

Remediation Action Plan

Lot 2 in the proposed subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow
NSW



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Executive summary

Background

A contamination investigation undertaken at Lot 2 in the proposed subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow NSW by Envirowest Consulting Pty Ltd and reported on 17 November 2021 (report number R12227c1), identified arsenic and nickel at levels exceeding residential land-use thresholds for human health in fill material on the site. Levels of zinc and chromium (III) exceeded ecological thresholds for residential land-use. Naturally occurring asbestos (NOA) was identified in rock across the investigation area. A Remediation Action Plan (RAP) is required to develop an effective plan to remediate the impacted areas to enable residential land-use.

Objective

Undertake remediation works to enable the site to be suitable for residential land-use.

Summary

The site is located in a residential area in Lucknow and was rural-residential land at the time of site inspection. The site has a land use history of mining from the 1860's until the 1900's. Fill has been introduced to the site from mine waste and other sources.

The soil across the site is well vegetated with bare patches occurring in areas of exposed serpentinite rock and recent soil disturbance. Surface cover on the site consisted of broadleaved weeds including plantain, Paterson's curse and pasture grasses. No surface staining or odours were detected on the site.

On-site containment is considered the preferred option for remediation of the impacted soil. The impacted material will be encapsulated by a geotextile barrier and 500mm of excavated natural material or a hard impermeable layer.

Encapsulation will not be a health risk due to low mobility and non-volatile nature of contaminants. Ecological impacts will be low under encapsulation as the contaminants are stable and disturbance will not occur.

Remediation works will be supervised by an Environmental Scientist and comply with EPA guidelines including *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 2020), NEPC (1999) *National Environment Protection (Assessment of Site Contamination) Measure 1999 (Revised 2013)* and *Remediation of Contaminated Land State Environmental Planning Policy (SEP55)*.

Implementation of the described strategies will ensure the successful remediation of the site for future residential land-use.

Contents

Executive summary	3
1. Introduction	5
2. Objectives	5
3. Site identification	5
4. Site history	6
5. Site condition and surrounding environment.....	6
6. Previous investigations.....	9
7. Area requiring remediation.....	9
8. Conceptual model of the contamination	13
9. Remediation options.....	11
10. Remediation plan.....	13
11. Remediation works issues	17
12. Remediation work validation	20
13. Other issues	21
14. References.....	23

Figures

Figure 1. Site locality

Figure 2. Site plan with exceedances requiring remediation

Appendices

Appendix 1. Data quality indicators

Appendix 2. Soil sampling protocols

1. Introduction

A contamination investigation undertaken at Lot 2 in the proposed subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow NSW by Envirowest Consulting Pty Ltd and reported on 17 November 2021 (report number R12227c1), identified arsenic and nickel at levels exceeding residential land-use thresholds for human health in fill material on the site. Levels of zinc and chromium (III) exceeded ecological thresholds for residential land-use. Naturally occurring asbestos (NOA) was identified in rock across the investigation area. A Remediation Action Plan (RAP) is required to develop an effective plan to remediate the impacted areas to enable residential land-use.

2. Objectives

The objective of the investigation was to determine the most suitable method of remediation.

3. Scope of work

Envirowest Consulting Pty Ltd has been commissioned by Ben Taylor to prepare a RAP for the remediation of Lot 2 in the proposed subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow NSW and:

- Set remediation goals based on land-use threshold
- Propose a cost effective and workable remediation method
- Establish a validation procedure for the site
- Ensure remediation works comply with:
 - Consultants reporting on contaminated land (EPA 2020)*
 - The Contaminated Land Management Act (1997)*
 - Remediation of Contaminated Land State Environmental Planning Policy (SEPP55)*
 - National Environment Protection (Assessment of Site Contamination) Measure 1999 NEPC (2013)*

3. Site identification

Address	4625 Mitchell Highway Lucknow NSW
Deposited plans	Lot 2 in the proposed subdivision Lot 1 DP880582
Latitude and longitude	-33.35° 149.16°
Geographic coordinates	55H E701051m N6308251m
Client	Ben Taylor
Owner	Taylor Family
Current occupier	Taylor Family
Area	2,626m ²
Local government area	Orange City Council
Current zoning	RU5 – Village (Orange LEP 2012)
Trigger for investigation	Change in land-use
Locality map	Figure 1

5. Site history

5.1 Land-use

The site is located in a residential area in Lucknow along the Mitchell Highway on a former mining site. The site was being used for grazing of goats and sheep at the time of site inspection.

5.2 Summary of council records

The site is mapped in a moderately high groundwater vulnerability area (Orange LEP 2012).

5.3 EPA contaminated sites list

The investigation area is not listed on the NSW EPA register of contaminated sites (3 February 2021) or sites notified to the EPA (14 January 2021).

5.4 Sources of information

Site inspection 18 August 2020 by Ashleigh Adams of Envirowest Consulting

NSW EPA records of public notices under the CLM Act 1997

Soil and geological maps

Aerial photographs

Orange City Council LEP 2012

5.5 Aerial photographs

Year	Comment
1964	No buildings or structures are visible in the investigation area. Areas of possible soil disturbance are evident across the site expected to be associated with mining in the area. Soil disturbance expected to be mining activity is evident in the land north, south and west of the site with orchards beyond to the west. Land to the north east appears to form part of Lucknow village.
1972	Areas of fill stockpiles are evident in the southern section of the site expected to be associated with mining activity. A dwelling is visible east of the investigation area. Agricultural grazing is expected to occur on land surrounding the site.
1984	Mining activity appears to have ceased on the site. Established trees are visible north east of the investigation area. No evidence of mining activity occurring adjacent the site is visible. Residential dwellings have been constructed in the surrounding area.
1994	The investigation area now appears to be used for five dog runs with a shelter/kennel in each run and a fence dividing the runs. No other infrastructure is evident on the site. Further residential development has occurred in the surrounding area.
2003	No change
2020	No change

5.6 Chronological list of site uses

A review of historical aerial photographs and documents identified gold mining on the site had begun in the 1860's with Aladdins Shaft constructed on the site. Extracted overburden was expected to be disposed on-site. Ore was crushed in adjacent areas and some tailings may have been returned to the site. Aladdins Shaft was determined to be located in the western section of the site. The investigation area has been used as part of a larger rural-residential property since the 1990's with grazing of sheep and goats and keeping of greyhounds.

5.7 Buildings and infrastructure

Infrastructure known to occur on the site included fences associated with dog runs located on the site.

5.8 Spills, losses or discharges

No records for spills or losses on the site were available. No records for discharges to land, water or air were available.

5.9 Relevant complaint history

Nil

5.10 Historical neighbouring land-use

North – Residential village

South – Mining and agricultural grazing

East – Residential with Mitchell Highway

West – Mining and agricultural grazing

5.11 Contaminant sources

Potential exists for contaminating activities to have been undertaken on site which may impact on the suitability for the proposed land-use. The historic mining land-use may have resulted in mobilisation of heavy metals. Naturally occurring asbestos is known to occur in the locality.

5.12 Contaminants of concern

Based on previous investigations the contaminants of concern are:

- Heavy metals (arsenic, chromium, nickel and zinc)
- Naturally occurring asbestos

5.13 Integrity assessment

The site history was obtained from a site inspection and history review. The information is consistent with the current site condition and to the best of the assessor's knowledge is accurate.

6. Site condition and surrounding environment

6.1 Site inspection

The site was inspected by Ashleigh Adams of Envirowest Consulting Pty Ltd on 18 August 2020.

6.2 Land-use

The site was being used for grazing of goats and sheep at the time of inspection. The site forms part of a larger residential lot with a dwelling.

6.3 Current neighbouring land-use

North – Residential and Orange Mens Shed

South – Large lot residential

East – Residential with Mitchell Highway beyond

West – Rural-residential with grazing

6.4 Surface cover and vegetation

Surface cover on the site comprised broadleaved weeds including capeweed and pasture grasses.

6.5 Evidence of visible contamination

Bare patches of exposed rock including naturally occurring asbestos in the form of serpentinite rock were identified across the site. The serpentinite rock contained naturally occurring asbestos excavated in mining activities. Fill was identified across the site.

No other signs of visible contamination such as discolouration or staining was identified on the surface of the site or within borehole cuttings.

6.6 Topography

The site is located on a middle to lower slope with elevations ranging from 882 to 886m.

6.7 Soils and geology

The site is located within the Spring Hill Soil Landscape. Krasnozems are the dominant soils with yellow podzolic on lower slopes and solodic soils in drainage lines.

The site occurs with the Oakdale formation including Dacite ultramafics, andesite, siltstone and mafic volcanics. The Lucknow Fault is located within the Oakdale formation. The fault separates hanging wall serpentinite from the footwall volcanic rocks of the Oakdale formations. Naturally occurring asbestos (NOA) is known to occur within the serpentinite rock, especially with the dacite ultramafic contact along the fault. The volcanic rocks of the Oakdale Formation on the footwall are competent and subject to brittle deformation, whereas the hanging wall serpentinite is far less competent, and more subject to ductile deformation.

The investigation area falls within the Macquarie Arc known to contain large gold deposits. Historically 11 tonne of gold has been extracted from the Lucknow Fault in a matrix of quartz, gold, pyrite and calcite veins along the fault line.

Fill was identified across the site to the investigation depth and comprised silty clay, sandy clay, silty sand (weathered rock). The final depth of fill was not determined.

6.8 Water

6.8.1 Surface water

Surface water is expected to flow north east across the site into councils stormwater system. Bakers Creek is located west of proposed Lot 2 and drains into Summer Hill Creek approximately 500m north of the site.

6.8.2 Groundwater

No groundwater bores are located on the site. The NSW Office of Water groundwater database identifies one bore (GW803715) located within 500m from the site located approximately 120m north east. The bore is licensed for stock and domestic and has a standing water level from 20m and water bearing one from 36m.

6.9 Evidence of possible naturally occurring contaminants

No evidence of natural sources of polycyclic aromatic hydrocarbons (PAH) were identified.

The site is not mapped as an acid sulphate soil risk (NSW SEED Portal accessed 16 September 2020).

The site is mapped as a geological unit with high naturally occurring asbestos (NOA) potential (NSW SEED Portal accessed 16 September 2020).

6.10 Environmentally sensitive features or habitats

Bakers Creek is located approximately 15m west of proposed Lot 2. Bakers Creek drains into Summer Hill Creek approximately 500m to the north and is impacted by upstream residential and agricultural land-uses.

7. Previous investigations

7.1 Envirowest Consulting Pty Ltd (2020) Preliminary contamination investigation of Lot 2 in the proposed subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow NSW (report number R12227c1)

A preliminary contamination investigation was undertaken of the site in 2020 by Envirowest Consulting Pty Ltd. The site is located in a residential area in Lucknow and was rural-residential land at the time of site inspection. The site has a land use history of mining from the 1860's until the 1900's. Fill has been introduced to the site from mine waste and other sources.

The soil across the site is well vegetated with bare patches occurring in areas of exposed serpentinite rock and recent soil disturbance. Surface cover on the site consisted of broadleaved weeds including plantain, Paterson's curse, and pasture grasses. No surface staining or odours were detected on the site.

An abandoned car and trailer were identified in the southern central section of the site. The abandoned refuse is an amenity hazard.

The soil profile was described by drilling eight boreholes to a depth of 1,000mm or drill refusal. The profile was inspected, described and the presence of fill identified. Fill was identified across the site to depths greater than 2m. The fill comprised silty clay with gravel and rock including mine overburden and waste.

Four soil samples exceeded HIL thresholds and three exceeded EIL thresholds for arsenic. Seven soil samples exceeded HIL and EIL thresholds for nickel. One soil samples exceeded EIL thresholds for zinc. Twelve samples collected exceeded the adopted EIL thresholds for chromium (III).

The levels of all other analytes in the soil samples collected were below adopted residential land-use thresholds.

Asbestos was visually identified in ultramafic rock samples collected from on-site.

8. Area requiring remediation

Arsenic and nickel impacted fill was identified across the site exceeding the adopted health and ecological thresholds for residential land-use. Zinc and chromium (III) was identified across the site exceeding adopted ecological thresholds for residential land-use. Naturally occurring asbestos was visually identified in ultramafic rock samples collected from on-site.

The extent of the impacted area is expected to be within the fill material covering the site.

9. Conceptual site model

9.1 Sources of contamination

Potential exists for contaminating activities to have been undertaken on site which may impact on the suitability for the proposed land-use. The historic mining land-use may have resulted in mobilisation of heavy metals. Naturally occurring asbestos is known to occur in the locality.

9.2 Contaminants of concern

Based on previous investigations the contaminants of concern are:

- Heavy metals (arsenic, chromium, nickel, zinc)
- Naturally occurring asbestos

9.3 Potential receptors

The proposed land-use of the site is residential. The site has historically been used as a mining operation.

Human receptors include:

- Residents
- Visitors
- Construction workers
- Intrusive maintenance workers

Ecological receptors include

- Flora and fauna on the site and adjacent to the site
- Aquatic flora and fauna receptors on-site and off-site

9.4 Exposure pathways

Pathways for exposure to contaminants are:

- Dermal contact following soil disturbance
- Ingestion and inhalation after soil disturbance
- Surface water and sediment runoff into waterways
- Leaching of contaminants into the groundwater
- Direct contact of flora and fauna with the soil

9.5 Source receptor linkages

Potential source pathway receptor linkages are identified to enable evaluation of any adverse impact on human health or ecology.

The proposed land-use of the site is a residential subdivision and human receptors to the investigation area are likely. Proposed users of the site may have a risk of exposure if contaminants are present and the soil is disturbed. Construction workers, visitors, intrusive maintenance workers and construction workers to the site may potentially be receptors to soil contaminants through direct contact to soil which includes ingestion and dermal contact.

The contaminants of concern are not volatile and inhalation of vapours of soil material is not considered a pathway for exposure receptor linkage. Inhalation of asbestos fibres from NOA may occur as a result of soil disturbance and dust production. Major soil disturbance before and after the development of the site is considered unlikely. Soil disturbance during construction and development of the site is expected to be accompanied by erosion control measures which will reduce the incidence of dust production.

Vegetation on the site may be potential receptors to soil contamination through direct uptake of contaminants.

The source receptor linkage to aquatic organisms and ecosystems is considered incomplete as the site is well vegetated and movement of sediments from the site is unlikely. During construction work it is expected that erosion control measures will be implemented and movement of sediment off site will be unlikely. Following development of the site it is expected that vegetation will be re-established and will control sediment movement from the site. The nearest waterway to the site is Bakers Creek which is located west

of the site. It is not expected that contaminants from the site will be transported to aquatic receptors within the creek as it is located across slope and upslope. Bakers Creek drains into Summer Hill Creek approximately 500m north of the site.

Groundwater is not identified as a potential receptor to contamination. Groundwater bores are located greater than 100m meters from the site. Contaminants are expected to originate from the soil surface and groundwater levels in the area are at depths greater than 3m below the soil surface.

Source/contaminants	Transport	Potential exposure pathways	Receptors
<ul style="list-style-type: none"> ■ Former mining activities (heavy metals) ■ Naturally occurring asbestos 	<ul style="list-style-type: none"> ■ Wind ■ Sedimentation □ Groundwater 	<ul style="list-style-type: none"> ■ Direct contact (ingestion and absorption) (human and environment) ■ Inhalation □ Runoff □ Leaching 	<ul style="list-style-type: none"> ■ Construction workers ■ Residential ■ Visitors ■ Intrusive maintenance workers ■ Vegetation
■ Potential, □ unknown/unlikely			

10. Remediation options

The NSW EPA (2017) hierarchical order for soil remediation and management is:

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

The appropriateness of the remediation option depends on technical feasibility, local factors and cost.

10.1 On-site treatment

10.1 Heavy metal impacted soils

Treatment on-site would involve:

- Soil washing process
- Validation of the remediated soil and excavation

Advantages: Soil remains on the site.

Disadvantages: Variable rate of effectiveness and not proven technology, high cost, not suitable for fine grained soils, high capital costs.

10.2 Naturally occurring asbestos impacted soil

On-site treatment is not an option.

Advantages: Nil

Disadvantages: Not technically feasible

10.2 Excavation, off-site treatment and returned to the site

10.2.1 Heavy metal impacted soil

This would involve:

- Excavation of the material
- Transportation to a licensed facility for treatment
- Validation of the excavated material and excavated areas
- Return soil to the site

Advantages: Reduces the risk of contaminant migration.

Disadvantages: Not a viable alternative as no remediation facilities nearby able to accept the contaminants. Cost unknown.

10.2.2 Naturally occurring asbestos impacted soil

Off-site treatment is not an option.

Advantages: Nil

Disadvantages: Not technically feasible.

10.3 Excavation and off-site disposal

10.3.1 Heavy metals impacted soil

The contaminated material could be excavated and transported to a landfill.

This would involve:

- Excavation of the material
- Transportation to a suitably licensed facility
- Validation of the excavated areas
- Replacement with clean fill

Advantages: No on-going site liability or restrictions on land-use.

Disadvantages: Requires use of scarce landfill space. Cost can be significant if large volume of material requires excavation and transport. May require importation of fill to replace excavated material.

10.3.2 Naturally occurring asbestos impacted soil

Asbestos containing materials may be removed in accordance with SafeWork NSW requirements and disposed as asbestos waste to a licensed landfill.

The removal areas will require a visual inspection to ensure all asbestos containing materials have been removed from the investigation area.

Advantages: Reduces the risk of ongoing liability

Disadvantages: Cost. Large amount of material to be removed.

10.4 On-site containment

10.4.1 Heavy metal impacted soil

This would involve:

- Installation of a barrier over the impacted soil layer
- Placing of soil cap to a depth of 500mm or impermeable hard layer (concrete)
- Restrictions placed on excavation into the impacted soil

Advantages: This option has the advantage of reducing the risk of contaminant migration and adverse impacts. Construction costs are relatively low.

Disadvantages: On-going liability for the material remaining on the site and the ongoing requirement to monitor the material on-site.

10.4.2 Naturally occurring asbestos impacted soil

This would involve:

- Installation of a barrier over the impacted soil layer
- Placing of soil cap to a depth of 500mm
- Restrictions placed on excavation into the impacted soil

Advantages: Construction costs are relatively low.

Disadvantages: On-going liability with management plan

10.5 Preferred management option

On-site containment is considered the preferred option for remediation of the impacted soil. The impacted material will be encapsulated by a geotextile barrier and 500mm of excavated natural material or a hard impermeable layer.

Encapsulation will not be a health risk due to low mobility and non-volatile nature of contaminants. Ecological impacts will be low under encapsulation as the contaminants are stable and disturbance will not occur.

11. Remediation plan

11.1 Remediation goal

To establish site conditions that will be an acceptable risk to human health or the environment from contaminated soil at the site. The proposed land-use is residential.

11.2 Remediation criteria

11.2.1 Soil

The proposed land-use of the site is rural-residential with access to soil which will include a residential dwelling and associated yard, landscaped areas including ornamental gardens and vegetable beds and driveway. The most applicable land-use category for the proposal is considered residential.

The assessment criteria for the soil data in residential sites is described in Table 1A(1) of *Guideline on Investigation Levels for Soil and Groundwater* (NEPC 1999). The criteria lists health investigation levels (HIL) for a range of land-uses. The appropriate initial comparison for the site is column 1, *residential with access to soil (HIL A)*. The HIL A threshold is the most conservative threshold and considered appropriate for the proposed land-use of the site.

Ecological investigation levels (EIL) have been developed for the protection of terrestrial ecosystems for selected metals and organic substances in the soil in the guideline (NEPC 1999). The EILs consider the properties of the soil and contaminants and the capacity of the local ecosystem to accommodate increases in contaminant levels. Typical CEC value for the site is >20-30cmol(+)/kg and pH values of between 5 and 5.5 (eSPADE 2019). The proposed land-use is residential (urban residential areas and open space). The contaminants have been identified in the soil for at least two years and are considered aged.

Ecological Investigation Levels (EILs) are obtained by adding the added contaminant limit (ACL) and the ambient background concentration (ABC). The ABC values were estimated from typical background levels of metals in the surface soil of the locality. EILs vary with land-use and apply to contaminants up to 2m depth below the surface. The EILs for residential land-use are listed in Tables 2 and 3.

Table 2. Soil assessment criteria (mg/kg)

Analyte	Residential land-use with access to soil threshold <i>HIL A (NEPC 1999)</i>	EIL – Urban residential and public open space
Arsenic	100	100
Chromium	100 ¹	405 ²
Nickel	300	1,100
Zinc	7,400	375

¹ - Chromium (VI), ² - Chromium (III)

Table 3. EIL Calculation sheet, residential land-use

Analyte	Rationale	ACL (mg/kg)	ABC (mg/kg)	EIL (mg/kg)
Arsenic	Aged	100	-	100
Chromium (III)	Clay content >10%	400	5	405
Nickel	CEC 30cmol/kg	370	5	375
Zinc	CEC 30cmol/kg, pH 5.5	350	25	375

ACL - added contaminant limit, ABC - ambient background concentration, EIL - Ecological investigation limit (ACL+ABC)

The health-based investigation levels of asbestos in the soil for residential land-use, for the substances for which criteria are available, are listed in Table 4, as recommended in the NEPM (1999). The surface is considered the depth likely to be disturbed by routine activities or 500mm.

Table 4. Health screening levels for asbestos contamination in soil

Form of asbestos	Health Screening Levels (w/w) Residential
All forms of asbestos	No visible asbestos for surface soil

11.2.2 Waste material

Any waste that is disposed off-site will be classified against the NSW EPA (2014) guidelines. Total levels will be made against the major or limiting contaminants to determine the classification.

Waste classification thresholds are described in Table 5.

Table 1. Waste classification (DECC 2014)

Analyte	General solid – CT1 (mg/kg)	Restricted solid – CT2 (mg/kg)
Arsenic	100	400
Cadmium	20	80
Copper	NA	NA
Chromium (total)	NA	NA
Lead	100	400
Nickel	40	160
Zinc	NA	NA
Mercury	4	16
PAH (total)	200	800
TRH C6-C9	650	2,600
TRH C10-C36	10,000	40,000
PCB	50	50

The excavated material is expected to be classified as asbestos waste.

11.2.3 Airborne fibres

Monitoring of airborne fibres will be undertaken at selected locations during soil disturbance work and compared with acceptable limits (Table 5).

Table 5. Criteria for asbestos fibres action levels (SafeWork NSW 2019)

Action level (airborne asbestos fibres/mL)	Control	Action
Less than 0.01	No new control measures are necessary	Continue with control measures
Between 0.01 and 0.02	1. Review	Review control measures
	2. Investigate 3. Implement	Investigate the cause Implement controls to eliminate or minimise exposure and prevent further release
More than 0.02	1. Stop removal work 2. Notify regulator	Stop removal work Notify the relevant regulator by phone followed by fax or written statement that work has ceased and the results of the air monitoring
	3. Investigate the cause	Conduct a thorough visual inspection of the enclosure (if used) and associated equipment in consultation with all workers involved with the removal work.
	4. implement controls to eliminate or minimise exposure and prevent further release	Extend the isolated/barricaded area around the removal area/enclosure as far as reasonable practicable (until fibre levels are at or below 0.01 fibres/ml), wet wipe and vacuum the surrounding area, seal any identified leaks (e.g. with expandable foam or tape) and smoke test the enclosure until it is satisfactorily sealed.
	5. Do not recommence removal work until further air monitoring is conducted	Do not recommence until fibre levels are at or below 0.01 fibres/ml.

11.2.4 Imported fill

Any imported fill used on the site will be classified as ENM in accordance with the excavated natural material order 2014 (Table 5).

Table 5. ENM assessment criteria

Analyte	Units	Maximum average concentration for characterisation	Absolute maximum concentration
Mercury	mg/kg	0.5	1
Cadmium	mg/kg	0.5	1
Lead	mg/kg	50	100
Arsenic	mg/kg	20	40
Chromium (total)	mg/kg	75	150
Copper	mg/kg	100	200
Nickel	mg/kg	30	60
Zinc	mg/kg	150	300
Electrical conductivity	ds/m	1.5	3
pH	mg/kg	5 to 9	4.5 to 10
PAH	mg/kg	20	40
Benzo(a)pyrene	mg/kg	0.5	1
TPH(C10-C36)	mg/kg	250	500
Benzene	mg/kg	NA	0.5
Toluene	mg/kg	NA	65
Ethylbenzene	mg/kg	NA	25
Xylenes	mg/kg	NA	15
Rubber, plastic, bitumen, paper, cloth, paint and wood	%	0.05	10

11.3 Remediation method

11.3.1 Encapsulating impacted material

- The impacted area will be covered in geotextile Bidim A44 as a warning layer
- The extent and current surface elevation of the impacted material will be surveyed
- The geotextile will be covered by 500mm of ENM or an impermeable layer (concrete)
- The depth of capping material will be surveyed
- Monitoring of airborne fibres will be undertaken at selected locations during soil disturbance work and compared with acceptable limits
- Personal protection equipment (PPE) required during soil disturbance works includes P2 rated disposable masks, disposable gloves and coveralls.
- Clearance inspection by an environmental scientist or asbestos assessor to confirm no asbestos remain on the surface.
- Validation will be undertaken by inspection of the area, survey and preparation of a report
- A site management plan will be developed to manage future potential breaches in the capping layer

10.3.2 Site management plan

A site management plan will be prepared to manage activities undertaken in the area of encapsulation.

11.4 Services, excavation and earth moving

Excavation, stockpiling, transport and disposal methods must ensure that potentially affected soil is not spread onto non-excavation areas. Care will be taken to separate differently classified materials from each other and from the surrounding soil. The impacted material will be removed with an excavator or backhoe. Excavated material will be stockpiled on plastic on site to enable waste classification to be undertaken in accordance with NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste*. The stockpiled material will be loaded onto trucks for disposal to an appropriately licensed landfill as determined from the waste classification.

11.5 Validation of excavation areas

Requirements for validation of excavation areas and backfill are discussed in Section 13.

11.6 Supervision

Remediation works will be supervised by an Environmental Scientist and comply with EPA guidelines including *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 2020) and *Remediation of Contaminated Land State Environmental Planning Policy* (SEPP55).

12. Remediation works issues

12.1 Approvals

The site is located in groundwater vulnerability under the Orange LEP (2011). The works are a Category 1 remediation. A development application is required to be submitted to Orange City Council and approval granted prior to commencement.

Applications for approval to dispose of waste in this manner will follow the guidelines set out in NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste*. Approval from the landfill will be required before transportation.

12.2 Access

In order to ensure there is no unauthorised access to the excavation site, appropriate barricading may be established as required. Vehicle access to the site shall be stabilised to prevent the tracking of soils onto non-excavation areas, the roads and footpaths. Care will be taken to ensure soil, earth or similar materials are retained within the excavation site. Soil, earth, mud or similar materials must be removed from non-excavation surfaces by shovelling or a means other than washing, at the end of the day or as required.

12.3 Dust control

Dust emission shall be confined within the site boundary. The following dust control procedures may be employed to comply with those requirements:

- Securely covering all loads entering or exiting the site
- Use of water sprays across the site to suppress dust, as appropriate
- Covering of stockpiles may be considered
- Excavation surfaces will be kept moist
- Work to stop during high winds to minimize problems with dust generation
- Control measures as required in the asbestos removal control plan
- Air monitoring around the perimeter of the work area

Daily air monitoring (control monitoring) will be undertaken on the site during soil disturbance and excavation works. The monitoring will be undertaken in accordance with the *Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Dust, 2nd Edition [NOHSC:3003(2005)]*. Air monitoring will be undertaken by an independent environmental scientist or asbestos assessor at fixed locations along boundaries representative of the work areas as determined by the independent environmental scientist or asbestos assessor.

12.4 Sediment and water management

The NSW Department of Housing Blue Book *Managing Urban Stormwater – Soil and Conservation* August 2004 outlines the general requirement for the preparation of a soil and water management plan. All remediation works shall be conducted in accordance with a soil and water management plan prepared by the contractor using this Remediation Management Plan. A copy of the plan shall be kept on-site and made available to Council officers on request. All erosion and sediment measure must be maintained in a functional condition throughout the remediation works.

12.5 Stockpile management

Stockpiling of material is not expected to be required. If any excavated material requires temporary stockpiling prior to removal off-site the following will be implemented:

- Care will be taken to separate differently classified materials from each other and from the surrounding soils,
- Contaminated material stockpiles shall be placed on PVC plastic, in a secure bund consisting of hay bales/sand bags and if required covered,
- All stockpiles of soil or other material shall be placed within an erosion containment boundary away from drainage lines, gutters or stormwater pits or inlets,
- All stockpiles of soil or other materials likely to generate dust or odours shall be covered, and
- Inspections will be undertaken to ensure liner not breached. If the liner has been breached, samples will be taken from the soil beneath the liner and analysed for hydrocarbons.

12.6 Excavation pump-out

Based on our knowledge of the site subsurface conditions, pump-out will not be required. In the unlikely event that a pump-out is required the following will be carried out:

- Any excavation pump-out water must be analysed for suspended solid concentrations, pH, and any contaminants of concern identified during the site investigation prior to discharge to the stormwater system or other disposal method as appropriate. The analytical results must comply with relevant Council/EPA and ANZG standards for water quality, and
- Other options for the disposal of excavation pump-out water include disposal to sewer with prior approval from Orange City Council or off-site disposal by a liquid waste transporter for treatment/disposal to an appropriate waste treatment/processing facility.
- Contaminated groundwater will need to be collected by a liquid waste contractor.

12.7 Landscaping/rehabilitation

The filled area will be graded to conform with the current land gradient. All erosion and sediment measures will be maintained until a complete grass cover has been established.

12.8 Bunding

Appropriate bunding will be undertaken if stockpiling of soil is required.

12.9 Timing

The removal of the contaminated material is expected to be completed over a period of 4 weeks.

12.10 Noise control

The site activities should not generate any noise other than that normally associated with a building site. Hours of operation will be 8am to 5pm, Monday to Friday.

All remediation work shall comply with the Environment Protection Authority's *Environmental Noise Manual and the Protection of the Environment Operations Act (1997)*.

12.11 Odour control

Based on the current knowledge of the site it is our expectations that odour control measure will not be required.

12.12 Public and work health and safety (P&WH&S)

12.12.1 Prior remediation

Interim site management to protect human health and environment prior to remediation will include fencing of the site to prevent unauthorized access. Soil bunding will be constructed around the site to prevent surface water flow over the site and act as a silt fence for wind erosion. Warning signs will be erected.

12.12.2 During remediation

Standard P&WH&S procedures for earthworks projects should be implemented on the site together with emergency and evacuation procedures.

A site specific P&WH&S plan is to be developed by the contractor prior to starting the works. This plan may include but not be limited to the following:

- Briefing of all staff on P&WH&S concern, contractors' and individuals' responsibilities and personal protective procedures
- Site access exclusively for briefed and authorized staff. A log book shall be kept.
- Soil and Water, Dust and Waste Management plans
- Dust suppression particularly during the excavation and handling of materials
- Staff personal protection handling affected soils
- Crib and washing facilities
- Provision of site security at all times, and
- Emergency and evacuation procedures. The nearest hospital is Orange Health Service, 1502 Forest Road, Orange NSW. Relevant telephone numbers are:

▪ Orange Health Service	6369 3000
▪ Fire Brigade, Police, Ambulance	000
▪ Poisons Information Centre	131126
▪ SafeWork NSW	131050

The following protective equipment should be used:

- Highly visible safety vests
- Safety boots with steel toe and shank
- Safety glasses with side shields
- Hardhat
- Gloves when handling the soil
- P2 mask and coveralls

Smoking, eating or drinking on the site is prohibited whilst remediation works are active. Exposed areas including hands and face are to be washed thoroughly upon completion of work and prior to eating and drinking. Heat stress is an important consideration that must be taken into account in hot weather.

12.13 Vibration

Site development involves excavating soil. It is not expected that any *in situ* rock will be excavated for the remediation proposed. The contractor should ensure that excessive vibration does not occur in the existing surrounding buildings.

12.14 Site, signage and contact numbers

The following are contact numbers that will be needed for the various parties involved:

- Environmental Supervisor: Envirowest Consulting Pty Ltd, ph 6361 4954
- Contractor: To be determined

Signage displaying the contact details of the remediation contractor (and site facilitator) and asbestos removalist shall be displayed on the site adjacent to the site access. These signs shall be displayed throughout the duration of the remediation works.

12.15 Transport

All haulage routes for trucks transporting soil, materials, equipment or machinery to and from the site shall be selected to meet the following objectives:

- Comply with all road traffic rules
- Minimize noise, vibrations and odour to adjacent premises
- Securely cover all loads to prevent any dust or odour during transportation
- Exit the site in a forward direction and
- Will not track soil, mud or sediment onto the road.

12.16 Decontamination

Footwear of workers should be rinsed prior to leaving the site. Plant and equipment removed from the site must be inspected and brushed down before leaving the site.

Decontamination of personnel undertaking the works should be undertaken prior to breaks and at completion of works. Decontamination should be undertaken by moistening gloves prior to removal, washing of hands and removal of masks. The PPE will be disposed as asbestos waste at completion of collection.

12.17 Hazardous materials

In the event that hazardous and/or intractable wastes are encountered during the remediation work, they shall be treated and disposed of in accordance with the requirements of the NSW EPA and SafeWork NSW, together with the relevant regulations.

A suitable management plan for their proper disposal to a licensed landfill would be developed by and approved by the principal. The plan would include additional testing to quantify the material and classify it to ensure proper off-site disposal to a licensed landfill. Material will not be removed from the site until this approval is given.

12.18 Imported fill

Any imported fill material will be validated prior to importing in accordance with EPA requirements to ensure it is compatible with the proposed site use. The fill will be validated as ENM or VENM. Requirements for imported fill are discussed in detail in Section 13.

12.19 Site security

The contractor will be responsible to ensure any temporary barricading/fencing erected is secure and prevents unauthorized access to the site. All SafeWork NSW requirements will be followed regarding signs and safety measures when working near excavations.

13. Remediation work validation

13.1 Validation

Validation of the encapsulated area will be by visual inspection and surveying. The remediation works will be supervised by an Environmental Scientist who will determine the extent based on previous investigations.

The lateral extent of the encapsulation will be surveyed to allow nomination of the area covered by the site management plan. The surface elevation will be surveyed following completion of the encapsulation to demonstrate the required depth of encapsulation.

13.2 Validation imported fill

Validation of all imported fill is required including:

- An ENM certificate issued by a suitably qualified professional including a description of the source of the material, typical analysis results, and a statement that the material is suitable for the proposed use.
- Systematic and documented inspection of loads of fill entering the site will be undertaken. Loads of material suspected to not be ENM or that are not consistent with the material at the source site will be rejected.
- Validation will be achieved by sampling and analysis for pH, electrical conductivity, metals, total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH) and benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN). Additional laboratory analysis of samples will be undertaken if any additional potential contaminants of concern are identified at the source site. Results will be compared against ENM order (2014) assessment criteria.
- The frequency of samples will be a minimum of 3 samples per source site for less than 500 tonnes. Sampling frequency and analysis will be increased if site condition or analytical results suggest a potential risk of contamination. The results of analysis will reflect background concentrations for the material. The sample density and results will be adequate to characterize the imported fill as ENM suitable for the proposed land-use.

13.3 Validation reporting

Following the completion of the remediation, a validation report will be prepared in accordance with NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites (2011)* and *Guidelines for the NSW Site Auditor Scheme (2006)*. The validation report will:

- provide a brief summary of previous assessment work carried out
- outline remediation works undertaken on-site
- summarise field observations
- describe validation sampling and analysis
- confirm that any imported fill has been validated as required and are accompanied with ENM certificates
- confirm that the RAP objectives have been achieved, and
- detail any on-going management requirements.

13.4 Ongoing management

A description of the contaminants will be undertaken on the land title and the S10.7 certificate.

A site management plan (SMP) will be finalised for activities which have potential to breach the capping layer. The SMP will describe the impacted area, responsibilities of the owner, occupier and procedures to be implemented for disturbance in the contaminated material.

14. Other issues

14.1 Community consultation

Nearby residents shall be consulted and notified in accordance with Council policies.

14.2 Contingency plans

In order to obviate potential effect on the surrounding environment and community the contractor will implement the following contingency plan.

Table 6. Contingency plan

Issue	Contingency Response
Excessive odour	Cover with plastic sheeting until a solution is developed by an environment consultant.
Excessive dust	Increase the use of moisture sprays to suppress dust and/or cover with plastic sheeting.
Excessive noise	Reduce noise until noise is monitored by an acoustics consultant. Adopt recommendations made.
Excessive vibrations	Cease activities causing vibrations and engage a vibrations consultant to monitor. Implement any vibration control measure recommended.
Discovery of unknown underground storage tanks (UST)	The Environmental Supervisor and Client Representative shall be notified and work within the vicinity will cease. A RAP and Sampling and Analysis Quality Plan (SAQP) will be prepared for the USTs. Upon approval of the RAP and SAQP, the offending UST's shall be removed and disposed at a licensed landfill. Samples shall be taken from the area where the UST once was located and soil analysis undertaken. Upon the results of the soil samples appropriate works shall proceed; either further excavation and remediation or continuation of the development works proposed.
Discovery of further contamination	Remediation works shall take place accordingly. All unsuitable material shall be removed and disposed off-site to a licensed landfill. If contamination is more extensive than initially determined, other remediation methods may be considered and the RAP revised. Discussions with the Orange City Council may be required in regards to appropriate course of action.
Spillage/leakage of oil, hydraulic fluid or fuels from excavator/backhoe and trucks	An environmental management plan shall be prepared by the contractor detailing procedures and emergency responses to be undertaken in the event of spillages. Procedures to be followed may include: Major spill: Stop spill and contain. Place sandbags downslope, cover area in sand, excavate impacted soil and dispose in appropriate approved facility Minor spill: Stop spill and contain. Cover area in sand, excavate impacted sand and soils and dispose in EPA approved facility

14.3 Progress reporting

No progress reporting will be undertaken.

14.4 Regulatory compliance

All works are to comply with the relevant regulations ensuring that the remediation works do not adversely impact on the environment and public amenity.

15. References

ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Waters* (Australian and New Zealand Environmental and Conservation Council, Canberra)

NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste* (Department of Environment and Climate Change, Sydney)

NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999 revised 2013* (National Environment Protection Council Service Corporation, Adelaide)

EPA (2020) *Consultants reporting on contaminated land* (NSW Environment Protection Authority: Chatswood)

SafeWork (2019) How to Safely Remove Asbestos Code of Practice

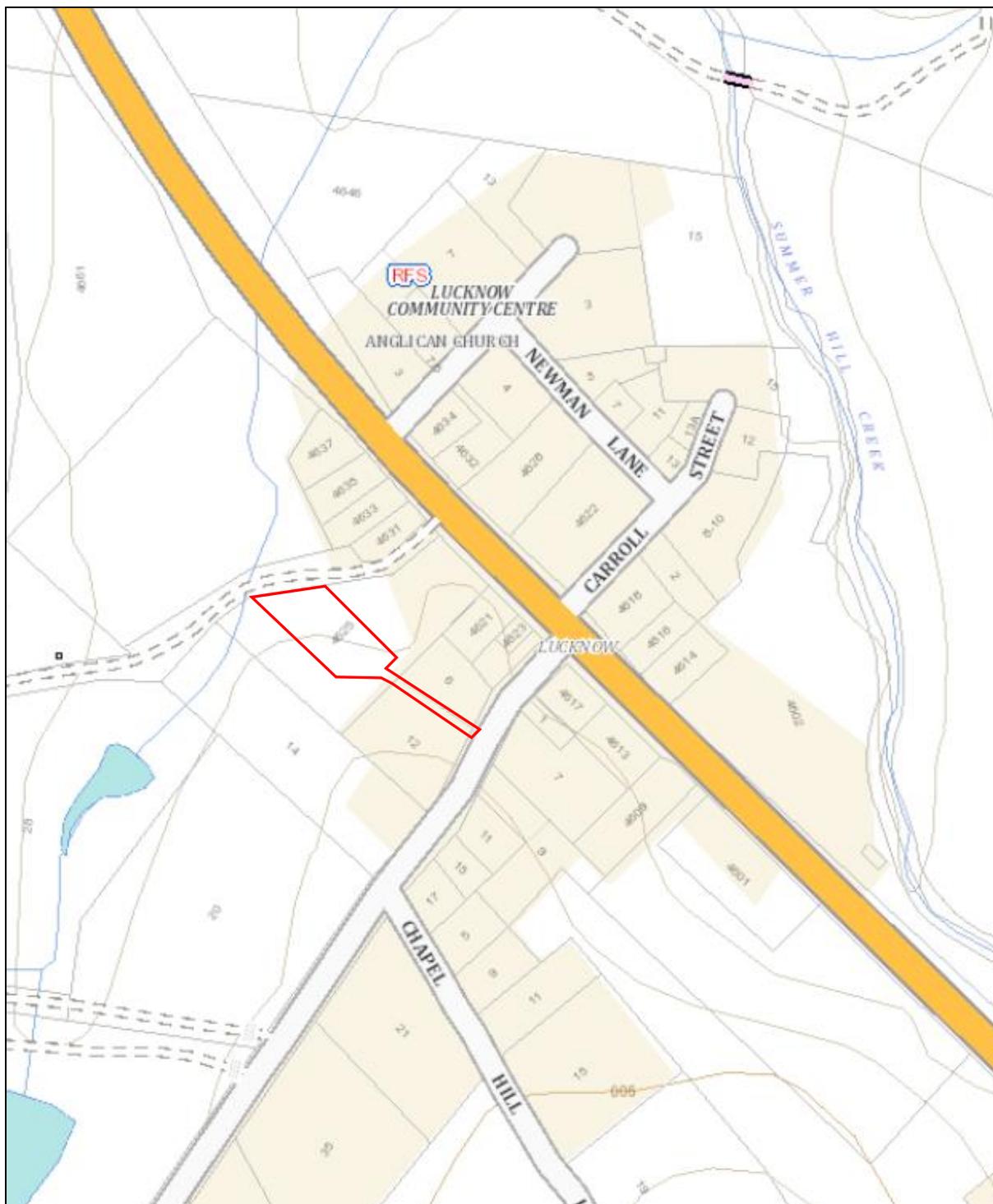
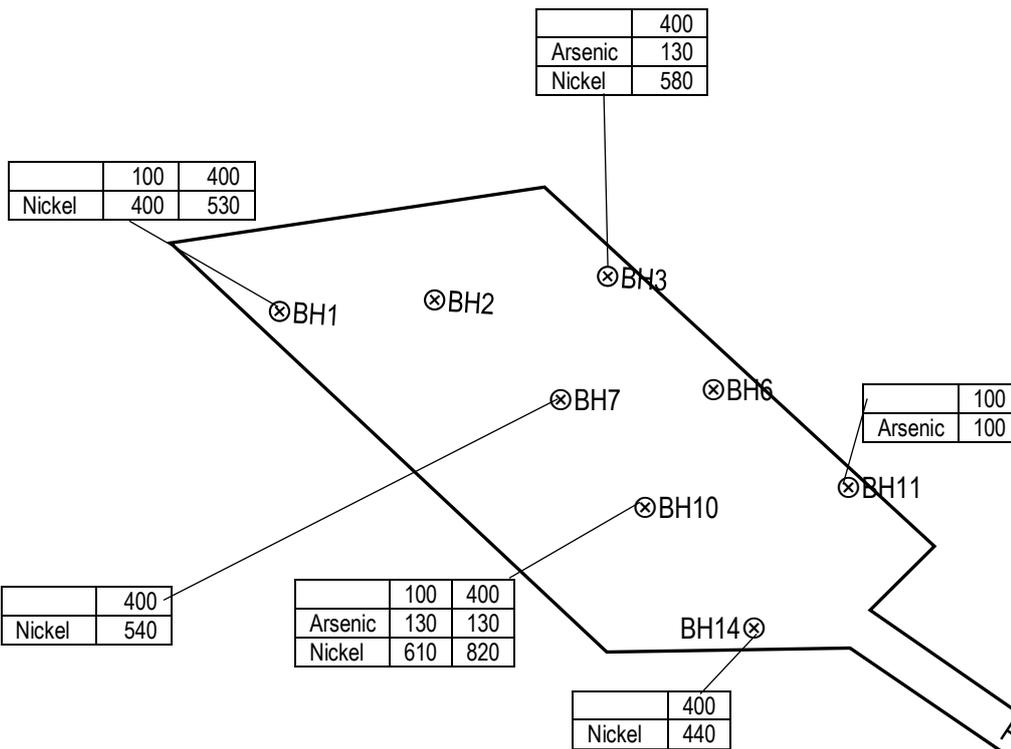


Figure 1. Site locality		
Proposed Lot 2 in the subdivision of Lot 1 DP880582 Mitchell Highway, Lucknow NSW		
	Enviwest Consulting Pty Ltd	
Job: R12227rap	Drawn by: AA	Date: 17/11/2020



Mitchell Highway



Proposed access

Phoenix Mine Road

Legend

⊗ Borehole and sampling locations

— Proposed lot boundary

	depth
Analyte	mg/kg

Approximate Scale 1: 800

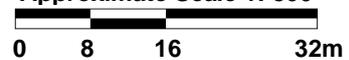


Figure 2. Locations with HIL exceedances

Proposed Lot 2 in the subdivision of Lot 1 DP880582
Mitchell Highway, Lucknow NSW



Envirowest Consulting Pty Ltd

Job: R12227rap

Drawn by: AA

Date: 17/11/2020

Appendix 1. Data quality indicators

Quality control and assurance is undertaken to ensure the representativeness and integrity of field and laboratory procedures to ensure accuracy and reliability results.

1. Completeness

A measure of the amount of usable data for a data collection activity (total to be greater than 90%)

1.1 Field

Consideration	Requirement
Locations to be sampled	Described in the sampling plan
Depth to be sampled	Described in the sampling plan, each layer or explained
SOP appropriate and compiled	Described in the sampling plan
Experiences sampler	Sampler or supervisor
Documentation correct	Sampling log and chain of custody completed

1.2 Laboratory

Consideration	Requirement
Samples analysed	Number according to sampling and quality plan
Analytes	Number according to sampling and quality plan
Methods	EPA or other recognised methods with suitable PQL
Sample documentation	Complete including chain of custody and sample description
Sample holding times	Metals 6 months, OCP, PAH, TPH, PCB 14 days

2. Comparability

The confidence that data may be considered to be equivalent for each sampling and analytical event

2.1 Field

Consideration	Requirement
SOP	Same sampling procedures to be used
Experienced sampler	Sampler or supervisor
Climatic conditions	Described as may influence results
Samples collected	Sample medium, size and preparation

2.2 Laboratory

Consideration	Requirement
Analytical methods	Same methods
PQL	Same
Same laboratory	Justify if different
Same units	Justify if different

3. Representativeness

The confidence (expressed qualitatively) that data are representative of each media present on the site

3.1 Field

Consideration	Requirement
Appropriate media sampled	Sampled according to sampling and quality
All media identified	Sampling media identified in the sampling and quality plan

3.2 Laboratory

Consideration	Requirement
Samples analysed	Blanks

4. Precision

A quantitative measure of the variability (or reproduced of the data)

4.1 Field

Consideration	Requirement
Field duplicates	Frequency of 5%, results to be within +/-40% or discussion required indicate the appropriateness of SOP

4.2 Laboratory

Consideration	Requirement
Laboratory and inter lab duplicates	Frequency of 5%, results to be within +/-40% or discussion required
Field duplicates	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared volatile trip spikes	One per sampling batch, results to be within +/-40% or discussion required

5. Accuracy

A quantitative measure of the closeness of the reported data to the true value

5.1 Field

Consideration	Requirement
SOP	Complied

5.2 Laboratory

Consideration	Requirement
Field blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Rinsate blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Method blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Matrix spikes	Frequency of 5%, results to be within +/-40% or discussion required
Matrix duplicates	Frequency of 5%, results to be within +/-40% or discussion required
Surrogate spikes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory control samples	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared spikes	Frequency of 5%, results to be within +/-40% or discussion required

Appendix 2. Soil sampling protocols

1. Sampling

The samples will be collected from the auger tip, mattock, hand auger or excavator bucket immediately on withdrawal.

The time between retrieval of the sample and sealing of the sample container will be kept to a minimum.

The material will be collected using single use disposal gloves or a stainless steel spade which represented material which has not been exposed to the atmosphere prior to sampling.

All sampling jars will be filled as close to the top as possible to minimise the available airspace within the jar.

2. Handling, containment and transport

Daily sampling activities will be recorded including sampling locations, numbers, observations, measurements, sampler, date and time and weather condition.

The sampling jars will be new sterile glass jars fitted with plastic lid and airtight Teflon seals, supplied by the laboratories for the purpose of collecting soil samples for analysis. Sample containers will be marked indelibly with the sample ID code to waterproof labels affixed to the body of the container.

All samples will be removed from direct sunlight as soon as possible after sampling and placed in insulated containers. Samples will be stored in a refrigerator at 4°C prior to transportation to the laboratory in insulated containers with ice bricks in accordance with AS4482.1.

Handling and transportation to the laboratory will be accompanied with a chain of custody form to demonstrate the specimens are properly received, documents, processed and stored.

Maximum holding time for extraction (AS4482.1) are:

Analyte	Maximum holding time
Metals	6 months
Mercury	28 days
Sulfate	7 days
Organic carbon	7 days
OCP, OPP, PCB	14 days
TRH, BTEX, PAH, phenols	14 days

3. Decontamination of sampling equipment

Sampling tools will be decontaminated between sampling locations by

- Removing soil adhering to the sampling equipment by scraping, brushing or wiping
- Washing with a phosphate-free detergent
- Rinsing thoroughly with clean water
- Repeating if necessary
- Collect rinsate per sampling time and preserve according to AS 2031.1
- Dry equipment with disposable towels or air