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MASTER EMPIRE CONSTRUCTIONS PTY LTD

Remediation Action Plan

859 Mamre Road, Kemps Creek NSW

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1. INTRODUCTION

Master Empire Constructions Pty Ltd (the client) engaged EI Australia (EI) to prepare a Remediation Action Plan (RAP) for the property located at 859 Mamre Road, Kemps Creek NSW (herein referred to as 'the site'). The purpose of this Remediation Action Plan is to guide remediation for future divestment / sale of the property and assist the client in rendering the site suitable for all potential future land uses and subsequent site redevelopment (including the most sensitive land use residential with garden / accessible soil). The site (see **Figure A.1)** is located within the Local Government Area of the Penrith City Council, and is identified as Lot 30 in DP 258414.

Previous investigations completed at the site include:

- EI. (2019). *Detailed Site Investigation 859 Mamre Road, Kemps Creek NSW*. Project No. E24287.E02_Rev0, dated 25 November 2019.

Based on this investigation, the site had been used as vacant/grazingland up until the 1990s, when a low density residential dwelling was established fronting Mamre Road. Use of the site for agricultural purposes, including a market garden appear to have been periodical since the 1990s.

The DSI (EI, 2019) indicated that analytical results of zinc within shallow topsoil/fill throughout the majority of the site above the most conservative SILs. Additionally, asbestos was identified within surface soils in the central portion of the site, highlighting a requirement for this assessment.

1.1 Proposed Development

At the time of writing this report, no development plans had been provided by the client. However, it is understood that site remediation is proposed to accompany future divestment / sale of the property and to render the site suitable for all potential future land uses.

1.2 Remedial Objective

The main objective of the remediation action plan (RAP) is to inform and guide site remediation by providing detailed procedures so they may occur in a safe and acceptable manner which complies with relevant guidelines while preventing adverse effects on human and environmental receptors.

1.3 Remedial Scope

The remedial objective will be achieved by:

- Outlining the legislative framework and provision of guidance on approvals and licences required for the remediation works;
- Identifying stakeholders and their responsibilities required to complete the remediation;
- Provide a summary of previous investigations and available data, the site setting and contamination status which were relied on for development of the RAP;
- Definition of remediation goals and acceptance criteria;
- Review remediation technologies and evaluation of the most appropriate (or combination of) for the site, including methods and procedures to ensure works are completed in accordance with relevant environmental legislation (e.g. SEPP 55);

- Provision of information to assist the contractor in their preparation of a Work, Health and Safety Plan and other site management/planning documents; and
- Provision of a preliminary Sampling and Analytical Quality Plan (SAQP) for site validation and to evaluate the effectiveness of the remedial works.

1.4 Regulatory Framework

The following regulatory framework and guidelines were considered during the preparation of this report:

- *Contaminated Land Management Act 1997*;
- DEC (2007) Guidelines for the Assessment and Management of Groundwater Contamination;
- EPA (1995) Sampling Design Guidelines;
- NEPC (2013) Schedule B(1) Guideline on Investigation Levels for Soil and Groundwater;
- NEPC (2013) Schedule B(2) Guideline on Site Characterisation;
- OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites;
- *Penrith Development Control Plan 2014;*
- *Penrith Local Environmental Plan 2010*; and
- *State Environment Protection Policy 55 (SEPP 55) – Remediation of Land*.

1.5 Deviations from this RAP

While it may be possible to vary the sequence and/or details of the actual site remediation and validation works to meet site constraints, a qualified Environmental Scientist performing the roles of Environmental Management Coordinator and Remediation Supervisor will be appointed to the project to ensure that:

- Critical stages of the site remediation/validation process (including, but not limited to, proper site induction of site personnel in relation to contamination hazards and environmental management issues, marking of remediation areas, inspection of environmental monitoring systems, implementation of specified control measures and validation sampling), are appropriately supervised, implemented and documented, with the relevant data collected for environmental reporting purposes; and
- Any deviations from the works specified in this RAP are properly documented and approved, as required under the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

Performing remedial works without the presence of a qualified environmental engineer/scientist when necessary may lead to project delays and extra costs due to additional environmental investigation requirements imposed by a Qualified Independent Consultant or the appointed Site Auditor, to confirm the environmental status of the site.

In worst case scenarios, waste materials removed from the site without proper characterisation and/or waste classification assessment, may lead to regulatory action and potential penalties, as described under the *Waste Regulation 2014*, the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997*.

2. SITE DESCRIPTION

2.1 Property Identification, Location, and Physical Setting

Table 2-1 Site Identification, Location, and Zoning

Attribute	Description
Street Address	859 Mamre Road, Kemps Creek NSW
Location Description	The site itself comprises a residential dwelling fronting Mamre Road, with market garden farmland and serval work sheds evident. Power lines and a portion of Kemps Creek intersect the central portion of the site, followed by vacant land covering the western portion.
Surrounding Land Use	The site is bound by a low density residential dwelling and farm/vacant land (north), a low density residential dwelling and market garden farmland (south), vacant/grazing land and South Creek (west) and Mamre Road followed by a low density residential dwellings and market garden farmland (east).
Site Coordinates	Northeast corner of site (GDA94-MGA56) ▪ Easting: 294720.493 ▪ Northing: 6252801.981 (Source: http://maps.six.nsw.gov.au)
Site Area	Approximately 31 ha (Source: http://maps.six.nsw.gov.au)
Lot and Deposited Plan (DP)	Lot 30 in DP.258414.
State Survey Marks	Two State Survey (SS) marks are situated in proximity to the site: ▪ PM33563: 104 m south of the site, on Mamre Road; and ▪ PM33564: 97 m south of the site, on Mamre Road; (Source: http://maps.six.nsw.gov.au).
Local Government Authority	Penrith City Council
Parish	Melville
County	Cumberland
Current Zoning	RU2: Rural Landscape (for the majority of the site) E2: Environmental Conservation (within Kemps Creek) (Penrith Local Environment Plan, 2010)

2.2 Regional Setting

Local topography, geology, soil landscape and hydrogeological information are summarised in **Table 2-2**.

Table 2-2 Regional Setting Information

Attribute	Description
Topography	The local topography of the site is generally flat with a slight fall towards the east (Kemps Creek). Steep rises to encapsulate Kemps Creek are noted. Gentle undulating rises and falls are apparent in the eastern most part of the site across the open land.
Site Drainage	As the majority of the site is currently unpaved, stormwater is expected to infiltrate directly into exposed soils. Surface runoff is expected to flow westerly, downslope towards Kemps Creek.
Regional Geology	With reference to the 1:100 000 scale Geological Series Penrith Sheet 9030 (Ref. DMR, 1991), the site is underlain by Holocene and Pleistocene elements of fine-grained sands, silts and clays (*Qal*).
Soil Landscapes	The Soil Conservation Service of NSW Soil Landscapes of Penrith 1:100,000 Sheet (Chapman and Murphy, 2002) indicates that the site overlies the residual *Blacktown Landscape (bt)* and the alluvial *South Creek Landscape (sc)*. The Blacktown Landscape includes gently undulating rises on Wianamatta Group shales. Local relief up to 30 m, with slopes usually broad rounded crests and ridges, with gently inclined slopes. Soils are shallow to moderately deep hard setting mottled texture-contrast soils, including red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines. The South Creek Landscape includes floodplains, valley flats, and drainage depressions and incised channels on the Cumberland Plain. Soils are often very deep layered sediments over bedrock or relict soils. Where pedogenesis has occurred, structured plastic clays or structured loams in and immediately adjacent to drainage lines occur. Red and yellow podzolic soils are most on common terraces, with structured grey clays, leached clays and yellow solodic soils.
Acid Sulfate Soil Risk	There was no Acid Sulfate Soils (ASS) risk classification map pertaining to the site available through the Department of Land and Water Conservation. There was no Acid Sulfate Soils (ASS) risk classification map pertaining to the site available on the Penrith Local Environmental Plan 2010. Given the above information, further Acid Sulfate Soils Assessment is not warranted.
Likelihood & Depth of Filling	Where fill was identified across the site, the approximate depth of fill was approximately 0.4 mBGL. Based on observations during intrusive investigations, the maximum depth of fill was recorded at approximately 0.8 mBGL.
Typical Soil Profile	Silty topsoil, overlying residual and alluvial clays, followed by shale bedrock.

Attribute	Description
Depth to Groundwater	Groundwater was not assessed during this investigation; however, groundwater was encountered during drilling within proximity to Kemps Creek, at approximately 2.5 and 3.3 mBGL.
Nearest Surface Water Feature	Kemps Creek, located within the western portion of the site.
Anticipated Groundwater Flow Direction	Groundwater is anticipated to flow hydraulically west, towards Kemps Creek.

3. SITE CHARACTERISATION

3.1 Previous Investigations

Previous investigations have been conducted at the site by *EI Australia* (EI), and are summarised below in **Table 3-1**.

- EI. (2019). *Detailed Site Investigation 859 Mamre Road, Kemps Creek NSW*, dated 25 November 2019.

Table 3-1 Summary of Previous Investigation Works and Findings

Assessment Details	Project Tasks and Findings
EI (2019) – Detailed Site Investigation	
Purpose	▪ To evaluate the potential for site contamination by means of intrusive sampling and laboratory analysis for relevant contaminants of concern.
Scope of Works	▪ Drilling of one-hundred and ten (110) test boreholes down to 'clean' natural soils, or until refusal. ▪ Multiple level sampling from both fill and natural soil horizons.
Key Findings	▪ Based on historical information, the site was vacant/grazing land up until the 1990s when a low density residential dwelling was established fronting Mamre Road. The use of the site for agricultural purposes, including a market garden appear to have been periodical since the 1990s. Storage of chemicals for agricultural use was noted during a site walkover; ▪ A SafeWork NSW search did not identify any underground storage tanks (USTs) or the storage of hazardous chemicals at the site; ▪ Penrith City Council records indicated that they were unable to locate any documents other than a Building Application relating to the existing dwelling; ▪ The site was free of statutory notices issued by the EPA, and was not recorded on the list of NSW Contaminated Sites Notified to the EPA/POEO public register; ▪ Soil sampling and analysis was conducted at one-hundred and ten (110) test bore locations: ▪ The sub-surface layers comprised a layer of topsoil and/or fill overlying residual and alluvial clays, followed by weathered shale bedrock; ▪ An assessment against the NEPM (2013) HIL-A/HSL-A investigation levels did not indicate soil samples (composite or individual) exceeding adopted criteria, with the exception of zinc in BH22_0.1-0.2. ▪ An assessment against the NEPM (2013) and site specific EIL/ESL investigation levels did not indicate soil samples (composite or individual) exceeding adopted criteria, with the exception of zinc within shallow topsoil/fill at BH1_0.1-0.2 (130 mg/kg), BH15_0.1-0.2 (210 mg/kg), BH21_0.6-0.7 (160 mg/kg), BH62_0.1-0.2 (1200 mg/kg), BH110_0.1-0.2 (2700 mg/kg). In addition the majority of the composite samples exceeded the adjusted ecological criteria for zinc. ▪ Asbestos was not identified during intrusive sampling; however surface cement-fibre sheeting fragments were reported to contain asbestos in the central portion of the site. ▪ Areas in the western portion of the site within former creek alignments may have been excavated and backfilled with uncontrolled fill, and the condition of this area remains unresolved.

Conclusions and Recommendations	EI concluded contamination was identified during the investigation. Areas of human health / ecological risks and locations with surface asbestos cement sheeting fragments were noted at the site, along with the possibility of uncontrolled filling in the western portion of the site. EI conclude that the site can be made suitable for future site redevelopment (including the most sensitive land use – residential with garden/accessible soils), so long as the following recommendations are implemented: ▪ A Remediation Action Plan (RAP) should be prepared prior to the commencement of works as part of the proposed development. The RAP will provide details of the methodology and procedures required for effective site remediation, including: - Sampling Analysis and Quality Plan (SAQP) for the validation and remediation activities performed on-site; - Design of supplementary investigations to close the data gaps identified during this investigation (Section 9.1); - Waste classification assessment, in order to enable classification of any surplus site soils to be excavated and disposed off-site during remediation works and material imported to the site, in accordance with the NSW EPA (2014) Waste Classification Guidelines and Waste Regulations; - Work health and safety considerations, and - Contingency plan to address unexpected finds. ▪ Preparation of a final site validation report by a suitably qualified environmental consultant, certifying the site suitability of soils for the future intended land use (including the most sensitive land use – residential with garden/accessible soils).

4. CONCEPTUAL SITE MODEL

In accordance with NEPM (2013) *Schedule B2 – Guideline on Site Characterisation* and to aid in the assessment of data collection for the site, EI developed a conceptual site model (CSM) to assess plausible pollutant linkages between potential contamination sources, migration pathways and receptors.

From the DSI (EI, 2019), many primary sources of contamination have been removed from the site and only residual contamination presents a potential risk to receptors near the site.

4.1 Existing Site Contamination

Based on the findings of previous investigations, the following sources of contamination were identified, and considered relevant to this RAP:

Surface Soils and Shallow Fill

Samples obtained within shallow fill identified exceedances of the adopted SILs.

Additionally, surface fragments of asbestos cement sheeting were identified within the central portion of the site.

Fill Soils - Western Portion of Site

Areas in the western portion of the site within former creek alignments may have been excavated and backfilled with uncontrolled fill, with the condition of this area remains unresolved.

4.2 Contaminants of Potential Concern

Based on the findings reported in the DSI (EI, 2019), the chemicals of concern (COC) for site remediation and validation are as follows:

- **Surface soils and shallow fill –** zinc and asbestos.
- **Fill soils – western portion of site** – Heavy metals (HM), total recoverable hydrocarbons (TRH), the monocyclic aromatic hydrocarbon compounds: *benzene, toluene, ethyl-benzene* and *xylenes* (BTEX), polycyclic aromatic hydrocarbons (PAH), organochlorine and organophosphorus pesticides (OCP/OPP), polychlorinated biphenyls (PCB), herbicides, and asbestos.

4.3 Potential Sources, Exposure Pathways, and Receptors

Potential contamination sources, exposure pathways, and human and environmental receptors that were considered relevant for the validation and remedial works at the site are summarised along with a qualitative assessment of the potential risks posed by complete exposure pathways in **Table 4-1**.

Table 4-1 Conceptual Site Model

Potential Sources	Impacted Media	Chemicals of Potential Concern	Transport mechanism	Exposure pathway	Potential receptor
Historic and current use of the site leading to contamination of near surface fill soils	Soil	▪ Zinc ▪ Asbestos	Disturbance of surface and sub-surface soils during site redevelopment,	▪ Ingestion ▪ Dermal contact ▪ Inhalation of dust/particulates	▪ Construction workers ▪ Adjacent Site Users
Uncontrolled backfill of areas within former creek alignments, within the western portion of the site	Soil	HM, TRH, PAH, OCP/OPP, PCB, herbicides, and BTEXN	Disturbance of surface and subsurface soils during site redevelopment, future site maintenance and future use of the site post redevelopment	Ingestion Dermal contact Inhalation of dust particulates	Construction and maintenance workers End users of the site post redevelopment
			Atmospheric dispersion from soil to outdoor and indoor air spaces	Inhalation dust particulates	
		F1 and F2 TRH, and BTEXN	Volatilisation of contamination from soil and diffusion to indoor air spaces	Inhalation of vapours from impacted soil	
		HM, TRH, PAH, OCP, BTEXN	Plant uptake of contamination present in root zone	Plant uptake	Future ecological receptors (e.g. site vegetation in landscaped areas post redevelopment)

4.4 Data Gaps

Data gaps or uncertainties faced from the DSI (EI, 2019) are as follows:

- Quality of soils within former creek alignments within the western portion of the site.

5. REMEDIATION GOALS & CRITERIA

5.1 Remediation Goals

The remediation goals for this RAP are consistent with the NSW EPA, SEPP 55 guidelines, and Council's contaminated land policy, and include:

- Meeting the conditions of the planning consent and to render the site suitable for all potential future proposed land use(s);
- Demonstrating that the proposed remediation strategy for the site is environmentally justifiable practical and technically feasible;
- Adopting clean-up criteria appropriate for the future use of the site to mitigate possible impacts to human health and the environment;
- Consideration of the principles of ecologically sustainable development in line with Section 9 of the *Contaminated Land Management Act 1997*;
- Minimising waste generation under the *Waste Avoidance and Resource Recovery Act 2001*;
- To remediate all contamination at the site so there are no unacceptable risks to onsite and offsite receptors; and
- Demonstrating that the plans for site management of remediation work consider work health and safety, environmental management, and site contingencies.

5.2 Remediation Criteria

The assessment criteria proposed for this project are outlined in **Table 5-1** and **5-2.** These were selected from available published guidelines that are endorsed by national or state regulatory authorities, with due consideration of the exposure scenario that is expected for various parts of the site, the likely exposure pathways and the identified potential receptors.

Table 5-1 Adopted Investigation Levels for Soil

Adopted Guidelines	Rationale
NEPM, 2013 Soil HILs, HSLs, EILs. ESLs & Management Limits for TPHs	**Soil Health-based Investigation Levels (HILs)** All soil samples will be assessed against the NEPM 2013 HIL-A thresholds for residential with gardens/accessible soils. **Soil Health-based Screening Levels (HSLs)** The NEPM 2013 HSL-A&B thresholds for residential sites for vapour intrusion would be applied to assess for potential human health impacts from residual vapours resulting from petroleum, BTEX, & naphthalene. Soils asbestos results to be assessed against the NEPM 2013 Soil HSL thresholds for "all forms of asbestos". **Ecological Investigation Levels (EILs)** Soil samples also to be assessed against the NEPM 2013 EILs for arsenic, copper, chromium (III), nickel, lead, zinc, DDT, and naphthalene; which have been derived for protection of terrestrial ecosystems. **Ecological Screening Levels (ESLs)** Soil samples to be assessed against the NEPM 2013 ESLs for selected petroleum hydrocarbons & TRH fractions for protection of terrestrial ecosystems. **Management Limits for Petroleum Hydrocarbons** Should the HSLs be exceeded for petroleum hydrocarbons, soil samples would also assessed against the NEPM 2013 *Management Limits* for the TRH fractions F1 – F4 to assess propensity for phase-separated hydrocarbons (PSH), fire and explosive hazards & adverse effects on buried infrastructure.

5.2.1 Waste Classification Criteria

Prior to being removed from the site, excavated soils must be classified in accordance with the NSW EPA (2014) *Waste Classification Guidelines* (the 'Waste Guidelines'). Under these guidelines, fill/soils may be classified into the following groups: *General Solid Waste*, *Restricted Solid Waste,* or *Hazardous Waste*, subject to chemical assessment using NATA-registered laboratory methods for total and leachable contaminant levels.

The total contaminant threshold concentrations and leachate thresholds tested using the TCLP methodology for each relevant contaminant parameter will then be interpreted against the respective NSW EPA (2014) thresholds. Any soils containing asbestos would also be classified as *Special Waste - Asbestos Waste*. In accordance with the *NSW Waste Regulation 2014*, waste soils must only be disposed to a waste facility that is appropriately licenced to receive the incoming waste. It is therefore recommended that confirmation is obtained from the waste facility prior the materials being removed from the site.

Should the analytical results exceed the SCC2 and/or TCLP2 thresholds, then the materials will be classified as *Hazardous Waste*. In such cases, material stabilisation treatment with EPA approval may be required prior to offsite disposal. Unexpected material may need to be segregated depending on the source of the waste, prior to conducting waste classification assessment. This approach is discussed in more detail under *Contingency Management* in **Section 8.2**.

6. SAMPLING, ANALYTICAL, AND QUALITY PLAN (SAQP)

The sampling, analytical and quality plan (SAQP) ensures that the data collected is representative and provide a robust basis for site assessment decisions.

6.1 Data Quality Objectives

In accordance with the NEPM and the Australian Standard AS4482.1 *Guide to the Sampling and Investigation of Potentially Contaminated Soil*, Data Quality Objectives (DQO) were developed in a sequential manner as documented in **Table 6-1**.

Table 6-1 Data Quality Objectives

Step	Description
State the Problem	The site is required to be rendered suitable for the any future proposed land uses. Previous site investigations (EI, 2019) have indicated the presence of soil contamination within shallow fill. In light of the proposed development and current information relating to contamination at the site, the proposed sampling of soils must provide supportive information on the environmental conditions of the site to determine the site's suitability for the proposed development.
Identify the Decision	Based on the remedial objectives outlined in **Section 1.2**, the following decisions are identified as: ▪ Has the nature and extent of soil impacts on-site been defined? ▪ Does the level of impact coupled with the fate and transport of identified contaminants represent an unacceptable risk to identified human and/or environmental receptors on or offsite? and ▪ Will further remediation and/or special management be required before the site is suitable for the intended land use?
Identify Inputs to the Decision	Inputs to the decision process include: ▪ Previous investigation works; ▪ Details of the proposed site use; ▪ Understanding of current site use and historic activities that have occurred, including potential offsite sources of contamination; ▪ Geological and hydrogeological data relevant to the area, including physicochemical parameters for calculating ecological criteria; ▪ Field screening data and site observations for the presence of visual/olfactory contamination indicators; ▪ Contaminant concentrations in soil validation samples confirming effective removal of identified impacts; and ▪ Further input to the decision will be sample collection and handling, field and laboratory QAQC and confirmation that data quality indicators (DQIs) were achieved.

Step	Description
Define the Boundary of the Assessment	**Lateral** – Works are limited to the site boundaries (**Figure A.2**), and within the proposed excavation area. **Vertical** – From existing ground surface, underlying fill and natural soil horizons, to the base of contaminated soil and/or bulk excavation level (BEL), including underlying water-bearing zones. **Temporal** – The results will be valid on the day samples are collected and will remain valid if no changes to site use occur, and contamination (if present) does not migrate from off-site sources. Constraints of sampling requiring consideration include access restrictions (due to site operations and/or conditions) and presence of both above and underground services / structures.
Develop a Decision Rule	The decision rules for validation are: ▪ Is the site suitable all potential land use(s)? *If the concentrations of contaminants that remain are below the relevant criteria for the intended land use; then the site will be deemed suitable for the proposed development.* ▪ Is additional information required to determine the suitability of the site for its potential proposed use? *Should additional information be required as determined by the conceptual site model (CSM), then appropriate recommendations will be provided.* Decision criteria for analytical data are defined by the Data Quality Indicators (DQI) in **Table 7-2**.
Specify Acceptable Limits on Decision Errors	Specific limits for this project are to be in accordance with NEPM, appropriate data quality indicators (DQIs) for assessing the useability of the data, and EI standard procedures for field sampling and handling. To assess the useability of the data, pre-determined DQIs for completeness, comparability, representativeness, precision, and accuracy, as presented below in **Table 7-2**. If any of the DQIs are not met, further assessment will be necessary to determine whether the non-conformance will significantly affect the useability of the data. Corrective actions may include requesting further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of samples.
Optimise the Design for Obtaining Data	▪ Written instructions will be issued to guide field personnel in the required fieldwork activities. ▪ Soil excavation is to be performed as per **Section 8**. Soil validation sampling is to be completed as per the methodology prescribed in **Section 10.** ▪ Validation sampling procedures that would be implemented to optimise data collection for achieving the DQOs. ▪ Review of the results will be undertaken to determine if further excavation and additional sampling is warranted. Additional investigations would be warranted where soil concentrations are found to exceed remediation criteria endorsed by the NSW EPA, relevant to the proposed land use(s).

6.2 Data Quality Indicators

To ensure that the data collected is of an acceptable quality, the data set will be evaluated against the data quality indicators (DQI) outlined in **Table 6-2**, which related to both field and laboratory-based procedures.

Table 6-2 Data Quality Indicators

Data Quality Objective	Data Quality Indicator	Acceptable Range
Accuracy	Field – Trip blank (laboratory prepared) Laboratory – Laboratory control spike and matrix spike	< laboratory limit of reporting (LOR) Prescribed by the laboratories
Precision	Field – Blind replicate and spilt duplicate Laboratory – Laboratory duplicate and matrix spike duplicate	<30% relative percentage difference (RPD [%]) Prescribed by the laboratories
Representativeness	Field – Trip blank (laboratory prepared) Laboratory – Method blank	< laboratory limit of reporting (LOR) Prescribed by the laboratories
Completeness	Completion (%)	-

7. REMEDIATION TECHNOLOGY

7.1 Regulatory Overview

The policy framework for the NEPC (2013) *National Environmental Protection (Assessment of Site Contamination) s6(16)* indicates that the preferred hierarchy for site remediation options and/or management is:

- On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
- Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or, if the above are not practicable:
- Consolidation and isolation of the soil on-site by containment with a properly designed barrier; and
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material; 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.

For this site, a number of remediation options were reviewed to examine the suitability of each method, the surrounding properties, geological and hydrogeological limitations and the following considerations:

- Development requirements (residential, with limited access to soils and landscaped areas);
- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to material and infrastructure limitations;
- Remedial timetable;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

7.2 Remediation Technologies Review

A number of soil remediation options were reviewed to examine the suitability of each method, with due regard for the surrounding land uses, as well as the geological and hydrogeological limitations.

Each of the available remediation technologies are summarised in terms of their suitability in **Table 7-1**.

Table 7-1 Remedial Technology Review - Soils

Remediation Methodology	Description	Advantages	Disadvantages	Suitability
No Action	'No Action' can be considered if: ▪ There is no measurable contamination; ▪ Contaminant concentrations are below assessment guidelines; ▪ Contaminants are not mobile; or ▪ Exposure to contaminated soils is unlikely.	No remediation costs Creates minimal disturbance to the site Retains material on-site	Not applicable to the kind of contamination encountered at the site. Would pose limitations on land use options. May require an Environmental Management Plan and ongoing monitoring.	Not Suitable – As the key objective of the remedial strategy is to make the site suitable for all potential future land uses without the need for ongoing monitoring.
On-site bioremediation	Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures.	Cost effective if soils are utilised on-site. Lower disposal costs. Limited requirement to import fill material to site. Retains material on-site.	Significant area of site required to land farm material. Undefined remediation timeframe. Potential for odour problems. Not suitable for metals or asbestos contamination.	Not suitable – May be utilised for hydrocarbon impacted soils. As there are currently no hydrocarbon impacted soils requiring remediation on-site, this technology is not suitable. Should hydrocarbon impacted soils be identified, this technology may be re-assessed.
In-situ treatment	*In-situ* treatment of impacted soils within the smear zone and saturated zone using *in-situ* treatment methods such as soil vapour extraction, injection of oxidising agents etc.	Creates minimal disturbance to the site (no excavation). Cost effective for large scale site remediation of light to mid-weight petroleum hydrocarbons. Potential to simultaneously remediate dissolved phase hydrocarbons in site groundwater.	Not applicable to the kind of contamination encountered at the site. Expensive establishment costs. Potential for odour problems. Requires detailed design, pilot trials and management.	Not suitable – This method is designed for widespread hydrocarbon impacted soils. Since the present dataset does not provide evidence of widespread hydrocarbon contamination; this is not considered to be an economically viable option.

Remediation Methodology	Description	Advantages	Disadvantages	Suitability
Consolidation and/or capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer of fill material.	Effectively removes risk to human health by eliminating exposure pathways.	Importance of capping design and materials utilised in the construction of capping layer. Would pose limitations on land use options. Typically requires an Environmental Management Plan and ongoing monitoring.	Potentially suitable – An environmental management plan (EMP) with ongoing monitoring would be required, due to the retention of contaminated materials on the site. There is sufficient space across the site to sufficiently bury impacted soils underneath hardstand. However, based on the low level of contamination found at the site, other remedial technologies may be considered more economically viable.
Excavation and off-site disposal	Excavate impacted materials. Transport directly to a licensed landfill facility. Reinstate site with imported clean fill material.	Fast – impacted material removed immediately, significantly reducing potential for impact to groundwater. No storage or treatment problems. Reduced vapour/odour issues as impacted materials removed from site. Minimal design and management costs.	Transfer of waste to another location (licensed waste facility). High costs associated with the disposal of waste soils and importation of clean backfill). Requires waste classification prior to disposal, keeping of thorough waste records, waste tracking and reporting. Sustainability issues related with disposal to landfill.	**Suitable** – For meeting the key project objective to make the site suitable for commercial/industrial use without the need for ongoing monitoring. This will remove impacted fill breaking any pollutant linkages present at the site (source removal).
Natural attenuation	Allowing the contaminants to biodegrade naturally following removal of the contamination source.	No remedial excavation of site. Retains materials on site. Sustainable, cost effective remediation method.	Slow process. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. Typically requires an Environmental Management Plan and ongoing monitoring.	Not Suitable – This approach is primarily suited to addressing groundwater contamination, which at the time of this report has not been identified. If groundwater contamination is identified, this remediation technology will be reassessed.

7.3 Preferred Remediation Option

Based on the available remedial technologies, the proposed site development (mixed residential/commercial with associated three level basement car parking), the potential risks to human health and the environment, as well as the relative cost effectiveness of feasible remedial techniques, the preferred remedial option for the site is:

- Offsite disposal to licensed waste facilities of all impacted fill. All wastes shall be transported to appropriate, EPA-licensed facilities, after formal classification. All excavated (remediation) areas shall be validated by base and wall, soil sampling; and
- Site reinstatement with validated, imported (or recovered) excavated natural materials (where required).

7.4 Site Preparation, Licences & Approvals

7.4.1 Consent Requirements

In accordance with *SEPP 55 - Remediation of Land*, the category of the remediation works defines whether consent is required prior to the commencement of the works. Under *SEPP 55*, works where there is the potential for significant environmental impact are classed as *Category 1* and require development consent. *Category 2* works pose a low potential for environmental impact and do not therefore require prior consent. The determination for the subject site is outlined in **Table 7-2**.

Table 7-2 Remediation Works Category Determination

Significant Environment Impact	Yes/No	Category
Designated Development or State Significant Development	No	2
Critical or threatened species habitat	No	2
Have significant impact on threatened species, populations, ecological communities or their habitats	No	2
In area identified environmental significance such as scenic areas, wetlands (see list*)	No	2
Comply with a policy made under the contaminated land planning guidelines by the council.	Yes	2
Is work ancillary to designated development	Yes	2

Notes: * Environmental significance list -coastal protection, conservation or heritage conservation, habitat area, habitat protection area, habitat or wildlife corridor, environment protection, escarpment, escarpment protection or escarpment preservation, floodway, littoral rainforest, nature reserve, scenic area or scenic protection, or wetland.

Based on the above assessment, the remediation works for the site are considered as Category 2 and will not require development consent. Category 2 works do however require notification to the consent authority; therefore, Council should be notified 30 days before commencement of the works. The 30-day limit does not prevent Council intervention after that time for a breach of the *EPA Act 1997* or non-compliance with *SEPP 55*. The notification also serves as the basis for updating Council records on properties in the local government area and must:

- Be in writing;
- Provide contact details for the notice;
- Briefly describe the remediation work;
- Show why the work is considered Category 2 remediation work;

- Specify the property description and street address on which the remediation work is to be carried out;
- Provide a location map; and
- Provide estimates for commencement and completion dates of the work.

Provision of this RAP, as well as an indication of commencement and completion dates of the works in writing, is usually sufficient to meet the requirements of this notification.

7.4.2 Development Consent & Control Plans

All works should be in accordance with Penrith City Council DCPs and any development consent issued by Council for the development.

7.4.3 Other Licence Requirements

The appointed site contractor should prepare an appropriate Construction Environmental Management Plan (CEMP), health and safety plans, and other plans required by the Council DA and DCPs. Where asbestos removal is required, the contractor must be appropriately licensed to perform such works.

8. REMEDIATION WORKS

Site characterisations revealed the presence of shallow fill contamination which were unsuitable for the proposed commercial/industrial site use. Additionally, surface fragments of bonded asbestos cement sheeting were noted in the central portion of the site. The quality of soil remaining onsite following remediation requires further assessment to ascertain site suitability. The remedial tasks required were:

- Removal of contaminant sources which will not be present at the end use of site, including shallow fill materials impacted with zinc; and
- Removal of bonded asbestos cement sheeting within surface soils located in the central portion of the site.

8.1 Remediation Sequence

The sequence of work for the remediation is summarised in **Table 8-1**, with an indicative timeframe of each task. Further details provided in the sections below.

Table 8-1 Summary of Remediation Sequence

Task	Timeframe	Description of Work
Preliminaries/Site Establishment	Weeks 1-2	▪ Development of pre-work plans (construction environmental management plan, occupational health and safety plan, hazardous material survey), approvals and permits to commence work. ▪ Establishment of site pollution monitoring and control measures to be maintained for the duration of the works as outlined in management plans.
Demolition of Structures	Weeks 3-4	▪ Note - Complete a hazardous materials inspection prior to the demolition of buildings and structures.
Additional Assessment	Weeks 5-8	▪ Analyse soils within former creek alignments in the western portion of the site for contaminants of concern.
Hotspot Excavation, Removal and Validation		▪ Conduct remedial removal works for impacted soils in impacted areas. ▪ Waste streams to be kept separate to prevent cross-contamination. ▪ Following removal of fill, natural surfaces are to be inspected and sampled to validate removal of contaminated soils from the site.
Importation of reinstated materials	Depends on remediation contractors	▪ Impotation of clean fill soils to backfill remedial areas and level off the site.
Reporting	2 weeks thereafter	▪ All findings and investigation methodologies of the additional investigations and remedial works will be reported within a validation report.

8.1.1 Preliminaries/Site Establishment

Notice should be given to Council at least 30 days prior to the commencement of remediation works. A list of all required work permits will be obtained from Council and arrangements are to be made to obtain the necessary approvals from the relevant regulatory authorities.

The site itself will be prepared in accordance with the requirements of the Site Management Plan outlined in **Section 9**. The site developer would also need to prepare and implement a Construction Environmental Management Plan (CEMP) and Site Work Health and Safety (WHS) Plan prior to any site works. Establishment of environmental controls, site access, security, fencing, warning signage and preparation of a Health Safety and Environment Plan is required prior to works commencement. A project plan should also be developed to outline engineering design for excavation support (if required), water treatment requirements and design, staging of excavation works, stockpiling, waste stabilisation, waste material loading, traffic management and waste tracking.

As part of the site preparation phase and preliminary tasks a remediation workshop should be conducted with the appointed contractor(s) to further develop any remedial measures, excavation plans and environmental management requirements.

Also prior to commencing work the site contractor is to complete a staging or project plan that outlines the basic stages of the remediation works. The staging plan should include, but not be limited to:

- Staging of the decommissioning and removal of tanks and associated equipment;
- Staging of areas to be excavated;
- Areas designated for waste segregation, screening and storage (stockpiling), amenities, soil and groundwater treatment (if required);
- Truck movements to allow loading to mitigate impacts to surrounding land users and council infrastructure; and
- Proposed environmental mitigation measures.

8.1.2 Demolition of Site Structures, Site Walkover

Building demolition should be in accordance with Australian standard (AS)2601 – 2001 and wherever possible, waste should be segregated into metal, wood and brick / concrete.

Prior to, and following the removal of hardstand pavement, a site walkover is to be conducted by a qualified and experienced environmental scientist/engineer to assess for any visual signs of contamination, supplementary asbestos contamination in surface fill soils, and buried building waste (potentially containing asbestos) that may have been buried beneath the existing pavements.

Should unexpected finds be discovered during the course of the site remediation program, then the procedures described under the Contingency Management (**Section 8.2**) and Unexpected Finds Protocol (**Appendix C**) are to be implemented until the site remediation goals have been achieved and the site is deemed suitable for the intended land use.

8.1.3 Additional Assessment

The DSI (EI, 2019) identified areas in the western portion of the site, within former creek alignments, which may have been backfilled with uncontrolled filling or waste. Additional works during this investigation are proposed to confirm the quality of soils and delineate potential contamination.

8.1.4 Hotspot Excavation, Removal and Validation

Fill soils impacted with zinc and surface asbestos can be managed by waste classification, excavation, and off-site disposal. Any additional contamination identified in the additional assessment should be managed via this strategy as well.

Additional investigations of sub-surface soils via test pits are to be constructed, in order to assist in appropriate classification of materials for off-site disposal. Different waste streams are to be kept separate during excavation and disposal to prevent cross-contamination, as prescribed in **Section 9.3.** As part of the excavation of remaining fill soils, EI recommend over-excavation of fill by a minimum of 0.2m into the underlying natural soils, to allow for the removal of any residual impacts to the top of natural soils by overlying fill. Fill soils are to be classified in-situ, following which they will be directly loaded into trucks for off-site disposal. Following visual assessment, underling natural soils are to be validated by the collection and laboratory analysis of soils samples for contaminants of concern, in accordance with the methodology presented in **Section 10.1**.

All fill and contaminated soil needing to be remediated must be removed from the site and a shallow validation assessment of freshly exposed natural soil must be completed prior to the commencement of bulk excavation works. Natural soil is potentially classifiable as virgin excavated natural material (VENM), should it be required to be transported off-site, however, surface inspection and validation by near surface sampling and analysis is required.

8.1.5 Fill / Topsoil Removal (site wide)

Following the remedial excavation of all fill / topsoils as outlined in **Section 8.1.4**, remaining fill / topsoils not suitable to remain on-site from a geotechnical perspective for the any proposed new structures and roadways, from across the site should be classified and disposed off-site.

8.1.6 Imported Materials

Following remedial excavations and excavation of fill / topsoils from across the site, importation of materials would be required to backfill remedial voids and to level the site. Imported materials must be previously classified as VENM, ENM or under another EPA resource recovery exemption / order. Imported materials must be sampled and analysed as suitable for on-site use, in accordance with the methodology outlined in **Section 10.1**.

8.1.7 Reporting

All findings and investigation methodologies of the additional investigations will be reported within a validation report. Should significant contamination be identified, further works will be addressed via an addendum to this RAP. These works may include soil vapour sampling, indoor air quality assessment, active groundwater remediation and bioremediation of significantly contaminated soil.

Once site validation has been achieved, the findings of the work will be reported and conclusions on suitability of the land will be evaluated.

8.2 Remedial Contingencies

At this stage it is anticipated that the proposed remedial technologies should be effective in dealing with the contamination present, however, remedial contingencies may be required should scenarios detailed in **Table 8-2** arise.

Table 8-2 Remedial Contingencies

Scenario	Remedial Contingencies/Actions Required
Highly contaminated soils / sludges not identified during previous investigations are encountered, particularly at site boundaries	Work to be suspended until the Environmental Project Manager can assess impacted materials and associated risks. The leachability of contaminants to be assessed, before disposal options are considered. Follow the unexpected finds protocol in **Appendix C** of this RAP.

Scenario	Remedial Contingencies/Actions Required
Underground tanks (i.e. USTs that have not been previously identified) are encountered at the site	Should unexpected USTs be identified at the site, a GPR survey and visual inspection may be conducted by a certified and experienced service locator, to confirm the presence / absence of any further UPSS and any unknown subsurface infrastructure. Systems to be removed and the excavations appropriately validated and backfilled by an experienced contractor. Tank removal works to be reported by an appropriate environmental consultant, in accordance with EPA (2014b) *Technical Note: Investigation of Service Station Sites* and Australian Standard AS4976 (2008). Follow the unexpected finds protocol in **Appendix C** of this RAP.
Asbestos wastes are encountered	Work to be suspended and asbestos removed by a suitably qualified contactor, in accordance with SafeWork NSW regulations. Follow the unexpected finds protocol in **Appendix C** of this RAP.
Residual soil impacts remain on-site	Assess potential vapour hazard and delineate plume. Should significant soil vapour contamination be identified, consider soil vapour monitoring program and the implementation of a vapour membrane barrier system within the final development design.
Contaminated groundwater (including LNAPL or DNAPL) encountered	Review groundwater conditions on site (if required) and determine need for further investigation/remediation and/or longer-term management plan. Any dewatering may require approval under the *Water Management Act 2000*. Remedial options may include natural attenuation, extraction, bioremediation, PSH recovery using active pumping (including hydraulic control), installation of a groundwater permeability barrier, *in situ* oxidation or stabilisation.
Contaminated groundwater plume is identified and is migrating off-site, or there are increases in concentration due to increased infiltration	Review contaminant increase and analytes. Review active remediation alternatives (if necessary). Ensure down-gradient monitoring is undertaken. Carry out fate and transport modelling and assess the need for further action.
Contamination is identified near heritage items or significant trees (if identified)	Stop work. Review contaminant concentrations and risks to heritage items / flora. Assess human health and environmental risks if contamination remains in place. Review natural attenuation options.
Changes in proposed basement excavation depth	Review remediation works for the site.
Changes in proposed land use(s) at the site	Review remediation works for the site.

9. SITE MANAGEMENT

9.1 Roles and Responsibilities

Roles and responsibilities of key personnel required to make up the remedial management team, to support the completion of remedial works are provided in **Table 9-1,** and details of people responsible should be kept up to date throughout the remedial works.

Table 9-1 Remedial Management Team

Team Member	Organisation	Responsibilities
Property Owner	Master Empire Constructions Pty Ltd	▪ Overall responsibility of site and key liaison for council. ▪ Appoint site contractors and all other members of the remediation.
Project Manager – Site Operations	Master Empire Constructions Pty Ltd	▪ Overall site management and day to day decision maker. ▪ Key communicator between site and owner. ▪ Ensure relevant control plans are developed and implemented and appoints required staff to the roles required
Remediation Contractor	TBA	▪ Site preparation including the implementation of environmental controls required by the site management plans and relevant legislation. ▪ Completion of remedial tasks in accordance with the methods of the RAP and relevant legislation. ▪ Ensure consultant is informed of remedial schedules and is employed for key components, such as waste classification and validation. ▪ Effectiveness of mitigating measures required for remedial activities. ▪ Ensure appropriate handling of all material and correct offsite disposal of waste under appropriate documentation. Copies of all waste documents are required by the environmental consultant for inclusion to the site validation report. ▪ Reporting any environmental issues, complaints or unexpected finds to the project manager and environmental consultant.
Environmental Consultant	TBA	▪ Development of the remediation objectives and strategy. ▪ Support all other members of RMT in understanding the requirements of the RAP and the potential risks posed should measures not be implemented. ▪ Supervision of key remediation components, collection of all environmental samples and provide guidance to ensure the remediation is understood and effective. ▪ Complete site validation tasks and detail the works in a validation report concluding on site suitability.
Local Authority	Penrith City Council	▪ Responsible for the granting of all consents and ensuring the recommendations of environmental reports are implemented. ▪ Regulator of consent conditions

9.2 Materials Handling and Management

Table 9-2 summarises the measures that should be implemented in respect of materials handling during remedial and bulk excavation works at site.

Table 9-2 Materials Handling and Management Requirements

Item	Description/ Requirements
Excavation Contractors	Excavation should be completed by a suitably qualified contractor to ensure all staff are aware of the sites environmental and health and safety requirements, and that all adverse effects are mitigated, isolated, or reduced.
Stockpiling of Materials	All stockpiles will be maintained as follows: ▪ Present on sealed surfaces such as concrete, asphalt, or high-density polyethylene. If placed on bare soil, the land will be over-excavated to ensure adequate removal of all impacted material and located in areas of the site which do not pose environmental risk (e.g. sheltered areas). ▪ No greater than 2m in height, be appropriately battered and sediment measures surrounding each base to manage stormwater runoff. Material will either be covered or kept moist to prevent dust blow. ▪ Stockpiles will be in approved locations of the site, selected to mitigate environmental impacts while facilitating material handling requirements. Any contaminated material will only be stockpiled in non-remediated areas of the site or at locations that do not pose any risk (e.g. sheltered areas).
Transport of Material (off-site)	▪ Material shall be transported via a clearly distinguished haul route defined within construction management plans. All haulage routes for trucks transporting soil, materials, equipment, and machinery shall comply with all road traffic rules. ▪ Implementation of sediment measures to reduce the mechanical movement of soil onto public roadways or vehicle wheels is required, such as wheel washing/cleaning facilities placed at each site entry/exit. Any residue from the cleaning facility will be collected and deemed contaminated unless proven otherwise. ▪ Spoil material will require offsite disposal. Trucks transporting soils from the site are to be covered with tarpaulins (or equivalent). All deliveries of soil, materials, equipment, or machinery should be completed during the approved hours of remediation and exit the site in a forward direction. ▪ Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents, and approvals.
Material Tracking	Materials excavated from the site should be tracked from the time of their excavation until their disposal (“cradle to grave”). Tracking of the excavated materials should be completed by recording the following: ▪ Origin of material; ▪ Material type; ▪ Approximate volume; and ▪ Truck registration number. Disposal locations will be determined by the remediation contractor and the receiving facility, weighbridge dockets and waste certification information should be provided to the environmental consultant for validation reporting.

Item	Description/ Requirements
Importation of Material	Landscaping soil, or material imported as fill for planter boxes, is to be certified as either Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM) criteria by the supplying contractor. Copies of certification are to be provided to site management and the Environmental Consultant. Any material outside of these classifications are to be sampled for characterisation, which can be achieved by: 1. Collecting one soil sample per 100m^3 of imported soil in deposited areas. 2. Analysis of samples for contaminants of concern, including TRH, BTEX, PAH, Metals / Metalloids, PFAS, OCP / OPP, PCBs and asbestos (at least). 3. Acceptance will be achieved once all contaminant concentrations are reported to be below the site criteria. 4. Analysis results should be presented to the Environmental Consultant for inclusion in the site validation report. Visual inspection of the imported material to confirm consistency is recommended, and should excavated materials be identified as potentially contaminated or unsuitable for reuse, the following procedure should be undertaken: ▪ Visually assess if the contaminated material can be isolated from other material, and stockpile separately if possible. ▪ Stockpile in contaminated material area and sample in accordance with waste classification procedure detailed in **Section 10.1**. ▪ Subject to classification, 'clean' materials may then be reused as filling material on-site or disposed of at an appropriate receiving facility.
Excessive rainfall	Ensure sediment and surface water controls are operating correctly. If possible, divert surface water away from active work areas or excavations. Stockpiles should be covered to minimise run off.
Excessive dust	▪ Use water spray to suppress the dust or stop site activities generating the dust until it settles. ▪ Cover all stockpiled soils
Excessive noise	Identify the source, and isolate if possible. Modify the actions of the source or erect temporary noise barriers if required.
Excessive odours/vapours.	Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop works and monitor ambient air across the site and at site boundaries with a PID. Implement control measures including respirators for on-site workers, use of odour suppressants, wetting down of excavated material

9.3 Waste Management

1 Prior to any soil material being removed from the site, a formal waste classification certificate shall be completed, in accordance with the EPA (2014a) *Waste Classification Guidelines*.

2 Soil samples designated for waste classification will be collected at a rate of one sample per 25m^3 (minimum of three per stockpile), up to 250m^3. For soil exceeding 250m^3 but less than 2,500m^3, a minimum of 10 samples is required and 95% UCL statistical calculations of contaminant concentrations may be compared to the criteria. Samples are to be analysed for Metals / Metalloids, TRH, BTEX, PAH, organochlorine / organophosphorus pesticides (OCP / OPP), polychlorinated biphenyls (PCBs), and asbestos.

3 Any asbestos identified will be treated as an unexpected find and the unexpected finds protocol (**Appendix C**) will be engaged.

4 Results of analysis will be compared to the waste classification criteria set out in the NSW EPA (2014) *Waste Classification Guidelines* and a classification certificate will be provided, to enable off-site disposal.

5 Ensuring that the waste fill/soil streams are kept separate, material will be loaded, transported, and disposed offsite to waste landfill facilities that are appropriately licensed to receive the materials corresponding to the documented waste classifications.

6 In accordance with the *POEO (Waste) Regulation 2014*, waste movements will be tracked and disposal receipts (dockets) will be maintained by the site manager and copies provided to EI for final reporting purposes.

10. VALIDATION SAMPLING & ANALYSIS QUALITY PLAN

The remediation of the site will be deemed acceptable based on the achievement of the following validation objectives:

- ***Remedial Excavations*** – Validation of all remedial excavation areas where infrastructure or contaminated soils have been removed will involve sampling and analysis to ensure that contaminant concentrations are below the soil remediation criteria (**Section 5.2**). The sampling frequency will be in accordance with the NEPM (2013) and EPA (1995) sampling design guidelines. All tests shall be performed by NATA-accredited environmental analytical laboratories;
- ***Backfill Materials*** – Should backfilling be required, validation of imported fill materials used for the backfilling of remediated areas would be required to verify their suitability for the proposed land use.

10.1 Validation Sampling Methodology

The recommended validation methodology for sample collection is presented in **Table 10-1.**

Table 10-1 Validation Sampling Design

Remediation Area	Sampling Density	Potential Contaminants
Addition investigation of former creek line.	10 m grid (test pits)	HM, TRH, BTEX, PAHs, OC/OP pesticides, PCBs, asbestos.
Final natural ground surface in vicinity of remedial areas (BH22, BH110 and BH62)	10 m grid (surface)	Zinc
Final natural ground surface in vicinity asbestos area	10 m grid (surface)	Asbestos
Stockpiled material	Any soil material stockpiled on-site for off-site disposal, will be sampled for waste classification purposes at a rate of one per 25 m^3 (with a minimum of 3 samples for stockpiles <25 m^3).	HM, TRH, BTEX, PAHs, OC/OP pesticides, PCBs, asbestos.
Imported fill materials	If material is required to be sourced from off-site to reinstate excavations, it should be certified suitable for the intended use by sampling at a rate of one per 100 m^3.	HM, TRH, BTEX, PAHs, OC/OP pesticides, PCBs, asbestos.

Excavation of contaminated material shall continue until the analytical results indicate compliance with the criteria (i.e. either the concentrations of all contaminants are within the criteria, or the 95% UCL average contaminant concentration for each detected parameter is within the criteria). If results indicate that additional excavation is necessary, the excavation

shall be extended until the excavation surface samples indicate that the location is validated as meeting the criteria for each respective contaminant.

Soil sampling and handling of the collected samples will be as described in **Table 10-2**.

Table 10-2 Validation Sample Collection and Handling Procedures

Action	Description of Required Works
Sample Collection	Soil validation sampling will be directly from the exposed surface of excavation, or from the material brought to the surface by the backhoe/excavator bucket. Validation samples will be field screened for the presence of volatiles on site using a PID. Analysis of the head-space within a snap lock bag filled with sampled soil (at an approximate 1:5 soil to air ratio) and left to equilibrate. A small hole is made through the snap lock seal and the probe of the PID inserted. The VOC reading for the sample is recorded and provides information as a guide to vapour impacts to site.
Sampling, Handling, Transport and Tracking	▪ The use of stainless-steel or disposable (one time use) sampling equipment; ▪ All sampling equipment (including hand tools or excavator parts) to be washed in a 3% solution of phosphate free detergent (Decon 90), followed by a rinse with potable water prior to each sample being collected; ▪ Direct transfer of the sample into new glass jars, bottles, vials or plastic bags is preferred, with each plastic bag individually sealed to eliminate cross contamination during transportation to the laboratory; ▪ Label sample containers with individual and unique identification including Project No., Sample No., depth, date and time of sampling; ▪ Place sample containers into a chilled, enclosed, and secure container for transport to the laboratory; and ▪ Provide chain of custody documentation to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to the environmental laboratory.
Sample Containers & Holding Times	▪ Metals - 250g glass jar / refrigeration 4^{o}C / 6 months (maximum holding period); ▪ TRH/BTEX - 250g glass jar / refrigeration 4^{o}C / 14 days (maximum holding period); ▪ PAH - 250g glass jar / refrigeration 4^{o}C / 14 days (maximum holding period); and ▪ Asbestos – up to a 10 Litre resealable plastic (polyethylene) bag / no refrigeration / indefinite holding time.

Action	Description of Required Works
Field QA/QC	Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling program to ensure sampling precision and accuracy, which will be assessed through the analysis of 10% field duplicate/replicate samples. Appropriate sampling procedures will be undertaken to prevent cross contamination, in accordance with EI's Standard Operating Procedures Manual. This will ensure: ▪ Standard operating procedures are followed; ▪ Site safety plans are developed prior to works commencement; ▪ Split duplicate field samples are collected and analysed; ▪ Samples are stored under secure, temperature-controlled conditions; ▪ Chain of custody documentation is employed for the handling, transport and delivery of samples to the contracted environmental laboratory; and ▪ Contaminated soil, fill or groundwater originating from the site area is disposed in accordance with relevant regulatory guidelines. In total, field QA/QC will include one in 10 samples to be tested as intra-laboratory, blind field duplicates, one in 20 samples to be tested as inter-laboratory, split field duplicates, as well as one VOC trip blank, one VOC spike sample and one equipment wash blank sample per sample batch.
Laboratory Quality Assurance and Quality Control	The contract laboratory will conduct in-house QA/QC procedures involving the routine analysis of: ▪ Reagent blanks; ▪ Spike recoveries; ▪ Laboratory duplicates; ▪ Calibration standards and blanks; ▪ QC statistical data; and ▪ Control standards and recovery plots.
Achievement of Data Quality Objectives	Data quality objectives (**Table 6-1**) are to be achieved and an assessment of the overall data quality should be presented in the final validation report, in accordance with the EPA (2017) *Guidelines for the NSW Site Auditor Scheme*.

10.2 Validation Reporting

All fieldwork, chemical analyses, discussions, conclusions and recommendations will be documented in a validation report for the site. The validation report will be prepared in general accordance with requirements of the EPA (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and EPA (2017) *Guidelines for the NSW Site Auditor Scheme* and will confirm that the site has been remediated to a suitable standard for the proposed development.

The Site Validation Report will be submitted for Council and/or Site Auditor review at the completion of the remediation works program.

11. CONCLUSIONS

Based on the information available from previous investigations at the site, this RAP has been prepared to inform the remediation works at 859 Mamre Road, Kemps Creek NSW. Removal of contamination hotspots and further assessment of the western portion of the site is required to remediate the site to a condition suitable for any potential proposed land use(s) as part of future divestment / sale of the property.

The preferred approach involves excavation and off-site disposal of impacted fill materials. It is envisaged that the remediation works will be implemented in stages, as follows:

- Preliminaries and site establishment;
- Demolition of structures;
- Additional assessment;
- Hotspot excavation, removal and validation;
- Bulk excavation; and
- Reporting.

Material management procedures are provided to characterise soil for off-site disposal, and contingency measures are provided for any unexpected finds. In summary, EI considers that the site can be made suitable all potential future proposed land uses (including the most sensitive land use – residential with garden/accessible soils) through the implementation of the works described in this RAP.

12. STATEMENT OF LIMITATIONS

This report has been prepared for the exclusive use of Master Empire Constructions Pty Ltd (the client), being the only intended beneficiary of our work. The scope of the RAP is limited to that agreed with our client.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The methods and conclusions presented in this report are based on a limited investigation of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

REFERENCES

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EI (2019) *Detailed Site Investigation, 859 Mamre Road, Kemps Creek NSW*. Project No. E24287.E02_Rev0, dated 25 November, 2019.

EPA (1995) *Sampling Design Guidelines Environment Protection Authority of New South Wales*, Contaminated Sites Unit, EPA 95/59, September 1995.

Penrith Development Control Plan 2014.

Penrith Local Environmental Plan 2010.

US EPA (2006) *Data Quality Assessment: A Reviewers Guide – EPA QA/G-9R. USEPA Office of Environmental Information*, EPA/240/B-06/002, February 2006.

Appendix A – Figures & Tables of Results

eiaustralia Contamination | Remediation | Geotechnical	Drawn:	L.C.	Detailed Site Investigation 859 Mamre Road, Kemps Creek, NSW Site Locality Plan
	Approved:	J.H.	
	Date:	09-07-19	
	Scale:	Not To Scale	

Figure: A.1

Project: E24287 E02_Rev0

Suite 6.01, 55 Miller Street, PYRMONT 2009
PH (02) 9516 0722 FAX (02) 9518 5088

LEGEND

– — – Approximate site boundary

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

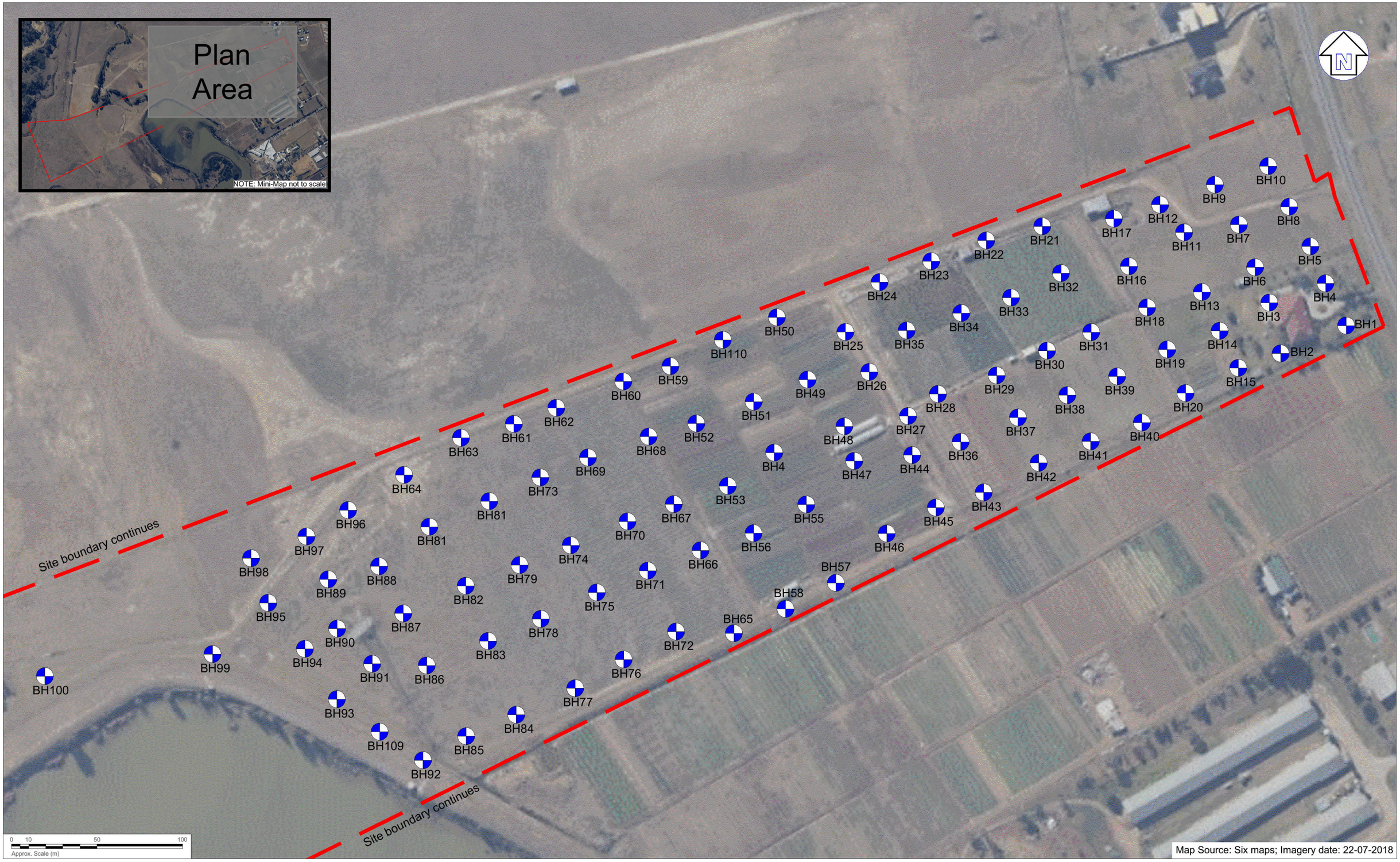
Drawn:	L.C.
Approved:	J.H.
Date:	08-08-19

Detailed Site Investigation
859 Mamre Road, Kemps Creek, NSW

Site Layout Plan

Figure:
A.2

Project:
E24287 E02_Rev0



LEGEND

- Approximate site boundary
- Approximate borehole location

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	L.C.
Approved:	J.H.
Date:	08-08-19

Detailed Site Investigation
859 Mamre Road, Kemps Creek, NSW

Sampling Location Plan (North-East part of site)

Figure: A.3

Project: E24287 E02_Rev0

LEGEND

- Approximate site boundary
- Approximate borehole location

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Drawn:	L.C.
Approved:	J.H.
Date:	08-08-19

Detailed Site Investigation
859 Mamre Road, Kemps Creek, NSW

Sampling Location Plan (South-West part of site)

Figure: A.4

Project: E24287 E02_Rev0

Table B.1 - Sample Register for 859 Mamre Road, Kemps Creek NSW

Sample ID	Date	PID	Scheduled Analysis #									Primary Laboratory	Secondary Laboratory
			Heavy Metals	TRH	BTEX	PAH	OCP / OPP	PCB	pH / CEC	Herbicides	Asbestos	SGS Batch No.	Envirolab Batch No.
Detailed Site Investigation - EI, 2019													
Soils													
BH1_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH1_0.7-0.8		0.3	X	X	X	X							
BH7_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH8_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH10_0.1-0.2		0.1							X				
BH10_1.0-1.1		-							X				
BH14_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH15_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH17_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH19_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH20_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH21_0.1-0.2		0.4	X	X	X	X	X	X			X		
BH21_0.6-0.7		0.7	X	X	X	X							
BH22_0.1-0.2		0.5	X	X	X	X	X	X			X		
BH23_0.1-0.2		0.4	X	X	X	X	X	X		X	X		
BH24_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH27_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH29_0.4-0.5		0.9	X	X	X	X							
BH30_0.1-0.2	24/07/2019	-	X	X	X	X	X	X			X		
BH32_0.1-0.2		-								X			
BH34_0.1-0.2		-								X			
BH37_0.1-0.2		-								X			
BH39_0.1-0.2		-								X			
BH45_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH45_0.3-0.4		0.2	X	X	X	X							
BH47_0.1-0.2		0.2	X	X	X	X	X	X			X		
BH50_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH52_0.1-0.2		0.1								X			
BH56_0.1-0.2		0.1								X			
BH57_0.1-0.2		0.2	X	X	X	X	X	X			X		
BH58_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH58_0.4-0.5		0.2	X	X	X	X							
BH59_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH62_0.1-0.2		0.1	X	X	X	X	X	X			X		
BH69_0.1-0.2		0.4								X			
BH71_0.1-0.2		0.5								X			
BH72_0.5-0.6		0.1	X	X	X	X							
BH82_0.4-0.5		0.2	X	X	X	X							
BH90_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH91_0.1-0.2		0.2	X	X	X	X	X	X			X		
BH95_0.1-0.2		0.2							X				
BH95_0.5-0.6		0.4							X			SE195772	-
BH95_3.8-3.9		0.4							X				
BH101_0.7-0.8		0.4	X	X	X	X							
BH103_0.1-0.2	25/07/2019	0.2	X	X	X	X	X	X			X		
BH105_0.1-0.2		0.2							X				
BH105_0.5-0.6		0.4							X				
BH105_4.0-4.1		0.4							X				
BH107_0.1-0.2		0.5	X	X	X	X	X	X			X		
BH108_0.6-0.7		0.3	X	X	X	X							
BH110_0.1-0.2		0.3	X	X	X	X	X	X			X		
BH110_0.6-0.7		0.4	X	X	X	X							
ASB 1	24/07/2019	-									X		
C1		-	X				X						
C2		-	X				X						
C3		-	X				X						
C4		-	X				X						
C5		-	X				X						
C6		-	X				X						
C7		-	X				X						
C8	24/07/2019	-	X				X						
C9		-	X				X						
C10		-	X				X						
C11		-	X				X						
C12		-	X				X						
C13		-	X				X						
C14		-	X				X						
C15		-	X				X						
C16		-	X				X						
C17		-	X				X						
C18		-	X				X						
C19		-	X				X						
C20		-	X				X						
C21		-	X				X						
C23	25/07/2019	-	X				X						
C24		-	X				X						
C25		-	X				X						
C26		-	X				X						
C27		-	X				X						
C28		-	X				X						
C29		-	X				X						
QD1/QT1	24/07/2019	-	X	X	X								222514
QD2/QT2	25/07/2019	-	X	X	X								

Table B.2 – Summary of Soil Investigation Results for 859 Mamre Road, Kemps Creek NSW **E24287.E02**

Sample ID	Material	Sampling Date	Heavy Metals								PAHs				BTEX				TRHs				OCPs	OPPs	Total PCBs	Herbicides				Physicochemical Parameters		Asbestos
			As	Cd	Cr#	Cu	Pb	Hg	Ni	Zn	Carcinogenic PAHs (as BaP TEQ)	Benzo(a)pyrene	Total PAHs	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylenes	F1	F2	F3	F4				2,4-D	MCPA	Picloram	pH	CEC	
BH1_0.1-0.2	Topsoil		7	<0.3	14	37	82	0.05	12	130	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH1_0.7-0.8	Natural		8	<0.3	16	18	18	<0.05	3.8	26	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH7_0.1-0.2	Topsoil		10	<0.3	16	13	21	<0.05	6.1	23	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH8_0.1-0.2	Topsoil		10	<0.3	17	21	24	<0.05	6.5	37	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH10_0.1-0.2	Fill		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4.8	15	N.A.
BH10_1.0-1.1	Natural		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	27	N.A.
BH14_0.1-0.2	Topsoil		9	<0.3	20	16	24	<0.05	4.9	55	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH15_0.1-0.2	Topsoil		11	<0.3	14	51	42	<0.05	5.3	210	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH17_0.1-0.2	Topsoil		9	<0.3	22	11	24	<0.05	5.2	86	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH19_0.1-0.2	Topsoil		8	<0.3	21	16	20	<0.05	5.2	43	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH20_0.1-0.2	Topsoil		10	<0.3	19	19	24	<0.05	5.6	68	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH21_0.1-0.2	Topsoil		10	<0.3	14	12	26	<0.05	5.4	160	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH21_0.6-0.7	Natural		7	<0.3	13	22	14	<0.05	6.1	29	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH22_0.1-0.2	Fill		4	1.4	37	51	130	<0.05	24	8100	1.4	1	9.3	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH23_0.1-0.2	Fill		8	<0.3	12	9.3	20	<0.05	3.5	39	0.7	0.5	3.9	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	No
BH24_0.1-0.2	Fill		7	<0.3	13	8.8	21	<0.05	4.6	29	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH27_0.1-0.2	Topsoil		9	<0.3	19	14	19	<0.05	3.7	31	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH29_0.4-0.5	Topsoil		9	<0.3	19	24	19	<0.05	7.1	24	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH30_0.1-0.2	Topsoil	24/07/2019	8	<0.3	28	16	23	<0.05	4	42	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH32_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH34_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH37_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH39_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH45_0.1-0.2	Topsoil		10	<0.3	29	13	26	<0.05	3.5	40	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH45_0.3-0.4	Natural		8	<0.3	17	15	15	<0.05	3.5	17	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH47_0.1-0.2	Topsoil		11	<0.3	21	15	30	<0.05	6.3	38	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH50_0.1-0.2	Fill		8	<0.3	18	12	22	<0.05	5.3	38	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH52_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH56_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH57_0.1-0.2	Topsoil		9	<0.3	16	21	20	<0.05	6.1	30	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH58_0.1-0.2	Topsoil		8	<0.3	16	22	21	<0.05	6.2	52	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH58_0.4-0.5	Natural		7	<0.3	15	16	11	<0.05	5.1	12	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH59_0.1-0.2	Fill		1	<0.3	1.8	1	4	<0.05	<0.5	54	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH62_0.1-0.2	Topsoil		6	<0.3	21	22	53	<0.05	23	1200	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH69_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH71_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	N.A.	N.A.	N.A.
BH72_0.5-0.6	Natural		7	<0.3	13	13	13	<0.05	4.1	16	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH82_0.4-0.5	Natural		8	<0.3	12	18	13	<0.05	5.4	27	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH90_0.1-0.2	Topsoil		7	<0.3	18	14	21	<0.05	4.9	47	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH91_0.1-0.2	Topsoil		7	<0.3	17	19	21	<0.05	9.7	54	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH95_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7.1	15	N.A.
BH95_0.5-0.6	Natural		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7.3	19	N.A.
BH95_3.8-3.9	Natural		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7.4	14	N.A.
BH101_0.7-0.8	Natural		5	<0.3	8.5	14	13	<0.05	8.2	22	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH103_0.1-0.2	Fill	25/07/2019	8	<0.3	8.6	18	28	<0.05	6.3	46	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH105_0.1-0.2	Topsoil		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6.7	3.5	N.A.
BH105_0.5-0.6	Fill		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6.9	4.4	N.A.
BH105_4.0-4.1	Natural		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	<0.5	<0.5	<0.5	<0.5	7	12	N.A.
BH107_0.1-0.2	Topsoil		4	<0.3	8.3	10	11	<0.05	5.6	12	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH108_0.6-0.7	Natural		7	<0.3	19	17	33	<0.05	7	21	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BH110_0.1-0.2	Fill		2	0.5	11	11	120	<0.05	3.5	2700	<0.3	0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<1	<1.7	<1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No
BH110_0.6-0.7	Natural		6	<0.3	20	16	17	<0.05	2.7	21	<0.3	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
ASB 1	Fragment	24/07/2019	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Statistical Analysis																																
Maximum Concentration			11	1.4	37	51	130	0.05	24	8100	1.4	1	9.3	0.1	0.1	0.1	0.1	0.3	25	25	90	120	1	1.7	1	0.5	0.5	0.5	0.5	7.4	27	NC
Mean			7.58	0.34	16.78	17.95	28.97	0.05	6.39	377.19	0.34	0.1	1.1	0.1	0.1	0.1	0.1	0.3	25	25	90	120	1	1.7	1	0.5	0.5	0.5	0.5	6.53	13.74	NC
SILs																																
HIL A - *Residential with garden/accessible soil*			100	20	100 Cr(VI)	6,000	300	40	400	7,400	3	NR	300										NR	NR	1	600	900	600	4,500			
HSL A - *low to high density residential*			Source depths (0 m to <1 m BGL)											5	0.7	480	NL	110	50	280											
Soil texture classification – Clay [1]			Source depths (1 m to <2 m BGL)											NL	1	NL	NL	310	90	NL											
			Source depths (2 m to < 4 m BGL)											NL	2	NL	NL	NL	150	NL											
			Source depths (4 m + BGL)											NL	3	NL	NL	NL	290	NL											
EIL/ESL - *Commercial / Industrial*			100	NR	190	90	1,100	NR	30	70	NR	33 [4]	NR	170	50	85	70	105	180	120	300	5,600	180	NR	NR							
Management Limits – Residential, parkland and public open space, Coarse grained soil texture [1]																			800	1,000	3,500	10,000										
Asbestos contamination HSL Bonded ACM (%w/w)																																<0.01
Asbestos contamination HSL Non Bonded / Friable Asbestos (%w/w)																																<0.001

Notes: All results are recorded in mg/kg, unless otherwise specified.

Highlighted value indicates concentration exceeds HIL / HSL

Highlighted value indicates concentration exceeds EIL / ESL

Highlighted value indicates concentration exceeds HIL / HSL and EIL / ESL

HIL D NEPM 2013 'HIL D' - Health Investigation Level - Commercial/Industrial land-use scenario assumes typical commercial or light industrial properties, consisting of single or multi-storey buildings supported by ground-level slabs.

HSL D Health Screening Level

EIL Ecological Investigation Level

ESL Ecological Screening Level

Thresholds are for Chromium VI.

NR No current published criterion.

NL 'Not Limiting'

ND 'Not detected' i.e. all concentrations of the compounds within the analyte group were found to be below the laboratory limits of detection.

NA 'Not Analysed' i.e. the sample was not analysed.

1 As strata is predominantly clay, fine grained soil values were applied.

2 Ecological values relate to selected analytes of pH / CEC analysed across the site.

3 Conservative EIL value used.

4 Value derived from CRC Care Report No. 39, Table 11.

F1 TRH C_6-C_{10} less the sum concentration of BTEX.

F2 TRH $C_{>10}$-C_{16} less the concentration of Naphthalene.

F3 TRH $C_{>16}$-C_{34}

F4 TRH $C_{>34}$-C_{40}

Table B.3 – Summary of Composite Soil Investigation Results for 859 Mamre Road, Kemps Creek NSW

Sample ID		Sampling Depth (@ m BGL)	Material	Sampling Date	Heavy Metals								Organochlorine Pesticides (OCPs)	Organophosphate Pesticides (OPPs)
					Arsenic	Cadmium	Chromium#	Copper	Lead	Mercury	Nickel	Zinc		
C1	BH2	0.1-0.4	Topsoil	24/07/2019	7	<0.3	14	18	20	<0.05	8.3	41	<1	<1.7
	BH3													
	BH4													
C2	BH5	0.1-0.2	Topsoil / Fill	24/07/2019	9	<0.3	19	14	26	<0.05	5.3	34	<1	<1.7
	BH6													
	BH13													
C3	BH9	0.1-0.2	Topsoil	24/07/2019	9	<0.3	15	17	18	<0.05	7.8	37	<1	<1.7
	BH10													
	BH12													
C4	BH11	0.1-0.2	Topsoil	24/07/2019	11	<0.3	21	12	26	<0.05	5.1	32	<1	<1.7
	BH16													
	BH18													
C5	BH31	0.1-0.2	Topsoil	24/07/2019	8	<0.3	24	20	22	<0.05	3.9	38	<1	<1.7
	BH39													
	BH40													
C6	BH32	0.1-0.2	Topsoil	24/07/2019	10	<0.3	18	18	21	<0.05	3.9	36	<1	<1.7
	BH33													
	BH34													
C7	BH30	0.1-0.2	Topsoil	24/07/2019	11	<0.3	20	23	24	<0.05	4.6	49	<1	<1.7
	BH38													
	BH41													
C8	BH37	0.1-0.2	Topsoil	24/07/2019	11	<0.3	22	22	30	<0.05	3.9	38	<1	<1.7
	BH42													
	BH43													
C9	BH28	0.1-0.2	Topsoil	24/07/2019	9	<0.3	22	15	20	<0.05	3.7	32	<1	<1.7
	BH35													
	BH36													
C10	BH25	0.1-0.2	Topsoil / Fill	24/07/2019	7	<0.3	17	13	19	<0.05	4.5	26	<1	<1.7
	BH26													
	BH44													
C11	BH48	0.1-0.2	Topsoil	24/07/2019	9	<0.3	22	17	25	<0.05	5.3	38	<1	<1.7
	BH49													
	BH51													
C12	BH46	0.1-0.2	Topsoil	24/07/2019	9	<0.3	19	19	22	<0.05	5.5	52	<1	<1.7
	BH54													
	BH55													
C13	BH52	0.1-0.2	Topsoil	24/07/2019	9	<0.3	21	18	22	<0.05	5.7	53	<1	<1.7
	BH53													
	BH56													
C14	BH60	0.1-0.2	Topsoil / Fill	24/07/2019	8	<0.3	18	11	21	<0.05	5.2	230	<1	<1.7
	BH67													
	BH68													
C15	BH65	0.1-0.2	Topsoil	24/07/2019	10	<0.3	21	12	24	<0.05	5.7	27	<1	<1.7
	BH66													
	BH72													
C16	BH69	0.1-0.2	Topsoil	25/07/2019	8	<0.3	19	15	19	<0.05	5.1	35	<1	<1.7
	BH70													
	BH71													
C17	BH73	0.1-0.2	Topsoil	25/07/2019	10	<0.3	30	18	24	<0.05	4.9	29	<1	<1.7
	BH74													
	BH75													
C18	BH76	0.1-0.2	Topsoil	25/07/2019	8	<0.3	20	15	23	<0.05	5	31	<1	<1.7
	BH77													
	BH78													
C19	BH79	0.1-0.2	Topsoil	25/07/2019	10	<0.3	24	17	21	<0.05	4.1	28	<1	<1.7
	BH80													
	BH81													
C20	BH82	0.1-0.2	Topsoil	25/07/2019	7	<0.3	24	11	21	<0.05	4.3	22	<1	<1.7
	BH83													
	BH84													
C21	BH85	0.1-0.2	Topsoil	25/07/2019	7	<0.3	18	13	19	<0.05	5	28	<1	<1.7
	BH86													
	BH87													
C23	BH88	0.1-0.2	Topsoil / Fill	25/07/2019	8	<0.3	22	9.9	20	<0.05	4	25	<1	<1.7
	BH96													
	BH97													
C24	BH89	0.1-0.2	Topsoil	25/07/2019	7	<0.3	18	9.9	24	<0.05	5.7	23	<1	<1.7
	BH95													
	BH98													
C25	BH93	0.1-0.2	Topsoil	25/07/2019	6	<0.3	12	23	14	<0.05	5.2	42	<1	<1.7
	BH94													
	BH109													
C26	BH92	0.1-0.2	Topsoil	25/07/2019	7	<0.3	23	9.7	20	<0.05	4	23	<1	<1.7
	BH99													
	BH100													
C27	BH101	0.1-0.2	Topsoil / Fill	25/07/2019	4	<0.3	7.4	9.3	12	<0.05	5.6	16	<1	<1.7
	BH102													
	BH104													
C28	BH105	0.1-0.2	Topsoil	25/07/2019	3	<0.3	9.9	6.9	10	<0.05	4.2	9.7	<1	<1.7
	BH106													
	BH107													
C29	BH61	0.1-0.2	Topsoil / Fill	25/07/2019	5	<0.3	12	13	20	<0.05	8.2	31	<1	<1.7
	BH63													
	BH64													
Statistical Analysis														
Maximum Concentration					11	0.3	30	23	30	0.05	8.3	230	1	1.7
Mean					8.11	0.3	19.01	14.99	20.96	0.05	5.13	39.49	1	1.7
SILs														
HIL A - *Residential with garden/accessible soil*					33	6.7	33.3 Cr(VI)	2,000	100	133	133	2,467	NR	NR
EILs / ESLs - *Urban Residential*[1]					33	NR	63	30	367	NR	13	23	NR	NR

Notes: All results are recorded in mg/kg, unless otherwise specified.

	Highlighted value indicates concentration exceeds HIL / HSL
	Highlighted value indicates concentration exceeds EIL / ESL
	Highlighted value indicates concentration exceeds HIL / HSL and EIL / ESL
HIL	NEPM 2013 'HIL A" - Health Investigation Level - residential land-use scenario.
HSL D	Health Screening Level
EIL	Ecological Investigation Level
ESL	Ecological Screening Level
#	Thresholds are for Chromium VI.
NR	No current published criterion.
NL	'Not Limiting'
ND	'Not detected' i.e. all concentrations of the compounds within the analyte group were found to be below the laboratory limits of detection.
NA	'Not Analysed' i.e. the sample was not analysed.
1	Ecological values relate to selected analytes of pH / CEC analysed across the site.
2	Conservative EIL value used.

Appendix B – Unexpected Finds Protocol

Unexpected Finds Protocol