Contamination Assessment

Remedial Action Plan

for

1 Progress Road, Mount Hutton, NSW, 2290

Report 66242

Version 1.0

Issued October 19th, 2023

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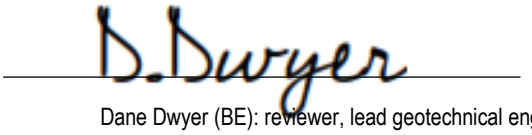
Version	Date	Description of Change	Editor	Reviewer
1.0	10-19-23	Original	Daniel Hall	
1.1	08-04-24	Corrected proposed zoning category with minor edits to conclusions and executive summary to reflect	Daniel Hall	
1.2	11-04-24	Added reference to section 3 Remediation Framework. Expanded E1 Local Centre land uses in section and header in 4.1. Zones. Clarified relevance to HIL-A criteria standards. Fixed grammatical errors.	Daniel Hall	Ben Apikotoa

This Remedial Action Plan has been commissioned by Backyard Grannys Pty. Ltd. and prepared by Ideal Geotech on October 20th, 2023.

Daniel Hall (BSc, MSc): author, consultant, investigator



Dane Dwyer (BE): reviewer, lead geotechnical engineer

EXECUTIVE SUMMARY

Situated 12 km southeast of Newcastle in Mount Hutton, 1 Progress Road (hereinafter "the Site") has a rectangular layout on relatively flat terrain. The geological formations of the region include conglomerate, sandstone, tuff, shale, and coal from the Permian Newcastle Coal Measures. The Site surface soil mainly consists of brown sandy loam and some gravel. The Site is bordered by Scrubby Creek to the west, a school to the north, a shopping plaza to the east, and Progress Road to the south.

In September 2023, Ideal Geotech conducted a combined preliminary and detailed Site investigation. We identified three areas of environmental concern: a house from the 1960s, an unpaved driveway, and other likely activities like farming near the Site. A subsequent detailed site investigation yielded eight soil samples from across the entire Site. Only the sample from the driveway area tested positive for lead and zinc that exceeded health criteria thresholds. The source of the contamination remains uncertain. However, it is presumed to have originated from current and historical vehicular and possibly renovation work related to the old house. All other test locations across the Site showed contamination levels within safe limits.

These findings led Ideal Geotech to the recommendation for this Remedial Action Plan (RAP). This RAP targets the soil contamination in the southwestern driveway area and aims to achieve five primary objectives before constructing two proposed office buildings:

Excavate the contaminated soil to a depth of at least 200 mm
Resample at the pit base and walls to confirm the extent of contamination or its adequate reduction
Classify and properly dispose of contaminated waste
Import clean fill
Document the remediation process

This plan also mandates additional soil sampling. This will delineate the boundaries of contamination both laterally and vertically within the excavated pit. Certified clean material will replace the removed soil. Documentation will cover all steps and site validation criteria.

Key actions recommended in this RAP include stakeholder notification, work risk assessment, contamination area demarcation, surface soil excavation, contaminated soil disposal, and clean soil replacement. Suggested safety protocols recommend using qualified experts, appropriate Personal Protective Equipment (PPE), and restricted area access. Liaison with Before You Dig services is advised prior to excavation. Contingency plans are be in place for unexpected findings.

Ideal Geotech maintains that by adhering to the actions outlined in this RAP, the Site can be remediated to meet or exceed HIL-A criteria, ensuring its suitability and safety for proposed constructions and the permissible uses and activities associated with 'E1 Local Centre' zoning.

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1. Objectives

The aim of this Remedial Action Plan is to remove, reduce, and/or mitigate the identified contaminants of concern in such a way that they will not pose unacceptable risks to human and/or environmental health by achieving the following objectives:

1. Excavation of the contaminated soil to a depth of at least 200 mm.
2. Resampling at the pit base and walls to ascertain contamination extent or validate its adequate reduction.
3. Classification and proper disposal of contaminated waste.
4. Importing clean certified fill.
5. Documentation the remediation process.

1.2. Scope of Work

i. Excavation and disposal of contaminated soils along the drive-way in southwestern area of the lot.
ii. Obtain at least 8 samples from base and walls of excavated area to determine lateral and vertical extent of contamination (and at what level it may still be present).
iii. Dispose of excavated waste according to its classification while adhering to relevant state and commonwealth regulations.
iv. Replace excavated area with new certified clean virgin or excavated natural material.
v. Document evidence of all remediation.
vi. Recommendations for Site validation of remediation work.

2. Site Information

	1 Progress Road, Mount Hutton, NSW 2290
Site location	**DMS:** 32°58'41.38" S, 151°40'05.88" E **GDA94:**16883640.8, -3892402.6
Lot/DP	8/29077
Client	**Name**: Alex Mitchell (Backyard Grannys Pty. Ltd.) **Phone:** 02 4947 2800 **Email:** alex@backyardgrannys.com.au
Council	Lake Macquarie City Council
Site dimensions	**Lot:** 1,704 m^2 **Expected area of remediation:** ~88 m^2
Zoning	**Current:** R2 Low Density Residential **Proposed:** E1 Local Centre
Trigger	Remediation (refer to Ideal Geotech PSI/DSI report ref. 65042)

2.1. Site Characteristics

Summarised from Ideal Geotech PSI/DSI report (ref. 65042).

- The Site is in Mount Hutton, 12 km south-east of Newcastle. It has a rectangular shape, 92 m long, widening from 13 m in the south to 32 m in the north. The terrain is mostly flat with a slight slope from the north-east to the south-west.
- 'The Geological Survey of the NSW (Newcastle 1:250000 Sheet SI 56-2)' indicates that the natural underlying Site geology consists of: conglomerate, sandstone, tuff, shale, coal from Permian Newcastle Coal Measures
- Surface soil samples taken from the Site appeared as brownish sandy loam with traces of gravel
- A soil core indicated that clay was present at depths greater than 200 mm.
- The Site is not considered to be within an area of environmental conservation or protection. However, Mullington Reserve is directly adjacent to the east of the Site, which includes Scrubby Creek.

At the time of the Site investigation, September, 2023 the following site characteristics were observed:

- The Site was mostly enclosed by a metal fencing.

- Scrubby Creek is 3-5 m adjacent to the west (dry at that time).
- The east boundary had a concrete wall with drainage for the adjacent carpark.
- The south part appeared well-maintained, but the north was somewhat overgrown with grasses.
- The Site hosted a single house, probably built in the 1960s.
- A partial driveway was present, but the driveway was predominately unsealed bare ground that and lead to a covered (but otherwise open) carport.
- The ground across the Site was mostly vegetated, with some healthy plants and a few young trees.
- No signs or odours indicative of contamination were noticed.
- There was no evidence found to suggest that there was any significantly contaminated groundwater on or flowing through the Site.

2.2. Site Description & Surrounding Environment

Summarised from Ideal Geotech PSI/DSI report (ref. 65042).

2.2.1.The Site: located in Mount Hutton, the Site is12 km south-east of Newcastle. It has a rectangular perimeter of approximately 92 m length, widening from 13 m in the south to 32 m in the north. There's a 2–3-degree slope falling from north-east to south-west. It's enclosed by solid metal fencing, with the south frontage adjacent to Progress Road. Scrubby Creek is 3 to 5 m west, and the eastern boundary has a 2.5 m high concrete wall with a self-contained drainage system for a neighbouring carpark. The south end of the Site appeared to be well-maintained, while the north was covered with overgrown vegetation. A rusted burn barrel with charred material was found behind the house. In the southern half of the Site there is a single 1960s-built residential house about 8 meters back from Progress Road. The site lacks a fully paved driveway and there was an occupied open carport connected to the west side of the house. The ground was mostly grass-covered with a few medium-aged trees scattered around. No water bodies or contamination indicators were observed during the investigation. However, three areas of potential environmental concern were identified during that inspection (refer to Ideal Geotech #65042) and a Site wide sampling plan was carried out to test surface soils. Out of 16 samples, only one area of concern yielded results with levels of contamination that exceeded the health investigation criteria thresholds (adopted from the ASC NEPM). This sample, E2, was obtained from the unpaved driveway area, next to the house's deck.

2.2.2. Surrounding area: to the north is Mount Hutton Public School. East is the Local Centre, featuring a large Aldi and a few other mixed businesses. South is Progress Road. On the other side of Progress Road is Mount Hutton Playground, which is a part of Mullington Reserve. To the west is Scrubby Creek and a continuation of Mullington Reserve. The Site is surrounded by a mixture of land uses, with the majority being low density residential and reserve land. The Site's surroundings appeared to be in good environmental condition at the time of the Site inspection on August 17, 2023.

2.3. Background & Context

Summarised from Ideal Geotech PSI/DSI report (ref. 65042).

In 2009, Douglas Partners conducted a PSI and DSI on the property next to the subject Site to the east: Aldi/Local centre. The area once housed a dairy farm, furniture store, and a hardware store. Two underground storage tanks and asbestos-contaminated stockpiles with high petroleum hydrocarbon levels were found by Douglas Partners on the adjacent eastern lot, along the eastern boundary of the Subject Site. Remediation was likely conducted as an Aldi was later constructed. In Douglas Partner's reports, there was no specific mention made of the subject Site (1 Progress Road). During Ideal Geotech's investigation, the Site was found to have a few potential environmental concerns: a 1960s house with a possibly renovated roof, evidence of burning in a burn barrel in the backyard, an unsealed driveway, and unclear northern yard activities possibly involving pesticides and metal contaminants. A preliminary and detailed site investigation (PSI/DSI) with soil sampling for laboratory analysis was deemed necessary for the subject Site.

Of the three areas of environmental concerned identified, only the driveway area yielded results (sample E2) that indicate lead and zinc contamination is present on the Site. Ideal Geotech, therefore, recommended in their PSI/DSI report (ref. 65042) that a remedial action plan be devised that includes:

- Possible excavation of the surface soil along the drive way area to a length of 30 m.
- Classification and disposal of excavated contaminated soil.
- Further soil sampling of the remediation area, post-excavation to ascertain is contamination has been adequately removed.

2.4. Identified Contaminates of Concern

2.4.1. Lead (Pb): Lead is a naturally occurring element, and low background levels in soils are common. Depending on the region and local geology, background concentrations of lead in soils average around 15 to 20 mg/kg. Higher than average levels can arise from various sources such as batteries, metal alloys, x-ray shielding materials, ammunition, chemical resistant linings, pigments, and, historically, petrol and paint additives. High concentrations of lead are harmful to human health, affecting cognitive functions and various body systems. They also negatively impact plants, aquatic life, and animals. The source of lead on the Site is currently unknown, but it is presumed to be from vehicular activity along the driveway over time, and/or possibly from paints involved with the old house (Table 1).

2.4.2. Zinc (Zn): Zinc (Zn) is an essential trace element found naturally in the environment. Typical background concentrations of zinc in soils range from 10 to 300 mg/kg, depending on the region's geology and mineralogy. Elevated levels of zinc in soils can originate from multiple sources, such as galvanized metal products, mining activities, wastewater discharge, fertilizers, and pesticides. While zinc is vital for many biological processes in plants and animals, excessive amounts can lead to toxic effects. In humans, high levels of zinc can disrupt copper and iron absorption and impair immune system function. In the environment, elevated zinc concentrations can harm aquatic life, alter soil microbial communities, and affect plant growth. The source of zinc on and around the Site is presumably from fertilizers related to historic agricultural activities, and/or metal works, such as fence construction and welding (Table 1).

__Table 1__. A summary of contamination and context at the Site.

AECs	Affected media	Identified Contaminates of Concern	Possible sources
Soil along the driveway on the western side of the house.	Surface soil (top 150 mm)	Lead (Pb) and Zinc (Zn)	**Lead:** If vehicles have been frequently using the unsealed driveway, there could be a potential for localized contamination of lead. Lead was a common additive in gasoline that was phased out starting in the 1980s to 2002. Given the age of the house, the driveway may have received a fair amount of traffic that has caused an accumulation lead in the soils. Alternatively, lead paint fragments could have accumulated nearby the doorway of the old house during historic renovations. **Zinc:** An important micronutrient commonly found in plant fertilizers. With a history of agriculture and farming in the area, zinc could have accumulated in the driveway area. Another possibility could be fencing work and welding that could have been carried out in that area.

3. Remediation Framework

Table 2. Important references utilised in this RAP for prescribed remediation work.

Criteria	Reference
Regulations and Policy	-Contaminated Land Management Act 1999 [5] -National Environment Protection (Assessment of Site Contamination) Measure 1999 [2] -NSW EPA Planning Guidelines SEPP 55 Remediation of Land 1998 [12] -NSW EPA State Environmental Planning Policy (Resilience and Hazards) [20]
Reporting	-NSW EPA Consultants reporting on contaminated land guidelines [11] -NSW EPA Guidelines for the NSW Site Auditor Scheme (3rd edition) [9] -National Environment Protection (Assessment of Site Contamination) Measure 1999 [2]
Sampling	-Australian Standard 4482.1: Guide to the Investigation and Sampling of Sites with -Potentially Contaminated Soil – Part 1: Non-volatile and Semi-Volatile Compounds [3] -NSW EPA: Sampling Design Guidelines [13]
Health investigation levels (HIL)	-National Environment Protection (Assessment of Site Contamination) Measure 1999, vol. 2, sch. B1 [2] -Lake Macquarie Local Environmental Plan 2014 [23]
Remediation	-Guidelines for the NSW Site Auditor Scheme (3rd edition) [9] -Dobrescu et al. 2022 [7] -Key Principles for the Remediation & Management of Contaminated Sites [10] -NSW EPA State Environmental Planning Policy (Resilience and Hazards) Chapter 4 -Remediation of land [20]
Waste management	-Protection of the Environment Operations Act 1997 [17] -NSW EPA Waste classification guidelines [18] -Guidelines for the NSW Site Auditor Scheme, section 4.3.7 [9] -Environmentally Hazardous Chemicals Act 1985 [8]
Safety	-Safe Work Australia: WHS duties to workers [19] -Work Health and Safety Act 2011 [21] -Work Health and Safety Regulation 2017 [22]

3.1. Rationale for Selected Remediation Criteria

3.1.1. Contaminate Health Investigation Levels (HILs)

The National Environmental Council, as appointed by the National Environment Protection Council Act 1994 (Cth), endorses and approves the environmental contamination criteria and guidelines published in the National Environmental Protection (Assessment of Site Contamination) Measure 1999. These criteria, as found in Schedule B1of the ASC NEPM, are used in this RAP because they are based on scientifically sound risk assessments. The majority of these assessments were produced by the Australian Department of Health and Aged Care's Environmental Health Standing Committee. The scientifically determined HIL thresholds indicate whether concentrations (mg/kg) of contaminants are at concerning levels and if further investigation is needed. HILs account for potential worst-case scenarios, specifically targeting individuals who are most vulnerable and sensitive to contaminants, such as children and those who are immunosuppressed or have pre-existing health conditions. HILs make generic assumptions based on broad categories like the environment, human behaviors, physiochemical properties, and the transport and fate of contaminants in soils. Contaminants at or above HIL thresholds do not necessarily signify a significant health risk. HILs are categorized as: A, B, C, and D. Each category has its own set of criteria, such as property zoning and population densities.

- This contamination assessment references HIL thresholds for categories A and D.

Category A HILs apply to typical low-density residential land use where people can access the property's soil. Category D HILs generally pertain to commercial and business (e.g., E1 Local Centres,), or industrial settings, anticipating higher contamination levels due to commercial and industrial activities. Ideal Geotech deems the criteria for contamination levels, referred to in this report as HILs, suitable for assessing contamination risks.

3.1.2. Work Health and Safety

The WHS Act aims to protect the health and safety of workers and workplaces by eliminating or minimizing risks arising from work. Referring to it in the context of contaminated land and remediation is mandatory and operates alongside the Contaminated Land Management Act.

3.1.3. Stakeholder Consideration

Cost and time are paramount to the success of any project. Site remediations can be inconvenient and are often unexpected. For these reasons, cost/time benefit analyses are considered as part of the remediation criteria when selecting the more appropriate actions to recommend.

3.1.4. Waste Regulation

NSW EPA laws and regulations are in place and must be consulted when addressing the classification, handling, transport, and disposal of contaminated waste. In NSW, transporting waste to a location that is not authorized to receive it, or dumping waste in a location not approved as a waste facility, is illegal.[17] Ensuring the responsible and safe collection, transport, and disposal of waste is crucial for maintaining a clean and healthy environment.

4. Results

In a combined PSI/DSI report from September of 2023, Ideal Geotech identified three potential areas of environmental concern (AECs) during the preliminary phase of their investigation: the eastern boundary of the Site, areas around the house that included the driveway, and the northern half of the Site (see Ideal Geotech PSI/DSI report # 65042 for full details).

During the second phase (DSI) of the investigation, a Site wide invasive sampling effort was carried out to investigate the condition of surface soils across the Site. Soil samples were obtained from depths ranging from 10 mm to 200 mm (approximately 80 mm on average), totalling 16 samples (which included a QA/QC sample and a sample taken at 2 meters).

Samples were analysed at NATA accredited ALS Laboratories for potential contamination of petroleum-based compounds (total recoverable hydrocarbons C6-C40, BTEXN, and polynuclear aromatic hydrocarbons), pesticides (organochlorine and organophosphorus pesticides), PCBs (polychlorinated biphenyls), and 8 metals.

Laboratory results showed that just one sample, E2, obtained from the drive-way next to the house contained quantities of metals that exceed ASC NEPM health investigation levels (HILs): lead (Pb = 2150 mg/kg) and zinc (Zn = 29,700 mg/kg; see Figure 1).

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	E1	E2	E3	E4	E5
				Sampling date / time	18-Aug-2023 00:00	18-Aug-2023 00:00	18-Aug-2023 00:00	18-Aug-2023 00:00	18-Aug-2023 00:00
Compound	CAS Number	LOR	Unit		ES2327995-001	ES2327995-002	ES2327995-003	ES2327995-004	ES2327995-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		14.2	7.0	28.8	32.0	21.7
EA200: AS 4964 - 2004 Identification of Asbestos in Soils									
Asbestos Detected	1332-21-4	0.1	g/kg		No	No	No	No	No
Asbestos (Trace)	1332-21-4	-	-		No	No	No	No	No
Asbestos Type	1332-21-4	-	--		-	-	-	-	-
Sample weight (dry)	----	0.01	g		10.0	17.4	4.59	12.0	23.8
APPROVED IDENTIFIER:	----	-	--		A. SMYLIE	A. SMYLIE	A. SMYLIE	A. SMYLIE	A. SMYLIE
Synthetic Mineral Fibre	----	-	--		No	No	No	No	No
Organic Fibre	----	-	--		No	No	No	No	No
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		5	829	40	84	28
Cadmium	7440-43-9	1	mg/kg		<1	<1	1	2	<1
Chromium	7440-47-3	2	mg/kg		10	26	16	25	8
Copper	7440-50-8	5	mg/kg		<5	777	88	107	43
Lead	7439-92-1	5	mg/kg		8	2150	855	346	212
Nickel	7440-02-0	2	mg/kg		<2	13	7	8	7
Zinc	7440-66-6	5	mg/kg		8	29700	4380	1490	1830

Figure 1. *Top image shows sampling areas indicated by yellow alphanumeric labels and targets. The red section highlights an approximation of the remediation area. The red arrow leads to an excerpt of the laboratory certificate of analysis that shows sample E2 yielded levels of lead and zinc that exceed HILs A, and lead that exceeds HILs D (compare with Figure 2). Blue dashed lines indicate samples (E1 and E5) that were used to delineate the expected extent of the remediation area, as they returned contamination levels below ASC NEMP thresholds.*

4.1. Zoning

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
Metals and Inorganics				
Arsenic[2]	100	500	300	3 000
Beryllium	60	90	90	500
Boron	4500	40 000	20 000	300 000
Cadmium	20	150	90	900
Chromium (VI)	100	500	300	3600
Cobalt	100	600	300	4000
Copper	6000	30 000	17 000	240 000
Lead[3]	300	1200	600	1 500
Manganese	3800	14 000	19 000	60 000
Mercury (inorganic)[5]	40	120	80	730
Methyl mercury[4]	10	30	13	180
Nickel	400	1200	1200	6 000
Selenium	200	1400	700	10 000
Zinc	7400	60 000	30 000	400 000
Cyanide (free)	250	300	240	1 500

Figure 2. *This figure shows the ASC NEPM thresholds for different zoning environments. Yellow highlights point out the type of contaminants found at the Site during the DSI. Image adapted from the ASC NEPM vol. 2, schedule B1, section 6, Table 1A(1).*

Current Zoning Criteria: Residential A

The Site is currently designated as a low-density residential area. The ASC NEPM HIL thresholds lead and zinc in low density residential environments (Residential A) are 300 mg/kg and 7,400 mg/kg, respectively. Therefore, the Site must be remediated to achieve even the most liberal criteria for commercial and industrial zoning.

Future Zoning Criteria: E1 Local Centre

The proposed Site zoning is 'E1 Local Centre', a mixed zoning designation that can include business and residential uses, among others (see below).[2,23] Therefore, this RAP expects remediation outcomes to comply with the strict HIL-A criteria, a criteria that will permit the Site's suitability for even the most sensitive land uses, including those associated with E1 Local Centre zones.

According to the NEPM, HIL-A criteria may allow for all permissible uses covered under E1 Local Centre zoning, including those listed in the Lake Macquarie Local Environmental Plan 2014:[23]

Building identification signs;
Business identification signs;
Home businesses;
Home industries;
Home occupations;
Amusement centres;
Boarding houses;
Centre-based child care facilities;
Commercial premises;
Community facilities;
Entertainment facilities;
Function centres;
Hostels;
Hotel or motel accommodation;
Information and education facilities;
Local distribution premises;
Medical centres;
Oyster aquaculture;
Places of public worship;
Public administration buildings;
Recreation facilities (indoor);
Residential flat buildings;
Respite day care centres;
Service stations;
Shop top housing;
Tank-based aquaculture;
Veterinary hospitals.

5. Conceptual Site Model

Table 3. Conceptual Site Model (CSM) revised from Ideal Geotech's PSI/DSI ref. 65042

CSM	Description
Potential Primary Sources of Contamination	-Historic activities on and around the Site (e.g., agricultural). -Metal/fence work/welding. -Roof renovation.
Known Secondary Sources of Contamination	-Surface soil in the driveway area.
Known Media Affected	-Soil.
Potential Transport Mechanisms	-Surface runoff. -Wind. -Vehicular movements (heavy tires churning and moving top soil).
Potential Exposure Routes	-Direct contact with soil. -Ingestion from soil/plants.
Potential Receptors	-Humans (residents, visitors, workers). -Local fauna and flora.
Potential Exposure Pathways	-Soil to human (e.g., during construction work, gardening, etc.). -Soil to plants to human. -Airborne contaminants to human (especially asbestos inhalation).

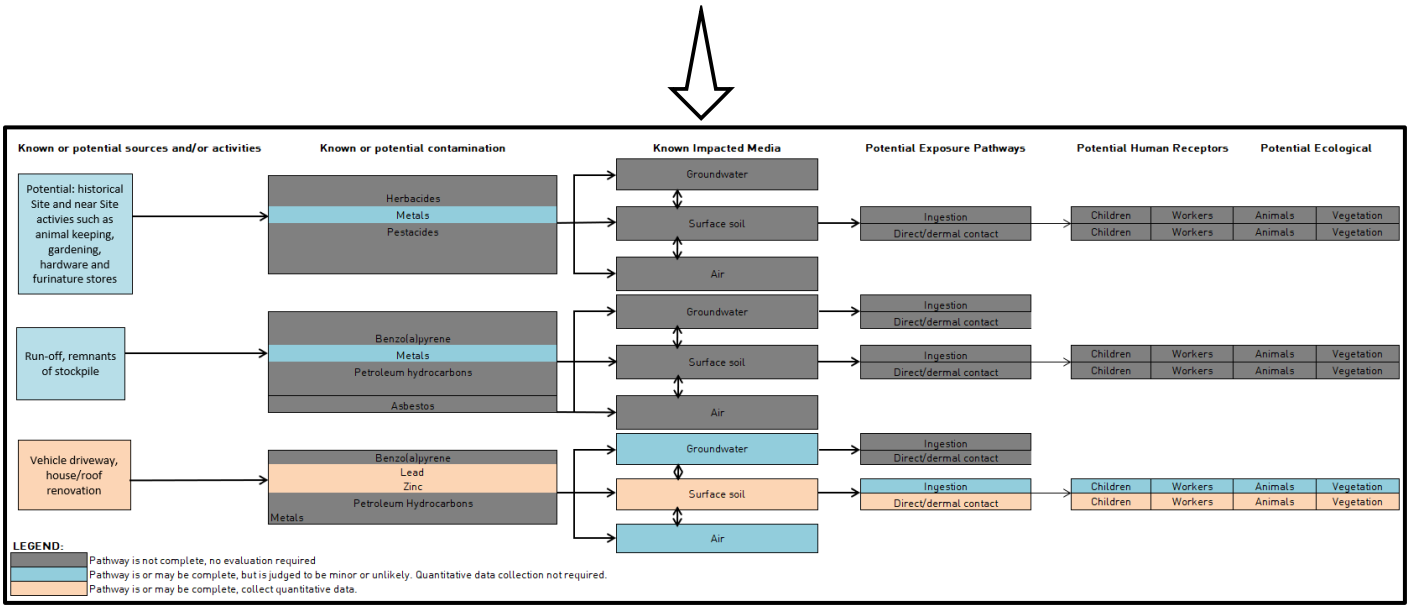

Figure 3. A visualisation of the Conceptual Site Model, revised from the DSI.

6. Remediation Options Assessment and Remediation Strategy

Figure 4. *Satellite imagery of the Site with the remediation area in red. The red* target and red label E2 indicate where the contaminated sample was obtained. The red boxed area *indicates where* excavation work is recommended to occur. *The yellow targets* and alphanumeric labels (E1 and E5) *are areas where sampling did not find contamination to exceed HIL thresholds.* Sample depths for E1, E2, and E3 were taken at 2 m, 30 mm, and 150 mm, respectively. Green outline indicates the approximate lot boundary. *Image adapted from Google Earth* 2023.

6.1. Selected remediation method and rationale

Ideal Geotech has considered the ASC NEPM's preferred options of in-situ and ex-situ soil treatment and remediation of the contaminated area. However, when considering a cost/time benefit analysis those options are impractical due to cost, effort, and time when considering the scale of contamination at the subject Site. A recent scientific review suggests that removal (i.e., excavation) is the most effective way to mitigate potential adverse health effects to people caused by contamination of metals in soils.[7] The unique remediation requirement of the subject Site is best suited towards excavation and disposal of contaminated soil, especially when considering that the Site is expected to undergo future demolition and reconstruction.

- Option number 3 from the ASC NEPM's 'preferred hierarchy of options for site clean-up and management' is recommended (Table 4).

***Table 4**. The preferred hierarchy of options for site clean-up and management, as stated by the ASC NEPM (supporting doc: Key Principles for the Remediation & Management of Contaminated Sites (distilled from ANZECC/NHMRC 1992 Guidelines):*

✗	On-site treatment of the soil, so that the contamination is either destroyed or the associated hazard is reduced to an acceptable level.
✗	Off-site treatment of excavated soil, so that the contamination is either destroyed or mitigated to an acceptable level, after which it is returned to the site.
↓	**If the above two options cannot be implemented, the other options for consideration are:** ↓
✓	Removal of contaminated soil to an approved site or facility, followed by (where necessary) replacement with clean fill.
✗	Isolation of the contamination on-site in an appropriately designed and managed containment facility.
✗	A less sensitive land use to minimise the need for remedial works which may include partial remediation.
✗	Leaving contaminated material in-situ providing there is no immediate danger to the environment or community and the site has appropriate management controls in place.

6.2. List of remediation options for soils contaminated with metals

- Physical remediation (e.g., removal, excavation, replacement, surface capping, encapsulation, solidification of soil).
- Chemical remediation (e.g., calcium phosphate, biochar, Maectite®, soil washing, stabilizing agents).
- Biological remediation (e.g., phytoremediation, fungal remediation, microbial remediation).
- Thermal remediation (e.g., vitrification).
- Combinations of these intervention.

6.3. Remediation Strategy

6.3.1. Description of remediation work

- Notify appropriate stakeholders (e.g., council and neighbours) 30 prior to commencement of remediation work.
- Convey work risk assessments to involved workers and personnel.
- Demarcate and cordon off the area of contamination as indicated in red on Figures 4 and 5.
- Remove concrete driveway slabs.
- Excavation of surface soil to a depth of approximately 200 mm. If possible, soil beneath the deck should also be removed to help reduce the risks of potential residual contamination.
- Export excavated contaminated soil to a government approved disposal site or facility.
- Notify an environmental consultancy (e.g., Ideal Geotech).
- They will obtain soil samples from the base and sides of the excavation pit.
- Review laboratory analysis of samples to ensure contamination has been adequately remedied.
- Refill excavated area with certified clean fill and retain receipts as proof of soil quality.
- Retain documentation of all remedial work which includes (but is not limited to): time and date of activities, pictures of work progress (with time stamps), all chains of custody, all receipts relevant to remediation work (e.g., fill import/export, hauling expenses, names of facilities, routes to and from facilities and sites, etc.). Incomplete or inaccurate documentation can lead to regulatory non-compliance or challenges in validation process.

6.3.2. Risk assessment and risk reduction

Remedial work is expected to be a low to moderate risk operation if the below recommended risk reductions are considered:

- Ensure that a qualified professionals are employed to carry out work. Inadequate training or understanding of the work risk assessments can lead to accidents or health issues for the workers involved.
- Always wear appropriate PPE (e.g., gloves and masks) when handling contaminated soils.
- Cordon off the contaminated work area until soil has been removed. If the contamination area is not correctly cordoned off, it could lead to the spread of contamination or exposure to uninvolved personnel (e.g., neighbours) and environments (e.g., Scrubby Creek).
- The removal of concrete driveway slabs and soil excavation can cause structural instability or damage to nearby infrastructure. Before You Dig will be consulted prior to any digging work.
- Consider wetting the working areas to mitigate the spread of potentially contaminated dust (if necessary).

- Ensure contaminated soil is properly disposed of. If the contaminated soil is not properly disposed of at an approved site, there might be legal repercussions or further environmental contamination.
- Remove fabrics curtains and seal building windows, doors, and other potential dust entry points with plastic and tape.
- Inform neighbouring residents so they can take precautions by closing windows and doors during excavation work.
- If indoor contamination cleanup is required use a wet wash with phosphate detergent and rinse with clean fresh water.
- Do not eat outside around contaminated work area.
- Wash hands after handling soils.
- Use HEPA air filters inside building if dust is generated during remediation work.
- Avoid tracking soil into uncontaminated areas (use tacky mats near doorways).
- Ensure refilled soil is certified. If it does not meet the required standards, it could introduce new contaminants.
- Develop and maintain contingency and emergency plans for unexpected outcomes.

6.3.3. Remediation contingencies

- Should the area of contamination become excessively inundated, halt work and contact an environmental consultancy, such as (preferably) Ideal Geotech. The area may require time to dry out and/or additional water sampling may be required.
- In the event that sampling of the excavated area yields further contamination (ascertained by sampling), the client will be consulted and provided with options that may include: continued excavation to determine actual extent of contamination, encapsulation, capping, or chemical fixation of the underlying contaminated soil matrix. These options will be paired with ongoing monitoring and considered before backfilling the site to prevent potential vertical and lateral leaching of contaminants, especially during events like flooding.

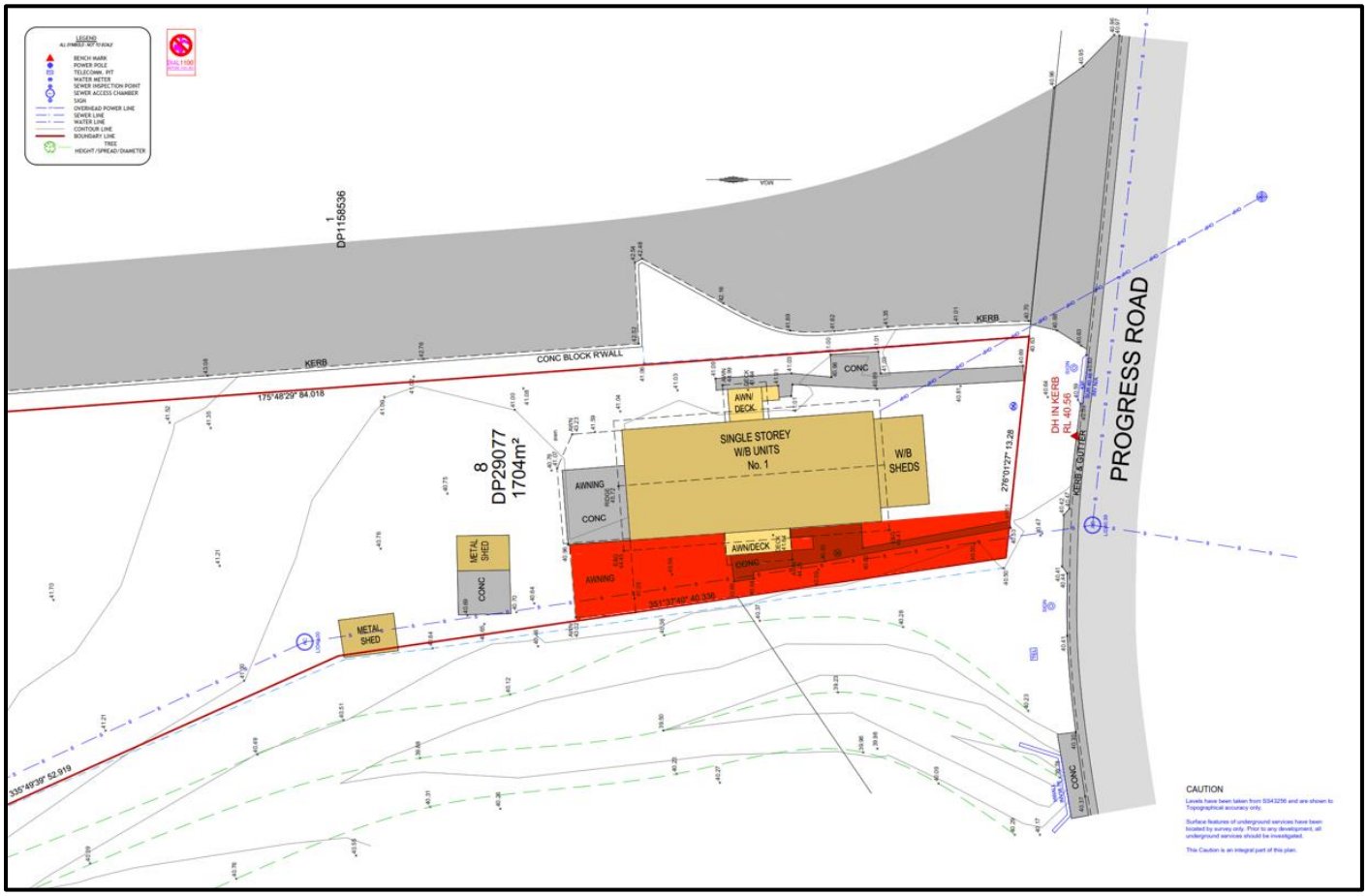

Figure 5. Surveyor's Plan marked with the recommended area of remediation coloured in red Image modified from original by Earth Surveying Consulting Surveyors.

6.4. Data Quality Objectives

Data Quality Objectives (DQO) are quantitative and qualitative criteria that aid in:

- Clarification of the study objective.
- Definition of the most appropriate type of data to collect.
- Determination of the most appropriate conditions from which to collect the data.
- Specification of acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.
- Evaluation of the data collected and confirmation that the objective has been met.

6.4.1. DQOs:

1. Sampling of the excavated area to determine extent of contamination.
2. Final determination (i.e., validation) that contamination levels have been reduced below ASC NEPM HIL thresholds.

6.4.2. DQO framework

Step 1: State the problem

- Pb and Zn contamination.

Step 2: Identify the decision/goal of the study

- Excavation > re-sampling.

Step 3: Identify the information inputs

- Systematic grid taking 8 samples from the base and walls of the pit.

Step 4: Define the boundaries of the study

- The driveway area from the frontage road to the end of the covered carport (Figure 4 and 5).

Step 5: Develop the analytical approach

- Collect duplicate samples for 10% of all sample points for quality control.

Step 6: Specify performance or acceptance criteria

Only 95 % or greater confidence levels are acceptable. All samples were collected with adherence to AS 4482.1 and NSW EPA Sampling Design. Samples will be analysed by ALS, a NATA-accredited laboratory that specialises in environmental chemical analyses. The results will be compared to levels provided in the National Environment Protection (Assessment of Site Contamination) Measure 1999. Original sample data certificates of analysis, laboratory QC, and chain of custody will be retained.

Step 7: Develop the plan for obtaining data

- See section 6.2. Validation Sampling and Analysis Quality Plan Quality
- Control measures help mitigate of biases, inconsistences, and cross contamination of samples.
- Collected samples and data will be:
- **Representative:**
  Sample data should accurately represent the population and environmental conditions from which it is collected, properly labeled, and have an adequate number of samples that are characteristic of the population and environment.
- **Complete:**
  Sampling should be in accordance to AS 4482.1, have a chain of custody, and be analysed in NATA accredited laboratories
- **Precise and accurate:**
  Besides primary samples, duplicate samples should be obtained for field and laboratory quality control purposes (AS 4482.1). Duplicates can be used for intra-laboratory testing to assess laboratory performance and validation of laboratory results. This can be accomplished using a relative percentage difference (RPD) analysis of the duplicates. RPD is calculated from the difference of the duplicate pair results by dividing the mean value, e.g.: RPD = Result No. 1 – Results No. 2 / mean result x 100
  One blind replicate should be made for every 20 samples (AS 4482.1). Blind samples are used to identify variation in analyte concentrations from samples taken from the same location. Blind replicates need to be submitted to the same laboratory as two individual samples with no indication to the testing laboratory that they have been duplicated. A rinsate blank sample may also be used to ensure that no cross-contamination of substances between sampling equipment has occurred.

All samples should be promptly transported and submitted to a NATA certified Laboratory for analyses along with a chain of custody. The same methods and protocol for validation sampling will be employed after remediation works have been carried out.

6.5. Validation Sampling and Analysis Quality Plan

To validate the Category 2 remediation of the contaminated driveway area in the southwestern part of the Site the following Sampling and Analysis Quality Plan (SAQP) has been developed:

Subject Site and Area of Contamination
Refer to Figures 4 and 5 for the designated soil excavation and replacement areas.

Conceptual Site Model (CSM) Summary (Table 3, Figure 3)
The site's primary sources of contamination include historic activities like agriculture, metal work, and roof renovation, while the secondary source is the soil in the driveway area. Contaminants can spread via surface runoff, wind, and vehicles, posing risks to humans and local wildlife through direct soil contact, ingestion, and airborne exposure.

Data Gap Analysis
1. Condition of the house interior and levels of contamination (if any).
2. Vertical extent (depth) of lead and zinc contamination.
3. Sub-terranean service lines and infrastructure under the remediation area.

Data Quality Objectives (DQOs) and QA/QC Plan
- QA Plan: Employ certified lab ALS for sample analysis.
- QC Samples: Collect duplicate samples for 10% of all sample points for quality control.
- See section 6.4. Data Quality Objectives

Pre-Mobilization Tasks
- Develop a site-specific health and safety plan.
- Notify stakeholders and neighbours 30 days before work commences.

Media to be Sampled
- Soil and groundwater (potentially)

Analytes and Parameters
- Heavy metals Lead (Pb) and Zinc (Zn)

Sampling Points
- Number: 8 samples
- Layout: Grid
- Location: Base and walls of excavated area
- Depth: Varying from 0 to 200 mm

Frequency and Pattern
- After excavation

Sampling Methods and Procedures
- Use stainless steel hand augers and trowels for soil sampling.

Data Interpretation
- Compare against ASC NEPM HIL contamination thresholds.
- Assess spatial and temporal trends.

Flexibility
This SAQP will allow adjustments based on findings such as unexpected widespread contamination or identification of sub-surface utilities that may act as pathways for contamination.

6.6. Soil Management Plan

Objectives
- Remove contaminated soil from the targeted areas.
- Track and document the handling, transport, and disposal of contaminated materials.
- Validate that the remediation work meets regulatory standards.

Scope
This plan covers the remediation Site located at 1 Progress Road, Mount Hutton, NSW, and pertains to all contaminated soil and related materials.

Responsibilities
- **Project Manager**: [Name]
- **Environmental Consultant**: *Ideal Geotech*
- **Contractors:** [Name]
- **Regulatory Agencies**: *Lake Macquarie City Council, NSW EPA*

Identification of Contaminated Soil
- **Previous Assessments**: *PSI/DSI* by *Ideal Geotech ref. 65042*

Material Tracking Method

- **Barcode Tagging**: Every batch of excavated soil will be tagged with a unique barcode and listed below.
- **Digital Database**: Information recorded in a database, updated in real-time.

Fields to be included in Material Tracking Database

- Batch ID
- Origin within Site
- Type of suspected contamination (e.g., lead and zinc)
- Date of Excavation
- Destination (On-site storage, disposal facility, etc.)
- Validation Status

Remediation Procedures

- **Excavation**: Remove contaminated soil using heavy machinery.
- **Segregation**: Separate contaminated soil from clean soil.
- **On-site Storage**: Temporarily store contaminated soil in designated areas.
- **Transport**: Ship the soil to a certified disposal or treatment facility.

Validation Steps

- **Post-Remediation Sampling**: Take soil samples from the remediated areas.
- **Laboratory Testing**: Confirm that contaminant levels are within permissible limits.
- **Documentation**: Compile all data, test results, and tracking records.

7. Waste Management

7.1. Waste classification

The NSW EPA and The Protection of the Environment Operations Act 1997 (POEO Act) classify types of waste into groups that may pose risks to the environment and human health. According to the POEO Act the subject Site's contaminated soil waste is classified as: ***general solid waste (non-putrescible) - Clause 49 Schedule 1 POEO Act.***

This classification includes:
"(i) waste contaminated with lead (including lead paint waste) from residential premises or educational or child care institutions"
Furthermore, the waste does not meet the definition of hazardous waste, which means waste (other than special waste or liquid waste) that is required to have the following criteria:
"(d) lead-acid or nickel-cadmium batteries (being waste generated or separately collected by activities carried out for business, commercial or community services purposes)."
"(e) lead paint waste arising otherwise than from residential premises or educational or child care institutions."

7.2. Transporting Waste

NSW EPA provides a list of precautions for transporting waste (visit Transporting waste (nsw.gov.au) for more information):

- Driver will know what the nature of their cargo is.
- Be aware of council development consent and environment protection licence for the waste facility to which the waste is being delivered.
- Provide waste classification, quantity, and origin information to the waste facility.
- Prevent spillage of waste from transport vehicle by ensuring cargo is properly secured and covered.
- Retain details of the waste (classification, name and address of its origin and quantity)
- Retain copies of waste dockets/receipts for the waste facility (date, time of delivery, name and address of the facility, its ABN, contact person).
- Receipts for wastes disposal must be obtained by the waste contractor and provided to the consultant. Receipts will be used as evidence of lawful disposal in the final validation report.

8. Conclusions and recommendations

Ideal Geotech concludes that the remediation methods and procedures outlined in this RAP will effectively accomplish the five objectives required to achieve the necessary category 2 remediation of 1 Progress Road, Mount Hutton, NSW.

1. Excavation of the contaminated soil to a depth of at least 200 mm.
2. Resampling at the pit base and walls to ascertain contamination extent or validate its adequate reduction.
3. Classification and proper disposal of contaminated waste.

4. Importing clean certified fill (i.e., ENM or VENM).
5. Documentation the remediation process.

8.1. Summary proposed remediation requires

- Notification of stakeholders, including the council and neighbours, 30 days prior to remediation work.
- Communication of work risk assessments to all workers and relevant personnel.
- Demarcation of the contamination area based on reference to Figures 4 and 5, the excavation work will cover approximately 88 m^2.
- Removal of concrete driveway slabs.
- Excavation of surface soil up to a depth of approximately 200 mm.
- Potential removal of soil beneath any decks on the site (if feasible).
- Transportation of the excavated contaminated soil to an approved disposal facility.
- Importation and filling of the excavated area with certified clean soil.
- Documentation of all remedial activities, including capturing photographic evidence of work progress and retaining all relevant receipts.

8.2. Expected physical changes to the Site

- The designated contamination area will be cordoned off and visibly demarcated.
- The concrete driveway slabs will be removed, leading to an exposed underlying area.
- A depth of approximately 200 mm of the surface soil will be excavated, leaving a shallow trench or depression until it is refilled.
- If applicable, the area beneath decks will be excavated and may appear altered or disturbed.
- The excavated areas will be refilled with clean soil, restoring the ground level.
- The appearance of the site will be documented with time-stamped photographs, showing the progression of the remediation work.

8.3. Assumptions and existing data gaps

- The depth of 200 mm for soil removal offers a good balance between efficacy and feasibility when considering samples E1 and E5, neither of which identified contamination, were taken at different depths.
- Classification of waste in this RAP were based on the assumption that no other types of waste will be encountered during remediation work. If they are, please contact Ideal Geotech or another Environmental Consultancy for advice.

Although the above data gaps exist about additional Site contamination, Ideal Geotech assumes they are not significant enough to prevent remediation work in the area of concern. However, to ensure they do not become future risks, the following data gap resolutions are recommended:

Vertical extent (depth) of lead and zinc contamination (will be addressed with future validation sampling)	Carry-out prescribed remediation plan and post-excavation sampling is expected reveal the extent of the contaminated area.
Condition of the house interior.	Consult an occupational hygienist and conduct post-demolition soil contamination sampling if necessary.
Underground services.	Apply for an up-to-date Before You Dig report.

8.4. Statement to remedial action implementation and Site suitability

Ideal Geotech maintains that the site can be rendered suitable for the proposed rezoning to 'E1 Local Centre' and its allowable uses, provided that the comprehensive Remedial Action Plan (RAP) is adhered to and the HIL-A criteria are met, with verification through validation sampling (See Part 2 of the Lake Macquarie Local Environmental Plan (2014) or 4.1. Zoning for a complete list of permissible uses).

Ideal Geotech recommends the excavation of identified contaminated soil as this method effectively mitigates potential adverse health impacts on people and the environment from contamination and is a preferred approach to meeting HIL-A criteria.[7] The excavation and disposal process is outlined and targets the only area of concern identified on the Site (the drive-way in the southwestern part of the lot).

Classification of contaminated waste must be made to ensures that waste is treated appropriately to minimizing risks, and adheres to NSW state and commonwealth waste regulations, ensuring legal compliance. After the importation of certified clean fill (VENM/ENM) to replace the excavated contaminated soil and validation sampling, the Site will be restored to a state where it is conducive for construction and long-term safety.

Please ensure detailed documentation throughout the remediation process is carried out in order to offer a transparent record that can be reviewed for compliance and effectiveness. This will include validating lab analysis to confirm that the contamination has been adequately remediated.

Safety procedures must be rigorous. They protect not just the workers but also the neighbouring community and the environment. From PPE requirements to steps aimed at minimizing the spread of contamination, these measures reduce the risk of accidental exposure or secondary contamination sites.

8.5. Recommendations for further work

If the existing house contains asbestos, lead, and/or other contaminants and they are not removed before demolition, soil sampling will be conducted after demolition to ensure contaminants did not spread during the demolition process.

9. Limitations

The extent and duration of Ideal Geotech's involvement in the remediation process are specified in this report and come with certain constraints. The criteria for soil quality referenced in the National Environment Protection (Assessment of Site Contamination) Measure 1999 are not necessarily definitive standards for permissible contamination levels. The satellite imagery employed serves as a rough timeline for site activities but does not pinpoint exact occurrences. Ideal Geotech has not conducted an exhaustive evaluation of every possible condition or circumstance at the site. Services not explicitly mentioned in this report should not be assumed to have been carried out, and issues not discussed should not be assumed to have been addressed by Ideal Geotech.

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