ENVIRONMENTAL CONSULTING SERVICES

REMEDIATION ACTION PLAN

Gladstone Street, 4 Terminal Place & 4A Terminal Place Merrylands NSW 2160

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TABLE OF CONTENTS

Tables

Figures

1.0 INTRODUCTION

Environmental Consulting Services Pty Ltd (ECS) was engaged by Merrylands (A) 88 Development Pty Ltd to prepare a Remediation Action Plan (RAP) of the property known as Gladstone Street, 4 Terminal Place & 4A Terminal Place in Merrylands (the Site). The location of the Site is presented in Figure 1.1 - Location Plan (Six Maps).

Figure 1.1 – Location Plan

The Site had been the subject of a detailed site investigation (DSI) with the findings presented in the report entitled:

- Detailed Environmental Site Investigation, Gladstone Street, 4 Terminal Place & 4A Terminal Place Merrylands NSW 2160 (ECS 18 January 2023).

This RAP has been prepared to formalise the remediation of the Site prior to the proposed development for residential purposes.

1.1 Objectives

The objectives of the RAP are to:

- Document the contamination status of the Site;
- Identify data gaps and establish required additional investigation activities;
- Set remediation goals so that impacted soils are appropriately managed;
- Specify the validation criteria for the Site and the validation sampling requirements;
- Assess the range of options available to manage soils excavated from the Site;
- Document the preferred remediation/management techniques and procedures; and
- Establish the various safeguards required to complete the work in a safe and environmentally acceptable manner.

1.2 Scope of Works

The scope of works to meet the objectives includes the following:

- Identify the remediation area;
- Collate and review existing data;
- Identify the contamination issues requiring remediation;
- Document the relevant guidelines;
- Set remediation goals;
- Evaluate the remediation options available;
- Outline the remediation strategy;
- Develop a health, safety and environmental plan; and
- Outline contingency and emergency response measures.

2.0 SITE IDENTIFICATION

2.1 Site Identification

The Site is located within multiple zoning boundaries and is primarily between a high-density residential and an enterprise corridor precinct of Merrylands. Additionally, to the north of the Site is Holroyd Gardens Park, which is zoned as public recreation space, and there is a railway track along the south-eastern boundary.

The location of the Site is presented in Figure 2.1 – Site Location Plan with the Site identification details summarised in Table 2.1 – Site Identification.

Figure 2.1 – Aerial Photograph

Table 2.1 – Site Identification

Attribute	Detail
Site Address	Gladstone Street, 4 & 4A Terminal Place, Merrylands NSW 2160
Lot & Deposited Plan	Lot 1 DP 229589, Lot 2 DP 1217412 & Lot 1 DP 1173048
Current Land Use	Vacant land adjoining a development site
Proposed Land Use	High Density Residential
Local Government Authority	Cumberland City Council
Current Zoning	RE1 – Public Recreation R4 – High Density Residential B6 – Enterprise Corridor
Site Area (m^2)	Approximately 16300
Geographical Location (approximate centre)	Latitude: -33.83515 Longitude: 150.993505

2.2 Site Description and Regional Setting

The Site is vacant cleared land with no permanent structures although there are some site sheds providing amenities to the development work being conducted on the neighbouring land. There however, some construction materials and equipment stored on the Site.

The Site is generally flat and is at an elevation of approximately 20m AHD (Australian Height Datum). The topography appears to follow the natural topography of the surrounding area although it is noted that the land surface in this location has been modified. There is an embankment along Neil Street leading to a bridge across the rail line to the east of the Site and there is a significant excavation for the residential development to the west of the Site.

2.3 Regional Geology and Hydrogeology

Regional geology of the area is shown on the Penrith Geological Map Sheet 1:100,000 (Sheet 9030 1st Edition 1991). The Site is located along the boundary of Ashfield Shale and Bringelly Shale of the Wianamatta Group. Bringelly shale is described as shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff. Ashfield shale is described as dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite.

The DSI included a review of the Cumberland Local Environment Plan (LEP) 2021 prepared by the Cumberland City Council which includes Acid Sulfate Soil (ASS) risk maps. The maps indicate a low likelihood of encountering ASS in the area. Additionally, The ASS risk maps prepared by the NSW Department of Planning, Industry and Environment do not extend over this area. There is a low likelihood for ASS to be encountered at the Site.

Groundwater beneath the Site is expected to occur within an unconfined aquifer within the weathered rock (or clay soils) at approximately 3m depth below ground surface. There may also be a discontinuous, perched water table within fill in the western section of the Site that is part of a former quarry which has been backfilled.

The nearest surface water body to the Site is A'Becketts Creek located approximately 50m to the north of the Site which appears to continue underground across the Site. A'Becketts Creek flows into Duck Creek, which connects to Duck River and ultimately discharges to the Parramatta River. Based on the topography and nearby surface water bodies, the expected direction of groundwater flow is to the north towards A'Becketts Creek and the Parramatta River.

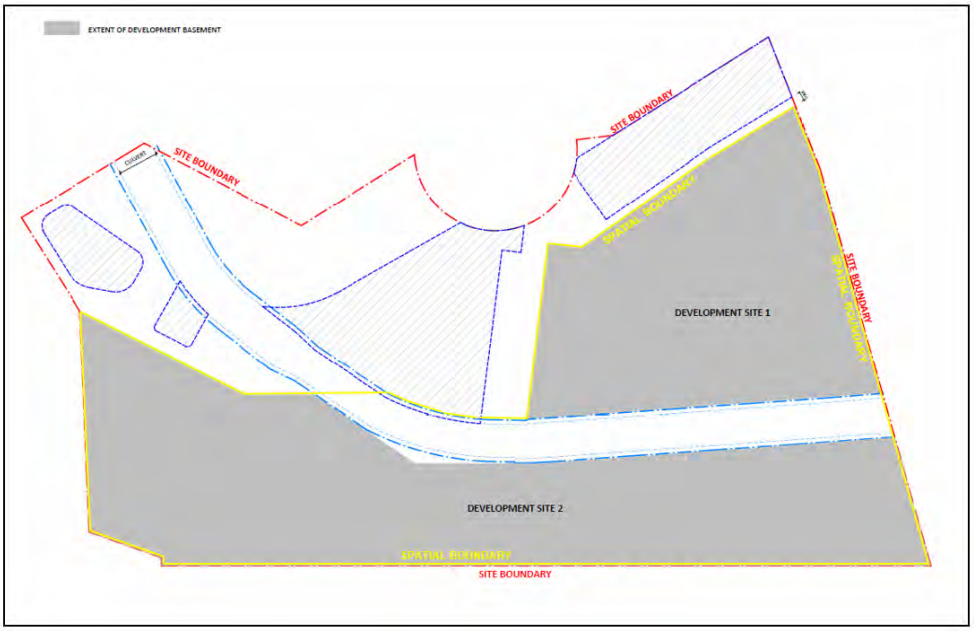
3.0 PREVIOUS INVESTIGATIONS

The Site is within a local precinct that is undergoing urban renewal through the demolition of redundant facilities and construction of new buildings. The results of the previous investigations are presented in the following reports:

- *Preliminary Environmental Site Investigation, 4 Gladstone Street & 4A Terminal Place Merrylands NSW 2160* (22 October 2022); and
- *Detailed Environmental Site Investigation, 4 Gladstone Street & 4A Terminal Place Merrylands NSW 2160* (18 January 2023).

The Site has a total area of approximately 16000m^2 although this RAP is for the development contained within an area of approximately 10700m^2. The section of the Site which is the subject to this RAP includes the areas described as Development Site 1 and Development Site 2 shown on Figure 3.1 – Spatial Boundaries. The area to the north of the two development sites is excluding from the RAP (and the proposed development) and will be developed as open space and subject to a separate Development Application.

Figure 3.1 – Spatial Boundaries



The findings of the Preliminary Site Investigation (PSI) and the Detailed Site Investigation (DSI) are summarised in the following sections.

3.1 Preliminary Site Investigation (PSI)

ECS completed a Preliminary Site Investigation (PSI) of the Site and presented to findings in the report entitled *Preliminary Environmental Site Investigation, 4 Gladstone Street & 4A Terminal Place Merrylands NSW 2160* (22 October 2022).

The objective of the environmental investigation was to evaluate the potential for contamination resulting from past Site activities and draw conclusion about the suitability of the Site for residential use.

The scope of work undertaken to meet this objective included:

- The review of selected background information including historical aerial photographs and certificates of title;
- The identification of potential contamination types and the development of a conceptual Site model (CSM);
- A Site inspection; and
- The preparation of a site assessment report.

The PSI noted that the Site appeared to have been part of a quarry (brick pit) prior to 1930. The quarry extended onto the Site across the north west boundary was backfilled between 1961 and 1965. There was also a creek across the Site (A'Becketts Creek) which was partly directed through a manmade culvert before 1943 and then completely piped (underground) by 1982.

Site developments appear to have included a flour mill on the southern boundary which was demolished prior to 2000.

Early Site ownership was by The Farmers Fertilizers Corporation Limited. Their use of the land has not been established but NSW EPA records (below) indicate the land to the north of the Site was used for stockfeed manufacturing which potentially indicates the activities undertaken by The Farmers Fertilizers Corporation Limited.

The title records show that the southern section (Lot) of the Site was owned by Donald Archibald McLeod (Flour Miller) and references to flour milling extended from 1925 to 1998.

The Site uses are considered to have been for commercial/industrial activities including brickmaking and flour milling. In addition, ownership by The Farmers Fertilizers Corporation Limited may indicate the storage or manufacture of fertilizer between 1914 and 1951 although no associated structure were observed on the Site.

The PSI concluded that there is a potential for significant or widespread contamination to be present associated with the historical Site activities.
Based on the history three potential Areas of Environmental Concern (AEC) are considered to be associated with the Site.

These AEC include; fill and natural soils in contact with the fill, groundwater impacted by fill material and groundwater impacted by off-site sources.

The PSI recommended that a Detailed Site Investigation is conducted that includes:

- Evaluation of the fill material in the section of the quarry on the Site;
- Evaluation of the fill material along the covered creek alignment;
- Evaluation of fill material across the Site surface and any stockpiles of excavated material remaining after development activities on the neighbouring land;
- Evaluation of groundwater conditions in and adjacent to the quarry, along the northern boundary and across the Site in general.

The findings of Detailed Site Investigation should be used to establish the suitability of the Site for the proposed development. Details of the development should be included in the Detailed Site Investigation.

3.2 Detailed Site Investigation (DSI)

ECS was engaged to undertake a DSI to evaluate for the presence of contamination based on the findings of the PSI. This DSI was intended to support a Development Application for the construction of multistorey residential tower buildings over basements that generally extend to 5 levels below ground although one area will extent to 6 levels down.

The following scope of work was conducted to meet this objective:

- The review of selected background information including the Preliminary Site Investigation report;
- The review of the potential contamination types and the conceptual Site model (CSM);
- The preparation of a Site Sampling Plan;
- A Site inspection and sampling; and
- The preparation of a site assessment report.

The DSI considered the potential Areas of Environmental Concern (AEC) and primary Contaminants of Potential Concern (CoPC) relevant to the Site which are summarised on Table 3.2 – Contaminants of Concern. Included in this table is an evaluation of the likelihood based on the Site history.

Table 3.1 – Contaminants of Concern

Areas of Environmental Concern	Contaminants of Concern	Impacted Medium	Likelihood
Uncontrolled backfilling – The former quarry has been filled and also the creek has been piped and the land above filled. There is also the potential for general surface filling undertaken to level the Site.	Heavy metals, TRH/BTEX, PAHs, OCPs, Asbestos	Soil and ground water	Medium to high
Hazardous building materials – Hazardous building material may be present as a result demolition of the building on the Site.	Asbestos, lead	Soil	Medium
Off-site impacts – The neighbouring facilities including the backfilled quarry and former stockfeed manufacturer, may have resulted in Site contamination.	Heavy metals, TRH/BTEX, PAHs, OCPs, Asbestos	Soil and ground water	Medium to high

Notes: TRH - Total Recoverable Hydrocarbons
BTEX - Benzene, Toluene, Ethyl-benzene and Xylenes (BTEX)
PAH - Polycyclic Aromatic Hydrocarbons (PAH)
OCP – Organochlorine Pesticides

The Site inspection undertaken during the DSI noted that:

- The surface of the study area generally appeared to be disturbed natural clays but with some concrete waste (gravel) and some fragments of timber.
- There was no distinctly visible evidence of the alignment of the culver that crosses the Site or the former quarry that encroaches onto the Site. Potential Asbestos Containing Material was not observed during the Site inspection or sampling activities.
- There was no evidence of underground storage tanks (USTs) on the Site (and none were expected based on the former land uses).

The intrusive investigation undertaken included excavation of 12 shallow test pits with the collection of soil samples and the sampling of three groundwater monitoring wells. The DSI indicated:

- The results of the soil analysis indicate concentrations of hydrocarbons below the site assessment criteria (SAC) for residential (with minimal opportunity for soil access) land use except for asbestos which was encountered at three locations.
- The low levels of petroleum hydrocarbon impacts were encountered in the groundwater samples collected from wells installed into the former quarry. These levels were not considered to represent a potential human health risk associated with the proposed development.
- Concentrations of chromium and zinc were also detected in the groundwater at levels above the SAC relevant to the protection of freshwater ecosystem. This impact was considered likely to be related to regional conditions including the former quarry to the north west of the Site.
- Concentrations of some metals were also above drinking water criteria. However, it is not considered likely the groundwater will be extracted for consumption at this location. The heavy metal concentrations encountered are not considered a potential human health risk at this location or an environmental risk at the Site.

Based on the Site investigation and sampling conducted, ECS considered the Site would be suitable for the proposed residential redevelopment provided the following recommendations are followed:

- Preparation of a Remediation Action Plan (RAP) to document the required works associated with the excavation and removal of fill material potentially impacted by asbestos. The RAP must also specify the required validation testing. The RAP should be prepared by an experienced contaminated land consultant in accordance with the NSW EPA (2020) Guidelines.
- Additional investigation should be undertaken along the culvert that crosses the Site to assess for asbestos. This can be included as a data gap assessment in the RAP. The results of this additional investigation may require the remediation of surface soils along this strip of land. The additional investigation scope can be included in the RAP; and
- All waste material should be classified in accordance with the NSW EPA Waste Classification Guidelines and disposed of to an appropriate and licenced facility in accordance with the POEO Act.

4.0 SITE CHARACTERISATION

Following the completion of the DSI the potential Areas of Environmental Concern (AEC) and primary Contaminants of Potential Concern (CoPC) considered relevant to the Site are summarised on Table 4.1 – Updated Conceptual Site Model (CSM).

Table 4.1 – Updated Conceptual Site Model

Areas of Environmental Concern	Contaminants of Concern	Impacted Medium	Likelihood
Uncontrolled backfilling – The DSI identified asbestos impact at 3 locations in surface fill material.	Asbestos	Soil	Medium to high

4.1 Mechanism for Contamination and Contaminated Media

The primary mechanisms for contamination are considered to be:

- 'top-down' impacts associated with surface filling across the Site or from demolition of former structures on the Site; and
- potentially sub-surface impacts from the leaching of contaminants in groundwater from backfill in the adjoining backfilled quarry. However, groundwater sampling undertaken during the DSI included groundwater sampling from wells installed into the quarry. This sampling did not encounter contamination considered to represent a potential human health risk associated with the proposed development.

The potential contaminated media identified at the Site are fill and groundwater.

4.2 Contaminant Receptors

The primary receptors of potential contamination are considered to be construction and demolition workers involved in the proposed development. Future occupants of the Site are not considered potential receptors to soils as the Site will be paved with concrete. However, there is the potential for vapour intrusion into the building. The human health receptors are:

- R1 – Construction and maintenance workers;
- R2 – End users (residential); and
- R3 – Adjacent users (residential).

The potential for ecological impacts are considered relatively low as the proposed development will result in the Site being covered with built structures and or pavements and the only identified contaminant is asbestos.

4.3 Potential Exposure Pathways

Potential exposure pathways relevant to human receptors during the development are identified as inhalation of dust. Future occupants and adjacent occupants may be exposed to contaminants during development of the Site or from residual fill material retained on the Site.

Environmental pathways are considered to be the movement of surface water on the Site and groundwater during development.

It is noted that there is a relatively high likelihood that during development, workers could be exposed to contamination (if it is present) and that as such, exposure would need to be managed during the development process.

The potential exposure pathways are:

- P1 – Ingestion and dermal contact;
- P2 – Inhalation of dust and/or vapours; and
- P3 – Surface water run-off.

A 'source–pathway–receptor' approach has been used to assess the potential risks of harm being caused to human, water or environmental receptors from potential contamination sources on or in the vicinity of the Site, via exposure pathways (complete pathways). The possible pathways between the above potential sources (AEC) and receptors (R1 to R3) are provided in Table 4.2 – Exposure Evaluation.

Table 4.2 – Source Pathway Exposure Evaluation

ACE	Pathway	Receptor	Comments
Fill	P1 – Ingestion and dermal contact	R1 – Construction and maintenance workers; R2 – End users (residential); and R3 – Adjacent users.	There is a potentially complete source/pathway/receptor link for construction workers and a potentially complete pathway to end users if fill is retained on Site. Given the depth to groundwater and the use of reticulated water, the pathway to site users from groundwater is considered incomplete.
	P2 – Inhalation of dust and/or vapours	R1 – Construction and maintenance workers; R2 – End users (residential); and R3 – Adjacent users.	There is a potentially complete source/pathway/receptor link for construction workers and a potentially complete pathway to end users if fill is retained on Site.
	P3 – Surface water run-off	R1 – Construction and maintenance workers;	There is a potentially complete source/pathway/receptor link during construction work.

5.0 ASSESSMENT GUIDELINE AND CRITERIA

5.1 Relevant Guidelines

The framework upon which the Site contamination status will be assessed is based on guidelines, “made or approved”, by the NSW EPA under Section 105 of the *Contaminated Land Management Act 1997*, including but not limited to the following:

- Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) – Guidelines for Fresh and Marine Waters.
- National Environmental Protection Council (NEPC) (2013) – National Environmental Protection (Assessment of Site Contamination) Measure.
- NSW EPA (2022) Sampling Design Guidelines.
- NSW EPA (2011) Guidelines for Consultants Reporting on Contaminated Sites.
- NSW EPA Site Auditor Scheme (2017, 3rd Edition).
- NSW EPA Waste Classification Guidelines, Part 1: Classifying Waste (2014).

5.2 Soil Assessment Criteria

The NSW Environment Protection Authority (EPA) has issued a number of guidelines relevant to the concentration of contaminants in soil. These are used in conjunction with the National Environment Protection Council (NEPC) – National Environment Protection (Assessment of Site Contamination) Measure 2013.

The Site Assessment Criteria (SAC) that have been used to evaluate surface soils are based on the National Environment Protection Measure (NEPM) for the Assessment of Site Contamination (NEPM 2013). These criteria are not derived as acceptance criteria for contamination at a site, but as levels above which specific consideration of risk, based on the site use and potential exposure, is required. If a risk is determined present, then remediation and/or management must be undertaken.

The National Environmental Protection Measure (NEPM) provides Health Investigation Levels (HILs) that are concentration levels, which have been tiered (provided in sets based on risk)

for various exposure settings pertaining to land uses. The site criteria within the NEPM are based on potential impact to human health and are intentionally conservative.

The HILs have been derived for four (4) generic land use settings. The HILs for the land use type considered in NEPM include:

- HIL A – residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, (no poultry), also includes children's day care 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 flats
- HIL C – public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate.
- HIL D – commercial/industrial such as shops, offices, factories and industrial sites.

Health Screening Levels (HSLs) for various petroleum hydrocarbon compounds have also been developed. The HSLs also relate to the land use (consistent with the HILs) and are dependent on soil type and depth.

Ecological investigation levels (EILs) are not considered necessary at the Site as the development will result in the almost the total area being paved with concrete. However, measures to mitigate ecological risks during development need to be implemented.

The Site has the potential to be redeveloped for residential purposes with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats. The suitable guidelines used for this proposed land use are residential guidelines (HIL B levels). Consistent with the HILs, HSLs for residential land use (HSL A/B) with clay soils have been adopted for the relevant SAC. These criteria are summarised on Table 5.1 – Site Assessment Criteria.

It is noted that the only contaminant identified at the Site is asbestos. However, the SAC for a range of contaminants is included for use if unexpected conditions are encountered.

Table 5.1 – Soil Assessment Criteria

Contaminant	Site Assessment Criteria (mg/kg)
Heavy Metals	
Arsenic	500[1]
Cadmium	150[1]
Chromium (VI)	500[1]
Copper	30000[1]
Lead	1200[1]
Mercury	120[1]
Nickel	1200[1]
Zinc	60000[1]
Total Recoverable Hydrocarbons (TRH)	
Naphthalene	5[2]
TRH C6-C10 (F1)	50[2]
TRH C10-C16 (F2)	280[2]
Monocyclic Aromatic Hydrocarbons	
Benzene	0.7[2]
Toluene	480[2]
Ethylbenzene	NL[2]
Xylene (Total)	110[2]
Polycyclic Aromatic Hydrocarbons (PAH)	
Benzo(a)pyrene	4[3]
Total PAH	40[3]
Asbestos	
Bonded ACM	0.04%
Friable asbestos (& asbestos fines)	0.001%

Notes: NL – Not Limiting
1. HIL B levels sensitive land use.
2. Health screening levels HSL A/B for clayey soils over the depth interval 0-1m.
3. Carcinogenic PAHs based on the 8 carcinogenic PAHs.
4. Health screening levels for bonded ACM of residential land use.

5.3 Groundwater Assessment Criteria

Groundwater contamination requiring remediation has not been identified at this Site. However, the assessment of groundwater encountered during development and for dewatering purposes should be undertaken.

The NSW EPA Guidelines for the Assessment and Management of Groundwater Contamination (NSW DEC 2007) describes the process to identify environmental values which must be considered in groundwater investigations at contaminated sites. Based on these guidelines, assessment of relevant environmental values requires that the consultant assess whether it is a major drinking water aquifer; assess the uses of the aquifer and identify if it is a suitable drinking water source.

The Australian and New Zealand Guidelines for the Protection of Aquatic Organisms have trigger values for 95% Protection of Species in freshwater ecosystem and these are considered applicable to assess groundwater at the Site. In addition, the ASC NEPM (2013) has HSL for vapour intrusion of petroleum hydrocarbon contaminants in groundwater.

There are also establish drinking water guidelines that can be used to assess water quality (Australian Drinking Water Guidelines NHMRC 2011). Groundwater is not currently being extracted for domestic consumption, however, the criterial are considered relevant as a potential measure of water quality. These criteria are summarised on Table 5.2 – Groundwater Criteria.

Table 5.2 – Groundwater Assessment Criteria

Contaminant	Site Assessment Criteria (µg/l)		
	ANZG[1]	ASC NEPM[2]	Drinking[3]
Monocyclic Aromatic Hydrocarbons			
Benzene	950	5000	1
Toluene	--	NL	800
Ethylbenzene	--	NL	600
Xylene	200[4]/350[5]	NL	300
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	16	NL	--
TRH F1	--	6000	--
TRH F2	--	NL	--
Heavy Metals			
Arsenic	13	--	10
Cadmium	0.2	--	2
Chromium (VI)	1	--	50
Copper	1.4	--	2000
Lead	3.4	--	10
Mercury	0.6	--	1
Nickel	11	--	2
Zinc	8	--	--
Polycyclic Aromatic Hydrocarbons			
Benzo(a)pyrene	--	--	0.01
Total PAH	--	--	--
Volatile Organic Chlorinated Compounds			
Tetrachloroethene (PCE)	--	--	50

Notes: NL – Not Limiting
1. Australian and New Zealand Guidelines for the Protection of freshwater organisms (2018).
2. ASC NEPM 2013 guidelines for vapour intrusion groundwater at 2m to 4m depth in sands.
3. Investigation levels are health values of the Australian Drinking Water Guidelines (NHMRC 2011).
4. P-xylene only. Criteria for total xylenes have not been provided
5. O-xylene only. Criteria for total xylenes have not been provided

5.4 Waste Classification Guidelines

It is expected that during the development and remedial process at the Site, excess soils will require off-site disposal to an appropriately licensed facility. As such, waste classification sampling of materials requiring off-site disposal will need to be undertaken.

Tables 1 and 2 of the NSW EPA "*Waste Classification Guidelines – Part 1: Classifying Waste*", 2014, provide criteria for assessing the appropriate waste classification and subsequent disposal location for contaminated soil requiring off-site disposal.

6.0 DATA GAP INVESTIGATIONS

The DSI has identified that fill material is potentially contaminated with asbestos. The data gaps at this Site associated with the proposed development included:

- The potential for asbestos impact in any residual fill retained above the culvert through which A'Becketts Creek flows. If the proposed development does not remove all fill from above of adjacent to the culvert additional assessment for asbestos is required.

The assessment of residual fill should include the collection of samples from above or beside the culvert at 20m spacing with analysis for asbestos.

7.0 REMEDIATION GOALS

7.1 Remediation Goals

The remediation goal is to render the Site suitable for the proposed development. This will need to include remediating the contamination fill from across the Site. The remediation will require soil sampling activities to characterise the fill and validation sampling to ensure remediation has been completed.

7.2 Extent of Remediation

At this stage soil remediation is anticipated to be limited to fill material that will be excavated during development.

Regional groundwater has been characterised at the Site and is not expected to be significant contaminated. Should a significant potential source of contamination (such as a UST with evidence of leakage) be encountered then further groundwater assessment will be required.

8.0 ASSESSMENT OF REMEDIATION OPTIONS

With regard to site remediation, the NSW EPA endorses the policy of the Australian and New Zealand Environment and Conservation Council (ANZECC) and National Health and Medical Research Council (NHMRC) – as published in the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, (ANZECC, 1992).

These guidelines present the following preferred options for site remediation and management (in descending order):

- On-site treatment of contamination – so that the contaminant(s) are either destroyed or the associated hazard is reduced to an acceptable level;
- Off-site treatment of contamination - so that the contaminant(s) are either destroyed or the associated hazard is reduced to an acceptable level, after which the formerly contaminated material is returned to the site.

If these options cannot be implemented, then the other options that should be considered include:

- Removal of contaminated material to an approved site or facility (such as a landfill), followed, where necessary by the reinstatement of formed excavations using clean fill;
- Consolidation and isolation of the contaminated material on-site by containing the contaminated material within a properly designed barrier.

8.1 Remediation Options

To order to establish the optimal remediation strategy for the Site, an assessment of the various remediation options hierarchy endorsed by NSW EPA, has been conducted. It is noted that at this stage contamination has not been identified at the Site although there is a potential for impacts to be located under the buildings and pavements on the Site.

The proposed development will require the excavation for the construction of basements. The need to removal surface soils will result in the removal of almost all the fill at the Site.

An appraisal of remediation methodologies considering the hierarchy of approach, technical feasibility, cost, time and site-specific requirements are presented in Table 8.1.

Table 8.1 - Evaluation of Remediation Options

Remediation Option	On-site treatment of soils	On-site containment of soil	Off-site disposal of soil
Hierarchy	Primary preference based on the hierarchy	Secondary preference based on the hierarchy	Secondary preference based on the hierarchy
Technical Feasibility	This is not considered feasible based on the expected potential contaminants.	It is technically feasibly to develop the Site incorporating a containment cell below the basement. This will require over-excavation which will introduce significant engineering issues to be managed.	Reliable. This approach removes the contaminated material from the Site and it is acknowledged that the excavation of fill material is required for the development to proceed.
Cost	Not feasible	High	Moderate to high
Time	Not feasible	Moderate	Moderate to Fast
Site Requirements	Not feasible	Containment under the Site, above the water table is not considered practicable	No site requirements if there is no contamination. Petroleum hydrocarbon impacted soils may require management prior to off site disposal
On-going Liability	Not feasible	On-going monitoring likely to be required to ensure no long-term issues arise	No on-going liability

At this stage regional groundwater underlying the Site is not considered to be significantly impacted from Site activities. Based on the understanding that primary source of contamination is likely to be the backfilled quarry on the adjoining land to the west, it is considered unlikely that active groundwater remediation will be needed. However, in the event that groundwater underlying the Site is found to be significantly impacted then this will be subject to remediation.

If required, the groundwater remediation goal would be to ensure that impacted groundwater sourced from the Site does not present an unaccepted risk to human health or the environment.

Groundwater remediation options include:

- Vapour extraction;
- Groundwater extraction;
- Total fluids (vapour and liquid) extraction; or
- Monitored natural attenuation.

The preferred groundwater remediation option would be dependent on the results of additional assessment.

8.2 Preferred Remedial Option for Soil

An evaluation of the available remedial options to address the soil contamination issues and also considering the Site constraints and the development proposal has been completed.

The excavation of soil for the development, while being the least preferred option for remediation, is the proposed remediation approach. The proposed development will require some excavation of the soils. As there is limited re-use capacity for the fill on Site, disposal off site is considered the most feasible remediation option.

9.0 REMEDIAL STRATEGY

The information presented in this section presents the remediation strategy and the procedures to be implemented in order to meet the stated objectives.

9.1 Staging of Works

Remediation and validation works are to be conducted in a logical, staged manner involving the steps identified in the bullet points that follow:

1. Site establishment of contractor for excavation of soils;
2. Additional assessment and observation of the Site surface and sampling of fill material that will not be excavated and removed during the development from over the culvert;
3. Delineation of potential “hot spots” based on the results of the additional assessments;
4. Hot spot management through excavation and off-site disposal;
5. Classification of fill material either in situ or from stockpiles and then off-site disposal in accordance with the NSW EPA Waste classification guidelines and current Waste regulations;
6. Waste classification of the natural soil following the removal of fill material. This will involve observations and some validation sampling;
7. Classification of the natural soils at the site and then excavation to the basement depth with the off-site disposal in accordance with the classification and current regulations. It is noted that suitable excavation support such as piles will need to be installed to facilitate the bulk excavation activities;
8. Investigation of groundwater quality if water is encountered or significant potential contamination sources are identified;
9. Demobilisation of plant and machinery; and
10. Reporting

It is noted that the exportation of waste (including fill or soil) from the Site must be in accordance with the provisions of the Protection of the Environment Operations Act 1997.

10.0 VALIDATION PROGRAM

10.1 Data Quality Objectives

The purpose of establishing Data Quality Objectives (DQO) is to ensure that the validation sampling and subsequent laboratory analyses are undertaken in a way that enables the collection and reporting of usable and representative data on which to base conclusions.

The process for establishing DQO for a site as defined by the US EPA has been adopted by the NSW EPA in the Guideline for the NSW Site Auditor Scheme.

The DQO process, involves the following seven steps:

1. State the problem;
2. Identify the decision;
3. Identify inputs to the decision;
4. Define the study boundaries;
5. Develop a decision rule;
6. Specify limits on decision errors; and
7. Optimise the design for obtaining data.

The DQO objectives defined above have been addressed as follows.

State the problem

The Site has asbestos impacted fill across the surface. Site development will include excavation of fill and natural soils. The Remediation Goal is to ensure the levels of CoPC do not pose an unacceptable risk to human health or the environment and that the Site is suitable for the proposed use (residential).

The purpose of this RAP is to provide a remediation and validation strategy to address the soils and groundwater potentially contaminated and to further evaluate for impact of any fill proposed to be retained on the Site.

Identify the decision

The remediation strategy to address the potentially contaminate soil is outlined in Section 9. It is noted however, that this strategy may change based on the findings of additional assessment that could include a groundwater investigation.

The primary soil validation criteria for remediation works will be the HIL/HSL(B) guidelines for residential land use with minimal opportunities for soil access.

In order to make the Site suitable (from a contamination perspective) for the proposed residential use, sufficient data is required for sound statistical analysis in order to appropriately characterise and validate impacts identified.

The principal study question is:

"Following remediation, is the site suitable for its proposed land use and how will any contamination remaining in-situ, be managed in the future?"

Inputs to the decision

Observations of the Site surface following the removal of fill material and additional assessment required for closing the identified potential data gap. Following the results of the additional assessment the decision making process will be:

- Has the additional assessment closed the data gaps?
- Has the fill material been removed from across the development area?

The validation program must be developed to provide sufficient information to allow a sound scientific and statistical evaluation of the principal study question set out in Step 2.

Inputs into the validation decision making process include:

- Has the fill and natural soil been waste classified and disposal with landfill dockets provided?
- Have enough validation samples been collected from the surface of the natural soils to conclude the fill has been successfully removed?
- Is the data set adequate to perform statistical analysis (i.e. calculate an occurrence rate);
- Have occurrences and concentrations exceeding the adopted criteria been observed during the investigation?
- If occurrences concentrations exceeding adopted criteria have been reported, have these areas been further remediated or otherwise managed?

Boundaries of the study

The lateral boundaries of the Site are depicted on Figure 3.1. The vertical boundary is potentially the depth to the base of the section of quarry that encroaches onto the Site (which is expected to be up to 12m).

Analytical Approach

If any potential AEC including impacted soil or unexpected finds are located then further evaluation is required. This additional evaluation must include soil sampling but may also include groundwater assessment.

Project analytical data must be compared to NSW EPA approved guidelines (listed in section 5.1) and including the assessment criteria defined in Section 5.2 and 5.3.

A summary of the Site decision rule (validation criteria) for the contamination issues is presented in Table 10.1.

Table 10.1 - Summary of Site Decision Rules

Issue	Decision Rule
Contamination is located in soil and beneath the existing fill or over the culvert.	Soils will be remediated to the anticipated maximum depth of developoment via excavation. The proposed depth of remediation is expected to reduce health risks associated with contaminants to an acceptable level. However, the depth of remediation is subject to ongoing sampling. Validation samples will be collected from the floor of the excavation after the removal of fill material compliance with the specified assessment criteria and assessment of the natural material for off-site disposal. Groundwater sampling will also be undertaken when water is encountered or where significant contamination is suspected.

Specify Performance or Acceptance Criteria

The DQOs for sampling techniques and laboratory analysis of collected soil samples defines the acceptable level of error required for this investigation. The data quality objectives will be assessed by reference to data quality indicators as follows:

- Data Representativeness - expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples in an appropriate pattern across

the Site area, and by using an adequate number of sample locations to characterise the Site. Consistent and repeatable sampling techniques and methods are utilised throughout the sampling.

- Completeness - defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study. If there is insufficient valid data, then additional data are required to be collected.
- Comparability - is a qualitative parameter expressing the confidence with which one data set can be compared with another data set. This is achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- Precision - measures the reproducibility of measurements under a given set of conditions. The precision of the data is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples. Duplicates will be assessed by calculating the Relative Percentage Difference (RPD) between the primary and duplicate samples. The proposed acceptable range for Relative Percent Difference (RPD) for duplicate samples have been set as follows:

  %RPD Range result >10 times PQL then maximum RPD 50%
  result >5 times PQL then maximum RPD 75%
  result >2 times PQL then maximum RPD 100%
  result <2 times PQL then no limit on the RPD.

Accuracy - measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards. Accuracy of field works is assessed by examining the level of contamination detected in equipment blanks.

Optimising the design for obtaining data

Remediation and validation works will be undertaken in accordance with NSW EPA guidelines and accepted industry standards.

Table 10.2 presents the recommended minimum sampling requirements.

Table 10.2 – Recommended Minimum Sampling

Area of concern (location)	Indicative no. of samples/locations	Action
1. Surface of the natural clay following excavation of fill	Minimum 25 samples collected in a methodical grid	Samples between 0–200 mm into natural clay soil. Samples to be tested for Asbestos, TRH, BTEX, PAH and heavy metals
4. Groundwater	Ponded water in the excavation and for each re-occurrence of ponded water.	Collect one sample from within the excavation. Samples to be tested for TRH, BTEX, PAH and heavy metals

10.2 Field Quality Control

The following quality procedures will be implemented during validation of the Site:

- Collection of samples by a suitably qualified and experienced contaminated land consultant using industry accepted standards for soil and groundwater sample collection;
- Collection of quality control samples duplicates (blind and split duplicate samples) at a ratio of one in twenty primary samples;
- Trip spike and trip blank for BTEX and TRH F1 carried into the field when sampling for volatile contaminants;
- Use of rinsate blanks where sampling equipment is used and the sampling was for contaminants other than asbestos;
- Placement of samples on ice for transport to the contract laboratory under standard chain of custody documentation but excluding asbestos samples which do not need refrigeration;
- Use of unique sampling identification and standardised field sampling forms; and
- Documenting field calibration for instruments used/required (eg PID).

10.3 Validation Sampling Procedures

Validation samples will be collected to assess the success of the remediation.

Soil samples will be collected using either a trowel or a gloved hand were possible and via an excavator bucket from excavation greater than 1m deep. The trowel will be decontaminated using potable water between each sampling location and air dried between each sample. A clean pair of disposable gloves will be used for each sampling location.

Soil samples will be collected into laboratory prepared sample containers and be clearly labelled with a sample number. The sample containers will be transferred to an ice filled cooler for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form will be completed and forwarded with the samples to the testing laboratory.

Following validation, the excavation will be measured to confirm the volume of excavated material.

11.0 SITE MANAGEMENT PLAN

The following section presents the management controls that should be implemented during remediation works. During remedial works the principal contractor will be responsible for all miscellaneous Site management issues, including (but not necessarily limited to):

- Site access and security (including installation of a security fence);
- Traffic control;
- Hours of operation;
- Noise control; and
- Erosion and sediment control

Management must be in accordance with the development consent and also the aspects presented in the following sub-sections.

11.1 Site Access and Security

The contractor will be responsible for ensuring the security of all work areas, plus all plant and equipment maintained on-site during remediation works. Appropriate signage should be maintained around all open excavations at all times and the contractor will be responsible for ensuring all persons on-site are authorised personnel (i.e. persons not employed by the contractor, the consultant, or their agents will not be permitted on-site unless authorised by the contractor and / or consultant).

11.2 Traffic Control

The contractor will be responsible for ensuring adequate traffic control measures are in place to ensure Site safety.

Plant and equipment needed to and remediate the Site must be contained on the Site. Access to and from the Site will be limited to the driveways along the eastern and southern boundaries of the Site.

The loading of vehicles for the removal of waste must be undertaken on the Site. In addition, open excavations resulting from remediation must be clearly marked (including safety fencing and appropriate signage).

11.3 Hours of Operation

In accordance with Council requirements, remediation works will only be permitted during the following hours:

- Monday to Friday: 7:00 am to 6:00 pm and on Saturdays from 7:00 am to 1:00 pm. No work must be carried out on Sundays and Public Holidays

11.4 Noise Control

Remedial works are anticipated to be limited to excavation or soil and transport of material off Site. Remediation should only be undertaken during the specified working hours using plant and machinery that meets original design specification.

11.5 Erosion and Sediment Control

To minimise the potential for sediment to be transported off Site silt control is required to be established at the excavation area. The silt control must include measures to inhibit the erosion of sediment during rain (such as silt curtains or sandbag).

All stockpiled excavated material must have silt control measures established to prohibit the erosion of sediment during rainfall. In addition, all vehicles shall be loaded on the existing concrete driveway to stop the tracking of sediment off-site.

12.0 OCCUPATIONAL HEALTH & SAFETY

This section describes the minimum standards to be adopted to protect the health and safety of all persons associated with the remediation works. The information herein should be used by the remediation contractor in conjunction with its own safe work method statements, occupational health and safety plans or other relevant documents, taking into account activities (e.g., hot works or electrical) that are not discussed.

12.1 Occupational Health & Safety Plan (OHSP)

An OHSP is an essential part of all remediation projects to ensure the health and safety of all personnel working on or visiting the Site. A detailed OHSP shall be prepared by the remedial contractor prior to the commencement of any Site activity.

The purpose of the OHSP is to provide all relevant health and safety information for all personnel undertaking work at the site and to provide and maintain safety standards and practices which offer the highest practical degree of personal protection to the on Site workers, based on current knowledge.

All personnel must read the OHSP and confirm acceptance of its requirements prior to commencing work at the Site.

The information provided by the OHSP includes:

- Assignment of responsibilities;
- A discussion of Site conditions;
- Details of the work;
- Identification of on-site and off-site hazards;
- Assessment of the potential risks associated with these hazards;
- Procedures to eliminate, or if not possible, control the potential risks;
- Establishment of personnel protection standards and mandatory safety practices and procedures;
- Establishment of occupational health and safety monitoring protocols;
- Training and responsibilities of emergency team members;
- Evacuation procedures and emergency drills;
- Emergency information;
- Incident reporting; and
- Provision for contingencies that may arise.

12.2 Site Hazards

In general, the primary contaminants of concern at the Site is asbestos and as such appropriate precautions must be taken to prevent unacceptable exposure to asbestos contaminants.

The contaminants of concern are considered a potential health risk to the personnel undertaking the Site remediation activities.

12.3 Safe Work Practices

In general, personnel working at the Site will be required to wear normal protective clothing at all times. This includes:

- Trousers and long sleeve shirt;
- Steel capped boots;
- Hard hat; and
- Safety vest/hi-viz workwear.

Dust mitigation measures must be established during this project and must be able to mitigate the generation of dust during remediation of the fill. The fill material at the Site must be kept moist during excavation and removal work.

Gloves and eye protection should also be worn when/if handling residual fluids.

13.0 CONTINGENCY MEASURES

The purpose of the contingency measures is to specify procedures that can be implemented to manage unexpected finds and prevent adverse impacts to the environment and human health.

The following issues have been identified that could require contingency measures:

- Extension of contamination beyond the Site boundaries;
- Generation of unacceptable odour;
- Underground storage tanks; and
- Confirmation of groundwater contamination.

Details of the procedures that will be adopted in the event of these occurrences are defined in the following sections.

13.1 Off-Site Contamination

The previous environmental assessment has not indicated the presence of significant contamination within groundwater. Thus it is not expected that there is likely to be impact beyond the Site boundary although there is a backfilled quarry on the adjoining land.

Notwithstanding the anticipated low potential for off Site impacts, if contaminated soil or groundwater are detected near the Site boundaries or off-Site then the Client will be notified in the first instance. Depending on the significance of the impact, Council and the NSW EPA may need to be notified.

In the event that off-Site contamination is identified then an assessment including sampling and analysis must be undertaken and management strategies established.

13.2 Control of Odour

The potential for odours to be encountered during excavation is considered to be low at this stage. This situation may change based on the results of additional assessments and the natural of the deep fill encountered in the section of the former quarry that extends onto the Site. Contingency measures shall be implemented when odour levels are considered to be discernible.

Initial odour control measures shall include:

- The ceasing or reduction of excavation activities;
- The use of water sprays; and / or
- The addition of an odour suppressant to the water sprays (such as “Anotec” or “Biosolve”) provided the chemicals do not pose any risk of contaminating the ground or surface waters and do not pose any unacceptable OHS hazard.

13.3 Underground Storage Tanks

The DSI did not identified the potential presence of underground storage tanks (USTs) at the Site. However, there is a potential that USTs may be identified.

If encountered, USTs must be inspected for residual chemicals and the nature of any fluids within the UST established. All liquids within USTs need to be disposed of in accordance with current Safework NSW regulations and guidelines. This inspection should be undertaken by an experienced remediation contractor..

Once residual fluids have been removed from USTs then a licensed contractor should remove the tank and transport it to a waste facility legally permitted to receive the UST.

The resulting excavation must be assessed in accordance with NSW EPA guidelines and Technical Notes and the results assessed prior to recommencing work in the area. The findings of this assessment should consider the need to amend the RAP.

13.4 Groundwater Contamination

In the event that groundwater contamination is identified during remediation works then an assessment must be undertaken to assess the potential for unacceptable risk to human health of the environment. This may require a review of the RAP.

The groundwater assessment must be conducted by a suitable qualified and experienced environmental consultant.

14.0 LIMITATIONS

This report has been prepared by ECS for Merrylands (A) 88 Development Pty Ltd (the Client).

The Report;

I. May only be used and relied upon by the client;
II. Must not be copied to, used by or relied upon by any person other than the Client;
III. May only be used for the purpose of remediation of the Site in order to make the Site suitable, from a contamination perspective, for the proposed redevelopment works (and must not be used for any other purpose).

ECS accepts no liability for use of, interpretation of or reliance upon this report by any person or body other than the Client. Third parties must make their own independent inquiries.

This report should not be altered amended or abbreviated, issued in part or issued incomplete without prior checking and approval by ECS. ECS accepts no liability that may arise from the alteration, amendment, abbreviation or part-issue or incomplete issue of this report.