storage and waste processing (non-thermal treatment) with wastes permitted included building and demolition waste, virgin excavated natural material, asphalt waste, wood waste, waste tyres, garden waste, soil and general waste. Penalty notices are noted to have been issued for the site including a clean-up notice relating to asbestos in a stockpile issued in October 2013.

- 17 Grand Avenue, Seaton's Transport.

AWT Ensight (1995) noted that a site survey by DJ Douglas & Partners Consultancy in 1991 identified chromium contamination in groundwater but not in soil. The report also made reference to several areas around Camellia being infilled with material from a demolished tannery. CMJA (2007c) subsequently assessed the site and hexavalent chromium contamination was not detected in soil or groundwater at the site.

CMJA (2007) also noted that it was a weighbridge site used by the site located at 39 Grand Avenue. The site was also noted as previously (prior to 1950s) occupied by the Rosehill train station. More recently, the site was occupied by a transport refuelling facility. CONSARA (2013) observed one 50,000 L diesel UST and associated fuel infrastructure (two fuel bowsers, vent pipe, fill point). The landowner has indicated it is currently in the process of remediating the site, including the removal of the fuel infrastructure.

- 37 Grand Avenue

AWT Ensight (1995) noted that the site was owned by Mayne Nickless and occupied by Collex Waste (western end) and Rapid Transport (eastern end). The western end was developed in 1969/1970 via excavation a depth of between 1 metre and 2.5 metres and filling with clean ripped rock. Investigations by Kinhill, Metcalf and Eddy in 1993 detected elevated hexavalent chromium concentrations in groundwater. The investigators concluded that the infill material on the site was waste from chrome pigment manufacturing, which was slowly dissolving into groundwater.

The NSW EPA (2002) report on the *Investigations into the Extent and Effects of Chromium VI Leachate in the Upper Parramatta River*, confirmed brightly coloured yellow, hexavalent chromium contaminated water seeps in mangroves adjacent to the former Collex Waste facility (at 37 Grand Avenue) (also known as the Veolia site). As noted previously, the contamination of the site with COPR was confirmed by CMJA (2007a) and in the Veolia remediation fact sheet prepared to support the redevelopment of the site to a Camellia Recycling Centre (Section 5.2).

As noted in Section 5.3, the site has an EPL for waste storage and recovery of general waste. Section 6.1.2 notes the site is also regulated under the *CLM Act*, with several notices issued. Notice 21008 declared the site to be a remediation site due to: concentrations of hexavalent chromium present in site groundwater and in water seeping into Parramatta River from the site. The most recent Notice (20154435) issued in January 2016 notes the proposed remedial approach at the site has changed. The revised remedial approach was noted to involve blocking the existing stormwater system onsite, raising the level of the site with imported clean material and installing a new drainage network in the clean material. In addition, a subsurface barrier was proposed to be installed along the western boundary of the site. A previous notice (Number 20144428, 2012) referred to the remediation of the site changing from a continuous Permeable Reactive Barrier (PRB) to a funnel and gate PRB. This is consistent with the assumption in Section 5.2 that the PRB described in the remediation fact sheet was never constructed and that site remediation works have been limited to upgrade of site drainage and reduction of surface infiltration.

- 39 Grand Avenue

AWT Ensight (1995) noted that the site was previously known as Southern Cross Machinery and was acquired in 1989. Chromium contamination was first observed in 1989 during demolition of Southern Cross Machinery, when “bright yellow liquid was seen running into the Parramatta River”. Analysis determined the presence of chromium, predominantly in the hexavalent form. Contamination was also evident on the ground surface as distinct yellow patches and it was reported that during heavy rainfall the runoff-off from stormwater drains was discoloured yellow because of seepage of groundwater into the drain. Mangroves growing near the stormwater outlet reportedly “were obviously affected by the contamination”.

As noted in Section 4.4 the site was assessed by CMJA (2007c) and it was confirmed that site fill mainly comprised COPR with the northern part of the site shown in historical aerials as former swamp land. Section 6.1.2 notes the site is also regulated under the *CLM Act*, with several notices issued. Notice 21116 declared the site to be a remediation site due to: concentrations of hexavalent chromium present in site groundwater and in water seeping into Parramatta River from the site. The most recent Notice (2017108) issued in January 2018 is an approved VMP implies the remediation approach involves installation of surface engineered capping, presumably to reduce surface infiltration and ongoing monitoring, including visual inspections of the foreshore area for potential seepage. This appears consistent with the remediation approach on the adjoining site at 37 Grand Avenue.

- 41 Grand Avenue, Water Board (now Sydney Water Corporation).

AWT Ensight (1995) noted that an investigation by AWT in 1994 identified “high levels” of hexavalent chromium contamination in soil and groundwater, above the applicable guidelines.

Section 6.1.2 notes the site was regulated under the *CLM Act*, with 3 former notices issued. Notice 15034 declared the site to be a remediation site due to concentrations of hexavalent chromium present in site groundwater and the potential to discharge into Parramatta River. In the response to this Notice a voluntary investigation proposal was completed and in 2008 a Notice (16004) was issued for the site noting that the EPA was satisfied, based on monitoring results, that the land to which this notice applied was no longer contaminated in such a way as to present a significant risk of harm.

- 11B and 11 Grand Avenue

As noted in Section 4.4, CMJA (2007b) documented a 2006 investigation of a narrow strip of Council-owned land approximately 350 metres long (east-west) and 20 metres wide (north-south) on the bank of the Parramatta River at 11B Grand Avenue. The site was once part of the former Goodyear tyre factory on 11 Grand Avenue and was purchased as undeveloped land by Council for the purpose of constructing a pedestrian and cycling access along the Parramatta River. CMJA (2007) completed soil and groundwater investigations at four locations along the Council owned strip of land. The soil and groundwater assessment results indicated that the Council land was not contaminated with hexavalent chromium. The fill material encountered during drilling was mainly building rubble consisting of bricks and concrete, generally to a depth of 2 to 3 metres below the ground surface.

CMJA (2007) also noted that during 1996-1997 Douglas Partners (report title not disclosed) completed an investigation of the site, including the land occupied by API (the former Goodyear tyre factory). That investigation did not detect any significant hexavalent chromium contamination in groundwater or soil. It was noted that remediation of the site included a few hotspot areas contaminated by lead and that the site was validated and a development application was approved for the development of the API factory complex. As noted in Section 4.4, although localised remediation of this site occurred prior to its most recent redevelopment, the site is documented to be underlain by 1-2 metres thickness of fill materials, with fill thickness increasing towards the north consistent with reclamation works along the frontage with the Parramatta River. Fill sources are undocumented, but fill was noted as containing ash layers. Golder

(1996) notes that areas of fill were retained onsite due to the need to retain site structures and services. It is probable that there are areas of residual fill contamination on this site.

- 14 Thackeray Street

As noted previously the 14 Thackeray site was previously occupied by Anschau's Tannery from 1895 until 1923. The site is currently occupied by Concrete Recyclers who operate under an EPL and licensed activities include recovery of general waste and waste storage. A clean up notice issued in June 2019 (asbestos) was revoked in June 2019 following remediation.

As noted in Section 6.1.1, although the site was notified to the NSW EPA under Section 60 of the *CLM Act.* It was determined that the contamination at the site was not significant enough to warrant regulation by the EPA. No further details on the contamination status of the site are currently available but current and former land use activities suggest the potential for site contamination and the Council 10.7 indicate contamination records on Council files.

- 27A Grand Avenue - Sandown Line

The DECCW (2010) *Proactive Regulation Project, James Hardie Asbestos Waste Contamination Legacy, Summary Project Report*, April 2010 noted the following site as subject to James Hardie asbestos disposal:

- Lot 11 in DP603547 located at 27A Grand Avenue, which was owned by RailCorp.

DECCW Noted that a Clean-up Notice was issued on 28 March 2007, requiring RailCorp to submit a remediation action plan to DECC for removal of the asbestos. This is consistent with the summary presented in Section 4.4 that the rail corridor had been filled with asbestos wastes from James Hardie, particularly the area adjoining the Parramatta River, as reported by Coffey (2017). Whilst this area appears to have been subject to earthworks and potentially capping, it is assumed that there is residual asbestos waste subject to some form of environmental management plan. Further, Section 6.1.1 above notes that although the site was notified to the NSW EPA under Section 60 of the *CLM Act* it was determined that the contamination at the site was not significant enough to warrant regulation by the EPA.

- 1 Grand Avenue

The site at 1 Grand Avenue, in the north-west corner of the Precinct, represents land formerly used for manufacture of asbestos-cement products. The land comprises a largely level site containing buried asbestos waste and is also impacted by petroleum hydrocarbon contamination. The site was proposed for commercial/ industrial redevelopment and a Remediation Action Plan (RAP) was developed by CES (CES, 2008) on the basis of results from previous investigations completed between 1994 and 2007.

The following summary of information for the site is based on the information presented in the RAP. The site was previously owned by James Hardie Industries for the manufacture of fibrous cement products, including up until 1981, asbestos cement products. Aboveground structures at the site were demolished between 1995 and 2001 to slab level and building rubble was used to level some stepped areas of the slabs. Approximately 95% of the site was left as sealed with either concrete or bituminous concrete pavements, with the remaining unsealed areas comprising landscaped areas and embankments.

Between 2000 and 2003 Sydney Water Corporation undertook works, in accordance with a Voluntary Remediation Agreement (VRA) with the NSW EPA, to clean up surface asbestos contamination at the site and improve surface seals (concrete and bituminous concrete pavements) to ensure that buried asbestos waste was isolated so that exposure pathways to humans and the environment were not present. The site is subject to a Positive Covenant lodged by the NSW EPA under Section 88E (3) of the

Conveyancing Act 1919. This is consistent with Section 6.1 which notes that ongoing maintenance of the site is required to manage residual contamination.

Whilst the RAP considered a variety of remediation and/or management options for the site it is understood that these options may have been revised in an Addendum to RAP to accommodate the NSW EPA's strong desire that the asbestos waste should not be disturbed. Golder is not aware of the remediation works having been undertaken. Golder notes that the recent PLR construction works in the vicinity of the site may have included acquisition of a portion of the site and a requirement to manage asbestos wastes contained on the land.

- 181 James Ruse Drive

The site at 181 James Ruse Drive, in the north-west corner of the Precinct, represents land formerly used for manufacture of asbestos-cement products and arsenic-based herbicides. The land contains capped mounds and areas of landfilled asbestos wastes and is also impacted by arsenic and petroleum hydrocarbon contamination.

As noted previously a DA had been lodged with Council for construction of high-density residential development on the site. Several environmental assessments have been completed for the site between 1994 and 2012. On the basis of these investigations a Remediation Action Plan (RAP) was prepared for the site by URS (URS, 2013) as well as an Addendum to the RAP (Sullivan Environmental Sciences, 2015). The investigation reports and RAP (URS, 2013) were subject to review by an accredited site auditor and a *Site Audit Report (SAR), 181 James Ruse Drive, Camellia, NSW*, was prepared by Environmental Strategies for Statewide Planning Pty Ltd, dated 30 September 2013. The SAR confirmed the site was historically used for: the manufacture of asbestos-containing materials by James Hardie; an arsenic herbicide factory (Camellia Chemicals Pty Ltd) in the north-west corner of the site; for a drum cleaning operation in the north east corner of the site; and a former boiler near the southeast corner of the site. These activities resulted in asbestos filling (consisting of fibro sheeting, asbestos sludge, asbestos pulp textured material, and corrugated or flat asbestos cement sheeting) across most of the site, and localised metal and hydrocarbon-impacted shallow soil, with limited occurrences of buried materials containing elevated concentrations of polycyclic aromatic hydrocarbons. The filling of the site occurred to a depth of approximately 4 metres below ground level in some areas and occurred between 1971 until the mid-1960s. Localised phase-separated hydrocarbons (PSH) were detected in shallow groundwater at the northeast corner of the site, and elevated arsenic was identified in groundwater close to the western boundary of the site. Statewide Planning Pty Ltd had proposed to redevelop the site for mixed land use comprising commercial and residential apartments with basement car parking, subject to planning approval. The RAP preferred remediation approach comprised encapsulation of the majority of buried wastes within three purpose-built containment cells on the site. Hydrocarbon impacted soil and groundwater in the north east corner of the site would be remediated via biopiling if mixed with asbestos or landfarming if asbestos is absent and then placed into the containment cells.

- Council Lands

Several contamination assessments have been completed on Council owned lands across the Precinct to establish if they are impacted by fill containing hexavalent chromium waste.

CMJA completed the following report: *Environmental Management Plan to Prevent Exposure to Hexavalent Chromium on Council Lands*, *Camellia Peninsula,* for Parramatta City Council in October 2012. This report noted that the full extent and degree of chromium contamination within the Precinct is unknown. This report noted that in 2006, CMJA undertook soil and groundwater investigations at a number of sites along Grand Avenue. The investigations noted variable concentrations of hexavalent chromium in groundwater and fill soil. A significant volume of asbestos containing material (ACM) was also identified in the Precinct. CMJA (2012) outlined measures to be implemented if it was necessary to

conduct construction or maintenance activities that may disturb the sub-surface at hexavalent chromium impacted sites.

Douglas Partners completed the following report: *Report on Contamination Assessment of Pavement Materials, Thackeray Street, Camellia,* for Parramatta City Council in November 2012. This report documented the results of seven borehole investigations of the pavement and underlying soils along the length of Thackeray Street. One sample of subsoil (0.15-0.35 m depth) of five soil samples analysed contained chrysotile and amosite asbestos. The sample with asbestos detections was located near the northern end of Thackeray Street. No hexavalent chromium was detected in the samples.

Noel Arnold & Associates completed the following report: *Soil Contamination Investigation for Parramatta City Council, Median Strip, Grand Avenue, Camellia,* for Parramatta City Council during September 2011. This report detailed the results of shallow soil investigations at 23 locations, to a maximum depth of 0.5 metres, along Grand Avenue, from 3 Grand Avenue through to 17 Grand Avenue. Suspected asbestos-containing materials were observed at most locations. Two of 21 soil samples analysed contained asbestos.

- Sydney Metro West Proposed Acquisition Sites

As noted in Section 5.2 the Sydney Metro West Project (SSI-10038) proposes to acquire several Precinct sites which have been identified as AEIs and potentially contaminated. As the Project CoA will require these sites to be investigated, and if required, remediated to make them suitable for the intended use they will not be required to be included in the proposed Precinct-wide remediation strategy.

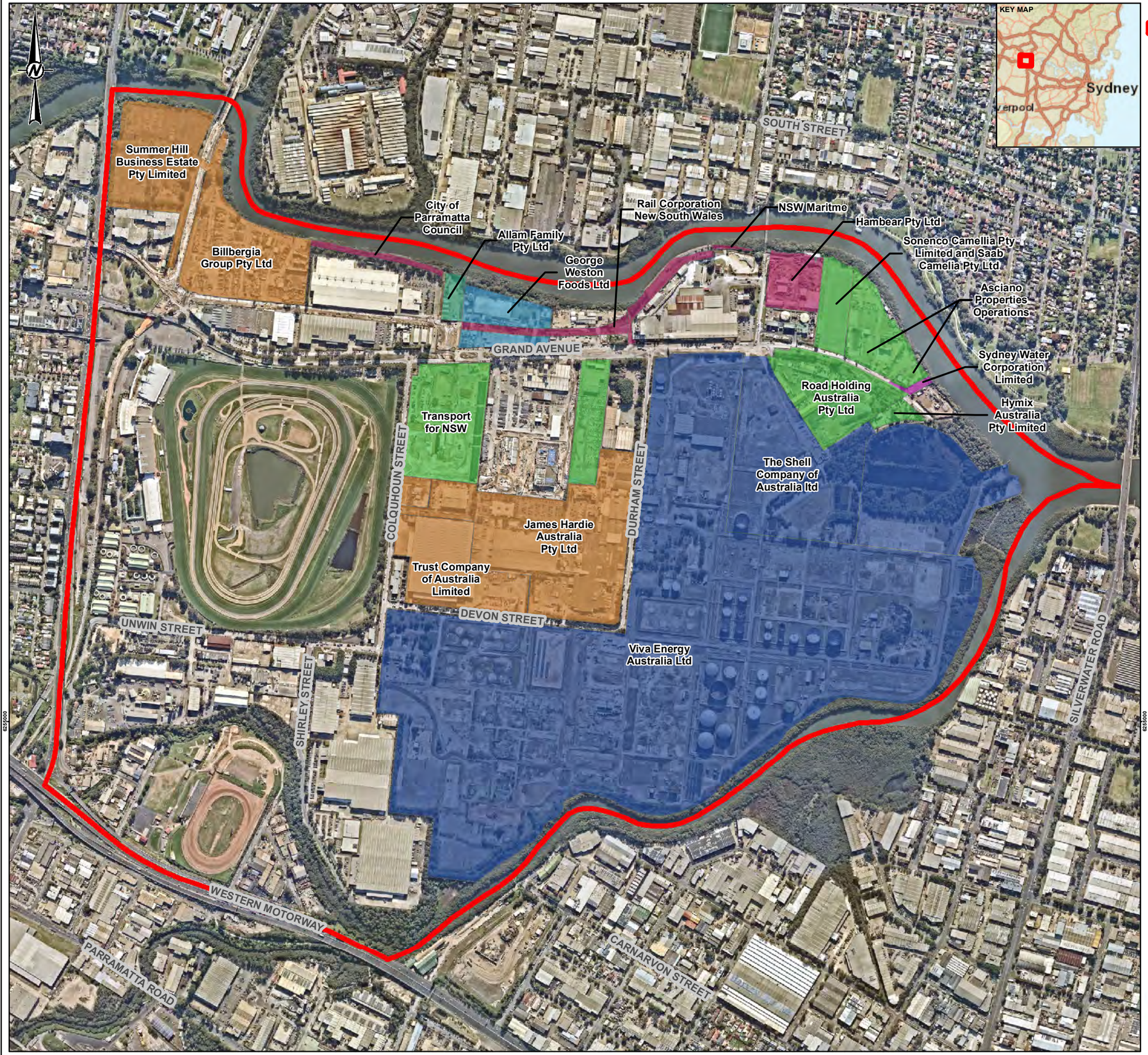
These AEI sites include:

- the Sydney Speedway site with identified potential contamination activities including leaks and spill from vehicle maintenance.
- The Downer EDI bitumen plant and recycling facility located at 1A Unwin Street.
- Potential reclaimed land adjoining Duck Creek.
- The Rosehill helipad site with identified potential contamination activities including refuelling spills and leaks (petroleum hydrocarbons) and potential PFAS.
- Rapid Oil Distributors on Deniehy Street, with identified potential contamination activities including leaks and spills form petroleum storage infrastructure.

Available previous studies relating to the Sydney Metro West Clyde SaM faciality are limited to the Douglas Partners (2006) assessment of the Unwin Street site and the report completed by DECCW to assess the status of asbestos contamination on 29 sites in the Parramatta Local Government Area identified through inquiries to James Hardie entities as potentially containing asbestos wastes. DECCW (2010) Identified sites included:

- The former Campbell's Transport site located north-east corner of Tennyson and Deniehy Streets, Clyde, adjacent to Duck Creek. Prior to 1977 asbestos material was disposed and partly covered with concrete. In December 2007, DECCW observed small amounts of bonded asbestos as broken asbestos sheet on the footpath between the industrial premises and Tennyson Street. It appeared that the cover material on the asbestos had eroded over time, exposing the asbestos material. DECCW considered that large stockpiles of material on the site may contain asbestos.
- 2 Deniehy Street, Clyde, used for Granville Showground and Parramatta City Raceway (Sydney Speedway site). Information from James Hardie indicated that some asbestos cement scrap sparsely mixed with large quantities of soil and concrete were buried on the site prior to 1977. An

inspection of the site by DECCW in December 2007 did not identify visual evidence of asbestos contamination on the open area of the site.



LEGEND

- Camellia Precinct Boundary

Sites Notified to the NSW EPA

- Under preliminary investigation order
- Regulation being finalised
- Contamination currently regulated under CLM Act
- Contamination currently regulated under POEO Act
- Contamination formerly regulated under the CLM Act
- Ongoing maintenance required to manage residual contamination (CLM Act)
- Regulation under CLM Act not required

0 250 500

1:10,000 METRES

NOTE(S)
1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)
1. IMAGERY NEARMAP 2021
2. CONTAMINATION SITE DATA: HTTP://WWW.EPA.NSW.GOV.AU/CLM/PUBLICLIST.HTM, EPA WEBSITE, 26 JUNE 2021
3. DIGITAL CADASTRE SUPPLIED BY DPIE APRIL 2021

CLIENT
DPIE

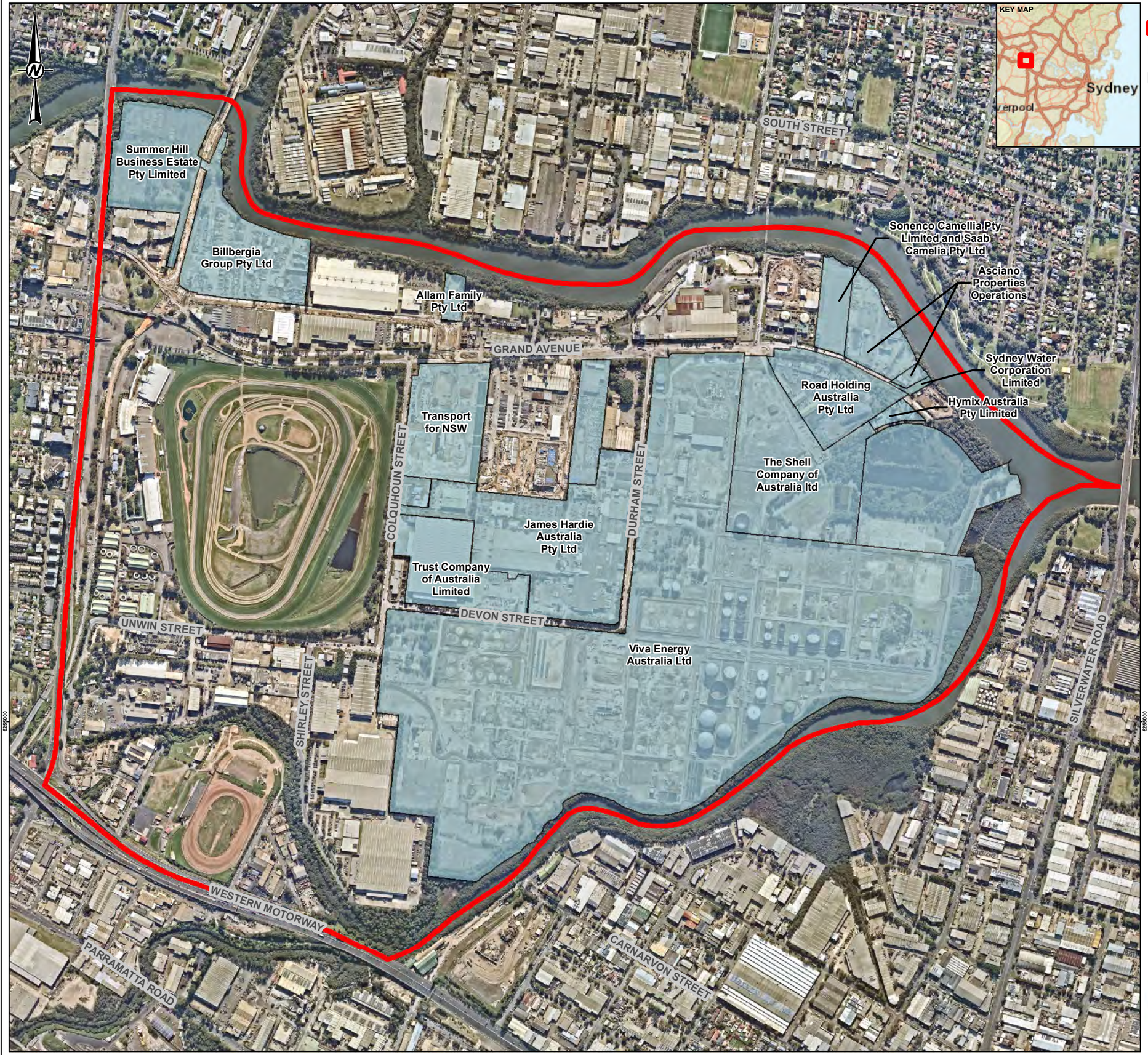
PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
SITES NOTIFIED TO THE NSW EPA

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	001	A	5



LEGEND

Camellia Precinct Boundary

Notices issued by the EPA under the CLM Act

Notices issued by the EPA under the CLM Act

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021
2. CONTAMINATION NOTICE DATA: NSW ENVIRONMENT PROTECTION AUTHORITY WEBSITE, HTTP://WWW.EPA.NSW.GOV.AU/PRCLMAPP/SEARCHREGISTER.ASPX JUNE 2021
3. DIGITAL CADASTRE SUPPLIED BY DPIE APRIL 2021

CLIENT

DPIE

PROJECT

CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE

LIST OF NOTICES ISSUED BY THE EPA UNDER THE CLM ACT

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
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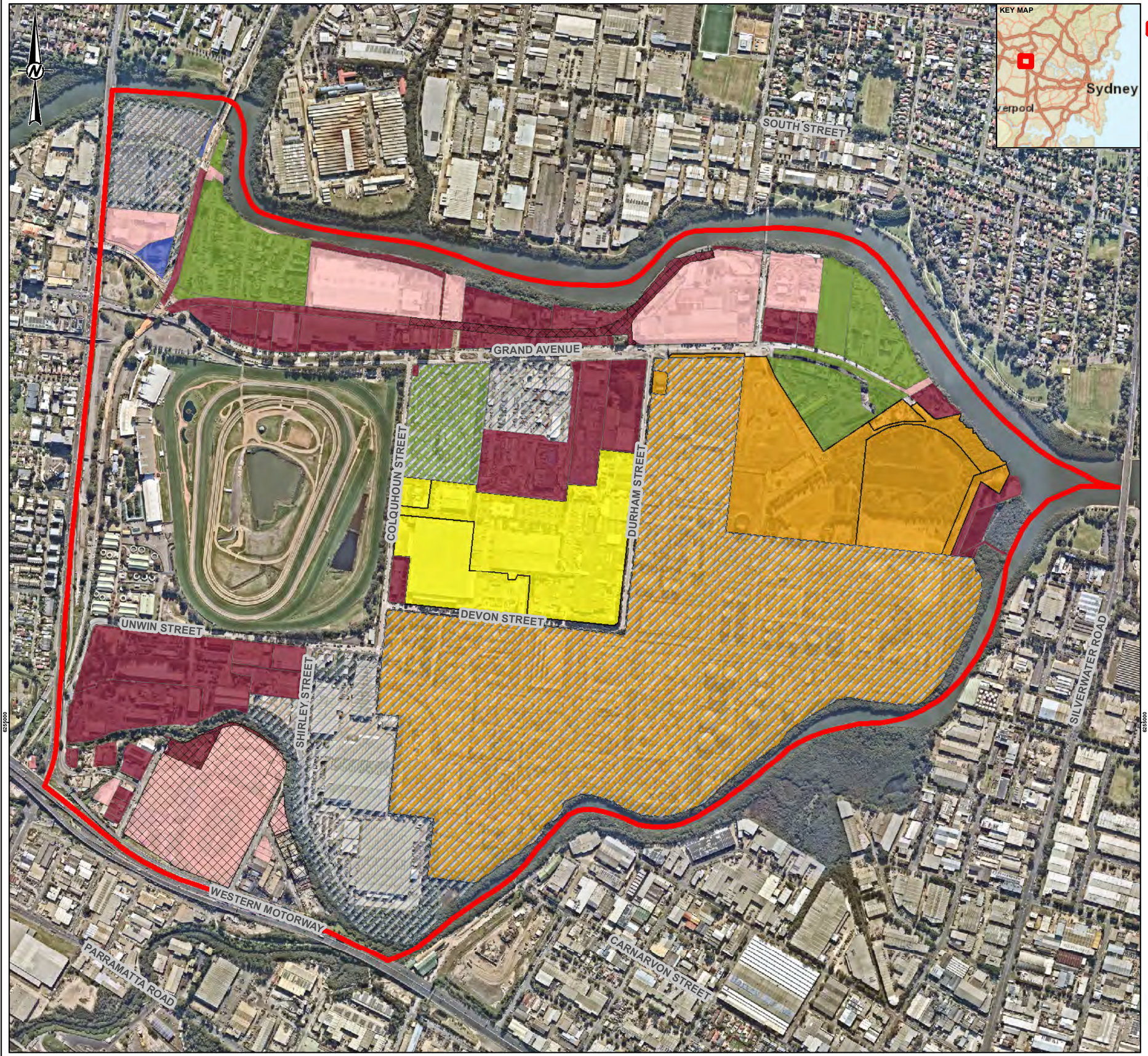


LEGEND

- Camellia Precinct Boundary

Planning Instrument

- James Hardie Asbestos Waste Contam Legacy Report
- Site audit statement
- Ongoing maintenance order
- Environmental Management Plan
- Significantly contaminated land
- Voluntary management proposal
- Potential Contamination - Records in Council
- Potential contamination/59(2) CLM act

0 250 500

1:10,000 METRES

NOTE(S)
1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)
1. IMAGERY NEARMAP 2021
2. SECTION 10.7 PLANNING INFORMATION: PARRAMATTA CITY COUNCIL APRIL 2021
3. DIGITAL CADASTRE SUPPLIED BY DPIE APRIL 2021

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
SECTION 10.7 PLANNING CONDITIONS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
21465238	001	A	7

7.0 SUMMARY OF KNOWN AND POTENTIAL CONTAMINANT SOURCES AND CONTAMINANTS

The preceding sections of this report have identified those properties within the Precinct where available information indicates that they are at risk of contamination due to historical industrial and/or landfilling activities. Information on actual contamination concentrations is limited due to lack of access to reports of investigations of soil and groundwater conditions undertaken on private lands. Nonetheless the following generalised comments are made about potential contamination at the Precinct.

The most widely spread contaminants across the Precinct are considered to be:

- Asbestos – Asbestos wastes from the James Hardie manufacturing operations have resulted in large scale asbestos contamination at 181 James Ruse Drive, 1 Grand Avenue, and on the former quarries backfilled with asbestos waste on the north side of Devon Street. Asbestos material has also been reported as uncontrolled fill in shallow soil along Grand Avenue, in the railway easement north of the Boral Plasterboard Plant at 3 Thackeray Street, within Clyde Refinery, on the north-east corner of Tennyson Street, at the PLR SaM sites, at the former CSR site and at the Sydney Raceway at 2 Deniehy Street.

  The long-term asbestos manufacturing process in the area has likely also resulted in the deposition of asbestos dust within the vicinity of the former manufacturing site. The key contamination risks associated with the presence of asbestos are disturbance causing airborne particles which may be inhaled and present a risk of causing asbestos-related cancers.

- Hexavalent chromium originating from the former Chrome Chemicals manufacturing facility at 6-8 Grand Avenue and possible also the former Wesco Paints facility at 13 Grand Avenue, a former tannery at 14 Thackeray Street and a former timber treatment facility involving use of wood preservatives used in the timber yard at 16 Grand Avenue. Hexavalent chromium waste materials reportedly were used as fill material resulted in contamination at 6-8 Grand Avenue, 37 Grand Avenue, 39 Grand Avenue, 41 Grand Avenue, 12 Grand Avenue, 14 Grand Avenue and the Clyde Refinery site, including immediately west of the Wetland area. Hexavalent chromium is a known carcinogen, the main pathway is via inhalation of dusts and aerosols and direct exposure resulting in skin absorption and potential ingestion. Hexavalent chromium also presents a health risk to sensitive ecological species.

- Petroleum hydrocarbons as dissolved phase and/or phase separated (LNAPL) at the Clyde Refinery site, the SAMI bitumen plant site at 12 Grand Avenue, the Hymix Australia site at 14 Grand Avenue, the EDI Downer site at 1 Unwin Street.

  To a lesser extent they were also identified as COPC at 1 Grand Avenue, 181 James Ruse Drive and associated with potential refuelling facilities at 10 Grand Avenue, 17 Grand Avenue, the Rosehill helipad site and Rapid Oil Distributors on Deniehy Street.

  Petroleum hydrocarbons may present both human health and ecological risks associated with the presence of chemical species such as benzene, toluene, ethyl benzene, xylenes and polycyclic aromatic hydrocarbons (including naphthalene). Dissolved phase petroleum hydrocarbons LNAPL also present a potential risk of explosion in underground services.

- VCHs in fill soil and groundwater (carbon tetrachloride, chloroform, dichlorodifluoromethane and trichlorofluoromethane) are known to be present on the PLR SaM site located at 4-8 Grand Avenue, as well as on the adjoining CSR site located at 10 Grand Avenue. It is not known where these contaminants have migrated in groundwater/ below ground services to other adjoining sites.

  VCHs present both human health and ecological risks. Risk to human health from exposure to VCHs depends on exposure concentration and length of exposure. Short term impacts of exposure to high concentrations include (but are not limited to) headaches, dizziness and drowsiness. Long-term impacts of exposure to high concentrations include (but are not limited to) impacts to the central nervous system, kidneys and liver. Due to their volatile nature VCHs can migrate through the

subsurface in the vapour state from soil and/or groundwater sources. Vapours can accumulate in buildings, entering through cracks in foundations and at points where services enter buildings.

- Perfluoroalkyl and polyfluoroalkyl (PFAS) substances in groundwater are known to be present on the Shell refinery site and may have migrated on to adjoining sites in groundwater.

  PFOS and PFOA are both very stable chemicals that bioaccumulate, do not break down, and can persist for a long time in the environment. Due to their widespread use in a range of industrial and consumer products over many decades PFAS contamination is commonly found in the environment at low levels. Although there is no consistent evidence of human health impacts related to PFAS, the potential effects to human health cannot be excluded, and NSW EPA are taking very cautious approach to regulating PFAS.

- Landfill gas may be present at the James Hardie Devon Street landfill site and in select locations on the sites located at 12 Grand Avenue and on the PLR SaM, site located at 4-8 Grand Avenue. Landfill gases can become potentially explosive, asphyxiating or acute toxicants when they are encountered at elevated concentrations. Landfill gases become most hazardous when they intrude into buildings and structures, such as utility access pits and inspection chambers, where they can accumulate.

8.0 GEOTECHNICAL REVIEW

This section describes potential geotechnical issues across the Precinct to provide preliminary input for the master planning process.

Shallow spread footings or raft foundations on treated ground (pre-load and bridging fill) may be possible for some paved areas and settlement tolerant, single storey buildings. Piled foundations will very likely be required for all non-settlement tolerant structures and slabs and may also be required for single level buildings depending on each structure's tolerance for differential settlement and the level of ground treatment adopted.

The key geotechnical issues that will need to be addressed include:

- Allowable bearing pressures (deep and shallow).
- Design parameters for ground treatment areas (compressibility, strength, consolidation properties).
- Allowable total and differential settlement, including long term creep settlement.
- Chemical attack on buried concrete (soil and groundwater, Acid Sulfate Soils, ph, sulphate, chloride).
- Generally shallow depth to groundwater.

For road pavement constructions, the key geotechnical issues will be the potential strength, moisture condition and reactivity of the sub-grade materials, as well as the potential for long term creep settlement, which could impact cross falls and required service gradients beneath the pavements.

Targeted site-specific investigations are recommended to better define each of these issues once land use rezoning proposals have been developed for the Precinct.

9.0 CONTAMINATION RISK ASSESSMENT

9.1 Land contamination risk ranking framework

A qualitative assessment of the contamination risk across the Precinct has been undertaken as follows. The assessment considered the following contamination risk factors:

- Reported soil or groundwater contamination as documented in available soil and groundwater investigation reports or Council's Section 10.7 database on contamination for properties in the Precinct.
- Notices issued by the NSW EPA under *the CLM Act*.
- Contaminated sites notified to the NSW EPA under Section 60 of *the CLM Act*.
- Sites subject to an EPL.
- Sites subject to landfilling.
- Sites subject to industrial activities which may use significant quantities of chemicals, oils or fuels.
- Visual indications of contamination such as surface staining, adverse odours, discoloured surface water or stressed vegetation.

The risk of contamination on the properties throughout the Precinct has been classified against the risk rankings listed in Table 5 represented in **Figure 8**. The risk rankings are based on, and limited by, the readily available information and Golder's judgement as to the relative potential for land contamination given the current or historic use of a given land parcel within the Precinct. These risk rankings are not quantitative. Further investigation (potentially involving intrusive investigations) of each land parcel would be required to refine risk rankings and to quantify potential remediation requirements.

Table 5: Land contamination risk ranking

Risk Ranking	Definition
Unlikely	Reports of previous investigations on the site indicate that no significant soil or groundwater contamination was identified and/or was unlikely to be present.
Low	There is a low likelihood of significant soil or groundwater contamination having occurred. The information suggests that there may have been some activities on the site that have resulted in localised soil contamination of the land but the site is not likely to be a source site for groundwater impact. No investigation reports have been sighted.
Medium	There is a medium likelihood of significant soil and groundwater contamination having occurred. No investigation reports have been sighted.
High	There is a high likelihood of significant soil and groundwater contamination having occurred. Investigation reports may have been sighted confirming contamination status.

9.2 Remediation and/or management risk ranking framework

Remediation and/or management options may be required to enable some of the Precinct properties to be redeveloped to more sensitive land use. Generally, the proposed land use can have a significant influence on the amount of remediation and/or management that is required for a redevelopment. For example, a more sensitive target land-use (e.g., a school or childcare centre) with more sensitive receptors and will likely more potential exposure pathways generally have more significant remediation implications than a less sensitive target land use (e.g. heavy industrial). The remediation requirements may differ for each target land-use with respect to:

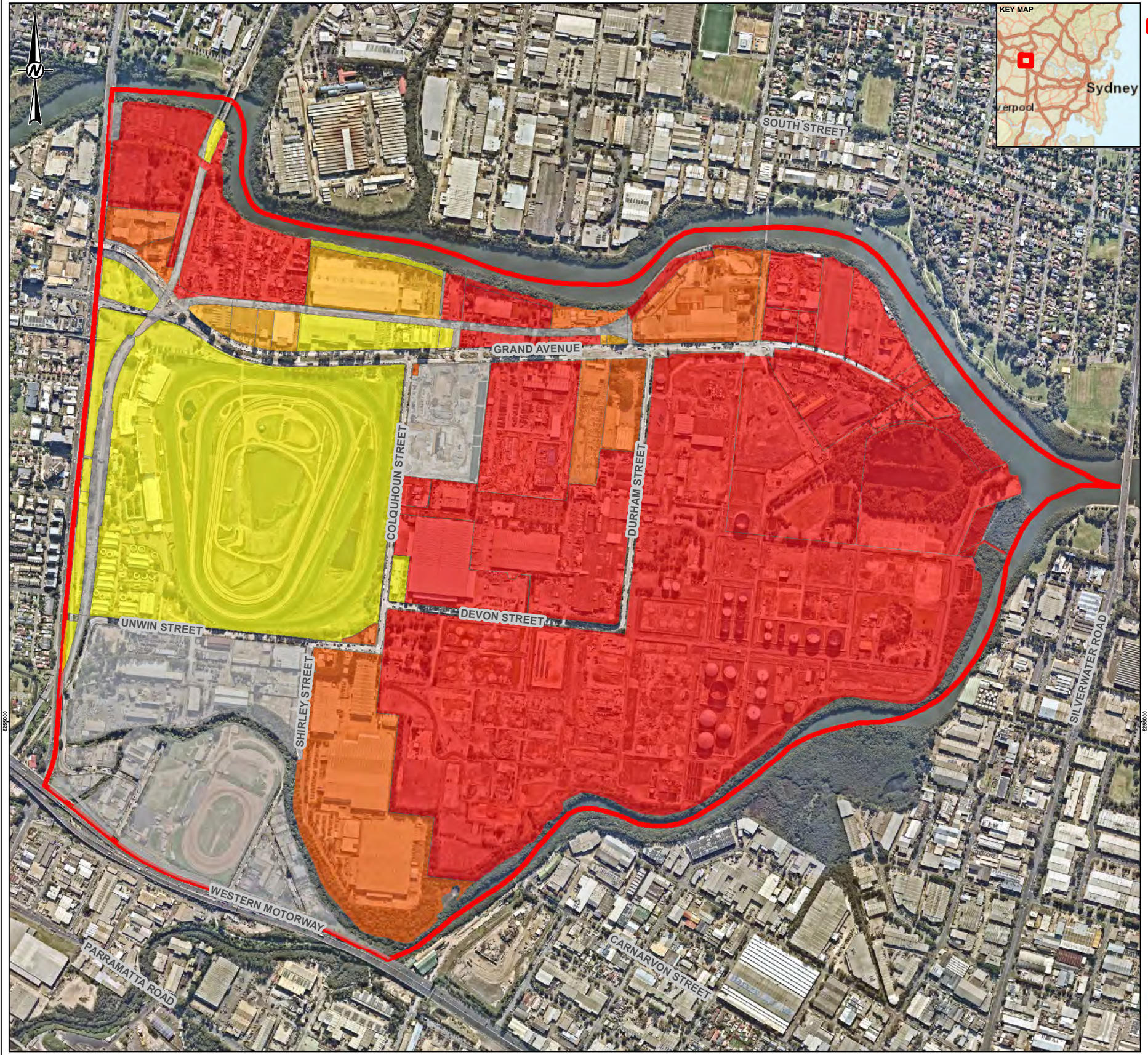
- The extent of remediation that is required.
- The type of remediation technology that is selected.
- The complexity of remediation and/or management program.
- The capital cost of remediation works during the site redevelopment.
- The costs that are associated with the ongoing management of residual contamination on the site.

To assess each land-use scenario developed as a part of the CRPS, proposed land uses have been allocated a likelihood ranking for whether remediation would be required to achieve the identified land use. This is identified in Table 6 below. The likelihood rankings include “unlikely”, “possible” and “likely”. This matrix assumes that there will not be any freehold residential development in the Precinct (e.g. including gardens with access to soil).

Table 6: Remediation and/or management risk ranking

Land Contamination Risk Rank	Definition of Risk Rank	Likelihood that remediation is needed to Achieve Identified Land Use			
		School / Kindergarten	High Density Residential	Recreational	Commercial / Industrial
Low	**Soil Contamination is Likely & Groundwater Contamination is Possible**. The information suggests that there may have been some activities on the site that have resulted in localised contamination of the land but the site is not likely to be a source site for groundwater impact.	Possible	Unlikely	Unlikely	Unlikely
Medium	**Soil & Groundwater Contamination is Likely.** The information suggests that the site activities may have contaminated the land and/or groundwater. Some remediation of soil will potentially be required and there will be a potential need for groundwater remediation.	Possible with some restrictions	Possible	Possible	Unlikely
High	**Soil &/or Groundwater Pollution**. The information suggests that the site activities are likely to have caused pollution that would likely require soil remediation and/or active groundwater remediation.	Likely	Likely	Likely	Possible

The risk ranking definitions use the terms “unlikely”, “possible” and “likely” to represent an increasing level of risk. The term “pollution” reflects higher risk than “contamination”. “Pollution” of soil or groundwater implies that further investigation and possibly remedial action is required irrespective of the proposed land use. This ranking structure has been used to assess **relative risk** based on available “desktop” information. The outcome of this risk assessment will be mapped for each of the land use scenario developed during the CPRS.



LEGEND

- Camellia Precinct Boundary

Contamination Risk Ranking (Updated)

- High
- Medium
- Low - medium
- Low
- PLR and TfNSW Land

0 250 500

1:10,000 METRES

NOTE(S)

1. CO-ORDINATE SYSTEM: MGA56, GDA94

REFERENCE(S)

1. IMAGERY NEARMAP 2021

CLIENT
DPIE

PROJECT
CAMELLIA PLACE STRATEGY BASELINE STUDY

TITLE
POTENTIAL CONTAMINATION RISK RANKING

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	30-06-2021
DESIGNED	KJS
PREPARED	KJS
REVIEWED	JND
APPROVED	CMV

PROJECT NO.	CONTROL	REV.	FIGURE
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10.0 IDENTIFIED CONTAMINATION CONSTRAINTS AND OPPORTUNITIES

10.1 Constraints

- **Widespread Soil and Groundwater Contamination:** As summarised in Section 7.0, contamination should be considered to be a potential constraint across the entire Precinct where land has been subject to historical industrial land use and/or potential contaminating activities and/or landfilling. This widespread contamination across the Precinct may be limiting on land use potential due to increased costs for developers and government to facilitate safe remediation and/or management. Identified widespread Precinct groundwater impacts broadly include:
  - Chlorinated hydrocarbons centred around the former Akzo Nobel site (now the PLR SaM redevelopment site):
  - Petroleum hydrocarbons and PFAS associated with the former Shell refinery and SAMI bitumen sites: and
  - Hexavalent chromium associated with COPR used as fill across the wider Precinct, particularly to the north and east along the Parramatta River.

  Examples of other point sources of groundwater contamination include various localised industrial activities such as storage facilities (above and below ground) for petroleum-based liquids, storage of oils and chemicals, use of oils and chemicals in workshops and factories and operation of equipment and vehicle maintenance workshops and wash bays.

  Precinct remediation strategies should, where possible, avoid creating exposures pathways to chromium and asbestos contamination in fill/soil. For example, it is preferable that remediation and/or redevelopment requiring large scale bulk earth works are avoided in areas where these wastes are located because of the associated environmental management risks, including contaminated dust, asbestos fibres and surplus wastes requiring offsite management. On this basis, there is limited opportunity for below ground redevelopment (e.g., basement car parking on several sites due to impacted soils) that would potentially generate large volumes of surplus spoil comprising hazardous and/or asbestos (special) waste. Shallow groundwater is also a common feature in the Precinct. The management of contaminated groundwater (e.g., collection and/or treatment) would also need to be considered as part of any below ground development proposals including infrastructure corridors.

  In areas of widespread hexavalent chromium waste, surface barriers are required to prevent exposure but also to reduce surface infiltration and leaching, contributing to groundwater and surface water impacts. The ability of hexavalent chromium to wick and form surface blooms (which can create toxic dust) on pavements and structures also needs to be managed with the use of barriers such as capillary break layers (CBLs). As noted in Section 6.3, CBLs are being constructed across the SaM remediation site to manage this potential exposure pathway.

- **Inadequacy of Remediation Works Completed to Date:** The NSW EPA has cited a need to consider the adequacy of existing remediation solutions applied to date in the Precinct. To accommodate a range of future, potentially more sensitive land uses, the existing remediation solutions may need to be either enhanced or superseded by new strategies. For example, proposals which facilitate more access to foreshore areas imply a greater potential for exposure to contamination. In this case it is unlikely that current remediation and management strategies applied for hexavalent chromium contamination on the various sites located at the north-eastern end of the Precinct and in the Wetland area have addressed public recreational exposure scenarios along the foreshore.

- **Ministerial Direction on Rezoning Contaminated Land**: None of the Precinct land can be rezoned until the obligations under Ministerial direction (No 2.6) Remediation of Contaminated Land are met. In accordance with this direction, in order to support any rezoning proposal for the Precinct there will be a requirement to demonstrate that land within the Precinct is or can be made suitable for the proposed land use. The Master Plan will need to ensure that land is assessed and remediated/managed so that the land is suitable for the proposed use and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment. Where possible remediation of contamination in the Precinct needs to be facilitated.
- **Potential Remediation Staging Conflicts:** During the development of Homebush Bay and Rhodes peninsula, individual sites for high density residential land use were developed and occupied and conflicts arose as adjoining sites were remediated and redeveloped. To prevent similar conflicts, there should be controls on Staging of any proposed remediation of the Precinct. These controls should be developed to promote staging priorities for remediation and redevelopment activities, such as a mechanism whereby development of selected sites may be restrained or controlled to account for future potential remediation impacts on adjoining land.
- **Competing interests of multiple land holders:** Although there is a preference to consider contamination remediation holistically across the Precinct (rather than site by site), the multiple (over 100 individual) landowners and conflicting land uses will make this challenging. Many landowners are likely to resist change of use in short to medium term creating future conflicts as sites redevelop. E.g. the current recycling facilities and premises with Environment Protection Licences (EPLs) located in the north east of the Precinct present various odour, dust and noise issues for more sensitive, mixed use, land uses.
- **Flooding and rising sea level:** Large areas of the site comprise low lying land within the 1:100-year average recurrence interval flood level. Capping remediation solutions may increase site levels and have a significant influence on flooding behaviour. Understanding this interface will be critical to the success of the Precinct planning. In order to accommodate capping levels, surplus contaminated soil may be generated as waste which may require offsite management. This would be contrary to State waste minimisation objectives. Future potential coastal inundation, potentially exacerbated by climate change, could also impact on the Parramatta foreshore area and add further limitations to available remediation options.
- **Shallow Groundwater:** During construction activities dewatering activities can generate contaminated groundwater requiring management. Dewatering can also generate acid runoff (in areas of acid sulfate soil). Longer term contaminated soil and groundwater can impact on services (e.g., aggressive ground) or groundwater/soil gas can enter services and migrate/ accumulate (e.g., hazardous ground gas/ vapour).
- **Acid Sulfate Soils:** The presence of potential acid sulfate soils in some areas of the Precinct would require management during excavation works and/or dewatering activities to prevent generation of acid forming conditions.
- **Contamination in the intertidal zone:** The NSW EPA requires that land parcels proposed for remediation and redevelopment which adjoin foreshore areas must include the remediation of foreshore land if it is also impacted by contamination. This is consistent with other Sydney Harbour foreshore redevelopment and remediation approaches such as the Rhodes Peninsula and Kendall Bay. To create a more accessible foreshore could also mean some destruction of the natural intertidal zone, with a requirement to remove and/or cap contamination and the potential requirement in some locations for the inclusion of cut off walls or groundwater treatment barriers on adjoining land parcels.

Whilst a holistic approach to remediation of the foreshore area, particularly along the Parramatta River, could assist in its regeneration, there will be constraints which will make remediation, to allow improved access to the public, challenging. The land use scenarios developed during the CRPS Project may consider public recreational land uses along the foreshore of the Parramatta River and parts of the Duck River, subject to ongoing environmental management. For example, this might include a shared use trail parallel and adjacent to the river. To maximise amenity, it is assumed that access to the river would not be fenced, but there would be no direct access routes and recreational use of the river would be discouraged (e.g., signage). To control the potential exposure pathways of direct contact or inhalation by recreational users to asbestos fibres and/or hexavalent chromium dust, some removal and replacement of fill material along the riverbank, and its replacement with e.g. clay/ rock armour (e.g. rock fillets to protect regeneration areas from wash and to allow fish movement) would likely be unavoidable. This would generate surplus waste, unlikely to be able to be accommodated onsite and therefore requiring offsite management. This would be an expensive remediation option. In some locations it would also need to be complemented with remediation measures to address the potential for ongoing seepage of contamination, e.g. hexavalent chromium contaminated groundwater, on selected adjoining sites.

There may be some unavoidable disturbance to/destruction of the natural environment of the intertidal zone. In Homebush Bay the removal of contaminated sediments, for example, near the former Dulux paint factory was only achievable by removal of mangrove communities. As part of a more recent sediment remediation in Kendall Bay it is understood that the removal of all mangroves was considered unacceptable by community stakeholders and the proposed remedial works were only expected to require the removal of one mature mangrove. Current remediation proposals, e.g., asbestos sheeting along the foreshore area of the site located at 1 Grand Avenue, where some mangrove removal would be unavoidable to access contamination, the mangrove community may need to be removed and subsequently rehabilitated. Council planning controls currently require redevelopment proposals to include rehabilitation and restoration strategies for flora and fauna. It is, however, further noted that many of the mangrove communities located in the eastern area of the Precinct have only become established since the placement of fill, including Chromium Ore Processing Residues.

More information on the actual extent of the proposed foreshore redevelopment area, including potential exposure pathways to contamination and details of current land ownership is also required (e.g. Crown land).

- **Key geotechnical constraints:**
  - CES (2007) identifies deep variable fill and soft soils requiring piled foundations to support concentrated building loads (columns, footings, etc).
  - CES (2007) implies that ground bearing slabs may be used, although this would carry a high risk of ongoing differential settlements over laterally variable fills and alluvium (both across slabs and between slabs and piled elements) especially where levels are adjusted from existing ground level.
  - Widespread filling to raise site levels would result in significant and varying settlements. Site filling would need to be done well ahead of piling work to reduce down drag on piles and to limit post-construction differential movements between piled structures and surrounding (non-piled) areas. As noted above, the impact of site filling on flooding behaviour would also need to be well-considered in the planning process.
  - Constructing foreshore retaining structures would be challenging due to low strength, compressible soils, tidal groundwater, ASS and aggressive / saline conditions.

- The CES (2007) report contains no discussion of long-term consolidation and creep effects (or design parameters) which would be critical when considering total and differential settlement impacts affecting the proposed works.

10.2 Precinct-wide strategic opportunities

Outlined below is a selection of potential precinct wide contamination strategies that may encourage redevelopment in the Precinct, reduce potential costs and development delays and result in improved environmental outcomes.

- ***Progressing the Early Assessment and Remediation of High-Risk Sites that are Potential Sources of Offsite Groundwater Pollution*:** The development of sites or land parcels affected by potential source sites can be problematic to development type, assessment and remediation cost, timing and the approval process, particularly where:
  - It is identified that the potential source site is generating a groundwater plume below a potential development site which presents an unacceptable risk without development re-design, remediation and/or management; or
  - The proposed development site is the only reasonable area (e.g., due to location of the impact or other logistical constraints (e.g., adjacent area built out)) that would allow access for the impact to be remediated now or at some time in the future.

  Whilst many of the Precinct point sources of groundwater contamination will be able to be managed as part of sub-Precinct remediation activities, the Precinct wide sources associated with: the former Akzo Nobel site; hexavalent chromium fill; and the Shell refinery warrant a more Precinct based remediation Strategy. The current remediation of the former Akzo Nobel site as part of the PLR SaM facility redevelopment has sought to address one of the main sources of chlorinated hydrocarbon contamination in groundwater. Notwithstanding, downgradient impacts and other potential source areas remain and may warrant a Precinct wide approach for their remediation and/or ongoing management.

  The hexavalent chromium impacted groundwater and surface water would benefit from a Precinct wide remediation strategy. Previous studies have strongly advocated such an approach at north-eastern end of the peninsula for sites adjoining the Parramatta River. This would be substantially more effective and cost efficient than independent approaches and fit with ecologically sustainable development principles.

  Similarly, a site-wide approach to the remediation/management of groundwater contamination on the former refinery should be applied prior to creation of potential sub-Precincts for divestment and redevelopment. The Viva Energy Clyde Western Remediation Area Project concept remediation plan does include some groundwater remediation/management strategies.

- ***Review Strategic Opportunities to Integrate Land Parcels into Super Lots**:* This has the advantage of providing the opportunity to integrate contamination (soil and groundwater) management across multiple land parcels thereby minimising the cost of remediation works and provides greater opportunity to retain contaminated materials within developed sites**.** To some degree, there has been early adoption of this approach by the Camellia Gateway developer group (comprising Billbergia, the GPT Group and the Australian Turf Club) in the north-western portion of the Precinct. Viva is also a primary landowner in the Precinct and the site transition from a refinery to fuel import terminal has freed up large areas of land for redevelopment. This approach provides the following benefits:
  - Grouping sites with similar contaminants to facilitate lower cost and more holistic remediation approaches.
  - Reduction in potential for remediation staging conflicts.
  - Stimulates investment to facilitate the redevelopment of adjoining areas.

- Changes to more sensitive land use/ exposure scenarios will trigger a requirement for more complex, higher cost, remediation solutions. Future land use returns will need to be able to support these higher remediation costs. Complex, high cost, remediation requirements can often result in unachievable redevelopment profits.

- ***Prepare Precinct Wide Hydrogeological and Groundwater Quality; and Chromium and Asbestos Waste Fill Summaries***: The collation of Precinct wide summaries could assist with the characterisation of regional properties and conditions that need to be considered by planning authorities, environmental consultants, land developers and/or Site Auditors as part of their assessment of land suitability for its intended use.

  The types of information that should be considered in the groundwater quality summary include regional hydrostatigraphy, groundwater flow system and direction(s), background chemistry and quality of the shallow and deeper aquifer units across various part of the Precinct.

  The types of information that should be considered in the fill include hexavalent fill/soil contamination concentration, depth and extent data and asbestos in soil and/or buried asbestos type, depth and extent. Where possible the summary should also include visual and physical descriptions.

  These summaries would draw upon the large volume of existing contamination information prepared for individual sites. This information could be made public to environmental consultants and land developers. As further information is collected as part of public documents, such as DAs or Site Audit Reports this information could be collated and managed by a single public entity. There may be confidentiality issues associated with some of the existing studies, but there are already large volumes of information in the public domain associated with previous planning approvals.

  The regulation project completed by the NSW EPA (then the DECCW (DECCW, 2010)) is an example of a similar summary prepared in 2007. This summarised the known James Hardie asbestos contaminated sites/ areas across Sydney.

  The findings of the groundwater and soil summaries could be used to support a strategic, Precinct-wide approach to addressing groundwater contamination and present an opportunity to improve the water quality in the Parramatta River and Duck River.

  The information from both summaries could also be used to inform concept Remediation Action Plans (RAPs) (see below).

  The summaries could have the following additional benefits:

  - Assist with the fast tracking of site assessments and Site Audits as part of sub-precinct scale redevelopment.
  - Potential to reduce some of the contamination related costs for developers. For example, this may have benefits in the eastern portion of the Precinct where there is a high-density of small individual sites where hexavalent chromium impacted groundwater is currently being addressed by individual landowners using a piece-meal approach. A Precinct-wide study to develop a remediation strategy for hexavalent chromium impacted soil and groundwater would be substantially more effective and cost efficient than current independent approaches.

- ***Prepare a Precinct Wide Concept Level Remediation Strategies****:* There is an opportunity for future development control plans prepared for the Precinct to be informed by a Precinct wide conceptual RAPs which would identify a preferred approach for managing contamination across the Precinct. Each concept plan would be reviewed by a NSW EPA Accredited Site Auditor to establish suitability. There are good examples of similar concept RAPs having been prepared for the other Sydney precinct

developments including: the Wentworth Point Precinct DCP 2014; and the site-wide remedial concept plan prepared for the Bays Precinct Urban Transformation Area. These concept RAPs would:

- Support rezoning of the Precinct for a range of land uses.
- Supporting planning and documentation of future applications for individual sites within the Precinct.
- Facilitate a co-ordinated approach to remediation/management of site contamination issues during future development of individual sites.

- ***Encourage Site Owners to "get house in order"* and Group Collaboration:** The individual site operators will often be the owners of the site and the associated contamination legacy issues. These operators have the best knowledge and resources to address contamination issues while they have time between current operations and potential future divestment and redevelopment opportunities. The earlier some contamination issues are considered, the more options that may be available and often the issue can be treated at a lower cost. Hence, the early undertaking of due diligence assessments by these operators should be encouraged to identify key contamination issues.

  With minimal state government land holdings in the Precinct, any Precinct-wide contamination strategies may require private owners to collectively agree to strategies within their land. This may not be easy to achieve. This approach does, however, have the potential to:

  - Save a considerable amount in investigation costs.
  - Shorten the timeframe for clean-ups (if required).
  - Allows for a more orderly roll out of "renewal ready" land.
  - Provide more certainty around the remediation/ management process.

- ***Review the Planning for Placement of Infrastructure and Services*:** When planning large scale infrastructure changes or improvements consideration should be given to the design to either minimise the potentially contaminated fill disturbance or for the return of the fill to the depth and location from which it was removed. Alternatively, consideration should be given to potential opportunities to manage contaminated soils on site within a designated part of the Precinct using features such as mounds or reclaimed excavations with protective barriers. Discussion would need to be held with various stakeholders (e.g. NSW EPA, Council, DPIE and others) to seek a durable long term agreement on the overall approach of maintaining as much of the contaminated soils on the site as is practicable. Such an agreement with various stakeholders could require clarity about eventual patterns / types of land uses on the land parcels, especially over areas occupied by the containment facilities, and about the long-term management / monitoring regime for the integrity and functionality of such a facility. Adequate provisions for governance of long term management plans would also be a consideration.

- ***Mapping higher and lower risk/opportunity sites for filling:*** As noted in Section 4.0, large areas of the Precinct are at risk of flooding. Some approaches to remediate sites (e.g. cap and contain) may raise elevations on sites, which may cause flooding impacts in areas both on the Precinct, and off the Precinct. A Precinct wide capping strategy should be developed in unison with a Precinct wide flood management strategy. Detailed flood modelling would need to be undertaken to identify suitable cut and fill areas and where filling can occur to meet flood management performance criteria for the Precinct.

- ***Identify Remediation Funding Opportunities:*** Any proposed State Infrastructure Contribution framework to fund state and regional infrastructure (e.g. schools, parks and public spaces) should where possible include funding estimates for contamination investigation and/or remediation works and

ongoing long term management, e.g. for infrastructure along the foreshore area to manage potential exposures to contaminated stormwater, groundwater, fill and sediment.

- ***Key geotechnical opportunities**:*
  - Minimise excavations where possible to reduce generation of contaminated and ASS impacted spoil and groundwater.
  - Pre-loading the site would be a potentially attractive (low cost) ground treatment option to 'build-out' settlements on fill and compressible soils. It would be prudent to commence site-wide filling as early as possible in the construction program (or even arrange for fill placement as a separate early works contract). If required, and subject to analysis, the time required for preloading to consolidate the ground could be accelerated by installation of wick drains (although these would require management of acidic / contaminated expelled pore water).
  - Assuming the works do not involve significant basement excavations (to avoid contamination / ASS issues), then there would be a significant 'net filling' requirement to raise site levels. It would therefore be prudent to secure suitable fill sources that are compatible with the site end use such as selected tunnel spoil from the nearby Sydney Metro extension to Parramatta.
  - Obtain / utilise learnings from Camelia ground treatment project and nearby PLR embankment treatments where possible (Concrete Injected Columns (CIC), soil mixing, preloading just completed at James Ruse Drive which can help validate compressibility parameters, etc).
  - Ground treatments for foreshore retaining structures could include rigid inclusions (driven piles or displacement columns to avoid spoil generation) installed to lower / stiffer alluvium along with geotextile reinforced bridging layers and flexible / articulated wall systems.
  - Slab options include suspended / piled slabs or ground treatment through preloading, optionally in conjunction with one or more of the following:
    - Engineered fill layers (potentially geogrid reinforced).
    - Rigid inclusions (e.g. CICs).
    - Dynamic replacement (involves driving selected material into the ground to displace the in-situ material partially or completely to form columns of compacted material).
- ***Precinct specific Development Control Plan (DCP) or a standalone Contamination Land Action Plan (CLAP):*** This is recommended to ensure that land is assessed and remediated/managed so that the land is suitable for the proposed use and that the contamination does not present an unacceptable risk to human health or any other aspect of the environment. The NSW EPA has previously cited a need for a CLAP which does not substitute legal obligations of *CLM Act* and *SEPP 55* but underpins the Master Plan by providing the community, landowners, development industry and government with a clear strategy that includes information, guidance, expectations in relation to land contamination and its management to inform redevelopment of the Precinct. This Plan should identify Precinct specific contamination risk factors both during and post construction. The EPA has noted that particular emphasis should be on areas of Precinct extending to waterways and foreshore areas identified for public recreational land use. The CLAP might also include: Precinct wide staging strategies; management of contaminated groundwater and/or stormwater associated with land; and management of waste to guide remediation.

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12.0 IMPORTANT INFORMATION RELATING TO THIS REPORT

Please refer to Appendix B for important information relating to this report.

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https://wsponline-my.sharepoint.com/personal/james_dudley_wsp_com/documents/project files/crps/21465238-005-r-rev3 remediation baseline analysis report.docx

APPENDIX A

Summary of Section 10.7 Certificate Information

Table A1: City of Parramatta Council – Planning Conditions Relating to Contamination

Code	Title	Description
PCONTAM09A	"Significantly contaminated land"	Applied to properties that are significantly contaminated land under Clause 59(2) of the Contaminated Land Management Act 1997.
PCONTAM09B	"Management order contamination"	Applied to properties that are subject to a Management order under Clause 59(2) of the Contaminated Land Management Act 1997.
PCONTAM09C	"Voluntary management proposal"	Applied to properties that are subject to a Voluntary Management Plan under Clause 59(2) of the Contaminated Land Management Act 1997.
PCONTAM09D	"Ongoing maintenance order"	Applied to properties that are subject to a ongoing maintenance order under Clause 59(2) of the Contaminated Land Management Act 1997.
PCONTAM09E	"Site audit statement"	Applied to properties that are subject to a Site Audit Statement under Clause 59(2) of the Contaminated Land Management Act 1997.
PCONTAM09G	Potential contamination/59(2) CLM act	Applied to properties which are potential contaminated where we may not have records in the Council (old Condition)
PCONTAM09N	Potential Contamination - Records in Council	Applied to properties which are potential contaminated where we have records in the Council (New Condition)
PCONTAM09O	Loose-Fill Asbestos Insulation Register	Applied to properties identified on NSW Fair Trading Loose-Fill Asbestos Insulation Register
PCONTAM09P	*James Hardie Asbestos Waste Contam Legacy Report*	Applied to properties identified in the *Department of Environment, Climate Change and Water in April 2010 entitled 'James Hardie Asbestos Waste Contamination Legacy report.* **(Wording has been updated on 5 September 2015)**
PCONTAM09Q	*James Hardie Asbestos Waste Contam Summary Report*	Applied to properties identified in the *NSW Environment Protection Authority for the Heads of Asbestos Coordination Authorities on 12 May 2017 entitled 'Summary Report: Reassessment of James Hardie Asbestos Waste Contamination Legacy Sites' as being within an area formerly used as an asbestos disposal site by James Hardie Industries.* **(No longer used and has been replaced with PCONTAM09P)**

Code	Title	Description
PCONTAM11A	*James Hardie Asbestos Waste Contam EPA Testing A*	Applied to properties identified where the EPA program of soil sampling at potential James Hardie legacy sites had been undertaken and an Interim Report indicates the Test Results are Positive.
PCONTAM11B	*James Hardie Asbestos Waste Contam EPA Testing B*	Applied to properties identified where the EPA program of soil sampling at potential James Hardie legacy sites had been undertaken and the Final Report indicates the Test Results are Positive.
PCONTAM11C	*James Hardie Asbestos Waste Contam EPA Testing C*	Applied to properties identified where the EPA program of soil sampling at potential James Hardie legacy sites had been undertaken and the Final Report indicates the Test Results are negative.
PCONTAM11D	*James Hardie Asbestos Waste Contam EPA Testing D*	Applied to properties identified where the EPA program of soil sampling at potential James Hardie legacy sites had been undertaken and the Final Report indicates the Positive. However Test results did not indicate the presence of asbestos (HSL's) stipulated by the National Environment Protection (Assessment of Site Contamination).
PCONTAM11E	*James Hardie Asbestos Waste Contam EPA Testing E*	Applied to properties identified where the EPA program of soil sampling at potential James Hardie legacy sites had been undertaken and the Final Report indicates the Test Results are positive. However Non-friable asbestos only was found.
PCONTAM11G	*Environmental Management Plan*	Applied to properties identified where an Asbestos Management Plan or other similar Environmental Management Plan

Table A2: Summary of Section 10.7 Planning Conditions Relating to Contamination

a	Site Owner	Section 10.7 Status
Grand Avenue CAMELLIA NSW 2142	Transport for NSW	■ PCONTAM09C: Voluntary management proposal ■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM11G: Environmental Management Plan
11A-B-C Grand Avenue, CAMELLIA NSW 2142	GPT RE Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1A Unwin Street, CLYDE NSW 2142	Roads and Maritime Services	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1A Unwin Street, ROSEHILL NSW 2142	Downer Edi Works Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1B Grand Avenue, CAMELLIA NSW 2142	Sydney Water	■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM11G: Environmental Management Plan
1B Unwin Street, ROSEHILL NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1C Grand Avenue, CAMELLIA NSW 2142	Sassen Constructions Pty Ltd and Sam Sassen & Sons Developments Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1C Unwin Street, ROSEHILL NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1 Grand Avenue, CAMELLIA NSW 2142	Billbergia Group Pty Ltd	■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM09C: Voluntary management proposal
1 Kay Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09N: Potential Contamination - Records in Council
1 Tennyson Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09N: Potential Contamination - Records in Council

a	Site Owner	Section 10.7 Status
		■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
1 Unwin Street, CLYDE NSW 2142	Old Bawn Contruction Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
1X Grand Avenue, CAMELLIA NSW 2142	Transport For NSW	■ PCONTAM09E: Site audit statement
10A Grand Avenue, ROSEHILL NSW 2142	N G P INVESTMENTS NO 2 PTY LTD	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
10B Grand Avenue, ROSEHILL NSW 2142	Simmonds Lumber Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
10 Colquhoun Street, ROSEHILL NSW 2142	James Hardie Australia Pty Ltd	■ PCONTAM09D: Ongoing maintenance order
11D Grand Avenue, CAMELLIA NSW 2142	City of Parramatta Council	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
11 Grand Avenue, CAMELLIA NSW 2142	GPT RE Ltd	■ PCONTAM09N: Potential Contamination - Records in Council
12 Grand Avenue, ROSEHILL NSW 2142	Road Holding Australia Pty Ltd	■ PCONTAM09C: Voluntary management proposal
13 A Grand Avenue, CAMELLIA NSW 2142	Transport for NSW	■ PCONTAM09G: Potential contamination/59(2) *CLM act*

a	Site Owner	Section 10.7 Status
13 Grand Avenue, CAMELLIA NSW 2142	Allam Family Pty Ltd	■ PCONTAM09N: Potential Contamination - Records in Council
14 Grand Avenue, ROSEHILL NSW 2142	Hymix Australia Pty Limited	■ PCONTAM09A: Significantly contaminated land
14 Thackeray Street, CAMELLIA NSW 2142	Hambear Pty Ltd	■ PCONTAM09N: Potential Contamination - Records in Council
15 Grand Avenue, CAMELLIA NSW 2142	George Weston Foods Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
16 Grand Avenue, CAMELLIA NSW 2142	Trebor Enterprises Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
17 Grand Avenue, CAMELLIA NSW 2142	Epic developments Co Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
175 A James Ruse Drive, CAMELLIA NSW 2142	Transport for NSW	■ PCONTAM09N: Potential Contamination - Records in Council
175 James Ruse Drive, CAMELLIA NSW 2142	Tuck Hing Ho Pty Limited	■ PCONTAM09N: Potential Contamination - Records in Council
181 James Ruse Drive, CAMELLIA NSW 2142	Summer Hill Business Estate Pty Limited	■ PCONTAM09E: Site audit statement
189 James Ruse Drive, CAMELLIA NSW 2142	Sydney Water	■ PCONTAM09N: Potential Contamination - Records in Council

a	Site Owner	Section 10.7 Status
		■ PCONTAM11G: Environmental Management Plan
19 Grand Avenue, CAMELLIA NSW 2142	Mrs Carolyn Deigan	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
2 - 8 Thackeray Street, CAMELLIA NSW 2142	Tanert Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
2 A Grand Avenue, ROSEHILL NSW 2142	Epsilon Distribution Ministerial Holding Corp	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
2 Deniehy Street, CLYDE NSW 2142	Sydney Water Corporation Limited	■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
2 Kay Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
2 Shirley Street, ROSEHILL NSW 2142	Sydney Metro	■ PCONTAM09E: Site audit statement
2 Tennyson Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09N: Potential Contamination - Records in Council
21 A Wentworth Street, CLYDE NSW 2142	Parramatta/Granville Sportsground Reserve Trust	■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
21 Grand Avenue, CAMELLIA NSW 2142	Mr Anthony Lahood and Mrs Charlotte Lahood	■ PCONTAM09G: Potential contamination/59(2) *CLM act*

a	Site Owner	Section 10.7 Status
21 Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09N: Potential Contamination - Records in Council ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
23A Wentworth Street, CLYDE NSW 2142	Parramatta/Granville Sportsground Reserve Trust	■ PCONTAM09G: Potential contamination/59(2) *CLM act* ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
23B Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
23 Grand Avenue, CAMELLIA NSW 2142	USG Boral Building Products Pty Limited	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
23 Wentworth Street, CLYDE NSW 2142	The State of New South Wales and Parramatta/Granville Sportsground Reserve Trust	■ PCONTAM09G: Potential contamination/59(2) *CLM act* ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
27A Grand Avenue, CAMELLIA NSW 2142	State Rail Authority of NSW	■ PCONTAM09G: Potential contamination/59(2) *CLM act* ■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
27B Grand Avenue, CAMELLIA NSW 2142	Rail Corporation New South Wales	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
27C Grand Avenue, CAMELLIA NSW 2142	Rail Corporation New South Wales	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
27D Grand Avenue, CAMELLIA NSW 2142	Rail Corporation New South Wales	■ PCONTAM09G: Potential contamination/59(2) *CLM act*

a	Site Owner	Section 10.7 Status
29 Grand Avenue, CAMELLIA NSW 2142	Stilmark Holdings Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
3 - 11 Shirley Street, ROSEHILL NSW 2142	GTA Industrial Custodian Pty Ltd	■ PCONTAM09E: Site audit statement
3A Thackeray Street, CAMELLIA NSW 2142	USG Boral Building Products Pty Limited	■ PCONTAM09N: Potential Contamination - Records in Council
3 Grand Avenue, CAMELLIA NSW 2142	Grand 3 Investment Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
3 Tennyson Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
3 Thackeray Street, CAMELLIA NSW 2142	USG Boral Building Products Pty Limited	■ PCONTAM09N: Potential Contamination - Records in Council
33A Grand Avenue, CAMELLIA NSW 2142	NSW Maritime	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
34 - 36 Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
35 Grand Avenue, CAMELLIA NSW 2142	Tanert Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
37 A Grand Avenue, CAMELLIA NSW 2142	Camellia Grande Pty Ltd	■ PCONTAM09C: Voluntary management proposal

a	Site Owner	Section 10.7 Status
37 Grand Avenue, CAMELLIA NSW 2142	Sonenco Camellia Pty Limited and Saab Camelia Pty Ltd	■ PCONTAM09C: Voluntary management proposal
38 - 40 Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
39 Grand Avenue, CAMELLIA NSW 2142	Camellia Grande Pty Ltd	■ PCONTAM09C: Voluntary management proposal
4 Grand Avenue, ROSEHILL NSW 2142	Transport for NSW	■ PCONTAM09C: Voluntary management proposal ■ PCONTAM09E: Site audit statement
4 Kay Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
4 Tennyson Street, CLYDE NSW 2142	Sydney Water Corporation Limited	■ PCONTAM09N: Potential Contamination - Records in Council
41 Grand Avenue, CAMELLIA NSW 2142	Sydney Water Corporation Limited	■ PCONTAM09N: Potential Contamination - Records in Council
46 Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
5 Devon Street, ROSEHILL NSW 2142	The Trust Company Australia Ltd and The Trust Company Australia Ltd	■ PCONTAM09D: Ongoing maintenance order
5 Tennyson Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
5 Unwin Street, ROSEHILL NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
50 - 54 Wentworth Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*

a	Site Owner	Section 10.7 Status
6 Grand Avenue, ROSEHILL NSW 2142	Grand 4 Investments Pty Limited	■ PCONTAM09E: Site audit statement
6 Shirley Street, ROSEHILL NSW 2142	Hy-Tec Industries Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
7 Devon Street, ROSEHILL NSW 2142	Epsilon Distribution Ministerial Holding Corp	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
7 Grand Avenue, CAMELLIA NSW 2142	Grand 5 Investment Pty Ltd	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
7 Tennyson Street, CLYDE NSW 2142	Sydney Metro	■ PCONTAM09P: James Hardie Asbestos Waste Contam Legacy Report
8 Colquhoun Street, ROSEHILL NSW 2142	TC Development Co Pty Ltd	■ PCONTAM09D: Ongoing maintenance order
8 Grand Avenue, ROSEHILL NSW 2142	Equinix Australia Pty Limited	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
8 Shirley Street, ROSEHILL NSW 2142	Sydney Metro	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
9B Devon Street, ROSEHILL NSW 2142	NSW Maritime	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
9C Devon Street, ROSEHILL NSW 2142	NSW Maritime	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
9D Devon Street, ROSEHILL NSW 2142	NSW Maritime	■ PCONTAM09G: Potential contamination/59(2) *CLM act*
9 Devon Street, ROSEHILL NSW 2142	Viva Energy Australia Ltd	■ PCONTAM09A: Significantly contaminated land ■ PCONTAM09E: Site audit statement

a	Site Owner	Section 10.7 Status
9 Grand Avenue, CAMELLIA NSW 2142	Grand 9 Investment Pty Limited	■ PCONTAM09G: Potential contamination/59(2) *CLM act*

APPENDIX B

Important Information Relating to This Report

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification

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APPENDIX E

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