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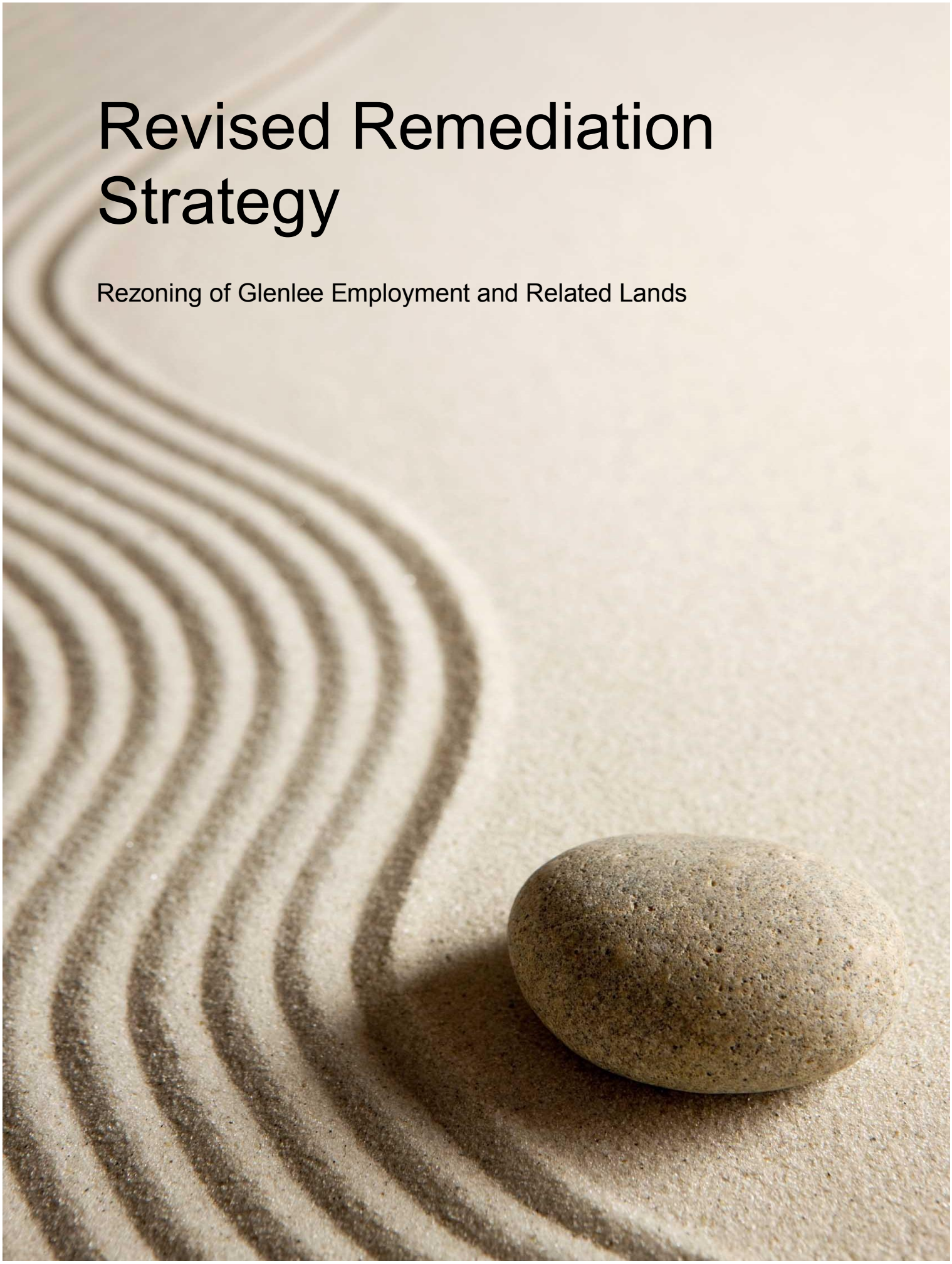
Revised Remediation Strategy

Rezoning of Glenlee Employment and Related Lands



Revised Remediation Strategy

Rezoning of Glenlee Employment and Related Lands

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Introduction

AECOM Australia Pty Limited (AECOM) has been commissioned by the Glenlee Consortium[1] to prepare this *Revised Remediation Strategy* for the Glenlee Precinct located at Glenlee Road, Narellan, NSW ('the Precinct' - refer to **Figure 1** in **Appendix A**). This report documents potential remedial strategies available for the Glenlee Precinct in the event that contamination is identified during future Phase 2 Contamination Investigations.

The Precinct comprises approximately 107.6 hectares of land at Glenlee and is associated with the operations of three owner companies, namely Sada Services Pty Ltd (Sada), J & W Tripodi Holdings Pty Ltd (Camden Soil Mix) and Glenlee Properties Pty Ltd (TRN Group), referred to collectively as the Glenlee Consortium.

Preparation of this *Revised Remediation Strategy* is part of a broader scope of works required to update the following reports prepared by AECOM in 2009:

- *Rezoning of Glenlee Employment and Related Lands - Consolidated Phase 1 Contamination Assessment* (AECOM, 2009a);
- *Rezoning of Glenlee Employment and Related Lands - Consolidated Phase 2 Contamination Assessment Sampling and Analytical Quality Plan ([SAQP]* AECOM, 2009b);
- *Rezoning of Glenlee Employment and Related Lands – Glenlee Precinct – Remediation Strategy* (AECOM, 2009c).

The Precinct has generally been used for industrial related purposes, notwithstanding the current rural zoning of the land for a number of years. These industrial uses include the Sada Services landholding (truck maintenance and depot, coal washery and reject coal emplacement), Camden Soil Mix (truck maintenance and depot, and green waste recycling facility), and TRN (truck maintenance and depot).

The three 2009 reports listed above were reviewed and endorsed by a NSW Environment Protection Authority (EPA) Contaminated Land Auditor (accredited in accordance with the *Contaminated Land Management Act*, 1997). In the *Site Auditor Report* (JBS, 2009) the Auditor concluded that:

- *"Contamination-related aspects of the Glenlee Precinct environment have been appropriately investigated; and*
- *Sufficiently robust plans are in place to further investigate and deal with contamination".*

Consequently the Auditor was "*satisfied that an appropriate framework has been established to investigate, manage and/or remediate contamination at the site in order to make the site suitable for the proposed commercial/industrial, parks/open space and standard residential uses".*

It is noted that the three above reports previously assessed a portion of land that is now excluded from the Precinct and which is located directly to the north (the SITA lands, refer to **Figure 2**). The removal of the SITA lands removed the proposed residential and commercial zonings from the project. Consequently, this *Revised Remediation Strategy* has been amended accordingly, and also takes into consideration the findings of an inspection of the Precinct in May 2013.

Compliance with the Project Plan

This Phase 3 Remediation Strategy report complies with the requirements of Section 3.3 of the Camden Council (August 2013) *Glenlee – Proposed Industrial Employment Land, Project Plan (draft) – Specialist Studies Requirements* (hereafter referred to as the 'Project Plan') as it establishes a framework of management strategies to demonstrate to interested parties that remedial strategies, should contamination be found through Phase 2 investigations, are available and feasible and capable of rendering the Precinct suitable for the intended uses.

Conclusions

Based on the information presented herein, in the event that parts of the Precinct are confirmed to be contaminated to the extent that remedial works are warranted, it is considered that that feasible and proven remediation / management measures are available.

[1] Sada Services, Glenlee Properties Pty Ltd and J & W Tripodi Holdings Pty Ltd

The primary PCAs are the fuel storage areas and workshop facilities. Despite all fuel storage areas being appropriately bunded there is the potential for some spillage of petroleum products outside the bunded areas over time. Similarly, the workshops within the Precinct have been equipped with concrete flooring and appropriate oil containment facilities. However, over time there is the potential for contamination to occur around the apron in front of the workshops.

Likely strategies that could feasibly be implemented to remediate / manage contamination that may be found in the identified PCAs are presented in this document. It should be noted that some of the strategies (i.e. capping and containment of soil, monitored natural attenuation of groundwater, etc) may require future implementation of a Long-Term EMP and/or notice of contamination on the Precinct's S149 certificate or similar.

It is important to note that the strategies presented are generalised only. The extent and nature of contamination is required to be confirmed by a Phase 2 contamination assessment at which time the remedial strategies will need to be reviewed and a RAP (including detailed methodologies) prepared for the Precinct.

If a RAP is required, appropriate contingency measures and unexpected finds protocols should be developed and implemented during remediation, earthworks and other development activities providing procedures to be followed in the event that additional or different contamination is encountered.

1.0 Introduction

1.1 Background

AECOM Australia Pty Limited (AECOM) has been commissioned by the Glenlee Consortium[2] to prepare this *Revised Remediation Strategy* for the Glenlee Precinct located at Glenlee Road, Narellan, NSW ('the Precinct' - refer to **Figure 1** in **Appendix A**). This report documents potential remedial strategies available for the Glenlee Precinct in the event that contamination is identified during future Phase 2 Contamination Investigations.

The Precinct comprises approximately 107.6 hectares of land at Glenlee and is associated with the operations of three owner companies, namely Sada Services Pty Ltd (Sada), J & W Tripodi Holdings Pty Ltd (Camden Soil Mix) and Glenlee Properties Pty Ltd (TRN Group), referred to collectively as the Glenlee Consortium.

Preparation of this *Revised Remediation Strategy* is part of a broader scope of works required to update the following reports prepared by AECOM in 2009:

- *Rezoning of Glenlee Employment and Related Lands - Consolidated Phase 1 Contamination Assessment* (AECOM, 2009a);
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The Precinct has generally been used for industrial related purposes, notwithstanding the current rural zoning of the land for a number of years. These industrial uses include the Sada Services landholding (truck maintenance and depot, coal washery and reject coal emplacement), Camden Soil Mix (truck maintenance and depot, and green waste recycling facility), and TRN (truck maintenance and depot). The three 2009 reports listed above were reviewed and endorsed by a NSW Environment Protection Authority (EPA) Contaminated Land Auditor (accredited in accordance with the *Contaminated Land Management Act*, 1997). In the *Site Auditor Report* (JBS, 2009) the Auditor concluded that:

- *"Contamination-related aspects of the Glenlee Precinct environment have been appropriately investigated; and*
- *Sufficiently robust plans are in place to further investigate and deal with contamination".*

Consequently the Auditor was "*satisfied that an appropriate framework has been established to investigate, manage and/or remediate contamination at the site in order to make the site suitable for the proposed commercial/industrial, parks/open space and standard residential uses".* The reference to residential land only applied to the SITA land and does not apply to the current rezoning proposal.

It is noted that the three above reports previously assessed a portion of land that is now excluded from the Precinct and which is located directly to the north (the SITA lands, refer to **Figure 2**). Consequently, this *Revised Remediation Strategy* has been amended accordingly, and also takes into consideration the findings of an inspection of the Precinct in May 2013.

The changing nature of activities at the Precinct and the evolution of the planning for the locality and service infrastructure provision required a need to review the prevailing planning controls and update the original 2009 reports listed above.

In December 2006, Camden Council and Campbelltown City Council resolved to prepare a Local Environmental Study (LES) and draft Local Environmental Plan (LEP) for the rezoning of the Precinct. A draft LES was submitted to both councils in February 2009, which included a number of technical support studies. These studies included:

- Land Capability – AECOM
- Ecology – Hayes Environmental Services
- Noise – AECOM

[2] Sada Services, Glenlee Properties Pty Ltd and J & W Tripodi Holdings Pty Ltd

- Air Quality/Odour - AECOM
- Water Cycle Management – AECOM
- European and Aboriginal Heritage – Historyworks and Cultural Heritage Connections
- Transport/Traffic/Accessibility – AECOM
- Landscape and Visual – Musecape
- Bushfire – Eco Logical
- Civil Infrastructure/Servicing – AECOM
- Masterplanning/Urban Design – Geolyse
- Human Service – BBC Consulting

In addition to these studies, a draft LEP, draft Development Control Plan (DCP), was prepared for each Council area, including an Infrastructure Strategy/Section 94 Contributions Plan.

The draft LES, LEP and DCP were not placed on public exhibition due to a number of issues arising from the technical studies, which required additional information to be provided to Councils.

Since that time, the key issues pertaining to the development have been progressively resolved to the extent that would satisfy the requirements of the Planning Proposal (PP) to gain a Gateway Determination.

On 28 February and 23 April 2013 Campbelltown City Council and Camden Council respectively resolved to provide 'in principle' support to the intentions of the PP.

The PP received a Gateway Determination on 3 July 2013 to proceed with the rezoning of the Precinct subject to various conditions including additional/updated information for a number of specialist technical studies.

A number of these specialist studies were prepared for the rezoning application lodged with the Local Environmental Study in 2008. However, legislation has changed in respect of a number of studies and therefore there is a need for these studies to be reviewed and revised, particularly as the SITA lands no longer form part of the PP.

In August 2013, a Preliminary Draft Project Plan was submitted to Councils including an outline of the various specialist technical study requirements. Camden and Campbelltown Councils responded with comments addressing these requirements, therefore forming the basis of the sub-consultant's brief for the various specialist technical studies. AECOM has since responded to confirm requirement expectation.

1.2 The Planning Proposal

The indicative concept design is shown in **Figure 3**, **Appendix A**. The zoning request is generally in accordance with the proposed zoning map shown in **Figure 4**, highlighting General Industrial, Infrastructure and Environmental Conservation zones. Surveyed zone areas are shown in **Figure 5**.

The proposed zones and stated objectives are as follows:

Zone IN1 General Industrial

- To provide a wide range of industrial and warehouse land uses.
- To encourage employment opportunities.
- To minimise any adverse effect of industry on other land uses.
- To support and protect industrial land for industrial uses.
- To enable other land uses that provides facilities or services to meet the day to day needs of workers in the area.
- To enable non-industrial land uses that are compatible with and do not detract from the surrounding industrial and warehouse land uses.

Zone SP2 Infrastructure

- To provide for infrastructure and related uses.
- To prevent development that is not compatible with or that may detract from the provision of infrastructure.

Zone E2 Environmental Conservation

- To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values.
- To prevent development that could destroy, damage or otherwise have an adverse effect on those values.
- To provide for land uses compatible with the high ecological, scientific, cultural or aesthetic values of this zone.
- To foster the protection, enhancement and creation of natural systems corridors.

Based on the PP, the majority of the Precinct is proposed to be redeveloped for various industrial purposes. There are also proposed corridors for roads and [existing] rail (which would be considered consistent with an industrial landuse) and proposed open space areas.

The assessment excludes the SITA lands (also known as the Macarthur Resource Recovery Park (MRRP)) which is located off-site to the north and is not part of the proposed redevelopment.

1.3 Objective

The main objective of this *Revised Remediation Strategy* is to:

- Provide a description of the broad remediation strategies that may be available for the pre-redevelopment cleanup of areas identified by Phase 2 techniques as being contaminated above land use criteria and warranting remediation; and
- Provide general procedures and applicable standards which should be followed during the course of any remediation operations at the Precinct to demonstrate that remediation is likely to be practicable and feasible.

The above objective applies to each of the sub-areas identified in **Table 2**.

This *Revised Remediation Strategy*:

- avoids, to the extent possible, repetition of narrative from the *Revised Phase 1 Contamination Assessment'* and the *Revised SAQP* reports and instead refers the reader to the relevant sections of those reports; and
- is intended to demonstrate to the stakeholders that the broad issues associated with selection and management of remedial measures have been considered.

1.4 Report Format

The format of this *Revised Remediation Strategy* is as follows:

- **Section 1** provides an introduction to the project background, prior site assessments and associated documentation and the requirement to prepare this Phase 3 report;
- **Section 2** describes the legislative context and principal instruments controlling contamination remediation in NSW;
- **Section 3** provides a brief description potentially contaminated materials that may require remediation;
- **Section 4** describes a range of approaches to remediation of the potential contaminant categories;
- **Section 5** discusses a range of available remedial options;
- **Section 6** presents conclusions and recommendations; and
- **Section 7** outlines study limitations.

This *Revised Remediation Strategy* retains the Potentially Contaminated Areas (PCAs) identifiers adopted in the *Revised Phase 1 Contamination Assessment* and *Revised SAQP* and referenced in the *Land Capability Assessment* report (AECOM, 2008).

It is not the intention of this *Revised Remediation Strategy* to set out step-by-step procedures for remediation of the PCAs, the complexity of which is speculative until the required Phase 2 site investigations have been completed. It is anticipated that based on the findings of the Phase 2 site investigations, a Remedial Action Plan (RAP) may be prepared based on the guidance in this remedial strategy document.

1.5 Site Regional Environmental Context

The reader is referred to Section 2 *Broad Site Description and Context*, in the *Revised Phase 1 Contamination Assessment*.

1.6 Proposed Future Land Uses

As discussed in **Section 1.2**, the Precinct landowners seek to rezone the subject properties to the following land uses:

- Zone IN1 - General Industrial;
- Zone SP2 – Infrastructure; and
- Zone E2 - Environmental Conservation

1.7 Project and Remediation Objectives

If required, the key objectives for remediation works are:

- Protection of the environment by ensuring that the PCAs within the Glenlee Precinct are remediated such that they do not present an unacceptable risk to the surrounding environment within the context of the land uses proposed for each of the PCAs;
- Compliance with legislative requirements and the appropriate requirements from Council, the NSW Department of Planning (DoP) and the NSW Environment Protection Authority (EPA); and
- To carry out actions that will provide certainty to regulators, consent authority, the community and future landowners that the Glenlee Precinct land is suitable, with respect to contamination, for the anticipated ongoing land uses in each PCA.

The remediation techniques that have been identified in this *Revised Remediation Strategy* have a long history of success when properly applied to the typical contaminants anticipated to be encountered at the Glenlee Precinct. The techniques are conventional and are supported by the literature. Matters that are evolving with respect to remediation techniques relate to energy efficiency and a better understanding of chemistry which in turn improves both commercial and environmental effectiveness of those techniques.

1.8 Precinct Identification

The scope of remediation works will generally be limited to the Glenlee Precinct, which comprises a number of holdings and ownerships. The ownership, Lot and Deposited Plan (DP) number for each land holding within the Precinct is summarised in **Table 1** below:

Table 1 The Precinct – Property Descriptions

Owner	Property Description	Size
Sada Services	Lot 38 DP 1098588	71.04 Ha
	Lot 1 DP 250033	3,071 m^2
	Part Lot 1 DP 405624	2,800 m^2
J&W Tripodi Holdings Pty Ltd (Camden Soil Mix leased and operated by SITA Pty Ltd)	Lot 1102 DP 883495	27.16 Ha
Glenlee Properties Pty Ltd (TRN Group)	Lot 54 DP 864754	8.836 Ha
Total Precinct Area		107.62 Ha

Source: Michael Brown Planning Strategies, *Submission to Campbelltown City Council – Planning Proposal,* October 2012

Based on the findings of the *Revised Phase 1 Contamination Assessment*, it is unlikely that significant remediation works will be required within the Precinct. However, this report has been prepared to provide a sufficient level of detail in relation to remediation strategies that could be adopted based on the potential contamination at each PCA, while recognising that the strategies will need to be reviewed and more detail provided following the Phase 2 contamination assessments.

If required, it will be necessary to prepare a Remedial Action Plan (RAP) prior to remedial works commencing at the Precinct.

1.9 Identified Potential Contaminated Areas

Based on the findings of the *Revised Phase 1 Contamination Assessment,* the areas to which this document applies are as follows:

Table 2 Summary of PCAs

PCA Reference	PCA Description	Activity	Potential Contamination	Environmental Media
A	Sada Tank	Refuelling and drum storage	Metals, PAH, TPH, BTEX	Soil, Groundwater
B	Sada Workshops	Vehicle Maintenance	Metals, PAH, TPH, BTEX, Phenols, VOCs, SVOCs, Asbestos	Soil, Groundwater
C	Sada Truck Wash	Truck Wash	PAH, TPH	Soil, Groundwater
D	Sada Rail Easement	Rail Easement	TPH, BTEX, Metals, Asbestos, PAHs	Soil
E	Sada Decommissioned Coal Washery	Transformer Storage	PCBs, TPH, BTEX, Metals	Soil, Groundwater
F	CSM/Tripodi Tank	Refuelling	Metals, PAH, TPH, BTEX	Soil Groundwater
G	CSM/SITA Workshops	Vehicle Maintenance	Metals, PAH, TPH, BTEX, Phenols, VOCs, SVOCs	Soil, Groundwater
H	TRN Workshop and Truck Wash	Vehicle Maintenance, underground waste oil tank and truck wash	Metals, PAH, TPH, BTEX, Phenols, VOCs, SVOCs	Soil, Groundwater
I	TRN Tank Farm	Refuelling	Metals, PAH, TPH, BTEX	Soil, Groundwater
J	CSM/SITA Stockpiling Areas	Composting Operations	Odours	Aesthetics
M	CSM/Tripodi Dams	Ephemeral Storage of Surface Water	Nutrients, Metals, PAHs, TPH	Groundwater, Former Sediments, Soil
P*	CSM/Tripodi Tank	Refuelling	Metals, PAH, TPH, BTEX	Soil, Groundwater
Q*	CSM/Tripodi Workshop	Vehicle Maintenance	Metals, PAH, TPH, BTEX, Phenols, VOCs, SVOCs	Soil, Groundwater
S*	Sada Plant and Machinery "Graveyard"	Vehicle, buildings, plant, tyres and machinery storage	PAHs, BTEX, TPH, Metals	Soil, Groundwater
X	Emplacement	Consolidation of coal washery reject	PAHs, TPH, Metals	Soil/coal wash, Groundwater
Z	Remainder of Site	As yet unidentified potentially contaminating activities (if any) or potential area of filling	Based on nature of an identified potentially contaminating activity (if any)	Based on nature of an identified potentially contaminating activity (if any)

***Notes**: Sampling and analysis of soil for asbestos assessment to be included in surface soil samples based on environmental scientist field observations of prevalence of surface debris and/or obvious fibro.*

Metals include As, Cd, Cr, Cu, Ni, Pb, Zn and Hg

1.10 Contamination Categories

Based on the findings of the *Land Capability Assessment*, (Maunsell AECOM, 2008) and *Revised Phase 1 Contamination Assessment*, the following broad categories of contamination were found to have the potential to be present in the Glenlee Precinct:

- Areas potentially contaminated by fuel and oil products/residues from either refuelling or workshop operations;
- One area potentially contaminated by PCB transformer oil;
- One area potentially impacted by nutrient rich surface water runoff;
- An area where composting activities may leave residual odours which could pose an aesthetic issue; and
- Potential presence of other fill areas of unknown quality including potential for fly tipping.

The historical practices that have led to the possible presence of contamination were discussed in the *Revised Phase 1 Contamination Assessment* and planning for Phase 2 intrusive investigations was set out in the *Revised SAQP*.

Methods and guidelines for Phase 2 intrusive investigations of the above categories of contaminants, and Concept Phase 3 [remedial measures] actions and solutions are well developed in industry, with significant expertise and equipment available in the local (NSW) market.

2.0 Assesment and Approval Process

2.1 Legislation Relevant to Remediation Works

The NSW EPA and Department of Planning and Infrastructure (DoPI) administer a number of Acts, legislative instruments and guidelines relevant to remediation works. These include:

- *Contaminated Land Management (CLM) Act* (1997);
- *The Protection of the Environment Operations (POEO) Act* (1997), in particular, licensing obligations under that Act;
- NSW EPA (1994). *Guidelines for Assessing Service Station Sites*;
- NSW EPA (1997). *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*;
- National Environment Protection Council (NEPC), *National Environment Protection (Assessment of Site Contamination) Measure (NEPM,1999*);
- NEPC, *National Environment Protection (Assessment of Site Contamination) Amendment Measure (NEPAM,* 2013 [No. 1]);
- DEC (2006). *Contaminated Sites – Guidelines for the NSW Site Auditor Scheme (2nd Edition)*;
- DECC (2007). *Guidelines for the Assessment and Management of Groundwater Contamination*;
- Department of Urban Affairs and Planning (DUAP) and NSW EPA (1998) *Managing Land Contamination - Planning Guidelines SEPP 55 - Remediation of Land*;
- *The Environmentally Hazardous Chemicals (EHC) Act* (1985), in particular the Chemical Control Order (CCO) for PCBs under that *Act*.

This document should be reviewed and updated as required in the event that there is a change of regulations prior to preparation of a RAP.

2.2 *Contaminated Land Management Act* (1997)

The *CLM Act* (1997) is the primary Act under which contaminated land is regulated by the NSW EPA. Relevant legislation relating to the *CLM Act* (1997) includes the *Contaminated Land Management Regulation* (2008), which commenced on 1 September 2008.

This section addresses the following aspects of the *Act*:

- Determination and suitability of a contaminated site for a proposed use including the generation of remediation criteria;
- Existing orders and regulatory instruments applicable to the Precinct; and
- Voluntary remediation proposals and agreements.

The *Guidelines for the NSW Site Auditor's Scheme (The Auditor Guidelines)* (DEC, 2006) were prepared by the Department of Environment and Conservation (DEC, now known as the NSW EPA) under the *CLM Act* (1997). DEC (2006) describe a decision process for assessing redevelopment sites that should be followed by contaminated land consultants. The guidelines prescribe Soil Investigation Levels (SILs) which are the concentration levels of particular contaminants above which further investigation and evaluation are required.

The future commissioning of a site auditor will depend on the level of contamination encountered during the Phase 2 intrusive investigation. If the results of the Phase 2 are as expected, that is, low level hydrocarbons being detected in discrete areas (such as around diesel storage tanks and workshops), the use of a site auditor may not be warranted.

2.3 Amended NEPM (1999)

The *National Environment Protection (Assessment of Site Contamination) Measure (NEPM*, 1999) has previously been endorsed by the NSW EPA under Section 105 of the *CLM Act* (1997) as amended. The purpose of the *NEPM* (1999) is to '*establish a nationally-consistent approach to the assessment of site contamination to ensure*

sound environmental management practices by the community which includes regulators, site assessors, contaminated land auditors, land owners, developers and industry'.

The *NEPM* (1999) has recently been amended by the *National Environment (Assessment of Site Contamination) Amendment Measure NEPM* (ASC NEPC, 1999) which was made by the Council of Australian Governments Standing Council on Environment and Waste on 11 April 2013. The *NEPM* (ASC NEPC, 1999) has subsequently also been approved by the NSW EPA under Section 105 of the *CLM Act* (1997) as amended on 11 June 2013.

It is understood that the NSW EPA will update DEC (2006) and other guidelines under the transitional arrangements for the *NEPM* (ASC NEPC, 1999). Consequently, the investigation and screening outlined in the *NEPM* (ASC NEPC, 1999) have been adopted in the *Revised SAQP* and this report .

Most, but not all, of the CoPC identified within the Precinct are substances for which HILs have been prescribed. HILs have not been prescribed for some of the VOCs, SVOCs and herbicides.

As HILs are available for most CoPC identified in the *Revised Phase 1 Contamination Assessment*, this *Revised Remediation Strategy* does not address:

- The development of health-based risk assessments for determining suitable clean-up criteria for the CoPC for which HILs have not been established; or
- Non-standard methods and levels of remediation clean-up criteria required for the proposed future land uses.

It should be noted that HILs are investigation levels and not clean-up levels and as such are conservative if used as clean-up goals.

It should be sufficient in the current context to note that:

- Clean-up levels for certain CoPC can be developed through health-based risk assessment as part of detailed Phase 3 remediation goal setting; and
- It remains open to the landowners to develop health-based remediation criteria even for those CoPC for which standard criteria exist.

The *CLM Act* (1997) sets out requirements for site audits. The *Act* requires a site audit to be undertaken under certain circumstances such as where a voluntary investigation proposal or voluntary remediation proposal has been agreed with the NSW EPA or where required under *SEPP 55* (1998).

Currently, *SEPP 55* (1998) does not require a mandatory site audit at any stage of the planning process for remediation work, and the Glenlee Precinct is not subject to a voluntary investigation or voluntary remediation proposal, therefore a statutory site audit under the *CLM Act* (1997) is not required at this time. Although a site audit is not required at this time, the landowners previously engaged an independent Auditor to review and endorse the original 2009 version of this document and the associated reports (as detailed in **Section 1.1**).

It is noted that the majority of the provisions in the *CLM Amendment Act* (2008) received assent on 10 December 2008. The purpose of the amendments was to allow contaminated sites to be cleaned up more efficiently while reinforcing the 'polluter pays' principle. The new provisions cast a wider net in terms of those with responsibility for reporting, investigating and cleaning up contamination in NSW. The *CLM Amendment Act* (2008) provides the NSW EPA with broader powers to issue investigation and management orders.

2.4 Protection of the Environment Operations Act (1997)

The *POEO Act* (1997) repealed the following Acts with effect from 1 July 1999:

- *Clean Air Act* (1961);
- *Clean Waters Act* (1970);
- *Environmental Offences and Penalties Act* (1989);
- *Noise Control Act* (1975); and
- *Pollution Control Act* (1970).

The major regulatory provisions of the *Waste Minimisation and Management Act* (1995) were also repealed by the *POEO Act*, but are incorporated within the *POEO Act*.

Section 48 of the POEO Act requires a person to obtain a license from the NSW EPA before carrying out any of the premises-based activities described in Schedule 1 of that *Act*. Schedule 1 includes the following activity:

- Contaminated soil treatment works for on-site or off-site treatment (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site) that:
  - handle more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the works are located; or
  - handle contaminated soil originating exclusively from the site on which the works are located; and
  - incinerate more than 1,000 cubic metres per year of contaminated soil, or
  - treat otherwise than by incineration and store more than 30,000 m^3 of contaminated soil, or
  - disturb more than an aggregate area of 3 hectares of contaminated soil.

The remediation works have a low likelihood that they will involve the treatment of more than 30,000 m^3 of contaminated soil. In the event that remediation works did involve such significant volumes of material, those remediation works would require an Environment Protection Licence (EPL) under the *POEO Act*. This scenario would become apparent after the completion of Phase 2 contamination assessments.

2.5 Environmentally Hazardous Chemicals Act (1985)

With respect to the possible presence of polychlorinated biphenyls (PCBs) at the former coal washery site, DEC (2006) state that Chemical Control Orders (CCOs, established under the *Environmentally Hazardous Chemicals [EHC] Act* [1985]) set out requirements for manufacturing, keeping, using, processing, storing, selling, transporting or disposing of chemicals and declared chemical wastes. A site auditor must not endorse a management strategy proposed for a site which involves chemicals or chemical wastes subject to a CCO, unless they are satisfied it complies with the requirements set down in the CCO. For example, certain chemicals occurring above the prescribed concentrations are prohibited from being disposed of at any landfill.

There is a program of national management plans for *Schedule X Wastes* (ANZECC 1994b). The program includes wastes associated with (amongst others), PCBs (ANZECC 1996c). The national management plans set timelines for the destruction and disposal of Schedule X wastes. The relevant authorities implement regulatory aspects of the plans. Site auditors should be aware that CCOs either have been or will be revised by the NSW EPA as part of implementing the national management plans.

CCOs are a primary regulatory tool under the *EHC Act* (1985) and are used by the NSW EPA to control particular compounds, and their potential or actual impact on the environment. For potential PCB remediation in the event that the average (95% UCL) concentration at which PCBs, if any, are identified greater than the 2 mg/kg threshold for PCB wastes, the PCB CCO would apply. However, if PCB concentrations are below the threshold for scheduled PCB waste the material would be classified as non-scheduled PCB waste and therefore fall within the ambit of classification under the *NSW DECCW (2009) Waste Classification Guidelines* (with respect to disposal).

2.6 SEPP 55 (1998)

State Environmental Planning Policy (SEPP) 55 – Remediation of Land was prepared by both the DUAP and DECC in 1998. SEPP 55 states that remediation is often carried out in conjunction with other development, to make the land suitable for that development.

SEPP 55 states that development consent is generally only required for remediation work where there is potential for significant environmental impacts from the work. Remediation work which requires development consent is known as Category 1 work. Category 1 refers to work:

- Which is designated development under Schedule 3 of the *Environmental Planning and Assessment (EP&A) Regulation* (2000) or under a planning instrument
- Proposed on land identified as critical habitat under the *Threatened Species Conservation Act* (1995);

- Where consideration of Schedule 5A of the *EP&A Regulation* (2000) indicates the remediation work is likely to have a significant effect on threatened species, populations, ecological communities or their habitats;
- Proposed in an area or zone identified in a planning instrument as being an area of environmental significance such as scenic areas, wetlands. These are listed in the SEPP 55;
- Which requires consent under another SEPP or a regional environmental plan; or
- Which does not comply with a Council's Contaminated Land Policy.

SEPP 55 contains the following requirements for remediation as ancillary development:

- Remediation work may be treated as Category 2 work instead of Category 1 if the only reason it is in Category 1 is that it is ancillary to designated development (which is the case in the Glenlee Precinct – however, refer to 2.6 *Local Matters* below);
- Remediation work that meets the criteria for Category 1 work may not be treated as Category 2 just because it is ancillary to development without consent;
- If Category 1 remediation work is carried out ancillary to development without consent, this does not result in a requirement for consent for that development; and
- If remediation work is designated development under Schedule 3 of the EP&A Regulation or the provisions of a planning instrument, this does not mean that any associated development is also designated.

With respect to remediation standards, the SEPP 55 states that all remediation work, both Category 1 and Category 2, must:

- Be consistent with the SEPP 55 guidelines; and
- Be carried out in accordance with standards in NSW EPA guidelines made under the *CLM Act* (1997).

The SEPP 55 also states that:

> *Ideally, a RAP should be prepared for all remediation proposals, as a guide to the objectives of the remediation and to assist in the planning of work. A RAP also provides a useful measure for validation of the work after it is completed. However, a RAP is a mandatory requirement only for Category 1 remediation work. For this work the RAP must be submitted to the consent authority with a development application for approval. The RAP may form part of an environmental impact statement if the remediation work is designated development. A RAP must be prepared by an appropriately qualified consultant in accordance with the EPA's guidelines (1997b).*

2.7 Local Matters

2.7.1 Camden Council

Camden Council's revised *Management of Contaminated Lands* Policy, which commenced in March 2008, sets out a framework for the management of contaminated land within the Camden Local Government Area (LGA) and forms part of the whole-of-government approach to contamination and remediation. The policy adopts a precautionary-based approach and specifically *SEPP 55*.

Typically, the extent of investigation into potential contamination and subsequent remediation of a site, if required, is influenced by the site's current or proposed land use. Initial evaluation focuses on the site's previous potentially contaminating land uses and any Council and agency records. The results of the initial evaluation should be used to assess the suitability of a site for the proposed use. In the event that initial evaluation indicates that contamination may be present, then Council will either:

- Require further investigation and possible subsequent activities such as remediation; or
- Make a planning decision.

Camden Council's *Management of Contaminated Lands* Policy (2008) states that as a result of overriding requirements in *Sydney Regional Environmental Plan N° 20* (SREP 20), Category 2 remediation works within its LGA automatically take on the status of Category 1 remediation works and, as such, require Council consent.

This means any remediation works on parts of the Glenlee Precinct within Camden Council will need Council's consent.

2.7.2 Campbelltown City Council

Campbelltown City Council has no formal contaminated land policy. Requirements in respect of contaminated land are detailed under the *Contamination Management Plan* requirements of Appendix 10 of the *Campbelltown (Sustainable City) Development Control Plan (DCP)* (2012). While Appendix 10 does not mention SEPP 55 or other NSW policies, it outlines a framework similar to the Camden Council *Management of Contaminated Lands* Policy (2008).

Campbelltown City Council *Contamination Management Plan* states that *all applications on land, that has been identified as contaminated or of having the potential to be contaminated shall require the following information to be submitted:*

i. land use history;

ii. any past or present potentially contaminating activities;

iii. provide preliminary assessment of any site contamination and if required, provide a basis for a more detailed investigation; and

iv. *preliminary sampling and analysis may be required where contaminating activities are suspected or known to have occurred, or the land use history is incomplete.*

3.0 Site Contamination Identification and History

3.1 Previous Contamination Investigations

The reader is referred to the following reports which document the history of the Precinct and the processes by which potential contamination has and will be identified and assessed:

- *Rezoning of Glenlee Employment and Related Lands – Revised Consolidated Phase 1 Contamination Assessment* (AECOM, 2014); and
- *Rezoning of Glenlee Employment and Related Lands - Revised Consolidated Phase 2 Contamination Assessment SAQP* (AECOM, 2014).

3.2 Previous Remediation and Validation Works

It is noted that former 'PCA L - Sada Decommissioned Tank Farm' which was identified in the original *Phase 1 Contamination Assessment* (AECOM, 2009) was subsequently investigated and identified to have minor petroleum impacts in the shallow soils. Remediation and validation works were undertaken within the impacted area and David Lane Environmental concluded that the remediated area was validated '*suitable for an end land use consistent with NEPM 1999 Table 5a Column F - Commercial / Industrial*'. The Phase 2 site investigations, remediation, validation and auditing works are detailed in the following reports:

- DLA (2009a). Phase 2 Detailed Environmental Site Assessment, Springs Road, Glenlee (Part Lot 38 DP 1098588), Proposed Lot 1101 DP 883495. May 2009;
- DLA (2009b). Remediation Action Plan, Glenlee, Springs Road, Glenlee, Part Lot 38 DP 1098588. June 2009;
- JBS Environmental (2009). Site Audit Report, 0503-0807, Sada Administration Building, Part Lot 38 DP 1098588 (Proposed Lot 1101 DP 883495). June 2009;
- DLA (2012). Validation Report, SADA, Administration and Maintenance Buildings, Springs Road, Glenlee, Part Lot 38 DP 1098588. September 2012; and
- Enviroview (2012). Site Audit Report (including Site Audit Statement 0301-1208), Part Lot 38 DP 1098588, 214 Springs Road, Mount Annan, NSW. October 2012.

Based on the investigation, remediation, validation and auditing works detailed in the above reports, former PCA L is no longer considered to be an area of concern and, subsequently, is not discussed further in this report.

3.3 Material Types

The main types of material identified in the *Revised SAQP* to be a potential source of contamination include:

- Washery reject contaminated by residues of fuel tank-related activities, maintenance and workshop activities;
- Soil, sediment and topsoil contaminated by residues of fuel tank-related activities, maintenance and workshop activities;
- Soil contaminated by possible spills of PCB-containing transformer oil;
- Soil contaminated by asbestos in very localised areas (i.e. surrounding buildings which may contain asbestos containing material [ACM]);
- Localised filling derived from an unknown source;
- Soil contaminated by residues of sandblasting activities;
- Dam and pond sediment contaminated by surface runoff laden with nutrients, PAHs, metals and TPHs; and
- Groundwater contaminated by any of the above substances other than asbestos.

3.4 Characterisation of Material

Potential contaminated soil, sediment and groundwater at the Precinct will be characterised in accordance with the *Revised SAQP*. The contamination assessment will include:

- Confirmation, or otherwise, of the presence and CoPC concentrations above the adopted guidelines for the respective proposed land uses for soil and groundwater and potentially sediment and surface water;
- Data quality assessment;
- The lateral and vertical delineation of any identified contamination and whether any further investigations are required; and
- Assessment of whether remediation is warranted to make the Precinct areas suitable for the proposed land uses.

3.5 Data Suitability

The above reports list the range of previous and proposed site environmental investigations undertaken and proposed to be undertaken. The suitability of analytical data reported in a range of literature referenced in the above reports has not been assessed.

Assessments of accuracy and precision using quality control data collected in the field and at the laboratory must be performed on the Phase 2 assessment data at the time of reporting. Such data should be suitable for use in the assessment of CoPC concentrations and comparison to the adopted guidelines.

4.0 Potential Approaches to Remediation

4.1 Amended NEPM (1999)

The *NEPM* (ASC NEPC, 1999) presents the following hierarchy of options for site clean-up and/or management:

- *onsite treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level*
- *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*

if the above is not practicable,

- *consolidation and isolation of the soil on site by containment with properly designed barrier*
- *removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material*

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.*

When deciding which 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.

4.2 DEC (2006) Guidelines for the NSW Site Auditor Scheme

The DEC (2006) *Guidelines for the NSW Site Auditor Scheme* state that:

The policy of the then Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) on remediation of contaminated sites is published in the Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC & NHMRC 1992) and is followed in NSW. This means that soil remediation and management is implemented in the following preferred order:

1. *On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level;*
2. *Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site;*
3. *Removal of contaminated soil to an approved site or facility, followed where necessary by replacement with clean fill; and*
4. *Consolidation and isolation of the soil on-site by containment within a properly designed barrier.*

DECC 2006 further states that if remediation is likely to cause a greater adverse effect than leaving the site undisturbed, remediation should not proceed. In cases where it is not viable to remediate large quantities of soil with low levels of contamination, alternative strategies should be considered or developed.

4.3 NSW DEC (2007) Groundwater Management Approach

NSW DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination* indicate that *where contamination is identified, the management objectives are to protect human and ecological health and to ultimately restore the groundwater to its natural background quality. To achieve these objectives, the following management responses must be considered:*

- *control short-term threats arising from the contamination;*
- *restrict groundwater use;*
- *prevent or minimise further migration of contaminants from source materials to groundwater prevent or minimise further migration of the contaminant plume; and*

- *clean up groundwater to protect human and ecological health, restore the capacity of the groundwater to support the relevant environmental values and, as far as practicable, return groundwater quality to its natural background quality.*

As a minimum, the guidelines indicate that *management of contaminated groundwater should continue until human and ecological health is protected and the capacity of the groundwater to support relevant environmental values is restored.*

Management responses to groundwater contamination should focus on the greatest threats first, and the benefits of groundwater cleanup must outweigh any incidental negative impacts that could arise.

4.4 Contamination Remediation Options Considered

The remediation options considered for contaminants in soil, and some of their typical benefits and disadvantages, are presented in **Table 6**, **Section 5.1.1**.

Remediation options considered for contaminants in groundwater are presented and considered in **Table 7**, **Section 5.1.2**.

These tables can be used to screen options that are considered inappropriate under the situation that exists at the time redevelopment actions prompt the requirement for Phase 2 and Phase 3 operations.

Other remedial options may be available and a full remediation review should be undertaken at the time of preparation of the RAP.

4.5 Remediation Criteria

The following sections present generic remediation criteria for soil, groundwater and sediment.

The remediation criteria have been based on the investigation criteria adopted in the *Revised SAQP*.

These remediation criteria have been presented as a guide only. Alternate remediation criteria may be proposed by the environmental consultant based on risk assessment (health / ecological), consideration of background concentrations and a range of other factors. Should alternate remediation criteria be proposed these must be approved by Council or a Site Auditor (as required).

Given some of the remediation may occur a number of years after completion of this document, the remediation criteria are required to be reviewed prior to use and updated for any changes to guidelines that may have occurred as well as any alternate contaminants that may require remediation. This should be undertaken in consultation with Council or a Site Auditor (as required).

4.5.1 Soil Remediation Criteria

As detailed in Section 3.2 of the *Revised SAQP*, the soil remediation criteria are proposed to be primarily based upon:

- Those stated in Schedule B1 of the *NEPM* (ASC NEPC, 1999) for the following likely land uses (refer to **Section 1.6**):
    - **Commercial/Industrial** - HIL D, commercial/industrial such as shops, offices, factories and industrial sites.
- Those detailed in Friebel, E. and Nadebaum, P., 2011. *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater.* Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), Technical report series No. 10.

Note that *NEPM* (ASC NEPC, 1999) states that *when land is used for more than one purpose, the HILs that are relevant to the more sensitive land use should be adopted for that site*.

The *NEPM* (ASC NEPC, 1999) states that HILs *are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required. HILs are generic to all soil types and generally apply to the top 3 m of soil*. An exceedance of a HIL does not indicate that there is a definite risk to a receptor, but rather, that further site-specific assessment is required to quantify the potential risk. Nevertheless these are proposed as initial remediation criteria.

The following **Table 3** sets out the proposed land use categories/zones within which each of the identified PCAs are located based on current master planning. This land use categorisation is important with respect to establishing the remediation criteria in various parts of the Precinct.

Should there be any changes to the proposed masterplan then the following should be reviewed and updated where required.

Table 3 Applicable Remediation Criteria

Report Reference	Area	Proposed Land Use *NEPM* (ASC NEPC, 1999) Category HIL	*NEPM* (ASC NEPC, 1999) Exposure Setting
A	Sada Tank	Commercial/Industrial	D
B	Sada Workshops	Commercial/Industrial	D
C	Sada Truck Wash	Commercial/Industrial	D
D	Sada Rail Easement	Commercial/Industrial	D
E	Sada Decommissioned Coal Washery	Commercial/Industrial	D
M	CSM Dams	Commercial/Industrial	D
J	CSM/SITA Compost Storage and Processing Areas	Commercial/Industrial	D
F	CSM/SITA Tank	Commercial/Industrial	D
G	CSM/SITA Workshops	Commercial/Industrial	D
H	TRN Workshop and Truck Wash	Commercial/Industrial	D
I	TRN Tank Farm	Commercial/Industrial	D
P*	CSM/Tripodi Tank	Commercial/Industrial	D
Q*	CSM/Tripodi Workshop	Commercial/Industrial	D
S*	Sada plant and Machinery “Graveyard”	Commercial/Industrial	D
X	Emplacement	Commercial/Industrial	D
Z	Remainder of Precinct	Commercial/Industrial	D

Petroleum Hydrocarbons

The Health Screening Levels (HSLs, presented in *NEPM* (ASC NEPC, 1999) and Friebel, E. and Nadebaum, P., 2011) were developed to be protective of human health by determining the reasonable maximum concentration from site sources for a range of situations commonly encountered on contaminated sites. The HSLs apply to the same land use settings as for the HILs, although the values for residential A and B are combined, and include additional consideration of soil texture and depth to source to determine the appropriate soil, groundwater and soil vapour criteria for the exposure scenario.

It is noted that not all of the HSLs from Friebel, E. and Nadebaum, P. (2011) are presented within NEPC (1999). For example, NEPC (1999) does not adopt the direct contact HSLs or the Shallow Trench Worker HSLs.

Table 4 Health Screening Level Summary

HSL	Land Use	Soil Depths	Soil Types (all land uses)
HSL_A	See **Section 4.5.1** above.	0 m to <1 m 1 m to <2 m 2m to <4m 4m +	**Sand** (sand, sandy clay, sandy clay loam, sandy loam, loamy sand, loam, sandy silt and silty sand) **Silt** (silt, silty clay and silty clay loam) **Clay** (clay, clay loam and silt loam)
HSL_B			
HSL_C			
HSL_D			
Shallow Trench Worker	Utility / intrusive maintenance workers involved in shallow trenches (to a maximum depth of 1m)	0m to <2m 2m to <4m 4m +	

Neither NEPC (1999) as amended or Friebel, E. and Nadebaum, P. (2011) provide numeric aesthetic guidelines. However, NEPC (1999) as amended states that site assessment requires balanced consideration of the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity.

Ecological Risk Assessment

The *NEPM* (ASC NEPC, 1999) states that the *assessment of site contamination should include a consideration of risks to water resources and other ecological risks*. In most jurisdictions, at least some level of ecological risk assessment (ERA) is mandatory. The ERA process is based on the following principles:

- The need to maintain ecosystem structure and function, both of which are vital to maintaining healthy and sustainable ecosystems;
- The need for a holistic approach to ERA which recognises that all aspects of the environment are interdependent and cannot be considered in isolation;
- The environmental values to be protected are the driving force for the assessment, noting that the values of sites with different land uses may be different. The objectives of the assessment must also recognise the sustainable use of resources in an environmental, economic, social and cultural context;
- The ERA process requires an integrated approach, using multiple lines of evidence gathered from physical, chemical and biological data combined with site-specific data about exposure, toxicological and chemical parameters and the consideration of properties of soil, sediments and water relevant to the site, in order to estimate the level of effects. The movement of contaminants from soil to other environmental media (such as air, water or sediment) and subsequent exposure to biota should be included in the ERA process; and
- Communication strategies should be an integral part of the ERA, so the process requires a cooperative approach to encourage effective communication among industry, government and communities.

NEPM 2013 requires that an appropriate level of ERA be undertaken to ensure that environmental values are maintained and that potential impacts on ecological values are minimised. The guidelines provide a two tiered approach commencing with a Preliminary ERA designed to establish the potential ecological risks associated with the site. The process is iterative with increasing degrees of data collection and complexity incorporated if specific ecological or water quality risks are identified. The results of the ERA process are then used in the design of both the data collection phase and subsequent assessment of contamination.

For the Glenlee Precinct, several terrestrial and aquatic ecological assessments have been completed to date as well as a long history of water quality monitoring from the licensed site discharge. The Hayes (2009) Ecology Assessment noted healthy vegetation growth with the main threat being woody weed infestation. The assessment also found that the water storages around the reject emplacement including the main licensed discharge dam provide good and diverse habitat for aquatic macroinvertebrates compared to the Nepean River habitats although both habitats included listed pest fish species Plague Minnow. The primary recommendations from this assessment involved a commitment to long-term weed control and vegetation management.

A further study was undertaken in 2013 (Eco Logical, 2014) included a literature review of aquatic and terrestrial studies in the local area, additional on-site studies and provided specific management recommendations for existing and proposed new vegetation corridors across the Precinct. The study confirmed that the primary threat to ecological values was weed invasion while water quality from the site did not appear to be a limiting factor other than sediment movement.

Given that there is no evidence of the Precinct causing offsite impacts on ecological function and quality, the ERA will consist of a detailed review of available data and assessments in order to confirm the outcomes of previous studies and to ensure that all aspects have been adequately addressed. It is likely that the outcome of the ERA will involve provision of adequate erosion and sedimentation controls during any intrusive works, ensuring that weed invasion is not exacerbated by cleaning any equipment to be used on site and to ensure that any required remediation is appropriately managed via the implementation of a Remedial Action Plan.

Asbestos in Soils

Soils identified to be impacted with asbestos will be assessed in accordance with the *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* (Western Australian [WA] Department of Health, 2009) which have been included in the *NEPM* (ASC NEPC, 1999).

4.5.2 Groundwater and Surface Water Remediation Criteria

The following guidelines will be adopted for the assessment of groundwater concentrations, as presented in the *NEPM* (ASC NEPC, 1999)

- Friebel, E. and Nadebaum, P., 2011. *Health Screening Levels for petroleum hydrocarbons in soil and groundwater* (as presented in the *NEPM* [ASC NEPC, 1999]).

The following guidelines will also be adopted for the assessment of groundwater concentrations based on the *NEPM* (ASC NEPC, 1999):

- NHMRC, 2011. *Australian Drinking Water Quality Guidelines*; and
- ANZECC, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Human Health - Health Screening Levels (HSLs)

For the assessment of petroleum hydrocarbon contamination, the *NEPM* (ASC NEPC, 1999) refers to the use of the Friebel, E. and Nadebaum, P. (2011) *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater*, which are applicable for assessing vapour intrusion risks from contaminated groundwater. The HSLs presented are based on five specific land uses/receptors, three soil types and three depth ranges for groundwater.

Drinking Water Quality Guidelines

For the assessment of drinking water, *NEPM (*ASC NEPC, 1999) refer to the use of the *Australian Drinking Water Quality Guidelines* which were most recently published in 2011 (NHMRC, 2011). These guidelines have been developed for health and aesthetic quality levels for supplying good quality drinking water.

The Australian Drinking Water Guidelines (ADWG) do not present guideline values for TRH in drinking water. In the absence of other Australian guidance relating to drinking water standards, the World Health Organisation (WHO) Petroleum Products in Drinking Water (2008) have been adopted for the following reasons:

- The ADWG are based on the WHO drinking water guidelines; and
- The *NEPM (*ASC NEPC, 1999) notes that *Australia is a party to the WHO process and has incorporated their material in a variety of environmental health criteria*.

Ecological

The ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. provide 'trigger' values for chemicals within the water, which represent the best current estimates of the concentration of chemicals that should have no significant adverse effects on the aquatic ecosystem.

ANZECC (2000) indicates that an exceedance of a trigger values does not necessarily imply that there is an inherent risk, rather that further assessment and monitoring may be required prior to implementing appropriate management actions. AECOM notes that according to ANZECC (2000), low reliability trigger values are interim levels only because "*low reliability trigger values were derived, in the absence of a data set of sufficient quantity, using larger assessment factors to account for greater uncertainty"*, and, *"low reliability values should not be used as default guidelines".*

Whilst ANZECC (2000) provide an interim, low reliability trigger level of 7 µg/L for crude oil in water, there is no trigger level for TRH. AECOM notes that current laboratory limits of reporting (LOR, typically 100 µg/L) cannot quantify TRH to this concentration. Therefore the Dutch (2000) mineral oil criteria of 600 µg/L (intervention value)

will be adopted. The ANZECC (2000) criteria for aromatic hydrocarbons (1,500 µg/L) will be adopted as investigation criteria.

Adopted Groundwater Assessment Criteria (GAC)

The following criteria will be adopted as the groundwater assessment criteria (GAC):

Table 5 Groundwater Assessment Criteria

Receptor	Guideline	Level Adopted
Human Health	NEPC (1999)/Friebel, E. and Nadebaum, P. (2011)	Vapour Intrusion: HSL_A (residential), 2 m to >4m, sand
		Vapour Intrusion: HSL_D (commercial/industrial), 2 m to >4m, sand
	NHMRC (2011)	Health Drinking Water Guidelines
	Dutch (2000)	Mineral oil criteria
	WHO (2008)	Petroleum Products in Drinking Water
Ecological	ANZECC (2000)	Fresh waters, 95% level of species protection where applicable, including moderate and low reliability trigger values

The investigation criteria that have been adopted for groundwater and surface water are summarised in **Appendix B**.

4.5.3 Sediment Criteria

The ANZECC (2000) *Sediment Quality Guidelines* provides interim trigger values for sediments which are proposed to be adopted as sediment investigation levels in the event that sediment sampling is undertaken. If required, all sediment investigations should be undertaken with reference to the *Handbook for Sediment Quality Assessment* (Commonwealth Scientific and Industrial Research Organisation [CSIRO], 2005).

ANZECC (2000) provides ISQG (Low) and ISQG (High) trigger values. If a sediment concentration is below the ISQG Value then this indicates a low risk. If the concentrations are between the ISQG (Low) and ISQG (High) trigger values and below background concentrations then this also indicates a low risk. If the concentrations are between the ISQG (Low) and ISQG (High) trigger values and above background concentrations or above the ISQG (High) trigger values then this could indicate a potential risk and either further site specific risk assessment and / or remediation / management is required.

The ISQG Low and High Values for identified potential contaminants of concern are summarised in **Appendix D**.

For contaminants for which no ISQG values are provided, ANZECC (2000) recommends deriving a value on the basis of natural background (reference) concentration multiplied by an appropriate factor. A factor of two is recommended although in some highly disturbed ecosystems a slightly larger factor may be more appropriate, but no larger than three. An alternative approach is to apply the water quality guideline values to sediment pore waters.

Note that the former sediments from the former drainage depression/s on the CSM site which have now been filled no longer represent sediments and soil criteria are considered appropriate for their assessment.

4.6 Extent of Remediation

The required extent of any soil, sediment and groundwater remediation will be considered based on findings of the Phase 2 assessments.

The material surrounding and beneath the delineated contamination will be tested and assessed against remediation soil criteria.

If the material or part of the material does not meet the criteria, then remediation will be continued to the extent practicable until material that is below remediation criteria is reached.

Further discussion regarding the potential extent of contamination for each contamination category is discussed in **Section 5.2**.

5.0 Assessment of Options

5.1 Remediation Scenarios/Strategies

Table 6 and **Table 7** provide the general range of conventional available remediation strategies for contaminant types assessed by Phase 1 investigations as being the most likely to occur at the Precinct. Without the actual results of the Phase 2 investigations it is not possible to provide specific remediation strategies however the discussion provided in **Table 6** and **Table 7** demonstrate that there are several remediation options available. Based on the anticipated results of the Phase 2 investigation being the identification of minor hydrocarbon contamination around fuel containment areas and workshops, onsite bioremediation is the most likely remediation option that would be required. For completeness though, other remediation options are discussed.

The remediation options will be confirmed once the Phase 2 results are available**.**

5.1.1 Soil Remediation

Table 6 Assessment of Main Soil Remediation Options

Remediation Option	Description	Merits	Disadvantages
Onsite treatment of TPH and PAH – land farming / bioremediation	Excavation of impacted soil and on-site bioremediation. Reinstatement of excavated areas with material validated as suitable for the intended land use.	- Protective of the environment. - On-going future liabilities including human health and the environment would be minimised following remediation. - Consistency with the principles of Ecologically Sustainable Development. - Consistent with community and regulatory expectations of minimal impacts. - Traffic volumes and potential community impacts reduced compared to other alternatives.	- Extended timeframe for on-site treatment and soil sampling and analysis. - Restricted to petroleum hydrocarbon (better for lighter end compounds) impacted material and some other organics. - Land farming generates odours during placement and turning of material. Erosion and sediment controls would be required.

Remediation Option	Description	Merits	Disadvantages
In-situ bioremediation	Bioremediation *in-situ* by introduction of additives to enhance microbial degradation	- Protective of human health during works including on-site workers and community surrounding the site. - Traffic volumes and potential community impacts reduced compared to other alternatives. - On-going future liabilities including human health and the environment would be minimised following remediation. - Consistency with the principles of Ecologically Sustainable Development. - Consistent with community and regulatory expectations of minimal impacts.	- Extended timeframe for on-site treatment. - Timeframe difficult to estimate. - Restricted to TPH only impacted material. - Need for pilot trials. - Potentially expensive implementation to ensure adequate coverage.
Excavation of contaminated soil and disposal to licensed landfill or removal to a storage facility	Excavation of impacted soil and off-site disposal to a licensed facility or removal to a storage facility following waste classification.	- On-going future liabilities including human health and the environment would be minimised at the Precinct following remediation. - Proven technology widely applied in Australia and internationally. - Shorter time frame when compared with other options. - Able to handle most solid waste streams generated at the Precinct (hazardous materials excepted). - Limited on-site handling of wastes thereby reducing odour issues.	- Inconsistent with the NSW EPA remediation hierarchy, including preference for recycling and treatment rather than disposal. - Inconsistent with the principles of Ecologically Sustainable Development due to re-location of impacts instead of treatment. - In the event of large volumes to be remediated - increased community impacts associated with increased traffic inconvenience and potential for dust and odour impacts if not managed appropriately. - Suitably licensed landfill facilities may not be locally available.

Remediation Option	Description	Merits	Disadvantages
On-site Containment	Excavation of impacted soil and on-site burial within an approved lined on-site containment cell. Reinstatement of excavated areas with stabilised material validated as suitable fill.	- Moderately protective of human health including on-site workers and community surrounding the site. - On-going future liabilities including human health and the environment would be low following remediation. - Partial consistency with community and regulatory expectations of minimal impacts. - Protective of the environment if appropriately designed. - The Glenlee Precinct is likely to have sufficient space to accommodate construction of a containment cell(s) without impacting significantly on future redevelopment.	- Inconsistent with the NSW EPA remediation hierarchy, as the waste is not treated, reduced in concentration or destroyed. - Land area needed for containment of impacted material. - Restricted future land use following remediation. - Ongoing monitoring may be required to ensure the efficacy of the containment cell. - The treatment approach is not considered a permanent waste solution in Australia. As a result, there may be contingent liability associated with this approach. - Ongoing monitoring.
Clay capping or covering with clean soil	Cap contamination to prevent infiltration of surface water into contaminated soil and /or to prevent contact with site users.	- Moderately protective of human health including on-site workers and community surrounding the site. - On-going future liabilities including human health and the environment would be relatively low following remediation. - Partial consistency with community and regulatory expectations. - Protective of the environment and human health if appropriately designed and managed into the future.	- Inconsistent with the NSW EPA remediation hierarchy, as the waste is not treated, reduced in concentration or destroyed. - Restricted future land use following remediation. - Ongoing management and/ or management plan is required. - Lateral groundwater flow may still lead to contamination migration, excluding in the case of asbestos impacted soil. - Not suitable for areas with difficult access for machines etc.
Stabilisation of metal or PAH impacted soils	Excavation of impacts soils and immobilisation of metals or PAHs in the soil matrix by mixing with cement or similar.	- Reduces leaching of contaminants. - Can be used to lower waste classification of highly contaminated soils prior to offsite disposal.	- Contamination still remains and hence requires capping and ongoing management if left onsite.

Remediation Option	Description	Merits	Disadvantages
Onsite treatment of asbestos impacted materials	Screening or sorting materials to remove asbestos (as per NEPM [1999] as amended requirements)	- May reduce quantity of asbestos impacted material requiring offsite disposal or capping.	- The screening and sorting process can potentially result in further breakdown of asbestos materials and potentially liberation of asbestos fibres. - Asbestos fragments smaller than the screen and fibres would not be removed. - It is often not practicable to selectively remove asbestos particularly in fill materials and in clayey soils. - It is difficult to demonstrate all asbestos has been removed.
No Remediation – Site Management Plan	Do nothing – other than prepare a Site Management Plan No remedial action taken. Impacted soil left *in-situ*. Potential ongoing off-site migration of contaminated groundwater.	- No disturbance to site required. - No remedial costs incurred other than cost of preparing the Site Management Plan. - No potential impacts related to the remediation of the site. - Risks to human health and the environment managed through defined work practices.	- On-going liabilities including human health and the environment would remain in some Precinct areas. - On-going liabilities including risks to human health and the environment in some Precinct areas would need to be transferred with divestment of the site. - On-going obligation to adhere to Site Management Plan would need to be transferred with divestment of the site. - Changes to a more sensitive land use other than commercial/industrial would not be possible. - Impacted material would remain on-site indefinitely. - Not consistent with the principles of Ecologically Sustainable Development, particularly inter-generational equity. - Inconsistent with community expectations for remediation.

Remediation Option	Description	Merits	Disadvantages
Institutional controls / management	Manage contamination by restricting access to the area, signage, management plans etc	- Potential exposure to human and environmental receptors is reduced or monitored. - No disturbance to site required. - No remedial costs incurred. - No potential impacts related to the remediation of the site.	- On-going liabilities including human health and the environment would remain in some Precinct areas. - On-going obligation for maintenance of institutional controls would need to be transferred with divestment of the site. - Changes to a more sensitive land use other than commercial/industrial would not be possible. - Impacted material would remain on-site indefinitely. - May be considered inconsistent with community expectations for remediation.

5.1.2 Groundwater Remediation

Table 7 Assessment of Main Groundwater Remediation Options

Remediation Option	Description	Merits	Disadvantages
In-situ Bioremediation	Removal or reduction of organic contamination in the saturated zone by injecting anaerobic reactors	- Minimal affects for off-gases to impact the atmosphere.	- Extensive monitoring necessary to ensure that the final product of the remediation is not vinyl chloride. - Can take very long time period.
In-situ Chemical Oxidation	Removal or reduction of organic contamination in the saturated zone by injecting chemical oxidising compounds	- Rapidly destroys contaminants.	- Oxidising compounds can be used up by non-target organics in soil or groundwater. - Oxidant can impact upon surface water systems if not used up prior to discharging. - Need to ensure compound reaches impacted parts of aquifer.
Ex-situ treatment	Extraction of groundwater and ex-situ treatment, for example as per processes similar to those adopted in sewage treatment plants	- Proven technologies available. - Possible to completely destroy volatiles.	- Disposal of sludge may be required.

Remediation Option	Description	Merits	Disadvantages
Combined Air Stripping and Carbon Absorption	Combines technologies of air stripping and granular activated carbon (GAC) adsorption.	- Proven technology and current popular method for remediating contaminated water.	- A given sorbent has a finite capacity for absorption of a given contaminant (sorbent may need to be changed or cleaned). - High dissolved organic carbon and other contaminants can compete with some compounds for binding sites, therefore increasing the likelihood of breakthrough.
Air stripping	Stripping of volatile organic compounds by allowing for percolation of large volumes of air through contaminated water.	- Proven technology.	- Not suitable for heavy fraction hydrocarbons. - Restrictions on venting of VOCs to the atmosphere may preclude the use of such technology or require treatment of the air-stripped off-gases by carbon adsorption.
Removal of the contamination source and natural attenuation	Removal of impacted soil.	- Removal of the contamination source.	- Residual contamination will remain in groundwater in the short to medium term. - Ongoing groundwater monitoring.
Permeable reactive barriers (funnel-and-gate or continuous)	Construction of sub surface structures to enable in situ treatment of groundwater plumes.	- Cost effective passive treatment effective for organics, DNAPLs, metals, arsenic. - Treats upstream contaminated water before it reaches receptors. - Treats only contaminated water and allows clean water to pass through.	- Limited but expanding information about long term performance and enduring efficiency. - Possible fouling. - Disruption of natural conditions. - Uncertainties associated with scaling up from lab-scale. - Suited to narrow and shallow plumes due to the cost of sub surface barrier wall construction.

The most common techniques used for remediation of soil in Australia have been to excavate contaminated soil and remove it to a landfill, or to cap-and-contain the contaminated areas of a site to eliminate or limit ecological or human exposure to the material. The methods have some drawbacks. The first method moves the contamination elsewhere (often within the context of diminishing landfill capacities) and may create risks in the excavation, handling, and transport of hazardous material. Additionally, it is increasingly expensive to dispose of soil off-site. The cap and contain method is an interim solution since the contamination remains on site, requiring monitoring and maintenance of the isolation barriers into the future, with associated costs and potential liability and loss of developable land. A preferable approach is to destroy the pollutants if possible, or at least to transform them to low risk substances. However, this is not always feasible.

For groundwater a common option is to remove the source and soil contamination and then to allow the groundwater CoPC concentrations to naturally attenuate. Where active groundwater remediation is required, pump and treat, in-situ bioremediation and in situ-oxidation are all relatively common. These are proven technologies for the CoPC identified at the Precinct and are generally accepted for use by the NSW EPA.

5.2 Remediation Approach for Each Identified Contamination Category

The following sub-sections discuss potential feasible remedial strategies for each of the identified PCAs (refer to **Section 1.9**) based on consideration of the potential extent and nature of contamination in each PCA and the broad remediation options presented in the previous Section.

It is important to note that the estimated extent and nature of contamination is required to be confirmed by a Phase 2 contamination assessment at which time the remedial strategies outlined herein should be reviewed (if required), followed by development of a RAP (including detailed methodologies) for the Precinct.

5.2.1 PCAs Potentially Contaminated by Fuel and Oil Products/Residues

The primary PCAs are the fuel storage areas and workshop facilities. Despite all fuel storage areas being appropriately bunded there is the potential for some spillage of petroleum products outside the bunded areas over time. Similarly, the workshops within the Precinct have been equipped with concrete flooring and appropriate oil containment facilities. However, over time there is the potential for contamination to occur around the apron in front of the workshops.

Other PCAs which would need to be targeted in the Phase 2 investigation include the site of the original Coal Washery, equipment storage areas and the truck washing station. These areas may contain incidental contamination levels which would need to be validated.

There are also a number of small dams and pollution control structures on the Precinct which would be included in the Phase 2 investigation. These dams contain the runoff from the primary target areas and therefore may contain contamination (in both water and sediment) as this was their designed purpose.

The main CoPC associated with these PCAs are likely to be petroleum hydrocarbon contaminants.

While the extent of contamination needs to be confirmed by the Phase 2 contamination assessments, based on the available information, in the context of the size of the Precinct, contamination (if any) associated with the PCAs is likely to be relatively localised. That is, most of the sources involve single or small numbers of storage tanks or workshop areas and contamination is likely to be mainly confined to the vicinity of these sources.

A suitable remedial strategy for petroleum hydrocarbon contaminated in the PCAs is likely to include removal of any remaining fuel infrastructure (fuel storage tank/s, pipework etc) and then depending on the volume of soil and level and nature of contamination in the soil, either offsite disposal of the soil to a licensed landfill or onsite bioremediation by landfarming.

Landfarming could be undertaken to lower hydrocarbon concentrations to either meet the land use criteria or reduce the waste classification to a lower category (in the event the initial waste category of the stockpiled soil was higher than General Solid Waste[3]). Generally landfarming becomes feasible when the volume of contaminated soil is greater than around 200m^3. Note that this may take several months or longer to complete and would require enough space to spread the soil out in a maximum 2.0 m high layer. Landfarming could potentially be made more efficient by treating hydrocarbon contamination generated from multiple sub-sites together.

If the contamination is found to extend deep, over a significant distance or under adjacent structures making excavation of all contaminated material not practicable, then other remedial strategies may need to be considered for that portion of the contamination in consultation with Council or the Site Auditor (as required). An area- and CoPC-specific human health risk assessment may be undertaken in accordance with Schedule B4 of the *NEPM* (ASC NEPC, 1999) to assess the significance of specific exceedances of the adopted soil and/or groundwater criteria.

Once the primary (fuel infrastructure) and secondary sources (contaminated soil) of hydrocarbon contamination are removed, the concentration of any residual contamination would be expected to decrease overtime. For this reason and due to the likely depth of groundwater, monitored natural attenuation may be a suitable remedial strategy for groundwater contamination (if such contamination is present). However, this would need to be assessed once the extent of groundwater contamination (if any) is identified based on the recommended Phase 2 groundwater monitoring and observations / groundwater validation following soil remediation. As discussed in the previous Section, there are a variety of options available for treatment of petroleum hydrocarbon groundwater contamination if required.

[3] As defined by the NSW DECCW (2009) *Waste Classification Guidelines*.

5.2.2 PCB Contamination

PCA E – Sada Decommisioned Coal Washery has a low potential to be contaminated by PCB residues.

During the Phase 1 research undertaken as part of the original *Phase 1 Contamination Assessment* (2009) report, it was reported that one or several electrical transformers were stored to the north of the current Sada offices, to the side of a decommissioned coal washery structure. Staff interviewed stated that the storage and removal of the transformers, and any subsequent cleanup, occurred prior to the commencement of Sada's operations. Given the time period in question, it is possible that the transformers contained PCB-laden oil.

Based on the available information, the likelihood of significant PCB contamination being present is considered to be low, and if present would be considered likely to be localised.

Should PCB contamination requiring remediation be identified during the Phase 2 contamination assessment then the most likely strategy would be to excavate the impacted soil and then either dispose of it offsite to a suitable treatment plant or treat it or encapsulate it onsite.

Note that offsite disposal to landfill is unlikely to be a viable option in the event remediation is required as the criteria for total PCB for commercial / industrial sites (50mg/kg) is the same concentration that would render the PCB as a Schedule Chemical Waste[4] (SCW) and hence unable to be disposed to landfill. Again the likelihood of such concentrations being present are considered low.

If required, excavation would commence in the identified contaminated zone and would be extended until visual and/or olfactory observations by the environmental consultant site personnel indicate that the PCB contaminated soil is likely to have been removed to the extent practicable.

Excavated soil should be temporarily stockpiled on a designated temporary stockpiling area.

The stockpiled material should then be sampled and the waste classified in accordance within the NSW DECCW (2009) *Waste Classification Guidelines*.

If the concentrations are elevated rendering the soil as a SCW, then the material could be treated at a suitably licensed offsite facility. Other options could be considered such as onsite thermal desorption although given the likely low quantities this would be unlikely to be cost effective.

A consultant or contractor charged with remediating PCB waste should be made aware of the additional materials handling and treatment requirements/constraints imposed by the Chemical Control Order (CCO) for PCBs as set out in the *Environmentally Hazardous Chemicals (EHC) Act* (1985). The CCO, which triggers strict materials management at concentrations at or above 50 mg/kg is known as the *PCB CCO* (1997) and can be found at www.environment.nsw.gov.au/resources/pesticides/pcbcco1997.pdf.

5.2.3 Nutrient Rich Surface Water Runoff Accumulated in Former Sediments

The former sediments of PCA M - CSM Dams (now buried) have the potential to be contaminated by nutrients or other contaminants from past surface water runoff. The Precinct has been backfilled by use of material (washery reject) won from the Emplacement over which the CSM area has been developed.

It is considered unlikely that remediation of the sediments would be required. In the event that it were to be required then there a range of potential remedial strategies that could be adopted including capping the area to prevent infiltration or as a last resort excavation and offsite disposal of the impacted sediments.

5.2.4 Odorous Soils Resulting From Composting Activities

Soil in PCA J - CSM Compost Processing and Storage has the potential to be odorous as a result of the composting activities.

PCA J is in a proposed commercial / industrial area.

It is considered that residual odours (if present at significant levels) should be able to be readily managed through aeration of the odorous soil (potentially with addition of additives to enhance odour reduction and /or removal of the material prior to redevelopment.

If neither of the above options is effective or desirable then the odorous soil could be excavated and disposed offsite to a suitably licenced landfill.

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[4] As defined by the ANZECC (2003) *Polychlorinated Biphenyls Management Plan*.

5.2.5 Coal Washery Reject Emplacement

As discussed in Section 2.3.6 of the Phase 1 Contamination Assessment, the coal reject (sourced from the Illawarra Coal Measures) is considered to be chemically benign and has previously been found to contain low metals concentrations and is usually non-detect for BTEX and polycyclic aromatic hydrocarbons (PAHs). The coal reject has been confirmed by the NSW EPA to comply with the POEO (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A *the coal washery rejects general exemption 2009*.

Much of the southern portion of the Glenlee Precinct (the former coal washery site and CSM area) is overlain by fill, tailings and solid waste from the coal washery. The tailings form a relatively flat platform of this area (the emplacement). The dimensions of the Emplacement are approximately 850 m x 600 m x approx 20 m deep, forming a body of reject materials of the order of 10,000,000 m^3.

The *Revised Phase 1 Contamination Assessment* (AECOM, 2014) report states that the only material processed at the Sada (and previously owned) washery was Bulli seam coal. No information exists which might indicate that material other than coal washery reject was deposited in the Emplacement. The reject material was either pumped or trucked to the various emplacement cells.

It is understood that the Emplacement area will be developed for commercial / industrial land and that earthworks will be completed to re-profile the Emplacement and address geotechnical issues during the development process.

In the unlikely event that substantial contamination was identified in the Emplacement we consider that remediation would be likely to be able to be practically completed through a cap and contain remedial strategy.

A cap and contain strategy would typically involve installation of a capping layer constructed of clean soil layer, hardstand such as asphalt or concrete etc over the contaminated material. In the event that it was assessed there was potential for contaminants within the fill to leach to groundwater as a result of surface water infiltration, the cap may be required to be constructed of low permeability material such as compacted clay.

Alternate groundwater management options may need to be considered in the event that groundwater flowing through the Emplacement (i.e. in direct contact with the Emplacement) was becoming significantly contaminated as the result of leaching. Such options could potentially include ongoing monitoring, hydraulic containment, pump and treat or installation of treatment walls however a detailed options analysis would need to be undertaken in the event that such groundwater management was required.

If a capping strategy was adopted then a long term Site Environmental Management Plan would be prepared in accordance with DEC (2006) *Guidelines for the NSW Site Auditor Scheme* and would be required to be implemented in perpetuity. The Site Environmental Management Plan identifies the party(ies) responsible for adhering to the plan, and includes commitments for ongoing monitoring and maintenance of the cap as well as control of future excavations, which must be minimised or if required, the appropriate occupational health and safety procedures are adopted and permits acquired before work is carried out. Furthermore the containment and presence of the environmental management plan would be required to be noted on the S149 certificate for the Precinct or similar.

5.2.6 Potential Presence of Other Fill of Unknown Quality and Asbestos

The *Revised Phase 1 Contamination Assessment* (AECOM, 2014) report cites the *Geotechnical* section of the Land Capability Assessment report which states that:

> *Fill materials are present over sections of steeper slopes such as in the east-west oriented Green Link/TRN area. The fill materials appear to be non-engineered sidecast materials overlying the formed (cut) slopes. Such materials are generally considered to be undesirable for permanent development due to their unknown, variable and unpredictable nature.*
>
> *The presence or otherwise of debris in the subject fill should be investigated.*

The contamination status of fill materials will depend upon the source of the fill, which is unknown.

In the event that fill materials are encountered / identified and assessed to be contaminated, it is considered that remediation by capping and /or excavation and offsite disposal would be the most feasible remedial options. The selection of these options would be dependent on a range of factors including contaminant type and volume of material etc.

It is recommended that an inspection and testing program and unexpected finds protocol be implemented during any earthworks within fill materials.

At this stage no asbestos has been positively identified on site and no obvious sources of asbestos have been identified. Nevertheless asbestos materials have been widely used across Sydney and are commonly found around former structures constructed of asbestos containing material and in fill material containing building rubble (if present).

If asbestos is identified it would require remediation or management as required by the *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in WA* (WA Department of Health, 2009). Localised areas of asbestos can typically be dealt with through excavation and offsite disposal to a suitably licensed landfill. Asbestos impacted fill if encountered could typically be dealt with using the options for general contaminated fill above (i.e. cap and contain or excavate and dispose offsite). It should be noted that handling of asbestos impacted material is required to be undertaken by a WorkCover licensed Asbestos Removal Contractor in accordance with the requirements of the following:

- *NSW Work Health and Safety Act* 2011;
- *NSW Work Health and Safety Regulation* 2011;
- *Code of Practice: How to Safely Remove Asbestos,* Safe Work Australia 2011; and
- *Code of Practice: How to manage and control asbestos in the workplace,* Safe Work Australia 2011.

Again it is recommended that an unexpected finds protocol should be implemented providing procedures to be followed in the event asbestos materials are encountered during earthworks or other devolvement activities.

5.3 Validation Principles

Validation observation, sampling and analysis will be required following completion of each remediation phase to demonstrate that remediation goals have achieved.

Typically after each remediation activity has been completed an inspection will be undertaken to visually check that remediation has been appropriately completed. Field screening tools such as a photoionisation detector (PID) for the assessment of VOCs in soil may also be used at this stage to assess the completeness of the remediation.

Visual inspections will also be required under any structures or slabs that are demolished to check for contamination that was not identified through the Phase 2 assessment process.

Once visual inspections and field screening indicate that remediation is likely to have been adequately completed, validation sampling will be undertaken.

Validation sampling will include soil sampling (typically base and wall samples collected from remedial excavations and treated and untreated stockpile samples), groundwater monitoring (new and/or existing wells) and potentially sediment and surface water sampling. Where remediation of volatile contaminants occurred, air monitoring should also be considered. Validation samples should generally be tested for the CoPC being targeted by the remediation.

The validation sampling and analysis will involve demonstrating that the relevant remediation criteria have been achieved through the:

- use of systematic sampling patterns;
- collection of an appropriate number of samples for estimation of the arithmetic average concentration of contaminant(s) within relevant environmental media and exposure areas; and
- estimation of the 95% upper confidence limit (UCL) of the arithmetic average concentration for soils.

Where applicable, the above statistical analysis will be applied to the PCAs. This will also apply if different strata (i.e. fill materials, natural soils and bedrock) are excavated and are proposed to be reused onsite as part of the remediation works. Consequently, the analytical data obtained from the validation of materials to be reused onsite will be assessed separately as per the requirements of the *NEPM* (ASC NEPC, 1999).

If required, further assessment of risks, further validation and/or further remediation would be required. Validation should also include consideration of aesthetic issues, although given the mainly commercial / industrial proposed landuse aesthetic issues are considered unlikely to be significant in the majority of areas.

The details of validation sampling should be provided in the RAP to be prepared and based on the findings of the Phase 2 investigations, once the nature and extent of contamination is better understood. To this end a detailed validation SAQP should be included as part of the RAP prepared for the Precinct. This will need to be reviewed and approved by the Site Auditor.

5.4 Site Management Plan for Remediation Works

A Site Management Plan for the remediation should be prepared by the Consultant and/or Contractor prior to the commencement of remediation works. The objectives of the Site Management Plan would be to:

- Protect the health of site workers and the general public during the remediation works; and
- Provide certainty that the works do not negatively impact on potential environmental receptors and comply with applicable environmental legislation.

The Site Management Plan should include (but not necessarily be limited to):

- Site access;
- Site signage requirements (including contact numbers);
- Soil and stormwater management;
- Transport and disposal of contaminated soil;
- Mitigation measures for noise, dust and odour control;
- Control of spillages and vehicular tracking of soils off site;
- Refuelling and maintenance restrictions;
- Waste management;
- Covering of loads and stockpiles;
- Material tracking and documentation;
- Designation, delineation and control of access to work zones;
- Inductions and awareness of personnel accessing the Precinct during remediation;
- Contingencies; and
- Occupational health and safety (including risks posed by contaminants).

The Site Management Plan must comply with:

- Council's Contaminated Land Policy;
- Applicable guidelines and legislation; and
- Auditor requirements (as required).

An assessment should be made of any regulatory approvals required for the works and these should be obtained before commencement. A valuable resource to this end is the maintenance of collaborative communication with the appointed Auditor (as required).

5.5 General Programme of Work

The remediation processes to be performed will have significantly variable durations, depending on the size/volume, location and complexity of the problem being addressed.

The process includes site establishment, pre-treatment, treatment, validation, decommissioning and reinstatement.

The breakdown of a conventional remedial programme, of which any of the nominated sub-sites are an example, is generally as follows:

- Site establishment and construction;
- Excavation, treatment, characterisation, off-site disposal, validation;

- Backfilling of remedial excavations (if required) with suitable material;
- Site reinstatement; and
- Decommissioning and demobilisation.

Remediation and demobilisation hours would be set in the consent authority's approval conditions but would usually be between the hours of 7am and 6pm Monday to Friday, and 7am to 1pm Saturdays. No construction work would occur on Sundays and Public Holidays.

Prior to demobilisation from the remediation site/s, the short term and long term site management measures must be in place.

5.6 Long-Term Environmental Management Plan (Post Remediation)

Depending on the remedial strategy/ies adopted a Long-Term Environmental Management Plan (EMP) may be required to be designed and implemented to ensure that any remaining contamination is managed in a manner which protects human health and the environment. The Long-Term EMP would be prepared in accordance with the DEC (2006) *Guidelines for the NSW Site Auditor Scheme.*

The contents of the Long-Term EMP would depend on the nature of contamination left on site (if any) and how it is proposed to be managed.

Key elements of the Long-Term EMP could include:

- A survey plan clearly identifying the presence of contaminated and potentially contaminated soil or groundwater and containment details if any (engineered and as-constructed drawings of the remediation works);
- Advice on how to recognise if contaminated soil is exposed in the future;
- A long term maintenance and monitoring/inspection program for remediation measures;
- The application of controls on future excavations where required;
- Health and safety requirements for construction workers and other site personnel and environmental management requirements in the event that work exposing potentially contaminated soil or groundwater is to be undertaken in the future;
- Development and implementation of a groundwater monitoring program where required;
- Contingency plans;
- Statement of Responsibilities;
- Enforcement mechanism;
- Process for Periodic Review; and
- Ongoing Documentation Requirements.

The Long-Term EMP will need to be reviewed and approved by the Site Auditor (as required).

The Long-Term EMP will not be able to be finalised until completion of the development when as constructed plans will be available.

6.0 Conclusions and Recommendations

Based on the information presented herein, in the event that parts of the Precinct are confirmed to be contaminated to the extent that remedial works are warranted, it is considered that that feasible and proven remediation / management measures are available.

The primary PCAs are the fuel storage areas and workshop facilities. Despite all fuel storage areas being appropriately bunded there is the potential for some spillage of petroleum products outside the bunded areas over time. Similarly, the workshops within the Precinct have been equipped with concrete flooring and appropriate oil containment facilities. However, over time there is the potential for contamination to occur around the apron in front of the workshops.

Likely strategies that could feasibly be implemented to remediate / manage contamination that may be identified in the identified PCAs are presented in this document. It should be noted that some of the strategies (i.e. capping and containment of soil, monitored natural attenuation of groundwater, etc) may require future implementation of a Long-Term EMP and/or notice of contamination on the Precinct's S149 certificate or similar.

It is important to note that the strategies presented are generalised only. The extent and nature of contamination is required to be confirmed by a Phase 2 contamination assessment at which time the remedial strategies will need to be reviewed and a RAP (including detailed methodologies) prepared for the Precinct.

If a RAP is required, appropriate contingency measures and unexpected finds protocols should be developed and implemented during remediation, earthworks and other development activities providing procedures to be followed in the event that additional or different contamination is encountered.

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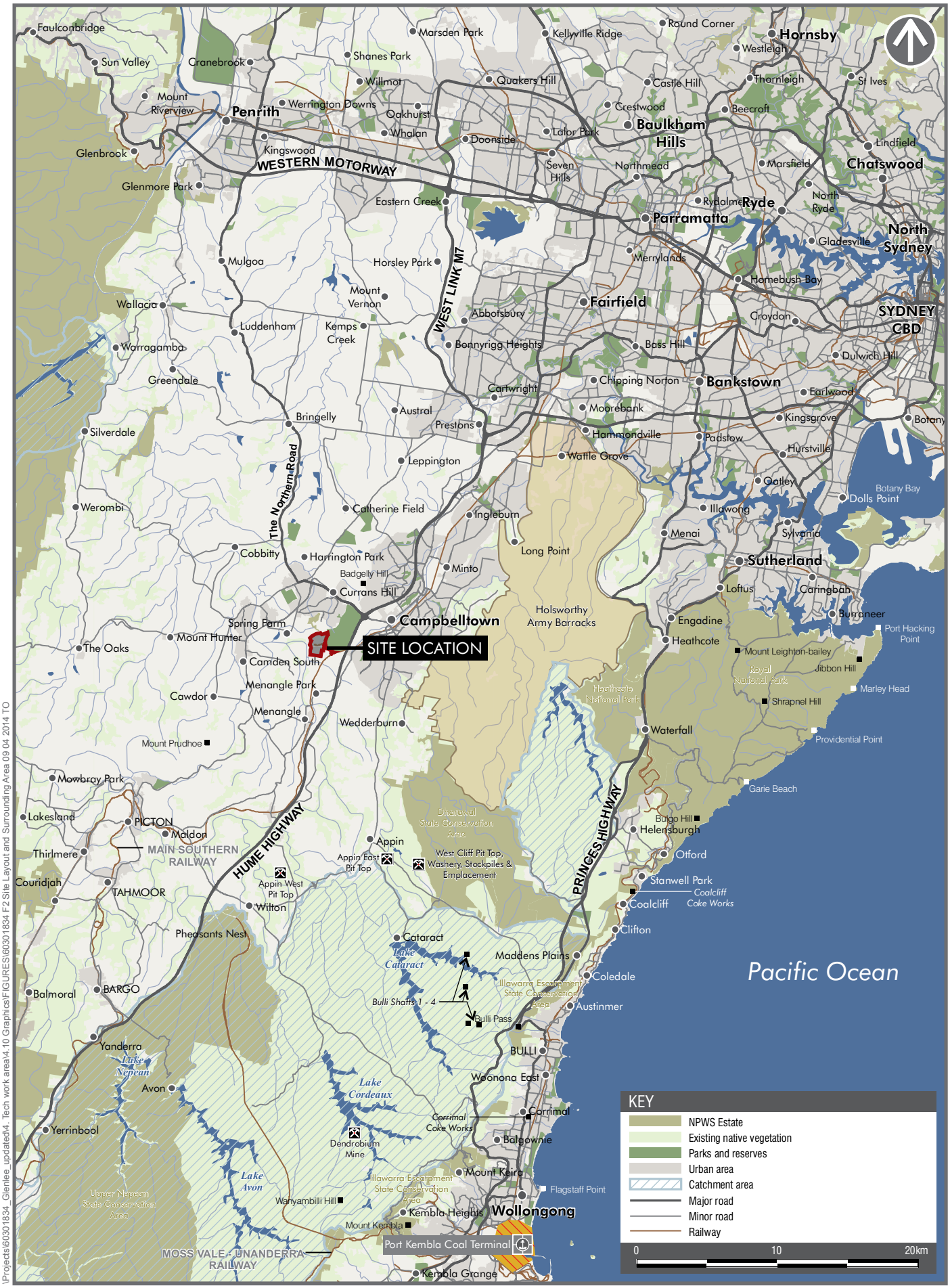
Appendix A

Site Figures

Appendix A



AECOM

SITE LOCATION

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 1

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F2 Site Layout and Surrounding Area 09 04 2014 TO

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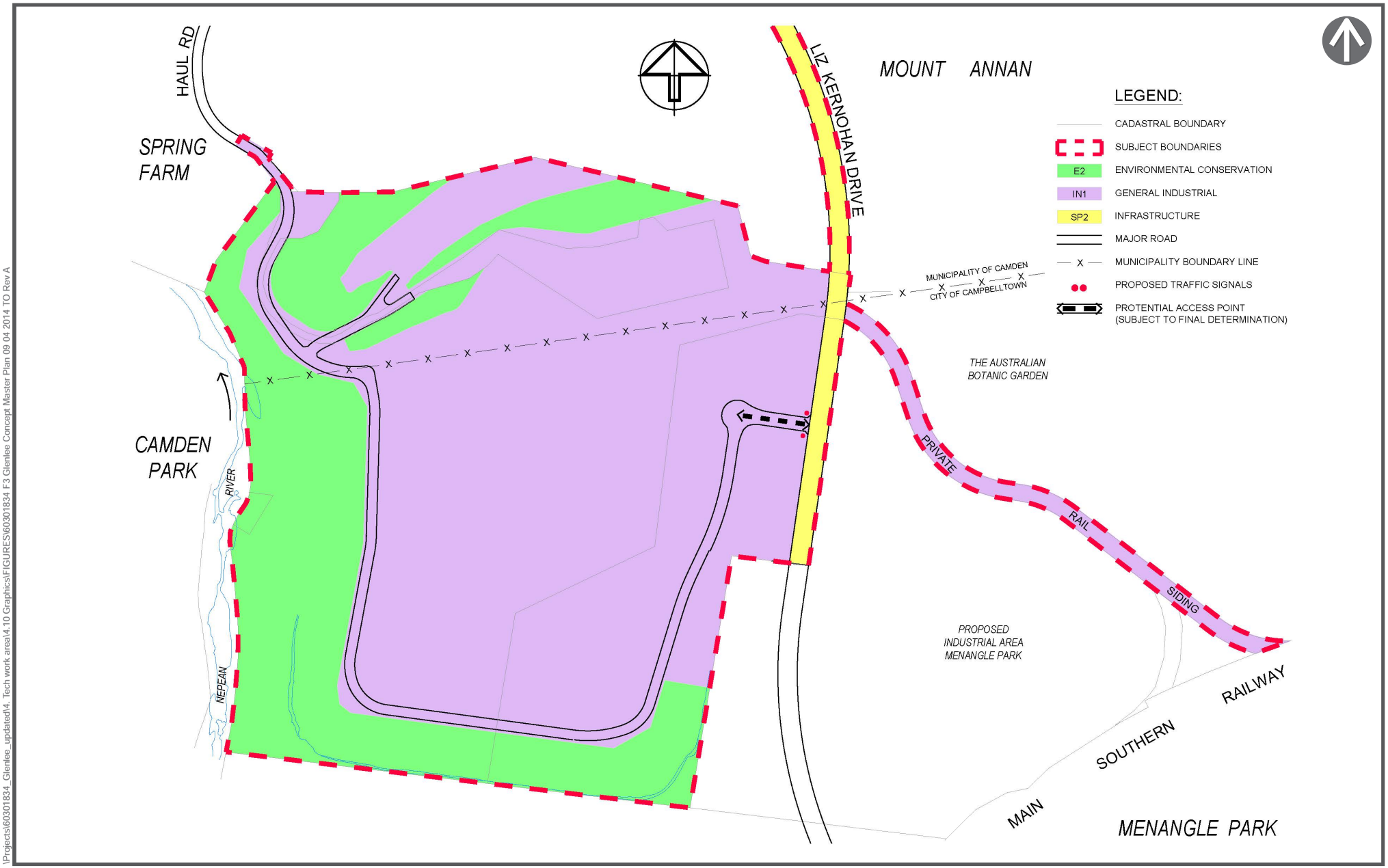
SITE LAYOUT AND SURROUNDING AREA

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 2



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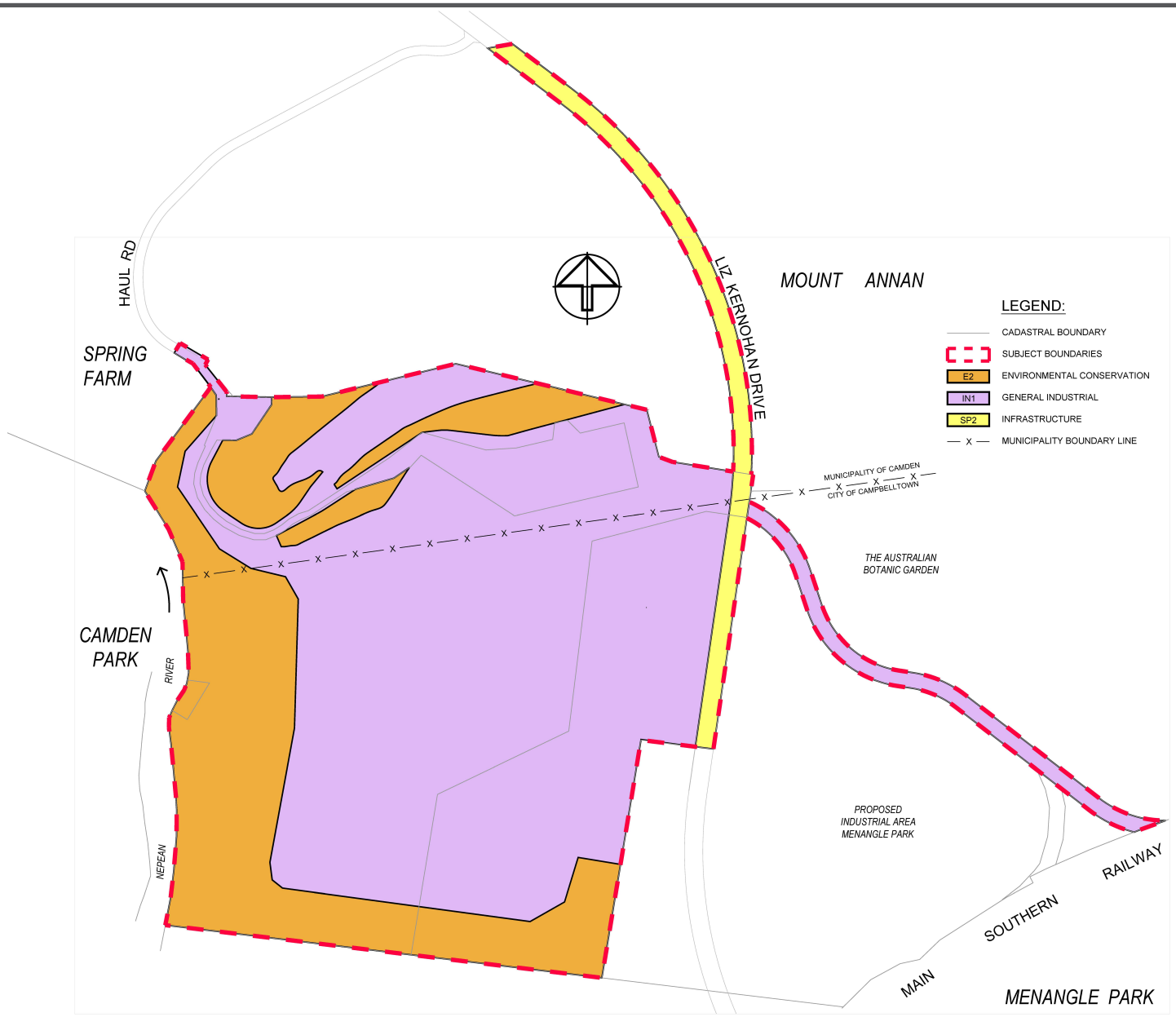
GLENLEE CONCEPT MASTER PLAN
Revised Remedial Strategy
Glenlee Road, Narellan, New South Wales

Source: Inspire Urban Design and Planning, 2014

FIGURE 3



AECOM

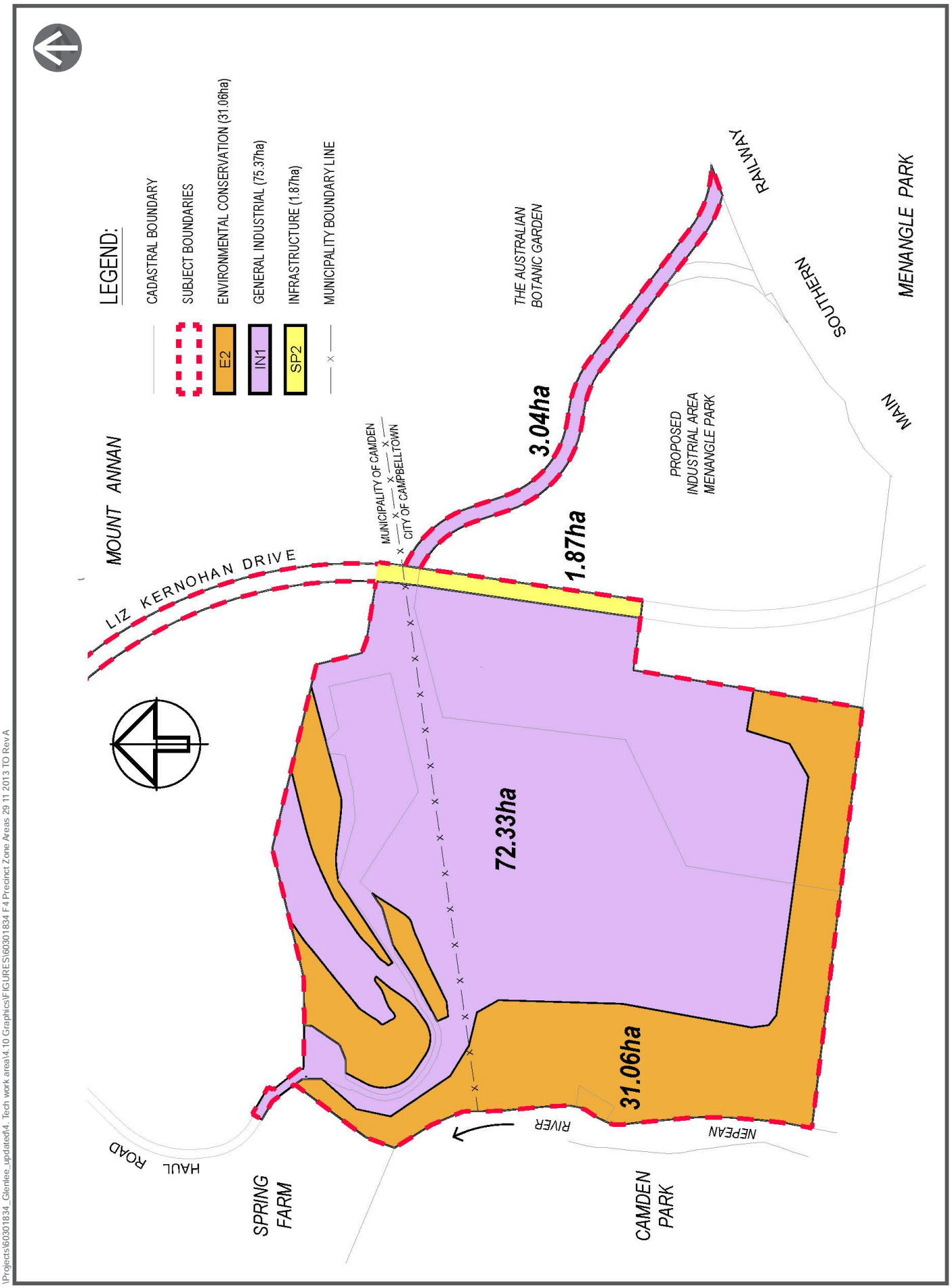
GLENLEE CONCEPT MASTER PLAN - PROPOSED ZONING

Revised Consolidated SAQP for Phase 2 Contamination Assessment
Glenlee Road, Narellan, New South Wales

Source: Inspire Urban Design and Planning, 2014

FIGURE 4

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F4 Glenlee Concept Proposed Zoning 26 02 2014 TO



\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F4 Precinct Zone Areas 29 11 2013 TO Rev A

AECOM

PRECINCT ZONE AREAS

Revised Consolidated Phase 1 Contamination Assessment
Glenlee Road, Narellan, New South Wales

FIGURE 5

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F6 PCA ABC Sada Tank Workshops and Truck Wash 02 04 2014 TO

AECOM

PCA A B C - SADA TANK WORKSHOPS AND TRUCK WASH

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 6

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F7 PCA E Former Transformer Area 04 04 2014 TO Rev A

AECOM

PCA E - FORMER TRANSFORMER AREA

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 7

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F8 PCA F and G Workshop Yard and CSM Tank 04 04 2014 TO Rev A

AECOM

PCA F AND G WORKSHOP YARD AND CSM TANK

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 8

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F9 PCA H TRN Workshops 02 04 2014 TO

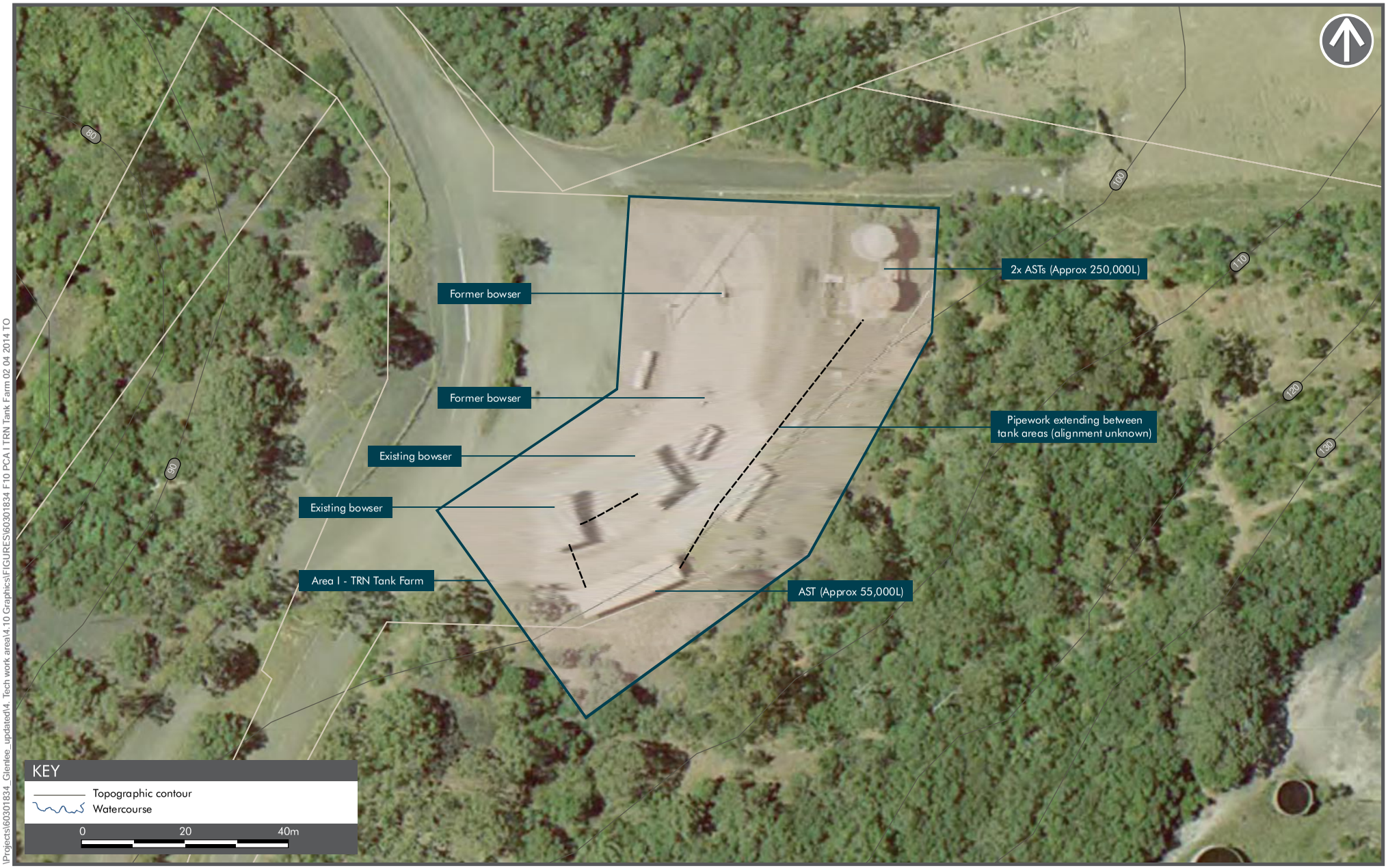
AECOM

PCA H - TRN WORKSHOPS

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 9



\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F10 PCA I TRN Tank Farm 02 04 2014 TO

AECOM

PCA I - TRN TANK FARM

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 10

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 PCA J Area J Raw Materials and Compost Storage 02 04 2014 TO

AECOM

PCA J - RAW MATERIALS AND COMPOST STORAGE

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 11

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F12 PCA S Plant Machinery Materials and AST Graveyard 12 12 2013 TO

AECOM

PCA S - PLANT MACHINERY MATERIAL AND AST GRAVEYARD

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 12

\Projects\60301834_Glenlee_updated\4. Tech work area\4.10 Graphics\FIGURES\60301834 F13 Area x Workshop and Diesel Refuelling Facility 02 04 2014 TO

AECOM

PCA P & Q - WORKSHOP AND DIESEL REFUELLING FACILITY

Revised Remedial Strategy

Glenlee Road, Narellan, New South Wales

FIGURE 13

Appendix B

Groundwater and Surface Water Remediation Criteria

Appendix B Groundwater and Surface Water Remediation Criteria

Substance		Groundwater Investigation Levels		
		Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
		(µg/L)	(µg/L)	(mg/L)
Metals and Metalloids				
Aluminium, Al pH>6.5		55	-	-
Antimony		-	-	0.003
Arsenic		24 as As(III) 13 as As(V)	-	0.01
Barium		-	-	2
Beryllium		-	-	0.06
Boron		370[C]	-	4
Cadmium	H	0.2	0.7[D]	0.002
Chromium, Cr (III)	H	-	27	-
Chromium, Cr (VI)		1[C]	4.4	0.05
Cobalt		-	1	-
Copper	H	1.4	1.3	2
Iron, (Total)		-	-	-
Lead	H	3.4	4.4	0.01
Manganese		1900[C]	-	0.5
Mercury (Total)		0.06[D]	0.1[D]	0.001
Molybdenum		-	-	0.05
Nickel	H	11	7	0.02
Selenium (Total)		5[D]	-	0.01
Silver		0.05	1.4	0.1
Tributyl tin (as Sn)		-	0.006[C]	-
Tributyl tin oxide		-	-	0.001
Uranium		-	-	0.017
Vanadium		-	100	-
Zinc	H	8[C]	15[C]	-
Non-metallic Inorganics				
Ammonia[E] (as NH_3-N at pH 8)		900[C]	910	-
Bromate		-	-	0.02
Chloride		-	-	-
Cyanide (as un-ionised Cn)		7	4	0.08
Fluoride		-	-	1.5
Hydrogen sulphide (un-ionised H_2S measured as S)		1	-	-
Iodide		-	-	0.5

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Nitrate (as NO_3)	refer to guideline	refer to guideline	50
Nitrite (as NO_2)	refer to guideline	refer to guideline	3
Nitrogen	refer to guideline	refer to guideline	-
Phosphorus	refer to guideline	refer to guideline	-
Sulphate (as SO_4)	-	-	500
Organic alchohols/other organics			
Ethanol	1400	-	-
Ethylenediamine tetra-acetic acid (EDTA)	-	-	0.25
Formaldehyde	-	-	0.5
Nitrilotriacetic acid	-	-	0.2
Anilines			
Aniline	8	-	-
2,4-Dichloroaniline	7	-	-
3,4-Dichloroaniline	3	150	-
Chlorinated Alkanes			
Dichloromethane	-	-	0.004
Trichloromethane (chloroform)	-	-	0.003
Trihalomethanes (total)	-	-	0.25
Tetrachloromethane (carbon tetrachloride)	-	-	0.003
1,2-Dichloroethane	-	-	0.003
1,1,2-Trichloroethane	6500	1900	-
Hexachloroethane	290[D]	-	-
Chlorinated Alkenes			
Chloroethene (vinyl chloride)	-	-	0.0003
1,1-Dichloroethene	-	-	0.03
1,2-Dichoroethene	-	-	0.06
Tetrachloroethene (PCE) (Perchloroethene)	-	-	0.05
Chlorinated Benzenes			
Chlorobenzene	-	-	0.3
1,2- Dichlorobenzene	160	-	1.5
1,3- Dichlorobenzene	260	-	-

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
1,4- Dichlorobenzene	60	-	0.04
1,2,3- Trichlorobenzene	3[D]	-	0.03 for individual or total trichlorobenzenes
1,2,4- Trichlorobenzene	85[D]	20[D]	
1,3,5-Trichlorobenzene	-	-	
Polychlorinated Biphenyls (PCBs)			
Aroclor 1242	0.3[D]	-	-
Aroclor 1254	0.01[D]	-	-
Other Chlorinated Compounds			
Epichlorohydrin	-	-	0.1
Hexachlorobutadiene	-	-	0.0007
Monochloramine	-	-	3
Monocyclic Aromatic Hydrocarbons			
Benzene	950	500[C]	0.001
Toluene	-	-	0.8
Ethylbenzene	-	-	0.3
Xylenes	350 (as o-xylene) 200 (as p-xylene)	-	0.6
Styrene (Vinyl benzene)	-	-	0.03
Polycyclic Aromatic Hydrocarbons (PAHs)			
Naphthalene	16	50[C]	-
Benzo[a]pyrene	-	-	0.00001
Phenols			
Phenol	320	400	-
2-Chlorophenol	340[C]	-	0.3
4-Chlorophenol	220	-	-
2,4-Dichlorophenol	120	-	0.2
2,4,6-Trichlorophenol	3[D]	-	0.02
2,3,4,6-Tetrachlorophenol	10[D]	-	-
Pentachlorophenol	3.6[D]	11[D]	0.01
2,4-Dinitrophenol	45	-	-
Phthalates			
Dimethylphthalate	3700	-	-
Diethylphthalate	1000	-	-
Dibutylphthalate	10[D]	-	-
Di(2-ethylhexyl) phthalate	-	-	0.01

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Pesticides			
Acephate	-	-	0.008
Aldicarb	-	-	0.004
Aldrin plus Dieldrin	-	-	0.0003
Ametryn	-	-	0.07
Amitraz	-	-	0.009
Amitrole	-	-	0.0009
Asulam	-	-	0.07
Atrazine	13	-	0.02
Azinphos-methyl	-	-	0.03
Benomyl	-	-	0.09
Bentazone	-	-	0.4
Bioresmethrin	-	-	0.1
Bromacil	-	-	0.4
Bromoxynil	-	-	0.01
Captan	-	-	0.4
Carbaryl	-	-	0.03
Carbendazim (Thiophanate-methyl)	-	-	0.09
Carbofuran	0.06	-	0.01
Carboxin	-	-	0.3
Carfentrazone-ethyl	-	-	0.1
Chlorantraniliprole	-	-	6
Chlordane	0.03[D]	-	0.002
Chlorfenvinphos	-	-	0.002
Chlorothalonil	-	-	0.05
Chlorpyrifos	0.01[D]	0.009[D]	0.01
Chlorsulfuron	-	-	0.2
Clopyralid	-	-	2
Cyfluthrin, Beta-cyfluthrin	-	-	0.05
Cypermethrin isomers	-	-	0.2
Cyprodinil	-	-	0.09
1,3-Dichloropropene	-	-	0.1
2,2-DPA	-	-	0.5
2,4-D [2,4-dichlorophenoxy acetic acid]	280	-	0.03
DDT	0.006[D]	-	0.009
Deltramethrin	-	-	0.04

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Diazinon	0.01	-	0.004
Dicamba	-	-	0.1
Dichloroprop	-	-	0.1
Dichlorvos	-	-	0.005
Dicofol	-	-	0.004
Diclofop-methyl	-	-	0.005
Dieldrin plus Aldrin	-	-	0.0003
Diflubenzuron	-	-	0.07
Dimethoate	0.15	-	0.007
Diquat	1.4	-	0.007
Disulfoton	-	-	0.004
Diuron	-	-	0.02
Endosulfan	0.03[D]	0.005[D]	0.02
Endothal	-	-	0.1
Endrin	0.01[D]	0.004[D]	-
EPTC	-	-	0.3
Esfenvalerate	-	-	0.03
Ethion	-	-	0.004
Ethoprophos	-	-	0.001
Etridiazole	-	-	0.1
Fenamiphos	-	-	0.0005
Fenarimol	-	-	0.04
Fenitrothion	0.2	-	0.007
Fenthion	-	-	0.007
Fenvalerate	-	-	0.06
Fipronil	-	-	0.0007
Flamprop-methyl	-	-	0.004
Fluometuron	-	-	0.07
Fluproponate	-	-	0.009
Glyphosate	370	-	1
Haloxyfop	-	-	0.001
Heptachlor	0.01[D]	-	-
Heptachlor epoxide	-	-	0.0003
Hexazinone	-	-	0.4
Imazapyr	-	-	9
Iprodione	-	-	0.1
Lindane (γ-HCH)	0.2	-	0.01

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Malathion	0.05	-	0.07
Mancozeb (as ETU, ethylene thiourea)	-	-	0.009
MCPA	-	-	0.04
Metaldehyde	-	-	0.02
Metham (as methylisothiocyanate, MITC)	-	-	0.001
Methidathion	-	-	0.006
Methiocarb	-	-	0.007
Methomyl	3.5		0.02
Methyl bromide	-	-	0.001
Metiram (as ETU, ethylene thiourea)	-	-	0.009
Metolachlor/s–Metolachlor	-	-	0.30
Metribuzin	-	-	0.07
Metsulfuron-methyl	-	-	0.04
Mevinphos	-	-	0.006
Molinate	3.4	-	0.004
Napropamide	-	-	0.4
Nicarbazin	-	-	1
Norflurazon	-	-	0.05
Omethoate	-	-	0.001
Oryzalin	-	-	0.4
Oxamyl	-	-	0.007
Paraquat	-	-	0.02
Parathion	0.004[C]	-	0.02
Parathion methyl	-	-	0.0007
Pebulate	-	-	0.03
Pendimethalin	-	-	0.4
Pentachlorophenol	-	-	0.01
Permethrin	-	-	0.2
Picloram	-	-	0.30
Piperonyl butoxide	-	-	0.6
Pirimicarb	-	-	0.007
Pirimiphos methyl	-	-	0.09
Polihexanide	-	-	0.7
Profenofos	-	-	0.0003

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Propachlor	-	-	0.07
Propanil	-	-	0.7
Propargite	-	-	0.007
Proparzine	-	-	0.05
Propiconazole	-	-	0.1
Propyzamide	-	-	0.07
Pyrasulfatole	-	-	0.04
Pyrazophos	-	-	0.02
Pyroxsulam	-	-	4
Quintozene	-	-	0.03
Simazine	3.2	-	0.02
Spirotetramat	-	-	0.2
Sulprofos	-	-	0.01
2,4,5-T	36	-	0.1
Tebuthiuron	2.2	-	-
Temephos	-	0.05[D]	0.4
Terbacil	-	-	0.2
Terbufos	-	-	0.0009
Terbuthylazine	-	-	0.01
Terbutryn	-	-	0.4
Thiobencarb	2.8	-	0.04
Thiometon	-	-	0.004
Thiram	0.01	-	0.007
Toltrazuril	-	-	0.004
Toxafene	0.1[D]	-	-
Triadimefon	-	-	0.09
Trichlorfon	-	-	0.007
Triclopyr	-	-	0.02
Trifluralin	2.6[D]	-	0.09
Vernolate	-	-	0.04
Surfactants			
Linear alkylbenzene sulfonates (LAS)	280	-	-
Alcohol ethoxylated sulfate (AES)	650	-	-
Alcohol ethoxylated surfactants (AE)	140	-	-

Appendix C

Soil Remediation Criteria

Appendix C Soil Remediation Criteria

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
Metals and Inorganics				
Arsenic[2]	100	500	300	3 000
Beryllium	60	90	90	500
Boron	4500	40 000	20 000	300 000
Cadmium	20	150	90	900
Chromium (VI)	100	500	300	3600
Cobalt	100	600	300	4000
Copper	6000	30 000	17 000	240 000
Lead[3]	300	1200	600	1 500
Manganese	3800	14 000	19 000	60 000
Mercury (inorganic)[5]	40	120	80	730
Methyl mercury[4]	10	30	13	180
Nickel	400	1200	1200	6 000
Selenium	200	1400	700	10 000
Zinc	7400	60 000	30 000	400 000
Cyanide (free)	250	300	240	1 500
Polycyclic Aromatic Hydrocarbons (PAHs)				
Carcinogenic PAHs (as BaP TEQ)[6]	3	4	3	40
Total PAHs[7]	300	400	300	4000
Phenols				
Phenol	3000	45 000	40 000	240 000
Pentachlorophenol	100	130	120	660
Cresols	400	4 700	4 000	25 000
Organochlorine Pesticides				
DDT+DDE+DDD	240	600	400	3600
Aldrin and dieldrin	6	10	10	45
Chlordane	50	90	70	530
Endosulfan	270	400	340	2000
Endrin	10	20	20	100
Heptachlor	6	10	10	50
HCB	10	15	10	80
Methoxychlor	300	500	400	2500
Mirex	10	20	20	100
Toxaphene	20	30	30	160
Herbicides				
2,4,5-T	600	900	800	5000
2,4-D	900	1600	1300	9000
MCPA	600	900	800	5000

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
MCPB	600	900	800	5000
Mecoprop	600	900	800	5000
Picloram	4500	6600	5700	35000
Other Pesticides				
Atrazine	320	470	400	2500
Chlorpyrifos	160	340	250	2000
Bifenthrin	600	840	730	4500
Other Organics				
PCBs[8]	1	1	1	7
PBDE Flame Retardants (Br1–Br9)	1	2	2	10

- HIL A - residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.
- HIL B - residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
- HIL C - public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate.
- HIL D - commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

Generic land uses are described in detail in Schedule B7 Section 3 of the *NEPM* (ASC NEPC, 1999).

Appendix D

Sediment Remediation Criteria

Appendix D Sediment Remediation Criteria

Contaminant	ANZECC (2000) ISQG-Low	ANZECC (2000) ISQG-high
Metals (mg/kg dry wt)		
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Zinc	200	410
Organics (ug/kg dry wt)[1]		
Acenapthene	16	500
Acenapthalene	44	640
Anthracene	85	1100
Flourene	19	540
Naphthalene	160	2100
Phenanthrene	240	1500
Low Molecular Weight PAHs	552	3160
Benzo(a)anthrancene	261	1600
Benzo(a)pyrene	430	1600
Dibenzo(a,h)anthracene	63	260
Chrysene	384	2800
Flouranthene	600	5100
Pyrene	665	2600
High Molecular Weight PAHs	1700	9600
Total PAHs	4000	45000
Total DDT	1.6	46
p.p'-DDE	2.2	27
o,p'-+p,p'-DDD	2	20
Chlordane	0.5	6
Dieldren	0.02	8
Endrin	0.02	8
Lindane	0.32	1
Total PCB	23	-

1. Normalised to 1% organic content